# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

# STORMWATER MANAGEMENT PLAN

August 2011

*Prepared for*

## Stormwater Quality Management Committee

*Prepared by*

MWH

BUILDING A BETTER WORLD

# ACKNOWLEDGEMENTS

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# Appendices

Appendix A. Las Vegas Valley Municipal Separate Storm Sewer System Permit (NV0021911)

Appendix B. Proposed Best Management Practices

# Volume II. Technical Appendix

# 1 INTRODUCTION

This document is the 2011 Stormwater Management Plan (SWMP) for the Las Vegas Valley Municipal Separate Storm Sewer System (MS4) permit. The MS4 permit was issued by Nevada Division of Environmental Protection (NDEP) to the Las Vegas Valley Permittees (Clark County Regional Flood Control District [CCRFCD], Clark County, City of Las Vegas [CLV], City of North Las Vegas [CNLV], and City of Henderson [CoH]). The SWMP documents the stormwater management programs adopted by the Permittees, including measures, schedules, and responsible parties. The Stormwater Quality Management Committee (SQMC) is comprised of two representatives from each of the MS4 Permittees. The SQMC's mission is to coordinate the efforts of the Permittees in developing and implementing stormwater management measures, complying with MS4 permit requirements, and cooperating with outside agencies.

## 1.1 MS4 Permit Requirements

The National Pollutant Discharge Elimination System (NPDES) Permit authorizing discharges from the municipal separate storm sewer system in Las Vegas Valley was issued to the Permittees on February 9, 2010 (NDEP, 2010). The Las Vegas Valley urban area is a Phase 1 community under the U.S. Environmental Protection Agency's (EPA) stormwater regulations, and received its first MS4 permit in 1991. The new permit represents a substantial revision to previous permits, and requires more from the Permittees in terms of program elements and documentation.

The MS4 permit is contained in **Appendix A**. It requires the Permittees to develop and implement a variety of programs to minimize the impact of development on receiving water quality. These programs must address runoff from new development and significant redevelopment, construction sites, industrial sites, and municipal sites, and must incorporate pollution prevention measures, public education activities and measures to eliminate illicit connections to the stormwater system. The permit requires the Permittees to demonstrate adequate legal authority and financial capacity to implement the proposed measures.

## 1.2 Purpose of SWMP

The SWMP presents the Permittees' program to comply with the MS4 permit requirements related to management programs and is a specific requirement of the MS4 permit. It documents the specific measures, activities, programs, ordinances, and commitments proposed by the Permittees to comply with the general performance standards contained in the MS4 permit. The SWMP provides the EPA, NDEP and the public with information to measure permit compliance.

## 1.3 Report Organization

The SWMP is organized to address each of the main programs required by the MS4 permit for the Las Vegas Valley. Specific permit paragraphs are referenced in each SWMP section. For each

proposed program, information is provided on best management practices (BMPs), responsibility for implementation, monitoring and tracking, measurable goals, and implementation schedule.

Numerous technical memoranda (TMs) were generated by the Permittees in the process of developing the various MS4 programs. These TMs are contained in a separately bound Technical Appendix, and are referenced in the SWMP, as appropriate.

# 2 AREA OF COVERAGE

The area of coverage of the MS4 permit is the area draining to "Las Vegas Wash and its tributaries." Paragraph *IV.A.9* of the permit states that, *"The scope and coverage of the updated SWMP shall extend at least to the parts of the Las Vegas Valley which are or could reasonably be urbanized within the time covered by the permit."*

The SWMP applies to all of the urbanized and urbanizing watershed area naturally tributary to Las Vegas Wash at Lake Las Vegas, located approximately 2 miles upstream of Lake Mead. It includes all of the cities of Las Vegas, North Las Vegas and Henderson, and portions of unincorporated Clark County in Las Vegas Valley. The SWMP does not apply to federal or state owned land in Las Vegas Valley, or to sites that have their own NPDES stormwater permit (e.g., Nellis Air Force Base).

The Clark County Regional Flood Control District (CCRFCD) established an urban development boundary (UDB) in the 2008 Las Vegas Valley Master Plan Update (MPU). The UDB denotes the expected limit of any future land development in the Valley, using criteria such as steep slopes and the location of parks and environmental areas. In addition, the Bureau of Land Management (BLM) manages a "disposal boundary" in Las Vegas Valley, which designates federally managed lands that could eventually be privatized and therefore potentially developed. The SWMP area of coverage encompasses all of the UDB area and all of the BLM disposal area in Las Vegas Valley.

# 3 STORMWATER MANAGEMENT APPROACH

This section describes the overall stormwater management approach developed by the Permittees for Las Vegas Valley. The MS4 permit requires the Permittees to develop a stormwater program that is suited to the unique local hydrologic, hydrogeologic and regional conditions, and is consistent with local and state laws, regulations, and water resources plans.

A stakeholder group was formed to assist the Permittees in developing construction and new development programs. This is discussed further in Section 15. The stakeholder group adopted the following mission statement for compliance with the new MS4 permit:

*Our goal is to comply with the MS4 permit by developing construction and post-construction program enhancements that are:*

- *clear, simple and effective*
- *consistent*
- *cost-effective*
- *consensus-based*
- *fiscally and environmentally responsible*
- *sensible for the Las Vegas Valley*

This section summarizes the unique factors that influenced development of the stormwater program, and presents the overall strategy adopted for the stormwater program that meets all the program objectives and is consistent with the guidance received from the stakeholder group.

## 3.1 Unique Conditions in Las Vegas Valley

Local conditions in Las Vegas Valley are unique compared to other large metropolitan areas in the U.S., and thus setting and complying with MS4 permit requirements require a different approach. This section summarizes the factors that make Las Vegas Valley unique, and identifies the implications of these unique factors in developing an appropriate MS4 program. *Technical Memorandum IV.5 – Unique Factors Influencing the Las Vegas Valley Municipal Separate Storm Sewer System Program* provides a comprehensive evaluation of these unique factors; it is included in the Technical Appendix.

Unique conditions that affect development of the MS4 permit programs in Las Vegas Valley are discussed for the following categories: Climate, Hydrology, Watershed and Land Use, Geology, Hydrogeology, Urban Runoff Quality, Legal, and Stormwater Management Approach.

### 3.1.1 Climatic Factors

With a mean annual rainfall of 4.2 inches, Las Vegas Valley is the driest large MS4 in the nation (see **Table 3-1**). Depending on soil and site conditions, developed areas and construction sites have the

potential to produce measurable runoff on an average of only 6 to 11 days per year. Most runoff-producing events are short-duration (less than 3 hours) thunderstorms of limited areal extent. The median number of dry days between rainfall events that produce runoff (greater than 0.2 inches) at the McCarran Airport gage is 22 days. This is representative of any given location in Las Vegas Valley.

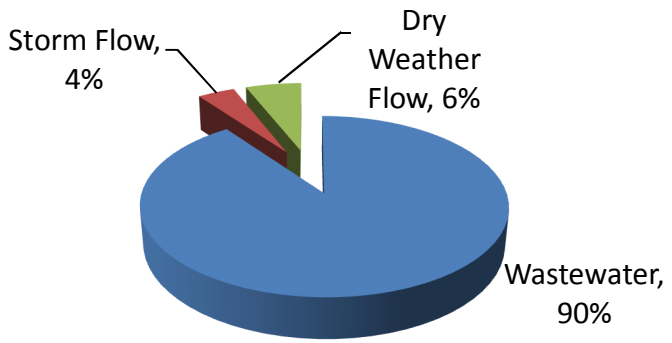
**Table 3-1. Mean Annual Rainfall in Western United States Cities**

| Community | Mean Annual Rainfall (inches) |
|---|---|
| Las Vegas, NV | 4.2 |
| Reno, NV | 7.5 |
| Phoenix, AZ | 7.7 |
| Riverside, CA | 10 |
| San Diego, CA | 11 |
| Tucson, AZ | 12 |
| Los Angeles, CA | 12 |
| San Bernardino, CA | 16 |
| Sacramento, CA | 18 |
| San Francisco, CA | 21 |
| Seattle, WA | 35 |
| Portland, OR | 40 |

### 3.1.2 Hydrologic Factors

Lower Las Vegas Wash is the receiving water for all storm runoff and other flows in Las Vegas Valley. It is an effluent dominated stream, with 90 percent of annual flow originating from wastewater effluent. Only 4 percent of average annual flows are due to storm runoff, and 6 percent of average annual flows are due to urban dry weather contributions. This is shown in **Figure 3-1**.

**Figure 3-1. Distribution of Annual Flows in Lower Las Vegas Wash**




In lower portions of tributaries to Las Vegas Wash, that are not influenced by wastewater effluent, annual flow volumes comprise about 50 percent dry weather baseflows and 50 percent storm runoff. Most parts of the MS4 system in Las Vegas Valley are dry for the entire year except in response to direct rainfall. When storm runoff does occur, it is typically of very short duration (e.g., a few hours).

Annual volumes of storm runoff and dry weather flow have increased over the past 20 years (which is the duration of the MS4 permit) due to urbanization (see **Figure 3-2**); however, pollutant concentrations have remained within a constant range.

In recent years, water conservation measures adopted by Southern Nevada Water Authority (SNWA) and all the MS4 Permittees have slowed the increase, and in some cases reduced, dry weather return flows to the MS4 from landscape irrigation and other normal urban uses. An example is shown in **Figure 3-3** for Las Vegas Wash at Desert Rose Golf Course.

Figure 3-2. Annual Storm Runoff in Las Vegas Wash

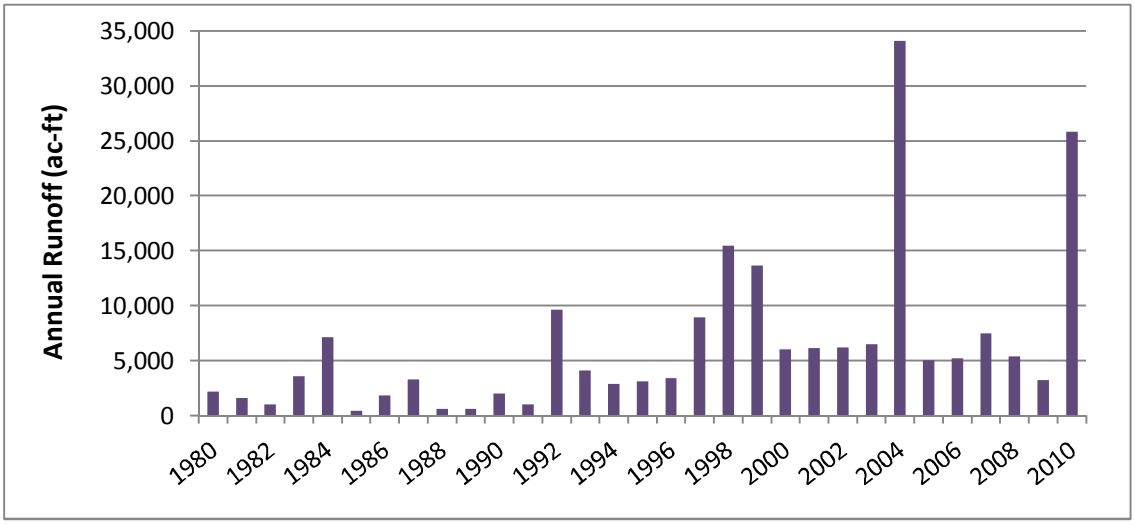
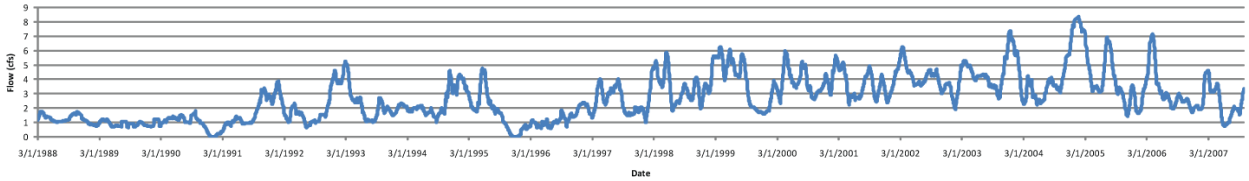



Figure 3-3. Las Vegas Wash at Desert Rose Dry Weather Flow 30-Day Moving Average




### 3.1.3 Watershed and Land Use Factors

High rates of erosion and sediment transport occur naturally in the Las Vegas Valley watershed, and are primarily associated with high flow events (greater than the 2-year event). Land development in Las Vegas Valley tends to stabilize the watershed surface and reduce soil loss compared to native conditions (see **Figure 3-4**).

Las Vegas Valley was one of the fastest growing urban areas in the nation before the economic recession that began in 2008. Almost 1.5 million people moved to the area between 1980 and 2008, a 300 percent increase in population. New development is occurring in an outward pattern from the valley center, in nearly all directions. The majority of new development consists of residential

housing and associated commercial development, and large hotel/casinos. The majority of significant redevelopment consists of new hotel/casinos and high-rise residential development in the vicinity of the Las Vegas Strip and Interstate 15 in the central valley area. Las Vegas Valley hosts over 40 million visitors per year, highlighting the importance of the hotel/casino and tourism industries to the local economy and landscape.

**Figure 3-4. Aerial Photograph of New Development Adjacent to Undisturbed Area**



### 3.1.4 Geologic Factors

Caliche, expansive soils and collapsible soils are prevalent throughout Las Vegas Valley, and compromise the effectiveness of standard infiltration BMPs. Mapping is available for expansive and collapsible soils, but caliche deposits are not mapped and can be encountered anywhere within the alluvial fans and valley floor. Infiltration will be ineffective for stormwater disposal or will lead to other potential problems in much of Las Vegas Valley. This is described in *Technical Memorandum IV.6 – Limitations on Use of Infiltration-Based BMPs for New Development and Significant Redevelopment in Las Vegas Valley* in the Technical Appendix. **Figure 3-5** depicts the areas in which infiltration would be an unsuitable stormwater disposal method in Las Vegas Valley based on geologic conditions, shallow groundwater, and potentially contaminated soils from industrial activity.

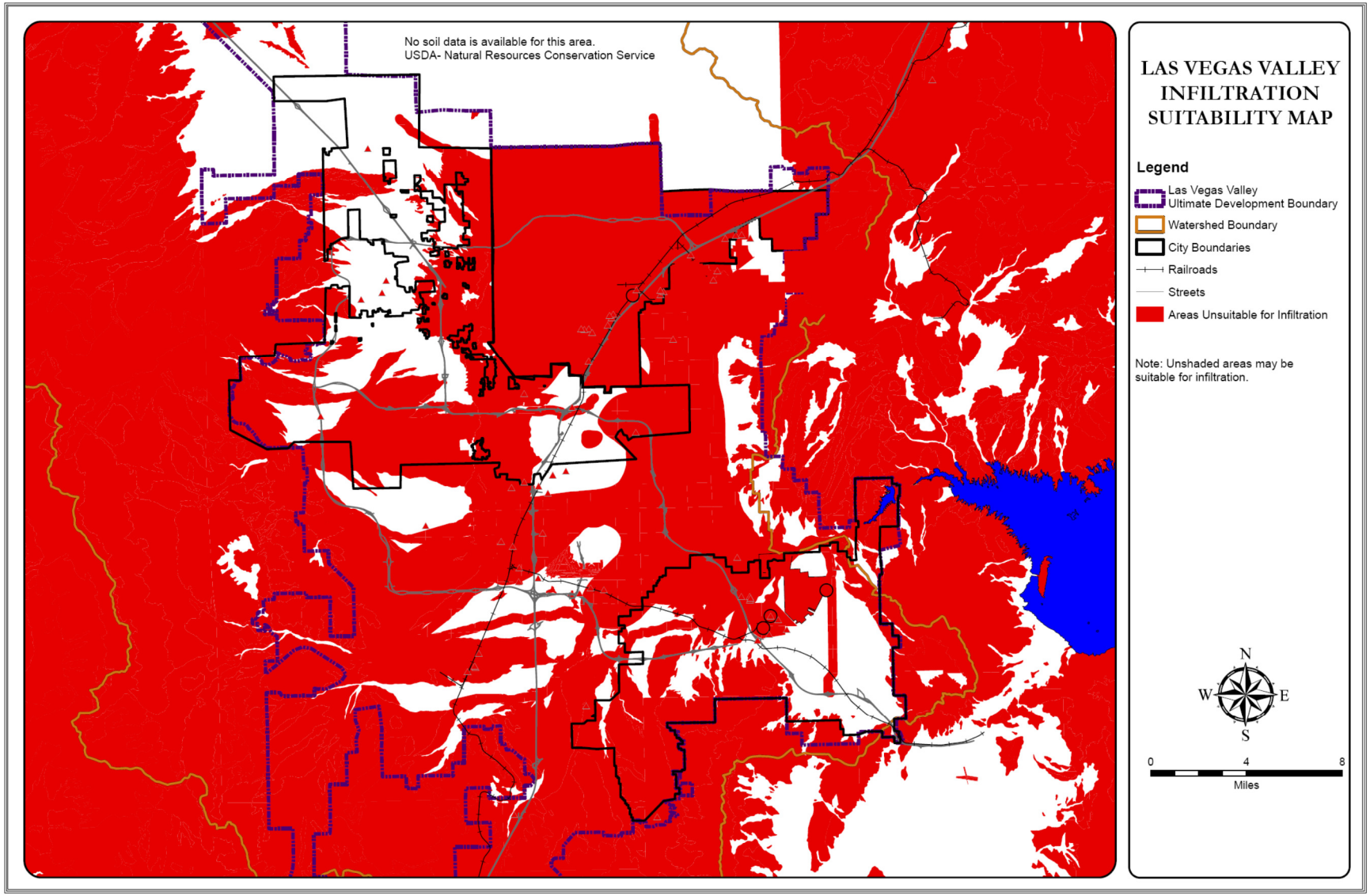
### 3.1.5 Hydrogeologic Factors

The Las Vegas Wash aquitard creates a shallow alluvial aquifer and areas of perched groundwater that are of poor quality and are not beneficially used. **Figure 3-6** shows the general hydrogeologic conditions in Las Vegas Valley.

A separate deep aquifer is used as a source of local water supply. Virtually all recharge to the deep aquifer occurs along the mountain front of the Spring Mountains, located on the western side of the

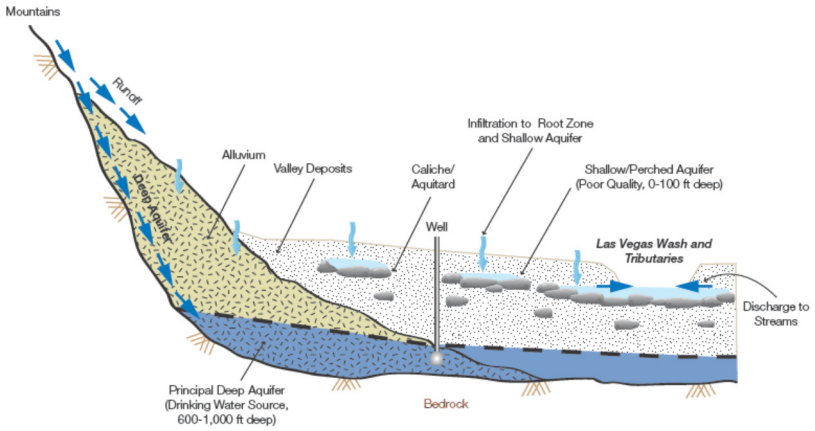
valley. The Las Vegas Wash aquitard forces groundwater to the surface in tributaries near Las Vegas Wash. The aquitard tends to direct most infiltration in the Valley toward Las Vegas Wash.

Figure 3-5. Las Vegas Valley Infiltration Suitability Map



Flow of infiltrated surface water through native soils significantly increases total dissolved solids (TDS) and selenium concentrations. Shallow groundwater is high in TDS and selenium, and is responsible for stream segments being listed on the State's 303(d) list of impaired waters. Infiltration BMPs would aggravate this condition.

**Figure 3-6. Hydrogeologic Schematic of Las Vegas Valley**

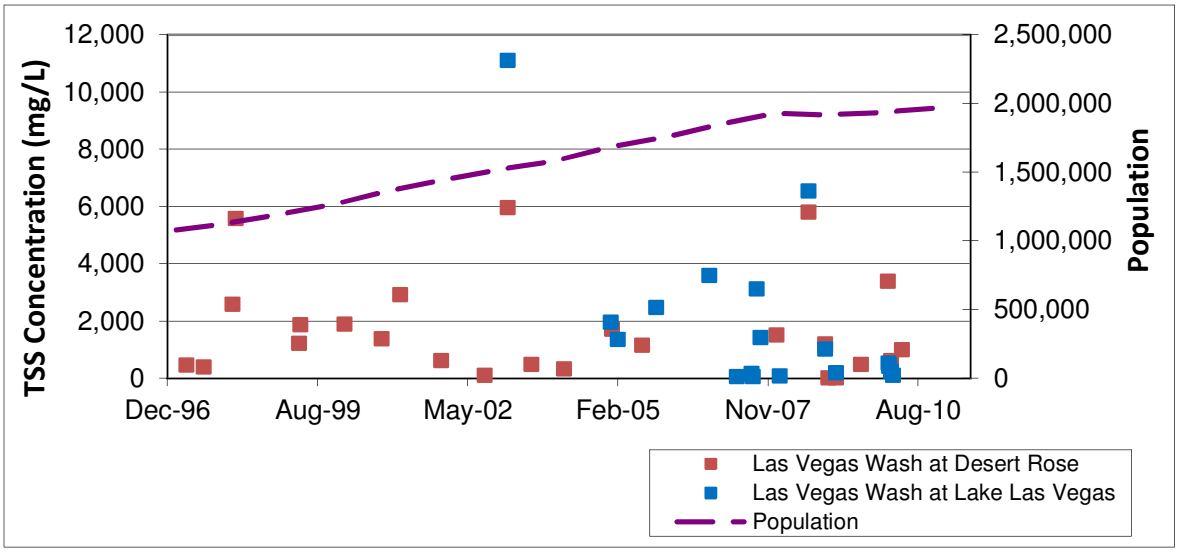



### 3.1.6 Urban Runoff Quality Response to Development

Significant urbanization in Las Vegas Valley over the past 20 years has not resulted in an increase in concentration of most constituents in wet or dry weather flows (see **Figure 3-7**). Although concentrations have not increased significantly, pollutant loads to lower Las Vegas Wash have increased over the period of the MS4 permit due to increases in wet and dry weather flow volumes.

Pollutants more strongly associated with wet weather flows (e.g., total suspended solids [TSS], phosphorus, metals) have experienced a greater increase in loads than those more strongly associated with dry weather flows (e.g., TDS, nitrate). Additional information on stormwater quality data is provided in *Technical Memorandum IV.1 – Summary and Evaluation of Las Vegas Valley Water Quality Data* provided in the Technical Appendix.

Figure 3-7 Total Suspended Solids Wet Weather Trends for Two Las Vegas Wash Sites (above and below Lake Las Vegas)




### 3.1.7 Stormwater Management Approach

All regional facilities are designed to control the runoff from the 100-year storm occurring under full build-out conditions in the upstream watershed, with no assumption of onsite peak or volume reductions in new development. Runoff management is primarily accomplished using large regional detention basins that capture runoff from large watershed areas and capture runoff from the majority of Las Vegas Valley (see **Figure 3-8**). These basins have been shown to capture significant sediment volumes but are only marginally effective at reducing concentrations of other pollutants.

Most regional conveyance facilities are concrete lined to manage erosion. Current CCRFCD policy and local development codes require new development to stabilize and prevent erosion from any waterways within the development and mitigate downstream erosion attributable to the development.

Las Vegas Wash has experienced significant erosion and loss of wetlands over the past 40 years. SNWA has implemented an erosion control structure program in lower Las Vegas Wash consisting of 22 structures, 12 of which have been constructed to date (March 2011). Erosion and sediment transport in lower Las Vegas Wash have been reduced dramatically by the existing structures.

### 3.1.8 Legal and Water Right Factors

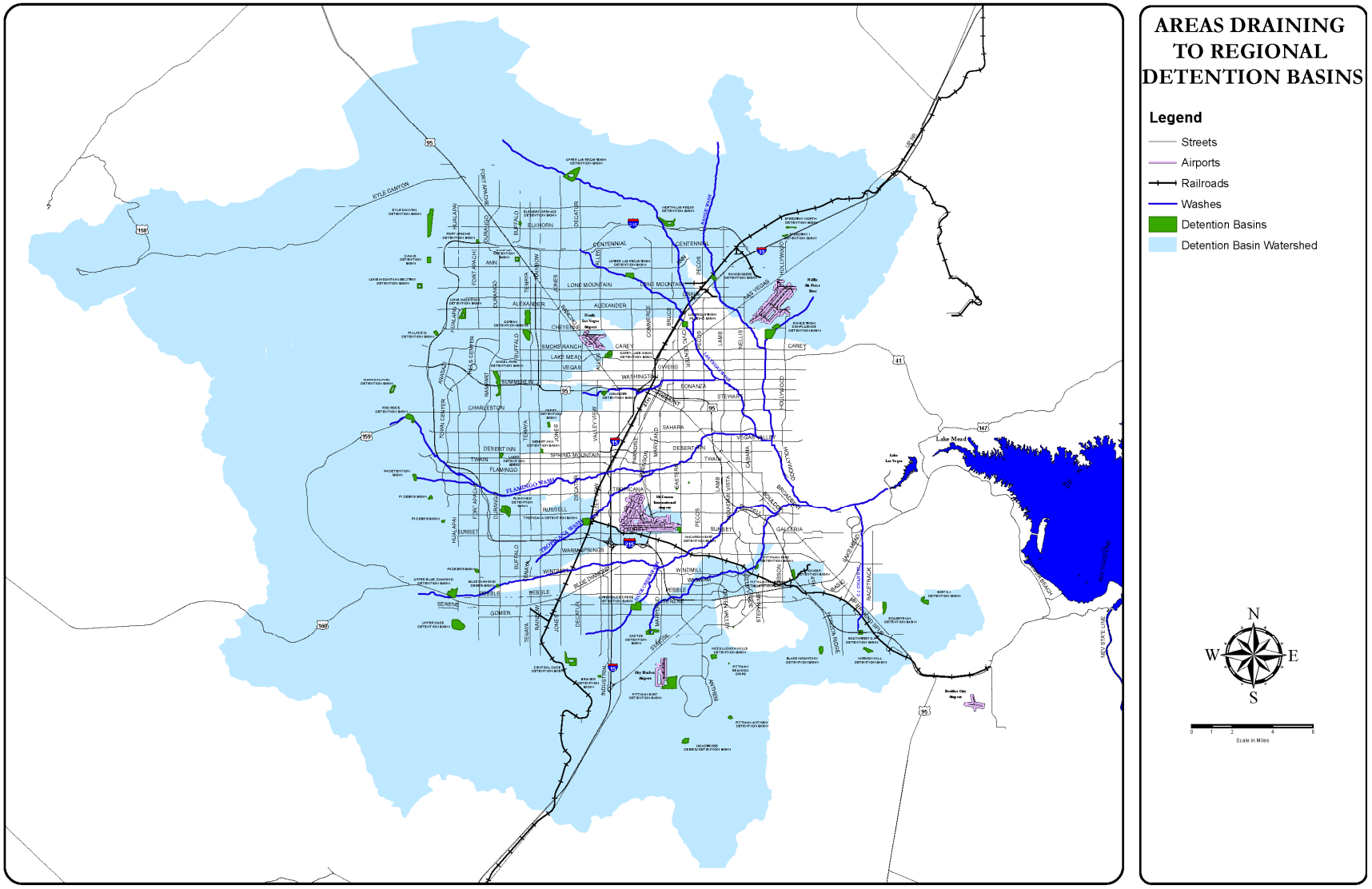
The Nevada State Engineer's Office requires permits for capture of surface waters that are put to beneficial use, and must demonstrate that current water rights holders are not injured by the proposed diversion. At present, new developments that desire to implement onsite stormwater retention would be required to contact the State Engineer to determine if a surface water permit would be required.

Stormwater retention combined with beneficial use onsite would have the support of Colorado River Commission (CRC) and SNWA. Retention without beneficial use would be opposed by CRC. Retention that induced infiltration that would have adverse impacts on water quality would be opposed by both CRC and SNWA.

Infiltration of stormwater such that it increases concentrations or loads of selenium and TDS in Las Vegas Wash or the Colorado River would violate state and federal water quality regulations and the objectives of the Colorado River Basin Salinity Control Program.

More information on legal and water rights issues is provided in *Technical Memorandum IV.7 Potential Legal and Water Rights Issues Associated with Onsite Retention of Stormwater*, found in the Technical Appendix.

Figure 3-8. Areas Draining to Regional Detention Basins



### 3.1.9 Conclusions

The unique factors summarized above lead to several important implications for developing stormwater management programs and specific BMPs and control measures to comply with the Las Vegas Valley MS4 permit.

***Due to the unique environmental factors present in the arid Las Vegas Valley, programs that rely heavily on local detention/retention of stormwater flows at the on-site development scale and infiltration of stormwater are not practical.*** Rainfall events are localized and occur infrequently with the result that onsite development-level stormwater controls could go months or even years without seeing significant runoff. For this reason, regional watershed-level controls that capture stormwater from large drainage areas would be more technically effective and more cost-effective. Because these regional detention basins are downstream of virtually all new development, using this existing public infrastructure to manage stormwater runoff quality would be less maintenance intensive for the overall community than implementing individual development-level controls, many of which would be located on private property. Additionally, BMPs must remain effective even after long periods with no rainfall. Considering the mean annual rainfall of the Las Vegas Valley is 4.2 inches, any BMP that relies on constant or frequent water flows for pollutant removal effectiveness or reasonable maintenance frequency, such as wetlands or extended detention basins, are not feasible in this environment. Most redevelopment is high-density residential and hotel/casino properties near the valley center. Ultra-urban BMPs that require very little land area would be required to address stormwater management onsite. Regional solutions would be better adapted to this situation.

***Infiltration-based BMPs are not feasible in new development or redevelopment areas underlain by caliche, expansive clays, or collapsible soils.*** Poor soil conditions occur across large portions of Las Vegas Valley. No caliche maps of the valley are available and the presence of any of these geologic conditions must be evaluated on a site-specific basis through geotechnical evaluations.

***Channel stability, not onsite controls, should be the focus of BMPs designed to treat erosion impacts of development.*** Undeveloped land in the Las Vegas Valley produces naturally high sediment loads when runoff occurs due to minimal vegetation cover, erosive soils and highly shifting natural channels. This is evidenced by the large volumes of sediment captured by detention basins located in undeveloped drainage areas. Contrary to less arid parts of the country where development tends to be the cause of higher sediment loads from watershed surfaces, land development in the Las Vegas Valley stabilizes soil surfaces; however, it does increase the potential for downstream channel erosion. At this time, most regional conveyance facilities are concrete-lined to manage erosion and the CCRFCD design manual requires all channels to be stabilized in some manner, effectively addressing the primary erosion issues associated with urban runoff and reducing the need for onsite controls.

***Onsite BMPs that rely on vegetation for treatment are not feasible.*** Approximately 90 percent of the Las Vegas Valley's drinking water supply is obtained from Lake Mead, which is part of the Colorado River system. The Colorado River system has been experiencing a historical drought for over 10 years. As a result, local municipalities and SNWA have implemented drought and conservation measures to reduce water use. Many standard BMP and Low Impact Development (LID) designs rely on vegetation (e.g. thick turf or wetlands) for all or part of their treatment processes. In the Las Vegas Valley, these areas occur very rarely under natural conditions and would require extensive artificial irrigation if they were to be maintained as part of site landscaping. Additional dry weather flow may be generated from irrigated areas, which is contrary to local water management objectives. Creation of these types of BMPs would be inconsistent with the water conservation objectives of SNWA and the ordinances established by the local municipalities. Actually, increased stormwater runoff of acceptable quality into Lake Mead is a benefit to the valley's drinking water supplies.

***Stormwater retention in the Las Vegas Valley faces legal and policy changes, and should not be part of mandatory programs developed by the Permittees.*** Nevada water law was reviewed, and the Nevada State Engineer's Office, SNWA, and the CRC were contacted to determine potential legal and water rights issues that could affect use of stormwater management facilities in the Las Vegas Valley. Stormwater retention without onsite beneficial use (infiltration and evaporation losses only) would contradict local agency policies and potentially exacerbate existing water quality problems, and is not recommended. Proposed stormwater retention with onsite beneficial use (e.g., for irrigation water) would have agency support but would have to be submitted to the State Engineer for approval; approval is not certain due to potential impacts on Lake Las Vegas and other water rights holders.

In conclusion, many of the standard approaches promoted by EPA for stormwater quality management in urban areas are not applicable to the Las Vegas Valley due to unique local conditions. However, there is an opportunity to create a unique stormwater program that meets the intent of the stormwater regulations and is adapted to local conditions. Rare and limited rainfall in Las Vegas Valley dictates that regional management measures will be more practical and cost-effective than onsite controls. Infiltration of stormwater in the Las Vegas Valley is often not feasible due to soil conditions, and where feasible, may not be desirable due to the increase in groundwater levels and pollution (including possible exceedances of selenium standards) that results. However, other solutions effective in arid climates are available to prevent pollution and minimize impacts on receiving waters. Existing practices unique to the arid Las Vegas Valley environment, such as water conservation and drought management programs, have been effective in significantly reducing sources of dry weather flows from areas of new and existing development and provide important stormwater management benefits. The SWMP incorporates these unique local practices wherever possible.

## 3.2 Regional Watershed-Based Strategy

Based on the requirements of the MS4 permit, the unique conditions in Las Vegas Valley, the goals of the MS4 Permittees, and the desires of the local stakeholders, a strategy was developed for preparing the overall SWMP. This strategy is based on *regional, watershed-based* approaches to stormwater quality management. The Permittees believe strongly that a regional approach is the most practical, cost-effective, and locally supportable approach, and therefore has the greatest likelihood of having a positive impact on surface water quality. The following describes the key components of a regional watershed-based strategy.

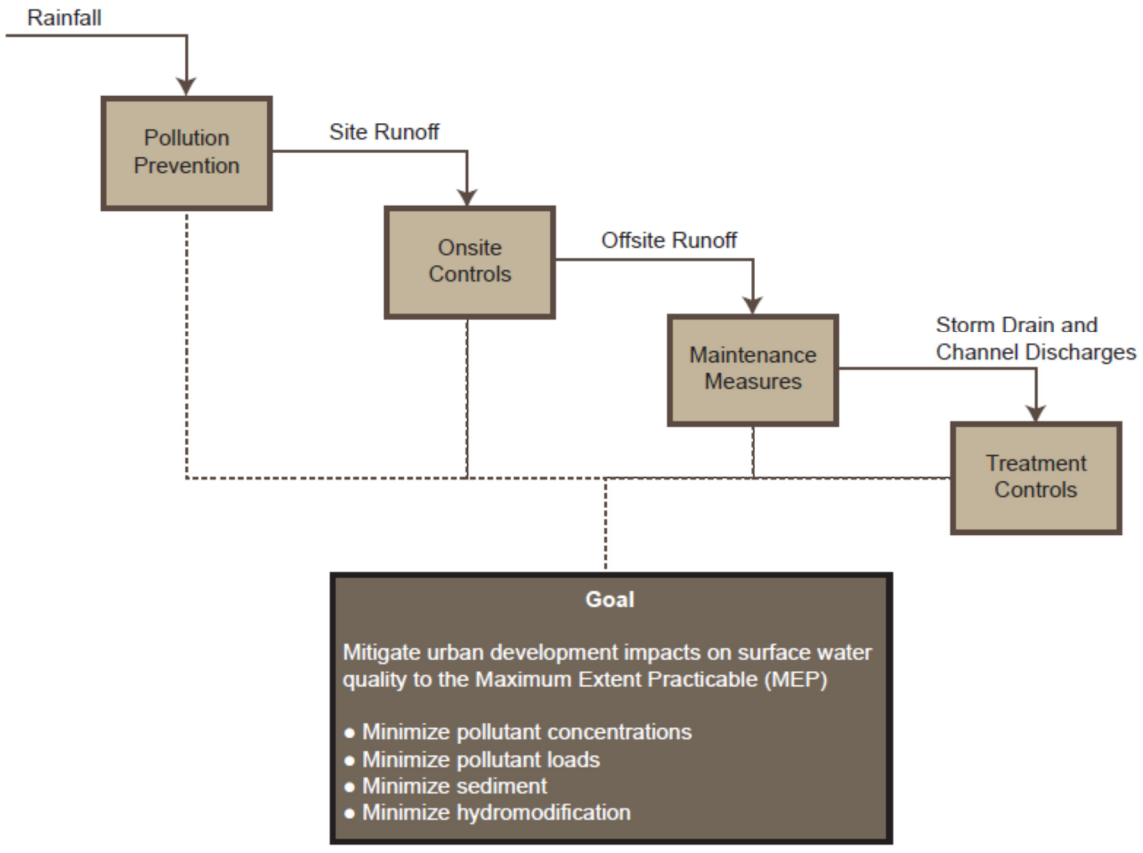
- **Reliance on Regional Measures.** In general, regional watershed-based measures for stormwater quality management are preferred over on-site measures. In an environment in which rainfall is extremely infrequent and isolated, regional measures addressing runoff from large areas are more cost-effective for the community than on-site measures. A watershed approach is consistent with EPA's promotion of watershed-based solutions to water quality issues.
- **Use of Existing Facilities.** Existing facilities are incorporated into the MS4 program wherever possible to maximize the benefits from past infrastructure investments and to minimize the need for new structural measures. Las Vegas Valley has adopted a regional approach to flood risk reduction that includes dozens of large detention basins typically serving many square miles of drainage area rather than hundreds of smaller basins serving single lots or subdivisions. Budget constraints and prudent public policy mandate maximizing use of existing infrastructure to provide multiple benefits. Regional flood control facilities provide the most cost effective opportunities to address stormwater quality from areas of New Development and Significant Redevelopment (NDSR).
- **Incorporation of Existing Related Programs.** Many existing public programs developed for the arid Las Vegas Valley provide stormwater quality benefits by reducing runoff rates or volumes, thereby reducing the potential for stormwater pollution and addressing concerns with hydromodification. Examples include water conservation measures, turf reductions, and open space requirements. Although these ancillary programs were not developed specifically for MS4 permit compliance, they are considered to be an effective part of the overall MS4 program to address regional surface water quality conditions.
- **Recognition of Infiltration Limitations.** Stormwater infiltration will not be a significant factor in the Las Vegas Valley MS4 program. As described in the previous section, infiltration of stormwater is problematic in Las Vegas Valley due to poor soils and other issues. Therefore, other approaches will be adopted for mitigating stormwater runoff impacts. This is one of the key factors in driving the program toward regional rather than onsite measures.

## 3.3 SWMP Framework

The Las Vegas Valley SWMP is uniquely tailored to local conditions and relies on regional management solutions. In addition, the SWMP framework is based on commonly applied stormwater treatment train principles that consist of progressively applied layers of management measures, as described by the EPA. **Figure 3-9** depicts the SWMP framework for the Las Vegas Valley. It shows a tiered approach that begins with pollution prevention, then applies site design, MS4 maintenance and treatment measures in sequence to different portions of the hydrologic cycle. The primary strategy is pollution prevention to keep rainwater from contacting potential pollutant sources. Site design principles are then applied to minimize impacts on runoff at the site level. MS4 maintenance measures such as street sweeping and drain inlet maintenance address runoff in the MS4 system. Finally, "end-of-pipe" treatment measures reduce pollutant concentrations and loads prior to or after entering downstream receiving waters. The various programs making up the SWMP include best management practices from the four treatment train categories.

The SWMP specifies requirements for the following MS4 programs: Source Control and Maintenance Measures, Public Outreach and Education, New Development and Significant Redevelopment, Illicit Discharge and Detection Program, Industrial Facility Program, and Construction Site Program. Because the Las Vegas Valley MS4 program relies heavily on regional strategies, a Watershed Program was added to the MS4 SWMP to include regional BMPs that address runoff from large portions of the Las Vegas Valley watershed. These measures are described in Section 12, and include regional detention basins, regional detention basin retrofits, regional channel lining, and Las Vegas Wash erosion control structures. The BMPs in this program can be considered treatment controls, since their function is to mitigate impacts of runoff in lieu of or in addition to onsite controls or pollution prevention measures. They are similar in function to other more traditional treatment controls such as wetland treatment areas or stormwater treatment plants. **Figure 3-10** depicts the MS4 Program Organization.

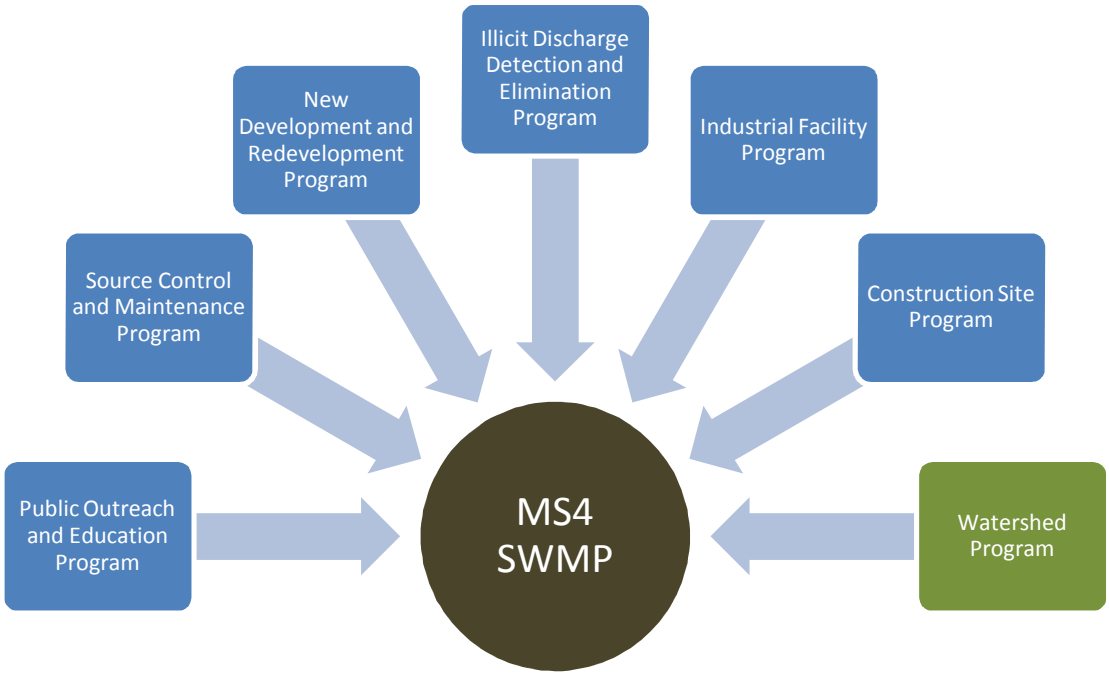
Figure 3-9. Las Vegas Valley MS4 Stormwater Treatment Train




**REPRESENTATIVE BEST MANAGEMENT PRACTICES (BMP)**

| Pollution Prevention | Onsite Controls | Maintenance Measures | Treatment Controls |
|---|---|---|---|
| • Public Education | • Xeriscape Regulations | • Street Sweeping | • Regional Detention Basins |
| • Water Conservation | • Turf Reduction | • Inlet Cleaning | • Regional Detention Basin Retrofits |
| • Drain Inlet Marking | • Parking Lot Design | • Channel Cleaning | • Channel Lining |
| • Housekeeping Practices | • Construction BMPs | • Detention Basin Cleaning | • Las Vegas Wash Stabilization Structures |
| • Construction Inspections | • Hillside Ordinances | | |
| • Industrial Inspections | • Fueling Station Design | | |
| • Household Waste Collection | | | |
| • Pet Waste Management | | | |
| • Fertilizer, Pesticide, and Herbicide Management | | | |

Figure 3-10. MS4 Program Organization




The proposed BMPs that will be implemented in each program to comply with permit requirements are shown in **Table 3-2**. A full description of each BMP is included in the BMP fact sheets which are provided in **Appendix B**. Many BMPs provide benefits to multiple MS4 programs; however, BMPs were assigned to only one program based on the primary benefits they provide. This simplifies tracking and reporting activities. A few of the proposed BMPs included in **Table 3-2** are shown to fit into multiple programs, due to permit requirements. It is important to note that the proposed BMP will only be reported in one section, which is identified in the fact sheet.

The party(ies) responsible for implementing the proposed BMPs listed in **Table 3-2** is included in **Table B-1** entitled, "Parties Responsible for Implementing Proposed BMPs," in **Appendix B**. The majority of BMPs are solely the responsibility of the Permittees; however, there are some exceptions. Some of the BMPs are implemented solely by or with assistance from another organization that is not a Permittee. If one of the proposed BMPs that is not the sole responsibility of the Permittees is discontinued, the proposed BMP may be removed from the SWMP. The Permittees may implement a different BMP, if necessary, if no other BMPs in the SWMP can satisfy the permit requirement.

## Table 3-2 – Proposed Best Management Practices for the Stormwater Management Plan Programs

| Measure Type | ID No. | Proposed BMP | SWMP Program | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Public Outreach & Education | Source Control & Maintenance Measures | New Development & Significant Redevelopment | Illicit Discharge Detection | Industrial Facility Monitoring & Control | Construction Site | Watershed |
| Maintenance | MM-1 | Street Sweeping | | X | | | | | |
| | MM-2 | Local Storm Drain System Maintenance | | X | | | | | |
| | MM-3 | Regional Detention Basin Maintenance | | X | | | | | |
| | MM-4 | Maintenance of Public Facilities | | X | | | | | |
| Source Control | SC-1 | Water Conservation (Drought) Ordinance | | X | | | | | |
| | SC-2 | Turf Conversion Program | | X | | | | | |
| | SC-3 | Public Employee Supervisor Fertilizer / Pesticide Training | | X | | | | | |
| | SC-4 | Use of Alternate Products and Application Procedures | | X | | | | | |
| | SC-5 | Household Hazardous Waste Collection | | X | | | | | |
| | SC-6 | Commercial/Industrial Housekeeping Practices | | | | | X | | |
| | SC-7 | Ordinances Prohibiting Non-Stormwater Discharges and Littering | | X | | | | | |
| | SC-8 | Desert Dumping Controls | | X | | | | | |
| | SC-9 | Grease Interceptor Program | | | | | X | | |
| | SC-10 | Dust Control Measures | | X | | | | | |
| | SC-11 | Storm Drain Marking Program | X | | | | | | |

## Table 3-2 – Proposed Best Management Practices for the Stormwater Management Plan Programs (Continued)

| Measure Type | ID No. | Proposed BMP | SWMP Program | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Public Outreach & Education | Source Control & Maintenance Measures | New Development & Significant Redevelopment | Illicit Discharge Detection | Industrial Facility Monitoring & Control | Construction Site | Watershed |
| Source Control | SC-12 | Spill Control Prevention Plan | | | | X | | | |
| | SC-13 | Industrial Pretreatment Program | | | | | X | | |
| | SC-14 | Trash Receptacle Enclosures | | X | | | | | |
| | SC-15 | Southern Nevada Health District Inspections | | | | | X | | |
| | SC-16 | Regional Water Quality Planning | | | | | | | X |
| | SC-17 | Pet Waste Management | X | | | | | | |
| | SC-18 | Stormwater Outfall Map | | | X | | | | |
| | SC-19 | Sanitary Sewer Line Inspection and Replacement Program | | | | X | | | |
| | SC-20 | Construction Site BMP Guidance Manual | | | | | | X | |
| | SC-21 | Construction Site Inspections | | | | | | X | |
| | SC-22 | Construction Site Training Workshops | | | | | | X | |
| | SC-23 | Industrial Facility Stormwater Inspections | | | | | X | | |
| | SC-24 | Industrial Facility Stormwater Inventory | | | | | X | | |
| | SC-25 | Industrial Facility Stormwater Inspection Checklist | | | | | X | | |
| | SC-26 | Storm Channel Inspections | | | | X | | | |
| | SC-27 | Dry Weather Monitoring | | | | X | | | |
| | SC-28 | Industrial Facility Inspector Training Workshops | | | | | X | | |
| | SC-29 | Stormwater-Related Complaint Response | | | | X | | | |
| | SC-30 | LVV Stormwater Quality Website | X | | | | | | |

## Table 3-2 – Proposed Best Management Practices for the Stormwater Management Plan Programs (Continued)

| Measure Type | ID No. | Proposed BMP | SWMP Program | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Public Outreach & Education | Source Control & Maintenance Measures | New Development & Significant Redevelopment | Illicit Discharge Detection | Industrial Facility Monitoring & Control | Construction Site | Watershed |
| Source Control | SC-31 | Public Outreach Events | X | | | | | | |
| | SC-32 | Elementary School Presentations | X | | | | | | |
| | SC-33 | Public Service Announcements / Flood Channel | X | | | | | | |
| | SC-34 | Brochures and Printed Material | X | | | | | | |
| | SC-35 | Stormwater Outfall Map with Areas of NDSR | | | X | | | | |
| Site Design | SD-1 | Open Space and Landscaping Objectives | | | X | | | | |
| | SD-2 | Rural Land Overlay | | | X | | | | |
| | SD-3 | Hillside Development Ordinances | | | X | | | | |
| | SD-4 | Sustainability and Green Building Initiatives | | | X | | | | |
| | SD-5 | Covered Fuel Areas | | | X | | | | |
| | SD-6 | Raised Fuel Areas | | | X | | | | |
| | SD-7 | Emergency Shut-off Switch and Shear Valve | | | X | | | | |
| | SD-8 | Standard Drainage Design Criteria | | | X | | | | |
| | SD-9 | Parking Lot Low Impact Development (LID) Measures | | | X | | | | |
| | SD-10 | Low Impact Development (LID) Measures | | | X | | | | |
| Treatment Control | TC-1 | Regional Detention Basins | | | | | | | X |
| | TC-2 | Regional Channel Lining | | | | | | | X |

## Table 3-2 – Proposed Best Management Practices for the Stormwater Management Plan Programs (Continued)

| Measure Type | ID No. | Proposed BMP | SWMP Program | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Public Outreach & Education | Source Control & Maintenance Measures | New Development & Significant Redevelopment | Illicit Discharge Detection | Industrial Facility Monitoring & Control | Construction Site | Watershed |
| Treatment Control | TC-3 | Las Vegas Wash Stabilization Structures | | | | | | | X |
| | TC-4 | Sand/Oil Separator | | | X | | | | |
| | TC-5 | Sand Filter | | | X | | | | |
| | TC-6 | Regional Detention Basin Retrofit | | | | | | | X |

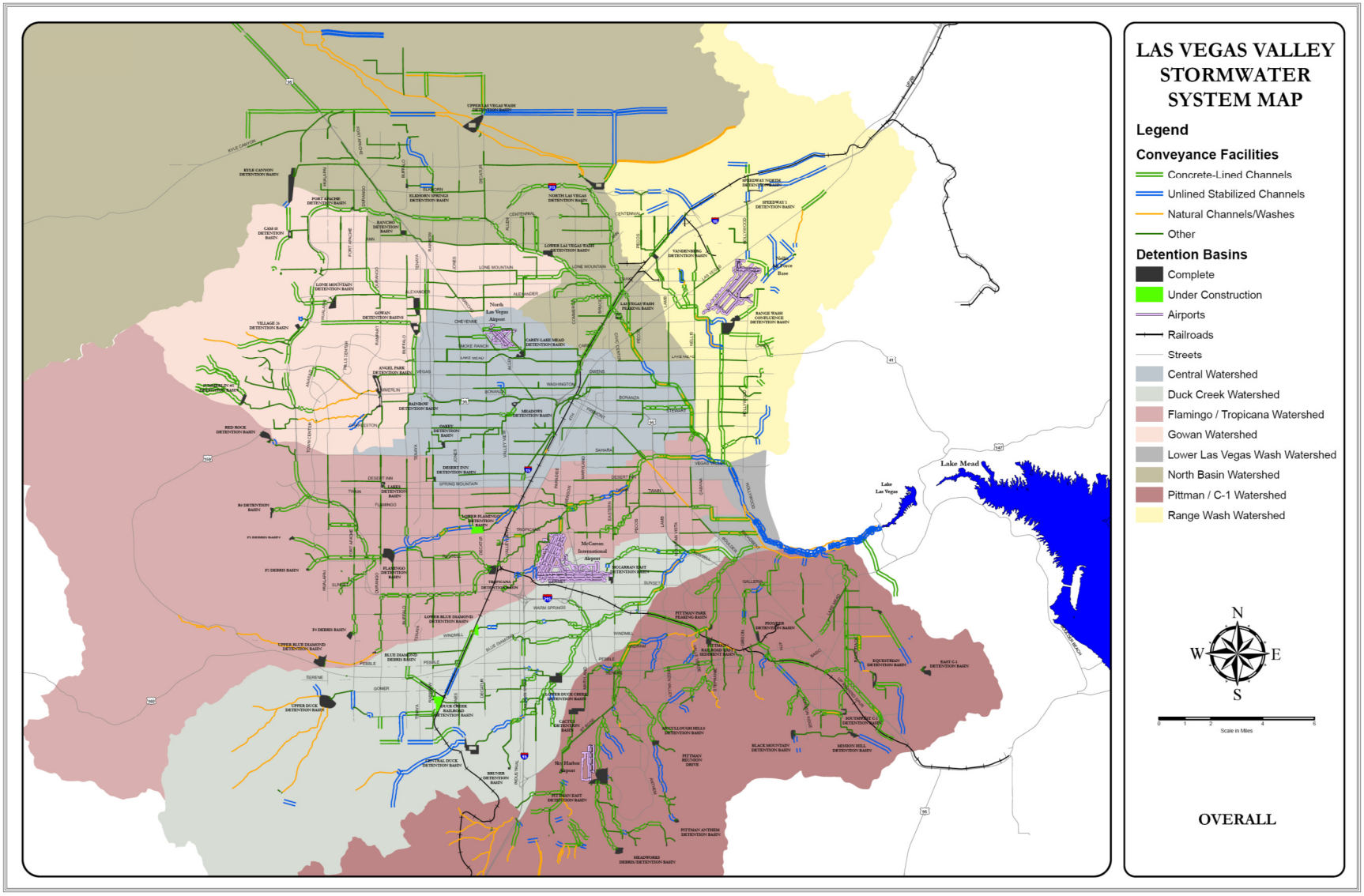
# 4 SOURCE IDENTIFICATION

Section *IV.B* of the permit requires the following: *"The updated SWMP shall provide updated maps of the Permittees' MS4s, including the location of any major outfall that discharges to waters of the United States that was not reported in the previous SWMP."*

A single valley-wide GIS map depicting areas of the major stormwater outfall system in Las Vegas Valley will be prepared annually based on asset tracking software currently used by the entities, review of aerial photographs or similar resources. CCRFCD regularly updates GIS maps of regional flood control infrastructure based on construction projects it funds and 5-year updates of the Master Plan Update for Las Vegas Valley. An updated map showing new flood control infrastructure completed during the previous permit year will be provided in each MS4 Annual Report.

**Figure 4-1** is a map depicting existing (2010) regional stormwater facilities and major outfalls to Las Vegas Wash and its tributaries. A similar map has been prepared for all the Annual Reports submitted under the previous MS4 permit. The map is normally printed in more detail, with the overall area divided into four panels. This map meets the requirements for showing locations of all major outflalls that discharge to waters of the United States. Updated regional stormwater facility and outfall maps will be prepared annually by the Permittees for inclusion in the Annual Report.

Figure 4-1. Las Vegas Valley Stormwater System Map



# 5 STORMWATER MONITORING

This section summarizes water quality characterization data for surface water bodies in Las Vegas Valley, and describes the adopted plan for preparing a monitoring program for wet weather discharges, as required by the MS4 permit. The monitoring program will be submitted to NDEP annually before October 1 each year, and will be related to Las Vegas Valley water quality problems identified by previous sampling by CCRFCD and others. CCRFCD has implemented a stormwater characterization monitoring program since 1991, in which characterization data are collected and the water quality database is updated annually. The proposed monitoring program will be coordinated annually with other regional monitoring programs through SNWA, the Las Vegas Wash Coordination Committee, and the Las Vegas Valley Watershed Advisory Committee to make the best use of resources and to avoid duplication of effort. A companion dry weather monitoring program is described in Section 9 – Illicit Discharge Detection Program.

## 5.1 Permit Requirements

Section *IV.C* of the MS4 Permit for Las Vegas Valley specifies a requirement to evaluate available water quality characterization for the MS4 permit area.

*IV.C.1 The updated SWMP shall evaluate characterization data previously submitted and include additional data collected in the same manner, and evaluate whether existing data collection programs should be modified to improve characterization of stormwater discharges, effects of BMPs, or ambient water quality. This information shall be submitted for approval as part of the annual monitoring plan required in Part V.A.*

Section V.A of the MS4 Permit for Las Vegas Valley includes the following requirements for a Monitoring program.

*V.A.1 The Permittees shall submit to NDEP a stormwater monitoring plan for the following year on or before October 1 each year. In developing the plan, the Permittees must evaluate and update as necessary how monitoring may assist in making decisions about program compliance, the appropriateness of identified BMPs, and progress toward achieving identified measurable goals. Pending submittal of the annual monitoring plan, the Permittees shall continue to implement the existing monitoring plan.*

*V.A.2 When the Permittees conduct monitoring at the Permittees' MS4, the Permittees are required to comply with the following:*

*V.A.2.a Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge. This requirement does not prevent Permittees from analyzing or reporting samples that are representative of a limited situation (e.g. concentration at peak flow);*

*V.A.2.b Test procedures for the analysis of pollutants shall conform to regulations (40 CFR, Part 136) published pursuant to Section 304(h) of the Act, unless other procedures are approved by NDEP.*

*V.A.2.c Records of monitoring information shall include:*

*V.A.2.c.i The date, exact place, and time of sampling or measurements;*

*V.A.2.c.ii The names(s) of the individual(s) who performed the sampling or measurements;*

*V.A2.c.iii The date(s) analyses were performed;*

*V.A2.c.iv The name(s) of the individual(s) who performed the analyses;*

*V.A.2.c.v The analytical techniques or methods used; and*

*V.A2.c.vi The results of such analyses.*

*V.A.2.d Analyses shall be performed by a State of Nevada-certified laboratory. Laboratory reports shall be provided if requested by NDEP.*

*V.A2.e If the Permittees perform stormwater monitoring more frequently than required by the stormwater monitoring plan the results of such monitoring shall be reported in the Annual Report.*

## 5.2 Summary of Available Data

Results of water quality sampling and analysis for wet and dry weather flow conditions conducted as part of the Las Vegas Valley MS4 program since its inception in 1991 are summarized in this section. A full description of the water quality data analysis is provided in *Technical Memorandum No. IV.1 – Summary and Evaluation of Las Vegas Valley Water Quality Data, MWH*. 2010a.

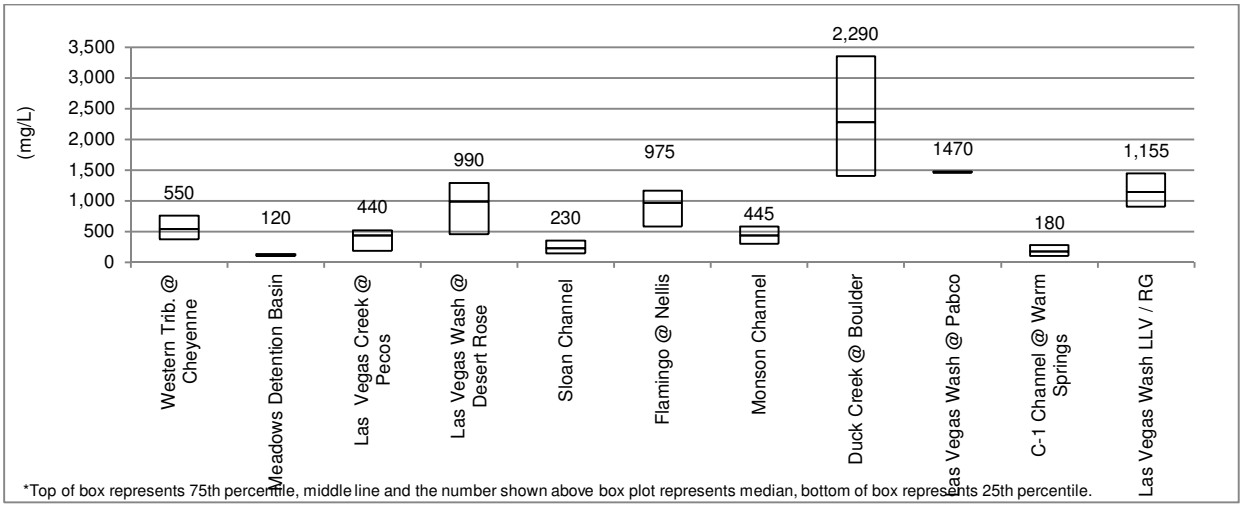
The Las Vegas Valley MS4 monitoring program has evolved over time in response to changing requirements and increased understanding of regional water quality conditions. The program began by sampling the major tributary outfalls to Las Vegas Wash (Western Tributary, Las Vegas Creek, Range Wash, Flamingo Wash, Duck Creek, C-1 Channel, Upper Las Vegas Wash). Special studies were added during particular years to address specific pollutants or issues of concern. These included a first-flush study, a bacteria source identification study, and a detention basin pollutant removal effectiveness study. As a substantial database on the Las Vegas Wash tributaries was assembled and no significant changes were observed from year to year, the monitoring program was modified to focus on Las Vegas Wash stormwater quality for a wider range of constituents. To provide data of interest to SNWA, the constituent list was expanded to include selenium, organics, and other constituents of interest.

Monitoring results were compiled and analyzed for dry and wet weather in the following two ways:

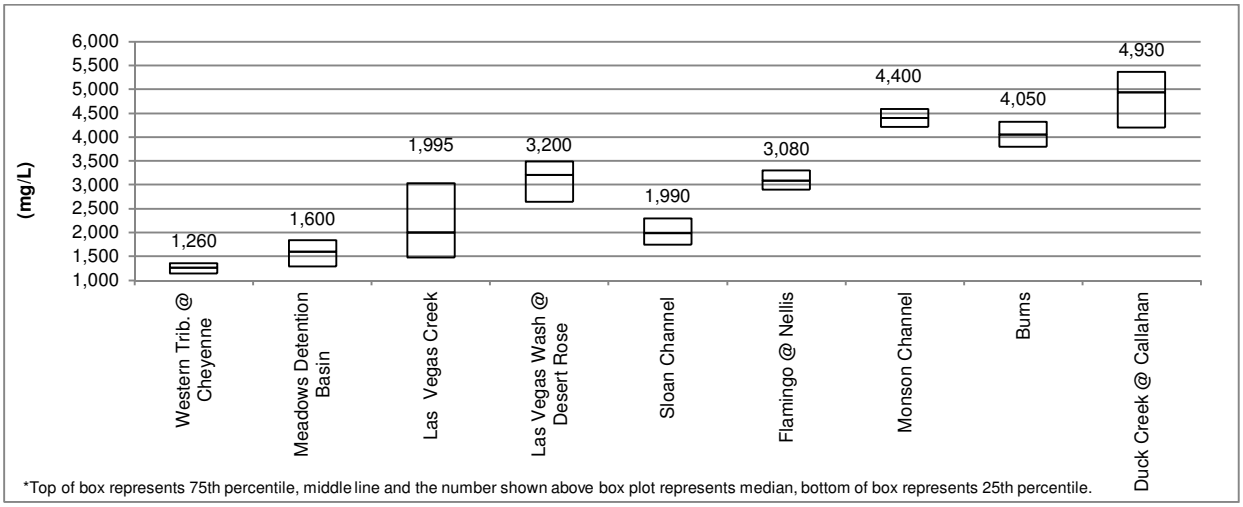
- The range of constituent concentrations (as a box plot) at sampling locations arranged from upstream to downstream in the Las Vegas Valley. The purpose of these plots is to display spatial differences in the data. The box plot represents the 75th percentile (top line, indicating 75% of results were at or below this value), the median (the middle line and number shown above the box plot) and the 25th percentile (the bottom line indicating 25% of results were at or below this value).
- The constituent concentration versus the growth in population in the Las Vegas Valley over the monitoring period. The purpose of these plots is to identify temporal trends in the dry weather data and determine if increasing urbanization (represented by population) appears to be contributing to higher constituent concentrations.

The data represented in the following figures (**Figures 5-1** through **5-9**) summarizes the results for TDS, nitrate and selenium for dry and wet weather monitoring at sampling sites arranged from upstream to downstream.

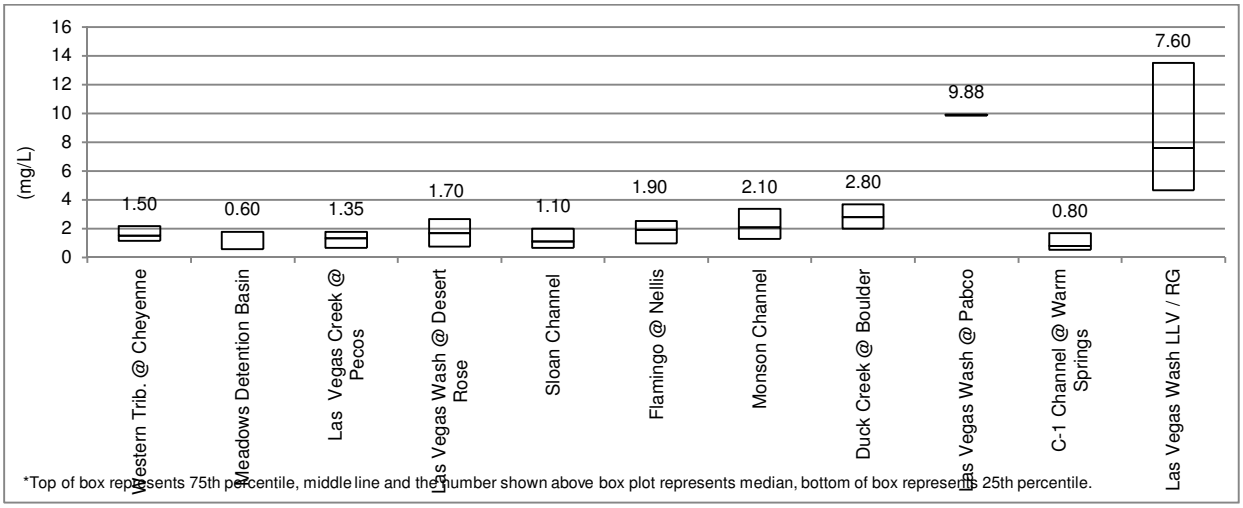
**Figure 5-1 Wet Weather TDS vs. Location 1992-2010**



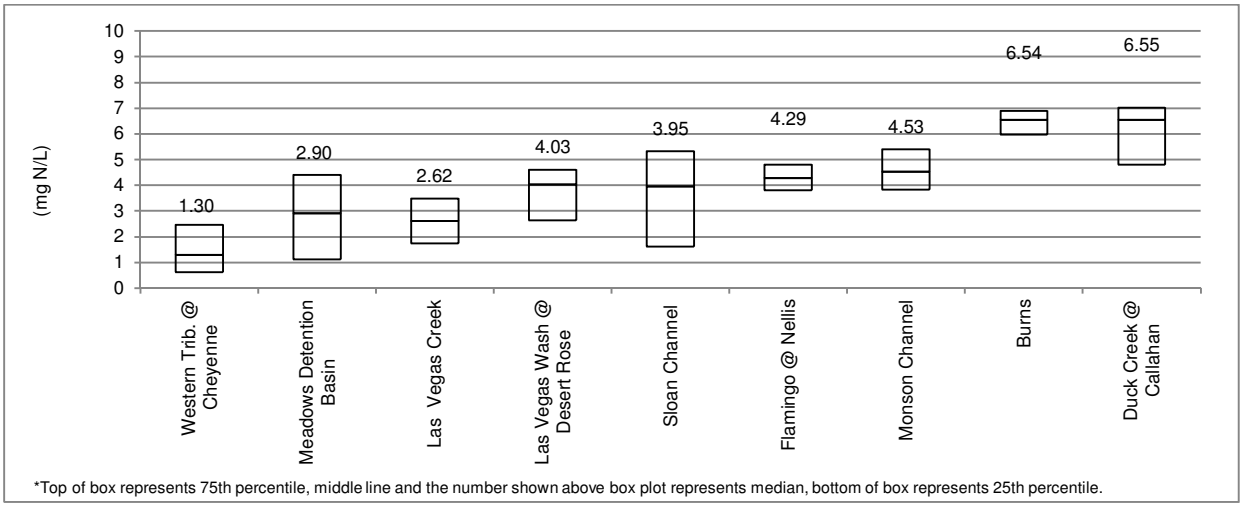
## Figure 5-2 Dry Weather TDS vs. Location 1991-2010




## Figure 5-3 Wet Weather Nitrate as N vs. Location 1992-2010

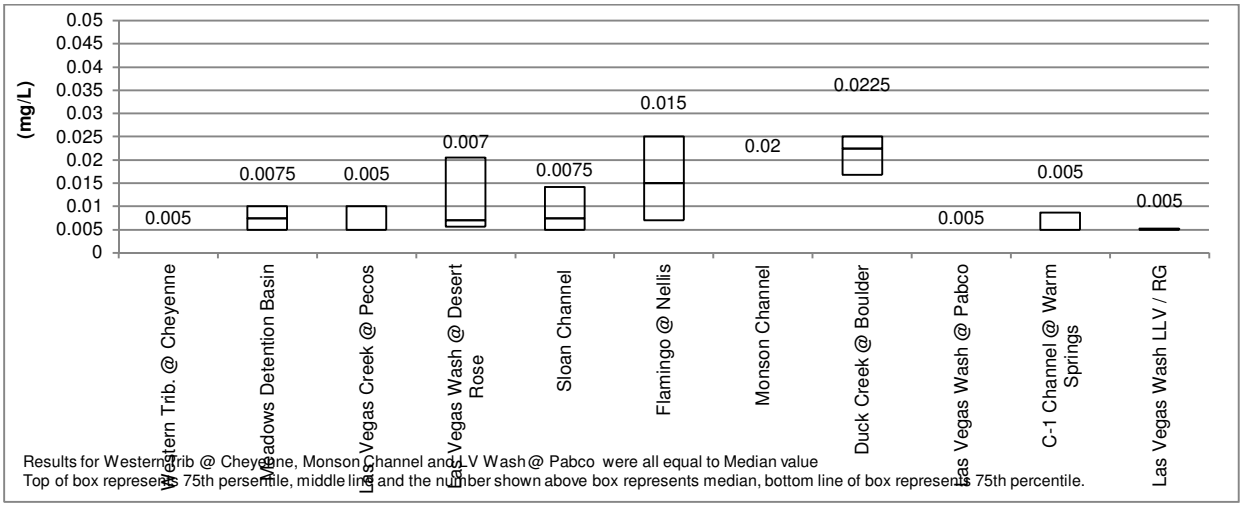


## Figure 5-4 Dry Weather Nitrate vs. Location 1991-2010



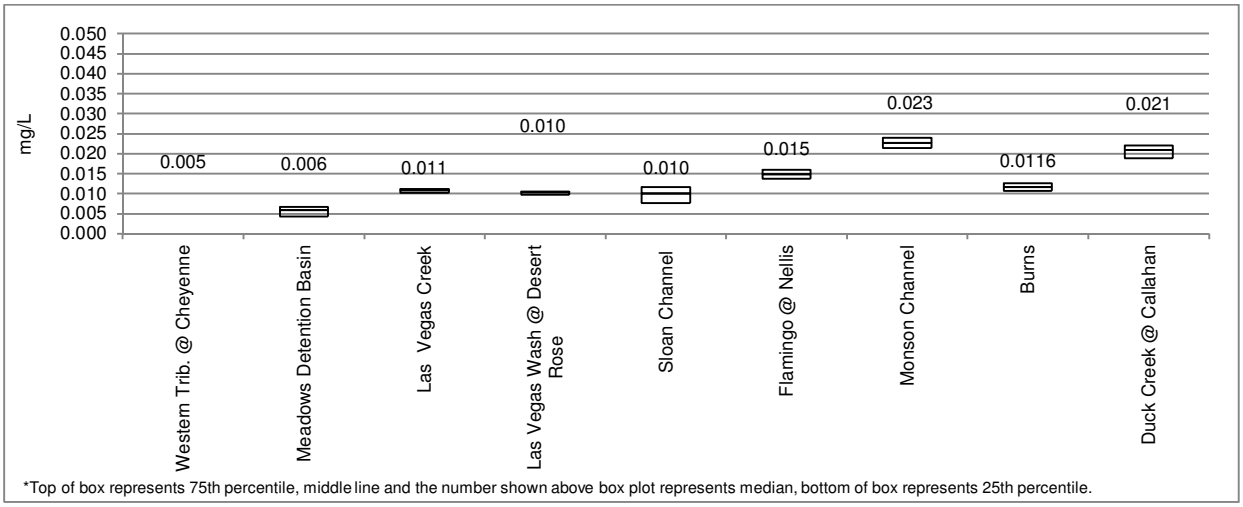

*Top of box represents 75th percentile, middle line and the number shown above box plot represents median, bottom of box represents 25th percentile.

## Figure 5-5 Wet Weather Selenium vs. Location 1992-2010




Results for Western Trib @ Cheyenne, Monson Channel and LV Wash @ Pabco were all equal to Median value
Top of box represents 75th percentile, middle line and the number shown above box represents median, bottom line of box represents 75th percentile.

## Figure 5-6 Dry Weather Selenium vs. Location




## Figure 5-7 Wet Weather Las Vegas Wash @ Desert Rose TDS and TSS 1997-2010

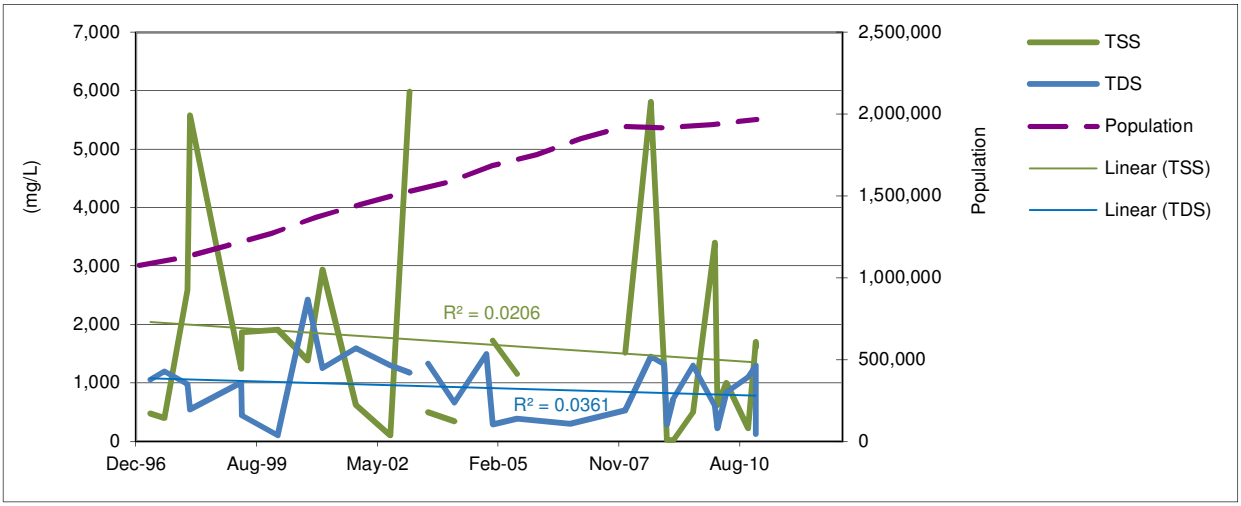


Figure 5-8 Wet Weather Las Vegas Wash @ Desert Rose Nutrients 1997-2010

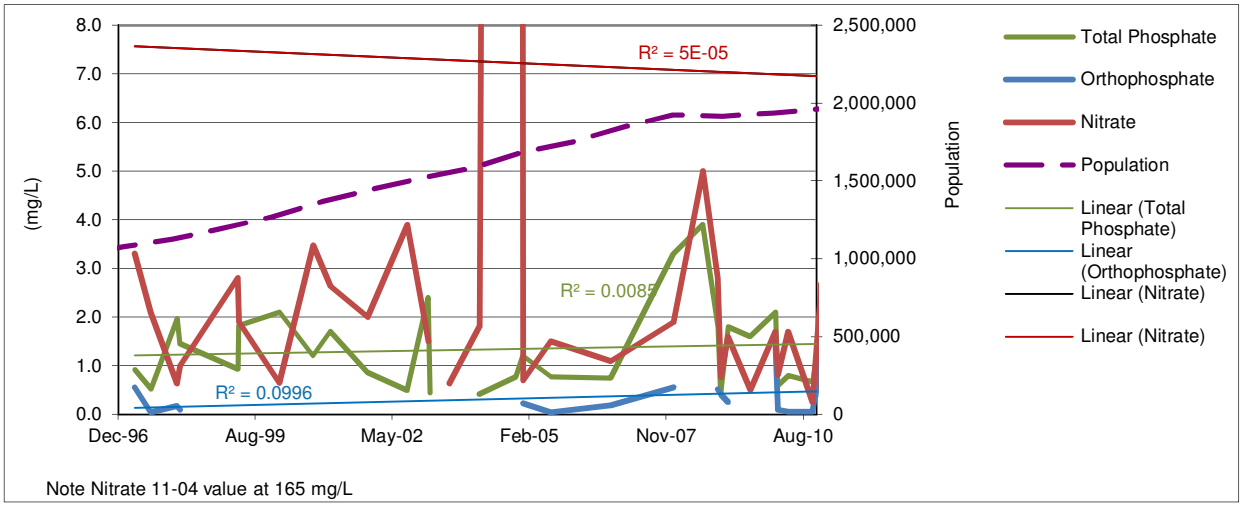
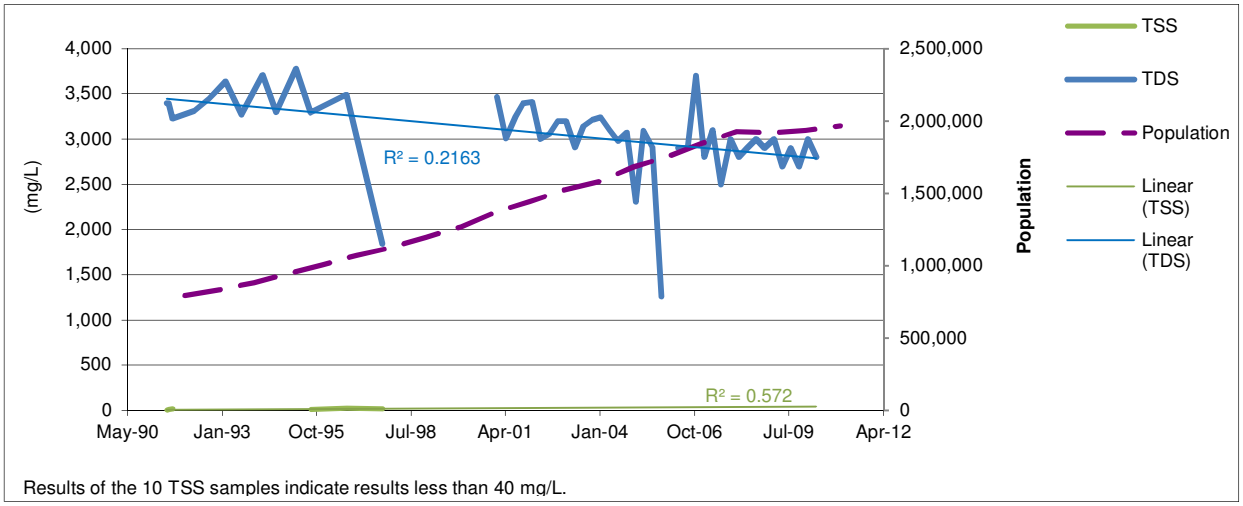



Figure 5-9 Dry Weather Flamingo Wash @ Nellis TDS 1991-1997, 2001-2010




The following conclusions can be made from the data analysis provided in *Technical Memorandum No. IV.1 – Summary and Evaluation of Las Vegas Valley Water Quality Data, MWH*. 2010a.

- The more urbanized watersheds generally have higher concentrations of urban-generated pollutants, but all watersheds contribute pollutants in concentrations exceeding background levels.
- The significant increase in Las Vegas Valley population and areas of urban development over the past 20 years has not resulted in statistically significant increases in pollutant concentrations. This suggests that the stormwater management measures that have been applied in the past have been reasonably successful in mitigating many water quality impacts of development.

- Concentrations of most constituents in wet weather runoff show significant variability from storm to storm, but that variability has occurred within a fairly constant range for each constituent during the MS4 monitoring period.
- The variability in dry weather constituent concentrations is typically much less than in the wet weather monitoring program.
- Constituent concentrations in specific samples are affected at least as much by storm conditions (e.g., intensity, location, areal extent) as by watershed characteristics.
- The most significant spatial trends are associated with the influence of seepage from the shallow groundwater aquifer in Lower Las Vegas Wash and its tributaries.
- Water quality standard exceedances of TDS and selenium in dry weather flows is due primarily to seepage from the shallow groundwater aquifer rather than urban runoff. Management practices that reduce infiltration of stormwater or applied irrigation water to the shallow aquifer would help mitigate this condition.
- Because the volume of wastewater effluent discharge is much greater than the dry weather urban runoff volume, dry weather constituent concentrations in Las Vegas Wash downstream of the wastewater treatment plant discharges are more strongly affected by the wastewater effluent quality than by urban runoff quality.
- Reducing runoff volume can be a means of improving downstream water quality for those constituents positively correlated to streamflow (e.g., TSS, phosphorus, total metals, etc).

## 5.3 Proposed Monitoring Program

At present, the wet weather monitoring plan consists of the following:

- Two sampling stations on Las Vegas Wash – Desert Rose Golf Course (USGS station upstream of all wastewater treatment plant discharges) and Rainbow Gardens (upstream of Lake Las Vegas and downstream of all wastewater treatment plant discharges)
- Minimum of three storms sampled at each station per year
- Automated samplers used to collect flow-weighted composite samples when possible
- Constituent list in **Table 5-1**.

## Table 5-1. MS4 Wet Weather Sampling Constituents

| Parameter | Units |
|---|---|
| **Constituents in Original MS4 Monitoring Plan** | |
| Oil and Grease – Gravimetric | mg/L |
| Total Dissolved Solids (TDS) | mg/L |
| Total Suspended Solids (TSS) | mg/L |
| Total Phosphorus-P | mg/L |
| Orthophosphate-P | mg/L |
| Nitrite, Nitrogen by IC | mg/L |
| Nitrate-N by IC | mg/L |
| Metal Digestion Performed | Y/N |
| Total Kjeldahl Nitrogen (TKN) | mg/L |
| Copper, Total, ICAP | mg/L |
| Lead, Total, ICAP | mg/L |
| Zinc, Total, ICAP | mg/L |
| Copper, ICAP, Dissolved | mg/L |
| Lead, ICAP, Dissolved | mg/L |
| Zinc, ICAP, Dissolved | mg/L |
| Boron, Total, ICAP | mg/L |
| Turbidity | NTU |
| Fecal Coliform Bacteria | MPN/100mL |
| Fecal Streptococci | MPN/100mL |
| SOCs | # of Detects |
| Volatile Organic Compounds (VOC) | # of Detects |
| Pesticides | # of Detects |
| Herbicides | # of Detects |
| **Constituents on Expanded Constituent List** | |
| 2-Chloroethylvinylether | µg/L |
| Alkalinity in CaCO3 | mg/L |
| Aluminum, Total, ICAP | mg/L |
| Anion Sum, Calculated | meq/L |
| Antimony, Total, ICAP | µg/L |
| Arsenic, Total GF | µg/L |
| Barium, Total, ICAP | µg/L |
| Beryllium, Total, ICAP | µg/L |
| Bicarbonate Alkalinity as HCO3 | mg/L |
| Bromide | mg/L |
| Bromate by IC | µg/L |
| CO2, Free, Calculated | mg/L |
| Carbonate, Calculated | mg/L |
| Cadmium, Total, ICAP | µg/L |
| Calcium, Total, ICAP | mg/L |
| Cation Sum, Calculated | meq/L |
| Chlorate, IC | mg/L |
| Chloride | mg/L |
| Chlorite, IC | mg/L |
| Chromium, Total, ICAP | µg/L |
| Diuron | µg/L |
| Diquat | µg/L |
| Paraquat | µg/L |

**Table 5-1. MS4 Wet Weather Sampling Constituents (Continued)**

| Parameter | Units |
|---|---|
| Endothall | µg/L |
| Fluoride | mg/L |
| Glyphosate | µg/L |
| Hardness as CaCO3 | mg/L |
| Hydroxide as OH, Calc | mg/L |
| Iron, Total, ICAP | mg/L |
| Langelier Index – 25 degree | None |
| Magnesium, Total, ICAP | mg/L |
| Manganese, Total, ICAP | mg/L |
| Mercury | µg/L |
| Nickel, Total, ICAP | mg/L |
| pH, Lab | Units |
| Potassium, Total, ICAP | mg/L |
| Reactive Silica | mg/L |
| Selenium, Total | mg/L |
| Silver, Total, ICAP | µg/L |
| Sodium, Total, ICAP | mg/L |
| Specific Conductance | umho/cm |
| Sulfate | mg/L |
| Surfactants | mg/L |
| Thallium, Total, ICAP | µg/L |
| Total Organic Carbon | mg/L |

In response to a significant algae bloom in Lake Mead in 2001 the Lake Mead Water Quality Forum (LMWQF) formed the Algae Task Force (ATF). The ATF has representatives from SNWA, the wastewater dischargers and the MS4 Permittees. The ATF has expressed an interest on the part of SNWA and the Clark County Water Reclamation District to conduct stormwater monitoring to improve understanding of phosphorus loading. In particular, they would like to conduct monitoring to determine phosphorus pollutographs for a variety of runoff conditions to study the connection between phosphorus loads in stormwater runoff and algae conditions in downstream water bodies. In response to the 2001 algae bloom the wastewater treatment facilities (WWTFs) went to year round phosphorus removal. Phosphorus levels and clarity of Lake Mead have improved as a result. At this point, it is believed by the Permittees that phosphorus from stormwater is important during short-duration runoff events but is only a small part of the overall constituent balance. However, the MS4 Permittees will cooperate with other agencies and contribute to regional monitoring programs in this regard if requested. Details of a cooperative sampling effort will be worked out with SNWA and other regional entities, and will be coordinated with NDEP if a change in the previous stormwater monitoring program is required.

A proposed monitoring program for each permit year will be submitted by October 1 in the annual report. The monitoring program will include sample locations, sampling frequency, sample collection and handling procedures, constituents to be analyzed, and laboratory testing methods.

# 6 PUBLIC OUTREACH AND EDUCATION PROGRAM

This section describes the public outreach and education activities adopted by the Permittees in response to the MS4 permit requirements for such a program. The rationale for the program is to inform the general public as to the importance of stormwater quality issues, and to influence behavior in a way that benefits regional water quality. Activities were selected to take advantage of existing programs, and to target specific water quality problems and audiences that are important in Las Vegas Valley.

The overall objectives of the Public Outreach and Education Program are to:

- Inform the general public in Las Vegas Valley about important water quality issues related to stormwater runoff;
- Influence behavior of the general public to reduce activities that have a negative impact on stormwater runoff quality and increase activities that have a positive impact on stormwater runoff quality.

## 6.1 Permit Requirements

Section *IV.D* of the MS4 Permit for Las Vegas Valley includes the following requirements for a Public Outreach and Education program.

*IV.D.1* *The updated SWMP covering the duration of this permit shall describe public outreach and education to reduce the discharge of pollutants to the MEP;*

*IV.D.2* *The updated SWMP shall contain information about the different types of educational material distributed during environmental fairs or other public outreach events; and*

*IV.D.3* *The updated SWMP shall describe educational activities, public information activities, and other appropriate activities;*

*IV.D.4* *The updated SWMP shall describe how the Permittees will inform developers, contractors, operators, and agency staff about upcoming educational and training workshops on construction site erosion and sediment control and construction materials management sponsored by industry groups, professional organizations and public agencies;*

*IV.D.5* *The updated SWMP shall describe how the Permittees will inform architects, engineers, municipal development personnel, and local government officials on water quality problems associated with urban runoff and the requirements for meeting NPDES laws and program goals for properly managing the quality of urban runoff.*

## 6.2 Program Development

The Public Outreach and Education Program was developed by first reviewing existing practices performed by the Permittees to reduce the discharge of pollutants to the MEP. These practices may

be implemented specifically for the MS4 permit program, or may be implemented primarily to meet other community objectives. In either case, they are considered part of the overall Public Outreach and Education Program. New measures were then identified, if needed, to meet the specific program requirements as outlined in the permit. The Public Outreach and Education Program includes activities identified in other SWMP programs that involve outreach to the general public or specific audiences (e.g., industrial owners/operators).

To date, public outreach and education activities have included regional activities performed by CCRFCD, and local activities performed by the individual Permittees. CCRFCD media relations staff have coordinated the majority of regional activities, including TV public service announcements, spots on The Flood Channel station, and printed materials. Las Vegas Valley Water District has contributed staff time to maintain an informative web site dedicated to distributing regional stormwater information (lvstormwater.com). CCRFCD plans to use internet and social media technology to expand public outreach and education opportunities.

The Public Outreach and Education Program includes BMPs that fit within the pollution prevention portions of the overall SWMP management plan framework depicted in **Figure 3-9**.

## 6.3 Proposed Best Management Practices

**Table 6-1** lists the proposed BMPs for the Public Outreach and Education Program. The status of the proposed BMPs is shown in the final column of **Table 6-1**, to indicate whether the BMP is an existing program, existing program with planned enhancements based on the MS4 permit renewal, or a new program that is a result of the MS4 permit renewal. Descriptions of each BMP are provided in **Appendix B**.

**Table 6-2** lists the Public Outreach and Education Program permit requirements and the proposed BMPs that address those requirements. Descriptions of how the proposed measures meet the specific permit requirements are provided in the following subsections.

**Table 6-1. Proposed BMPs for the Public Outreach and Education Program**

| Measure Type | ID No. | Proposed BMP | Status |
|---|---|---|---|
| Source Control | SC-11 | Storm Drain Marking Program | Existing Program Enhancement |
| Source Control | SC-17 | Pet Waste Management | Existing Program |
| Source Control | SC-30 | LVV Stormwater Quality Website | Existing Program Enhancement |
| Source Control | SC-31 | Public Outreach Events | Existing Program |
| Source Control | SC-32 | Elementary School Presentations | Existing Program |
| Source Control | SC-33 | Public Service Announcements/Flood Channel | Existing Program |
| Source Control | SC-34 | Brochures and Printed Material | Existing Program |

**Table 6-2. Public Outreach and Education Program for the Las Vegas Valley**

| MS4 Permit Section | MS4 Permit Requirements | Proposed Measures |
|---|---|---|
| IV.D.1 | The updated SWMP covering the duration of this permit shall describe public outreach and education to reduce the discharge of pollutants to the MEP | SC-11 – Storm Drain Marking Program<br>SC-17 – Pet Waste Management<br>SC-30 – LVV Stormwater Quality Website<br>SC-31 – Public Outreach Events<br>SC-32 – Elementary School Presentations<br>SC-33 – Public Service Announcements/Flood Channel<br>SC-34 – Brochures and Printed Material |
| IV.D.2 | The updated SWMP shall contain information about the different types of educational material distributed during environmental fairs or other public outreach events | SC-17 – Pet Waste Management<br>SC-31 – Public Outreach Events<br>SC-34 – Brochures and Printed Material |
| IV.D.3 | The updated SWMP shall describe educational activities, public information activities, and other appropriate activities | SC-11 – Strom Drain Marking Program<br>SC-30 – LVV Stormwater Quality Website<br>SC-31 – Public Outreach Events<br>SC-32 – Elementary School Presentations<br>SC-33 – Public Service Announcements/Flood Channel<br>SC-34 – Brochures and Printed Material |
| IV.D.4 | The updated SWMP shall describe how the Permittees will inform developers, contractors, operators, and agency staff about upcoming educational and training workshops on construction site erosion and sediment control and construction materials management sponsored by industry groups, professional organizations and public agencies | SC-30 – LVV Stormwater Quality Website |
| IV.D.5 | The updated SWMP shall describe how the Permittees will inform architects, engineers, municipal development personnel, and local government officials on water quality problems associated with urban runoff and the requirements for meeting NPDES laws and program goals for properly managing the quality of urban runoff. | SC-30 – LVV Stormwater Quality Website |

### 6.3.1 Permit Section IV.D.1 – Public Outreach and Education Program

Section *IV.D.1* of the MS4 Permit requires the Permittees to develop a program for public outreach and education. This program is comprised of several elements, all coordinated to reach different segments of the public with messages related to reducing discharge of pollutants to Las Vegas Valley waterways. CCRFCD, which coordinates regional education and outreach activities on behalf of the MS4 Permittees, has found that the most cost-effective method of distributing important information to the general public is through use of internet technology, including a web site and social media. This philosophy is combined with strategic use of television, radio, brochures and public appearances at environmental fairs and community events to distribute information intended to change public behaviors that may have an adverse impact on surface water quality.

Key elements of the Public Outreach and Education Program are described as follows.

- SC-11 Storm Drain Inlet Marking. Phase 1 of the program is complete, and involved installing "do not dump" markers and signs at existing storm drain inlets and channels in Clark County, Las Vegas and Henderson. In Phase 2, the Permittees will adopt standards requiring developers to install inlet markers in all areas of new development and significant redevelopment in the Las Vegas Valley.
- SC-17 Pet Waste Management. The Permittees will direct public outreach activities toward pet owners to clean up waste left by their pets in yards, parks and open spaces. This measure can have substantial benefits in reducing the potential for stormwater to pick up pathogens from pet waste in public and private areas.
- SC-30 Las Vegas Valley Stormwater Quality Website. The Las Vegas Valley Water District (LVVWD) and the SQMC will continue to host the website **www.lvstormwater.com**, which provides information about the storm drain system, monitoring programs, public outreach, community programs, monitoring programs, MS4 annual reports, and Federal and State regulations. Several guidelines for the construction industry, home owners, and business and industry are also found on the website (as a link) to educate the public about reducing the quantity and improving the quality of stormwater runoff. Tracking measures provide the SQMC with information on how the site is being used and which sections are accessed most frequently. The lvvstormwater.com website will be upgraded to act as a repository for additional BMP information as required for specific SWMP program elements, and as a portal to other information available on the internet that may be useful for residents, business owners, and professional groups. In addition to the regional website, the municipal Permittees will continue to maintain and periodically update their websites to provide the public with information on topics such as water quality, BMPs, and related links to other information sources.
- SC-31 Public Outreach Events**.** Permittees will continue to routinely attend environmental fairs and community events to distribute information on stormwater quality and how it can be influenced by common behaviors. Many of the environmental fairs are held in the Spring to capitalize on Earth Day media exposure. Depending on the event, a variety of materials will continue to be distributed including brochures and fact sheets on the Las Vegas Valley MS4 program, magnets, pooper scoopers, reusable canvas shopping bags, etc.
- SC-32 Elementary School Presentations. CCRFCD will continue its program of making presentations to elementary school students on stormwater quality and flood safety.
- SC-33 Public Service Announcements/Flood Channel. CCRFCD will continue its program of creating and broadcasting public service announcements (PSAs) related to stormwater quality. Past PSAs have addressed the relationship between stormwater runoff and Lake Mead water quality, littering, vehicle maintenance, and proper disposal of household chemicals. CCRFCD's goal is to create a new PSA every two years, and broadcast past PSAs in alternate years. CCRFCD will also

continue to produce the "Flood Channel" programs on cable as a way to inform the public of flood safety and stormwater quality issues.

- SC-34 Brochures and Printed Material. CCRFCD will continue to produce brochures and printed material on specific stormwater quality topics if that is deemed the best method of distributing the information to the public. In the past brochures or flyers have been prepared on appropriate BMPs for mobile businesses, appropriate construction site BMPs, and general stormwater quality information.

### 6.3.2 Permit Section IV.D.2 – Educational Material

Section *IV.D.2* of the MS4 Permit requires the Permittees to provide information about the different types of educational material distributed during environmental fairs or other public outreach events. The Permittees will continue to distribute the types of material distributed in the past under the following BMPs:

- SC-17 Pet Waste Management
- SC-31 Public Outreach Events
- SC-34 Brochures and Printed Material

Types of material distributed include:

- Fact sheets on the MS4 program
- Brochures on BMPs for mobile businesses
- Pooper scoopers and pet waste bags
- Magnets (storm drain inlet marker design, pet waste reminders, conservation messages, etc.)
- Elementary school children workbooks
- Chip clips
- Pet food lids
- Key chains
- Reusable canvas shopping bags.

### 6.3.3 Permit Section IV.D.3 – Educational and Public Information Activities

Section *IV.D.3* of the MS4 Permit requires the Permittees to describe educational activities, public information activities, and other appropriate activities. Educational and public information activities will be met by the following BMPs:

- SC-11 Storm Drain Marking Program
- SC-17 Pet Waste Management
- SC-30 LVV Stormwater Quality Website
- SC-31 Public Outreach Events

- SC-32 Elementary School Presentations
- SC-33 Public Service Announcements/Flood Control Channel
- SC-34 Brochures and Printed Material

The Permittees will continue to actively participate in other organizations in Las Vegas Valley to promote interagency cooperation and conduct common outreach and education functions. The activities include:

- Las Vegas Valley Watershed Advisory Committee – The Permittees each participate in LVVWAC, a regional organization formed to coordinate water quality management activities among agencies and municipalities in Las Vegas Valley. LVVWAC has prepared a Regional Water Quality Plan that includes stormwater management.
- Southern Nevada Water Authority – The Permittees have been successful in the past in cooperating with SNWA on public education programs funded in part with Section 319 Nonpoint Source Pollution grant money. Cooperative programs with SNWA and Section 319 grant funds will continue to be pursued.

### 6.3.4 Permit Section IV.D.4 – Informing Developers and Others

Section *IV.D.4* of the MS4 Permit requires the Permittees to inform developers, contractors, operators, and agency staff about upcoming educational and training workshops on construction site erosion and sediment control and construction materials management. Workshops could be sponsored by industry groups, professional organizations and public agencies.

The **www.lvstormwater.com** website (described in BMP SC-30 LVV Stormwater Quality Website) the **ccrfcd.org** website, and the air quality management system's DustFax network (which is used to inform contractors of air quality permit issues) will be used to notify developers, contractors, operators, and agency staff about upcoming construction site training workshops. Construction site training sessions are described in the Construction Site Program. Construction related materials will be posted on the **www.lvstormwater.com** website.

Clark County has construction related stormwater materials available to developers, contractors, and others at the permit counter.

Clark County Real Property Management includes language within their contracts for County construction projects notifying potential contractors of their responsibilities under the NPDES program and the transfer of monetary penalties if the County is found in violation. CoH also has this language in Standard Section 637 of its contracts for public works projects.

Clark County Department of Air Quality and Environmental Management (DAQEM) includes a statement on their dust control permit application to notify applicants that are going to disturb ¼ acre or greater of land that compliance with regulations associated with stormwater is required by the State of Nevada. This statement is also included within the County's grading permit application language.

### 6.3.5 Permit Section IV.D.5 – Informing Architects, Engineers, and Others

Section *IV.D.5* of the MS4 Permit requires the Permittees to inform architects, engineers, municipal development personnel, and local government officials on water quality problems associated with urban runoff and the requirements for meeting NPDES laws and program goals for properly managing the quality of urban runoff.

Information related to water quality problems associated with urban runoff and the requirements for meeting NPDES laws and program goals for properly managing the quality of urban runoff will be posted on the **www.lvstormwater.com** website (BMP SC-30 LVV Stormwater Quality Website).

## 6.4 Responsibility for Implementation

**Table 6-3** shows the entity responsible for implementing each proposed BMP. Many of the media related public outreach and education activities will continue to be performed on a regional basis by CCRFCD. Each individual Permittee is responsible for attending environmental fairs and community events. The lvstormwater.com website will continue to be supported by staff of LVVWD.

**Table 6-3. Public Outreach and Education Program Responsible Parties, Monitoring & Tracking, and Measurable Goals**

| Best Management Practices | Responsible Parties | Monitoring and Tracking | Measurable Goals |
|---|---|---|---|
| SC-11 – Storm Drain Marking Program | Clark County<br>CLV<br>CNLV<br>CoH | Number of new public storm drain inlet markers approved after adoption of standard. | 100% of all new drain inlets and catch basins in public right-of-way outfitted with drain inlet markers |
| SC-17 – Pet Waste Management | CCRFCD<br>Clark County<br>CLV<br>CNLV<br>CoH | Number of outreach programs addressing pet waste<br>Number of poop bags purchased | None |
| SC-30 – LVV Stormwater Quality Website | CCRFCD<br>Las Vegas Valley Water District | Online website use tracking routine | Review website every 6 months to be sure it is current |
| SC-31 – Public Outreach Events | CCRFCD<br>Clark County<br>CLV<br>CNLV<br>CoH | Number of events attended annually by all Permittees combined | Attend 3 community events annually and distribute materials |
| SC-32 – Elementary School Presentations | CCRFCD | Number of schools presentations made annually | 5 elementary school presentations annually |
| SC-33 – Public Service Announcements / Flood Channel | CCRFCD | Number of PSAs aired annually and duration of broadcast<br>Number of new Flood Channel segments produced annually on stormwater | Produce or update one new PSA every 2 years<br>Broadcast one PSA annually for 2 months |
| SC-34 – Brochures and Printed Material | CCRFCD (regional use)<br>Clark County<br>CLV<br>CNLV<br>CoH | Number of brochures printed annually<br>Number of page hits for brochures on website annually | Produce printed material annually as needed |

## 6.5 Monitoring and Tracking

The Permittees propose to monitor and track certain key elements of the Public Outreach and Education Program, and report progress annually in the Annual Report. These elements are shown in **Table 6-3.** On a regional scale, CCRFCD will continue to conduct residential surveys to assess the level of public understanding of stormwater and flood control issues as a way to measure the effectiveness of their outreach program.

## 6.6 Measurable Goals

**Table 6-3** lists measurable goals proposed for the Public Outreach and Education Program. Most goals are numerical and measurable; where this was not possible, narrative goals are proposed.

Goals for existing activities are largely the same goals that have been part of the previous SWMP for the past several years or through the regional implementation entity. The levels of the existing

programs have been effective in informing the public of their role in mitigating impacts of development on surface water quality.

## 6.7 Implementation Schedule

**Table 6-4** presents the implementation schedule for the proposed Public Outreach and Education Program measures. Most of the measures are existing activities that are being continuously implemented by the Permittees. In accordance with the requirement of the new MS4 permit, all program measures will be fully implemented within two years of approval of the SWMP by NDEP.

**Table 6-4. Implementation Schedule for Public Outreach and Education Program Measures**

| Best Management Practice | Required Implementation Activities and Time Period after SWMP Approval |
|---|---|
| SC-11 – Storm Drain Marking Program | Expand Drain Inlet Marking Program to include NDSR – 1 year |
| SC-17 – Pet Waste Management | Existing Practice |
| SC-30 – LVV Stormwater Quality Website | Expand and upgrade website – 6 months |
| SC-31 – Public Outreach Events | Existing Practice |
| SC-32 – Elementary School Presentations | Existing Practice |
| SC-33 – Public Service Announcements/ Flood Channel | Existing Practice |
| SC-34 – Brochures and Printed Material | Existing Practice |

# 7 SOURCE CONTROL AND MS4 MAINTENANCE PROGRAM

## 7.1 Permit Requirements

Section *IV.E* of the 2010-2015 MS4 Permit for Las Vegas Valley includes the following requirements for a source control and MS4 maintenance program to reduce pollutants in stormwater runoff from commercial and residential areas.

*IV.E.1 The updated SWMP shall include a description of structural and source control measures expected to reduce pollutants from stormwater runoff from commercial and residential areas that are discharged into the MS4. This section shall also discuss the basis for the expected reduction of pollutant loads and a proposed schedule for implementing such controls. At a minimum, the description shall include:*

*IV.E.1.a A description of maintenance activities and a maintenance schedule to reduce pollutants in discharges from MS4's;*

*IV.E.1.b A description of practices for operating and maintaining public streets, roads and highways and procedures for reducing the impact on receiving waters of discharges from the MS4's;*

*IV.E.1.c A description of a program to evaluate, monitor and reduce pollutants in runoff from operating or closed municipal landfills or other treatment, storage or disposal facilities for municipal waste;*

*IV.E.1.d A description of a program to evaluate and reduce pollutants in discharges from MS4s associated with the application of pesticides, herbicides, and fertilizer.*

## 7.2 Program Development

The Source Control and MS4 Maintenance Program was developed by first reviewing existing maintenance practices performed by the Permittees that reduce the load of pollutants in the MS4 system. These practices may be implemented specifically for the MS4 permit program, or may be implemented primarily to meet other community objectives. In either case, they are considered part of the overall Source Control and MS4 Maintenance Program. New measures were then identified if needed to meet the specific program requirements as outlined in the permit.

The Source Control and MS4 Maintenance Program includes BMPs that fit within the Pollution Prevention and Maintenance Measures portions of the overall SWMP framework depicted in **Figure 3-9**. The focus of the source control portion of the permit is pollution minimization, i.e., minimizing pollutants from entering the MS4 system from commercial and residential areas (note – industrial sites are addressed separately in Section 10). The measures to accomplish this goal could be structural or non-structural. The focus of the maintenance portion of the permit is removing sediment and other pollutants from public streets and drainage systems.

In preparing a program to comply with the permit requirements, the Permittees have emphasized measures that would be applied to areas of existing development. Similar measures are proposed for areas of new development, as described in the New Development and Significant Redevelopment Program (MWH, 2010b).

## 7.3 Proposed Best Management Practices

**Table 7-1** lists the proposed Source Control and MS4 Maintenance Program BMPs. It is noted that all the program elements are existing practices (possibly with small modifications) and are non-structural. This approach is adopted for the following reasons.

- It is consistent with existing measures and programs that, based on review of local water quality data, have been found to be effective (MWH, 2010a).
- It avoids the need for structural measures that require ongoing maintenance, inventorying and tracking, and agreements with private property owners.

**Table 7-1. Proposed BMPs for Source Control and MS4 Maintenance Program for Las Vegas Valley**

| Measure Type | ID No. | Proposed BMP | Status |
|---|---|---|---|
| Maintenance | MM-1 | Street Sweeping | Existing Program |
| Maintenance | MM-2 | Local Storm Drain System Maintenance | Existing Program |
| Maintenance | MM-3 | Regional Detention Basin Maintenance | Existing Program Enhancement |
| Maintenance | MM-4 | Maintenance of Public Facilities | Existing Program |
| Source Control | SC-1 | Water Conservation (Drought) Ordinance | Existing Program |
| Source Control | SC-2 | Turf Conversion Program | Existing Program |
| Source Control | SC-3 | Public Employee Supervisor Fertilizer / Pesticide Training | Existing Program Enhancement |
| Source Control | SC-4 | Use of Alternate Products and Application Procedures | Existing Program Enhancement |
| Source Control | SC-5 | Household Hazardous Waste Collection | Existing Program |
| Source Control | SC-7 | Ordinances Prohibiting Non-Stormwater Discharges and Littering | Existing Program |
| Source Control | SC-8 | Desert Dumping Controls | Existing Program |
| Source Control | SC-10 | Dust Control Measures | Existing Program |
| Source Control | SC-14 | Trash Receptacle Enclosures | Existing Program |

Descriptions of each BMP are provided in **Appendix B**.

There are no active municipal landfills in the MS4 permit area. The landfill that currently serves Las Vegas Valley is the Apex Landfill, which is located outside Las Vegas Valley and the MS4 permit area. The closed Sunrise Landfill is located in Las Vegas Valley, but it is being completely capped and stabilized with channels and retention basins to fully manage all site runoff. If a new municipal landfill is opened in the MS4 permit area, the SWMP will be updated to include management measures for this facility.

Program elements related to fertilizer, pesticide and herbicide management come from four families of BMPs: those with a goal of reducing water use and runoff from irrigated urban areas (water conservation, turf reduction); public education; household hazardous waste collection; and measures directly related to fertilizer, pesticide and herbicide use (supervisor training, use of alternate products).

**Table 7-2** shows how the BMPs are aligned with the specific Source Control and MS4 Maintenance Program requirements. This is described further in the following sections.

**Table 7-2. Proposed Source Control and MS4 Maintenance Program for Las Vegas Valley**

| MS4 Permit Section | MS4 Permit Requirements | Proposed Measures |
|---|---|---|
| IV.E.1.a | A description of maintenance activities and a maintenance schedule to reduce pollutants in discharges from MS4's. | MM-2 – Local Storm System Maintenance<br>MM-3 – Regional Detention Basin Maintenance<br>MM-4 – Maintenance of Public Facilities |
| IV.E.1.b | A description of practices for operating and maintaining public streets, roads and highways and procedures for reducing the impact on receiving waters of discharges from the MS4s. | MM-1 – Street Sweeping<br>MM-2 – Local Storm Drain System Maintenance |
| IV.E.1.c | A description of a program to evaluate, monitor and reduce pollutants in runoff from operating or closed municipal landfills or other treatment, storage or disposal facilities for municipal waste. | Not required – no operating or closed landfills in the study area. |
| IV.E.1.d | A description of a program to evaluate and reduce pollutants in discharges from MS4s associated with the application of pesticides, herbicides, and fertilizer. | SC-1 – Water Conservation Ordinances<br>SC-2 – Turf Conversion Program<br>SC-3 – Public Employee Supervisor Fertilizer / Pesticide Training<br>SC-4 – Use of Alternate Products and Application Procedures<br>SC-5 – Household Hazardous Waste Collection<br>SC-7 – Ordinances Prohibiting Non-Stormwater Discharges and Littering<br>SC-8 – Desert Dumping Controls<br>SC-10 – Dust Control Measures<br>SC-14 – Trash Receptacle Enclosures<br><br>Source Control Measures included in the Public Outreach and Education, and Industrial Facility Monitoring and Control programs of the SWMP. |

### 7.3.1 Permit Section IV.E.1.a – Maintenance Activities and Schedule

Section *IV.E.1*.a of the MS4 Permit requires the Permittees to develop maintenance activities and a schedule to reduce pollutants in discharges from the MS4. The maintenance activities include:

- MM-2 Local Storm Drain System Maintenance. The Permittees inspect and, as needed, remove sediment, debris and trash from storm drain inlets and catch basins in the public MS4 system. Routine maintenance is performed to assure proper hydraulic performance, prevent clogging and to remove potential sources of pollution. After large storms, additional inspections of facilities that historically have

problems with debris accumulation and clogging are performed and the facilities are cleaned if necessary in preparation for the next storm event. The Permittees will inspect 20 percent of inlets a minimum of once per year and clean as appropriate.

- MM-3 Regional Detention Basin Maintenance. Based on criteria developed by CCRFCD and adopted by all the entities, detention basins are designed to control the 100-year flood to discharges that can be safely conveyed in downstream channels. The purpose of the detention basin maintenance program is to remove sediment and other pollutants from the detention basin, so that they are not transported downstream through the MS4. The Permittees' inspect and, as needed, remove sediment, debris and trash from detention basins that are part of the MS4 system. Maintenance activities, including rehabilitation, are performed to preserve flood storage capacity, assure proper hydraulic performance, and remove potential sources of pollution. The Permittees will inspect regional detention basins on a semi-annual basis and after a major storm and will clean as appropriate.
- MM-4 Maintenance of Public Facilities. This measure is for maintaining entity-owned sites with urban land uses such as parking lots, garages, and vehicle storage and maintenance areas. These measures are similar to MM-1 and MM-2 and involve street sweeping, drain inlet cleaning and vehicle maintenance on publicly owned parcels. Each public facility will have a maintenance plan in place two years from acceptance of the SWMP. The maintenance plan will be reviewed every other year for any revisions.

### 7.3.2 Permit Section IV.E.1.b – Operating and Maintaining Streets and Roads

Section *IV.E.1.b* of the MS4 Permit requires the Permittees to develop practices for operating and maintaining public streets, roads, and highways and procedures for reducing the impact on receiving waters of discharges from the MS4. The maintenance activities include:

- MM-1 Street Sweeping. The street sweeping program applies to public streets under the jurisdiction of the local entities. As new areas are developed, the entities expand their street sweeping programs to encompass all new public streets with curb and gutter. State highway and freeway maintenance is the responsibility of the Nevada Department of Transportation, which has its own MS4 permit and its own street sweeping procedures and goals. Street maintenance includes street sweeping of paved streets with curb and gutter. Curbed and paved public streets are swept on a regular basis to remove accumulated sediment, debris, trash, hydrocarbons, and other chemicals. Maintenance of private streets and parking lots is the responsibility of the private owner. The Permittees will inspect curbed and paved areas every 30 days and sweep on an as needed basis.
- MM-2 Local Storm Drain System Maintenance. The Permittees inspect and, as needed, remove sediment, debris and trash from storm drain inlets and catch basins in the public MS4 system. Routine maintenance is performed to assure proper hydraulic performance, prevent clogging and to remove potential sources of pollution. After large storms, additional inspections of facilities that historically have problems with debris accumulation and clogging are performed and the facilities are cleaned if necessary in preparation for the next storm event.

### 7.3.3 Permit Section IV.E.1.c – Municipal Landfills or other Treatment, Storage or Disposal Facilities

Section *IV.E.1.c* of the MS4 Permit requires the Permittees to develop a program to evaluate, monitor and reduce pollutants in runoff from operating or closed municipal landfills or other treatment storage or disposal facilities for municipal waste. The only landfill within the Las Vegas Valley is the Sunrise Landfill, which has been closed since 1993. It is being completely capped and stabilized with channels and retention basins to manage runoff. The Apex Regional Landfill is currently the only active local landfill, but is located outside of the Las Vegas Wash Watershed. As a result, no municipal landfills are covered under the MS4 Permit requirements since there are no active municipal landfills in the Las Vegas Wash drainage area.

### 7.3.4 Permit Section IV.E.1.d – Application of Pesticides, Herbicides, and Fertilizer

Section *IV.E.1.*f of the MS4 Permit requires the Permittees to develop a program to evaluate and reduce pollutants in discharges from MS4s associated with the application of pesticides, herbicides, and fertilizer. Permittees have various existing programs to minimize the impacts of fertilizer, pesticide and herbicide use on water quality, although they have not all been documented in previous Las Vegas Valley NPDES MS4 Permit Annual Reports. In addition, many of the effective measures and programs are not directly associated with managing use of these products, but with reducing the amount of turf and landscaping areas on which they could be applied. This reduces the overall volume of these chemicals applied for landscaping purposes, and reduces the use of landscape irrigation water that could convey these products into the MS4 during dry weather conditions. Water quality data for Las Vegas Valley indicates that the majority of loadings for pollutants associated with these products occur during storm runoff periods, not during dry weather periods. For example, common fertilizers contain significant amounts of phosphorus, and the typical phosphorus concentration in wet weather flows is about 1.0 mg/L as compared to <0.05 mg/L in dry weather flows.

Elements of local fertilizer, pesticide and herbicide management programs and other BMPs that address these chemicals include:

- SC-1 Water Conservation (Drought) Ordinances. Each entity has a water conservation ordinance designed to reduce use of water outdoors. The water conservation ordinances adopted by the entities include restrictions on new turfed areas, particularly in front yards, and incentives for removal of existing turf. Turf areas are the largest recipients of fertilizers. Significant reductions in existing turf areas and avoidance of new turf installations have substantially reduced the areas where fertilizers would potentially be used. Associated with turf restrictions is the requirement to use xeriscaping for new landscaped areas whenever possible. Use of native and drought tolerant plants, combined with extensive use of rock and non-vegetative landscaping treatments, reduces the need for use of fertilizers, pesticides and herbicides to manage plant growth.
- SC-2 Turf Conversion Program. SNWA has a turf conversion program, sometimes called "cash for grass," that offers a rebate for removal of existing turf areas. The

Water Smart Landscapes rebate helps property owners convert water-thirsty grass to desert landscaping. SNWA will rebate customers $1.50 per square foot of grass removed and replaced with desert landscaping up to the first 5,000 square feet converted per property, per year. Beyond the first 5,000 square feet, SNWA will provide a rebate of $1.00 per square foot. Every square foot of grass replaced with water-smart trees, shrubs and flowers saves an average of 55 gallons of water per year. It also reduces the potential for lawn care chemicals to be washed into the MS4.

- SC-3 Public Employee Supervisor Fertilizer / Pesticide Training. Permittees require supervisors responsible for personnel who commonly use fertilizers, pesticides and herbicides to be trained. This primarily includes Parks and Recreation Department personnel responsible for landscaping maintenance. At this time there is no requirement for private landscaping companies to use personnel certified in handling and application of fertilizers, pesticides and herbicides.
- SC-4 Use of Alternate Products and Application Procedures. Permittees are experimenting with or transitioning to use of "green" products to replace traditional fertilizers, pesticides and herbicides. For example, the CLV is encouraging use of more organic pesticides and herbicides. The CoH is using pelletized corn meal as an herbicide to control pre-emergent vegetation. The CNLV is looking into using green herbicides on a pilot program. Permittees will try alternate products and application procedures on an intermittent basis when promising products or methods become available.

Other Source Control measures included in Public Outreach and Education and Industrial Facility Monitoring and Control programs of the SWMP are pollution prevention measures that address pollutants at their source. These include storm drain inlet marking (SC-11), pet waste management (SC-17), and commercial/industrial housekeeping practices (SC-6).

## 7.4 Responsibility for Implementation

**Table 7-3** shows the entity responsible for implementing each proposed BMP. In most cases the local entities (Clark County, CLV, CNLV and CoH) are responsible for providing staff, equipment and other financial resources to implement the measures. Regional activities common to all Permittees are sometimes funded by CCRFCD (e.g., maintenance of regional flood control facilities, public outreach and education), and sometimes the responsibility of SNWA (e.g., turf conversion).

## Table 7-3. Source Control and MS4 Maintenance Program Responsible Parties, Monitoring and Tracking, and Measurable Goals

| Best Management Practice | Responsible Parties | Monitoring and Tracking Information | Measurable Goals |
|---|---|---|---|
| MM-1 – Street Sweeping | Clark County<br>CLV<br>CNLV<br>CoH | Number of lane miles swept<br>Quantity/volume of material removed | Sweep all public streets in urban areas every 30 days |
| MM-2 – Local Storm Drain System Maintenance | Clark County<br>CLV<br>CNLV<br>CoH | Number of drain inlets and catch basins inspected and cleaned<br>Quantity/volume of material removed | Inspect/ 20% of inlets a minimum of once per year, and clean as appropriate |
| MM-3 – Detention Basin Maintenance | CCRFCD<br>Clark County<br>CLV<br>CNLV<br>CoH | Number of detention basins inspected and cleaned<br>Quantity/volume of material removed | Inspect all regional detention basins on semi-annual basis and after a major storm; clean as appropriate |
| MM-4 – Maintenance of Public Facilities | Clark County<br>CLV<br>CNLV<br>CoH | Number of maintenance plans modified annually | Public facilities to have maintenance plan in place<br>Review Maintenance Plans every other year<br>Develop SWPPPs as appropriate |
| SC-1 – Water Conservation (Drought) Ordinance | SNWA<br>Clark County<br>CLV<br>CNLV<br>CoH | Trends in dry weather flow at key stream gages | 100% compliance with drought ordinance development standards<br>No increase in per capita water use rates |
| SC-2 – Turf Conversion Program | SNWA | Total area of existing turf purchased under SNWA turf buy-back program | Goals and funding levels established by SNWA |
| SC-3 – Public Employee Supervisor Fertilizer / Pesticide Training | Clark County<br>CLV<br>CNLV<br>CoH | Track training or certificates on file | 100% of public landscaping crew supervisors trained within 12 months |
| SC-4 – Use of Alternate Products and Application Procedures | Clark County<br>CLV<br>CNLV<br>CoH | List of alternate products being tested or adopted and/or list of application procedures | Review products and procedures each year and revise lists as appropriate |
| SC-5 – Household Hazardous Waste Collection | Contracted Vendor | Annual description of services provided by Republic Services and any future vendors<br>Amount of household hazardous waste received by Republic Services | Hazardous waste drop-off locations available to residents |
| SC-7 – Ordinances Prohibiting Non-Stormwater Discharges and Littering | Clark County<br>CLV<br>CNLV<br>CoH<br>SNHD | Number of enforcement actions taken under these ordinances<br>Changes to stormwater ordinances | Maintain and enforce ordinances |

**Table 7-3. Source Control and MS4 Maintenance Program Responsible Parties, Monitoring and Tracking, and Measurable Goals (Continued)**

| Best Management Practice | Responsible Parties | Monitoring and Tracking Information | Measurable Goals |
|---|---|---|---|
| SC-8 – Desert Dumping Controls | Clark County<br>CLV<br>CNLV<br>CoH<br>SNHD | Number of enforcement actions taken under these ordinances | Maintain and enforce ordinances |
| SC-10 – Dust Control Measures | DAQEM | Performed for Air Quality Management Program; will not be reported for MS4 program | Per Air Quality Management Program |
| SC-14 – Trash Receptacle Enclosures | Clark County<br>CLV<br>CNLV<br>CoH | RTC Standard | All new trash enclosures in compliance with standards |

## 7.5 Monitoring and Tracking

The Permittees propose to monitor and track certain key elements of the Source Control and MS4 Maintenance Program, and report progress annually in the Annual Report. These elements are shown in **Table 7-3.**

For monitoring and tracking related to changes in dry weather streamflows, the following existing stream gages are tentatively selected as benchmarks because they are strongly influenced by urban dry weather flows (and not wastewater discharges):

- Flamingo Wash at Nellis Blvd
- Duck Creek at Broadbent St
- Sloan Channel at Charleston Blvd

## 7.6 Measurable Goals

**Table 7-3** lists measurable goals proposed for the Source Control and MS4 Maintenance Program. Most goals are numerical and measurable; where this was not possible, narrative goals are proposed.

Goals for storm drain maintenance and street sweeping activities are the same goals that have been part of the previous SWMP for the past several years. These levels of maintenance and street sweeping have been effective in managing impacts of urban development on the MS4.

## 7.7 Implementation Schedule

**Table 7-4** presents the implementation schedule for the proposed Source Control and MS4 Maintenance Program measures. Most of the measures are existing activities that are being continuously implemented by the Permittees. In accordance with the requirement of the new MS4

permit, all program measures will be fully implemented within two years of approval of the SWMP by NDEP.

**Table 7-4. Implementation Schedule for Source Control and MS4 Maintenance Program Measures**

| Best Management Practice | Required Implementation Activities and Time Period after SWMP Approval |
|---|---|
| MM-1 – Street Sweeping | Existing Practice |
| MM-2 – Drain Inlet Cleaning | Existing Practice |
| MM-3 – Regional Detention Basin Maintenance | Existing Practice |
| MM-4 – Maintenance of Public Facilities | Develop and implement Standard Operating Procedures – 2 years |
| SC-1 – Water Conservation (Drought) Ordinances | Existing Practice |
| SC-2 – Turf Conversion | Existing Practice |
| SC-3 – Public Employee Supervisor Fertilizer/Pesticide Training | Existing Practice |
| SC-4 – Use of Alternate Products and Application Procedures | Existing Practice |
| SC-5 – Household Hazardous Waste Collection | Existing Practice |
| SC-7 – Ordinances Prohibiting Non-Stormwater Discharges and Littering | Existing Practice |
| SC-8 – Desert Dumping Controls | Existing Practice |
| SC-10 – Dust Control Measures | Existing Practice |
| SC-14 – Trash Receptacle Enclosures | Existing Practice |
| SC-15 – Southern Nevada Health District Inspections | Existing Practice |

# 8 POST-CONSTRUCTION PROGRAM FOR NEW DEVELOPMENT AND SIGNIFICANT REDEVELOPMENT

This section presents proposed measures and practices to address the impacts of new development and significant redevelopment on urban runoff water quality in Las Vegas Valley. The intent is to incorporate measures into the design and management of urban landscapes that will reduce impacts on water quality on a permanent basis, long after construction is completed.

## 8.1 Permit Requirements

Section *IV.F* of the 2010-2015 MS4 Permit for Las Vegas Valley includes the following requirements for a post-construction program for new development and significant redevelopment (NDSR).

*IV.F.1 The Permittees shall develop a Post-Construction BMP Program for new development and significant redevelopment ("NDSR") projects that is suited for the unique hydrologic, hydrogeologic and regional conditions of the Las Vegas Valley. The program shall focus on planning procedures consistent with the goals identified in Part IV.F.2.*

*IV.F.2 The Post-Construction Program shall have the following goals:*

*IV.F.2.a To prevent stormwater discharges from post-construction projects from causing or contributing to downstream violations of water quality standards of selenium to the MEP;*

*IV.F.2.b To promote anti-degradation of ambient water quality by reducing the discharge of pollutants in stormwater causing or contributing to any degradation identified by NDEP's anti-degradation program; and*

*IV.F.2.c To develop BMPs to promote the reuse of stormwater for municipal water supplies.*

*IV.F.3 The Post-Construction Program shall address at a minimum the following elements:*

*IV.F.3.a Describe how the Permittees will review and enhance the SWMP post-construction program requirements in a manner appropriate for the unique hydrologic, hydrogeologic and regional conditions and needs of the Las Vegas Valley. The review shall address the following elements:*

*VI.F.3.a.i Describe how the Permittees will develop, implement and enforce a program to address post-construction urban runoff from NDSR projects that disturb areas ≥1 acre, including projects <1 acre that are part of a larger common plan of development or sale, that discharge into the MS4 by ensuring that NDSR projects are complying to the MEP with the requirements of this program;*

*IV.F.3.a.ii* *Describe how the Permittees will develop low-impact development ("LID") measures that will remain in effect after construction is complete and are effective and appropriate for the Las Vegas Valley and its environment. The program will outline the selected LID measures found effective and appropriate for the Las Vegas Valley along with a summary and schedule for implementation in the MS4;*

*IV.F.3.a.iii* *Describe how the Permittees will develop any additional structural and non-structural BMPs that will remain in effect after construction is complete and are effective and appropriate for Las Vegas Valley and its environment. The program will outline the selected BMP measures found effective and appropriate for the Las Vegas Valley along with a summary and schedule for implementation in the MS4;*

*IV.F.3.a.iv* *Describe procedures to assure that future regional flood management projects assess the impacts on the water quality of receiving water bodies and that existing structural flood control devices have been evaluated to determine if retrofitting the device to provide additional pollutant removal from stormwater is feasible and appropriate;*

*IV.F.3.a.v* *Describe how the Permittees will develop and implement an ordinance or other regulatory mechanism to address urban stormwater runoff from NDSR projects;*

*IV.F.3.a.vi* *Describe how the Permittees will provide verification of maintenance provisions for structural BMPs located on private property that are subject to post-construction structural BMP requirements;*

*IV.F.3.a.vii* *Describe how the Permittees will develop and implement an inventory and tracking system for post-construction structural stormwater BMPs. The inventory and tracking system shall use at a minimum the following items: project name, project location, project acreage, BMP type and description, inspection date and summary, and any corrective actions undertaken;*

*IV.F.3.a.viii* *Describe how the Permittees will inspect and enforce the proper installation and long-term maintenance of post-construction structural stormwater BMPs ; and*

*IV.F.3.a.ix* *Describe how the Permittees will update its MS4 maps to show areas of NDSR, including any new stormwater major infrastructure that was constructed to serve these areas.*

*IV.F.3.b* *All NDSR projects submitted to the permitting authority subsequent to program implementation as identified in IV.A.2 that fall into one of the following categories shall*

*be subject to one or more of the SWMP design standards developed in accordance with Part IV.F.4:*

*IV.F.3.b.i Residential subdivisions five (5) acres or greater in size;*

*IV.F.3.b.ii Single-family residences subject to local ordinances governing hillside development;*

*IV.F.3.b.iii 100,000 square foot commercial and industrial developments;*

*IV.F.3.b.iv Automotive repair shops (with Standard Industrial Classification ("SIC") codes 5013, 7532, 7533, 7534, 7537, 7538, and 7539);*

*IV.F.3.b.v Retail gasoline outlets disturbing greater than one (1) acre;*

*IV.F.3.b.vi Restaurants disturbing greater than one (1) acre;*

*IV.F.3.b.vii Parking lots greater than one (1) acre potentially exposed to urban runoff; and*

*IV.F.3.b.viii Any other NDSR projects the Permittees deem necessary to be included in this part.*

*IV.F.4 Design Standards. The post-construction program shall describe how NDSR projects specified in the previous section will implement the design standards outlined in this section. Subject to Section IV.F.4.e, the design standards program shall address at minimum the following criteria:*

*IV.F.4.a Peak-Urban Runoff Discharge Rates. Describe how the Permittees will develop design standards for peak-urban runoff from NDSR projects that will provide protection against downstream erosion;*

*IV.F.4.b Site Design BMPs. Describe how the Post-Construction Program will develop and implement site design BMPs in the site layout during the design and approval process to meet the goals of this program identified in Part IV.F.2;*

*IV.F.4.c Source Control BMPs. The Post-Construction Program shall describe how source control BMPs will be implemented. The design standards program shall include the following source-control BMPs that are consistent with the goals of this program:*

*IV.F.4.c.i Slopes and channel design or protection to minimize erosion;*

*IV.F.4.c.ii Properly designed outdoor material storage areas; and*

*IV.F.4.c.iii Properly designed trash storage areas.*

*IV.F.4.d Treatment Control BMPs. The post-construction program shall describe how treatment control BMPs will be developed and implemented. "Treatment control BMPs" and "treat"*

*refer to any onsite or offsite process that provides for infiltration or detention of stormwater or that removes pollutants through any physical, chemical, or biological process. The design standards program shall describe in sufficient detail how the Permittees will size treatment control BMPs using accepted hydrologic engineering quantitative methods and the following design criteria:*

*IV.F.4.d.i Volumetric Treatment Control BMP design criteria. The post-construction program shall describe how the Permittees will design volume-based BMPs to treat stormwater discharges from projects listed in Part IV.F.3.b. The Permittees shall use one of the following conditions to develop the volumetric treatment control BMP design criteria:*

*IV.F.4.d.i.1 Historical rainfall records for the Las Vegas Valley to determine the maximized capture stormwater volume for the area for the 24-hour event using the formula recommended in Urban Runoff Quality Management, Water Environment Federation Manual of Practice No. 23/ASCE Manual of Practice No. 87, (1998); or*

*IV.F.4.d.i.2 The volume of annual runoff based on unit basin storage water quality volume, to achieve at least 80% of volume treatment by the method recommended in hydrology manuals, textbooks or similar technical publications; or*

*IV.F.4.d.i.3 An alternative treatment design criteria, appropriate for the unique hydrologic, hydrogeologic and regional conditions of the Las Vegas Valley. Any alternative design criteria shall be submitted to NDEP with sufficient technical data to establish the appropriateness of the alternative treatment design criteria.*

*IV.F.4.d.ii Flow-Based BMP Design Criteria. The post-construction program shall describe how the Permittees will design flow-based BMPs to treat stormwater discharges from projects listed in Part V.F.3.b. The Permittees shall use one of the following conditions to develop flow-based BMP design criteria:*

*IV.F.4.d.ii.1 Historical rainfall data for the Las Vegas Valley to determine the maximum flow rate of runoff from rainfall per hour, for each hour of a storm event; or*

*IV.F.4.d.ii.2 The maximum flow rate of runoff produced by the 80th percentile hourly rainfall intensity (for each hour of the*

*storm event), as determined from the local historical rainfall record; or*

*IV.F.4.d.ii.3* *The maximum flow rate of runoff for each hour of a storm event, as determined from the local historical rainfall record that achieves approximately the same reduction in pollutant loads and flows as achieved by mitigation of the 80th percentile hourly rainfall intensity; or*

*IV.F.4.d.ii.4* *An alternative treatment design criteria, appropriate for the unique hydrologic, hydrogeologic and regional conditions of the Las Vegas Valley. Any alternative design criteria shall be submitted to NDEP with sufficient technical data to establish the appropriateness of the alternative treatment design criteria.*

*IV.F.4.e* *If the Permittees will not use some or all of the design standards described in this section, the Permittees shall provide justification using documentation and engineering analyses, and propose reasonable alternatives that are appropriate for the unique hydrologic, hydrogeologic and regional conditions in Las Vegas Valley.*

*IV.F.5 Effect of the Post-Construction Program on Water Quality Standards and Drinking Water Supply*

*IV.F.5.a* *The Permittees shall provide a written evaluation whether the criteria developed as part of the post-construction program will tend to cause or contribute to elevated levels of selenium in surface waters within Las Vegas Valley, including an exceedance of the water quality standards for selenium in identified washes, and shall submit the evaluation to NDEP as part of the post-construction program; and*

*IV.F.5.b* *The Permittees shall provide a written evaluation whether the criteria developed as part of the post-construction program will tend to reduce or degrade the contribution of stormwater to the water supplies provided by the Colorado River.*

*IV.F.5.c* *If any criteria developed under the post-construction program in accordance with the provisions of this permit would have a reasonable potential of causing or contributing to any water quality or water quantity impairment, or violates Nevada law, they shall be rescinded, and the Permittees shall determine whether alternate criteria can be implemented without causing water quality or water quantity impairments or violating Nevada law.*

## 8.2 Program Development

The proposed NDSR Program was developed based on the following strategic approach.

1. Develop a program that is tailored to the unique local meteorologic, hydrologic, geologic, water quality, land use, legal, and flood control planning characteristics, as described in Section 3.
2. Adopt a regional, watershed-based approach. This approach is consistent with the principles adopted for this SWMP, the general environmental planning objectives of the EPA, and the flood control planning strategy of CCRFCD. It is also well-suited to the unique local conditions.
3. Maximize incorporation of existing management measures already being implemented by the Permittees and other regional agencies, including those not specifically developed to address stormwater quality conditions.
4. Identify new BMPs needed to meet the MEP requirement of the MS4 permit and address known, documented water quality problems in Las Vegas Valley surface waters.
5. Avoid BMPs that would likely have adverse effects such as degrading surface or ground water quality or creating legal problems.

The NDSR Program was developed by first reviewing existing practices that the Permittees and other regional agencies in Las Vegas Valley are currently engaged in that benefit runoff quality from existing and future urban areas. Some of these are part of the existing NDSR Program, while others are associated with other regional environmental initiatives (e.g., air quality management, water conservation, Las Vegas Wash restoration). The Permittees completed a comprehensive review of existing BMPs that could be appropriate for inclusion in the proposed NDSR program. This review is described in *Technical Memorandum No. IV.9 – Description of Existing BMPs and Need for New BMPs for NDSR Program* (MWH, 2010g).

A "gap analysis" was performed to determine whether new or expanded programs are required to comply with the MS4 permit. The gap analysis is described in *Technical Memorandum No. IV.9*. Existing and potential BMPs were linked to specific pollutants of concern and pollutant sources (land uses). A gap is defined as a situation in which the existing BMPs would clearly not meet the MEP standard, there are other BMPs feasible for Las Vegas Valley that could be implemented, and the pollutant/land use combination is important enough that it deserves considering additional BMPs.

BMP effectiveness was assessed based on the MEP test. BMPs not currently being implemented to the MEP were recommended for expansion or upgrade. BMPs identified in a separate assessment of measures required to address impaired waterbodies and total maximum daily loads (TMDLs) were incorporated into the assessment (MWH, 2011a).

In preparing a program to respond to the permit requirements, the Permittees have emphasized measures that would be applied to areas of NDSR. Some measures listed are also proposed for areas of existing development (as described in the Source Control and MS4 Maintenance Program).

## 8.3 Proposed Best Management Practices

**Table 8-1** lists the proposed BMPs for the NDSR Program. The status of the proposed BMPs is shown in the final column of **Table 8-1**, to indicate whether the BMP is an existing program, existing program with planned enhancements based on the MS4 permit renewal, or a new program that is a result of the MS4 permit renewal and the gap analysis. Descriptions of each BMP are provided in **Appendix B**.

**Table 8-2** lists the proposed NDSR BMPs that address each of the permit elements. There is a heavy emphasis on continuing and expanding existing practices. This approach is adopted as it is consistent with existing measures and programs that, based on review of local water quality data, have been found to be effective in managing the quality of urban runoff in the Las Vegas Valley study area (MWH, 2010a). Discussions of the proposed measures and how they satisfy each of the specific MS4 permit requirements for the NDSR program are provided in the following subsections.

In addition to the BMPs specifically assigned to the NDSR program, most of the BMPs in the Public Education, Source Control and MS4 Maintenance, Illicit Connection and Industrial Programs will be automatically applied to all areas of new development. For example, the street sweeping program in BMP MM-1 will be applied to all new streets in areas of new development. Similarly, the channel inspection BMP SC-28 will automatically be extended to new regional channels in areas of new development.

**Table 8-1. Proposed BMPs for NDSR Program**

| Measure Type | ID No. | Proposed BMP | Status |
|---|---|---|---|
| Source Control | SC-18 | Stormwater Outfall Map | Existing Program |
| Source Control | SC-35 | Stormwater Outfall Map with Areas of NDSR | Existing Program Enhancement |
| Site Design | SD-1 | Open Space and Landscaping Objectives | Existing Program |
| Site Design | SD-2 | Rural Land Overlay | Existing Program |
| Site Design | SD-3 | Hillside Development Ordinances | Existing Program |
| Site Design | SD-4 | Sustainability and Green Building Initiatives | Existing Program |
| Site Design | SD-5 | Covered Fuel Areas | Existing Program |
| Site Design | SD-6 | Raised Fuel Areas | Existing Program |
| Site Design | SD-7 | Emergency Shut-off Switch and Shear Valve | Existing Program |
| Site Design | SD-8 | Standard Drainage Design Criteria | Existing Program Enhancement |
| Site Design | SD-9 | Parking Lot Low Impact Development (LID) Measures | New Program |
| Site Design | SD-10 | Low Impact Development (LID) Measures | New Program |
| Treatment Control | TC-4 | Sand/Oil Separator | Existing Program |
| Treatment Control | TC-5 | Sand Filter | Existing Program |

## Table 8-2. New Development and Significant Redevelopment Program for the Las Vegas Valley

| MS4 Permit Section | MS4 Permit Requirements | Proposed Measures |
|---|---|---|
| IV.F.3.a.i | Describe how the Permittees will develop, implement and enforce a program to address post-construction urban runoff from NDSR projects that disturb areas ≥1 acre, including projects <1 acre that are part of a larger common plan of development or sale, that discharge into the MS4 by ensuring that NDSR projects are complying to the MEP with the requirements of this program. | All measures apply to NDSR projects that disturb ≥1 care and smaller projects that are part of a larger common plan of development. Most BMPs are watershed–scale measures that apply to all new and existing development. |
| IV. F.3.a.ii | Describe how the Permittees will develop low-impact development ("LID") measures that will remain in effect after construction is complete | SD-1 – Open space set-asides<br>SD-9 – Parking Lot Low Impact Development (LID) Measures<br>SD-10 – Low Impact Development (LID) Measures |
| IV.F.3.a.iii | Describe how the Permittees will develop any additional structural and non-structural BMPs that will remain in effect after construction is complete and are effective and appropriate for Las Vegas Valley and its environment. | Additional measures are:<br>SD-9 – Parking Lot Low Impact Development (LID) Measures<br>SD-10 – Low Impact Development (LID) Measures<br>Upgraded public education and outreach<br>Upgraded interagency coordination |
| IV. F.3.a.iv | Describe procedures to assure that future regional flood management projects assess the impacts on the water quality of receiving water bodies and that existing structural flood control devices have been evaluated to determine if retrofitting the device to provide additional pollutant removal from stormwater is feasible and appropriate; | Treatment Control measures included in the Watershed Program of the SWMP. |
| IV. F.3.a.v | Describe how the Permittees will develop and implement an ordinance or other regulatory mechanism to address urban stormwater runoff from NDSR projects. | See Section 8.3.3.5 |
| IV. F.3.a.vi | Describe how the Permittees will provide verification of maintenance provisions for structural BMPs located on private property that are subject to post-construction structural BMP requirements. | See Section 8.3.3.6 |
| IV. F.3.a.vii | Describe how the Permittees will develop and implement an inventory and tracking system for post-construction structural stormwater BMPs. | See Section 8.3.3.6 |
| IV. F.3.a.viii | Describe how the Permittees will inspect and enforce the proper installation and long-term maintenance of post-construction structural stormwater BMPs. | See Section 8.3.3.6 |
| IV. F.3.a.ix | Describe how the Permittees will update its MS4 maps to show areas of NDSR, including any new stormwater major infrastructure that was constructed to serve these areas. | SC-18 – Stormwater Outfall Map<br>SC-35 – Stormwater Outfall Map with Areas of NDSR |

**Table 8-2. New Development and Significant Redevelopment Program for the Las Vegas Valley (Continued)**

| MS4 Permit Section | MS4 Permit Requirements | Proposed Measures |
|---|---|---|
| IV. F.3.b.i | Residential subdivisions five (5) acres or greater in size; | SD-1 – Open Space and Landscaping Objectives<br>SD-2 – Rural Land Overlay<br>SD-4 – Sustainability and Green Building Initiatives<br>SD-10 – Low Impact Development (LID) Measures<br>Source Control measures included in the Public Outreach & Education Program of the SWMP. |
| IV. F.3.b.ii | Single-family residences subject to local ordinances governing hillside development; | SD-3 – Hillside Development Ordinances |
| IV. F.3.b.iii | 100,000 square foot commercial and industrial developments; | TC-4 – Sand/Oil Separator<br>TC-5 – Sand Filter<br>Source Control Measures included in the Source Control, Illicit Discharge Detection and Industrial Facility Monitoring & Control Programs of the SWMP. |
| IV. F.3.b.iv | Automotive repair shops (with Standard Industrial Classification ("SIC") codes 5013, 7532, 7533, 7534, 7537, 7538, and 7539); | Source Control Measures included in Source Control, Illicit Discharge Detection and Industrial Facility Monitoring & Control Programs of the SWMP. |
| IV. F.3.b.v | Retail gasoline outlets disturbing greater than one (1) acre; | SD-5 – Covered Fuel Areas<br>SD-6 – Raised Fuel Areas<br>SD-7 – Emergency Shut-off Switch and Shear Valve |
| IV. F.3.b.vi | Restaurants disturbing greater than one (1) acre; | Source Control measures included in the Source Control and Industrial Facility Monitoring & Control Programs of the SWMP |
| IV. F.3.b.vii | Parking lots greater than one (1) acre potentially exposed to urban runoff; and | SD-9 – Parking Lot Low Impact Development (LID) Measures |
| IV. F.3.b.viii | Any other NDSR projects the Permittees deem necessary to be included in this part. | Hotel/Casinos – same BMPs already identified for commercial/industrial sites, restaurants, and parking lots |

### 8.3.1 Permit Section IV.F.1 – New Development and Significant Redevelopment Program

The MS4 Permit requires the Permittees to develop and implement a Post-Construction Program that is suited for the unique hydrologic, hydrogeologic and regional conditions of the Las Vegas Valley. Section 3 of the SWMP describes these unique conditions, which are characterized by extremely low annual rainfall, isolated intense thunderstorms, low wet and dry weather streamflows, poor soils for stormwater infiltration, and an effective existing system of regional stormwater infrastructure. Section 3 also outlines the regional approach adopted for stormwater management because of these unique factors. The NDSR Program follows this approach by relying heavily on regional rather than onsite controls, and by adopting effective management strategies that do not rely primarily on infiltration for stormwater disposal. An NDSR program has been proposed that is technically and economically feasible for Las Vegas Valley, and has the industry and political support to actually be implemented.

### 8.3.2 Permit Section IV.F.2 – New Development and Significant Redevelopment Program Goals

The MS4 Permit section requires the Post-Construction Program to meet the following goals.

- *To prevent stormwater discharges from post-construction projects from causing or contributing to downstream violations of water quality standards of selenium to the MEP.* The primary source of selenium in Las Vegas Valley surface water is resurfacing groundwater in lower Las Vegas Wash and associated tributaries and seeps. This is described in *Technical Memorandum No. IV.6 – Limitations on Use of Infiltration-Based BMPs for New Development and Significant Redevelopment in Las Vegas Valley* (MWH, 2010d). The NDSR Program avoids relying on induced infiltration of stormwater that could transport additional selenium to drainages in the lower Valley. In addition, several BMPs minimize use of water for landscape irrigation and thus minimize infiltration to the shallow aquifer and return flows to the MS4.
- *To promote anti-degradation of ambient water quality by reducing the discharge of pollutants in stormwater causing or contributing to any degradation identified by NDEP's anti-degradation program.* The NDSR Program was developed to manage discharges of pollutants to the surface water system. In addition, management practices were selected with the intent of minimizing potential impacts on groundwater quality, and minimizing consequences of increasing discharges of poor quality groundwater on surface water quality.
- *To develop BMPs to promote the reuse of stormwater for municipal water supplies.* Beneficial use of stormwater in Las Vegas Valley does not occur through locally capturing runoff and using it onsite. Rather, the best beneficial use of stormwater is to deliver as much runoff of good quality as possible to Lake Mead. SNWA delivers the majority of the Las Vegas Valley water supply from Lake Mead through Nevada's allotment of Colorado River water. The NDSR Program meets this goal by not relying heavily on infiltration of stormwater but by managing runoff quality and conveying runoff to Lake Mead where it can be recovered by SNWA for local water supplies.

### 8.3.3 Permit Section IV.F.3 – New Development and Significant Redevelopment Program Elements

The NDSR Program addresses the elements included in permit sections *IV.F.3.a* through *IV.F.3.d*, as described in the subsections below.

#### *8.3.3.1 Permit Section IV.F.3.a.i – Applicable Area of NDSR Program*

The MS4 Permit requires the Permittees to set a minimum limit of 1.0 acre for applicability of the Post-Construction Program to NDSR areas. All BMPs incorporated into the NDSR program will be applied as a minimum to new development and significant redevelopment projects with land disturbance of at least 1.0 acre. They will also apply to smaller areas that are part of a common plan of development or sale that disturbs at least 1.0 acre. The majority of proposed BMPs are implemented regionally or at the watershed scale, and will thus apply to all new development and redevelopment, as well as all existing development.

#### 8.3.3.2 Permit Section IV.F.3.a.ii – LID Measures

The MS4 Permit requires the Permittees to consider LID measures for managing runoff from areas of new development and significant redevelopment. LID consists of a variety of site planning and site design measures or practices to minimize the impact of individual urban developments on stormwater runoff quantity and quality. A detailed evaluation of potentially feasible LID measures for Las Vegas Valley is presented in *Technical Memorandum No. IV.10 – Evaluation of Low Impact Development Measures for NDSR Program* (MWH, 2010h).

LID measures were selected for the Las Vegas Valley LID "toolbox" using the following process.

1. Review all known LID measures based on national manuals and guidelines.
2. Identify those LID measures that would be feasible in the context of the Las Vegas Valley climate, hydrology, hydrogeology, and watershed conditions.
3. Identify those locally feasible measures that meet the objective of LID for the NDSR Program, which is to fill gaps in existing measures or supplement existing programs.

The LID measures determined to be feasible for use in the Las Vegas Valley NDSR program, are listed in **Table 8-3**.

**Table 8-3. LID Measures for the Las Vegas Valley NDSR Program**

| LID Category | Specific Measure or Practice |
|---|---|
| Minimize directly connected impervious area | Minimize overall impervious area |
| | Direct runoff onto properly designed unpaved surfaces |
| | Disconnect rooftop drains |
| Parking Lot Design | Depressed medians |
| | Buffer strips |
| | Porous paving – modular pavers |
| | Minimize parking requirements |
| Street Design | Minimum street widths |
| | Cul de sac design |
| | Buffer strips |
| | Depressed medians |
| Site Design | Depressed landscaping |
| | Landscaped drainage swales |
| | Open space set-asides |
| | Density tradeoffs |
| Landscape Design | Xeriscaping |
| | Depressed landscape areas |
| | Buffer strips |

These LID measures have been incorporated into the various elements of the NDSR Program as appropriate. Some are part of the standard process of planning and designing new developments in Las Vegas Valley (e.g., open space set-asides, density tradeoffs, street design), others are part of the regional landscaping policies (e.g., xeriscaping), and others may be applied to design of new parking lots under the proposed Parking Lot Design Program.

The BMPs addressing this permit section are as follows:

- SD-1 Open Space Set-asides. The open space set-aside measure allows entity planning departments to work with master plan communities to allow more open space and set landscaping requirements in large developments in trade for other considerations. This measure includes the preservation of natural washes, allowing entities to limit development in and near natural wash floodplains. These land use planning approaches allow preservation of open space and permeable areas that will generate less runoff and pollutant load than developed areas, preservation of natural wash areas that may provide natural runoff treatment, and minimization of development immediately adjacent to active stream courses.
- SD-9 Parking Lot LID Measures. Measures will require application of LID measures to most new parking lots. These measures will reduce runoff rates and volumes and pollutant loads generated from new parking lots.
- SD-10 LID Measures. This BMP consists of voluntary measures for managing runoff from areas of new development and significant redevelopment, consisting of a variety of site planning and site design measures or practices to minimize the impact of individual urban developments on stormwater runoff quantity and quality.

#### 8.3.3.3 Permit Section IV.F.3.a.iii – New NDSR Programs

The MS4 Permit requires the Permittees to assess existing programs and identify new programs necessary to meet the goals of the Post-Construction Program. The following additional BMPs are proposed and are described below:

- Additional mandatory BMPs for parking lots.
- Voluntary LID measures for all types of development.
- Upgraded public outreach and education program.
- Upgraded interagency coordination.

Although local water quality data does not show high concentrations of pollutants typically associated with parking lots (hydrocarbons, heavy metals), they are listed among the land uses requiring special attention in the MS4 permit (paragraph *IV.F.3.b.vii*). The BMP gap analysis shows there are few existing practices specifically targeting parking lot runoff. Based on review of potential parking lot BMPs, several site design measures were selected as being feasible for Las Vegas Valley. It was decided that treatment control measures (e.g., sand filters, oil/water separators, hydrodynamic separators) would not be mandated but could be used by the developer to address stormwater issues if other site design or source control measures are not feasible. Source control measures for parking lots generally involve site housekeeping and maintenance practices; this will be addressed through the upgraded public outreach program. In addition to source control measures, site design measures for NDSR parking lots are addressed in SC-9 Parking Lot LID Measures.

An expanded public outreach and education program is needed to address issues of general public awareness for new residents, as well as concerns associated with new commercial and industrial site

owners in targeted categories. The details of this program are presented under the Public Outreach and Education Program.

Many agencies and groups of agencies are involved with various aspects of water quality management in Las Vegas Valley. Improved coordination among these agencies would result in more efficient and effective water quality management programs and policies. Permittees will be more involved with regional water quality planning agencies in order to explain program objectives and coordinate activities.

LID measures have been described for street design, landscape design, and general land development, as listed in **Table 8-3**. These measures will be voluntary. The Permittees will review current development codes and standards and, where feasible, remove constraints to implementing the identified LID measures.

#### *8.3.3.4 Permit Section IV.F.3.a.iv – Flood Control Facility Design and Retrofit*

The MS4 Permit requires the Permittees to assure that new flood control facilities are designed with water quality objectives in mind, and that existing facilities are reviewed for potential retrofit opportunities to improve water quality benefits. The Permittees have determined that the best opportunities for adding water quality design features to new and existing flood control facilities occur at regional detention basins. Therefore, a plan has been developed to investigate the feasibility and benefits of retrofitting existing regional detention basins to improve their pollutant removal capabilities for small storms using one or more strategies (e.g., modified water quality outlet, in-basin sediment storage, wetland vegetation). A proposed strategy for investigating and implementing a regional detention basin retrofit program has been developed by the Permittees, and is described in a separate memorandum (*Technical Memorandum No. IV.11 0 Potential Water Quality Retrofits of Regional Detention Basins – Strategic Plan;* MWH, 2010i). In summary the plan consists of the following:

- Target water quality capture volumes were established for each major watershed in Las Vegas Valley based on developable land area.
- A master plan for detention basin design and retrofitting will be prepared.
- Regional detention basins will be designed or retrofit to provide the target water quality capture volume based on the following priority:
  - New regional detention basins with urbanized watersheds will be outfitted with water quality outlet structures;
  - Regional detention basins that must be upgraded due to flood control inadequacies will be provided with water quality outlet structures;
  - Other existing regional detention basins may be retrofit as needed to meet the target water quality capture volume for the major watershed.

This BMP is TC-1 Regional Detention Basins, and is described as part of the Watershed Program.

#### 8.3.3.5 Permit Section IV.F.3.a.v – Stormwater Ordinances

The MS4 Permit requires the Permittees to develop and implement an ordinance or regulatory mechanisms to address urban stormwater runoff from NDSR projects. The Permittees have committed to modifying their stormwater ordinances as necessary to accommodate the requirements of the new NDSR program. The following Post-Construction BMPs will require changes to ordinances, codes or development standards.

- SD-8 Standard Drainage Design Criteria. Permittees will modify drainage design criteria and development standards to remove obstacles to implementing LID measures in new developments. This will make it easier for new projects to use LID design concepts that reduce runoff rates and volumes.
- SD-9 Parking Lot LID Measures. Development standards will be modified to include requirements for LID parking lot designs.
- SD-10 LID Measures. Development codes and standards will be reviewed to remove obstacles for implementing LID measures.

Revised stormwater regulatory mechanisms for each entity will be prepared by staff and reviewed by the Stormwater Stakeholders Working Group. Revised ordinances or development standards will be adopted by August 31, 2012. New and updated NDSR ordinances will be included in the Annual Report in the year for which they were created and revised.

#### 8.3.3.6 Permit Sections IV.F.3.a.vi and IV.F.3.a.viii – Maintenance, Inspection and Enforcement of BMPs on Private Property

The MS4 Permit requires the Permittees to: provide verification of maintenance provisions for structural BMPs located on private property that are subject to post-construction structural BMP requirements (paragraph *IV.F.3.a.vi*) and inspect and enforce the proper installation and long-term maintenance of post-construction structural stormwater BMPs (paragraph *IV.F.3.a.viii*). Maintenance of structural BMPs on private property is the responsibility of the private property owner. However, the Permittees understand that in some instances it may be necessary for private facilities to be inspected to assure adequate protection of the region's water quality.

The proposed program for verifying and enforcing adequate maintenance of privately owned and operated structural BMPs is as follows.

- Each individual entity will prepare a list of specific new development and redevelopment projects that pose a significant threat to water quality due to stormwater runoff or non-stormwater discharges. Each entity will develop its own criteria and process for identifying these projects. The following criteria will be considered:
  - Proximity to a major watercourse
  - Type of development/land use and activities expected to occur
  - Types of materials expected to be present onsite
  - Size of development

- History of similar sites or site owner/operators in complying with stormwater regulations and management practices
- Coverage by other environmental regulatory programs (e.g., hazardous materials)

This list will be updated at least annually.

- Each entity will establish priorities for inspecting new development and redevelopment sites on the list developed in Step 1. Priorities could be based on a number of factors, including perceived level of water quality threat, ability to integrate with other environmental inspection programs (e.g., industrial pretreatment program), and interest from business groups (e.g., hotel/casinos).
- Regardless of their priority or presence on the list developed in Step 1, inspections will be conducted for sites for which public complaints are received.
- Inspections will consist of visual observations only, and may be performed by a variety of types of entity personnel, depending on the type of site involved (i.e., industrial, commercial or residential).
- Entities currently have authority to inspect private facilities under existing stormwater ordinances, and can enforce existing ordinances related to nuisance conditions, littering, and prohibited non-stormwater discharges to the MS4.
- When potential problems are observed, the entity will take one of the following responses, depending on the severity of the potential problem and consistent with existing ordinances.
  - Discuss the problem with the site owner/operator and request corrective action
  - Send a letter to the site owner/operator requesting corrective action
  - Cite the site owner/operator for violation of stormwater ordinances.
- The objective of the program is to work with site owners/operators to educate them on the importance of proper site maintenance and gain compliance with accepted practices, as opposed to punishment.

Proper installation of post-construction structural stormwater BMPs on private property will be verified by the Permittees using one of three methods.

- Inspection may be performed under the Construction Site Program, by timing the last visit by construction site inspectors to review construction practices as well as verify that post-construction BMPs have been installed properly.
- Inspection may be performed by Building Department inspectors following completion of construction, as part of their normal inspection process.
- In Clark County the engineer-of-record for a construction project is required to certify that drainage facilities have been properly installed. This certification can be expanded to include post-construction stormwater BMPs.

Post-construction structural BMPs on new sites owned and operated by the entities will be inspected and properly maintained by the entity's public works department or other staff under current maintenance policies. BMPs on sites owned by other public agencies and departments (for example, Clark County School District, Clark County Department of Aviation, state agencies, federal agencies) are considered to be the responsibility of those agencies. However, the Permittees will inform these agencies of any public complaints received on issues affecting stormwater quality, and may perform site inspections if considered necessary to prevent pollutants from entering the MS4 in accordance with their stormwater ordinances.

#### *8.3.3.7 Permit Section IV.F.3.a.vii – BMP Inventory and Tracking*

The MS4 Permit requires the Permittees to develop and implement an inventory and tracking system for post-construction structural stormwater BMPs. The Permittees propose track information related to both structural and non-structural BMPs. This process is described below.

- Several non-structural measures applied to all areas of new development (street sweeping, storm drain system maintenance, household hazardous waste collection, fertilizer/pesticide/herbicide management) will be tracked and reported as part of the Source Control and MS4 Maintenance Plan (see Technical Memorandum No. IV.4 – Proposed Source Controls and Maintenance Program, MWH 2010b).
- Inspections of new industrial sites will be tracked as part of the Industrial Facility Program.
- Outreach activities for new residents and new commercial/industrial site owners will be tracked as part of the Public Outreach and Education Program.
- Certain non-structural measures are the primary responsibility of other agencies, which will be responsible for separate monitoring and tracking according to their adopted policies and procedures. These measures are: Grease Interceptor Program (wastewater agencies), Dust Control Measures (Clark County Department of Air Quality and Environmental Management), and Southern Nevada Health District inspections. Tracking information on these measures will not be reported as part of the annual MS4 permit documentation.
- For the new Parking Lot LID Program, all new parking lots falling under the program authority will have to comply with its requirements. The Permittees will track and report any changes to the parking lot BMP design standards and requirements.
- The number of new regional detention basins and the number of miles of new stabilized flood control channels (concrete, riprap, grade controls) is tracked by CCRFCD as part of its Master Plan implementation, and will be reported for the MS4 permit under the Watershed Program.
- The number of new Las Vegas Wash erosion control structures is tracked by SNWA as part of its Master Plan implementation, and will be reported for the MS4 permit under the Watershed Program.

- An inventory of regional detention basins with water quality features (new or retrofitted) will be maintained. The inventory will include facility location, type and size. The volume of material removed from water quality features in each regional detention basin will be tracked and reported under the Watershed Program.

#### 8.3.3.8 Permit Section IV.F.3.a.ix – NDSR Map

The MS4 Permit requires the Permittees to update the MS4 maps to show areas of NDSR, including any new stormwater major infrastructure that was constructed to serve these areas (see SC-35 Stormwater Outfall Map with Areas of NDSR). A single valley-wide GIS map depicting areas of new development and significant redevelopment in Las Vegas Valley will be prepared based on asset tracking software currently used by the entities and review of aerial photographs or similar resources. Data will be compiled only for development projects that have been completed (i.e., have received Certificates of Occupancy, Certificates of Completion, etc). The map may show boundaries of newly developed areas, or may simply indicate the approximate location of new development. A tabulation of the approximate acreage of new development and significant redevelopment occurring in each jurisdiction will be prepared. CCRFCD regularly updates GIS maps of regional flood control infrastructure based on construction projects it funds and 5-year updates of the Master Plan Update for Las Vegas Valley. An updated map showing new development and new flood control infrastructure completed during the previous permit year will be provided in each MS4 Annual Report. The following Post-Construction BMP will be developed:

#### 8.3.3.9 Permit Section IV.F.3.b – New Development and Significant Redevelopment Project Categories

The MS4 Permit requires the Permittees to adopt BMPs for specific land uses and development types. Selected BMPs may be site design, source control or treatment control BMPs. Structural BMPs should be designed based on accepted and standard criteria to be developed by the Permittees.

Specific land uses and development types listed in the subsections of permit section *IV.F.3.b*, are listed in **Table 8-4**. NSDR BMPs that specifically address these land uses and development types are also listed in **Table 8-4**. However, as noted previously, the Las Vegas Valley NDSR program stresses regional, watershed-based measures that address runoff from all land use types and from both new and existing urban development. These regional watershed-based measures contribute significantly to managing runoff from the specific land uses identified in the permit. Although not listed in Table 8-4, the following watershed-based measures apply to one or more of the specific land use types:

- SC-11 Storm Drain Marking Program
- SD-1 Open Space and Landscaping Objectives
- SD-2 Rural Land Overlay
- SD-4 Sustainability and Green Building Initiatives

**Table 8-4. NDSR BMPs for Specific Land Uses**

| Special Land Use | NDSR BMP |
|---|---|
| Residential subdivisions five (5) acres or greater in size | SD-10 – Low Impact Development (LID) Measures<br>All watershed-based measures apply. |
| Single-family residences subject to local ordinances governing hillside development | SD-3 – Hillside Development Ordinances |
| 100,000 square foot commercial and industrial developments | TC-4 – Sand/Oil Separator<br>TC-5 – Sand Filter<br>Source Control measures included in the Source Control, Illicit Discharge & Detection, and Industrial Facility Monitoring & Control programs of the SWMP. |
| Automotive repair shops (with Standard Industrial Classification ("SIC") codes 5013, 7532, 7533, 7534, 7537, 7538, and 7539) | Source Control measures included in the Source Control, Illicit Discharge & Detection, and Industrial Facility Monitoring & Control programs of the SWMP. |
| Retail gasoline outlets disturbing greater than one (1) acre | SD-5 – Covered Fuel Areas<br>SD-6 – Raised Fuel Areas<br>SD-7 – Emergency Shut-off Switch and Shear Valve |
| Parking lots greater than one (1) acre potentially exposed to urban runoff | SD-9 – Parking Lot Low Impact Development (LID) Measures |
| Any other NDSR projects the Permittees deem necessary to be included in this part. | Hotel/Casinos – same BMPs already identified for commercial/industrial sites, restaurants, and parking lots |

The MS4 Permit allows the Permittees to identify any other locally unique land use types that could cause or contribute to stormwater quality problems. The Permittees have identified hotel/casinos as locally unique development types that deserve consideration. BMPs already identified for new commercial/industrial sites, restaurants and parking lots will be effective for new hotel/casino sites. If requested, Permittees will conduct site audits with new hotel/casino managers to assure that all possible BMPs are used and implemented properly.

### 8.3.4 Permit Section IV.F.4 – Design Standards

The MS4 Permit requires that NDSR projects will implement design standards as indicated in permit sections *IV.F.4.a* through *IV.F.4.d*. The design standards address the following criteria:

- Peak-Urban Runoff Discharge Rates
- Site Design BMPs
- Source Control BMPs
- Treatment Control BMPs

The Permittees propose to use all of the design standards described in the above mentioned permit sections; thus, no measures are required for permit section *IV.F.4.e*.

#### *8.3.4.1 Permit Section IV.F.4.a – Peak Urban Runoff Design Standards*

The MS4 Permit requires that the Permittees describe how they will develop design standards for peak-urban runoff from NDSR projects that will provide protection against downstream erosion. Permittees currently have design standards for new development that require stabilization of onsite and offsite drainageways to protect against erosion. Regional facilities are designed for the 100-year

discharge using projected full drainage area development; local facilities are designed for the 100-year discharge. In each case hydrologic and hydraulic design criteria are applied from the CCRFCD Hydrologic Criteria and Drainage Design Manual (HCDDM). In addition, CCRFCD has policies for stabilizing all flood control channels (measure TC-2), and SNWA is implementing its Las Vegas Wash stabilization program (measure TC-3). These measures are included in the Watershed Program.

#### *8.3.4.2 Permit Section IV.F.4.b – Site Design BMPs*

The MS4 Permit requires that the Permittees describe how they will develop and implement site design BMPs in the site layout during the design and approval process. Site design BMPs proposed for the NDSR Program consist of measures SD-1 through SD-10 in **Appendix B**. Each measure is applied during the site design and approval process. The ability of each measure to meet the goals of the NDSR program is described below.

- SD-1 Open Space and Landscaping Objectives. Allows entity planning departments to work with master plan communities to allow more open space, set landscaping requirements in large developments in trade for other considerations and limit development in and near natural wash floodplains. These factors allow preservation of open space and permeable areas that will generate less runoff and pollutant load, preservation of natural wash areas that may provide natural runoff treatment, and minimization of development immediately adjacent to active stream courses.
- SD-2 Rural Land Overlay. Lets entities set special development standards for rural areas that don't require curb-and-gutter and other improvements. This reduces runoff rates and volumes and results in less pollutant load.
- SD-3 Hillside Development Ordinances. Limits development or sets strict criteria for developing on steep slopes. This reduces high flow rates from areas that could be susceptible to erosion.
- SD-4 Sustainability and Green Building Initiatives. The Permittees will promote green building practices including stormwater management designs for new developments that minimize runoff rates and volumes and provide onsite treatment. This approach will particularly be applied to new public projects, but incentives may also be provided to private developers.
- SD-5, SD-6, SD-7 Covered Fuel Areas, Raised Fuel Areas, Emergency Shut-Off Switch and Shear Valve. The Gas Station measures will reduce the potential for gas stations to contribute pollutants to the MS4 through stormwater runoff or fuel spills.
- SD-8 Standard Drainage Design Criteria. Permittees will modify drainage design criteria and development standards to remove obstacles to implementing LID measures in new developments. This will make it easier for new projects to use LID design concepts that reduce runoff rates and volumes.

- SD-9 Parking Lot LID Measures. Permittees will require application of LID measures to nearly all new parking lots. These measures will reduce runoff rates and volumes and pollutant loads generated from new parking lots.
- SD-10 LID Measures. Permittees will allow use of LID site design measures for residential subdivisions and commercial parcels. These measures, if selected by developers, will reduce runoff rates and volumes and pollutant load generated from new development.

#### 8.3.4.3 Permit Section IV.F.4.c – Source Control BMPs

The MS4 Permit requires that the SWMP describe how source control BMPs and design standards will be implemented to meet the following objectives:

- Slopes and channel design or protection to minimize erosion;
- Properly designed outdoor material storage areas; and
- Properly designed trash storage areas.

These requirements will be met by the following BMPs.

- For the slopes and channel design or protection to minimize erosion requirement, measure SD-8 Standard Drainage Design Criteria, requires new developments to stabilize onsite channels and offsite channels that could be affected by runoff from the new development.
- Measure SC-6 – Commercial/Industrial Housekeeping Practices is in the Industrial Facility Program and requires proper design and maintenance of outdoor material storage and handling areas.
- Measure SC-14 – Trash Receptacle Enclosures is in the Source Control and MS4 Maintenance Program, and requires proper design of enclosed outdoor trash containers.

#### 8.3.4.4 Permit Section IV.F.4.d – Treatment Control BMPs

The MS4 Permit requires that the SWMP describe how treatment control BMPs will be developed and implemented. The NDSR program includes development and implementation of treatment control BMPs, which includes volumetric treatment controls and flow-based treatment controls. Volume and flow-based design standards for treatment control measures are described as follows.

- TC-4 Sand/Oil Separator. Sand/oil separators are small vaults with chambers that separate sand (and other heavy particulates) and oil (and other floatables) from the flow stream. Flows and volumes for this measure are designed based on either the 85th percentile storm selected by the Permittees for BMP design, or on the 10-year storm to be consistent with drainage system design.
- TC-5 Sand Filter. Sand filters are treatment devices that are designed to remove small particulates and some dissolved pollutants from stormwater. Flows and volumes for this measure are designed based on either the 85th percentile storm

selected by the Permittees for BMP design, or on the 10-year storm to be consistent with drainage system design.

- The BMPs in the Watershed Program (regional detention basins, regional detention basin retrofits, regional channel lining, Las Vegas Wash Erosion Control Structures) are considered treatment controls. Design standards for these regional flood control facilities are provided in the CCRFCD Hydrologic Criteria and Drainage Design Manual.

### 8.3.5 Permit Section IV.F.5 – Effect on Water Quality Standards and Drinking Water Supply

The MS4 Permit requires that the Permittees provide a written evaluation of impacts of the NDSR program on water quality standards and drinking water supply, as described in permit section *IV.F.5*. The NDSR program described in the previous sections addresses the pollutants of concern in new development and significant development in Las Vegas Valley to the MEP. The Las Vegas Valley MS4 permit for Las Vegas Valley also recognizes three additional stormwater management goals. The ability of the NDSR Program to achieve these goals is described below.

*To prevent stormwater discharges from post-construction projects from causing or contributing to downstream violations of water quality standards of selenium to the MEP.* Selenium is contributed to the MS4 primarily by resurfacing groundwater. The NDSR program avoids these impacts from new development by adopting practices and policies to minimize additional infiltration of stormwater into the shallow aquifer system and reduce the amount of dry weather flow due to over-irrigation of landscaped areas. A key factor in meeting this objective is adopting BMPs that do not rely on onsite infiltration as a means of disposing of stormwater.

*To promote anti-degradation of ambient water quality by reducing the discharge of pollutants in stormwater causing or contributing to any degradation identified by NDEP's anti-degradation program.* Pollutants in Las Vegas Wash surface waters that have caused impairment to water quality conditions are described in MWH, 2010a. These include selenium, phosphorus, TDS, iron, pH and molybdenum. With the exception of iron and molybdenum which are naturally occurring, the NDSR BMPs were selected to target these and other pollutants of concern. In addition, BMPs were selected to avoid adverse impacts to these constituents (e.g., selenium, as described above). TDS is contributed by similar sources as selenium, so the factors described above that avoid selenium impacts also apply to TDS.

*To develop BMPs to promote the reuse of stormwater for municipal supplies.* In Las Vegas Valley, beneficial use of stormwater for municipal supply occurs through delivery of adequate quality stormwater to Lake Mead, from which it is pumped into the municipal water supply system. The proposed NDSR program maximizes delivery of stormwater to Lake Mead by minimizing reliance on stormwater infiltration devices. Infiltrating stormwater to the shallow aquifer system would not benefit the municipal water supply system because shallow groundwater quality is too poor for municipal use. Deep groundwater aquifers are tapped by municipal wells, but these aquifers are recharged by runoff at the mountain front, not by runoff from the valley floor and alluvial fans where urban development is occurring.

## 8.4 Responsibility for Implementation

**Table 8-5** shows the entity responsible for implementing each proposed BMP. In most cases the local entities (Clark County, Cities of Las Vegas, North Las Vegas and Henderson) are responsible for providing staff, equipment and other financial resources to implement the measures. Regional activities common to all Permittees are sometimes the responsibility or funded by CCRFCD (e.g., maintenance of regional flood control facilities, public outreach and education), and sometimes the responsibility of others (e.g., private owners).

**Table 8-5. New Development and Significant Redevelopment Program Responsible Parties, Monitoring and Tracking, and Measurable Goals**

| Best Management Practices | Responsible Parties | Monitoring and Tracking | Measurable Goals |
|---|---|---|---|
| SC-18 – Stormwater Outfall Map | CCRFCD<br>Clark County<br>CLV<br>CNLV<br>CoH | Track new regional flood control facilities (channels, storm drains, detention basins) | Annually report of stormwater outfall |
| SC-35 – Stormwater Outfall and NDSR Map | CCRFCD<br>Clark County<br>CLV<br>CNLV<br>CoH | Track new regional flood control facilities (channels, storm drains, detention basins)<br>Track areas of NDSR | Create stormwater outfall and NDSR map and update annually. |
| SD-1 – Open Space and Landscaping Objectives | Clark County<br>CLV<br>CNLV<br>CoH | Description of new and updated standards and policies as appropriate | 100% compliance with standards and policies |
| SD-2 – Rural Land Overlay | Clark County<br>CLV<br>CNLV<br>CoH | Description of new and updated standards and policies as appropriate | 100% compliance with standards and policies |
| SD-3 – Hillside Development Ordinances | Clark County<br>CLV<br>CoH | Description of new and updated ordinances | 100% of new development complies with Hillside Development Ordinances |
| SD-4 – Sustainability and Green Building Initiatives | Clark County<br>CLV<br>CNLV<br>CoH | None | None |
| SD-5 – Covered Fuel Areas | Industry Standard | None | 100% of all new gas stations have covered fuel areas based on industry standards |
| SD-6 – Raised Fuel Areas | Industry Standard | None | 100% of all new gas stations have raised fuel areas based on industry standards |
| SD-7 – Emergency Shut-off Switch and Shear Valve | Industry Standard | None | 100% of all new gas stations have emergency shut-off switches or shear valves based on industry standards |

**Table 8-5. New Development and Significant Redevelopment Program Responsible Parties, Monitoring and Tracking, and Measurable Goals (Continued)**

| Best Management Practices | Responsible Parties | Monitoring and Tracking | Measurable Goals |
|---|---|---|---|
| SD-8 – Standard Drainage Design Criteria | CCRFCD<br>Clark County<br>CLV<br>CNLV<br>CoH | Review studies and plans for compliance | 100% compliance with design criteria |
| SD-9 – Parking Lot Low Impact Development (LID) Measures | Clark County<br>CLV<br>CNLV<br>CoH<br>Private Owners | Describe new or updated standards and policies | Develop new criteria under SD-8<br>100% compliance with development standards and policies |
| SD-10 – Low Impact Development (LID) Measures | Clark County<br>CLV<br>CNLV<br>CoH<br>Private Owners | None | Review and update ordinances as appropriate.<br>Remove any impediments. |
| TC-4 – Sand/Oil Separator | Clark County<br>CLV<br>CNLV<br>CoH<br>Private Owners | Number of sand/oil separators installed | None |
| TC-5 – Sand Filter | Clark County<br>CLV<br>CNLV<br>CoH<br>Private Owners | Number of sand filters installed | None |

## 8.5 Monitoring and Tracking

The Permittees propose to monitor and track certain key elements of the Post-Construction Program, and report progress annually in the Annual Report. These elements are shown in **Table 8-5.**

## 8.6 Measurable Goals

**Table 8-5** lists measurable goals proposed for the Post-Construction Program. Most goals are numerical and measurable; where this was not possible, narrative goals are proposed.

Goals for existing activities are the same goals that have been part of the previous SWMP for the past several years. The levels of the existing programs have been effective in managing impacts of urban development on the MS4.

## 8.7 Implementation Schedule

**Table 8-6** presents the implementation schedule for the proposed Post-Construction Program measures. Most of the measures are existing activities that are being continuously implemented by the Permittees. In accordance with the requirement of the new MS4 permit, all program measures will be fully implemented within two years of approval of the SWMP by NDEP.

**Table 8-6. Implementation Schedule for Post-Construction Program Measures**

| Best Management Practice | Required Implementation Activities and Time Period after SWMP Approval |
|---|---|
| SD-1 – Open Space and Landscaping Objectives | Existing Practice |
| SD-2 – Rural Land Overlay | Existing Practice |
| SD-3 – Hillside Development Ordinances | Existing Practice |
| SD-4 – Sustainability and Green Building Initiatives | Existing Practice |
| SD-5 – Covered Fuel Areas | Existing Practice |
| SD-6 – Raised Fuel Areas | Existing Practice |
| SD-7 – Emergency Shut-off Switch and Shear Valve | Existing Practice |
| SD-8 – Standard Drainage Design Criteria | Review and revise design standards – 18 months |
| SD-9 – Parking Lot Low Impact Development (LID) Measures | Develop Design Standards – 12 months<br>Revise Design Manual – 18 months<br>Conduct Training Sessions for new Design Standards – 18 months |
| SD-10 – Low Impact Development (LID) Measures | Revise Design Manual – 18 months<br>Conduct Training Sessions for new Design Standards – 18 months |

# 9 ILLICIT DISCHARGE DETECTION PROGRAM

This section presents the proposed program to detect and eliminate illicit discharges and improper disposal into the MS4.

## 9.1 Permit Requirements

Section *IV.G* of the 2010-2015 MS4 Permit for Las Vegas Valley includes the following requirements for an illicit discharge and detection program:

*IV.G.1 The updated SWMP shall include a description of a program, including a schedule, to detect and remove illicit discharges and improper disposal into the MS4. The program shall include:*

*IV.G.1.a A description of a program, including inspections, to implement and enforce an ordinance, orders or similar means to prevent all types of illicit discharges to the MS4. Non-stormwater discharges, as defined in Part I.B.2.b, shall only be addressed where such discharges are identified by the Permittee as substantial contributors of pollutants to the Permittee's MS4;*

*IV. G.1.b A description of procedures to conduct on-going field screening activities during the life of this permit, including areas or locations that will be evaluated by such field screens;*

*IV. G.1.c Field screening protocol to investigate dry weather flows that would indicate when an illicit discharge may be present, and when follow-up investigation will be required;*

*IV. G.1.d A description of procedures to be followed to investigate portions of the MS4 that, based on the results of the field screen, or other appropriate information, indicate a reasonable potential of containing illicit discharges or other sources of non-stormwater;*

*IV. G.1.e A description of procedures to prevent, contain, and respond to spills that may discharge into the MS4;*

*IV. G.1.f A description of a program to facilitate public reporting of the presence of illicit discharges or water quality impacts associated with discharges from MS4s;*

*IV. G.1.g A description of educational activities, public information activities, and other appropriate activities to facilitate the proper management and disposal of used oil and toxic materials; and*

*IV. G.1.h An assessment of whether the procedures otherwise implemented in response to this section are sufficient to identify instances of exfiltration from the sanitary sewer to the storm sewers, and if not, a description of additional activities to be undertaken to control exfiltration.*

## 9.2 Program Development

The Illicit Discharge and Detection Program was developed by first reviewing existing practices performed by the Permittees that detect and remove illicit discharges and improper disposal in the MS4. These practices may be implemented specifically for the MS4 permit program, or may be implemented primarily to meet other community objectives. In either case, they are considered part of the overall Illicit Discharge and Detection Program. Existing practices consist primarily of enforcement of ordinances prohibiting discharges of non-stormwater to the MS4; field screening consisting of flow sampling during dry weather conditions; semi-annual inspections of all major open channels and detention basins; and public outreach and education. Review and analysis of dry weather monitoring data is described in *Technical Memorandum No. IV.1 – Summary and Evaluation of Las Vegas Valley Water Quality Data, MWH*, 2010a. This review determined that existing measures have been successful in avoiding increases in pollutant concentrations in dry weather flow in Las Vegas Valley despite the large increase in population and developed areas since 1991. New measures were identified, where needed, to meet the specific program requirements as outlined in the permit.

The Illicit Discharge and Detection Program includes BMPs that fit within the pollution prevention portions of the overall SWMP management plan framework depicted in **Figure 3-9**. The measures to accomplish this goal could be structural or non-structural.

## 9.3 Proposed Best Management Practices

**Table 9-1** lists the proposed BMPs for the Illicit Discharge and Detection Program. The status of the proposed BMPs are shown in the final column of **Table 9-1**, to indicate whether the BMP is an existing program, existing program with planned enhancements based on the MS4 permit renewal, or new program that is a result of the MS4 permit renewal. Descriptions of each BMP are provided in **Appendix B**.

**Table 9-2** lists the Illicit Discharge and Detection Program permit elements and the proposed BMPs. Descriptions of how the proposed measures meet each of the permit requirements are provided in the following subsections.

**Table 9-1. Proposed BMPs for the Illicit Discharge and Detection Program**

| Measure Type | ID No. | Proposed BMP | Status |
|---|---|---|---|
| Source Control | SC-12 | Spill Control Prevention Plan | Existing Program |
| Source Control | SC-19 | Sanitary Sewer Line Inspection and Replacement Program | Existing Program |
| Source Control | SC-26 | Storm Channel Inspections | Existing Program |
| Source Control | SC-27 | Dry Weather Monitoring | Existing Program |
| Source Control | SC-29 | Stormwater-Related Complaint Response | Existing Program |

**Table 9-2. Illicit Discharge and Detection Program for the Las Vegas Valley**

| MS4 Permit Section | MS4 Permit Requirements | Proposed Measures |
|---|---|---|
| IV.G.1.a | A description of a program, including inspections, to implement and enforce an ordinance, orders or similar means to prevent all types of illicit discharges to the MS4. | SC-12 – Spill Control Prevention Plan<br>SC-19 – Sanitary Sewer Line Inspection and Replacement Program<br>SC-26 – Storm Channel Inspections<br>SC-27 – Dry Weather Monitoring<br>Source Control measures included in the Public Outreach & Education and Source Control and MS4 Maintenance Measures programs of the SWMP. |
| IV.G.1.b | A description of procedures to conduct on-going field screening activities during the life of this permit, including areas or locations that will be evaluated by such field screens | SC-27 – Dry Weather Monitoring |
| IV.G.1.c | Field screening protocol to investigate dry weather flows that would indicate when an illicit discharge may be present, and when follow-up investigation will be required | SC-27 – Dry Weather Monitoring |
| IV.G.1.d | A description of procedures to be followed to investigate portions of the MS4 that, based on the results of the field screen, or other appropriate information, indicate a reasonable potential of containing illicit discharges or other sources of non-stormwater | SC-26 – Storm Channel Inspections |
| IV.G.1.e | A description of procedures to prevent, contain, and respond to spills that may discharge into the MS4 | SC-12 – Spill Control Prevention Plan<br>SC-29 – Stormwater-Related Complaint Response<br>Source Control measures included in the Source Control and MS4 Maintenance Measures program of the SWMP. |
| IV.G.1.f | A description of a program to facilitate public reporting of the presence of illicit discharges or water quality impacts associated with discharges from MS4s | SC-29 – Stormwater-Related Complaint Response |
| IV.G.1.g | A description of educational activities, public information activities, and other appropriate activities to facilitate the proper management and disposal of used oil and toxic materials | Source Control measures included in the Public Outreach & Education program of the SWMP. |
| IV.G.1.h | An assessment of whether the procedures otherwise implemented in response to this section are sufficient to identify instances of exfiltration from the sanitary sewer to the storm sewers, and if not, a description of additional activities to be undertaken to control exfiltration. | SC-19 – Sanitary Sewer Line Inspection and Replacement Program |

### 9.3.1 Permit Section IV.G.1 – Illicit Discharge and Detection Program

Section *IV.G.1* of the MS4 Permit requires the Permittees to develop a program to detect and remove illicit discharges and improper disposal into the MS4. The following subsections describe the program elements.

#### 9.3.1.1 Permit Section IV.G.1.a – Description of the Program

Section *IV.G.1.a* of the MS4 Permit requires the Permittees to develop a program including inspections, to implement and enforce an ordinance or similar means to prevent all types of illicit discharges to the MS4. Non-stormwater discharges will only be addressed where such discharges are identified by the Permittee as substantial contributors of pollutants to the MS4.

Permittees have all adopted stormwater ordinances that prohibit the discharge of non-stormwater to the MS4, except under certain allowable conditions (see measures in Section 7, Source Control and MS4 Maintenance Program). The Illicit Discharge and Detection Program is intended as means for checking compliance with the ordinances, and providing the public with information to encourage their compliance. The key components of the Illicit Discharge and Detection Program are:

- SC-27 Dry weather monitoring. Field screening (water quality sampling) of several key tributaries to Las Vegas Wash to identify any changes in water chemistry that would indicate the presence of illicit discharge or illegal dumping to the MS4.
- SC-26 Storm Channel Inspections**.** Semi-annual inspections of open channels and detention basins include, but are not limited to, inspecting for evidence of illicit discharges and illegal dumping.
- SC-12 Spill Control Prevention Plan. Plans at industrial sites to prevent and contain spills of hazardous materials that would impact downstream water quality.
- SC-19 Sanitary Sewer Line Inspection and Replacement Program. Program to prevent exfiltration from the sanitary sewer system to the MS4 by assuring the integrity of the sanitary sewer collection system
- Public Outreach and Education. Many of the educational activities included in the Public Outreach and Education Program (Section 6) address the types of behaviors that could result in illicit discharges or illegal dumping to the MS4.

These program elements are described further in the following sections.

#### 9.3.1.2 Permit Section IV.G.1.b – Field Screening Activities

Section *IV.G.1.b* of the MS4 Permit requires the Permittees to develop procedures to conduct on-going field screening activities during the life of this permit, including areas that will be evaluated by the field screenings.

Field screening activities in measure SC-27 Dry Weather Monitoring will consist of quarterly water quality sampling and analysis during dry weather conditions. The dry weather sampling program for the MS4 permit has two primary objectives:

- To develop a baseline of dry weather surface water quality data against which future changes can be measured and which can be used to compute urban pollutant loading to receiving waters
- To target potential illegal or illicit discharges to the MS4

Dry weather monitoring will be conducted by SNWA as part of its Urban Tributary Sampling program, and coordinated with the Permittees. Constituents to be analyzed will be determined by SNWA based on the needs of its Urban Tributary Sampling program. This constituent list will be sufficient to meet the needs of the MS4 program.

The field screening activities will be conducted at the following eight locations in the Las Vegas Valley:

- Meadows Detention Basin
- Flamingo Wash at Nellis Blvd
- Sloan Channel at Charleston Blvd
- Monson Channel at Stephanie St
- Duck Creek at Broadbent St
- Burns Street Channel
- Las Vegas Wash at Desert Rose Golf Course

#### 9.3.1.3 Permit Section IV.G.1.c – Field Screening Protocol for Dry Weather Flows

Section *IV.G.1.c* of the MS4 Permit requires the Permittees to develop field screening protocol to investigate dry weather flows that would indicate when an illicit discharge may be present, and when follow-up investigation will be required.

As described in SC-27 Dry Weather Monitoring, the Permittees will rely on the SNWA Urban Tributary Sampling program to provide the field screening data for the MS4 program. SNWA will collect quarterly samples each year in January, April, July, and October. Single grab samples will be collected at each monitoring site. The constituents that will be analyzed include: major ions, metals, nutrients, and organic compounds. An allowable range for selected constituents has been developed by the Permittees based on historical results to test new data to see if it may provide evidence of illicit discharges. SNWA will alert the Permittees when out-of-range data is encountered. The Permittees will investigate the potential causes of the out-of-range data and determine whether further field investigation is warranted. The data and results from the SNWA sampling program will be reported in the Annual Report.

#### 9.3.1.4 Permit Section IV.G.1.d – Procedures to Investigate Portions of the MS4

Section *IV.G.1.d* of the MS4 Permit requires the Permittees to develop procedures to be followed to investigate portions of the MS4 that, based on the results of the field screen, or other appropriate information, indicate a reasonable potential of containing illicit discharges or other sources of non-stormwater.

MS4 open channels will be formally inspected two times per year by visually observing open channel sections focusing on areas where dry weather flow persists and looking for evidence of non-stormwater discharges. Emphasis will be on those areas that, based on the results of field screening

or other appropriate information, indicate a reasonable potential of containing illicit discharges, exfiltration from the sanitary sewer system, or other sources of non-stormwater.

Under SC-26 Storm Channel Inspections, inspections will be performed by Permittee staff or designated representatives and problems will be reported to the proper authorities. Municipal maintenance staff for streets and storm drains from each Permittee will be trained to look for evidence of non-stormwater discharges to the drainage system during their normal duties. A process for reporting potential problems has been established and will continue to be followed.

#### 9.3.1.5 Permit Section IV.G.1.e – Procedures to Prevent, Contain, and Respond to Spills

Section *IV.G.1.e* of the MS4 Permit requires the Permittees to develop procedures to prevent, contain, and respond to spills that may discharge into the MS4.

The Permittees currently have spill prevention and response regulations and programs in place through their fire departments and contracts with special emergency response contractors, described in SC-12 – Spill Control Prevention Plan. These regulations and programs are authorized in response to other State requirements, but provide benefits to the MS4 program. In addition, the Permittees prepared a Spill Response Strategy to summarize their coordinated approach to responding to illegal spills. Key components of the Spill Response Strategy are described below.

The State and County each have hazardous material emergency response plans that adequately outline field procedures, roles and responsibilities, training requirements, and notifications. Each local entity also has standard operating procedures for dealing with illegal dumping or accidental spills.

The Clark County Local Emergency Planning Committee (LEPC) meets regularly to coordinate the activities of all emergency response agencies in Las Vegas Valley. The LEPC encourages use of common policies and procedures and passes on information related to regulations and spill response techniques. SQMC members coordinate with the LEPC as needed.

A private contractor is used by the Permittees to respond to and clean up hazardous material spills over 25 gallons.

The hazardous material emergency response plans contain extensive notification lists, of individuals and agencies that should be contacted in the event of a hazardous material spill. The CCRFCD is on the standard notification lists to assure that the MS4 representatives are aware of any hazardous material spills that could affect the stormwater systems in their jurisdictions.

#### 9.3.1.6 Permit Section IV.G.1.f – Public Reporting

Section *IV.G.1.*f of the MS4 Permit requires the Permittees to develop a program to facilitate public reporting of the presence of illicit discharges or water quality impacts associated with discharges from MS4s.

The Permittees have developed multiple avenues by which the public can and has reported potential illicit discharges to the MS4. These are described below.

The Co-Permittees' website, **www.lvstormwater.com**, has a link for reporting illicit discharges. This link gives contact information for reporting illicit discharges and clogged storm drains, and has an online complaint form through the Southern Nevada Health District (SNHD). This is BMP SC-30 LVV Stormwater Quality Website in the Public Outreach & Education program of the SWMP.

As described in SC-29 Stormwater-Related Complaint Response, the SNHD has the authority to enforce ordinances prohibiting dumping of solid waste and sewage to the Las Vegas Valley stormwater conveyance systems. The public can call SNHD and report problems directly, or a complaint form for reporting evidence of illegal dumping is found on the **www.lvstormwater.com** website.

The Clark County Public Response Office (CCPRO) receives public complaints related to illegal dumping and other ordinance violations, and is empowered to respond to and address these problems.

Each of the Permittees receives direct reports from citizens reporting dumping, illegal discharges of non-stormwater to the drainage system, maintenance problems, and other activities that may affect water quality. The CLV, CNLV and CoH follow up on these complaints within their jurisdiction; Clark County follows up on complaints in unincorporated Clark County. CCRFCD routinely receives through its citizen contact system and in the past have received citizen complaints in response to its PSAs.

#### 9.3.1.7 Permit Section IV.G.1.g – Public Outreach and Education

Section *IV.G.1.g* of the MS4 Permit requires the Permittees to develop educational activities, public information activities, and other appropriate activities to facilitate the proper management and disposal of used oil and toxic materials.

Many of the BMPs in the Public Outreach and Education Program (Section 6) address the proper disposal of used oil and toxic materials. These programs include the stormwater quality website (lvstormwater.com), distribution of materials at environmental fairs and community events, public service announcements, the Flood Channel, elementary school presentations, and brochures and printed material. Proper disposal of hazardous household chemicals has been a focus of the public outreach program in the past, and will continue to be so in the future.

#### 9.3.1.8 Permit Section IV.G.1.h – Exfiltration from Sanitary Sewers

Section *IV.G.1.h* of the MS4 Permit requires the Permittees to assess whether the procedures otherwise implemented in response to this section are sufficient to identify instances of exfiltration from the sanitary sewer to the storm sewers, and if not, a description of additional activities to be undertaken to control exfiltration.

SC-19 Sanitary Sewer Line Inspection and Replacement Program satisfies this requirement. The Clark County Water Reclamation District Collection System Services currently performs closed circuit televising (CCTV) of sewer collection system assets utilizing the National Association of Sewer Service Companies – Pipeline Assessment Certification Program and Manhole Assessment Certification Program (NASSCO-PACP/MACP). This program focuses on assessing both maintenance and structural deficiencies as well as identifying areas of infiltration, which in some instances could lead to exfiltration. They inspect approximately 80 miles of sewer lines and manholes annually. This program helps ensure that sewage does not get into the storm drain system.

## 9.4 Responsibility for Implementation

**Table 9-3** shows the entity responsible for implementing each proposed BMP. In most cases the local entities (Clark County, CLV, CNLV and CoH) are responsible for providing staff, equipment and other financial resources to implement the measures. Regional activities common to all Permittees are sometimes the responsibility of CCRFCD (e.g., public outreach and education), and sometimes the responsibility of others (e.g., Clark County Water Reclamation District [CCWRD]).

**Table 9-3. Illicit Discharge and Detection Program Responsible Parties, Monitoring and Tracking, and Measurable Goals**

| Best Management Practice | Responsible Parties | Monitoring and Tracking Information | Measureable Goals |
|---|---|---|---|
| SC-12 – Spill Control Prevention Plan | Clark County<br>CLV<br>CNLV<br>CoH | None | None |
| SC-19 – Sanitary Sewer Line Inspection and Replacement Program | CLV<br>CNLV<br>CoH<br>CCWRD | Provide annual description of program<br>Number of miles inspected and amount repaired and replaced (Clark County, CNLV, and CLV) | Minimize sanitary sewer overflows |
| SC-26 – Storm Channel Inspections | Clark County<br>CLV<br>CNLV<br>CoH | Track locations of inspections during storm channel inspections | Each Permittee to conduct semi-annual field inspections of open channels |
| SC-27 – Dry Weather Monitoring | SNWA | Report number of results indicating potential illicit discharges in Annual Report | Conduct dry weather monitoring 4 times per year |
| SC-29 – Stormwater-Related Complaint Response | CCRFCD<br>Clark County<br>CLV<br>CNLV<br>CoH | Track number of stormwater-related complaints | Respond to 100% of stormwater-related complaints<br>Include list of stormwater-related complaints in Annual Report |

## 9.5 Monitoring and Tracking

The Permittees propose to monitor and track certain key elements of the Illicit Discharge and Detection Program, and report progress annually in the Annual Report. These elements are shown in **Table 9-3.**

## 9.6 Measurable Goals

**Table 9-3** lists measurable goals proposed for the Illicit Discharge and Detection Program. Most goals are numerical and measurable; where this was not possible, narrative goals are proposed.

Goals for existing activities are the same goals that have been part of the previous SWMP for the past several years or through the regional implementation entity. The levels of the existing programs have been effective in detecting and eliminating illicit discharges and illegal dumping that could adversely impact surface water quality.

## 9.7 Implementation Schedule

**Table 9-4** presents the implementation schedule for the proposed Illicit Discharge and Detection Program measures. Most of the measures are existing activities that are being continuously implemented by the Permittees. In accordance with the requirement of the new MS4 permit, all program measures will be fully implemented within two years of approval of the SWMP by NDEP.

**Table 9-4. Implementation Schedule for Illicit Discharge and Detection Program Measures**

| Best Management Practice | Required Implementation Activities and Time Period after SWMP Approval |
|---|---|
| SC-12 – Spill Control Prevention Plan | Existing Practice |
| SC-19 – Sanitary Sewer Line Inspection and Replacement Program | Existing Practice |
| SC-26 – Storm Channel Inspections | Existing Practice |
| SC-27 – Dry Weather Monitoring | Existing Practice |
| SC-29 – Stormwater-Related Complaint Response | Existing Practice |

# 10 INDUSTRIAL FACILITY MONITORING AND CONTROL PROGRAM

This section presents proposed measures and practices to monitor and control pollutants in stormwater discharges to MS4s from certain industrial facilities in Las Vegas Valley.

## 10.1 Permit Requirements

Section *IV.H* of the 2010-2015 MS4 Permit for Las Vegas Valley includes the following requirements for an industrial facility monitoring and control program:

*IV.H.1 The updated SWMP shall include a description of a program to monitor and control pollutants in stormwater discharges to MS4s from municipal landfills, hazardous waste treatment, disposal and recovery facilities, industrial facilities that are subject to section 313 of title III of the Superfund Amendments and Reauthorization Act of 1986 ("SARA"), and industrial facilities that the municipal permit applicant determines are contributing a substantial pollutant loading to the MS4. The program shall include the following components:*

*IV.H.1.a Identify priorities and procedures for inspections and establishing and implementing control measures for such discharges;*

*IV.H.1.b Each Permittee shall develop and maintain an inventory of the facilities identified in part IV.H.I The inventory shall list the facilities by specific categories (e.g. restaurants, municipal maintenance yards, etc.) and list the minimum inspection frequency for each category of facilities;*

*IV.H.1.c Each Permittee shall provide a list of the inventoried facilities to NDEP by October 1, 2010. Each year thereafter for the life of this permit, each Permittee shall provide to NDEP by October I of that year, an updated list of the facilities inventoried during that year; and*

*IV.H.1.d Describe a monitoring program for stormwater discharges associated with the industrial facilities identified in this section, to be implemented during the term of the permit in accordance with the monitoring programs defined in Part V.A.*

## 10.2 Program Development

The Industrial Facility Monitoring and Control Program (Industrial Program) was developed by first reviewing existing practices performed by the Permittees that monitor and control pollutants in stormwater discharges to MS4s from specific industrial facilities listed in the permit. These practices may be implemented specifically for the MS4 permit program, or may be implemented primarily to meet other community objectives. In either case, they are considered part of the overall Industrial Program. New measures were then identified, if needed, to meet the specific program requirements as outlined in the permit.

The Industrial Program includes BMPs that fit within the pollution prevention, onsite controls, and treatment control portions of the overall SWMP management plan framework depicted in **Figure 3-9**. The measures to accomplish this goal could be structural or non-structural.

## 10.3 Proposed Best Management Practices

**Table 10-1** lists the proposed BMPs for the Industrial Program. The status of the proposed BMPs are shown in the final column of **Table 10-1**, to indicate whether the BMP is an existing program, existing program with planned enhancements based on the MS4 permit renewal, or new program that is a result of the MS4 permit renewal. Descriptions of each BMP are provided in **Appendix B**.

**Table 10-2** lists the Industrial Program permit elements and the proposed BMPs. Discussion of how the proposed measures meet each of the permit requirements for the Industrial Program are provided in the following subsections.

**Table 10-1. Proposed BMPs for Industrial Facility Monitoring and Control Program**

| Measure Type | ID No. | Proposed BMP | Status |
|---|---|---|---|
| Source Control | SC-6 | Commercial/Industrial Housekeeping Practices | Existing Program |
| Source Control | SC-9 | Grease Interceptor Program | Existing Program |
| Source Control | SC-13 | Industrial Pretreatment Program | Existing Program Enhancement |
| Source Control | SC-15 | Southern Nevada Health District Inspections | Existing Program |
| Source Control | SC-23 | Industrial Facility Stormwater Inspections | Existing Program |
| Source Control | SC-24 | Industrial Facility Stormwater Inventory | New Program |
| Source Control | SC-25 | Industrial Facility Stormwater Inspection Checklist | New Program |
| Source Control | SC-28 | Industrial Facility Inspector Training Workshops | Existing Program |

**Table 10-2. Industrial Facility Monitoring and Control Program for the Las Vegas Valley**

| MS4 Permit Section | MS4 Permit Requirements | Proposed Measures |
|---|---|---|
| IV.H.1.a | Identify priorities and procedures for inspections and establishing and implementing control measures for such discharges | SC-6 – Commercial/Industrial Housekeeping Practices<br>SC-9 – Grease Interceptor Program<br>SC-13 – Industrial Pretreatment Program<br>SC-15 – Southern Nevada Health District Inspections<br>SC-23 – Industrial Facility Stormwater Inspections<br>SC-24 – Industrial Facility Stormwater Inventory<br>SC-25 – Industrial Facility Stormwater Inspection Checklist<br>SC-28 – Industrial Facility Inspector Training Workshops<br>Site Design measures included in the New Development and Significant Redevelopment program of the SWMP<br>Treatment Control measures included in the Watershed program of the SWMP. |
| IV.H.1.b | Each permittee shall develop and maintain an inventory of the facilities identified in part IV.H.I. The inventory shall list the facilities by specific categories (e.g. restaurants, municipal maintenance yards, etc.) and list the minimum inspection frequency for each category of facilities. | SC-24 – Industrial Facility Stormwater Inventory |
| IV.H.1.c | Each Permittee shall provide a list of the inventoried facilities to NDEP by October 1, 2010. Each year thereafter for the life of this permit, each Permittee shall provide to NDEP by October I of that year, an updated list of the facilities inventoried during that year. | To be included in Annual Report |
| IV.H.1.d | Describe a monitoring program for stormwater discharges associated with the industrial facilities identified in this section, to be implemented during the term of the permit in accordance with the monitoring programs defined in Part V.A. | See Section 10.3.1.4 |

### 10.3.1 Permit Section IV.H.1 – Industrial Facility Program

The MS4 Permit requires the Permittees to develop a program to monitor and control pollutants in stormwater discharges to MS4s from:

- Municipal landfills
- Hazardous waste treatment, disposal and recovery facilities
- Industrial facilities that are subject to section 313 of title III of the Superfund Amendments and Reauthorization Act of 1986 ("SARA"), and
- Industrial facilities that the municipal permit applicant determines are contributing a substantial pollutant loading to the MS4.

The program addresses the following specific permit requirements, which are described in the following subsections:

- Identify priorities and procedures for inspections and establishing and implementing control measures for such discharges
- Develop and maintain an inventory of industrial facilities identified in this section
- Provide a list of the inventoried facilities to NDEP by October 1 of each permit year
- Describe a monitoring program for stormwater discharges associated with the industrial facilities identified in this section

#### *10.3.1.1 Permit Section IV.H.1a – Industrial Facility Inspections and BMPs*

The MS4 Permit requires the Permittees to identify priorities and procedures for inspections and establishing and implementing control measures for such discharges. The local Industrial Program complements the State's general industrial stormwater permit program and consists of control measures to reduce the potential for industrial sites to contribute significant pollutant loadings to the MS4. The proposed Industrial Program consists of the following elements:

- SC-6 Commercial/Industrial Housekeeping Practices. Promote maintenance and housekeeping practices on new commercial/industrial sites to prevent contact of rain water with potentially contaminated surfaces and materials and/or control site runoff. Commercial and industrial site operators are required to apply good housekeeping practices in exterior areas such that stormwater runoff would not contact pollutant sources and contribute a substantial load of pollution to the MS4. In addition municipal codes for each of the entities require that all activities and operations at industrial sites and commercial sites where hazardous materials and chemicals are used be conducted in and contained in enclosed structures. This includes gas stations (with the exception of fueling areas), vehicle repair shops, and manufacturing facilities. Code requirements will apply to these types of facilities in all new developments. Locating work areas indoors at new industrial sites will prevent pollutant contact with rain or runoff.
- SC-9 Grease Interceptor Program. Entities have existing ordinances requiring proper removal and disposal of grease from grease traps in restaurants and industrial facilities. Clogged grease traps could allow wastewater to be directed to the MS4. Las Vegas Valley experiences about 100,000 visitors per day, and combined with 1.8 million residents, there are hundreds of thousands of potential diners each day. Public wastewater treatment service providers inspect over 2,000 restaurants and industrial facilities each year. Best practices are employed consistently among each of the entities in Las Vegas Valley.
- SC-13 Industrial Pretreatment Program. Permittees have industrial pretreatment programs associated with their wastewater systems. The pretreatment program includes regulations on the types of materials that can be discharged to the wastewater collection system, as well as regular facility inspections to assure compliance with the program. All new qualifying industrial sites would have to

comply with the industrial pretreatment project and would be subject to regular pretreatment inspections.

- SC-15 Southern Nevada Health District Inspections. SNHD performs inspections of commercial and industrial sites that are "conditionally exempt generators of hazardous waste." These are smaller facilities that do not fall under the State's hazardous materials regulations. Inspections assure that no illicit discharges have occurred or could potentially occur, and check for secondary containment for hazardous materials. SNHD will expand its inspection program to any new industrial facilities that meet the definition of conditionally exempt generators of hazardous waste.

- SC-23 Industrial Facility Stormwater Inspections. The proposed industrial facility inspection process is similar to existing practices. The proposed inspection processes are described for each entity as follows:

  - Clark County staff inspect sites identified on the Superfund Amendments and Reauthorization Act of 1986 (SARA) Section 313 list, select industrial sites to determine if they have the potential to discharge a substantial pollutant load, and those identified with a potential to discharge a substantial pollutant load to the MS4 at least annually.

  - CLV and CNLV use their pretreatment program staff to conduct stormwater inspections during their regular site visits. All industrial sites in the pretreatment program are inspected. If issues pertaining to stormwater are discovered during normal inspections for compliance with discharges to the sanitary sewer, these are noted and addressed accordingly.

  - The CoH Building and Fire Safety Department fire safety inspectors identify and inspect facilities identified by the CoH as potential substantial contributors of pollutants to the MS4. The identification of facilities, inspection procedures, and enforcement of the industrial inspection program is based on the hazardous materials requirements in the 2006 International Fire Code.

Inspector training sessions are performed on an as-needed basis by each of the Permittees. Training materials for industrial facility inspectors are developed and will be updated annually as necessary. The training presentation includes a description of the Las Vegas MS4 NPDES Permit and the Las Vegas Valley SWMP. The local ordinances and the Industrial Facility Monitoring and Control Plans for each jurisdiction are described. Contact information, such as names and phone numbers for Permittees and other interested parties were given for the inspectors' information. Training materials have been updated and customized to individual entities as needed.

The general procedures of the inspections are reported by each of the Permittees in the annual report. The items reported include name and location of facility, date of the inspection, results and/or violations that are inspected, any actions taken, and any follow-up actions taken.

- SC-24 Industrial Facility Stormwater Inventory. Permittees will provide to NDEP a list of industrial facilities to be inspected. This list will be provided in the MS4 Annual Report. Pertinent inventories of covered industrial sites will be updated at

least annually by each Permittee. Because industrial site inspectors are conducting other types of inspections for other regulatory programs (e.g., pretreatment inspections, stormwater complaints, illicit discharge and detection inspections), many industrial sites will be inspected that do not fit into one of the four categories for which inspections are required. Lists of sites that are inspected but do not fit one of the four covered categories will not be provided, but a total number of industrial site inspections performed will be included in the Annual Report.

- SC-25 Industrial Facility Stormwater Inspection Checklist. The Permittees have developed a standard checklist to be used by inspectors to conduct industrial site inspections. Each entity may modify the standard checklist slightly to meet its needs. However, the general information collected during inspections by each entity will be similar. The basic information on the inspection form includes:
  - name, type of industry, location, jurisdiction and contact person of facility
  - date of the inspection and name of inspector
  - evidence of any non-stormwater discharges (e.g., process water, wastewater)
  - evidence of any violations of local stormwater ordinances
  - any actions taken or required in the future

The Permittees will file completed Industrial Site Inspection Checklists chronologically in a separate stormwater compliance file. For facilities that hold pretreatment permits, the Permittees may also file copies of the Industrial Site Inspection Checklists in the respective permit files.

- SC-28 Industrial Facility Inspector Training Workshops. Inspector training sessions are performed on an as-needed basis by each of the Permittees. Training materials for industrial facility inspectors are developed and will be updated annually as necessary. The training presentation includes a description of the Las Vegas MS4 NPDES Permit and the Las Vegas Valley SWMP. The local ordinances and the Industrial Facility Monitoring and Control Plans for each jurisdiction are described. Contact information, such as names and phone numbers for Permittees and other interested parties were given for the inspectors' information. Training materials have been updated and customized to individual entities as needed.
- The Spill Control Prevention Plan BMP (SC-12) included in the Illicit Discharge Detection program of the SWMP primarily addresses industrial sites.

#### *10.3.1.2 Permit Section IV.H.1.b – Inventory of Facilities*

The MS4 permit Section *IV.H.1* specifically identifies four classes of industrial facilities for which a program to monitor and control pollutants must be developed. These classes of industrial facilities, along with the proposed method of developing an inventory of these facilities, are described below.

**Industrial Facilities Subject to Section 313 of Title II of SARA**

The permit identifies industrial facilities that are subject to Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). The EPA regulates and keeps a list of

industrial and other facilities that are subject to Section 313 that release certain amounts of regulated chemicals into the environment. The EPA's website

(www.epa.gov/enviro/html/tris/tris_query.html)

will be used to search for and list all Toxic Release Inventory (TRI) facilities in Clark County. The Permittees will execute a geography search to identify all Section 313 facilities located within Clark County. The Permittees will then manually identify facilities located within their jurisdiction from the Clark County list. The EPA list has been found to be outdated in the past. Listings will be verified to assure the businesses are still active.

**Municipal Landfills**

The permit also identifies municipal landfills. There are no active municipal landfills in the Las Vegas Valley MS4 Permit area. Sunrise Landfill is a closed landfill within the Las Vegas Valley MS4 permit area. Entities are currently working with Republic Services, EPA and BLM on a closure process for the landfill. The closure plan design includes a complete cap, channels and retention basins to prevent downstream stormwater effects.

**Hazardous Waste Treatment, Disposal and Recovery Facilities**

Drain inlets and catch basins collect sediment, trash, debris, and other pollutants that have washed off streets and other paved surfaces. One of their functions is to keep this material out of the downstream storm drain system. The Permittees inspect and, as needed, remove sediment, debris and trash from storm drain inlets and catch basins in the public MS4 system. The permit identifies hazardous waste treatment, disposal and recovery facilities. The EPA keeps a list of hazardous waste treatment, disposal, and recovery facilities that are subject to the Resource Conservation and Recovery Act (RCRA). The EPA RCRA Info web site

(www.epa.gov/enviro/html/rcris/rcris_query.html)

will be searched to find hazardous waste treatment and disposal facilities within Las Vegas Valley. The Permittees will execute a geography search to identify all facilities subject to RCRA located within Clark County. Similar to the Section 313 facilities search, the Permittees will then manually identify facilities location within their jurisdiction from the Clark County list. The EPA list has been found to be outdated in the past. Listings will be verified to assure the businesses are still active.

**Other Facilities Identified by Permittees**

The final category is industrial facilities that the municipal permit applicant determines are contributing a substantial pollutant loading to the municipal storm sewer system. This category of facilities will be identified through Permittee inspections of facilities identified in illicit discharge and detection inspections, pretreatment inspections, stormwater complaints, and agency referrals. Note that CLV, CNLV and CoH combine stormwater inspections with industrial pretreatment inspections and fire safety inspections. Clark County uses a combination of business license data,

and water and sewer use data to identify facilities that should be inspected to determine if they are contributing a substantial pollutant loading to the municipal storm sewer system. As a result, a large number of sites are inspected that the Permittees have determined to not contribute a substantial pollutant loading to the MS4.

#### 10.3.1.3 Permit Section IV.H.1.c – List of Inventoried Facilities

Section *IV.H.1.c* of the MS4 Permit requires that the Permittees provide to NDEP a list of industrial facilities to be inspected. This list will be provided in the MS4 Annual Report. Pertinent inventories of covered industrial sites will be updated at least annually by each Permittee.

Because industrial site inspectors are conducting other types of inspections for other regulatory programs (e.g., pretreatment inspections, stormwater complaints, illicit discharge and detection inspections), many industrial sites will be inspected that do not fit into one of the four categories for which inspections are required. A total number of industrial site inspections performed will be included in the Annual Report; however, lists of sites that are inspected but do not fit into one of the four covered categories will not be provided.

#### 10.3.1.4 Monitoring Program for Industrial Facilities

Section *IV.H.1.d* of the MS4 Permit requires that the Permittees develop a monitoring program for stormwater discharges associated with the industrial facilities. Monitoring of discharges from certain industrial sites is currently required by other NPDES point-source discharge permits. The Permittees propose to perform monitoring of stormwater discharges from industrial sites under the MS4 Permit authority only under the following conditions:

- Stormwater discharge monitoring is not already required under another permit;
- Stormwater discharges are demonstrated to contribute a significant pollutant load to the MS4;
- Inadequate stormwater BMPs are in place; and
- The site owner has demonstrated an unwillingness to comply with industrial BMP requirements and stormwater monitoring is required to support local enforcement actions.

No stormwater monitoring of industrial sites is currently required based on these conditions.

## 10.4 Responsibility for Implementation

**Table 10-3** shows the entity responsible for implementing each proposed BMP. In most cases the local entities (Clark County, CLV, CNLV and CoH) are responsible for providing staff, equipment and other financial resources to implement the measures. Regional activities common to all Permittees are sometimes the responsibility of CCRFCD (e.g., public outreach and education), and sometimes the responsibility of others.

**Table 10-3. Industrial Program Responsible Parties, Monitoring and Tracking, and Measurable Goals**

| Best Management Practice | Responsible Parties | Monitoring and Tracking Information | Measurable Goals |
|---|---|---|---|
| SC-6 – Commercial/ Industrial Housekeeping Practices | Clark County<br>CLV<br>CNLV<br>CoH<br>Private Owners | Reported under SC-23 Industrial Facility Stormwater Inspections | Promote good housekeeping practices |
| SC-9 – Grease Interceptor Program | Clark County<br>CLV<br>CNLV<br>CoH | Number of grease interceptor inspections | Minimize sanitary sewer system overflows |
| SC-13 – Industrial Pretreatment Program | Clark County<br>CLV<br>CNLV<br>CoH | Reported separately under NPDES discharge program individual permits. | Wastewater is properly discharged to sanitary sewer |
| SC-15 – Southern Nevada Health District Inspections | SNHD | SNHD set policies and procedures; will not report for MS4 permit | Per SNHD policies and procedures |
| SC-23 – Industrial Facility Stormwater Inspections | Clark County<br>CLV<br>CNLV<br>CoH | Number of inspections conducted by Permittees annually<br>Number of follow-up actions that were required annually | Conduct Inspections – annually by June 30 |
| SC-24 – Industrial Facility Stormwater Inventory | Clark County<br>CLV<br>CNLV<br>CoH | Update inventory annually | Develop the inventory of facilities to be inspected<br>Update inventory annually |
| SC-25 – Industrial Facility Stormwater Inspection Checklist | Clark County<br>CLV<br>CNLV<br>CoH | Develop checklist and update annually as necessary | Update checklist as needed |
| SC-28 – Industrial Facility Inspector Training Workshops | Clark County<br>CLV<br>CNLV<br>CoH | Number of Inspectors trained annually | Checklist in annual report |

## 10.5 Monitoring and Tracking

The Permittees propose to monitor and track certain key elements of the Industrial Facility Monitoring and Control Program, and report progress annually in the Annual Report. These elements are shown in **Table 10-3.**

## 10.6 Measurable Goals

**Table 10-3** lists measurable goals proposed for the Industrial Facility Monitoring and Control Program. Most goals are numerical and measurable; where this was not possible, narrative goals are proposed.

Goals for existing activities are the same goals that have been part of the previous SWMP for the past several years or through the regional implementation entity. The levels of the existing programs have been effective in managing impacts of the specified industrial facilities on the MS4.

## 10.7 Implementation Schedule

**Table 10-4** presents the implementation schedule for the proposed Industrial Facility Monitoring and Control Program measures. Most of the measures are existing activities that are being continuously implemented by the Permittees. In accordance with the requirement of the new MS4 permit, all program measures will be fully implemented within two years of approval of the SWMP by NDEP.

**Table 10-4. Implementation Schedule for Industrial Facility Monitoring and Control Program Measures**

| Best Management Practice | Required Implementation Activities and Time Period after SWMP Approval |
|---|---|
| SC-6 – Commercial/Industrial Housekeeping Practices | Existing Practice |
| SC-9 – Grease Interceptor Program | Existing Practice |
| SC-13 – Industrial Pretreatment Program | Existing Practice |
| SC-15 – Southern Nevada Health District Inspections | Existing Practice |
| SC-23 – Industrial Facility Stormwater Inspections | Existing Practice |
| SC-24 – Industrial Facility Stormwater Inventory | Existing Practice |
| SC-25 – Industrial Facility Stormwater Inspection Checklist | Existing Practice |
| SC-28 – Industrial Facility Inspector Training Workshop | 12 months |

# 11 CONSTRUCTION SITE PROGRAM

This section presents a description of a program to implement and maintain structural and non-structural BMPs to reduce pollutants in stormwater runoff from construction sites to the MS4.

## 11.1 Permit Requirements

Section *IV.I* of the MS4 Permit for Las Vegas Valley includes the following requirements relative to a Construction Site BMP Program to reduce pollutants in stormwater runoff from construction sites to the MS4:

*IV.I.1 The updated SWMP shall include a description of a program to implement and maintain structural and non-structural BMPs to reduce pollutants in stormwater runoff from construction sites to the MS4, which shall include:*

*IV.I.1.a A description of procedures for notifying developers and operators of properties of one (1) acre or more (and less than one acre if part of a larger plan of development) of requirements applicable to stormwater runoff;*

*IV.I.1.b A description of nonstructural and structural BMPs to be utilized for construction sites;*

*IV.I.1.c A description of appropriate educational and training measures for construction site operators; and*

*IV.I.1.d A description of a procedure to check for coverage under NDEP's General Construction Permit for Construction Activity prior to permit issuance.*

Section *IV.J* of the MS4 Permit for Las Vegas Valley includes the following requirements relative to Inspection of Construction Sites in order to verify compliance with local ordinances and permits, and implementation/enforcement of follow-up actions necessary to comply with these renewal requirements.

*IV.J.1 Each permittee shall conduct construction site inspections for compliance with its local ordinances (grading, stormwater, etc.) and permits (construction, grading, etc.);*

*IV.J.2 Each permittee shall inspect at least monthly, all construction sites within its jurisdiction meeting the following criteria:*

*IV.J.2.a All sites disturbing 100 acres or more in size at one time;*

*IV.J.2.b All sites disturbing one (1) acre or more that are tributary to a CWA section 303(d) water body segment impaired for sediment or turbidity; and*

*IV.J.2.c Sites determined by the Permittees as a significant threat to water quality. In evaluating threat to water quality, the following factors shall be considered:*

*IV.J.2.c.i Soil erosion potential;*

*IV.J.2.c.ii Site slope;*

*IV.J.2.c.iii Project size and type;*

*IV.J.2.c.iv Sensitivity of receiving water bodies;*

*IV.J.2.c.v Proximity to receiving water bodies;*

*IV.J.2.c.vi Proximity to water bodies 303(d) listed for turbidity and sediment;*

*IV.J.2.c.vii Non-stormwater discharges;*

*IV.J.2.c.viii Past record of non-compliance by the construction site operators; and*

*IV.J.2.c.ix Any other relevant factors.*

*IV.J.2.d All other construction sites of > one (1) acre not listed in Part IV.J.2 shall be inspected at least two (2) times for the duration of ground disturbance activities;*

*IV.J.3 Based upon site inspection findings, each permittee shall implement all follow-up actions (i.e., re-inspection or enforcement) necessary to comply with this Permit;*

*IV.J.4 Inspections of construction sites shall include, but not be limited to:*

*IV.J.4.a Assessment of compliance with Permittee ordinances and permits related to urban runoff, including the implementation and maintenance of designated minimum BMPs;*

*IV.J.4.b Assessment of BMP effectiveness;*

*IV.J.4.c Visual observations for non-stormwater discharges and potential illicit connections;*

*IV.J.4.d Education and outreach on stormwater pollution prevention, as needed; and*

*IV.J.4.e Creation of a written or electronic inspection report.*

*IV.J.5 The Permittees shall track the number of inspections for the inventoried construction sites throughout the reporting period to verify that the sites are inspected at the minimum frequencies required. This information shall be included in the Annual Report.*

## 11.2 Program Development

The Construction Site Program and Construction Site Inspection Program (Construction Program) was developed by first reviewing existing practices performed by the Permittees. These practices may be implemented specifically for the MS4 permit program, or may be implemented primarily to meet other objectives. In either case, they are considered part of the overall Construction Program.

New measures were then identified, if needed, to meet the specific program requirements as outlined in the permit.

The Construction Program includes BMPs that fit within the pollution prevention and onsite controls portions of the overall SWMP management plan framework depicted in **Figure 3-9**. The measures to accomplish this goal could be structural or non-structural.

## 11.3 Proposed Best Management Practices

**Table 11-1** lists the proposed BMPs for the Construction Program. The status of the proposed BMPs are shown in the final column of **Table 11-1**, to indicate whether the BMP is an existing program, existing program with planned enhancements based on the MS4 permit renewal, or a new program that is a result of the MS4 permit renewal. Descriptions of each BMP are provided in **Appendix B**.

**Table 11-2** lists the Construction Program permit elements and the proposed BMPs. Discussion of how the proposed measures meet the specific requirements for the Construction Program are provided in the following subsections.

**Table 11-1. Proposed BMPs for the Construction Site Program**

| Measure Type | ID No. | Proposed BMP | Status |
|---|---|---|---|
| Source Control | SC-20 | Construction Site BMP Guidance Manual | Existing Program |
| Source Control | SC-21 | Construction Site Inspections | Existing Program Enhancement |
| Source Control | SC-22 | Construction Site Training Workshops | Existing Program |

**Table 11-2. Construction Site Program for the Las Vegas Valley**

| MS4 Permit Section | MS4 Permit Requirements | Proposed Measures |
|---|---|---|
| IV.I.1.a | A description of procedures for notifying developers and operators of properties of one (1) acre or more (and less than one acre if part of a larger plan of development) of requirements applicable to stormwater runoff | SC-20 – Construction Site BMP Guidance Manual provides requirements |
| IV.I.1.b | A description of nonstructural and structural BMPs to be utilized for construction sites | SC-20 – Construction Site BMP Guidance Manual |
| IV.I.1.c | A description of appropriate educational and training measures for construction site operators | SC-20 – Construction Site BMP Guidance Manual<br>SC-22 – Construction Site Training Workshops |
| IV.I.1.d | A description of a procedure to check for coverage under NDEP's General Construction Permit for Construction Activity prior to permit issuance | SC-20 – Construction Site BMP Guidance Manual provides requirements |
| IV.J.1 | Each permittee shall conduct construction site inspections for compliance with its local ordinances (grading, stormwater, etc.) and permits (construction, grading, etc.) | SC-21 – Construction Site Inspections |
| IV.J.2 | Each permittee shall inspect at least monthly, all construction sites within its jurisdiction meeting specified criteria | SC-21 – Construction Site Inspections |
| IV.J.3 | Based upon site inspection findings, each permittee shall implement all follow-up actions (i.e., re-inspection or enforcement) necessary to comply with this Permit | SC-21 – Construction Site Inspections |
| IV.J.4 | Inspections of construction sites shall include, specified criteria | SC-21 – Construction Site Inspections |
| IV.J.5 | The Permittees shall track the number of inspections for the inventoried construction sites throughout the reporting period to verify that the sites are inspected at the minimum frequencies required. This information shall be included in the Annual Report. | See Section 11.3.3.5 |

### 11.3.1 Permit Sections IV.I and IV.J – Construction Site BMPs and Inspections

Section *IV.I* of the MS4 Permit requires the Permittees to implement and maintain structural and non-structural BMPs to reduce pollutants in stormwater runoff from construction sites to the MS4. Section *IV.J* of the MS4 Permit requires the Permittees to implement a construction inspection program. The following subsections detail the components for the Construction Site BMPs and Inspection Programs.

### 11.3.2 Permit Sections IV.I.1 – Construction Site BMPs

The following subsections describe the program to implement BMPs for construction sites.

#### *11.3.2.1 Permit Sections IV.I.1.a – Notifying Developers and Operators*

Section *IV.I.1.a* of the MS4 Permit requires the Permittees to notify developers of properties of 1.0 acre or more, or smaller if part of a larger plan of development, of the requirements to comply with all State and local construction site stormwater permitting programs. Emphasis is on notifying

developers of the need to obtain a general stormwater construction permit from NDEP. Permittees will adhere to the developer notification program, consisting of:

- Standard comment on Grading Permit or Drainage Study review letter notifying developer of need for NDEP General Construction Permit.
- Standard general condition for construction plans or specifications requiring owner/contractor to obtain NDEP General Construction Permit.
- Grading plan submittals must include Construction Permit Submittal Checklist (included in the *Las Vegas Valley Construction Site Best Management Practices Guidance Manual*), Notice of Intent (NOI) for State General Construction Permit or letter of authorization from NDEP.

#### 11.3.2.2 Permit Sections IV.I.1.b – BMPs for Construction Sites

Section *IV.I.1.b* of the MS4 Permit requires the Permittees to describe nonstructural and structural BMPs to be utilized for construction sites.

The existing *Las Vegas Valley Construction Site Best Management Practices Guidance Manual* (BMP SC-20) describes the construction site runoff management program and provides non-structural and structural BMP implementation guidance. The manual provides guidance on selecting and designing construction site BMPs that are suitable to the unique environment and conditions in Las Vegas Valley.

**Table 11-3** shows a list of the various BMPs that are described in the *Construction Site BMP Guidance Manual*. The *Construction Site BMP Guidance Manual* is available to contractors, engineers, and other construction professionals on the CCRFCD website and on the www.lvstormwater.com website. The manual will be updated by CCRFCD as needed to incorporate new BMPs appropriate for the region and modify selection or design criteria for existing BMPs as more local experience is obtained.

The *Nevada Contractors Field Guide for Construction Site BMPs*, prepared by the Truckee Meadows MS4 group and funded in part by CCRFCD, is available in hardcopy form to contractors, engineers and other construction professionals. Copies are available at Permittees' permit counters, contractor training workshops, and other venues.

#### 11.3.2.3 Permit Sections IV.I.1.c – Contractor Education and Training Measures

Section *IV.I.1.c* of the MS4 Permit requires the Permittees to provide a description of the appropriate educational and training measures for construction site operators.

As described in SC-22 Construction Site Training Workshops, Permittees will host Contractor Training Workshops a minimum of once per year. The number of annual workshops will be tailored to the current level of interest and need. Workshops will address State and local construction permitting requirements, BMP requirements, and inspection programs. As in the past, the workshops will be conducted jointly by the Permittees and NDEP.

**Table 11-3. BMPs Described in Las Vegas Valley Construction Site BMP Guidance Manual**

| BMP ID | Construction Site BMPs | Structural Vs. Nonstructural |
|---|---|---|
| Construction Site Planning | Site Design | Nonstructural |
| | Scheduling | Nonstructural |
| | Phased Construction | Nonstructural |
| | Topsoil Reuse | Nonstructural |
| | Employee Training | Nonstructural |
| Construction Site Erosion Control | Erosion Control Mats | Structural |
| | Mulching | Structural |
| | Protection of Trees and Vegetation in Construction Areas | Structural |
| | Pipe Slope Drains | Structural |
| Construction Site Erosion Control (continued) | Stabilized Construction Entrance | Structural |
| | Construction Road Stabilization | Structural |
| | Dust Control | Structural |
| | Temporary Access Waterway Crossing | Structural |
| | Diversion Dikes | Structural |
| | Drainage Swales | Structural |
| | Outlet Protection, Velocity Dissipation Devices | Structural |
| | Surface Roughening | Structural |
| Construction Site Sediment And Pollution Control | Organic Filter Barrier | Structural |
| | Sand Bag Barrier | Structural |
| | Gravel Filter Berms | Structural |
| | Check Dams | Structural |
| | Silt Fence | Structural |
| | Revegetation and Landscape Buffers | Structural |
| | Storm Drain Inlet Protection | Structural |
| | Temporary Sediment Basins | Structural |
| | Temporary Sediment Traps | Structural |
| | Sediment Dewatering Operations | Structural |
| | Construction Entrance/Exit Tire Wash | Structural |
| Construction Site General House Keeping | Chemical Management | Nonstructural |
| | Solid Waste Management | Nonstructural |
| | Equipment Maintenance Procedures | Nonstructural |
| | Designated Washdown Areas | Nonstructural |
| | Spill Containment Plan | Nonstructural |
| | Road Sweeping/Trackout Cleaning | Nonstructural |

#### *11.3.2.4 Permit Sections IV.I.1.d – Coverage under NDEP's General Construction Permit*

Section *IV.I.1.d* of the MS4 Permit requires the Permittees to provide a description of the procedure to check for coverage under NDEP's General Construction Permit for Construction Activity prior to permit issuance. Permittees will conditionally issue grading and construction permits on proof of fee payment and coverage under the State's general permit for construction activity. As described in the procedures for notifying developers and operators, a grading plan submittal requires a copy of the Notice of Intent (NOI) for State General Construction Permit or letter of authorization from NDEP.

### 11.3.3 Permit Sections IV.J – Construction Site Inspections

The following subsections describe the program to implement inspections for construction sites.

#### *11.3.3.1 Permit Sections IV.J.1 – Construction Site Inspection Program*

Section *IV.J.1* of the MS4 Permit requires the Permittees to conduct construction site inspections for compliance with its local ordinances and permits.

Each municipal Permittee adopted a stormwater management ordinance in 2008 that includes regulatory authority to implement and enforce the provisions of their local construction site programs. These ordinances are based on EPA's model ordinance and apply to construction on sites with an area of 1.0 acre or greater.

The BMP SC-21 Construction Site Inspections satisfies this requirement. Each municipal Permittee will conduct construction site inspections for compliance with its local ordinances and permits. Each Permittee will use existing inspection staff to perform all construction site inspections. This process and schedule for each entity is summarized as follows.

- **CLV –** Offsite Inspection and Testing inspectors will inspect private development projects. CLV Construction Management personnel will inspect public construction projects. Stormwater inspections will occur during normal grading, offsite inspections.
- **CNLV –** Offsite Department inspectors will perform inspection and enforcement activities. Stormwater inspections will occur during normal grading, offsite inspections.
- **CoH –** Building Department, Public Works Department, and Quality Control Division inspectors will perform inspections. Stormwater inspections will occur during normal grading, offsite and building inspections.
- **Clark County –** Development Services personnel will perform inspection and enforcement activities. Stormwater inspections will occur during active normal grading, offsite and building inspections. In addition, air quality inspectors have been trained in the past to perform stormwater inspections, and will report any apparent problems possible violations during their normal air quality inspections.

#### *11.3.3.2 Permit Sections IV.J.2 – Construction Site Inspections*

Section *IV.J.1* of the MS4 Permit requires the Permittees to inspect, at least monthly, all construction sites within its jurisdiction that meet the criteria set forth on section *IV.J.2.a* through *IV.J.2.c* of the MS4 Permit. Each municipal Permittee will conduct the following inspections:

- All sites disturbing 100 acres or more at one time will be inspected at least monthly (par. *IV.J.2.a*).
- All sites disturbing more than 1.0 acre that are tributary to a water body segment impaired for sediment or turbidity as determined through the State's Clean Water Act 303(d) listing process will be inspected at least monthly (par. *IV.J.2.b*). Currently,

no water bodies or stream segments in Las Vegas Valley are listed as impaired for sediment or turbidity (see *Technical Memorandum II.1 Stormwater Contribution to Impaired Waters and TMDLs in Las Vegas Valley, MWH, 2010).* In the future, if any stream segments become impaired for sediment or turbidity in the Las Vegas Valley, the proposed inspection procedures in this section will apply. The Permittees will interpret the permit language "*sites… that are tributary to a CWA section 303(d) water body segment*" to mean a construction site that is "directly tributary" (i.e., discharges directly to) the impaired water body segment. For example, if the segment of Las Vegas Wash upstream of the wastewater treatment plant discharges became impaired for sediment or turbidity, and a new construction site drains directly into that waterway, the construction site would be considered "*tributary to*" the impaired water body and would come under this permit requirement.

- All sites determined by the Permittees as "*a significant threat to water quality*" will be inspected at least monthly (par. *IV.J.2.c*). The Permittees considered a number of factors in determining whether certain construction sites could present a significant threat to water quality. These included soil erosion potential, site slope, project size, project type, sensitivity of receiving waters, proximity of receiving waters, and current impairment of receiving waters for sediment and turbidity. It was determined that the infrequency and low volume of rainfall in Las Vegas Valley, combined with the high background erosion and sediment transport conditions in the desert environment, does not warrant special treatment for any construction sites beyond those already listed in the foregoing paragraphs.
- All construction sites greater than 1.0 acre not listed in Permit Section *IV.J.2* will be inspected at least two times during the period of ground disturbance activities, as long as this period is longer than four months.

#### 11.3.3.3 Permit Sections IV.J.3 – Construction Site Inspections Follow-Up Actions

Section *IV.J.3* of the MS4 Permit requires that the Permittees implement all follow-up actions necessary to comply with the permit. Each municipal Permittee will implement follow-up actions, based upon site inspection findings, necessary to comply with their local stormwater ordinances and with the MS4 Permit. Resolution of infractions will be verified by repeat inspections at a frequency established by each Permittee. Failure to resolve minor infractions or observance of major violations (e.g. active discharges) will result in immediate and progressively increasing enforcement action including suspension of further inspections, stop work orders and fines. Failure to resolve issues and egregious neglect for compliance may result in notification of State representatives, whereby compliance pressure can be further asserted. Each Permittee has an established appeals process if a contractor feels enforcement actions are inappropriate. Appeals are first to the inspector's supervisor and could ultimately rest with each jurisdiction's governing board.

#### 11.3.3.4 Permit Sections IV.J.4 – Construction Site Inspection Requirements

Section *IV.J.4* of the MS4 Permit requires that the Permittees inspections include the items listed in Permit Sections *IV.J.4.a* through *IV.J.4.e*. The Permittees construction site inspections will consist of the following activities.

- Assess compliance with Permittee stormwater ordinances.
- Verify proper implementation and maintenance of minimum BMPs.
- Assess potential BMP effectiveness.
- Conduct visual observations for non-stormwater discharges, potential illicit connections, and the potential to discharge pollutants to the MS4.
- Provide education and outreach materials to contractor personnel on stormwater pollution prevention and the MS4 and NDEP construction permit processes, as needed.
- Prepare a written or electronic inspection record.

These inspection items will be documented by using a Construction Site Inspection Checklist, which is included in the Las Vegas Valley Construction Site Best Management Practices Guidance Manual.

Supported by the ordinance language, construction sites will be inspected not only for active discharges to the MS4 but also for the potential to discharge (i.e., absence of or poorly installed and maintained BMPs), effective waste management onsite, and effective erosion and sediment control practices. Every effort will be made to resolve minor infractions through close coordination between the inspector and the site operator. The objective of the program will be education and compliance rather than punishment. Inspectors have the authority to review the Stormwater Pollution Prevention Plans (SWPPPs) required by NDEP's general construction permit if site conditions warrant; however, this is not a required aspect of every inspection.

#### *11.3.3.5 Construction Site Inspection Tracking*

Section *IV.J.5* of the MS4 Permit requires that the Permittees track the number of inspections for construction sites throughout the reporting period (i.e., the MS4 permit year) to verify that the sites are inspected at the minimum frequencies required. Each Permittee will track the number of inspections for construction sites and the results will be included in the Annual Report. Records of inspections will be retained by the Permittees, and will be provided to NDEP upon request.

## 11.4 Responsibility for Implementation

**Table 11-4** shows the entity responsible for implementing each proposed BMP. In most cases the local entities (Clark County, CLV, CNLV and CoH) are responsible for providing staff, equipment and other financial resources to implement the measures. Regional activities common to all Permittees are sometimes the responsibility of CCRFCD (e.g., public outreach and education), and sometimes the responsibility of others.

**Table 11-4. Construction Program Responsible Parties, Monitoring and Tracking, and Measurable Goals**

| Best Management Practice | Responsible Parties | Monitoring and Tracking Information | Measurable Goals |
|---|---|---|---|
| SC-20 – Construction Site BMP Guidance Manual | CCRFCD<br>Clark County<br>CLV<br>CNLV<br>CoH | Report changes made to manual | Review BMP Manual annually for need to update |
| SC-21 – Construction Site Inspections | Clark County<br>CLV<br>CNLV<br>CoH | Number of inspections performed<br>Number of enforcement actions taken | Inspect 100% of all construction sites >1.0 acre per entity policies<br>Follow-up on 100% of all potential violations per entity policies |
| SC-22 – Construction Site Training Workshops | CCRFCD<br>Clark County<br>CLV<br>CNLV<br>CoH | Number of attendees at contractor training workshops | Conduct minimum of one contractor training workshop annually |

## 11.5 Monitoring and Tracking

The Permittees propose to monitor and track certain key elements of the Construction Site Program, and report progress annually in the Annual Report. These elements are shown in **Table 11-4.**

## 11.6 Measurable Goals

**Table 11-4** lists measurable goals proposed for the Construction Site Program. Most goals are numerical and measurable; where this was not possible, narrative goals are proposed.

Goals for existing activities are the same goals that have been part of the previous SWMP for the past several years or through the regional implementation entity. The levels of the existing programs have been effective in managing impacts of construction sites on the MS4.

## 11.7 Implementation Schedule

**Table 11-5** presents the implementation schedule for the proposed Construction Site Program measures. Most of the measures are existing activities that are being continuously implemented by the Permittees. In accordance with the requirement of the new MS4 permit, all program measures will be fully implemented within two years of approval of the SWMP by NDEP.

## Table 11-5. Implementation Schedule for Construction Site Program Measures

| Best Management Practice | Required Implementation Activities and Time Period after SWMP Approval |
|---|---|
| SC-20 - Construction Site BMP Guidance Manual | Existing Practice |
| SC-21 - Construction Site Inspections | Plan for inspecting >100 ac and critical sites – 12 months |
| SC-22 - Construction Site Training Workshops | Existing Practice |

# 12 WATERSHED PROGRAM

This section presents a description of a program incorporating the watershed-wide measures in the Las Vegas Valley SWMP.

## 12.1 Permit Requirements

There is no specific MS4 permit requirement for the Watershed Program. The Permittees developed this program as a way to identify and track the watershed-based measures that were included in the SWMP to address the unique factors affecting the stormwater program in Las Vegas Valley and respond to the stakeholder direction to develop a watershed-based program. The measures in this program have broad benefits for all land development types and large land areas in Las Vegas Valley.

## 12.2 Program Development

The Watershed Program was developed by first reviewing existing practices performed by the Permittees that provide regional stormwater quality benefits. These practices may be implemented specifically for the MS4 permit program, or may be implemented primarily to meet other objectives. In either case, they are considered part of the overall Watershed Program. New measures were then identified, if needed, to meet the specific program requirements as outlined in the permit.

The Watershed Program includes BMPs that fit within the pollution prevention and treatment controls portions of the overall SWMP management plan framework depicted in **Figure 3-9**.

## 12.3 Proposed Best Management Practices

**Table 12-1** lists the proposed BMPs for the Watershed Program. The status of the proposed BMPs are shown in the final column of **Table 12-1**, to indicate whether the BMP is an existing program, existing program with planned enhancements based on the MS4 permit renewal, or a new program that is a result of the MS4 permit renewal. Descriptions of each BMP are provided in **Appendix B**.

**Table 12-1. Proposed BMPs for the Watershed Program**

| Measure Type | ID No. | Proposed BMP | Status |
|---|---|---|---|
| Source Control | SC-16 | Regional Water Quality Planning | Existing Program |
| Treatment Control | TC-1 | Regional Detention Basins | Existing Program |
| Treatment Control | TC-2 | Regional Channel Lining | Existing Program |
| Treatment Control | TC-3 | Las Vegas Wash Stabilization Structures | Existing Program |
| Treatment Control | TC-6 | Regional Detention Basin Retrofit | New Program |

Key elements of the Watershed Program are described as follows.

Regional water quality planning activities (SC-16 Regional Water Quality Planning) that are performed by a variety of agencies provide benefits to stormwater quality in existing and new development. SNWA, the Las Vegas Valley Watershed Advisory Committee (LVVWAC), the Las Vegas Wash Coordination Committee, and the Lake Mead Water Quality Forum are agencies or organizations formed to address regional water quality concerns, protecting and enhancing environmental resources. All of the Permittees participate in these regional planning organizations.

CCRFCD has developed a Flood Control Master Plan for Las Vegas Valley that presents a program for addressing existing and future flood control needs (TC-1 Regional Detention Basins). The regional detention basin approach is considered more effective in Las Vegas Valley than having a highly distributed system of small neighborhood-scale facilities due to the infrequency, randomness and localized nature of most storm events. Regional detention basins capture and regulate more runoff events than local facilities would, and concentrate the need for maintenance in fewer facilities.

The CCRFCD design manual requires all regional flood control channels to be stabilized in some manner (TC-2 Regional Channel Lining). Because slopes in Las Vegas Valley are generally moderate to steep, velocities are high, and soils are erodible, most channels are stabilized using concrete lining. CCRFCD has a preference for providing concrete lining for regional flood control channels to minimize capital costs, right-of-way requirements (when taking of developed property is involved) and maintenance costs. Some channels are stabilized using riprap, gabions, grade control structures, or grass (most often in golf courses). Concrete or other channel lining eliminates production of sediment from the previously unlined or natural channels due to scour and erosion, thereby reducing sediment loads to Las Vegas Wash and Lake Mead. As a result of the CCRFCD policy, very few channels within the existing developed area are unlined.

Over the past 40 years erosion in the Las Vegas Wash due to wastewater discharges and urban stormwater runoff has resulted in dramatic channel erosion and reduction in wetland areas from approximately 2,000 acres to 200 acres. In order to address this issue, the Las Vegas Wash Coordination Committee was formed in 1998 to prepare and implement a management strategy for the Las Vegas Wash. A key element of the management strategy was to construct grade control structures in the eroding sections of the Wash to stabilize erosion and support new wetlands. SNWA, through the Las Vegas Wash Coordination Committee, was delegated responsibility for this effort and has a well-funded program for stabilizing lower Las Vegas Wash through construction of a series of erosion control structures (TC-3 Las Vegas Wash Stabilization Structures).

Data shows that the regional detention basins are marginally effective at reducing many common stormwater pollutants. Because the regional detention basins are designed to reduce peaks from large flood events, in most cases small runoff events of the kind normally addressed by stormwater quality programs pass through the regional detention basins with relatively little attenuation and little removal of constituents such as nitrogen, phosphorus and heavy metals. The recommended

detention basin water quality retrofit approach is to develop a unique retrofit plan for each major watershed resulting in enough total water quality capture volume to address the runoff from new development and significant redevelopment (TC-6 Regional Detention Basin Retrofit).

## 12.4 Responsible for Implementation

**Table 12-2** shows the entity responsible for implementing each proposed BMP. In most cases the local entities (Clark County, CLV, CNLV and CoH) are responsible for providing staff, equipment and other financial resources to implement the measures. Regional activities common to all Permittees are sometimes the responsibility of CCRFCD and sometimes the responsibility of others.

**Table 12-2. Watershed Program Responsible Parties, Monitoring and Tracking, and Measurable Goals**

| Best Management Practice | Responsible Parties | Monitoring and Tracking Information | Measurable Goals |
|---|---|---|---|
| SC-16 – Regional Water Quality Planning | CCRFCD<br>Clark County<br>CLV<br>CNLV<br>CoH | None | Assure stormwater quality issues are represented in regional planning forums |
| TC1 – Regional Detention Basins | CCRFCD<br>Clark County<br>CLV<br>CNLV<br>CoH | Number of new detention basins constructed | Per CCRFCD Master Plan |
| TC2 – Regional Channel Lining | CCRFCD<br>Clark County<br>CLV<br>CNLV<br>CoH | Miles of new stabilized channel constructed | Per CCRFCD Master Plan |
| TC3 – Las Vegas Wash Stabilization Measures | SNWA | Number of LVW erosion control structures constructed | Per SNWA Master Plan |
| TC6 – Regional Detention Basin Retrofit | CCRFCD<br>Clark County<br>CLV<br>CNLV<br>CoH | Inventory of detention basins with water quality design<br>Volume or weight of material removed from detention basins | Per Detention Basin Retrofit Master Plan<br>Water quality designs for all new detention basins |

## 12.5 Monitoring and Tracking

The Permittees propose to monitor and track certain key elements of the Watershed Program, and report progress annually in the Annual Report. These elements are shown in **Table 12-2.**

## 12.6 Measurable Goals

**Table 12-3** lists measurable goals proposed for the Watershed Program. Most goals are numerical and measurable; where this was not possible, narrative goals are proposed.

Goals for existing activities are the same goals that have been part of the previous SWMP for the past several years or through the regional implementation entity. The levels of the existing programs have been effective in managing impacts of urban development on the MS4.

## 12.7 Implementation Schedule

**Table 12-3** presents the implementation schedule for the proposed Watershed Program measures. Most of the measures are existing activities that are being continuously implemented by the Permittees. In accordance with the requirement of the new MS4 permit, all program measures will be fully implemented within two years of approval of the SWMP by NDEP.

**Table 12-3. Implementation Schedule for Watershed Program Measures**

| Best Management Practice | Required Implementation Activities and Time Period after SWMP Approval |
|---|---|
| SC-16 – Regional Water Quality Planning | Existing Practice Enhancement |
| TC-1 – Regional Detention Basins | Existing Practice |
| TC-2 – Regional Channel Lining | Existing Practice |
| TC-3 – Las Vegas Wash Stabilization Structures | Existing Practice |
| TC-6 – Regional Detention Basin Retrofit | Finalize Retrofit Master Plan – 6 months<br>Conduct Pilot Retrofit Projects – 21 months<br>Develop Retrofit Implementation Plan – 24 months |

# 13 LEGAL AUTHORITY

This section addresses the MS4 permit requirements dealing with legal authority of the Permittees to implement the various aspects of the proposed SWMP and other requirements of the permit. The objective is to provide documentation that the Permittees either currently have adequate legal authority to conduct all necessary activities, or have a plan for obtaining that authority. The adopted activities satisfy the specific requirements of the permit in this category.

## 13.1 Permit Requirements

Paragraph *IV.A.4* of the MS4 permit for Las Vegas Valley requires the SWMP to present a review of legal authority to implement the requirements of the permit and the SWMP, and to identify additional ordinances or regulatory mechanisms to be adopted. More specifically, Section III of the MS4 Permit for Las Vegas Valley requires each of the Permittees to have an ordinance in place to authorize or enable the following activities:

*III.A.1 Each of the Permittees shall have an ordinance in place that authorizes or enables each Permittee to:*

*III.A.1.a Prohibit illicit discharges and illicit connections to the Permittees' MS4s;*

*III.A.1.b Control the discharge from spills, dumping or disposal of materials other than stormwater to any of the Permittees' MS4s;*

*III.A.1.c Require compliance with any condition contained in ordinances, permits, contracts or orders;*

*III.A.1.d Require structural and non-structural BMPs for erosion and sediment controls at construction sites;*

*III.A.1.e Inspect construction sites disturbing 2: one (I) acre or < one (I) acre if part of a common plan of development to ensure compliance with each Permittee's ordinance and take appropriate enforcement action as necessary;*

*III.A.1.f Inspect industrial sites that are part of each jurisdiction's inventory of industrial sites to ensure compliance with each Permittee's ordinance, and take appropriate enforcement action as necessary;*

*III.A.1.g Establish civil, administrative and criminal penalties for violations of the ordinance; and*

*III.A.1.h Carry out all inspection, surveillance, and monitoring procedures necessary to determine compliance and non-compliance with the prohibition of illicit discharges to the Permittees' MS4s.*

## 13.2 Existing Ordinances and Regulations

Documentation has been provided in past Annual Reports verifying the legal authority of each Permittee to conduct the following types of activities.

- Prohibit illicit discharges to the municipal separate storm sewer system.
- Control spills, dumping or disposal of materials other than stormwater to the storm sewer system.
- Require compliance with conditions in ordinances related to stormwater discharges.
- Require BMPs for erosion and sediment control at construction sites.
- Inspect construction sites disturbing ≥1.0 acre or <1.0 acre if part of a common plan to ensure compliance with each Permittee's ordinance and take appropriate enforcement action.
- Inspect industrial sites that are part of each Permittee's inventory to ensure compliance with each Permittee's ordinance and take appropriate enforcement action.
- Establish civil, administrative and criminal penalties for violations of the ordinance.
- Carry out inspection and monitoring procedures necessary to determine compliance with the prohibition on illicit discharges to the storm sewer system.

Copies of current ordinances have been submitted to NDEP by the Permittees in past Annual Reports. The Co-Permittees' ordinances pertaining to the MS4 are as follows:

- Chapter 24.40 of the Clark County Code: Storm Sewer System Discharge (http://ordlink.com/codes/clarknv/index.htm)
- Chapter 13.04 of the CoH Municipal Code: Stormwater Regulations.
  CoH Ordinance No. 2783 (Stormwater Quality Ordinance)
  (http://ordlink.com/codes/henderson/)
- Chapter 14.18 of the CLV Municipal Code: Stormwater and Stormwater Management (http://ordlink.com/codes/lasvegas/index.htm)
- Chapter 8.50 of the CNLV Municipal Code: Stormwater Regulations
  (http://municipalcodes.lexisnexis.com/codes/nolasvegas/index.htm)

## 13.3 Proposed New or Modified Ordinances and Regulations

New BMPs are being proposed as part of this SWMP. The Permittees have determined that the new BMPs described in this SWMP can be implemented and enforced using existing legal authority. If new BMPs must be added or proposed measures are changed in the future, it is possible that some may require additional legal authority for implementation. If the review of current regulations

and ordinances identifies deficiencies in the ability to implement new SWMP programs, a plan for addressing those deficiencies will be developed and submitted to NDEP in an Annual Report.

## 13.4 Measurable Goals

Measurable goals, responsible parties and monitoring and tracking commitments are provided in **Table 13-1**.

**Table 13-1. Legal Authority Responsible Parties, Monitoring and Tracking, and Measurable Goals**

| Best Management Practice | Responsible Parties | Monitoring and Tracking Information | Measurable Goals |
|---|---|---|---|
| Review current ordinances for ability to implement new SWMP measures | Clark County<br>CLV<br>CNLV<br>CoH | Document in Annual Report | Complete ordinance review if BMPs are changed in the future |
| Implement new ordinances if needed | Clark County<br>CLV<br>CNLV<br>CoH | Document in Annual Report | Adopt any necessary new or modified ordinances within 12 months of identification |

## 13.5 Implementation Schedule

The review of current ordinances will be completed within 6 months of approval of the final SWMP.

Adoption of any required new ordinances will be completed within 18 months of approval of the SWMP. In the future, any new ordinances will be adopted within 12 months of identifying the need for them.

# 14 STAFF AND RESOURCES

Permittees have been implementing stormwater management measures in response to MS4 permit requirements since 1990. Many of those measures were standard practices long before the first MS4 permit was issued to the Las Vegas Valley entities. Permittees have committed adequate staff and budget resources in the past to implement measures in their previous SWMPs. In many cases progressively more comprehensive activities have been performed as the MS4 program has evolved, requiring increased commitments of staff and budget resources. These commitments have been made in the past and will continue to be made in the future.

The previous sections of the SWMP describing the various management plans indicate which parties are responsible for implementing each of the proposed BMPs. The Permittees understand the staff and budget resources required to implement the proposed programs, and are committed to assigning those resources. It is anticipated that in most cases existing staff will be used to implement the SWMP programs; most of these programs are already part of the entities' normal activities. An exception is the construction inspection program, for which additional staff may have to be added depending on the volume of new construction activity from year to year.

CCRFCD will continue to fund its program responsibilities from revenue from the ¼ cent sales tax that provides funding for all District functions. Clark County, CLV, CNLV and CoH will all continue to fund their projects from their general tax revenues. A portion of the construction program measures (inspections, design reviews) may be financed through development permit fees.

# 15 PUBLIC INVOLVEMENT

This section describes the process used to gather input from specific stakeholder groups and the general public regarding appropriate stormwater management strategies and BMPs for Las Vegas Valley. Section *IV.A.3* of the MS4 permit requires that the draft SWMP be made available for public review and comment at a meeting noticed in accordance with the Nevada open meeting law, and that actions taken in response to the comments be documented. This section describes the method of compliance with that requirement.

## 15.1 Stakeholder Coordination

The Construction Site Program and NDSR Program were developed with input from a Stormwater Stakeholder Working Group (SSWG). The SSWG was formed with the express purpose of crafting BMP programs that would be in compliance with the permit and acceptable to local stakeholder groups.

The SSWG was first formed in response to changes in management programs that were an outgrowth of EPA's audit of the Las Vegas Valley MS4 permit in 2005. It was comprised of representatives from the development community, local stormwater engineers, and trade associations. Representatives of environmental organizations were invited but did not attend. The facilitated group met for over a year and had substantial input into the construction site management and inspection program and the NDSR program philosophy. The mission of the SSWG was:

> *Our goal is to comply with the MS4 permit by developing construction and post-construction program enhancements that are:*

- *clear, simple and effective*
- *consistent*
- *cost-effective*
- *consensus-based*
- *fiscally and environmentally responsible*
- *sensible for the Las Vegas Valley*

This goal served as the foundation of all the programs developed for the new MS4 permit.

## 15.2 Public Input and Response

A public meeting was held on June 14, 2011 to obtain input from the public on the draft SWMP. The meeting was held in conjunction with the normally scheduled monthly meeting of the Las Vegas Valley Stormwater Quality Management Committee. This meeting complies with the Nevada open meeting law regulations. The meeting was noticed in Las Vegas Review Journal on June 5th and June 12th. The draft SWMP was made available for public review at the CCRFCD office and on

the CCRFCD and lvstormwater.com websites with the ability for reviewers to leave comments electronically until June 30th.

No comments were received at the Public Meeting and no comments were received on the CCRFCD website.

## 15.3 Outreach to Development Community

The development community in Las Vegas Valley was keenly aware that aspects of the new NDSR and Construction Site programs in the SWMP could affect their daily operations and costs of doing business. Opportunities for the development community (primarily Southern Nevada Home Builders Association) to offer input to the SWMP were provided as follows.

- Representatives of the development community were actively involved on the Stormwater Stakeholder Working Group described previously.
- A representative of Southern Nevada Home Builders Association (SNHBA) and a local land development engineer participated in the Development Guidelines Working Group during development of the NDSR Program.
- Presentations were made by the Permittees at SNHBA meetings and to other groups of planners, architects and engineers during development of the NDSR to provide information on planned programs and management measures.

# 16 WATER QUALITY STANDARDS

The new Las Vegas Valley MS4 permit includes requirements for addressing stormwater contributions to impaired waters and TMDLs. This section summarizes water bodies currently impaired for water quality in Las Vegas Valley, and the potential for discharges from the MS4 to contribute to those impairments. A full description of the analysis is provided in *Technical Memorandum No. II.1 – Stormwater Contributions to Impaired Waters and TMDLs in Las Vegas Valley. MWH*. 2011a.

## 16.1 Permit Requirements

The new MS4 permit for Las Vegas Valley includes the following requirements relative to potential contributions of stormwater to impaired waters of the State.

*II.A.1 …the Permittees must evaluate whether stormwater discharges from any part of the MS4 contribute directly or indirectly to the listing of a waterbody on the 303(d) list (i.e., impaired waterbody).*

*II.B.1 If the Permittees' stormwater discharges contribute directly or indirectly to the listing of a waterbody on the 303(d) list as described above, the Permittees must also determine whether a Total Maximum Daily Load (TMDL) has been developed and approved by NDEP for the listed waterbody. If there is a TMDL, the Permittees must comply with Part II.B.2. If no TMDL has been approved, the Permittees must then comply with Part II.B.3."*

*II.B.2 If a TMDL is approved for any waterbody into which the Permittees discharge, the Permittees must:*

*II.B.2.a Determine and report whether the approved TMDL is for a pollutant likely to be found in stormwater discharges from the Permittees' MS4;*

*II.B.2.b Determine and report whether the TMDL includes a pollutant wasteload allocation ("WLA") or other performance requirements specifically for stormwater discharge from the Permittees' MS4;*

*II.B.2.c Determine and report whether the TMDL addresses a flow regime likely to occur during periods of stormwater discharge;*

*II.B.2.d Assess whether the WLAs are being met through implementation of existing stormwater control measures or if additional control measures are necessary;*

*II.B.2.e Document all control measures currently being implemented or planned to be implemented to be consistent with the WLA. Also include a schedule of implementation for all planned controls. Document the calculations or other evidence that shows that the WLA will be met;*

*II.B.2.f* *Describe a monitoring program to determine whether the stormwater controls are adequate to meet the WLA; and,*

*II.B.2.g* *If the evaluation shows that additional or modified controls are necessary, describe the type and schedule for the control additions/revisions, and an analysis that demonstrates the overall effectiveness.II.B.2.g If the evaluation shows that additional or modified controls are necessary, describe the type and schedule for the control additions/revisions, and an analysis that demonstrates the overall effectiveness.*

*II.B.3* *When a TMDL has not been established as described in Part II.B.2, the Permittees must include a section in the annual report describing the condition for which the water has been listed, evaluating possible Best Management Practices ("BMPs") that might practicably be implemented, examining whether these BMPs would have a substantial effect on achieving compliance, and identifying any BMPs that are selected for implementation."*

## 16.2 Impaired Waters and TMDLs in Las Vegas Valley

Lower Las Vegas Wash and selected tributaries are identified by NDEP in the 2006 303(d) list (February 2009) as being impaired for selenium, TDS, iron, pH and molybdenum, as indicated in **Table 16-1**. Phosphorus (total phosphorus, orthophosphate) and ammonia are not on the current 303(d) list for Las Vegas Valley. However, previous 303(d) lists included impairments for phosphorus and ammonia in lower Las Vegas Wash downstream of the WWTF discharges. As a result of these impairments, TMDLs for these constituents were developed by NDEP and management plans were implemented by local wastewater dischargers. Based on the effectiveness of the TMDL program implementation, these constituents were removed from the 303(d) list.

**Table 16-1. 2006 303(d) List of Impaired Waters in the Las Vegas Valley**

| Waterbody | Location | Parameter | Added in 2006 303(d) List |
|---|---|---|---|
| Las Vegas Creek | From its origin to Las Vegas Wash | pH | Yes |
| | | Selenium | Yes |
| Flamingo Wash | Above Las Vegas Wash | Selenium | Yes |
| | | Total Dissolved Solids | Yes |
| Duck Creek | From its origin to Las Vegas Wash | Selenium | Yes |
| | | Total Dissolved Solids | Yes |
| Las Vegas Wash | Above all wastewater treatment facilities | Iron | Yes |
| | | Selenium | Yes |
| | | Total Dissolved Solids | Yes |
| Las Vegas Wash | Telephone Line Rd to the confluence of Las Vegas Wash with Lake Mead; below all wastewater treatment facilities | Iron | No |
| | | Molybdenum | Yes |

Sources of pollutants causing impairment and the potential for direct or indirect contributions by flows in the MS4 system are summarized in **Table 16-2**. MS4 discharges have the potential to cause or contribute to the identified water quality impairments, but primarily through indirect means (e.g.,

recharge to shallow groundwater aquifers and increased erosion of unlined stream channels). Nevertheless, Part *II.B* of the permit requires the Permittees to propose BMPs to address these constituents. TMDLs have been established for total phosphorus and ammonia. MS4 discharges contribute significant loads of all these constituents except ammonia.

**Table 16-2. Sources of Pollutants and Effects of MS4 Discharges on Impaired Waterbodies in Las Vegas Valley**

| Pollutant | Sources in Las Vegas Valley | Direct or Indirect Effects of MS4 Discharges |
|---|---|---|
| pH | • Flow through native soils<br>• Runoff from industrial sites | **Indirect -** Increased urban baseflow may increase flow through high pH soils, contributing to high pH during dry weather conditions<br>**Direct -** Potentially contaminated runoff from industrial sites enters the MS4 and discharges to surface waters |
| Selenium | • Flow through native sub-surface soils<br>• Resurfacing shallow groundwater | **Indirect -** Increased urban baseflow may recharge upper portions of shallow aquifers and force high-selenium groundwater into the MS4 which carries it to the impaired segments |
| TDS | • Flow through native sub-surface soils<br>• Resurfacing shallow groundwater<br>• Wastewater discharges | **Indirect -** Increased urban baseflow may recharge upper portions of shallow aquifers and force high-TDS groundwater into the MS4 which carries it to the impaired segments |
| Iron | • Sediment transported in stream channels | **Indirect -** Increases in dry weather flows and storm flows may increase channel erosion and volume of sediment transported in channels |
| Molybdenum | • Sediment transported in stream channels | **Indirect -** Increases in dry weather flows and storm flows may increase channel erosion and volume of sediment transported in channels |

The total phosphorus TMDL includes a load allocation of 100 pounds per day (lb/day) for all nonpoint sources between March 1 and October 31, as indicated in **Table 16-3**. However, based on the method used to derive it, this load allocation does not appear to apply to stormwater runoff conditions. Monitoring data collected for the NPDES stormwater permit and wastewater discharge permits indicate that phosphorus loads from nonpoint sources are less than the 100 lb/day load allocation during dry weather conditions, but loads exceed this limit during most days of stormwater runoff. Thus, as long as the TMDL applies only to non-runoff conditions, discharges from the MS4 do not cause or contribute to TMDL exceedances.

**Table 16-3. Las Vegas Wash Wasteload and Load Allocations**

| | Total Phosphorus (lbs/day) | Total Ammonia (lbs/day) |
|---|---|---|
| Effective Dates | From March 1 - October 31 | From April 1 - September 30 |
| Total Wasteload Allocation for Wastewater Dischargers | 333 | 970 |
| Nonpoint Source Load Allocation | 100 | 0 |
| TMDL | 433 | 970 |

## 16.3 Permit Compliance for Constituents with TMDLs

Based on the foregoing analyses, the MS4 permit requires the Permittees to comply with permit section *II.B.2* for phosphorus (because it has an established TMDL) and with permit section *II.B.3* for selenium/TDS and naturally-occurring constituents associated with sediment loads (pH, iron, molybdenum). This subsection lists the specific permit requirements for constituents with a TMDL (total phosphorus), and responds to those requirements.

*II.B.2.a Determine and report whether the approved TMDL is for a pollutant likely to be found in stormwater discharges from the Permittees' MS4;*

Phosphorus is found in stormwater discharges and in dry weather discharges from the MS4.

*II.B.2.b Determine and report whether the TMDL includes a pollutant wasteload allocation ("WLA") or other performance requirements specifically for stormwater discharge from the Permittees' MS4;*

The TMDL includes a load allocation for all nonpoint sources combined. This includes stormwater, urban flows, groundwater return flows, and any other discharges not originating from the WWTFs. The TMDL does not include a separate load allocation for stormwater.

*II.B.2.c Determine and report whether the TMDL addresses a flow regime likely to occur during periods of stormwater discharge;*

The TMDL only addresses nonpoint sources in aggregate. Although the TMDL language does not specifically exclude stormwater discharges from compliance, the NDEP computations used to establish the nonpoint load allocation of 100 lb/day excluded data from days of stormwater runoff. Therefore, it is assumed for MS4 permit compliance that the TMDL load allocation for nonpoint sources does not apply during periods of stormwater runoff.

*II.B.2.d Assess whether the WLAs are being met through implementation of existing stormwater control measures or if additional control measures are necessary;*

The load allocation of 100 lb/day for total phosphorus is met during dry weather conditions. The load allocation is not met during wet weather conditions, but as noted above it is assumed that the load allocation does not apply during runoff conditions. Therefore, existing stormwater control measures are adequate and no additional control measures are necessary.

*II.B.2.e Document all control measures currently being implemented or planned to be implemented to be consistent with the WLA. Also include a schedule of implementation for all planned controls. Document the calculations or other evidence that shows that the WLA will be met;*

BMPs proposed for the new SWMP that address phosphorus and other nutrients are listed in **Table 16-4**. These BMPs are described in previous sections of the SWMP. Sediment is a major source of phosphorus, so BMPs that control sediment also reduce phosphorus. A technical memorandum was

prepared to describe these and other BMPs that address the various pollutants of concern identified for the Las Vegas Valley MS4 program (MWH 2010g).

**Table 16-4. Las Vegas Valley BMPs That Address Phosphorus**

| Pollutant Category | BMP Measure Type | Existing BMP or Other Activity |
|---|---|---|
| Nutrients (Nitrate, Total Phosphorus, Orthophosphate) | Maintenance Measures | MM-1 – Street Sweeping<br>MM-2 – Local Storm Drain System Maintenance<br>MM-3 – Regional Detention Basin Maintenance |
| | Source Control Measures | SC-1 – Water Conservation (Drought) Ordinance<br>SC-2 – Turf Conversion Program<br>SC-3 – Public Employee Supervisor Fertilizer/ Pesticide Training<br>SC-4 – Use of Alternate Products and Application Procedures<br>SC-5 – Household Hazardous Waste Collection<br>SC-6 – Commercial / Industrial Housekeeping Practices<br>SC-7 – Ordinances Prohibiting Non-Stormwater Discharges and Littering<br>SC-8 – Desert Dumping Controls<br>SC-10 – Dust Control Measures<br>SC-11 – Storm Drain Marking Program<br>SC-16 – Regional Water Quality Planning<br>SC-30 – LVV Stormwater Quality Website<br>SC-31 – Public Outreach Events<br>SC-32 – Elementary School Presentations<br>SC-33 – Public Service Announcement / Flood Control<br>SC-34 – Brochures and Printed Material |
| | Site Design | SD-1 – Open Space and Landscaping Objectives<br>SD-2 – Rural Land Overlay<br>SD-3 – Hillside Development Ordinances<br>SD-9 – Parking Lot Low Impact Development (LID) Measures<br>SD-10 – Low Impact Development (LID) Measures |
| | Treatment Control | TC-1 – Regional Detention Basins<br>TC-2 – Regional Channel Lining<br>TC-3 – Las Vegas Wash Stabilization Structures<br>TC-4 – Sand / Oil Separator<br>TC-5 – Sand Filter<br>TC-6 – Regional Detention Basin Retrofit |

*II.B.2.f Describe a monitoring program to determine whether the stormwater controls are adequate to meet the WLA; and,*

Dry weather phosphorus loads are lower than the load allocation for nonpoint sources; thus it is concluded that existing BMPs are adequate to meet the wasteload allocation for phosphorus and no additional monitoring of these programs is necessary. Public outreach and education programs are expanded, as described in Section 6 of the SWMP.

*II.B.2.g If the evaluation shows that additional or modified controls are necessary, describe the type and schedule for the control additions/revisions, and an analysis that demonstrates the overall effectiveness.*

No additional or modified BMPs are necessary beyond those described above.

## 16.4 Permit Compliance for Constituents without TMDLs

This section lists the specific permit requirements for constituents without a TMDL (selenium, TDS, iron, molybdenum) and responds to those requirements.

*II.B.3 When a TMDL has not been established as described in Part II.B.2, the Permittees must include a section in the annual report describing the condition for which the water has been listed, evaluating possible Best Management Practices ("BMPs") that might practicably be implemented, examining whether these BMPs would have a substantial effect on achieving compliance, and identifying any BMPs that are selected for implementation."*

Conditions for which the listed constituents cause impairments have been described previously. **Table 16-5** lists the BMPs proposed for the Las Vegas Valley SWMP that could be beneficial in addressing the listed constituents. BMPs are listed for pollutant categories expected to influence the constituents of interest, including general sediment/erosion. Descriptions of the BMPs in each category are provided in Appendix B. These BMPs satisfy the MEP standard for BMP implementation under the MS4 permit.

**Table 16-5. Las Vegas Valley BMPs that Address Pollutants without a TMDL**

| Pollutant Category | BMP Category | Existing BMP or Other Activity |
|---|---|---|
| Sediment (Sediment, TSS) | Maintenance Measures | MM-1 – Street Sweeping<br>MM-2 – Local Storm Drain System Maintenance<br>MM-3 – Regional Detention Basin Maintenance |
| | Source Control Measures | SC-10 – Dust Control Measures<br>SC-16 – Regional Water Quality Planning<br>SC-20 – Construction Site BMP Guidance Manual<br>SC-21 – Construction Site Inspections<br>SC-22 – Construction Site Training Workshops<br>SC-30 – LVV Stormwater Quality Website<br>SC-31 – Public Outreach Events<br>SC-32 – Elementary School Presentations<br>SC-33 – Public Service Announcement / Flood Control<br>SC-34 – Brochures and Printed Material |
| | Site Design | SD-1 – Open Space and Landscaping Objectives<br>SD-2 – Rural Land Overlay<br>SD-3 – Hillside Development Ordinances<br>SD-9 – Parking Lot Low Impact Development (LID) Measures<br>SD-10 – Low Impact Development (LID) Measures |
| | Treatment Control | TC-1 – Regional Detention Basins<br>TC-2 – Regional Channel Lining<br>TC-3 – Las Vegas Wash Stabilization Structures<br>TC-4 – Sand / Oil Separator<br>TC-5 – Sand Filter<br>TC-6 – Regional Detention Basin Retrofit |

**Table 16-5. Las Vegas Valley BMPs that Address Pollutants without a TMDL (Continued)**

| Pollutant Category | BMP Category | Existing BMP or Other Activity |
|---|---|---|
| Heavy Metals (Copper, Lead, Zinc, Molybdenum) | Maintenance Measures | MM-1 – Street Sweeping<br>MM-2 – Local Storm Drain System Maintenance<br>MM-3 – Regional Detention Basin Maintenance |
| | Source Control Measures | SC-7 – Ordinances Prohibiting Non-Stormwater Discharges and Littering<br>SC-8 – Desert Dumping Controls<br>SC-10 – Dust Control Measures<br>SC-16 – Regional Water Quality Planning<br>SC-30 – LVV Stormwater Quality Website<br>SC-31 – Public Outreach Events<br>SC-32 – Elementary School Presentations<br>SC-33 – Public Service Announcement / Flood Control<br>SC-34 – Brochures and Printed Material |
| | Site Design | SD-1 – Open Space and Landscaping Objectives<br>SD-2 – Rural Land Overlay<br>SD-3 – Hillside Development Ordinances<br>SD-9 – Parking Lot Low Impact Development (LID) Measures<br>SD-10 – Low Impact Development (LID) Measures |
| | Treatment Control | TC-1 – Regional Detention Basins<br>TC-2 – Regional Channel Lining<br>TC-3 – Las Vegas Wash Stabilization Structures<br>TC-4 – Sand / Oil Separator<br>TC-5 – Sand Filter<br>TC-6 – Regional Detention Basin Retrofit |
| Selenium | Source Control Measures | SC-1 – Water Conservation (Drought) Ordinance<br>SC-2 – Turf Conversion Program<br>SC-16 – Regional Water Quality Planning<br>SC-30 – LVV Stormwater Quality Website<br>SC-31 – Public Outreach Events<br>SC-32 – Elementary School Presentations<br>SC-33 – Public Service Announcement / Flood Control<br>SC-34 – Brochures and Printed Material |
| Total Dissolved Solids (Salinity) | Source Control Measures | SC-1 – Water Conservation (Drought) Ordinance<br>SC-2 – Turf Conversion Program<br>SC-16 – Regional Water Quality Planning<br>SC-30 – LVV Stormwater Quality Website<br>SC-31 – Public Outreach Events<br>SC-32 – Elementary School Presentations<br>SC-33 – Public Service Announcement / Flood Control<br>SC-34 – Brochures and Printed Material |
| pH | Source Control Measures | SC-1 – Water Conservation (Drought) Ordinance<br>SC-2 – Turf Conversion Program<br>SC-16 – Regional Water Quality Planning<br>SC-30 – LVV Stormwater Quality Website<br>SC-31 – Public Outreach Events<br>SC-32 – Elementary School Presentations<br>SC-33 – Public Service Announcement / Flood Control<br>SC-34 – Brochures and Printed Material |

As importantly, certain potential BMPs commonly used in other communities should not be implemented to avoid exacerbating existing water quality impairments. TDS impairments in Flamingo Wash, Duck Creek, and Las Vegas Wash upstream of the WWTFs are indicative of the overall salinity problem in the Colorado River Basin. Selenium impairments in Las Vegas Creek, Flamingo Wash, Duck Creek, and Las Vegas Wash upstream of the WWTFs are also indicative of regional problems in the Southwest. Both selenium and TDS originate primarily from the shallow

aquifer in lower Las Vegas Valley. This situation has been described in Section 3 and in Technical Memorandum IV.6 (MWH, 2010d). The SWMP recommends that stormwater infiltration be discouraged throughout Las Vegas Valley, and that it only be permitted in locations where site-specific geotechnical studies can demonstrate that it is technically feasible and will not adversely affect surface and ground water quality.

# 17 REFERENCES


MWH. 2008-2009 Annual Report, Las Vegas Valley Municipal Separate Storm Sewer System. September 2009.

MWH. Technical Memorandum No. II.1 – Stormwater Contributions to Impaired Waters and TMDLs in Las Vegas Valley. Prepared for Las Vegas Valley Stormwater Quality Management Committee. 2011a.

MWH. Technical Memorandum No. IV.1 – Summary and Evaluation of Las Vegas Valley Water Quality Data. Prepared for Las Vegas Valley Stormwater Quality Management Committee. 2010a.

MWH. Technical Memorandum No. IV.4 – Proposed Source Controls and Maintenance Program. Prepared for Las Vegas Valley Stormwater Quality Management Committee. 2010b

MWH, Technical Memorandum No. IV.5 – Unique Factors Influencing the Las Vegas Valley Municipal Separate Storm Sewer System Permit Program. Prepared for Las Vegas Valley Stormwater Quality Management Committee. 2010c.

MWH,. Technical Memorandum No. IV.6 – Limitations on Use of Infiltration-Based BMPs for New Development and Significant Redevelopment in Las Vegas Valley. Prepared for Las Vegas Valley Stormwater Quality Management Committee. 2010d

MWH,. Technical Memorandum No. IV.7 – Potential Legal and Water Rights Issues Associated with Onsite Retention of Stormwater. Prepared for Las Vegas Valley Stormwater Quality Management Committee. 2010e

MWH,. Technical Memorandum No. IV.8 – Pollutants of Concern for Las Vegas Valley MS4 NDSR Program. Prepared for Las Vegas Valley Stormwater Quality Management Committee. 2010f

MWH,. Technical Memorandum No. IV.9 – Description of Existing BMPs and Need for New BMPs for NDSR Program. Prepared for Las Vegas Valley Stormwater Quality Management Committee. 2010g

MWH,. Technical Memorandum No. IV.10 – Evaluation of Low Impact Development Measures for NDSR Program. Prepared for Las Vegas Valley Stormwater Quality Management Committee. 2010h

MWH,. Technical Memorandum No. IV.11 – Potential Water Quality Retrofits of Regional Detention Basins – Strategic Plan. Prepared for Las Vegas Valley Stormwater Quality Management Committee. 2010i

MWH. Technical Memorandum No. IV.12 – Proposed New Development and Significant Development Program for Las Vegas Valley. Prepared for Las Vegas Valley Stormwater Quality Management Committee. 2010j.

Nevada Division of Environmental Protection. 2010 Las Vegas Valley MS4 Permit NV0021911. February 2010.

# APPENDICES

Appendix A Las Vegas Valley Municipal Separate Storm Sewer System Permit

Appendix B Descriptions of BMPs

# APPENDIX A

ndep
NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
protecting the future for generations

STATE OF NEVADA
Department of Conservation & Natural Resources
DIVISION OF ENVIRONMENTAL PROTECTION

Jim Gibbons, Governor
Allen Biaggi, Director
Leo M. Drozdoff, P.E., Administrator

February 9, 2010

Kevin Eubanks, P.E., CFM
Clark County Regional Flood Control District
600 S. Grand Central Parkway, Suite 300
Las Vegas, Nevada 89106-3870

**RE: Las Vegas Valley MS4 Permit No. NV0021911 Renewal**

Dear Mr. Eubanks:

Pursuant to Nevada Revised Statute 445A.495, the Nevada Division of Environmental Protection ("NDEP") has reviewed the renewal application for Discharge Permit NV0021911. Copies of the draft permit conditions, fact sheet, and public notice were sent to your office and the Clark County Board of County Commissioners for review and comments. The public notice was also published in the **Las Vegas Review Journal** and sent to interested persons and governmental agencies on NDEP's electronic notification e-mail list. During the 30-day public notice period which closed at **5:00 P.M. on February 1, 2010**, NDEP did not receive any written comments or inquiries. Therefore, NDEP made the decision to issue the enclosed discharge permit for a period of five (5) years. This permit action does not constitute a significant change from the tentative determinations set forth in the public notice.

If you have questions concerning this letter, please contact me at (775) 687-9429.

Sincerely,

Steve McGoff, P.E.
Staff Engineer III
Technical Services Branch
Bureau of Water Pollution Control

Attachment: Final Permit

cc: Cliff Lawson, P.E., NDEP (w/o enclosure)
John Tinger, EPA – Region IX, 75 Hawthorne St, San Francisco, CA 94105 (w/enclosure)
Chip Paulson, MWH, 1801 California St, 29th Floor, Denver, CO 80202-1244 (w/enclosure)

**Permit No. NV0021911**

**Permit for Authorization to Discharge from Municipal Separate Storm Sewer Systems to Waters of the United States under the National Pollutant Discharge Elimination System**

In compliance with the provisions of the Clean Water Act, as amended, (33 U.S.C. 1251 et. seq.), and Chapter 445A of the Nevada Revised Statutes, the following Permittees are authorized to discharge municipal stormwater runoff to the Las Vegas Wash, its tributaries, and other waters of the United States in accordance with the conditions and requirements set forth herein:

The City of Henderson, City of Las Vegas, City of North Las Vegas, Clark County and the Clark County Regional Flood Control District.

This permit becomes effective February 9, 2010.

This permit and the authorization to discharge expire at midnight February 8, 2015.

Signed and issued this 9th day of February, 2010.

Steve McGoff, P.E.
Staff III Engineer
Bureau of Water Pollution Control

## I. Permit Area and Coverage under this Permit

### I.A. Permit Area

I.A.1 This permit authorizes stormwater discharges into receiving waters of the United States within the Cities of Henderson, Las Vegas and North Las Vegas, and Clark County ("Permittees") that are located within the Las Vegas Valley. This permit does not include Boulder City, Laughlin, Mesquite, Nellis Air Force Base or portions of unincorporated Clark County that are located outside the Las Vegas Valley.

### I.B. Permit Coverage

I.B.1 This permit authorizes discharges of stormwater from the Permittees' municipal separate storm sewer systems ("MS4s"), as defined in 40 Code of Federal Regulations ("CFR") §122.26. The Permittees are authorized to discharge stormwater in accordance with the terms and conditions of this permit.

I.B.2 The following are types of authorized discharges:

I.B.2.a **Authorized discharges.** This permit authorizes stormwater discharges and the non-stormwater discharges identified in Part I.B.2.b to waters of the United States from the Permittees' MS4s. This permit does not allow discharges listed in Part I.B.3.

I.B.2.a.i This permit authorizes the Permittees to accept from other dischargers, to pass through their MS4s, and to discharge stormwater and non-stormwater currently covered or required to be covered under another National Pollutant Discharge Elimination System ("NPDES") permit. The permittees shall implement on those discharges into their MS4s the measures required by this permit.

I.B.2.a.ii This permit does not authorize any non-Permittees to discharge into the MS4 any stormwater or non-stormwater that requires a separate NPDES permit. Those non-Permittees must obtain their own NPDES permits to cover discharges through the Permittees' MS4s into waters of the United States.

I.B.2.b **Non-stormwater discharges.** The Permittees are authorized to accept from other dischargers without requiring BMPs or other measures, to pass through their MS4s, and to discharge the following non-stormwater sources provided that the Nevada Division of Environmental Protection ("NDEP") has not determined these sources to be substantial contributors of pollutants to the Permittees' MS4:

I.B.2.b.i Water line flushing;
I.B.2.b.ii Diverted stream flows;
I.B.2.b.iii Rising ground waters;
I.B.2.b.iv Uncontaminated groundwater infiltration (infiltration is defined as water other than wastewater that enters a sewer system, including sewer service connections and foundation drains, from the ground through such means as defective pipes, pipe joints, connections, or manholes. Infiltration does not include, and is distinguished from, inflow.);
I.B.2.b.v Discharges from potable water sources;
I.B.2.b.vi Foundation and footing drains;
I.B.2.b.vii Air conditioning condensate;
I.B.2.b.viii Irrigation water for lawns and landscaping;
I.B.2.b.ix Springs;
I.B.2.b.x Water from crawl space pumps;
I.B.2.b.xi Individual residential car washing;
I.B.2.b.xii Flows from riparian habitats and wetlands;
I.B.2.b.xiii De-chlorinated swimming pool discharges;
I.B.2.b.xiv Street wash water, if no detergents or chemicals are used;
I.B.2.b.xv Discharges or flows from fire fighting activities; and
I.B.2.b.xvi Dewatering activities not requiring separate discharge permits.

### I.B.3 Non-Authorized Discharges

I.B.3.a This permit does not authorize the following :

I.B.3.a.i Discharges that do not comply with the Nevada's anti-degradation policy for water quality standards; and

I.B.3.a.ii Any discharge that causes or contributes to an in-stream exceedance of water quality standards.

## II. Discharges to Water Quality Impaired Waters

## II.A. Impaired Waters Listing on 303(d) List

II.A.1 Based upon the most current 303(d) list and subsequent updates, the Permittees must evaluate whether stormwater discharges from any part of the MS4 contributes directly or indirectly to the listing of a waterbody on the 303(d) list (i.e., impaired waterbody). Information concerning the most current 303(d) list can be found on the following NDEP website: Current 303(d) List. If Permittees have discharges meeting this criterion, the Permittees must comply with Part II.B. Part II does not apply if the Permittees do not have discharges meeting this criterion.

## II.B. Total Maximum Daily Load

II.B.1 If the Permittees' stormwater discharges contribute directly or indirectly to the listing of a waterbody on the 303(d) list as described above, the Permittees must also determine whether a Total Maximum Daily Load ("TMDL") has been developed and approved by NDEP for the listed waterbody. If there is a TMDL, the Permittees must comply with Part II.B.2. If no TMDL has been approved, the Permittees must then comply with Part II.B.3.

II.B.2 If a TMDL is approved for any waterbody into which the Permittees discharge, the Permittees must:

II.B.2.a Determine and report whether the approved TMDL is for a pollutant likely to be found in stormwater discharges from the Permittees' MS4;

II.B.2.b Determine and report whether the TMDL includes a pollutant wasteload allocation ("WLA") or other performance requirements specifically for stormwater discharge from the Permittees' MS4;

II.B.2.c Determine and report whether the TMDL addresses a flow regime likely to occur during periods of stormwater discharge;

II.B.2.d Assess whether the WLAs are being met through implementation of existing stormwater control measures or if additional control measures are necessary;

II.B.2.e Document all control measures currently being implemented or planned to be implemented to be consistent with the WLA. Also include a schedule of implementation for all planned controls. Document the calculations or other evidence that shows that the WLA will be met;

II.B.2.f Describe a monitoring program to determine whether the stormwater controls are adequate to meet the WLA; and,

II.B.2.g If the evaluation shows that additional or modified controls are necessary, describe the type and schedule for the control additions/revisions, and an analysis that demonstrates the overall effectiveness.

II.B.3 When a TMDL has not been established as described in Part II.B.2, the Permittees must include a section in the annual report describing the condition for which the water has been listed, evaluating possible Best Management Practices ("BMPs") that might practicably be implemented, examining whether these BMPs would have a substantial effect on achieving compliance, and identifying any BMPs that are selected for implementation.

II.B.4 If appropriate, the updated SWMP shall identify additional BMPs with a schedule for implementation consistent with the WLA for phosphorus and ammonia loadings into Lake Mead and shall be submitted in accordance with Part II.B.2.

## III. Adequate Legal Authority

### III.A. Ordinance

III.A.1 Each of the Permittees shall have an ordinance in place that authorizes or enables each Permittee to:

III.A.1.a Prohibit illicit discharges and illicit connections to the Permittees' MS4s;

III.A.1.b Control the discharge from spills, dumping or disposal of materials other than stormwater to any of the Permittees' MS4s;

III.A.1.c Require compliance with any condition contained in ordinances, permits, contracts or orders;

III.A.1.d Require structural and non-structural BMPs for erosion and sediment controls at construction sites;

III.A.1.e Inspect construction sites disturbing $\geq$ one (1) acre or $<$ one (1) acre if part of a common plan of development to ensure compliance with each Permittee's ordinance and take appropriate enforcement action as necessary;

III.A.1.f Inspect industrial sites that are part of each jurisdiction's inventory of industrial sites to ensure compliance with each Permittee's ordinance, and take appropriate enforcement action as necessary;

III.A.1.g Establish civil, administrative and criminal penalties for violations of the ordinance; and

III.A.1.h Carry out all inspection, surveillance, and monitoring procedures necessary to determine compliance and non-compliance with the prohibition of illicit discharges to the Permittees' MS4s.

## IV. Stormwater Management Program

### IV.A. General Requirements

IV.A.1 The Permittees shall continue to implement and enforce their Stormwater Management Program ("SWMP") designed to reduce the discharge of pollutants from the Permittees' MS4 to the maximum extent practicable

("MEP") to protect water quality, and to satisfy the appropriate water quality requirements of the Clean Water Act ("CWA");

IV.A.2 The Permittees may partner with other MS4s in the region to develop and implement the SWMP. The description of the Permittees' SWMP must clearly describe which Permittee is responsible for implementing each of the minimum control measures ("MCMs").

IV.A.3 The permittees shall review, revise as necessary and submit an updated SWMP to NDEP for its review and approval within eighteen (18) months of the effective date of this permit and shall implement the revised SWMP no later than two (2) years after receiving NDEP's approval;

IV.A.3.a Before the updated SWMP is submitted to NDEP for its review, it shall be made available for public comment at a meeting noticed in accordance with the Nevada open meeting law;

IV.A.3.b The Permittees shall compile any comments received as part of the process in IV.A.3.a., describe the actions taken concerning the public comments and include this information in the updated SWMP;

IV.A.4 The updated SWMP shall present a review of legal authority to ensure adequate authority to implement the requirements of this permit and the updated SWMP. Where necessary, additional ordinances or other regulatory mechanisms shall be submitted to the governing boards and councils for their adoption.

IV.A.5 The updated SWMP shall identify existing BMPs and any new BMPs that the Permittees or another entity will implement;

IV.A.6 The updated SWMP shall identify the measurable goals for the new BMPs, as appropriate, including the months and years in which the Permittees will undertake required actions;

IV.A.7 The updated SWMP shall provide information explaining how and why the Permittees selected each new BMP and measurable goals for the SWMP;

IV.A.8 Implementation of new and existing BMPs consistent with the provisions of the SWMP as required by this permit and approved by NDEP constitutes compliance with the standard of reducing pollutants to the MEP;

IV.A.9 The scope and coverage of the updated SWMP shall extend at least to the parts of the Las Vegas Valley which are or could reasonably be urbanized within the time covered by the permit;

IV.A.10 The updated SWMP shall include a description of the staff and resources available to implement the program elements;

IV.A.11 A separate updated SWMP, or one or more joint SWMPs, may be submitted by each Permittee;

IV.A.12 The updated SWMP may impose controls on a system-wide basis, a watershed basis, a jurisdictional basis, or on individual outfalls;

IV.A.13 The updated SWMP shall describe any new priorities for implementing MCMs and shall be based on Public Outreach and Education; Illicit Discharge and Detection; Industrial Facility Monitoring and Control; Post-Construction BMP Program for New Development and Significant Redevelopment, and a Construction Site BMP Program;

IV.A.14 The updated SWMP shall incorporate the BMPs identified in this permit; and

IV.A.15 Pending submittal and approval of the updated SWMP, the Permittees shall continue to implement the current SWMP and any existing BMPs.

**IV.B. Source Identification**

IV.B.1 The updated SWMP shall provide updated maps of the Permittees' MS4s, including the location of any major outfall that discharges to waters of the United States that was not reported in the previous SWMP.

**IV.C. Characterization Data**

IV.C.1 The updated SWMP shall evaluate characterization data previously submitted and include additional data collected in the same manner, and evaluate whether existing data collection programs should be modified to improve characterization of stormwater discharges, effects of BMPs, or ambient water quality. This information shall be submitted for approval as part of the annual monitoring plan required in Part VI.A.

**IV.D. Public Outreach and Education**

IV.D.1 The updated SWMP covering the duration of this permit shall describe public outreach and education to reduce the discharge of pollutants to the MEP;

IV.D.2 The updated SWMP shall contain information about the different types of educational material distributed during environmental fairs or other public outreach events; and

IV.D.3 The updated SWMP shall describe educational activities, public information activities, and other appropriate activities;

IV.D.4 The updated SWMP shall describe how the Permittees will inform developers, contractors, operators, and agency staff about upcoming educational and training workshops on construction site erosion and sediment control and construction materials management sponsored by industry groups, professional organizations and public agencies;

IV.D.5 The updated SWMP shall describe how the Permittees will inform architects, engineers, municipal development personnel, and local government officials on water quality problems associated with urban runoff and the requirements for meeting NPDES laws and program goals for properly managing the quality of urban runoff.

**IV.E. MS4 Maintenance Activities**

IV.E.1 The updated SWMP shall include a description of structural and source control measures expected to reduce pollutants from stormwater runoff from commercial and residential areas that are discharged into the MS4. This section shall also discuss the basis for the expected reduction of pollutant loads and a proposed schedule for implementing such controls. At a minimum, the description shall include:

IV.E.1.a A description of maintenance activities and a maintenance schedule to reduce pollutants in discharges from MS4s;

IV.E.1.b A description of practices for operating and maintaining public streets, roads and highways and procedures for reducing the impact on receiving waters of discharges from the MS4s;

IV.E.1.c A description of a program to evaluate, monitor and reduce pollutants in runoff from operating or closed municipal landfills or other treatment, storage or disposal facilities for municipal waste;

IV.E.1.d A description of a program to evaluate and reduce pollutants in discharges from MS4s associated with the application of pesticides, herbicides, and fertilizer.

**IV.F. Post-Construction Program For New Development and Significant Redevelopment Projects**

IV.F.1 The Permittees shall develop a Post-Construction BMP Program for new development and significant redevelopment ("NDSR") projects that is suited for the unique hydrologic, hydrogeologic and regional conditions of the Las Vegas Valley. The program shall focus on planning procedures consistent with the goals identified in Part IV.F.2.

IV.F.2 The Post-Construction Program shall have the following goals:

IV.F.2.a To prevent stormwater discharges from post-construction projects from causing or contributing to downstream violations of water quality standards of selenium to the MEP;

IV.F.2.b To promote anti-degradation of ambient water quality by reducing the discharge of pollutants in stormwater causing or contributing to any degradation identified by NDEP's anti-degradation program; and

IV.F.2.c To develop BMPs to promote the reuse of stormwater for municipal water supplies.

IV.F.3 The Post-Construction Program shall address at a minimum the following elements:

IV.F.3.a Describe how the Permittees will review and enhance the SWMP post-construction program requirements in a manner appropriate for the unique hydrologic, hydrogeologic and regional conditions and needs of the Las Vegas Valley. The review shall address the following elements:

IV.F.3.a.i Describe how the Permittees will develop, implement and enforce a program to address post-construction urban runoff from NDSR projects that disturb areas $\geq$1 acre, including projects <1 acre that are part of a larger common plan of development or sale, that discharge into the MS4 by ensuring that NDSR projects are complying to the MEP with the requirements of this program;

IV.F.3.a.ii Describe how the Permittees will develop low-impact development ("LID") measures that will remain in effect after construction is complete and are effective and appropriate for the Las Vegas Valley and its environment. The program will outline the selected LID measures found effective and appropriate for the Las Vegas Valley along with a summary and schedule for implementation in the MS4;

IV.F.3.a.iii Describe how the Permittees will develop any additional structural and non-structural BMPs that will remain in effect after construction is complete and are effective and appropriate for Las Vegas Valley and its environment. The program will outline the selected BMP measures found effective and appropriate for the Las Vegas Valley along with a summary and schedule for implementation in the MS4;

IV.F.3.a.iv Describe procedures to assure that future regional flood management projects assess the impacts on the water quality of receiving water bodies and that existing structural flood control devices have been

evaluated to determine if retrofitting the device to provide additional pollutant removal from stormwater is feasible and appropriate;

IV.F.3.a.v Describe how the Permittees will develop and implement an ordinance or other regulatory mechanism to address urban stormwater runoff from NDSR projects;

IV.F.3.a.vi Describe how the Permittees will provide verification of maintenance provisions for structural BMPs located on private property that are subject to post-construction structural BMP requirements;

IV.F.3.a.vii Describe how the Permittees will develop and implement an inventory and tracking system for post-construction structural stormwater BMPs. The inventory and tracking system shall use at a minimum the following items: project name, project location, project acreage, BMP type and description, inspection date and summary, and any corrective actions undertaken;

IV.F.3.a.viii Describe how the Permittees will inspect and enforce the proper installation and long-term maintenance of post-construction structural stormwater BMPs ; and

IV.F.3.a.ix Describe how the Permittees will update its MS4 maps to show areas of NDSR, including any new stormwater major infrastructure that was constructed to serve these areas.

IV.F.3.b All NDSR projects submitted to the permitting authority subsequent to program implementation as identified in IV.A.2 that fall into one of the following categories shall be subject to one or more of the SWMP design standards developed in accordance with Part IV.F.4:

IV.F.3.b.i Residential subdivisions five (5) acres or greater in size;

IV.F.3.b.ii Single-family residences subject to local ordinances governing hillside development;

IV.F.3.b.iii 100,000 square foot commercial and industrial developments;

IV.F.3.b.iv Automotive repair shops (with Standard Industrial Classification ("SIC") codes 5013, 7532, 7533, 7534, 7537, 7538, and 7539);

IV.F.3.b.v Retail gasoline outlets disturbing greater than one (1) acre;

IV.F.3.b.vi Restaurants disturbing greater than one (1) acre;

IV.F.3.b.vii Parking lots greater than one (1) acre potentially exposed to urban runoff; and

IV.F.3.b.viii Any other NDSR projects the Permittees deem necessary to be included in this part.

IV.F.4 **Design Standards.** The post-construction program shall describe how NDSR projects specified in the previous section will implement the design standards outlined in this section. Subject to Section IV.F.4.e, the design standards program shall address at minimum the following criteria:

IV.F.4.a **Peak-Urban Runoff Discharge Rates.** Describe how the Permittees will develop design standards for peak-urban runoff from NDSR projects that will provide protection against downstream erosion;

IV.F.4.b **Site Design BMPs.** Describe how the Post-Construction Program will develop and implement site design BMPs in the site layout during the design and approval process to meet the goals of this program identified in Part IV.F.2;

IV.F.4.c **Source Control BMPs.** The Post-Construction Program shall describe how source control BMPs will be implemented. The design standards program shall include the following source-control BMPs that are consistent with the goals of this program:

IV.F.4.c.i Slopes and channel design or protection to minimize erosion;

IV.F.4.c.ii Properly designed outdoor material storage areas; and

IV.F.4.c.iii Properly designed trash storage areas.

IV.F.4.d **Treatment Control BMPs.** The post-construction program shall describe how treatment control BMPs will be developed and implemented. "Treatment control BMPs" and "treat" refer to any onsite or offsite process that provides for infiltration or detention of stormwater or that removes pollutants through any physical, chemical, or biological process. The design standards program shall describe in sufficient detail how the Permittees will size treatment control BMPs using accepted hydrologic engineering quantitative methods and the following design criteria:

IV.F.4.d.i **Volumetric Treatment Control BMP design criteria.** The post-construction program shall describe how the Permittees will design volume-based BMPs to treat stormwater discharges from projects listed in Part IV.F.3.b. The Permittees shall use one of the following conditions to develop the volumetric treatment control BMP design criteria :

IV.F.4.d.i.1 Historical rainfall records for the Las Vegas Valley to determine the maximized capture stormwater volume for the area for the 24-hour event using the formula recommended in Urban Runoff Quality Management, Water Environment Federation Manual of Practice No. 23/ASCE Manual of Practice No. 87, (1998); or

IV.F.4.d.i.2 The volume of annual runoff based on unit basin storage water quality volume, to achieve at least 80% of volume treatment by the method recommended in hydrology manuals, textbooks or similar technical publications; or

IV.F.4.d.i.3 An alternative treatment design criteria, appropriate for the unique hydrologic, hydrogeologic and regional conditions of the Las Vegas Valley. Any alternative design criteria shall be submitted to NDEP with sufficient technical data to establish the appropriateness of the alternative treatment design criteria.

IV.F.4.d.ii **Flow-Based BMP design criteria.** The post-construction program shall describe how the Permittees will design flow-based BMPs to treat stormwater discharges from projects listed in Part V.F.3.b. The Permittees shall use one of the following conditions to develop flow-based BMP design criteria:

IV.F.4.d.ii.1 Historical rainfall data for the Las Vegas Valley to determine the maximum flow rate of runoff from rainfall per hour, for each hour of a storm event; or

IV.F.4.d.ii.2 The maximum flow rate of runoff produced by the 80th percentile hourly rainfall intensity (for each hour of the storm event), as determined from the local historical rainfall record; or

IV.F.4.d.ii.3 The maximum flow rate of runoff for each hour of a storm event, as determined from the local historical rainfall record that achieves approximately the same reduction in pollutant loads and flows as achieved by mitigation of the 80th percentile hourly rainfall intensity; or

IV.F.4.d.ii.4 An alternative treatment design criteria, appropriate for the unique hydrologic, hydrogeologic and regional conditions of the Las Vegas Valley. Any alternative design criteria shall be submitted to NDEP with sufficient technical data to establish the appropriateness of the alternative treatment design criteria.

IV.F.4.e If the Permittees will not use some or all of the design standards described in this section, the Permittees shall provide justification using

documentation and engineering analyses, and propose reasonable alternatives that are appropriate for the unique hydrologic, hydrogeologic and regional conditions in Las Vegas Valley.

IV.F.5 **Effect of the Post-Construction Program on Water Quality Standards and Drinking Water Supply**

IV.F.5.a The Permittees shall provide a written evaluation whether the criteria developed as part of the post-construction program will tend to cause or contribute to elevated levels of selenium in surface waters within Las Vegas Valley, including an exceedance of the water quality standards for selenium in identified washes, and shall submit the evaluation to NDEP as part of the post-construction program; and

IV.F.5.b The Permittees shall provide a written evaluation whether the criteria developed as part of the post-construction program will tend to reduce or degrade the contribution of stormwater to the water supplies provided by the Colorado River.

IV.F.5.c If any criteria developed under the post-construction program in accordance with the provisions of this permit would have a reasonable potential of causing or contributing to any water quality or water quantity impairment, or violates Nevada law, they shall be rescinded, and the Permittees shall determine whether alternate criteria can be implemented without causing water quality or water quantity impairments or violating Nevada law.

## IV.G. Illicit Discharge and Detection

IV.G.1 The updated SWMP shall include a description of a program, including a schedule, to detect and remove illicit discharges and improper disposal into the MS4. The program shall include:

IV.G.1.a A description of a program, including inspections, to implement and enforce an ordinance, orders or similar means to prevent all types of illicit discharges to the MS4. Non-stormwater discharges, as defined in Part I.B.2.b, shall only be addressed where such discharges are identified by the Permittee as substantial contributors of pollutants to the Permittee's MS4;

IV.G.1.b A description of procedures to conduct on-going field screening activities during the life of this permit, including areas or locations that will be evaluated by such field screens;

IV.G.1.c Field screening protocol to investigate dry weather flows that would indicate when an illicit discharge may be present, and when follow-up investigation will be required;

IV.G.1.d A description of procedures to be followed to investigate portions of the MS4 that, based on the results of the field screen, or other appropriate information, indicate a reasonable potential of containing illicit discharges or other sources of non-stormwater;

IV.G.1.e A description of procedures to prevent, contain, and respond to spills that may discharge into the MS4;

IV.G.1.f A description of a program to facilitate public reporting of the presence of illicit discharges or water quality impacts associated with discharges from MS4s;

IV.G.1.g A description of educational activities, public information activities, and other appropriate activities to facilitate the proper management and disposal of used oil and toxic materials; and

IV.G.1.h An assessment of whether the procedures otherwise implemented in response to this section are sufficient to identify instances of exfiltration from the sanitary sewer to the storm sewers, and if not, a description of additional activities to be undertaken to control exfiltration.

**IV.H. Industrial Facility Monitoring and Control**

IV.H.1 The updated SWMP shall include a description of a program to monitor and control pollutants in stormwater discharges to MS4s from municipal landfills, hazardous waste treatment, disposal and recovery facilities, industrial facilities that are subject to section 313 of title III of the Superfund Amendments and Reauthorization Act of 1986 ("SARA"), and industrial facilities that the municipal permit applicant determines are contributing a substantial pollutant loading to the MS4. The program shall include the following components:

IV.H.1.a Identify priorities and procedures for inspections and establishing and implementing control measures for such discharges;

IV.H.1.b Each permittee shall develop and maintain an inventory of the facilities identified in part IV.H.1 The inventory shall list the facilities by specific categories (e.g. restaurants, municipal maintenance yards, etc.) and list the minimum inspection frequency for each category of facilities;

IV.H.1.c Each Permittee shall provide a list of the inventoried facilities to NDEP by October 1, 2010. Each year thereafter for the life of this permit, each

Permittee shall provide to NDEP by October 1 of that year, an updated list of the facilities inventoried during that year; and

IV.H.1.d Describe a monitoring program for stormwater discharges associated with the industrial facilities identified in this section, to be implemented during the term of the permit in accordance with the monitoring programs defined in Part V.A.

## IV.I. Construction Site BMP Program

IV.I.1 The updated SWMP shall include a description of a program to implement and maintain structural and non-structural BMPs to reduce pollutants in stormwater runoff from construction sites to the MS4, which shall include:

IV.I.1.a A description of procedures for notifying developers and operators of properties of one (1) acre or more (and less than one acre if part of a larger plan of development) of requirements applicable to stormwater runoff;

IV.I.1.b A description of nonstructural and structural BMPs to be utilized for construction sites;

IV.I.1.c A description of appropriate educational and training measures for construction site operators; and

IV.I.1.d A description of a procedure to check for coverage under NDEP's General Construction Permit for Construction Activity prior to permit issuance.

## IV.J. Inspection of Construction Sites

IV.J.1 Each permittee shall conduct construction site inspections for compliance with its local ordinances (grading, stormwater, etc.) and permits (construction, grading, etc.);

IV.J.2 Each permittee shall inspect at least monthly, all construction sites within its jurisdiction meeting the following criteria:

IV.J.2.a All sites disturbing 100 acres or more in size at one time;

IV.J.2.b All sites disturbing one (1) acre or more that are tributary to a CWA section 303(d) water body segment impaired for sediment or turbidity; and

IV.J.2.c Sites determined by the permittees as a significant threat to water quality. In evaluating threat to water quality, the following factors shall be considered:

IV.J.2.c.i Soil erosion potential;

IV.J.2.c.ii Site slope;
IV.J.2.c.iii Project size and type;
IV.J.2.c.iv Sensitivity of receiving water bodies;
IV.J.2.c.v Proximity to receiving water bodies;
IV.J.2.c.vi Proximity to water bodies 303(d) listed for turbidity and sediment;
IV.J.2.c.vii Non-storm water discharges;
IV.J.2.c.viii Past record of non-compliance by the construction site operators; and
IV.J.2.c.ix Any other relevant factors.

IV.J.2.d All other construction sites of > one (1) acre not listed in Part IV.J.2 shall be inspected at least two (2) times for the duration of ground disturbance activities;

IV.J.3 Based upon site inspection findings, each permittee shall implement all follow-up actions (i.e., re-inspection or enforcement) necessary to comply with this Permit;

IV.J.4 Inspections of construction sites shall include, but not be limited to:

IV.J.4.a Assessment of compliance with Permittee ordinances and permits related to urban runoff, including the implementation and maintenance of designated minimum BMPs;

IV.J.4.b Assessment of BMP effectiveness;

IV.J.4.c Visual observations for non-stormwater discharges and potential illicit connections;

IV.J.4.d Education and outreach on stormwater pollution prevention, as needed; and

IV.J.4.e Creation of a written or electronic inspection report.

IV.J.5 The permittees shall track the number of inspections for the inventoried construction sites throughout the reporting period to verify that the sites are inspected at the minimum frequencies required. This information shall be included in the Annual Report.

## IV.K. Sharing Responsibility

IV.K.1 The Permittees may either share responsibility or assign responsibility to one or more Permittees, and may implement BMPs individually, as a group, or through consultants. The SWMP shall include a description of how responsibility to implement BMPs is being shared or assigned.

### IV.L. Reviewing and Updating Stormwater Management Programs

IV.L.1 After submittal and approval of the updated SWMP, the Permittees must complete an annual review of the SWMP in conjunction with preparation of the Annual Report required under Part VI.C;

IV.L.2 The Permittees may change the SWMP during the life of the permit in accordance with the following procedures:

IV.L.2.a Changes adding (but not subtracting or replacing) components, controls, or requirements to the SWMP may be made at any time upon written notification to NDEP;

IV.L.2.b Requests for changes replacing an ineffective, unfeasible, or inappropriate BMP specifically identified in the SWMP with an alternate BMP may be submitted to NDEP for approval at any time. If the request is denied, NDEP will send the Permittees a written response giving a reason for its decision. The Permittees modification requests must include the following:

IV.L.2.b.i An analysis of why the BMP is ineffective, infeasible (including cost prohibitive), or otherwise should be revised or replaced, and

IV.L.2.b.ii An analysis of why the replacement BMP is expected to be more effective, feasible, or appropriate than the BMP to be replaced.

### IV.M. Responsibility for Stormwater Management Program Implementation

IV.M.1 The Permittees must implement the SWMP on all new areas added to the Permittees portion of the MS4 (or for which the Permittees become responsible for implementation of stormwater quality controls) not later than one (1) year from addition of the new areas; and

IV.M.2 Information on all new annexed areas and any resulting updates required to the SWMP must be included in the Annual Report.

## V. Monitoring, Recordkeeping, and Annual Report

### V.A. Monitoring

V.A.1 The Permittees shall submit to NDEP a stormwater monitoring plan for the following year on or before October 1 each year. In developing the plan, the Permittees must evaluate and update as necessary how monitoring may assist in making decisions about program compliance, the appropriateness of identified BMPs, and progress toward achieving identified measurable goals.

Pending submittal of the annual monitoring plan, the Permittees shall continue to implement the existing monitoring plan.

V.A.2 When the Permittees conduct monitoring at the Permittees' MS4, the Permittees are required to comply with the following:

V.A.2.a Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge. This requirement does not prevent Permittees from analyzing or reporting samples that are representative of a limited situation (e.g. concentration at peak flow);

V.A.2.b Test procedures for the analysis of pollutants shall conform to regulations (40 CFR, Part 136) published pursuant to Section 304(h) of the Act, unless other procedures are approved by NDEP.

V.A.2.c Records of monitoring information shall include:

V.A.2.c.i The date, exact place, and time of sampling or measurements;

V.A.2.c.ii The names(s) of the individual(s) who performed the sampling or measurements;

V.A.2.c.iii The date(s) analyses were performed;

V.A.2.c.iv The name(s) of the individual(s) who performed the analyses;

V.A.2.c.v The analytical techniques or methods used; and

V.A.2.c.vi The results of such analyses.

V.A.2.d Analyses shall be performed by a State of Nevada-certified laboratory. Laboratory reports shall be provided if requested by NDEP.

V.A.2.e If the Permittees perform stormwater monitoring more frequently than required by the stormwater monitoring plan the results of such monitoring shall be reported in the Annual Report.

## V.B. Recordkeeping

V.B.1 The Permittees must retain records of all monitoring information, including: all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, a copy of the NPDES permit, and records of all data used to complete the application for this permit, for a period of at least three (3) years

from the termination date of this permit. This period may be extended at the direction of NDEP at any time.

V.B.2 The Permittees must submit the records to NDEP only when specifically asked to do so. The Permittees must retain a copy of the SWMP required by this permit (including a copy of the permit language) at a location accessible to NDEP. The Permittees must make the records, including a copy of the SWMP, available to the public if requested to do so in writing.

V.B.3 For public requests of records, the Permittees may impose a reasonable fee for personnel time and copying expenses.

**V.C. Annual Report**

V.C.1 Permittees shall submit an Annual Reports to NDEP by October 1 of each year of this permit term. Each Annual Report shall cover the period beginning July 1st of the previous year through June 30th of the current year.

V.C.2 Each year, Permittees shall review the SWMP defined under Part IV of this permit, and report to NDEP on the status of the program, whether Permittees have identified any modifications, and the plans for implementing those modifications.

V.C.3 At a minimum the Annual Report shall include:

V.C.3.a Status of the Permittees' compliance with permit conditions;

V.C.3.b An assessment of the appropriateness of the identified BMPs, and any revisions to previous assessments if appropriate;

V.C.3.c Progress towards achieving the statutory goal of reducing the discharge of pollutants to the MEP;

V.C.3.d Status of the achievement of measurable goals;

V.C.3.e Results of information collected and analyzed, if any, during the reporting period, including monitoring data used to assess the success of the program at reducing the discharge of pollutants to the MEP, a description of any identified improvements to or degradation in water quality attributable to the program, and a description of any identified effects on attainment of water quality standards attributable to the program;

V.C.3.f A summary of the stormwater activities the Permittees plan to undertake during the next reporting cycle (including an implementation schedule and a fiscal analysis);

V.C.3.g Changes to the SWMP, including changes to any BMPs or any identified measurable goals that apply to the program elements;

V.C.3.h Notice that the Permittees are relying on another government entity to satisfy some of the permit obligations (if applicable);

V.C.3.i Estimated reductions in loadings of pollutants from discharges of municipal storm sewer constituents from MS4s expected as the result of the municipal stormwater quality management program. The assessment shall also identify known impacts of stormwater controls on groundwater;

V.C.3.j A summary of inspections performed and enforcement activity taken during the report cycle; and

V.C.3.k Annual expenditures for the reporting period, with a breakdown for the major elements of the SWMP, and the budget for the year following each Annual Report.

V.C.4 An original signed copy of all reports and plans required herein shall be submitted to NDEP at the following address:

Stormwater Coordinator
Bureau of Water Pollution Control
Nevada Division of Environmental Protection
901 S. Stewart St., Suite 4001
Carson City, NV 89701

## VI. Standard Permit Conditions

### VI.A. Duty to Comply

VI.A.1 The Permittees must comply with all applicable conditions of this permit. Any permit noncompliance constitutes a violation of CWA and is grounds for enforcement action; permit termination; revocation and reissuance; modification; or for denial of a permit renewal application. Each Permittee is responsible for its own compliance with this permit, but not for any noncompliance of another Permittee. No Permittee shall be held liable for the violation of this permit by another Permittee.

### VI.B. Annual Fee

VI.B.1 The Permittees shall remit an annual review and services fee in accordance with Nevada Administrative Code 445A.232 starting July 1, 2010, and every year thereafter until the permit is terminated.

### VI.C. Continuation of the Expired Permit

VI.C.1 If this permit is not reissued or replaced prior to the expiration date, it will be administratively continued in accordance with the Administrative Procedures Act and remain in force and effect. Permittees granted permit coverage prior to the expiration date will automatically remain covered by the continued permit until the earlier of:

VI.C.1.a Reissuance or replacement of this permit; or

VI.C.1.b Issuance of another individual permit for the Permittees' discharges.

### VI.D. Need to Halt or Reduce Activity Not a Defense

VI.D.1 It shall not be a defense for the Permittees in an enforcement action that it would have been necessary to halt or reduce the permitted activity under the Permittees' control in order to maintain compliance with the conditions of this permit.

### VI.E. Duty to Mitigate

VI.E.1 The Permittees must take all reasonable steps to minimize or prevent any discharge in violation of this permit that has a reasonable likelihood of adversely affecting human health or the environment.

### VI.F. Duty to Provide Information

VI.F.1 The Permittees must furnish to NDEP any information that is requested by NDEP and needed to determine compliance with this permit or other information.

### VI.G. Other Information

VI.G.1 If the Permittees become aware that the Permittees have failed to submit any relevant facts in the Permittees SWMP or Annual Report or submitted incorrect information in the SWMP or Annual Report or in any other report to NDEP, the Permittees must promptly submit such facts or information.

### VI.H. Signatory Requirements

VI.H.1 All applications, reports, certifications, or information submitted to NDEP, or that this permit requires be maintained by the Permittees shall be signed and certified as follows:

VI.H.1.a **Applications.** All applications shall be signed by either a principal executive officer or ranking elected official.

VI.H.1.b **Reports and other information.** All reports required by the permit and other information requested by NDEP or authorized representative of NDEP shall be signed by a person described above from the lead agency (Clark County Regional Flood Control District) or by a duly authorized representative of that person. A person is a duly authorized representative only if:

VI.H.1.b.i **Signed authorization.** The authorization is made in writing by a person described above and submitted to NDEP.

VI.H.1.b.ii **Authorization with specified responsibility.** The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of manager, operator, superintendent, or position of equivalent responsibility for environmental matter for the regulated entity.

VI.H.1.c **Changes to authorization.** If an authorization is no longer accurate because a different operator has the responsibility for the overall operation of the MS4, a new authorization satisfying the requirement of Part VI.H.1.b must be submitted to NDEP prior to or together with any reports, information, or applications to be signed by an authorized representative.

## VI.I. Property Rights

VI.I.1 The issuance of this permit does not convey any property rights of any sort, or any exclusive privilege, nor does it authorize any injury to private property nor any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

## VI.J. Proper Operation and Maintenance

VI.J.1 The Permittees must at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the Permittees to achieve compliance with the conditions of this permit.

## VI.K. Inspection and Entry

VI.K.1 The Permittees shall allow NDEP or an authorized representative (including an authorized contractor acting as a representative of NDEP) upon the presentation of credentials and other documents as may be required by law, to do any of the following:

VI.K.1.a Enter the Permittees' premises where a regulated facility or activity is located or conducted or where records must be kept under the conditions of this permit;

VI.K.1.b Have access to and copy at reasonable times, any records that must be kept under the conditions of this permit;

VI.K.1.c Inspect at reasonable times any facilities or equipment (including monitoring and control equipment) practices, or operations regulated or required under this permit; and

VI.K.1.d Sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the CWA, any substances or parameters at any location.

### VI.L. Permit Actions

VI.L.1 This permit may be modified, revoked and reissued, or terminated for cause. The Permittees filing of a request for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition.

### VI.M. Deadlines for Reapplication to Continue Permit Coverage

VI.M.1 The Permittees shall submit written correspondence to NDEP requesting continued permit coverage not later than 180 days before this permit expires.

### VI.N. Permit Transfers

VI.N.1 This permit is not transferable to any person except after written notice to NDEP and approval by NDEP. NDEP may require modification or revocation and reissuance of the permit to change the name of the Permittee and incorporate such other requirements as may be necessary under the CWA.

### VI.O. Anticipated Noncompliance

VI.O.1 The Permittees shall give advance notice to NDEP of any planned changes in the permitted MS4 or activity which may result in non-compliance with this permit.

### VI.P. State Environmental Laws

VI.P.1 Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the Permittees from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority preserved by section 510 of the CWA.

VI.P.2 No condition of this permit releases the Permittees from any responsibility or requirements under other environmental statutes or regulations.

**VI.Q. Severability**

VI.Q.1 The provisions of this permit are severable, and if any provision of this permit or the application of any provision of this permit due to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit shall not be affected thereby.

**VI.R. Procedures for Modification or Revocation**

VI.R.1 Permit modification or revocation will be conducted according to 40 CFR §122.62, 122.63, 122.64 and 124.5.

**VI.S. Availability of Reports**

VI.S.1 Except for data determined to be confidential under Nevada Revised Statutes ("NRS") 445A.665, all reports and plans submitted in accordance with the terms of this permit shall be available for public inspection at NDEP's office in Carson City. As required by the CWA, effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in NRS 445A.710.

**VI.T. Furnishing False Information and Tampering with Monitoring Devices**

VI.T.1 Any person who knowingly makes any false statement, representation, or certification in any application, record, report, plan or other document submitted or required to be maintained by the provisions of NRS 445A.300 to 445A.730, inclusive, or by any permit, rule, regulation or order issued pursuant thereto, or who falsifies, tampers with or knowingly renders inaccurate any monitoring device or method required to be maintained under the provisions of NRS 445A.300 to 445A.730, inclusive, or by any permit, rule, regulation or order issued pursuant thereto, is guilty of a gross misdemeanor and shall be punished by a fine of not more than $25,000 or by imprisonment. This penalty is in addition to any other penalties, civil or criminal, pursuant to NRS 445A.300 to 445A.730, inclusive.

**VI.U. Penalty for Violation of Permit Conditions**

VI.U.1.a NRS 445A.675 provides that any person who violates a permit condition is subject to administrative and judicial sanctions as outlined in NRS 445A.690 through 445A.710.

## VI.V. Permit Modification, Suspension or Revocation

VI.V.1 After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term for cause including, but not limited to, the following:

VI.V.1.a Violation of any terms or conditions of this permit;

VI.V.1.b Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts;

VI.V.1.c A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge; or

VI.V.1.d To impose specific requirements for BMPs or annual reporting requirements in accordance with 40 CFR § 122.62 or §122.63.

VI.V.2 Any Permittee may request that NDEP reopen and modify this permit.

## VII. Definitions

**VII.A.** All applicable definitions contained in Section 502 of the CWA and 40 CFR §122 shall apply to this permit and are incorporated herein by reference. For convenience, simplified explanations of some regulatory/statutory definitions have been provided.

VII.A.1 **Best Management Practices ("BMPs")** means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

VII.A.2 **Clean Water Act ("CWA or The Act")** means the Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972) Pub.L. 92-500, as amended Pub. L. 95-217, Pub. L. 95-576, Pub. L. 96-483 and Pub. L. 97-117, 33 U.S.C. 1251 et.seq.

VII.A.3 **Discharge,** when used without a qualifier, refers to "discharge of a pollutant" as defined at 40 CFR §122.2.

VII.A.4 **Illicit Connection** means any man-made conveyance connecting an illicit discharge directly to a municipal separate storm sewer.

VII.A.5 **Illicit Discharge** is defined at 40 CFR §122.26(b)(2) and refers to any discharge to a municipal separate storm sewer that is not entirely composed of stormwater, except discharges authorized under an NPDES permit (other than the NPDES permit for discharges from the MS4) and discharges resulting from fire fighting activities. For the purposes of this permit, illicit discharges do not include discharges into the MS4 authorized in Part I.B.

VII.A.6 **Indian Country,** as defined in 18 USC 1151, means (a) all land within the limits of any Indian reservation under the jurisdiction of the United States Government, notwithstanding the issuance of any patent, and including rights-of-way running through the reservation; (b) all dependent Indian communities within the borders of the United States whether within the original or subsequently acquired territory thereof, and whether within or without the limits of a state, and (c) all Indian allotments, the Indian titles to which have not been extinguished, including rights-of-way running through the same. This definition includes all land held in trust for an Indian tribe.

VII.A.7 **Low Impact Development** ("LID") is an approach to land development or redevelopment that works to manage stormwater close to its source. LID employs principles such as preserving and recreating natural landscape features, and limiting imperviousness to create functional and appealing site drainage and treat stormwater as a resource rather than as a waste product. There are many LID practices that have been used throughout the US to adhere to these principles, such as rain gardens fed by downspouts and discontinuities in impermeable pavement. By implementing LID principles and practices, water can be managed in a way that reduces the impact of built areas and promotes the natural movement of water within an ecosystem or watershed. Applied on a broad scale, LID can support and promote a watershed's hydrologic and ecological functions.

VII.A.8 **Maximum Extent Practicable** ("MEP") the technology-based discharge standard for Municipal Separate Storm Sewer Systems to reduce pollutants in stormwater discharges that was established by CWA §402(p).

VII.A.9 **Minimum Control Measure** as used in this permit, refers to any BMP or other method used to prevent or reduce the discharge of pollutants to waters of the United States.

VII.A.10 **Municipal Separate Storm Sewer System** ("MS4") is used to refer to either a Large, Medium, or Small Municipal Separate Storm Sewer System (e.g. "the Las Vegas Valley MS4"). The term is used to refer to either the system operated by a single entity or a group of systems within an area that are operated by multiple entities (e.g., the Las Vegas Valley MS4 includes MS4s operated by the City of Las Vegas, the City of North Las Vegas, the City of Henderson, the Clark County Regional Flood Control District and Clark County). MS4 is defined at 40 CFR§ 122.26(b)(8) and means a conveyance

or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains): (i) Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law) having jurisdiction over disposal of sewage, industrial wastes, stormwater, or other wastes, including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the CWA that discharges to waters of the United States; (ii) Designed or used for collecting or conveying stormwater; (iii) Which is not a combined sewer; and (iv) Which is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR §122.2.

VII.A.11 **Permitting Authority** means the Nevada Division of Environmental Protection.

VII.A.12 **Sites that are tributary** are defined as sites that discharge directly into a CWA section 303(d)-listed water body segment.

VII.A.13 **Stormwater** is defined at 40 CFR §122.26(b)(13) and means stormwater runoff, snowmelt runoff, and surface runoff and drainage.

VII.A.14 **Stormwater Management Program (SWMP)** refers to a comprehensive program to manage the quality of stormwater discharged from the MS4.

## ACRONYMS

| | |
|---|---|
| BMP | Best Management Practice |
| CFR | Code of Federal Regulations |
| CWA | Clean Water Act |
| LID | Low-Impact Development |
| MCM | Minimum Control Measure |
| MEP | Maximum Extent Practicable |
| MS4 | Municipal Separate Storm Sewer System |
| NAC | Nevada Administrative Code |
| NDEP | Nevada Division of Environmental Protection |
| NDSR | New Development and Significant Redevelopment |
| NPDES | National Pollutant Discharge Elimination System |
| NRS | Nevada Revised Statute |
| SARA | Superfund Amendments and Reauthorization Act |
| SWMP | Stormwater Management Program |
| TMDL | Total Maximum Daily Load |
| USC | United States Code |
| WLA | Waste Load Allocation |

# APPENDIX B

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# MM Maintenance

This section presents the maintenance measures that will be implemented in public streets, drainageways and detention basins, and public entity facilities to remove pollutants that are generated onsite and deposited by run-on from upstream areas.

- MM-1 Street Sweeping
- MM-2 Local Storm Drain System Maintenance
- MM-3 Regional Detention Basin Maintenance
- MM-4 Maintenance of Public Facilities

# MM-1 Street Sweeping

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Source Control and Maintenance Measures

### Description

The street sweeping BMP consists of sweeping all publicly owned and maintained paved streets with curb and gutter. Curbed and paved public streets are swept on a regular basis to remove accumulated sediment, debris, trash, hydrocarbons, and other chemicals. Material collected by street sweepers is taken to transfer stations, from which it is hauled to the municipal landfill serving Las Vegas Valley. Street cleaning is performed during dry weather if possible. Because of the infrequency of storms in Las Vegas Valley, public streets are often swept multiple times between storms, improving the effectiveness of this measure for stormwater quality management relative to other communities.

The street sweeping program applies to public streets under the jurisdiction of the local entities. As new areas are developed, the entities expand their street sweeping programs to encompass all new public streets with curb and gutter. State highway and freeway maintenance is the responsibility of the Nevada Department of Transportation, which has its own MS4 permit and its own street sweeping procedures and goals.

Maintenance of private streets and parking lots is the responsibility of the private owner. Parking areas associated with commercial buildings are generally swept and/or cleaned (e.g., trash pickup) on a regular basis to maintain an attractive appearance for customers and building tenants.

To increase sweeping effectiveness the following will be considered by the Permittees:

- Notify residents of street sweeping schedules to discourage parking in problematic areas during periods of street sweeping.
- Regularly inspect public vehicles and equipment for leaks, and repair immediately.
- If available use vacuum or regenerative air sweepers in the high sediment and trash areas (typically industrial/commercial).
- No storing of swept material along the side of the street or near a storm drain inlet.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Numbers of lane miles swept.
- Quantity / volume of material removed.

### Measureable Goals

- Sweep all curbed and paved public streets in urban areas every 30 days, and in rural areas as needed.

# MM-2 Local Storm Drain System Maintenance

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Source Control and Maintenance Measures

### Description

Drain inlets and catch basins collect sediment, trash, debris, and other pollutants that have washed off streets and other paved surfaces. One of their functions is to keep this material out of the downstream storm drain system. The Permittees inspect and, as needed, remove sediment, debris and trash from storm drain inlets and catch basins in the public MS4 system. Routine maintenance is performed to assure proper hydraulic performance, prevent clogging and to remove potential sources of pollution. After large storms, additional inspections of facilities that historically have problems with debris accumulation and clogging are performed and the facilities are cleaned if necessary in preparation for the next storm event. Material may be removed by vactor truck or by hand. Collected material is hauled to a transfer station, from which it is transported to the municipal landfill serving Las Vegas Valley. New drain inlets and catch basins constructed as the local and regional drainage systems are expanded into areas of new development will be automatically incorporated into the current drain inlet cleaning program.

The National Flood Insurance Program (NFIP) provides federally backed flood insurance that encourages communities to enact and enforce floodplain regulations. The goals of NFIP are to provide flood insurance to property owners, encourage flood loss reduction activities by communities, and to save taxpayer's money. NIFIP encourages communities to participate in the Community Rating System. This system provides incentives, such as reduced flood insurance rates, when a community participates. The Permittees receive points for NFIP Activity 540 – Drainage System Maintenance.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Number of drain inlets and catch basins inspected and cleaned.
- Quantity/volume of material removed.

### Measureable Goals

- Inspect 20 percent of inlets a minimum of once per year, and clean as appropriate.

# MM-3 Regional Detention Basin Maintenance

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Source Control and Maintenance Measures

### Description

Regional detention basins are an important component of the flood control strategy in Las Vegas Valley. Based on criteria developed by CCRFCD and adopted by all the entities, detention basins are designed to control the 100-year flood to discharges that can be safely conveyed in downstream channels. Regional detention basin capture runoff from developed and undeveloped areas, and although they have not been designed with water quality management objectives, they allow sediment and associated pollutants to drop out. The purpose of the detention basin maintenance program is to remove sediment and other pollutants from the detention basin, so that they are not transported downstream through the MS4. The Permittees' inspect and, as needed, remove sediment, debris and trash from detention basins that are part of the MS4 system. Maintenance activities, including rehabilitation, are performed to preserve flood storage capacity, assure proper hydraulic performance, and remove potential sources of pollution. Material removed from detention basins is hauled to the municipal landfill serving Las Vegas Valley.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Funding from Clark County Regional Flood Control District

Detention basin inspection and cleaning activities are performed by entity staffs, but funding is provided by CCRFCD as part of its O&M obligation for regional flood control facilities.

### Monitoring and Tracking Information

- Number of detention basins inspected and cleaned.
- Quantity/volume of material removed.

### Measureable Goals

- Inspect all regional detention basins on semi-annual basis and after a major storm; clean as appropriate

# MM-4 Maintenance of Public Facilities

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Source Control and Maintenance Measures

### Description

This BMP consists of measures for maintaining entity-owned sites with urban land uses such as parking lots, garages, and vehicle storage and maintenance areas. These measures are similar to MM-1 and MM-2 and involve street sweeping, drain inlet cleaning and vehicle maintenance on publicly owned parcels, as well as other BMPs that may be unique to the specific site conditions. In some cases public sites are cleaned on a regular schedule (e.g., monthly) and in other cases maintenance occurs on an as-needed basis. In each case maintenance is the responsibility of the entity. Specific examples of maintenance criteria include the following.

- Clark County Real Property Management Department manages County property and cleans parking lots as needed.
- CNLV parking lots are swept monthly; washing bay at City Central Garage is cleaned daily.

A Stormwater Pollution Prevention Plan (SWPPP) will be prepared for entity-owned sites, if an industrial stormwater permit is required by NDEP. The SWPPP will define the specific onsite measures required to minimize the potential for discharging pollutants to the MS4 to the maximum extent practical. Each public facility will have a maintenance plan that describes measures required to minimize the potential for discharging pollutants to the MS4.

Clark County Department of Aviation manages McCarran Airport, Henderson Airport, North Las Vegas Airport and McCarran Bus Facility. All of these facilities have individual SWPPPs that identify specific maintenance activities to minimize contributions to stormwater pollutant loads.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Number of maintenance plans modified annually

### Measureable Goals

- Each public facility will have a maintenance plan in place 2 year from acceptance of the SWMP.
- Maintenance plans will be reviewed every other year for revisions.
- Develop SWPPPs as appropriate.

## SC Source Control

This section presents the non-structural best management practices that can be implemented to minimize the pollutant production from urban land areas. These measures are in the "pollution prevention" category, and are intended to prevent contact of rainfall or runoff with potential pollutant sources, minimize the use of chemicals, pesticides, herbicides, fertilizers, or other pollutant sources, and reduce discharges of non-stormwater to the MS4.

- SC-1 Water Conservation (Drought) Ordinance
- SC-2 Turf Conversion Program
- SC-3 Public Employee Supervisor Fertilizer/Pesticide Training
- SC-4 Use of Alternate Products and Application Procedures
- SC-5 Household Hazardous Waste Collection
- SC-6 Commercial/Industrial Housekeeping Practices
- SC-7 Ordinances Prohibiting Non-Stormwater Discharges and Littering
- SC-8 Desert Dumping Controls
- SC-9 Grease Interceptor Program
- SC-10 Dust Control Measures
- SC-11 Storm Drain Marking Program
- SC-12 Spill Control Prevention Plan
- SC-13 Industrial Pretreatment Program
- SC-14 Trash Receptacle Enclosures
- SC-15 Southern Nevada Health District Inspections
- SC-16 Regional Water Quality Planning
- SC-17 Pet Waste Management
- SC-18 Stormwater Outfall Map
- SC-19 Sanitary Sewer Lines Inspection and Replacement Program
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- SC-35 Stormwater Outfall Map with Areas of NDSR

# SC-1 Water Conservation (Drought) Ordinance

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Source Control and Maintenance Measures

### Description

The Southern Nevada Water Authority (SNWA) Drought Plan was adopted in 2003 and amended in 2005 and 2007 to respond to severe drought conditions in the Colorado River Basin. The plan identifies measures to reduce water demands.

Each entity has a water conservation ordinance designed to reduce use of water outdoors. The water conservation ordinances adopted by the entities include restrictions on new grassed areas, particularly in front yards, and incentives for removal of existing turf. Turf areas are the largest recipients of fertilizers in most urban landscapes. Significant reductions in existing turf areas and avoidance of new turf installations have substantially reduced the areas where fertilizers would potentially be used. Associated with turf restrictions is the requirement to use xeriscaping for new landscaped areas whenever possible. Use of native and drought tolerant plants, combined with extensive use of rock and non-vegetative landscaping treatments, reduces the need for use of fertilizers, pesticides and herbicides to manage plant growth. Watering restrictions and turf limitations reduce urban dry weather flows and associated load and transport of landscaping pollutants from new developments.

The local water conservation ordinances are Clark County Code, Chapter 24.34, Water Use Restrictions; City of Henderson Municipal Code, Chapter 14.14, Conservation; City of Las Vegas Municipal Code, Chapter 14.11, Drought Plan; and City of North Las Vegas, Chapter 13.08, Water Conservation and Drought. Examples of activities affected by these ordinances include: penalties for outdoor water waste (e.g., over-watering of landscaping, vehicle washing); adoption of water budgets and conservation-encouraging water rates; repair of water leaks; and turf restrictions and buy-back programs.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Supported by Southern Nevada Water Authority

### Monitoring and Tracking Information

- Trends in dry weather flow at key stream gages.

### Measureable Goals

- No increase in per capital water use rates.

# SC-2 Turf Conversion Program

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Source Control and Maintenance Measures

### Description

The Southern Nevada Water Authority's (SNWA's) "Water Smart Landscapes" rebate helps property owners convert turf to desert landscaping, also known as xeriscaping. SNWA will rebate customers $1.50 per square foot of grass removed and replaced with desert landscaping up to the first 5,000 square feet converted per property, per year. Beyond the first 5,000 square feet, SNWA will provide a rebate of $1.00 per square foot. The program includes filing an application, a pre-conversion site visit, and a confirmation of conversion. Potential landscape designs and a list of water smart contractors are available on SNWA's website.

SNWA estimates that every square foot of grass replaced with water-smart trees, shrubs and flowers saves an average of 55 gallons of water per year. This reduces the potential for overwatering of urban landscapes, which contributes to non-stormwater discharges in the MS4 during dry weather periods. It also reduces the use of lawn care chemicals (fertilizers, pesticides, herbicides), and thus reduces the potential for them to be washed into the MS4. As of mid-2010, the "Water Smart Landscape" rebate program has helped Las Vegas Valley convert more than 142 million square feet of lawn to water-smart landscaping. This has saved about 8 billion gallons of water, mitigated increases in dry weather flows in urban channels despite a dramatic increase in urbanization, and prevented use of pesticides, herbicides and fertilizers since the program's inception.

### Responsible Party

This measure is implemented by the following parties:

- Southern Nevada Water Authority

### Monitoring and Tracking Information

- Total area of existing turf purchased under SNWA turf buy-back program.

### Measureable Goals

- Goals and funding levels established by SNWA.

# SC-3 Public Employee Supervisor Fertilizer/Pesticide Training

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Source Control and Maintenance Measures

### Description

Permittees require supervisors responsible for personnel who commonly use fertilizers, pesticides and herbicides to be trained in the proper use, application and disposal of these chemicals. Some staff members are certified through the state certification program, but this is not proposed as a requirement under the SWMP. Trained staff will primarily include Parks and Recreation Department personnel and Public Works personnel responsible for landscaping maintenance. At this time there is no requirement for private landscaping companies to use personnel trained or certified in handling and application of fertilizers, pesticides and herbicides.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- None.

### Measureable Goals

- 100% of public landscaping crew supervisors trained within 12 months.

# SC-4 Use of Alternate Products and Application Procedures

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Source Control and Maintenance Measures

### Description

Permittees use natural products to minimize chemical use when feasible. Permittees will experiment with, and possibly transition to, use of "green" products to replace traditional fertilizers, pesticides and herbicides. These products are expected to have less impact on the environment than commonly used chemicals. For example, the City of Las Vegas is encouraging use of more organic pesticides and herbicides. The City of Henderson is using pelletized corn meal as an herbicide to control pre-emergent vegetation. The City of North Las Vegas is looking into using green herbicides on a pilot program. Permittees will try alternate products and application procedures on an intermittent basis when promising products or methods become available.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- List of alternate products being tested or adopted and/or list of alternate application procedures.

### Measureable Goals

- Review potentially feasible products and procedures when they become available.

# SC-5 Household Hazardous Waste Collection

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Source Control and Maintenance Measures

### Description

Many common household chemicals can cause significant water quality degradation if disposed of improperly. These chemicals include paint, solvents, fuel, oil, garden chemicals, and cleaning fluids. Without opportunities for proper disposal, residents may dump chemicals in gutters, storm drains or waterways. Even when these chemicals are put out for regular garbage pickup, they can find their way into drainage systems.

Permittees will provide household hazardous waste collection services for all residents in Las Vegas Valley. This will include hazardous waste drop-off locations, and occasional curb-side pickup opportunities. This service is currently provided through a franchise agreement with Republic Services, a private vendor.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Collection by Private Contractor

### Monitoring and Tracking Information

- Annual description of services provided by Republic Services and any future vendors.
- Amount of household hazardous waste received by Republic Services, as provided by Republic Services and/or Southern Nevada Health District.

### Measureable Goals

- Hazardous waste drop-off locations available to residents.

# SC-6 Commercial/Industrial Housekeeping Practices

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Industrial Facility Monitoring and Control

### Description

Permittees will promote good maintenance and housekeeping practices on new commercial/industrial sites to prevent contact of rain water with potentially contaminated surfaces and materials and/or control site runoff.

Commercial and industrial site operators are required to apply good housekeeping practices in exterior areas such that stormwater runoff would not contact pollutant sources and contribute a substantial load of pollution to the MS4. Depending on the type of facility and material storage and handling, good housekeeping practices could include one or more of the following:

- promptly pick up trash and waste material.
- promptly clean up chemical spills using proper methods.
- store chemicals and hazardous materials in closed containers and in covered areas.
- handle chemicals and hazardous materials in covered or enclosed areas where spills would not be contacted by stormwater runoff.
- use dry cleaning methods for outside areas (e.g., sweeping rather than washing down).
- clean and maintain vehicles indoors or in covered areas.

Permittees will promote good commercial/industrial site maintenance and housekeeping practices by providing information to site owners during industrial facility stormwater inspections (see SWMP Section 10), and by posting guidance on the lvstormwater.com website.

In addition, municipal codes for each entity require that all activities and operations at industrial sites and commercial sites where hazardous materials and chemicals are used be conducted in and contained in enclosed structures. This includes gas stations (with the exception of fueling areas), vehicle repair shops, and manufacturing facilities. Code requirements will apply to these types of facilities in all new developments. Locating work areas indoors at new industrial sites will prevent pollutant contact with rain or runoff.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Private Owners

### Monitoring and Tracking Information

- Reported Under SC-23 Industrial Facility Stormwater Inspection.

### Measureable Goals

- Promote good housekeeping practices.

# SC-7 Ordinances Prohibiting Non-Stormwater Discharges and Littering

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Source Control and Maintenance Measures

### Description

All entities have ordinances prohibiting discharges of non-stormwater (except as expressly permitted) to the MS4. These ordinances have recently been reviewed and enhanced ordinances were adopted in 2009 to better address stormwater pollution. Ordinances are based on EPA's model stormwater ordinance. The LVV entities coordinated ordinance development with each other to make them as uniform as possible across all jurisdictions. Ordinances give the entities the authority to take enforcement action against illegal and illicit discharges, illegal dumping, littering, and other practices that may adversely affect the quality of water in the MS4 system. They also include the authority to enforce for BMPs with respect to the "potential to pollute," in addition to those in place for actual pollution violations. Violations may be reported by code enforcement officers, public agency staffs, or by general citizens through hotlines and websites.

The MS4 permit requires all Permittees to regularly review their ordinances and other regulatory measures, and to assure that they have adequate authority to implement and enforce all elements of the SWMP.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Enforcement also by Southern Nevada Health District

### Monitoring and Tracking Information

- Number of enforcement actions taken under these ordinances.
- Changes to stormwater ordinances.

### Measureable Goals

- Maintain and enforce all stormwater ordinances and other regulatory measures.

# SC-8 Desert Dumping Controls

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Source Control and Maintenance Measures

### Description

Desert dumping has long been a problem in Las Vegas Valley communities. As a result, entities have existing ordinances prohibiting dumping of materials in the desert surrounding the developed areas of Las Vegas Valley. In addition to being unsightly and posing threats to the local ecology and human health, illegally dumped materials could be sources of water pollution if they come into contact with stormwater (e.g., old vehicles, household waste, commercial and industrial waste, construction waste, landscaping refuse). Depending on the type and location of the observation, reports of illegal dumping are referred to the Bureau of Land Management, the Southern Nevada Health District, or the Clark County Public Response Office for investigation and enforcement.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Enforcement also by Southern Nevada Health District

### Monitoring and Tracking Information

- Number of enforcement actions taken under these ordinances.

### Measureable Goals

- Maintain desert dumping ordinances and report updates.

# SC-9 Grease Interceptor Program

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Industrial Facility Monitoring and Control

### Description

Entities have existing ordinances requiring proper removal and disposal of grease from grease traps in restaurants and industrial facilities. Clogged grease traps could allow wastewater to be directed to the MS4. Las Vegas Valley experiences about 100,000 visitors per day, and combined with 1.8 million residents, there are hundreds of thousands of potential diners at thousands of restaurants each day. Public wastewater treatment service providers inspect over 2,000 restaurants and industrial facilities each year for proper grease trap design and maintenance. In addition, stormwater inspections of selected facilities under the Industrial Facility program (Section 10 of the SWMP) may include inspections of grease traps. Best practices are employed consistently among each of the entities in Las Vegas Valley.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Number of grease interceptor inspections.

### Measureable Goals

- Minimize sanitary sewer system overflows.

# SC-10 Dust Control Measures

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Source Control and Maintenance Measures

### Description

To meet regulations associated with the Clean Air Act, Las Vegas Valley entities enforce dust control measures at construction sites and stationary industrial sites that may generate significant dust (e.g., cement plants, rock crushing facilities). Deposition of airborne dust on watershed surfaces can be a source of pollutants in stormwater runoff. EPA has identified dust transport control as an effective mitigation measure for stormwater pollution, particularly in arid areas. This unique source of stormwater pollution in Las Vegas Valley has been addressed through a comprehensive air quality management program.

In Las Vegas Valley, Clark County Department of Air Quality and Environmental Management (DAQEM) has primary responsibility for assuring that air quality regulations are met. In Las Vegas Valley, the primary air quality concern is over PM10s, or small particulate matter (e.g, dust) with a diameter of 10 microns or less. In response to EPA requirements, Clark County adopted the current *PM10 State Implementation Plan for Clark County* in 2001. Based on the management plan, dust control plans for construction sites and areas of existing development are adopted and enforced in accordance with EPA regulations and guidelines. Control measures include stabilizing disturbed surfaces, using dust palliatives or water to control dust, and street sweeping to reduce sediment track-out.

Implementation of the PM10 management plan has brought Clark County into compliance with air quality regulations. Since 2001 it is estimated by DAQEM that the local dust control programs have reduced construction-related PM10 dust by about 100,000 tons and industry-related PM10 dust by over 100,000 tons. Although all of this dust would not have found its way to MS4 waterways, this significant reduction in airborne particulates is expected to have resulted in a reduction in fine particulates contributing to TSS concentrations during wet weather events.

At EPA Region 9's 10th Annual Environmental Awards Ceremony in San Francisco, Clark County was recognized in the Particulate Matter Program, which included adoption of fugitive dust rules and the implementation of a compliance program that directly resulted in a significant reduction in PM10 emissions in Clark County. EPA complimented the outreach campaign and the research conducted in PM10 paved road and vacant land emissions, stating that the Clark County dust control program served as a national model.

The primary effects of dust control regulations on new development and significant redevelopment will be to: (1) minimize dust generated during construction; (2) require virtually all roadways and parking areas to be paved; and (3) require stabilization of all disturbed areas with appropriate landscaping, hard-scaping, or other stabilization treatments.

### Responsible Party

This measure is implemented by the following parties:

- Department of Air Quality and Environmental Management

### Monitoring and Tracking Information

- Performed for Air Quality Management Program; will not be reported for MS4 program.

### Measureable Goals

- Per Air Quality Management Program.

# SC-11 Storm Drain Marking Program

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Public Outreach and Education

### Description

Storm drain inlet markers are plaques or signs placed on storm drain inlets or fences around open channels to discourage the public from dumping pollutants in the MS4. An inlet marker program was started by Las Vegas Valley MS4 Permittees and the Conservation District of Southern Nevada (CDSN) in 1999 using Section 319 grant funds. 10,000 metal signs were purchased with the message "Don't Pollute – Drains to Lake Mead." Approximately 5,100 plaques were installed by the entities and volunteers in areas of existing development. The program was discontinued after the grant money was spent and concerns were raised over the safety for volunteers working in or near channels and busy streets. In 2007 the CDSN, in partnership with CCRFCD, CLV and COH, won a second Section 319 grant for inlet marker installation. 6,600 plastic plaques, about 25 percent with a bi-lingual message, were purchased for installing at drain inlets. By June 2010 this program installed all of these inlet markers in areas of existing development, plus the remaining metal signs from the first inlet marker program.

Past inlet marker programs have targeted areas of existing development. The Permittees, in collaboration with the Clark County Regional Transportation Commission (RTC), have developed regional design standards for marking drain inlets in all new developments in each of the entities. Concrete will be imprinted with the "Don't Pollute – Drains to Lake Mead" message on the back of the inlet or on the top of the curb. Stamp may be permanently cast into cast iron frame or pre-cast concrete portions of inlet. All stamps will be approved by the City or County Engineer before being used. For redevelopment areas, an expoxied placard bearing the message and symbol approved by the appropriate City of County Engineer will be permanently affixed on the top of the adjacent curb. These new standards require developers to install inlet markers in all areas of new development and significant redevelopment in the Las Vegas Valley.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Regional Transportation Commission (for standards only)

### Monitoring and Tracking Information

- Description of new and updated RTC standards as appropriate

### Measureable Goals

- 100 percent of all new drain inlets and catch basins in public right-of-way outfitted with drain inlet markers.

# SC-12 Spill Control Prevention Plan

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Illicit Discharge Detection

### Description

Certain types of commercial and industrial sites are required by EPA to have spill control prevention plans. The EPA Spill Prevention, Control, and Countermeasure (SPCC) rule establishes requirements for oil spill prevention, preparedness, and response to prevent oil discharges to navigable waters and adjoining shorelines. The rule requires specific facilities to prepare, amend, and implement SPCC Plans. A facility is subject to the SPCC Rule if it meets three criteria: 1) it must be non-transportation-related; 2) it must have an aggregate aboveground storage capacity greater than 1,320 gallons or a completely buried storage capacity greater than 42,000 gallons; and 3) there must be a reasonable expectation of a discharge into or upon navigable waters of the United States or adjoining shorelines. All qualifying businesses must prepare a Facility Response Plan, which is a plan for responding to the maximum extent practicable to a worst-case discharge or threat of discharge of oil. This rule will apply to all existing and new qualifying commercial/industrial sites.

In addition, the Permittees have developed a spill response strategy that applies to all hazardous chemicals. It was prepared in response to a requirement in the previous MS4 permit. Key components of the spill response strategy are described below.

- The State and County each have hazardous material emergency response plans that are compliant with EPA requirements and that outline field procedures, roles and responsibilities, training requirements, and notifications. Each local entity also has standard operating procedures for dealing with illegal dumping or accidental spills.
- The Clark County Local Emergency Planning Committee (LEPC) meets regularly to coordinate the activities of all emergency response agencies in Las Vegas Valley. The LEPC encourages use of common policies and procedures and passes on information related to regulations and spill response techniques. Las Vegas Valley Water District staff participate the LEPC and act as a liaison to the SQMC, assuring that stormwater system concerns are adequately reflected in LEPC planning and coordination.
- H2O Environmental is a private contractor that is used by all entities in Las Vegas Valley to respond to and clean up hazardous material spills over 25 gallons. Standing contracts with H2O Environmental allow the firm to respond to spills quickly (within 45 minutes anywhere in Las Vegas Valley).

- The hazardous material emergency response plans contain extensive notification lists, of individuals and agencies that should be contacted in the event of a hazardous material spill. The CCRFCD is on the standard notification lists to assure that the MS4 representatives are aware of any hazardous material spills that could affect the stormwater systems in their jurisdictions.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- None.

### Measureable Goals

- None.

# SC-13 Industrial Pretreatment Program

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Industrial Facility Monitoring and Control

### Description

Each of the Permittees has an industrial pretreatment program associated with its wastewater system. The pretreatment program includes regulations on the types of materials that can be discharged to the wastewater collection system, as well as regular facility inspections to assure compliance with the program. Pretreatment program inspectors perform inspections of all qualifying industrial sites based on guidelines established by the wastewater agencies.

In addition, pretreatment program inspectors are trained to look for potential stormwater quality threats such as exposed chemical storage areas, spills, illicit connections to the MS4, and lack of hazardous material containment. Potential issues are reported to entity staff members for follow-up as part of the MS4 Industrial Program. All new qualifying industrial sites would have to comply with the industrial pretreatment project and would be subject to regular pretreatment inspections.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Reported separately under NPDES discharge program individual permits.

### Measureable Goals

- Wastewater is properly discharged to sanitary sewer.

# SC-14 Trash Receptacle Enclosures

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Source Control and Maintenance Measures

### Description

Municipal codes for each of the entities require that trash receptacles for commercial sites, industrial sites, and multi-family developments be enclosed but not necessarily covered. In the case of Las Vegas and North Las Vegas, the codes state that trash receptacles must be enclosed and covered with a roof or trellis; in the case of Clark County and Henderson, the codes state only that trash receptacles must be enclosed. For all entities, trash bins must have a lid. These code requirements reduce the potential for stormwater to contact sources of BOD, organics, bacteria, etc., and minimize the potential for litter to be blown from the trash receptacle into the MS4. Code requirements will apply to all new development.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- RTC Standard.

### Measureable Goals

- All new trash enclosures in compliance with standards.

# SC-15 Southern Nevada Health District Inspections

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Industrial Facility Monitoring and Control

### Description

Southern Nevada Health District (SNHD) performs inspections of commercial and industrial sites that are "conditionally exempt generators of hazardous waste." These are smaller facilities that do not fall under the State's hazardous materials regulations. Inspections assure that no illicit discharges have occurred or could potentially occur, and check for secondary containment for hazardous materials. SNHD will expand its inspection program to any new industrial facilities that meet the definition of conditionally exempt generators of hazardous waste.

### Responsible Party

This measure is implemented by the following parties:

- Southern Nevada Health District

### Monitoring and Tracking Information

- SNHD set policies and procedures; will not report for MS4 permit.

### Measureable Goals

- Per SNHD policies and procedures.

# SC-16 Regional Water Quality Planning

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Watershed

### Description

Regional water quality planning activities that are performed by a variety of agencies provide benefits to stormwater quality in existing and new development. All of the Permittees currently participate and will continue to participate in the following regional planning organizations.

- As the master agency over water quality in Clark County, the Board of County Commissioners, through its Water Quality Planning division, is responsible for the development and management of an integrated, countywide water quality management planning program. This program, mandated under Section 208 of the Clean Water Act, requires the development of an area-wide water quality management plan (WQMP) that outlines all contributors to water pollution. The plan manages point-sources of pollution, such as that of WWTFs, and non-point sources of pollution, including those covered under the MS4 permit. In September of 2010, the Clark County Board of County Commissioners and Clark County Water Reclamation District (CCWRD) Board of Trustees approved the transfer of these water quality planning activities and staff from Clark County to the CCWRD.
- SNWA is involved in several programs associated with water supply development and water quality protection that have secondary benefits for stormwater quality improvement. These include leadership in regional water conservation; water use restrictions during droughts; turf buy-back program; and general water use education. They also include the Las Vegas Wash erosion control program, and comprehensive water quality monitoring programs. CCRFCD, on behalf of the MS4 Permittees, and SNWA have applied for and received two Section 319 nonpoint source grants to fund general stormwater and water resources public education and outreach activities. All of these programs address problems associated with runoff from new development and redevelopment. The four MS4 local governments participate on SNWA boards and committees, and water users within the MS4 permit area fund SNWA activities.
- The Las Vegas Valley Watershed Advisory Committee (LVVWAC) is a recently formed organization comprised of SNWA, CCRFCD, the Clean Water Coalition, the MS4 Permittees, and others. Its objective is to address regional water quality

concerns in Las Vegas Valley and adopt cooperative solutions. One of the key issues to be addressed is non-point pollution such as that associated with stormwater runoff. A Regional Water Quality Plan has been developed and adopted by all the participating agencies. This plan integrates stormwater BMPs into the broader watershed context.

- The Las Vegas Wash Coordination Committee is comprised of the Permittees and a host of other agencies and groups with the mission of protecting and enhancing environmental resources associated with Las Vegas Wash. The Committee sponsors annual Wash clean-up days and other volunteer events to improve the Wash environment and increase public awareness of the unique resources associated with the Wash.
- The Lake Mead Water Quality Forum is a group of local, state and federal agencies that advances the science and coordinates management activities associated with southern Nevada's contribution to Lake Mead. The Forum is sponsored by NDEP and includes participation from U.S. Geological Survey, Bureau of Reclamation, local agencies and the Permittees. Water quality issues addressed in the past include perchlorate, selenium, phosphorus, and algae.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Clark County Regional Flood Control District
- Southern Nevada Water Authority
- Clark County Water Reclamation District
- Lake Mead Water Quality Forum
- Las Vegas Valley Watershed Advisory Committee
- Nevada Department of Environmental Protection
- Las Vegas Wash Coordination Committee

### Monitoring and Tracking Information

- Assure stormwater quality issues are represented in regional planning forums.

### Measureable Goals

- None.

# SC-17 Pet Waste Management

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Public Outreach and Education

### Description

Permittees will direct public outreach activities toward pet owners to clean up waste left by their pets in yards, parks and open spaces. Although not be required by regulation or ordinance, it is common practice for the Permittees to install pet waste stations in public parks and greenbelts to encourage residents to pick up after their pets. This measure can have substantial benefits in reducing the potential for stormwater to pick up pathogens from pet waste in public and private areas.

Increased establishment and use of dog parks throughout Las Vegas Valley provides the ability to reduce dog waste left in other public areas and concentrate it at sites where it can be better managed.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Number of outreach programs addressing pet waste.
- Number of poop bags purchased.

### Measureable Goals

- None.

## SC-18 Stormwater Outfall Map

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- New Development and Significant Redevelopment

### Description

A single valley-wide GIS map depicting the stormwater outfalls in Las Vegas Valley will be prepared based on asset tracking software currently used by the entities, review of aerial photographs or similar resources. CCRFCD regularly updates GIS maps of regional flood control infrastructure based on construction projects it funds and 5-year updates of the Master Plan Update for Las Vegas Valley. An updated map showing regional flood control infrastructure and stormwater outfalls will be provided in each MS4 Annual Report.

### Responsible Party

This measure is implemented by the following parties:

- Clark County Regional Flood Control District

### Monitoring and Tracking Information

- Track new regional flood control facilities (channels, storm drains, detention basins).

### Measureable Goals

- Annually update regional stormwater infrastructure and outfall map.

# SC-19 Sanitary Sewer Line Inspection and Replacement Program

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Illicit Discharge Detection

### Description

Leaking sanitary sewer lines could contribute raw sewage and associated pollutants (BOD, pathogens, etc.) to the MS4. The Permittees have programs to inspect and replace sanitary sewer lines to minimize the potential for cross connections between the sanitary and storm sewer systems. Because most of the development is Las Vegas Valley is relatively new compared to much of the rest of the United States, problems of aging infrastructure are not yet as severe as in many other areas. In addition, there are no combined sewer systems in Las Vegas Valley that would be designed for overflows from the sanitary to the storm sewer system under high flow conditions. Thus the potential for cross connections in the MS4 area is small. With the inspection and replacement programs of the Permittees this potential is very small, especially compared to other older urban areas in the East and South.

Examples of sanitary sewer inspection programs are provided below.

- The Clark County Water Reclamation District Collection System Services currently performs closed circuit televising (CCTV) of sewer collection system assets utilizing the National Association of Sewer Service Companies – Pipeline Assessment Certification Program and Manhole Assessment Certification Program (NASSCO-PACP/MACP). This program focuses on assessing both maintenance and structural deficiencies as well as identifying areas of infiltration, which in some instances could lead to exfiltration. They inspect approximately 80 miles of sewer lines and manholes annually. This program helps ensure that sewage does not get into the storm drain system.

- The City of Las Vegas Sanitary Sewer Planning Section manages a Condition Assessment Program that includes a Large Diameter Pipeline Assessment Program (LDPAP) and Small Diameter Pipeline Assessment Program (SDPAP) utilizing the National Association of Sewer Service Companies – Pipeline Assessment Certification Program and Manhole Assessment Certification Program (NASSCO-PACP/MACP). The LDPAP uses the services of a Professional Engineering consultant to complete a comprehensive structural and operational assessment on all CLV sewer pipelines 15-inch in diameter and above,

that are over ten years old, every five years. The SDPAP uses the services of a Professional Engineering consultant to complete a comprehensive structural and operational assessment on all CLV sewer pipelines from 8-inch to 12-inch in diameter, that are over ten years old, every fifteen years. Where significant defects exist, including identifiable levels of infiltration/exfiltration, immediate notification occurs, and repairs are made by city staff or are included in a Capital Improvement project. This program proactively identifies and eliminates potential sources of contamination.

### Responsible Party

This measure is implemented by the following parties:

- Clark County Water Reclamation District
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Provide annual description of program.
- Number of miles inspected and amount repaired and replaced will be reported.

### Measureable Goals

- Minimize sanitary sewer overflows.

# SC-20 Construction Site BMP Guidance Manual

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Construction Site

### Description

The existing *Las Vegas Valley Construction Site Best Management Practices Guidance Manual* describes the construction site runoff management program and provides non-structural and structural BMP implementation guidance. The manual provides guidance on selecting and designing construction site BMPs that are suitable to the unique environment and conditions in Las Vegas Valley.

The *Construction Site BMP Guidance Manual* is available to contractors, engineers, and other construction professionals on the CCRFCD website and on the www.lvstormwater.com website. The manual will be updated by CCRFCD as needed to incorporate new BMPs appropriate for the region and modify selection or design criteria for existing BMPs as more local experience is obtained.

The *Nevada Contractors Field Guide for Construction Site BMPs*, prepared by the Truckee Meadows MS4 group and funded in part by CCRFCD, is available in hardcopy form to contractors, engineers and other construction professionals. Copies are available at Permittees' permit counters, contractor training workshops, and other venues.

### Responsible Party

This measure is implemented by the following parties:

- Clark Country Regional Flood Control District

### Monitoring and Tracking Information

- Report changes made to BMP Manual.

### Measureable Goals

- Review BMP Manual annually for need to update.

# SC-21 Construction Site Inspections

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Construction Site

### Description

The Permittees will conduct construction site inspections for compliance with its local ordinances and permits. Each municipal Permittee adopted a stormwater management ordinance in 2008 that includes regulatory authority to implement and enforce the provisions of their local construction site programs. These ordinances are based on EPA's model ordinance and apply to construction on sites with an area of one acre or greater.

Each municipal Permittee will conduct construction site inspections for compliance with its local ordinances (SC-7 Ordinances Prohibiting Non-Stormwater Discharges and Littering) and permits. Each Permittee will use existing inspection staff to perform all construction site inspections. This process and schedule for each entity is summarized as follows.

- City of Las Vegas – Off Site Inspection and Testing inspectors will inspect private development projects. CLV Construction Management personnel will inspect public construction projects. Stormwater inspections will occur during normal grading, offsite inspections.
- City of North Las Vegas – Offsite Department inspectors will perform inspection and enforcement activities. Stormwater inspections will occur during normal grading, offsite inspections.
- City of Henderson – Building Department, Public Works Department, and Quality Control Division inspectors will perform inspections. Stormwater inspections will occur during normal grading, offsite and building inspections.
- Clark County – Development Services personnel will perform inspection and enforcement activities. Stormwater inspections will occur during normal grading, offsite and building inspections. In addition, air quality inspectors have been trained in the past to perform stormwater inspections, and will report any apparent problems possible violations during their normal air quality inspections.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Number of inspections performed.
- Number of enforcement actions taken.

### Measureable Goals

- Inspect 100% of all construction sites >1 acre per entity policies.
- Follow-up on 100% of all potential violations per entity policies.

# SC-22 Construction Site Training Workshops

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Construction Site

### Description

Permittees will host Contractor Training Workshops a minimum of once per year. The number of annual workshops will be tailored to the current level of interest and need. Workshops will address State and local construction permitting requirements, local construction site BMP requirements, and inspection programs. As in the past, the workshops will be conducted jointly by the Permittees and NDEP.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Clark County Regional Flood Control District

### Monitoring and Tracking Information

- Number of attendees at contractor training workshops.

### Measureable Goals

- Conduct minimum of one contractor training workshop annually.

# SC-23 Industrial Facility Stormwater Inspections

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Industrial Facility Monitoring and Control

### Description

Selected industrial facilities will be inspected for compliance with local stormwater ordinances. Categories of facilities requiring inspections are described in the Industrial Facility Monitoring and Control Program.

The proposed industrial facility inspection process is similar to existing practices. The proposed inspection processes are described for each entity as follows.

- Clark County staff inspect sites identified on the Superfund Amendments and Reauthorization Act of 1986 (SARA) Section 313 list, select industrial sites to determine if they have the potential to discharge a substantial pollutant load, and those identified with a potential to discharge a substantial pollutant load to the MS4 at least annually .
- CLV and CNLV use their pretreatment program staff to conduct stormwater inspections during their regular site visits. All industrial sites in the pretreatment program are inspected. If issues pertaining to stormwater are discovered during normal inspections for compliance with discharges to the sanitary sewer, these are noted and addressed accordingly.
- The COH Building and Fire Safety Department fire safety inspectors identify and inspect facilities identified by the COH as potential substantial contributors of pollutants to the MS4. The identification of facilities, inspection procedures, and enforcement of the industrial inspection program is based on the hazardous materials requirements in the 2006 International Fire Code.

The general procedures of the inspections are reported by each of the Permittees in the annual report. The items reported items include name and location of facility, date of the inspection, results and/or violations that are inspected, any actions taken, and any follow-up actions taken.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Number of inspections conducted by Permittees annually.
- Number of follow-up actions that were required annually.

### Measureable Goals

- Conduct annual inspections of all facilities required under the Industrial Facility Monitoring and Control Program.

# SC-24 Industrial Facility Stormwater Inventory

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Industrial Facility Monitoring and Control

### Description

Permittees will provide to NDEP a list of industrial facilities to be inspected. This list will be provided in the MS4 Annual Report. Pertinent inventories of covered industrial sites will be updated at least annually by each Permittee.

Because industrial site inspectors are conducting other types of inspections for other regulatory programs (e.g., pretreatment inspections, stormwater complaints, illicit discharge and detection inspections), many industrial sites will be inspected that do not fit into one of the four categories for which inspections are required. Lists of sites that are inspected but do not fit one of the four covered categories will not be provided, but a total number of industrial site inspections performed will be included in the Annual Report.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Update inventory annually.

### Measureable Goals

- Develop the inventory of facilities to be inspected.
- Updated inventory annually.

# SC-25 Industrial Facility Stormwater Inspection Checklist

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Industrial Facility Monitoring and Control

### Description

The Permittees have developed a standard checklist to be used by inspectors to conduct industrial site inspections. Each entity may modify the standard checklist slightly to meet its needs. However, the general information collected during inspections by each entity will be similar. The basic information on the inspection form includes:

- name, type of industry, location, jurisdiction and contact person of facility
- date of the inspection and name of inspector
- evidence of any non-stormwater discharges (e.g., process water, wastewater)
- evidence of any violations of local stormwater ordinances
- any actions taken or required in the future

The Permittees will file completed Industrial Site Inspection Checklists chronologically in a separate stormwater compliance file. For facilities that hold pretreatment permits, the Permittees may also file copies of the Industrial Site Inspection Checklists in the respective permit files.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Develop checklist and update annually as necessary.

### Measureable Goals

- Include checklist in Annual Report.

# SC-26 Storm Channel Inspections

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Illicit Discharge Detection

### Description

Storm channel inspections will be performed to search for evidence of illicit discharges or dumping to the MS4. Inspections will consist of visual observations of all major segments of open channels. Evidence of illicit discharges could include continuous inflows, colored water, stained channel lining, odors, and accumulations of trash and debris.

Inspections will be performed twice each year by Permittee staff or designated representatives and problems will be reported to the proper authorities. Municipal maintenance staff for streets and storm drains from each Permittee will be trained to look for evidence of non-stormwater discharges to the drainage system during their normal duties. A process for reporting potential problems has been established and will continue to be followed.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Document locations inspected during storm channel inspections.

### Measureable Goals

- Each Permittee to conduct semi-annual field inspections of open channels.

# SC-27 Dry Weather Monitoring

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Illicit Discharge Detection

### Description

Dry weather monitoring will be conducted to identify water chemistry changes that could indicate illegal discharges of non-stormwater to the MS4. Changes in water chemistry compared to the nearly 19 years of water quality characterization data in Las Vegas Valley could be evidence of new non-stormwater discharges or additional pollutants contributed at past discharge points.

Dry weather monitoring will be conducted by SNWA as part of its Urban Tributary Sampling program, and coordinated with the Permittees. Constituents to be analyzed will be determined by SNWA based on the needs of its Urban Tributary Sampling program. This constituent list will be sufficient to meet the needs of the MS4 program.

SNWA will collect quarterly samples each year in January, April, July, and October. Single grab samples will be collected at each monitoring site. The constituents that will be analysed include: major ions, metals, nutrients, and organic compounds. An allowable range for selected constituents has been developed by the Permittees based on historical results to test new data to see if it may provide evidence of illicit discharges. SNWA will alert the Permittees when out-of-range data is encountered. The Permittees will investigate the potential causes of the out-of-range data and determine whether further field investigation is warranted. The data and results from the SNWA sampling program will be reported in the Annual Report.

### Responsible Party

This measure is implemented by the following parties:

- Southern Nevada Water Authority

### Monitoring and Tracking Information

- Report number of results indicating potential illicit discharges in Annual Report.

### Measureable Goals

- Conduct dry weather monitoring 4 times per year.

# SC-28 Industrial Facility Inspector Training Workshops

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Industrial Facility Monitoring and Control

### Description

Industrial facility inspector training sessions are performed -for each new industrial inspector by each of the Permittees. Training materials for industrial facility inspectors are developed and will be updated annually as necessary. The training presentation includes a description of the Las Vegas MS4 NPDES Permit and the Las Vegas Valley SWMP. The local ordinances and the Industrial Facility Monitoring and Control Plans for each jurisdiction are described. Contact information, such as names and phone numbers for Permittees and other interested parties are given for the inspectors' information. Training materials have been updated and customized to individual entities as needed.

Industrial facility inspector training sessions are performed for current employees on an as-needed basis to provide updated information on any changes in the industrial stormwater program. If no changes have occurred to the industrial stormwater program, then re-training is not necessary.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Number of inspectors trained annually.

### Measureable Goals

- None.

# SC-29 Stormwater-Related Complaint Response

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Illicit Discharge Detection

### Description

This BMP provides mechanisms for the public to report evidence of possible non-stormwater discharges to the MS4, illegal dumping, sanitary spills, hazardous waste spills, and other violations of the local stormwater ordinances and related regulations.

Clark County Public Response Office (CCPRO) has a hotline that the public can call to report potential violations of ordinances related to stormwater, desert dumping, littering, and any other possible code violation. Southern Nevada Health District (SNHD) has the authority to enforce ordinances prohibiting dumping of solid waste and sewage to the Las Vegas Valley stormwater system, and has a phone line and complaint form for receiving evidence of illegal dumping from the public. Each of the Permittees receives direct reports from citizens regarding dumping, illegal discharges of non-stormwater to the MS4, maintenance problems, and other activities that may affect stormwater quality.

Several methods are available for the public to report complaints of possible illegal industrial discharges. These include the lvstormwater.com website, CCPRO hotline, SNHD hotline, and individual Permittee public works and wastewater departments. CCRFCD has a public service announcement that encourages residents to report complaints. The complaints received by CCRFCD are forwarded on to the appropriate permittee. The Permittees will respond to stormwater-related complaints associated with industrial activity when applicable. Each complaint response action will be documented using the Industrial Site Inspection Checklist. The Permittees will ensure industries execute any required corrective actions through follow up and/or referrals to other agencies or departments.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Clark County Regional Flood Control District

### Monitoring and Tracking Information

- Track number of stormwater-related complaints.

### Measureable Goals

- Respond to 100% of stormwater-related complaints.
- Include list of stormwater-related complaints in Annual Report.

# SC-30 LVV Stormwater Quality Website

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Public Outreach and Education

### Description

The Las Vegas Valley Water District (LVVWD) and the SQMC will continue to host the website www.lvstormwater.com, which provides information about the storm drain system, monitoring programs, public outreach, community programs, monitoring programs, MS4 annual reports, and Federal and State regulations. Several guidelines for the construction industry, home owners, and business and industry are also found on the website (as a link) to educate the public about reducing the quantity and improving the quality of stormwater runoff. Tracking measures provide the SQMC with information on how the site is being used and which sections are accessed most frequently. The website will be upgraded to act as a repository for additional BMP information as required for specific SMWP program elements, and as a portal to other information available on the internet that may be useful for residents, business owners, and professional groups. In addition to the regional website, the municipal Permittees will continue to maintain and periodically update their websites to provide the public with information on topics such as water quality, BMPs, and related links to other information sources.

### Responsible Party

This measure is implemented by the following parties:

- Clark County Regional Flood Control District
- Las Vegas Valley Water District

### Monitoring and Tracking Information

- Online website use tracking routine.

### Measureable Goals

- Review website every 6 months to be sure it is current.

# SC-31 Public Outreach Events

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Public Outreach and Education

### Description

Permittees will continue to routinely attend environmental fairs and community events to distribute information on stormwater quality and how it can be influenced by common behaviours. Many of the environmental fairs are held in the spring to capitalize on Earth Day media exposure. Depending on the event, a variety of materials will continue to be distributed including brochures and fact sheets on the Las Vegas Valley MS4 program, magnets, pooper scoopers, etc.

The National Flood Insurance Program (NIFP) provides federally backed flood insurance that encourages communities to enact and enforce floodplain regulations. The goals of NFIP are to provide flood insurance to property owners, encourage flood loss reduction activities by communities, and to save taxpayer's money. NIFP encourages communities to participate in the Community Rating System. This system provides incentives, such as reduced flood insurance rates, when a community participates. The Permittees received points for NIFP Activity 330 – Outreach Projects.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Clark County Regional Flood Control District

### Monitoring and Tracking Information

- Number of events attended annually by all Permittees combined.

### Measureable Goals

- Attend 3 community events annually and distribute material.

# SC-32 Elementary School Presentations

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Public Outreach and Education

### Description

CCRFCD will continue its program of making presentations to elementary school students on stormwater quality and flood safety. Working with elementary school students is an effective way of getting stormwater quality and other environmental messages out to the next generation of citizens and homeowners. In addition, children can influence the behaviour of the adults in their household. CCRFCD public outreach staff members make many classroom presentations each and distribute worksheets, coloring books, and other learning materials.

The National Flood Insurance Program (NIFP) provides federally backed flood insurance that encourages communities to enact and enforce floodplain regulations. The goals of NFIP are to provide flood insurance to property owners, encourage flood loss reduction activities by communities, and to save taxpayer's money. NIFP encourages communities to participate in the Community Rating System. This system provides incentives, such as reduced flood insurance rates, when a community participates. The Permittees received points for NIFP Activity 330 – Outreach Projects.

### Responsible Party

This measure is implemented by the following parties:

- Clark County Regional Flood Control District.

### Monitoring and Tracking Information

- Number of school presentations made annually.

### Measureable Goals

- 5 elementary school presentations annually.

# SC-33 Public Service Announcements / Flood Channel

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Public Outreach and Education

### Description

Public service announcements and documentaries will be used to inform the public of the connection between stormwater and water quality in Las Vegas Wash and Lake Mead, and of the influence their behaviour can have on environmental conditions in these important waterbodies. CCRFCD will continue its program of creating and broadcasting public service announcements (PSAs) related to stormwater quality. Past PSAs have addressed the relationship between stormwater runoff and Lake Mead water quality, littering, vehicle maintenance, and proper disposal of household chemicals. CCRFCD's goal is to create a new PSA every two years, and broadcast past PSAs in alternate years. CCRFCD will also continue to produce the "Flood Channel" programs on cable as a way to inform the public of flood safety and stormwater quality issues.

The National Flood Insurance Program (NIFP) provides federally backed flood insurance that encourages communities to enact and enforce floodplain regulations. The goals of NFIP are to provide flood insurance to property owners, encourage flood loss reduction activities by communities, and to save taxpayer's money. NIFP encourages communities to participate in the Community Rating System. This system provides incentives, such as reduced flood insurance rates, when a community participates. The Permittees received points for NIFP Activity 330 – Outreach Projects.

### Responsible Party

This measure is implemented by the following parties:

- Clark County Regional Flood Control District

### Monitoring and Tracking Information

- Number of PSAs aired annually and duration of broadcast.
- Number of new Flood Channel segments produced annually on stormwater.

### Measureable Goals

- Produce or update one new PSA every 2 years.
- Broadcast one PSA annually for 2 months.

# SC-34 Brochures and Printed Material

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Public Outreach and Education

### Description

Printed material can be effective in communicating information to targeted segments of the public. CCRFCD will continue to produce brochures and printed material on specific stormwater quality topics if that is deemed the best method of distributing the information to the public. In the past brochures or flyers have been prepared on appropriate BMPs for mobile businesses, appropriate construction site BMPs, and general stormwater quality information. Brochures and printed material are distributed by Permittees at public outreach events, during facility inspections, and at the entities' permit application counters. In addition, brochures and flyers will be posted on the MS4 website lvstormwater.com for download by the public.

The National Flood Insurance Program (NIFP) provides federally backed flood insurance that encourages communities to enact and enforce floodplain regulations. The goals of NFIP are to provide flood insurance to property owners, encourage flood loss reduction activities by communities, and to save taxpayer's money. NIFP encourages communities to participate in the Community Rating System. This system provides incentives, such as reduced flood insurance rates, when a community participates. The Permittees received points for NIFP Activity 330 – Outreach Projects.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Clark County Regional Flood Control District (Regional Use)

### Monitoring and Tracking Information

- Count web access to online brochures annually.
- Number of new brochures produced annually.

### Measureable Goals

- Produce new printed material annually as needed.

# SC-35 Stormwater Outfall Map with Area of NDSR

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- New Development and Significant Redevelopment

### Description

A single valley-wide GIS map depicting areas of new development and significant redevelopment in Las Vegas Valley will be prepared based on asset tracking software currently used by the entities, review of aerial photographs or similar resources. Data will be compiled only for development projects that have been completed (i.e., have received Certificates of Occupancy, Certificates of Completion, etc). The map may show boundaries of newly developed areas, or may simply indicate the approximate location of new development. A tabulation of the approximate acreage of new development and significant redevelopment occurring in Las Vegas Valley will be prepared if readily available. An updated map showing new development and new flood control infrastructure completed during the previous permit year will be provided in each MS4 Annual Report.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Clark County Regional Flood Control District

### Monitoring and Tracking Information

- Map of areas of NDSR.

### Measureable Goals

- Update NDSR map annually.

## SD Site Design

This section presents the planning and design concepts that can be incorporated into the design of new residential, commercial and industrial developments to provide permanent erosion and sediment controls, mitigation of hydromodification effects, and long-term water quality benefits.

- SD-1 Open Space and Landscaping Objectives
- SD-2 Rural Land Overlay
- SD-3 Hillside Development Ordinances
- SD-4 Sustainability and Green Building Initiatives
- SD-5 Covered Fuel Areas
- SD-6 Raised Fuel Areas
- SD-7 Emergency Shut-Off Switch and Shear Valve
- SD-8 Standard Drainage Design Criteria
- SD-9 Parking Lot Low Impact Development (LID) Measures
- SD-10 Low Impact Development (LID) Measures

# SD-1 Open Space and Landscaping Objectives

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- New Development and Significant Redevelopment

### Description

Entities currently have open space, landscaping, natural wash and/or recreation requirements for certain types of development. Setting aside land for open space will prevent impacts of development from occurring on that land. Similarly, applying low-impact landscaping approaches will minimize hydrologic and water quality impacts of new development. Through this measure entities will promote use of open space set-asides and landscaping requirements for Major Projects and for all projects in environmentally sensitive areas. Preservation of natural washes in upland Major Project areas and recreation areas allows for natural runoff attenuation and infiltration in unlined channels. If development can occur such that runoff to these natural upland channels is not increased, then leaving them unlined could provide water quality benefits. Major Projects have been defined by each entity; environmentally sensitive areas will be defined at a regional level.

Las Vegas Valley entities currently use developer agreements to define development standards in master-planned communities. Each master-planned community is required to create legally-binding development standards. Entities will continue to use these agreements to specify open space requirements, minimum road widths, and landscaping requirements that provide stormwater management benefits.

Existing ordinances addressing land use and open space requirements give the entities the legal authority to promote preservation of natural washes in areas of new development. Entities have been successful in working with developers in master planned areas to preserve some natural washes and surrounding floodplains.

The National Flood Insurance Program (NIFP) provides federally backed flood insurance that encourages communities to enact and enforce floodplain regulations. The goals of NFIP are to provide flood insurance to property owners, encourage flood loss reduction activities by communities, and to save taxpayer's money. NIFP encourages communities to participate in the Community Rating System. This system provides incentives, such as reduced flood insurance rates, when a community participates. The Permittees received points for NIFP Activity 420 – Open Space Preservation.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Description of new and updated standards and policies as appropriate.

### Measureable Goals

- 100% compliance with standards and policies.

# SD-2 Rural Land Overlay

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- New Development and Significant Redevelopment

### Description

Each entity's planning department has a Rural Land Overlay that allows for reduced development requirements in new rural residential areas. These reduced requirements include narrower street sections, no sidewalks, and no curb and gutter. Applying these alternate development standards results in less impervious areas, and less stormwater runoff per acre of development. As an example, the City of Henderson currently has four developments covered under this program. Special land development criteria for rural areas allow use of low impact development (LID) measures.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Description of new and updated standards and policies as appropriate.

### Measureable Goals

- 100% compliance with standards and policies.

# SD-3 Hillside Development Ordinances

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- New Development and Significant Redevelopment

### Description

Hillside development ordinances regulate development on steep slopes to minimize erosion and other environmental effects. As development in Las Vegas Valley continues to push outward from the valley center and toward the mountain fronts forming the Valley, encroachment in to steep hillside areas will be more common. Clark County, CLV and COH have existing hillside development ordinances; these ordinances will continue to be enforced. CNLV does not have areas with steep slopes and does not have an existing hillside development ordinance. It does not need to adopt a hillside development ordinance.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Description of new and updated Hillside Development Ordinances.

### Measureable Goals

- 100% of new development complies with Hillside Development Ordinances, unless waived by city council / county commission.

# SD-4 Sustainability and Green Building Initiatives

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- New Development and Significant Redevelopment

### Description

Local governments in Las Vegas Valley are adopting sustainability and green building initiatives for new public buildings. Clark County, Las Vegas and Henderson have done so to date, and North Las Vegas is considering proposed language to adopt. While these initiatives have many different objectives (e.g., smart site design, reduced energy consumption, reduced water consumption, efficient transportation, LEED certification), the site design components can have stormwater quality benefits through reduced irrigation runoff, better onsite stormwater management, and reduced use of pesticides and herbicides. Entities also promote use of these site design principles on private buildings through distribution of information to developers, involvement in local architecture and engineering professional groups, and setting examples on their own buildings.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- None.

### Measureable Goals

- None.

# SD-5 Covered Fuel Areas

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- New Development and Significant Redevelopment

### Description

This BMP consists of covering new gas station and fueling area pump islands. It is standard practice in the fuel service industry to cover fueling areas. Covered fueling areas prevent rainfall from contacting potential spilled hydrocarbons around gasoline pumps. Although it is not required by local ordinances, all fueling areas at recently constructed gas stations in Las Vegas Valley are covered with roofs or awnings based on this industry standard. All new gas stations will have covered fueling areas based on this standard; thus, additional codes will not be required for this measure in the stormwater program.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Private Owners

### Monitoring and Tracking Information

- None.

### Measureable Goals

- 100 percent of all new gas stations will have covered fuel areas based on industry standards.

# SD-6 Raised Fuel Areas

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- New Development and Significant Redevelopment

### Description

This BMP consists of raising all fueling areas above the surrounding pavement. It is standard practice in the fuel service industry to raise fueling areas on a small (e.g., 6-inch) concrete platform. Raised fueling areas prevent runoff on the gas station site from contacting potential spilled hydrocarbons around gasoline pumps. Although it is not required by local ordinances, all fueling areas at recently constructed gas stations in Las Vegas Valley are raised based on this industry standard. All new gas stations will have covered fueling areas based on this standard; thus, additional codes will not be required for this measure in the stormwater program.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Private Owners

### Monitoring and Tracking Information

- None.

### Measureable Goals

- 100 percent of all new gas stations to have raised fuel areas based on industry standards.

# SD-7 Emergency Shut-Off Switch and Shear Valve

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- New Development and Significant Redevelopment

### Description

This BMP consists of installing emergency shut-off switches and valves at new gas stations to isolate fueling areas after spills per the International Fire Code. It is standard practice in the fuel service industry to incorporate emergency shut-off switches and shear valves into design of all fuel pumps to prevent spills in case the fuel pump is not operated properly or is damaged.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Private Owners

### Monitoring and Tracking Information

- None.

### Measureable Goals

- 100 percent of all new gas stations to have emergency shut-off switches or shear valves.

# SD-8 Standard Drainage Design Criteria

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- New Development and Significant Redevelopment

### Description

Each entity has adopted standard drainage design criteria for new local drainage facilities. These criteria require stabilizing all drainage ways on site and downstream to prevent erosion and accumulation of sediment that could be deposited in downstream receiving waters. All new developments will be designed in accordance with these standard design criteria.

Existing standards will be modified to make it easier to use pre-approved alternates. This would make it easier for developers and engineers to creatively implement LID site design principles in new development. Each entity will review its design standards and development codes and adopt changes to facilitate implementation of LID measures.

The National Flood Insurance Program (NIFP) provides federally backed flood insurance that encourages communities to enact and enforce floodplain regulations. The goals of NFIP are to provide flood insurance to property owners, encourage flood loss reduction activities by communities, and to save taxpayer's money. NIFP encourages communities to participate in the Community Rating System. This system provides incentives, such as reduced flood insurance rates, when a community participates. The Permittees received points for NIFP Activity 450 – Stormwater Management.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Clark County Regional Flood Control District

### Monitoring and Tracking Information

- Review studies and plans for compliance.

### Measureable Goals

- 100% Compliance with design criteria.

# SD-9 Parking Lot Low Impact Development (LID) Measures

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- New Development and Significant Redevelopment

### Description

The objective of the Parking Lot Best Management Practices (BMP) Program is to minimize the impact of pollutants generated from parking lot runoff on surface water quality in Las Vegas Valley. The Parking Lot BMP Program applies to all new residential, commercial and industrial site parking lots of 1 acre and larger in Las Vegas Valley. The requirements in the Parking Lot BMP Program will apply to all new development and significant redevelopment projects requiring new site development permits. Any projects with active permits when the new program takes effect will not be subject to the new requirements. Projects that must reactivate an expired permit will be subject to the new requirements.

Requirements

*Requirements* - Runoff must be treated from at least 75% of the parking lot area using one or more Site Design or Treatment Control BMPs approved by the local municipal entities, or other measures proposed by the developer and approved by the local entity. Use of site maintenance measures or adherence to local entity regulations as required, to maintain acceptable site conditions does not relieve developers of the responsibility for implementing Site Design or Treatment Control BMPs for at least 75% of the parking lot area. The developer and site owner/operator are responsible for complying with all current local ordinances dealing with site design and maintenance.

*Permittee Requirements* – Permittees will incorporate appropriate education messages and activities into their Public Education and Outreach Program to encourage proper maintenance of parking areas. Permittees will enforce existing ordinances related to use of parking areas and appurtenant facilities such as trash storage areas and loading docks, and will investigate the potential benefits and obstacles to modifying standards for minimum and maximum parking lot sizes. Permittees will respond to citizen complaints regarding parking lot maintenance and potential pollutant sources.

Submittal and Approval Process

Requirements for parking lot designs will be included in the CCRFCD Uniform Regulations and Hydrologic Criteria and Drainage Design Manual (HCDDM) or similar design manual. Developers must submit parking lot designs to the appropriate local entity with the Technical Drainage Study required by Municipal Code. Verification of proper design will be

conducted during review of final design plans as currently required for drainage improvements.

Hydrologic and Drainage Design Criteria

Permittees will develop hydrologic and drainage design criteria for pre-approved structural BMPs. These criteria will be consistent with current standard practice for BMP design and local hydrologic conditions, and will be developed in cooperation with local flood control engineers.
Many stormwater quality BMPs may also serve as onsite flood control facilities. In this case hydrologic design will be based on the 10-year or 100-year storm as currently specified in the HCDDM. Site Design and Treatment Control measures sized only for stormwater quality management will be designed to capture and treat the runoff from the 85$^{th}$ percentile storm (i.e, the storm that is equal to or greater than 85 percent of historical storms) or a storm of similar frequency. Comprehensive design criteria will be developed and distributed by the Permittees after the proposed NDSR program is approved by NDEP. The intent is to develop a simple approach to determining the design storm and runoff characteristics (peak flow and volume) using information already required for onsite drainage design.

Approved Best Management Practices

This section lists parking lot BMPs that are pre-approved by the Las Vegas Valley Permittees. Other BMPs may be proposed by the developer and submitted to the local entity for consideration. The Parking Lot BMP Program requires that one or more of the following Site Design and Treatment Control BMPs be used to capture and treat runoff from at least 75 percent of the new parking lot area. Developers are encouraged to select Site Design measures because of their low cost, ease of maintenance, and ease of inspection. However, developers should treat the following list of BMPs as a "toolbox" from which the most appropriate measures for each specific application can be selected.

This section also lists the maintenance measures and code requirements that are expected of all parking lot owners/operators. Permittees will be responsible for conducting outreach activities to commercial and industrial site owners to inform them of the need to implement these measures on an ongoing basis.

*Site Design Measures (Preferred)*

- *Measures:* Landscaped Drainage Swale, Depressed Median, Depressed Landscaping, Buffer Strip, Minimize Directly Connected Impervious Area, Pervious Overflow Parking
- *Usage:* Low impact development site design measures accept drainage from impervious parking areas to reduce stormwater volumes and velocities and trap pollutants prior to stormwater leaving the site

- *Benefits:* Low cost, easy construction, low maintenance, easy to incorporate into most site plans

*Treatment Control Measures (Acceptable Alternates)*

- *Measures:* Sand Filter, Media Filter, Oil & Water Separator, Water Quality Inlet, Water Quality Basin (no infiltration)
- *Usage:* Treatment control measures accept site runoff and remove pollutants prior to stormwater leaving the site
- *Benefits:* Compact design allows for use in small areas, relatively efficient removal of many pollutants of concern

*Site Maintenance Measures (Required of all sites; Permittee education and outreach responsibility)*

- *Measures:* Building and Ground Maintenance, Prevent Non-Stormwater Discharges, Parking Cleaning, Plaza & Sidewalk Cleaning, Use and Disposal of Sorbents, Waste Handling and Disposal
- *Usage:* Site maintenance and pollution prevention measures to keep pollutants from contacting stormwater. Permittees will make information available to parking lot owners/operator on proper maintenance procedures and the importance of good site maintenance to regional water quality. Information will be distributed through brochures, websites, and other media as part of their Public Education and Outreach Program.
- *Benefits:* Already required, low cost to entities, easy to incorporate into site maintenance plans

*Code Measures (Require of all sites)*

- *Measures:* Trash Storage Areas, Vehicle & Equipment Washing Areas, Loading Dock Areas, Minimize Parking Requirements
- *Usage:* Pollution prevention measures associated with typical parking area appurtenances and activities, to keep potential pollutants from contacting stormwater. Permittees will review existing regulations to determine whether these measures should be required on all new parking lots.
- *Benefits:* Reduce pollutants from high potential sources, low implementation cost, close gaps in existing regulations

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Clark County Regional Flood Control District (Hydrologic Design Criteria)
- Private Owners

### Monitoring and Tracking Information

- Description of new and updated ordinances.

### Measureable Goals

- 100% compliance with development standards and policies.
- Develop new design criteria under SD-8 Standard Drainage Design Criteria.

# SD-10 Low Impact Development (LID) Measures

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- New Development and Significant Redevelopment

### Description

The MS4 permit requires the Permittees to consider low impact development (LID) measures for managing runoff from areas of new development and significant redevelopment. Low impact development consists of a variety of site planning and site design measures or practices to minimize the impact of individual urban developments on stormwater runoff quantity and quality. The LID measures determined to be feasible for use in the Las Vegas Valley NDSR program are listed below.

| LID Category | Specific Measure or Practice |
|---|---|
| Minimize directly connected impervious area | Minimize overall impervious area |
| | Direct runoff onto properly designed unpaved surfaces |
| | Disconnect rooftop drains |
| Street Design | Minimum street widths |
| | Cul-de-sac design |
| | Buffer strips |
| | Depressed medians |
| Site Design | Depressed landscaping |
| | Landscaped drainage swales |
| | Open space set-asides |
| | Density tradeoffs |
| Landscape Design | Xeriscaping |
| | Depressed landscape areas |
| | Buffer strips |

Except for the parking lot LID design measures required under BMP SC-9, LID site design measures are not required for all new residential and commercial developments. However, developers are encouraged to implement these measures whenever feasible. Developers proposing use of measures that rely on infiltration to dispose of stormwater must perform studies to demonstrate that infiltration will be effective and will not adversely affect groundwater or downstream surface water quality.

A limited LID Manual will be prepared by the Permittees that focuses only on the LID measures that are feasible for use in the Las Vegas Valley NDSR Program. The manual will reference other manuals for examples and/or design guidance.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Clark County Regional Flood Control District (Hydrologic Design Criteria)
- Private Owners

### Monitoring and Tracking Information

- None.

### Measureable Goals

- None.

# TC Treatment Control

This section presents treatment control BMPs that are designed to provide "end-of-pipe" water quality benefits for runoff that has been discharged from areas of new or existing development. Treatment control BMPs included site-level measures (sand/oil separators, sand filters) and regional watershed-scale measures.

- TC-1 Regional Detention Basins
- TC-2 Regional Channel Lining
- TC-3 Las Vegas Wash Stabilization Structures
- TC-4 Sand / Oil Separator
- TC-5 Sand Filter
- TC-6 Regional Detention Basin Retrofit

# TC-1 Regional Detention Basins

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Watershed

### Description

CCRFCD has developed a Flood Control Master Plan for Las Vegas Valley that presents a program for addressing existing and future flood control needs. A key element of the flood control program is a network of regional detention basins to capture and reduce peak flood discharges. The regional detention basin approach is considered more effective in Las Vegas Valley than having a highly distributed system of small neighborhood-scale facilities due to the infrequency, randomness and localized nature of most storm events. Regional detention basins capture and regulate more runoff events than local facilities would, and concentrate the need for maintenance in fewer facilities.

Basins have been shown to capture significant sediment volumes and reduce sediment delivered to downstream channels. All regional detention basins are designed with a sediment storage volume in addition to the flood control volume as an allowance for capturing sediment transported from upstream watershed areas. CCRFCD policy is to design sediment storage capacity equal to the computed inflow sediment volume of five 5-year storms plus one 100-year storm. This is more than sufficient to capture the sediment load associated with the typical frequent storms normally addressed by stormwater quality management programs (e.g., the 2-year event).

Data shows that the regional detention basins are marginally effective at reducing other pollutants. Because the regional detention basins are designed to reduce peaks from large flood events, in most cases small runoff events of the kind normally addressed by stormwater quality programs pass through the regional detention basins with relatively little attenuation and little removal of constituents such as nitrogen, phosphorus and heavy metals. See measure TC-6 Regional Detention Basin Retrofit for planned water quality retrofits for regional detention basins.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Clark County Regional Flood Control District

### Monitoring and Tracking Information

- Number of new detention basins constructed.

### Measureable Goals

- Per CCRFCD Master Plan.

# TC-2 Regional Channel Lining

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Watershed

### Description

The CCRFCD design manual requires all regional flood control channels to be stabilized in some manner. Because slopes in Las Vegas Valley are generally moderate to steep, velocities are high, and soils are erodible, most channels are stabilized using concrete lining. CCRFCD has a preference for providing concrete lining for regional flood control channels to minimize capital costs, right-of-way requirements (when taking of developed property is involved) and maintenance costs. Some channels are stabilized using riprap, gabions, grade control structures, or grass (most often in golf courses). Concrete or other channel lining eliminates production of sediment from the previously unlined or natural channels due to scour and erosion, thereby reducing sediment loads to Las Vegas Wash and Lake Mead.

As a result of the CCRFCD policy, very few channels within the existing developed area are unlined; there are very few segments of large unlined channels remaining. Approximately 450 miles of regional channels are currently stabilized and another 400 miles of regional channel improvement projects are planned. The CCRFCD Flood Control Master Plan for Las Vegas Valley provides a plan for stabilizing existing and future flood control channels to minimize production of sediment due to erosion of channel areas.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Clark County Regional Flood Control District

### Monitoring and Tracking Information

- Miles of new stabilized channel constructed.

### Measureable Goals

- Per CCRFCD Master Plan.

# TC-3 Las Vegas Wash Stabilization Structures

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Watershed

### Description

Over the past 40 years erosion in the Las Vegas Wash due to wastewater discharges and urban stormwater runoff has resulted in dramatic channel erosion and reduction in wetland areas from approximately 2,000 acres to 200 acres. Erosion of the Lower Las Vegas Wash channel and floodplain is estimated to have deposited 11.2 million tons of sediment in Las Vegas Bay between 1934 and 2001, as well as contributing to water quality degradation and loss of critical habitat.

In order to address this issue, the Las Vegas Wash Coordination Committee was formed in 1998 to prepare and implement a management strategy for the Las Vegas Wash. A key element of the management strategy was to construct grade control structures in the eroding sections of the Wash to stabilize erosion and support new wetlands. SNWA, through the Las Vegas Wash Coordination Committee, was delegated responsibility for this effort and has a well-funded program for stabilizing lower Las Vegas Wash through construction of a series of erosion control structures. Eleven structures have been constructed, and 11 more are planned. In addition, another 6 erosion control structures are now proposed between Lake Las Vegas and Las Vegas Bay of Lake Mead. These structures are downstream of essentially all possible new development and significant redevelopment in the Valley.

These structures provide water quality benefits by: (1) creating wetlands which can filter the water, and (2) reducing the velocity of water in the Las Vegas Wash to allow sediment to settle out upstream of the erosion control structures. Existing structures have significantly reduced the effects of scour and erosion, reducing sediment transport in the lower Wash by 60-80 percent. Lower Las Vegas Wash was on Nevada's 2002 303(d) list of impaired waters due to high TSS concentrations. By 2004 this segment was removed from the 303(d) list due to improvements in TSS associated with the erosion control structures. They have also re-established 165 acres of riparian wetlands between the Clark County Wetlands Park visitor's center and Lake Las Vegas. Both of these changes have resulted in water quality improvements in the lower Wash and Lake Mead. This program has received awards of recognition from EPA, the State of Nevada, and professional engineering and environmental associations. The program is featured on the EPA Non-Point Source website as an example of successful BMPs to address sediment (http://www.epa.gov/nps/success/state/nv.htm).

### Responsible Party

This measure is implemented by the following parties:

- Southern Nevada Water Authority.

### Monitoring and Tracking Information

- Number of Las Vegas Wash erosion control structures constructed.

### Measureable Goals

- Per SNWA Master Plan.

# TC-4 Sand / Oil Separator

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- New Development and Significant Redevelopment

### Description

Sand/oil separators are small vaults with chambers that separate sand (and other heavy particulates) and oil (and other flotables) from the flow stream. They are often used at industrial sites and commercial locations where hydrocarbons are present.

There is no current requirement to use sand/oil separators at specific types of industrial facilities in Las Vegas Valley. Application of this BMP is at the discretion of site owners and managers based on the potential of the site to contribute to pollutant discharges to the MS4 and the specific site characteristics. Entities will provide design criteria to developers wishing to use this BMP at a new industrial site.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Private Owners

### Monitoring and Tracking Information

- Number of sand/oil separators installed that discharge to the storm sewer system.

### Measureable Goals

- None.

# TC-5 Sand Filter

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- New Development and Significant Redevelopment

### Description

Sand filters are treatment devices that are designed to remove small particulates and some dissolved pollutants from stormwater. They are often used at commercial sites, industrial sites and parking areas to treat runoff prior to discharge to the MS4.

There is no current requirement to use sand filters at specific types of industrial facilities in Las Vegas Valley. Application of this BMP is at the discretion of site owners and managers based on the potential of the site to contribute to pollutant discharges to the MS4 and the specific site characteristics. Entities will provide design criteria to developers wishing to use this BMP at a new industrial site.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Private Owners

### Monitoring and Tracking Information

- Number of sand filters installed that discharge to the storm sewer system.

### Measureable Goals

- None.

# TC-6 Regional Detention Basin Retrofit

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Watershed

### Description

Data shows that the existing regional detention basins in Las Vegas Valley are marginally effective at reducing concentrations of many common stormwater pollutants. Because the regional detention basins are designed to reduce peaks from large flood events, in most cases small runoff events of the kind normally addressed by stormwater quality programs pass through the regional detention basins with relatively little attenuation and little removal of constituents such as nitrogen, phosphorus and heavy metals. This BMP involves adding water quality control features to existing regional detention basins and to the design of future basins in order to improve their pollutant removal efficiency.

The recommended detention basin water quality retrofit approach is to develop a unique retrofit plan for each major watershed resulting in enough total water quality capture volume to address the runoff from new development and significant redevelopment. The approach has the following elements.

- Consider the most practical opportunities for retrofit in each watershed, rather than retrofitting every single detention basin.
- Consider opportunities for retrofit beginning with the most downstream detention basins in a watershed.
- Combine water quality retrofits with detention basin construction and upgrades when possible to keep total design and construction costs to a minimum.
- Use existing capacity opportunities including sediment storage and capacity that is not needed for 100-year flood storage.

Regional detention basin design standards will be modified for application to regional detention basins.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- Clark County Regional Flood Control District

### Monitoring and Tracking Information

- Inventory of detention basins with water quality design.
- Volume or weight of material removed detention basins.

### Measureable Goals

- Per Detention Basin Retrofit Master Plan that will be submitted 1 year after approval of SWMP.
- Water quality designs for all new detention basins.

## Parties Responsible for Implementing Proposed BMPs

This section presents the **Table B-1** which lists the parties responsible for implementing the proposed BMPs listed in **Table 3-2**.

- Table B-1 Parties Responsible for Implementing Proposed BMPs

## Table B-1 Parties Responsible for Implementing Proposed BMPs

| Measure Type | ID No. | Proposed BMP | Responsible Parties | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Solely by Other Organization | Assistance from Other Organization | Clark County | CLV | CNLV | COH | CCRFCD |
| Maintenance | MM-1 | Street Sweeping | | | X | X | X | X | |
| | MM-2 | Local Storm Drain System Maintenance | | | X | X | X | X | |
| | MM-3 | Regional Detention Basin Maintenance | | | X | X | X | X | X |
| | MM-4 | Maintenance of Public Facilities | | | X | X | X | X | |
| Source Control | SC-1 | Water Conservation (Drought) Ordinance | | SNWA | X | X | X | X | |
| | SC-2 | Turf Conversion Program | SNWA | | | | | | |
| | SC-3 | Public Employee Supervisor Fertilizer/Pesticide Training | | | X | X | X | X | |
| | SC-4 | Use of Alternate Products & Application Procedures | | | X | X | X | X | |
| | SC-5 | Household Hazardous Waste Collection | | PC | X | X | X | X | |
| | SC-6 | Commercial/Industrial Housekeeping Practices | | PO | X | X | X | X | |
| | SC-7 | Ordinances Prohibiting Non-Stormwater Discharges and Littering | | SNHD | X | X | X | X | |
| | SC-8 | Desert Dumping Controls | | SNHD | X | X | X | X | |
| | SC-9 | Grease Interceptor Program | | | X | X | X | X | |
| | SC-10 | Dust Control Measures | | | X | X | X | X | |
| | SC-11 | Storm Drain Marking Program | | | X | X | X | X | |
| | SC-12 | Spill Control Prevention Plan | | PO | X | X | X | X | |
| | SC-13 | Industrial Pretreatment Program | | | X | X | X | X | |
| | SC-14 | Trash Receptacle Enclosures | | | X | X | X | X | |
| | SC-15 | Southern Nevada Health District Inspections | SNHD | | | | | | |

| Measure Type | ID No. | Proposed BMP | Responsible Parties | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Solely by Other Organization | Assistance from Other Organization | Clark County | CLV | CNLV | COH | CCRFCD |
| Source Control | SC-16 | Regional Water Quality Planning | | SNWA, LVVWAC, LMWQF, LVWCC, NDEP | X | X | X | X | X |
| | SC-17 | Pet Waste Management | | | X | X | X | X | |
| | SC-18 | Stormwater Outfall Map | | | X | X | X | X | X |
| | SC-19 | Sanitary Sewer Line Inspection and Replacement Program | | | X | X | X | X | |
| | SC-20 | Construction Site BMP Guidance Manual | | | | | | | X |
| | SC-21 | Construction Site Inspections | | | X | X | X | X | |
| | SC-22 | Construction Site Training Workshops | | | X | X | X | X | X |
| | SC-23 | Industrial Facility Stormwater Inspections | | | X | X | X | X | |
| | SC-24 | Industrial Facility Stormwater Inventory | | | X | X | X | X | |
| | SC-25 | Industrial Facility Stormwater Inspection Checklist | | | X | X | X | X | |
| | SC-26 | Storm Channel Inspections | | | X | X | X | X | |
| | SC-27 | Dry Weather Monitoring | | SNWA | | | | | |
| | SC-28 | Industrial Facility Inspector Training Workshops | | | X | X | X | X | |
| | SC-29 | Stormwater Related Complaint Response | | SNHD | X | X | X | X | X |
| | SC-30 | LVV Stormwater Quality Website | | | | | | | X |
| | SC-31 | Public Outreach Events | | | X | X | X | X | X |
| | SC-32 | Elementary School Presentations | | | | | | | X |
| | SC-33 | Public Service Announcements / Flood Channel | | | | | | | X |
| | SC-34 | Brochures and Printed Material | | | X | X | X | X | X |
| | SC-35 | Stormwater Outfall Map with Area of NDSR | | | X | X | X | X | X |

| Measure Type | ID No. | Proposed BMP | Responsible Parties | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Solely by Other Organization | Assistance from Other Organization | Clark County | CLV | CNLV | COH | CCRFCD |
| Site Design | SD-1 | Open Space and Landscaping Objectives | | | X | X | X | X | |
| | SD-2 | Rural Land Overlay | | | X | X | X | X | |
| | SD-3 | Hillside Development Ordinances | | | X | X | | X | |
| | SD-4 | Sustainability and Green Building Initiatives | | | X | X | X | X | |
| | SD-5 | Covered Fuel Areas | | PO | X | X | X | X | |
| | SD-6 | Raised Fuel Areas | | PO | X | X | X | X | |
| | SD-7 | Emergency Shut-off Switch and Shear Valve | | PO | X | X | X | X | |
| | SD-8 | Standard Drainage Design Criteria | | | X | X | X | X | X |
| | SD-9 | Parking Lot Low Impact Development | | PO | X | X | X | X | X |
| | SD-10 | Low Impact Development Measures | | PO | X | X | X | X | |
| Treatment Control | TC-1 | Regional Detention Basins | | | X | X | X | X | X |
| | TC-2 | Regional Channel Lining | | | X | X | X | X | X |
| | TC-3 | Las Vegas Wash Stabilization Structures | SNWA | | | | | | |
| | TC-4 | Sand/Oil Separator | | PO | X | X | X | X | |
| | TC-5 | Sand Filter | | PO | X | X | X | X | |
| | TC-6 | Regional Detention Basin Retrofit | | | X | X | X | X | X |

| | | | |
|---|---|---|---|
| CLV | City of Las Vegas | LVWCC | Las Vegas Wash Coordination Committee |
| CNLV | City of North Las Vegas | NDEP | Nevada Department of Environmental Protection |
| COH | City of Henderson | PC | Private Contractors |
| CCPRO | Clark County Public Response Office | PO | Private Owners |
| CCRFCD | Clark County Regional Flood Control District | RTC | Regional Transportation Commission |
| LMWQF | Lake Mead Water Quality Forum | SNWA | Southern Nevada Water Authority |
| LVVWAC | Las Vegas Valley Watershed Advisory Committee | SNHD | Southern Nevada Health District |

# VOLUME II. TECHNICAL APPENDIX (Separately Bound)

TM II.1 Stormwater Contributions to Impaired Waters and TMDLs in Las Vegas Valley

TM IV.1 Summary and Evaluation of Las Vegas Valley Water Quality Data

TM IV.4 Proposed Source Controls and Maintenance Program

TM IV.5 Unique Factors Influencing the Las Vegas Valley MS4 Permit Program

TM IV.6 Limitations on Use of Infiltration-Based BMPs for New Development and Significant Redevelopment in Las Vegas Valley

TM IV.7 Potential Legal and Water Rights Issues Associated with Onsite Retention of Stormwater

TM IV.8 Pollutants of Concern for Las Vegas Valley MS4 NDSR Program

TM IV.9 Description of Existing BMPs and Need for New BMPs for NDSR Program

TM IV.10 Evaluation of Low Impact Development Measures for NDSR Program

TM IV.11 Potential Water Quality Retrofits of Regional Detention Basins – Strategic Plan

TM IV.12 Proposed New Development and Significant Redevelopment Program for Las Vegas Valley

TM IV.14 Proposed Industrial Facility Program for Las Vegas Valley

TM IV.15 Proposed Construction Site Management Program for Las Vegas Valley

# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

## STORMWATER MANAGEMENT PLAN

## VOLUME II. TECHNICAL APPENDIX

August 2011

*Prepared for*

**Stormwater Quality Management Committee**

*Prepared by*

MWH

BUILDING A BETTER WORLD

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| 3 | **TECHNICAL MEMORANDUM IV.1**<br>Summary and Evaluation of Las Vegas Valley Water Quality Data (May 2, 2011) |
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# Section 1

MWH

# Introduction to Volume II. Technical Appendix

The enclosed Technical Memoranda (TM) were prepared to provide supporting and detailed evaluation of the programs summarized in the Stormwater Management Plan. The individual dates on the cover represent the date the TM was finalized.

# Section 2

MWH

TECHNICAL MEMORANDUM

# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

## STORMWATER MANAGEMENT PLAN DOCUMENTATION

## Technical Memorandum II.1

## Stormwater Contributions to Impaired Waters and TMDLs in Las Vegas Valley

January 7, 2011

*Prepared for*

**Stormwater Quality Management Committee**

*Prepared by*

MWH®

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# Executive Summary

The new Las Vegas Valley Municipal Separate Storm Sewer System (MS4) permit includes requirements for addressing stormwater contributions to impaired waters and Total Maximum Daily Loads (TMDL). Lower Las Vegas Wash and selected tributaries are identified by Nevada Division of Environmental Protection (NDEP) in the current 303(d) list as being impaired for selenium, total dissolved solids (TDS), iron, pH and molybdenum. TMDLs have been established for total phosphorus and ammonia. MS4 discharges contribute significant loads of all these constituents except ammonia.

The total phosphorus TMDL includes a load allocation of 100 lb/day for all nonpoint sources between March 1 and October 31. However, based on the method used to derive it, this load allocation does not appear to apply to stormwater runoff conditions. Monitoring data collected for the NPDES stormwater permit and wastewater discharge permits indicate that phosphorus loads from nonpoint sources are less than the 100 lb/day load allocation during dry weather conditions, but loads exceed this limit during most days of stormwater runoff. Thus as long as the TMDL applies only to non-runoff conditions, discharges from the MS4 do not cause or contribute to TMDL exceedances.

Many existing best management practices (BMPs) address the constituents on the 303(d) list and phosphorus. BMPs include source controls, site design principles, and treatment measures implemented at the individual site and watershed level. These BMPs are considered adequate based on the maximum extent practicable (MEP) standard to address each of the constituents of concern; no new BMPs are required based on this assessment. Stormwater infiltration must be discouraged as a BMP in Las Vegas Valley to avoid causing or contributing to further selenium and TDS impairments in the local watercourses and the Colorado River. The public education and outreach program for the MS4 Storm Water Management Plan may be expanded to address new development and significant development issues, providing benefits toward managing constituents on the 303(d) list.

# 1 Introduction

The new Municipal Separate Storm Sewer System (MS4) permit for Las Vegas Valley includes the following requirements relative to potential contributions of stormwater to impaired waters of the State.

> *"…the Permittees must evaluate whether stormwater discharges from any part of the MS4 contribute directly or indirectly to the listing of a waterbody on the 303(d) list (i.e., impaired waterbody)" (Part II.A.1)*
>
> *"If the Permittees' stormwater discharges contribute directly or indirectly to the listing of a waterbody on the 303(d) list as described above, the Permittees must also determine whether a Total Maximum Daily Load (TMDL) has been developed and approved by NDEP for the listed waterbody. If there is a TMDL, the Permittees must comply with Part II.B.2. If no TMDL has been approved, the Permittees must then comply with Part II.B.3." (Part II.B.1)*
>
> *"II.B.2 If a TMDL is approved for any waterbody into which the Permittees discharge, the Permittees must:*
>
> > *II.B.2.a Determine and report whether the approved TMDL is for a pollutant likely to be found in stormwater discharges from the Permittees' MS4;*
> >
> > *II.B.2.b Determine and report whether the TMDL includes a pollutant wasteload allocation ("WLA") or other performance requirements specifically for stormwater discharge from the Permittees' MS4;*
> >
> > *II.B.2.c Determine and report whether the TMDL addresses a flow regime likely to occur during periods of stormwater discharge;*
> >
> > *II.B.2.d Assess whether the WLAs are being met through implementation of existing stormwater control measures or if additional control measures are necessary;*
> >
> > *II.B.2.e Document all control measures currently being implemented or planned to be implemented to be consistent with the WLA. Also include a schedule of implementation for all planned controls. Document the calculations or other evidence that shows that the WLA will be met;*
> >
> > *II.B.2.f Describe a monitoring program to determine whether the stormwater controls are adequate to meet the WLA; and,*
> >
> > *II.B.2.g If the evaluation shows that additional or modified controls are necessary, describe the type and schedule for the control additions/revisions, and an analysis that demonstrates the overall effectiveness.II.B.2.g If the evaluation shows that additional or modified controls are necessary, describe the type and schedule for the control additions/revisions, and an analysis that demonstrates the overall effectiveness.*

*II.B.3 When a TMDL has not been established as described in Part II.B.2, the Permittees must include a section in the annual report describing the condition for which the water has been listed, evaluating possible Best Management Practices ("BMPs") that might practicably be implemented, examining whether these BMPs would have a substantial effect on achieving compliance, and identifying any BMPs that are selected for implementation."*

This technical memorandum responds to these permit requirements. It includes information on the current 303(d) list, current TMDLs, contributions of MS4 discharges in affecting the listed pollutants, and best management practices to address these constituents.

# 2 Impaired Waterbodies in Las Vegas Valley

The 2006 303(d) List (February 2009) is the current list of impaired waterbodies list for Nevada. The impaired waterbodies and pollutants causing impairment in Las Vegas Valley are shown in **Table 1**. The most common impairments are associated with selenium and total dissolved solids (TDS).

Sources of pollutants causing impairment and the potential for direct or indirect contributions by flows in the MS4 system are summarized in **Table 2**. MS4 discharges have the potential to cause or contribute to the identified water quality impairments, but primarily through indirect means (e.g., recharge to shallow groundwater aquifers and increased erosion of unlined stream channels). Nevertheless, Part II.B of the permit requires the Permittees to propose Best Management Practices (BMPs) to address these constituents.

**Table 1. 2006 303(d) List of Impaired Waters in the Las Vegas Valley**

| Waterbody | Location | Parameter | Added in 2006 303(d) List |
|---|---|---|---|
| Las Vegas Creek | From its origin to Las Vegas Wash | pH | Yes |
| | | Selenium | Yes |
| Flamingo Wash | Above Las Vegas Wash | Selenium | Yes |
| | | Total Dissolved Solids | Yes |
| Duck Creek | From its origin to Las Vegas Wash | Selenium | Yes |
| | | Total Dissolved Solids | Yes |
| Las Vegas Wash | Above all wastewater treatment facilities | Iron | Yes |
| | | Selenium | Yes |
| | | Total Dissolved Solids | Yes |
| Las Vegas Wash | Telephone Line Rd to the confluence of Las Vegas Wash with Lake Mead; below all wastewater treatment facilities | Iron | No |
| | | Molybdenum | Yes |

**Table 2. Sources of Pollutants and Effects of MS4 Discharges on Impaired Waterbodies in Las Vegas Valley**

| Pollutant | Sources in Las Vegas Valley | Direct or Indirect Effects of MS4 Discharges |
|---|---|---|
| pH | • Flow through native soils<br>• Runoff from industrial sites | **Indirect -** Increased urban baseflow may increase flow through high pH soils, contributing to high pH during dry weather conditions<br>**Direct -** Potentially contaminated runoff from industrial sites enters the MS4 and discharges to surface waters |
| Selenium | • Flow through native sub-surface soils<br>• Resurfacing shallow groundwater | **Indirect -** Increased urban baseflow may recharge upper portions of shallow aquifers and force high-selenium groundwater into the MS4 which carries it to the impaired segments |
| TDS | • Flow through native sub-surface soils<br>• Resurfacing shallow groundwater<br>• Wastewater discharges | **Indirect -** Increased urban baseflow may recharge upper portions of shallow aquifers and force high-TDS groundwater into the MS4 which carries it to the impaired segments |
| Iron | • Sediment transported in stream channels | **Indirect -** Increases in dry weather flows and storm flows may increase channel erosion and volume of sediment transported in channels |
| Molybdenum | • Sediment transported in stream channels | **Indirect -** Increases in dry weather flows and storm flows may increase channel erosion and volume of sediment transported in channels |

# 3 Total Maximum Daily Loads Established in Las Vegas Valley

Phosphorus (total phosphorus, ortho-phosphate) and ammonia are not on the current 303(d) list for Las Vegas Valley. However, previous 303(d) lists included impairments for phosphorus and ammonia in lower Las Vegas Wash downstream of the wastewater treatment facility (WWTF) discharges. As a result of these impairments, TMDLs for these constituents were developed by Nevada Division of Environmental Protection (NDEP) and management plans were implemented by local wastewater dischargers. Based on the effectiveness of the TMDL program implementation, these constituents were removed from the 303(d) list.

TMDLs for total phosphorus and ammonia were developed by NDEP for the Las Vegas Wash and are documented in the Evaluation of Total Maximum Daily Loads and Associated Water Quality Standards Attainment for the Las Vegas Wash, Las Vegas Bay and Lake Mead (October 2003), herein referred to as the Evaluation of TMDLs for LVW. Load allocations were developed for point sources (i.e., the WWTFs) and nonpoint sources (i.e., urban runoff, groundwater discharges, storm runoff). The discharges from the MS4 would contribute to the non-point load. A load allocation for nonpoint sources was not developed for ammonia, because urban runoff, groundwater discharges and storm runoff have extremely low concentrations of ammonia; therefore this will not be discussed further in this memorandum.

For phosphorus, wasteload allocations (WLAs) were developed for the wastewater dischargers and a load allocation (LA) was developed for nonpoint sources, both of which are shown in **Table 3**. The nonpoint load allocation for phosphorus is 100 pounds per day (lbs/day) from March 1 to October 31. According to the *Evaluation of TMDLs for LVW*,

daily flows that exceeded 110 percent of average daily flows (considered to be storm flow events) were excluded from the calculations performed to develop the nonpoint LA.

**Table 3. Las Vegas Wash Wasteload and Load Allocations**

| | Total Phosphorus (lbs/day) | Total Ammonia (lbs/day) |
|---|---|---|
| Effective Dates | From March 1 - October 31 | From April 1 - September 30 |
| Total Wasteload Allocation for Wastewater Dischargers | 333 | 970 |
| Nonpoint Source Load Allocation | 100 | 0 |
| TMDL | 433 | 970 |

The *Evaluation of TMDLs for LVW* included conclusions and recommendations from a UNLV Water Quality Study that relate to the Las Vegas Wash TMDLs. Of particular importance, the UNLV Water Quality Study recommended that more comprehensive TMDLs may be necessary if seasonal algal blooms occur. It also pointed out that total phosphorus levels during wet weather periods approach the permit levels and exceed the nonpoint source load allocation of 100 lbs/day. The following section of this TM estimates nonpoint loads attributable to discharges from the MS4 using data collected by the MS4 permit stormwater monitoring program to confirm the validity of this statement.

The *Evaluation of TMDLs for LVW* also suggests that phosphorus in wet weather runoff may have significantly less bioavailability for algal growth than the phosphorus in dry weather flows. In order to validate this statement, additional studies would be required. If it is determined that this assumption is correct, additional sampling and analyses would be required to refine nonpoint point source LAs for wet weather and dry weather conditions in Las Vegas Wash.

Finally, the TMDL does not state that the point or nonpoint load allocations apply only during dry weather periods (or during periods when the flow is less than 110 percent of average baseline flow) even though periods of high flow were removed from the calculations when the LA was computed. Based on NDEP's analytical approach, it is assumed that the nonpoint source LA does not apply during periods of storm flow.

# 4 Total Phosphorus Load Estimates from MS4

Pollutant load is the product of flow volume and pollutant concentration. Each of these parameters is described below to compute total phosphorus load from the MS4 for wet weather and dry weather conditions in lower Las Vegas Wash. This analysis is an update to a similar analysis performed by the MWH for the Permittees in the 2002-03 permit year.

## 4.1 Flow Estimates

Hydrologic data from 1980-2009 was used to estimate annual storm flow volumes. The process for estimating nonpoint source discharges in lower Las Vegas Wash consisted of the following steps.

1. Daily streamflow data was obtained for USGS streamgages on Las Vegas Wash at Three Kids Wash and Pabco Road (depending on the year).
2. Wastewater discharges from the WWTFs, as reported by the dischargers, was subtracted from the total daily streamflow to determine the total daily nonpoint flow.
3. Plots of daily nonpoint streamflow were created and a typical baseflow value was selected for each day by subtracting obvious storm runoff. This baseflow represented the dry weather component of the daily nonpoint flow. Daily baseflow volumes were summed to compute the annual dry weather flow volume.
4. Storm flow volumes for each day were summed for the year to compute the annual wet weather flow volume.

**Table 4** presents annual volumes of wastewater effluent to the Las Vegas Wash, stormwater runoff volume, nonpoint baseflow volume, and total nonpoint flow volume for 1991-2009, which is the period during which water quality samples have been collected for the MS4 monitoring program.

Results for flows in lower Las Vegas Wash downstream of the urban area are summarized as follows.

- **Wet Weather Flows**
  - Average Stormwater Flow = 7,800 ac-ft/year (AFY)
  - Wet Year Stormwater Flow = 34,100 AFY (wettest year in 1990-2009 period)
  - Dry Year Stormwater Flow= 1,000 AFY (driest year in 1990-2009 period)
- **Dry Weather Flows**
  - Average Nonpoint Baseflow = 30,000 AFY
  - Wet Year Nonpoint Baseflow = 75,400 AFY (maximum value in 1991-2009 period)
  - Dry Year Nonpoint Baseflow = 16,200 AFY (minimum value in 1991-2009 period)

**Table 4. Annual Volumes of Stormwater Runoff, Nonpoint Baseline Flow, and Wastewater Effluent**

| Year | Wastewater Effluent Volume (ac-ft) | Total Nonpoint Source Volume (ac-ft) | Stormwater Runoff Volume (ac-ft) | Nonpoint Baseflow Volume (ac-ft) |
|---|---|---|---|---|
| 1991 | 86,039 | 23,972 | 1,000 | 22,972 |
| 1992 | 92,114 | 45,195 | 9,600 | 35,595 |
| 1993 | 96,652 | 25,390 | 4,100 | 21,290 |
| 1994 | 102,971 | 19,907 | 2,900 | 17,007 |
| 1995 | 110,449 | 23,465 | 3,100 | 20,365 |
| 1996 | 116,557 | 45,578 | 3,400 | 42,178 |
| 1997 | 125,407 | 84,325 | 8,900 | 75,425 |
| 1998 | 131,053 | 54,485 | 15,423 | 39,062 |
| 1999 | 139,574 | 47,451 | 13,625 | 33,826 |
| 2000 | 147,988 | 23,752 | 6,031 | 17,721 |
| 2001 | 160,013 | 25,567 | 6,154 | 19,413 |
| 2002 | *162,377 | 25,867 | 6,200 | 19,657 |
| 2003 | *172,274 | 22,738 | 6,490 | 16,248 |
| 2004 | *174,385 | 59,097 | 34,100 | 24,997 |
| 2005 | 196,037 | 48,380 | 5,000 | 43,380 |
| 2006 | *187,124 | 29,403 | 5,200 | 24,203 |
| 2007 | *188,008 | 57,316 | 7,500 | 49,816 |
| 2008 | *183,604 | 34,643 | 5,400 | 29,243 |
| 2009 | *182,364 | 19,993 | 3,205 | 16,728 |

*Values from SWAC Reports

Rainfall records for the official Las Vegas raingage indicate an average of 26 days of measurable rainfall per year from 1949 to 1989. On many of these days rainfall was less than 0.10 inch, which does not produce measurable runoff. Review of streamflow records for the Las Vegas Wash at Three Kids gage for 1991 to 1997 showed an average of 25 days per year with flow above the baseflow level. However, this includes days on which flow was elevated due to sustained groundwater recharge of stream channels after a wet period. In general it appears that typical years have about 15 days of measurable runoff, and that values between 10 and 20 days per year are common.

## 4.2 Concentrations from MS4 Program Sampling

Dry and wet weather samples are collected at various sites along the Las Vegas Wash and its tributaries for the MS4 permit program. The various sites that have been sampled over the course of the monitoring efforts are shown in **Table 5**. The NPDES 2008-09 MS4 Permit Annual Report for Las Vegas Valley (MWH, 2009) provides median and mean concentrations for total phosphorus (TP) for all the wet and dry weather samples collected over the history of the NPDES sampling program. These are also shown in **Table 5**. This includes sites on the mainstem of Las Vegas Wash (for which the TMDL is established), as well as for the tributaries that contribute stormwater runoff to the Wash. Evaluating water quality data for the tributaries and Las Vegas Wash above the WWTFs provides insight into concentrations in urban area runoff, while data for lower Las Vegas Wash provides information on the combined effects of urban runoff and wastewater effluent. Mean concentrations are consistently higher than median concentrations; this is normally due to

one or two high values that significantly skew the mean. In this case the median is used as the best estimate of commonly occurring concentrations.

**Table 5. Dry and Wet Weather Total Phosphorus Concentrations**

| Sample Location | Dry Weather TP Concentration (mg/L) – Median / Mean | Wet Weather TP Concentration (mg/L) – Median / Mean |
|---|---|---|
| **Las Vegas Wash** | | |
| Desert Rose | 0.02 / 0.46 | 1.20 / 1.39 |
| Near Lake Las Vegas | No samples | 1.04 / 1.40 |
| Sloan Channel near confluence | 0.02 / 0.03 | 0.91 / 1.38 |
| Flamingo Wash near confluence | <0.04 / 0.04 | 1.20 / 1.52 |
| Duck Creek near confluence | <0.02 / 0.21 | 1.00 / 1.59 |
| Burns Street Channel | 0.018 / 0.023 | No samples |
| Monson Channel near confluence | 0.01 / 0.02 | 0.80 / 1.27 |
| Meadows Detention Basin | 0.05 / 0.10 | 0.33 / 0.42 |
| Las Vegas Creek near confluence | 0.06 / 0.07 | 0.94 / 1.23 |
| Western Tributary to LVW near confluence | <0.05 / 0.05 | 0.55 / 0.86 |
| C-1 Channel near confluence | No samples | 2.03 / 2.48 |
| Summary for All Sites | 0.026 / 0.138 | 0.97 / 1.41 |

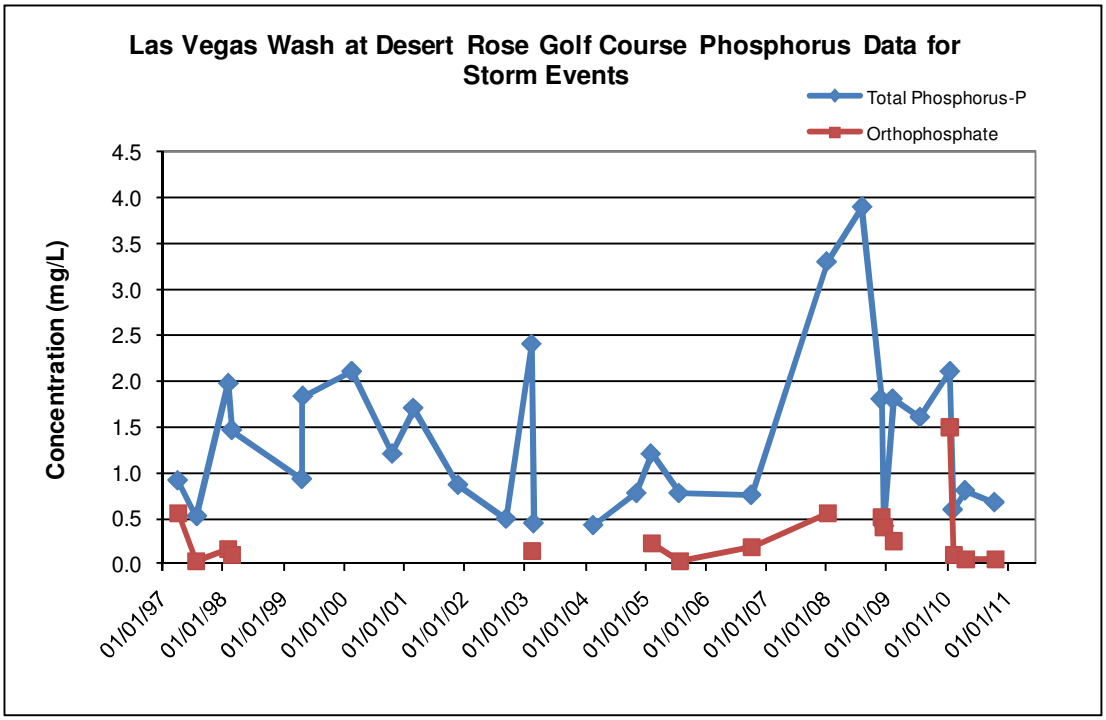
For wet weather samples at all sites, the median TP concentration of all samples is 0.97 mg/l. The median TP concentration of the wet weather samples in Las Vegas Wash at Desert Rose (above the WWTFs) is 1.20 mg/L. Below the WWTFs, the median TP concentration in wet weather samples from Las Vegas Wash near Lake Las Vegas is 1.04 mg/L. The mean concentration in wet weather flows at both locations is almost the same. In general then, WWTF discharges have little effect on TP concentrations during storm events and the concentrations are determined primarily by upstream runoff.

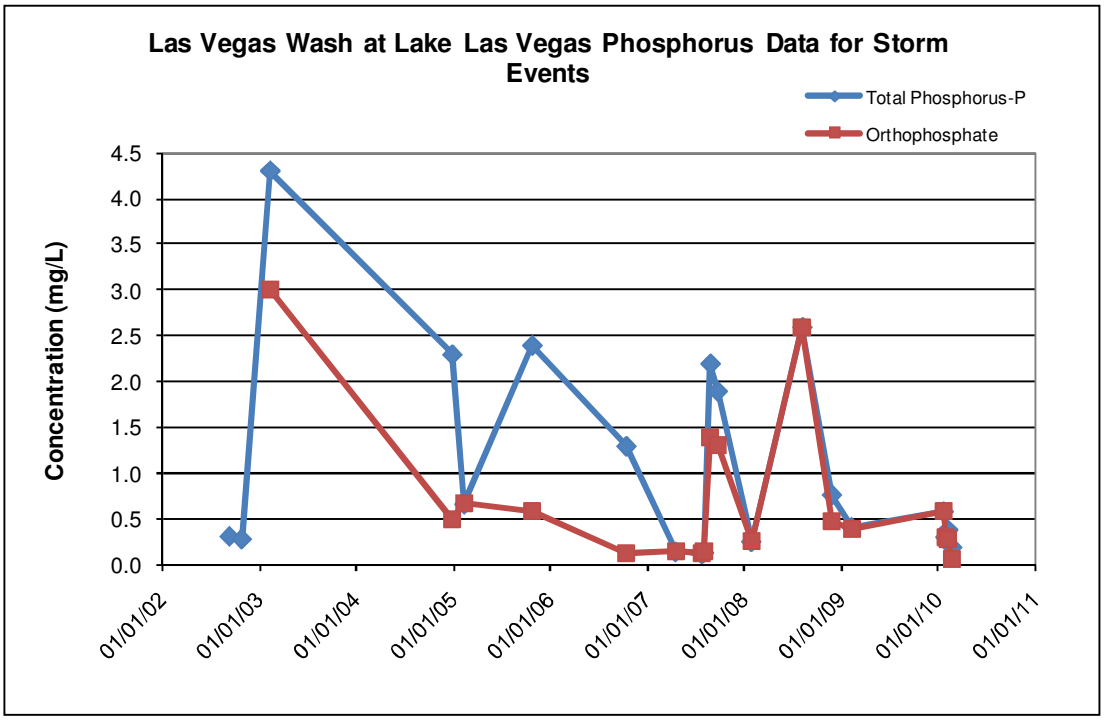
For dry weather samples, the median TP concentration of all samples is 0.026 mg/l. Dry weather data collected quarterly by SNWA on tributaries to Las Vegas Wash in October 2008 – October 2009 had an average TP concentration of 0.06 mg/l.

**Figure 1** summarizes MS4 permit wet weather phosphorus data for Las Vegas Wash upstream of the WWTFs (i.e., at the Desert Rose sampling station) and downstream of the WWTFs (i.e., near Lake Las Vegas). **Figure 2** shows wet weather phosphorus data for Las Vegas Creek, Duck Creek, Sloan Channel, Flamingo Wash and Las Vegas Wash relative to the population increase in Las Vegas Valley from 1992 to 2009. Population is used as a surrogate for urban development. Wet weather results show a somewhat greater trending for higher TP concentrations in recent years compared to the early years of the sampling program (but not at all stations). Individual storm characteristics, rather than land use conditions, may be responsible for some of the higher TP concentrations. **Figure 3** shows MS4 permit dry weather total phosphorus data for Las Vegas Wash and major tributary sampling points. Concentrations have not increased in response to increased urbanization. This is evidence that existing urban BMPs are effective in addressing phosphorus concentrations. It appears reasonable to assume that future TP concentrations will be similar to recent sampling data.

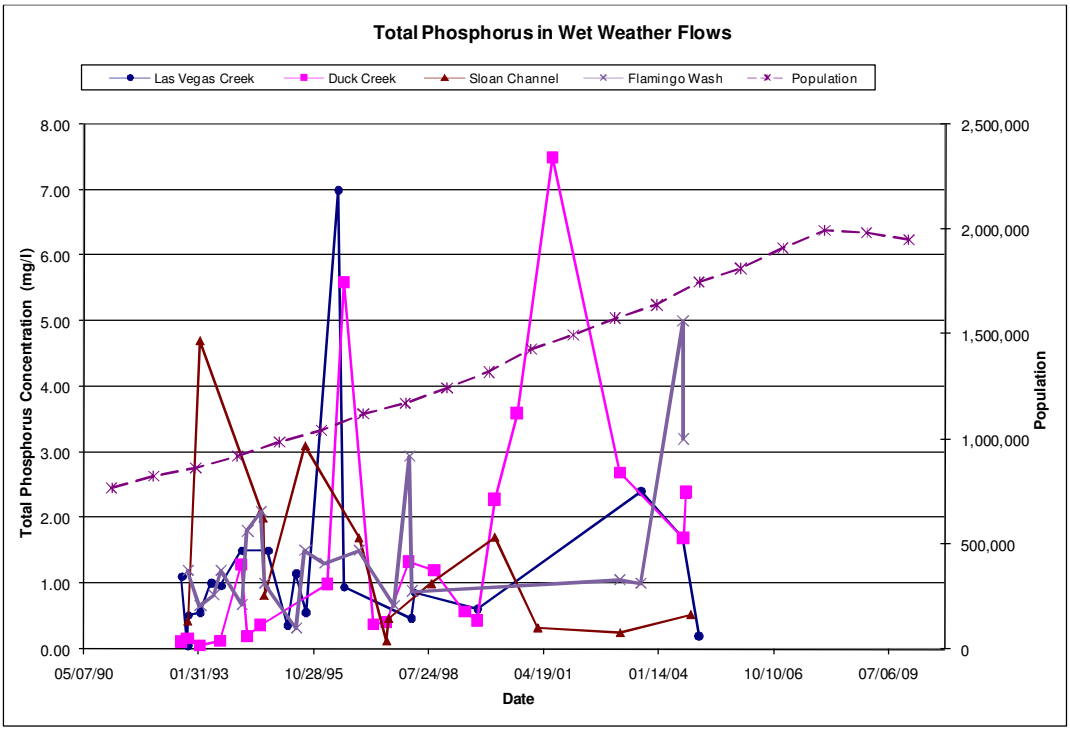
**Figure 4** presents box plots showing the range of total phosphorus data collected on tributaries to Las Vegas Wash during dry weather conditions. Stations are arranged from upstream to downstream through Las Vegas Valley. There is a modest downward trend in TP concentrations from upstream to downstream; this may be due to the dilution effects of resurfacing shallow groundwater that is generally low in phosphorus compared to surface water runoff.

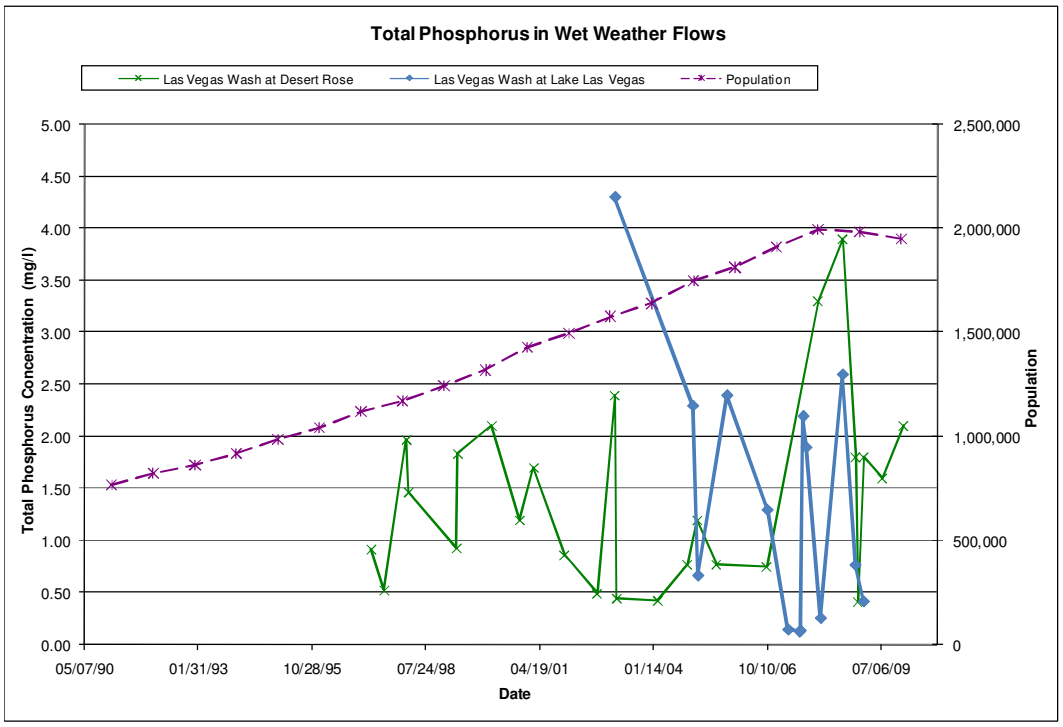
Figure 1. Las Vegas Wash Phosphorus Data for Wet Weather Events



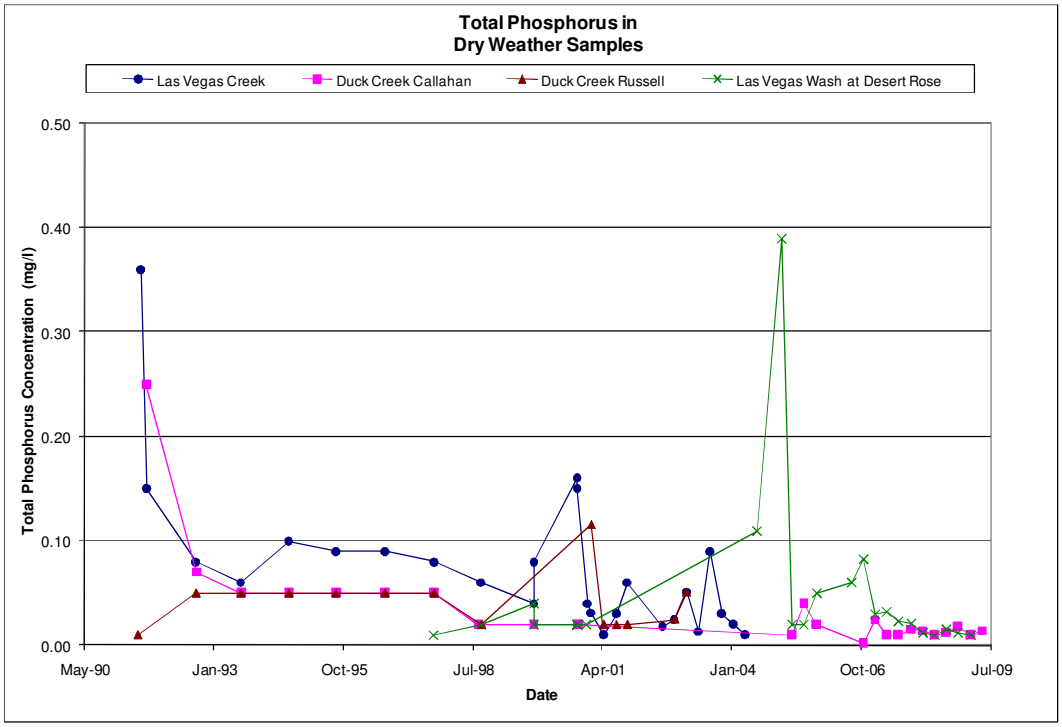



## Figure 2. Comparison of Population to Total Phosphorus in Wet Weather Flows



## Figure 3. Total Phosphorus in Dry Weather Samples




Note: Two spikes were removed from plot to show general trending of TP in dry weather samples. The spike were 4.9 mg/L at Duck Creek Callahan in December 2000 and 10 mg/L in Las Vegas Wash at Desert Rose in April 2009.

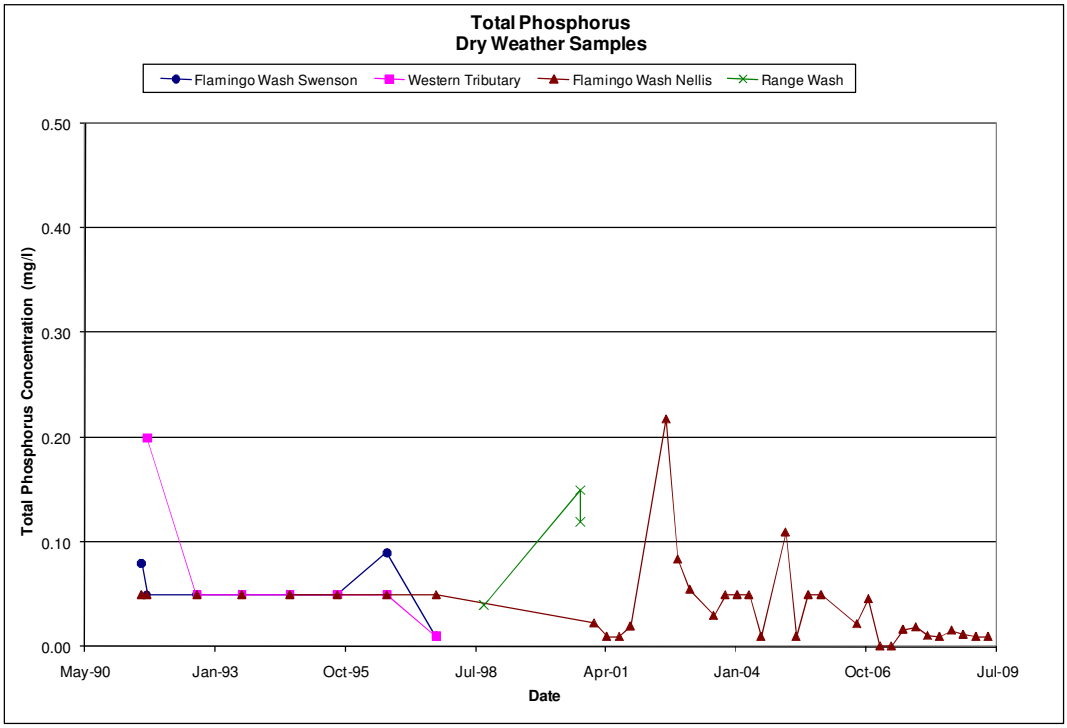
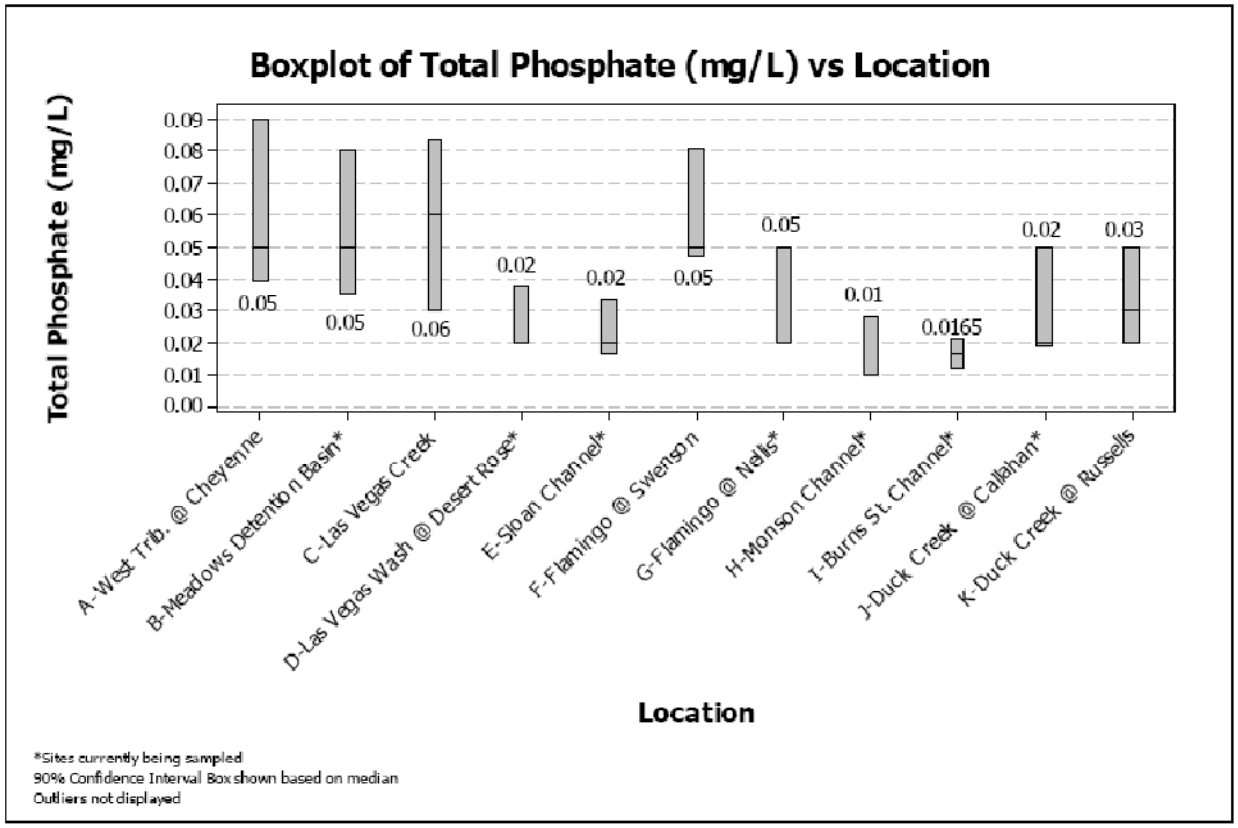


Figure 4. Dry Weather Total Phosphorus Data – Upstream to Downstream




## 4.3 Concentrations from Clean Water Coalition Data

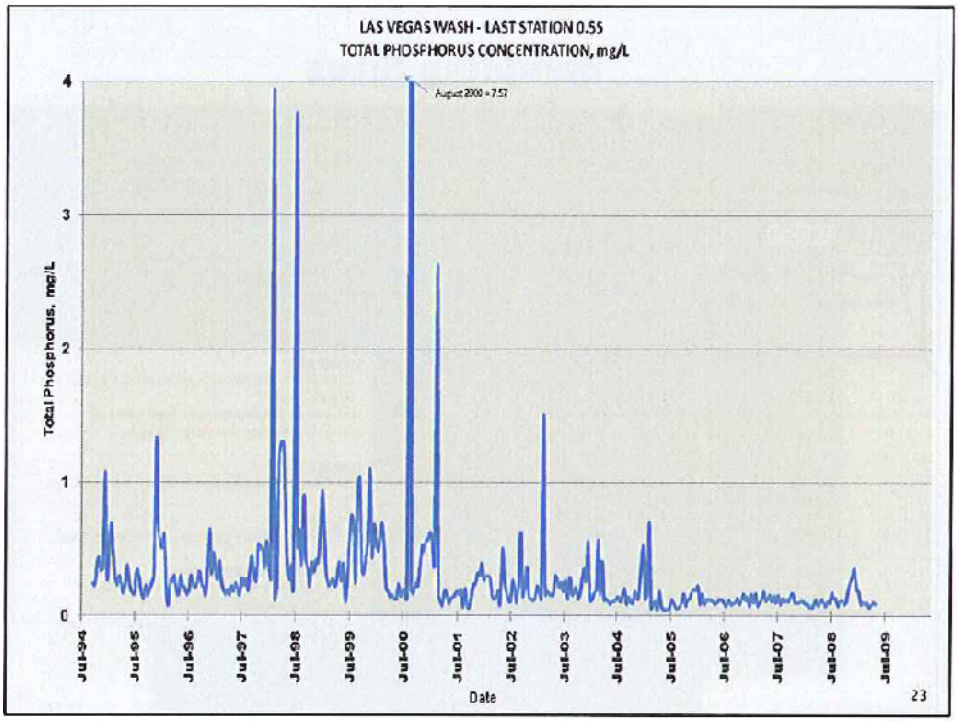
The Clean Water Coalition reported total phosphorus data collected at station 0.55 (Las Vegas Wash at Northshore Road, below all the WWTF discharges) in a summary presentation on water quality effects of the regional wastewater treatment facilities. **Figure 5** shows total phosphorus concentrations from 1994-2009. This figure shows the effects of two important changes in wastewater treatment processes:

- All WWTF operators agreed to improve winter phosphorus removal in response to algae problems in Lake Mead. Plant upgrades were started in winter 2001-02 and completed in winter 2002-03.
- The Clark County Water Reclamation District optimized phosphorus removal at its plant in spring 2004.

**Figure 5** shows that under current conditions the dry weather total phosphorus concentration in lower Las Vegas Wash is about 0.1 mg/l, and wet weather flows increase the total phosphorus concentration to 0.2 – 1.5 mg/l (combined effluent and storm flow).

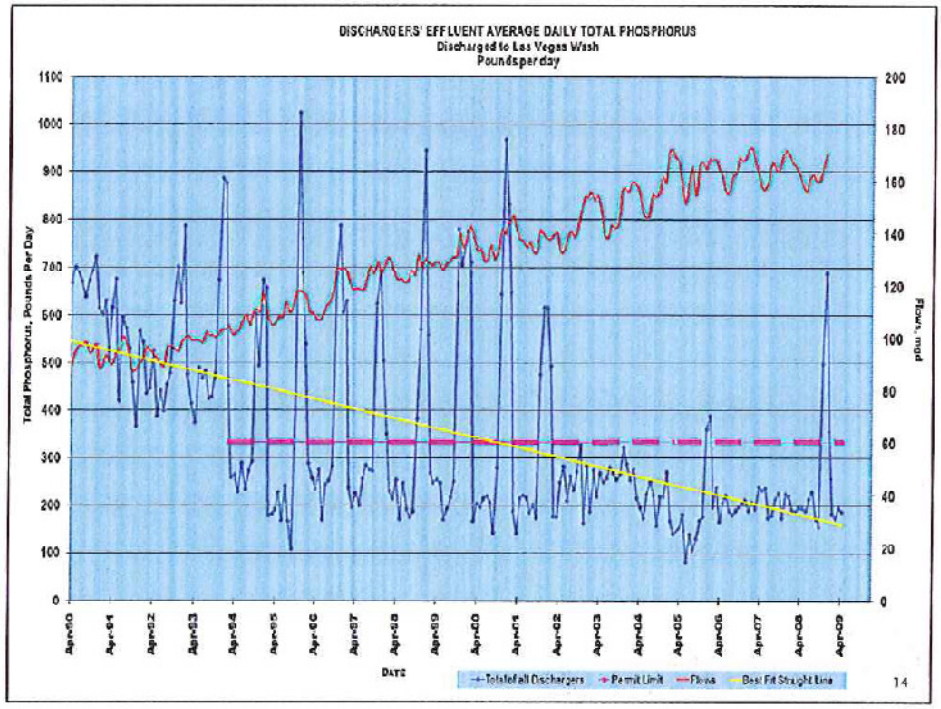
**Figure 6** shows the benefits of these WWTF improvements on phosphorus discharged from all the wastewater plants from 1990 to 2009.

## Figure 5. Total Phosphorus in Las Vegas Wash at Northshore Road Bridge, 1994-2009




Source: Clean Water Coalition

## Figure 6. Phosphorus in Wastewater Discharges, 1990-2009




Source: Clean Water Coalition

## 4.4 Concentrations from City of Henderson NPDES Sampling Program

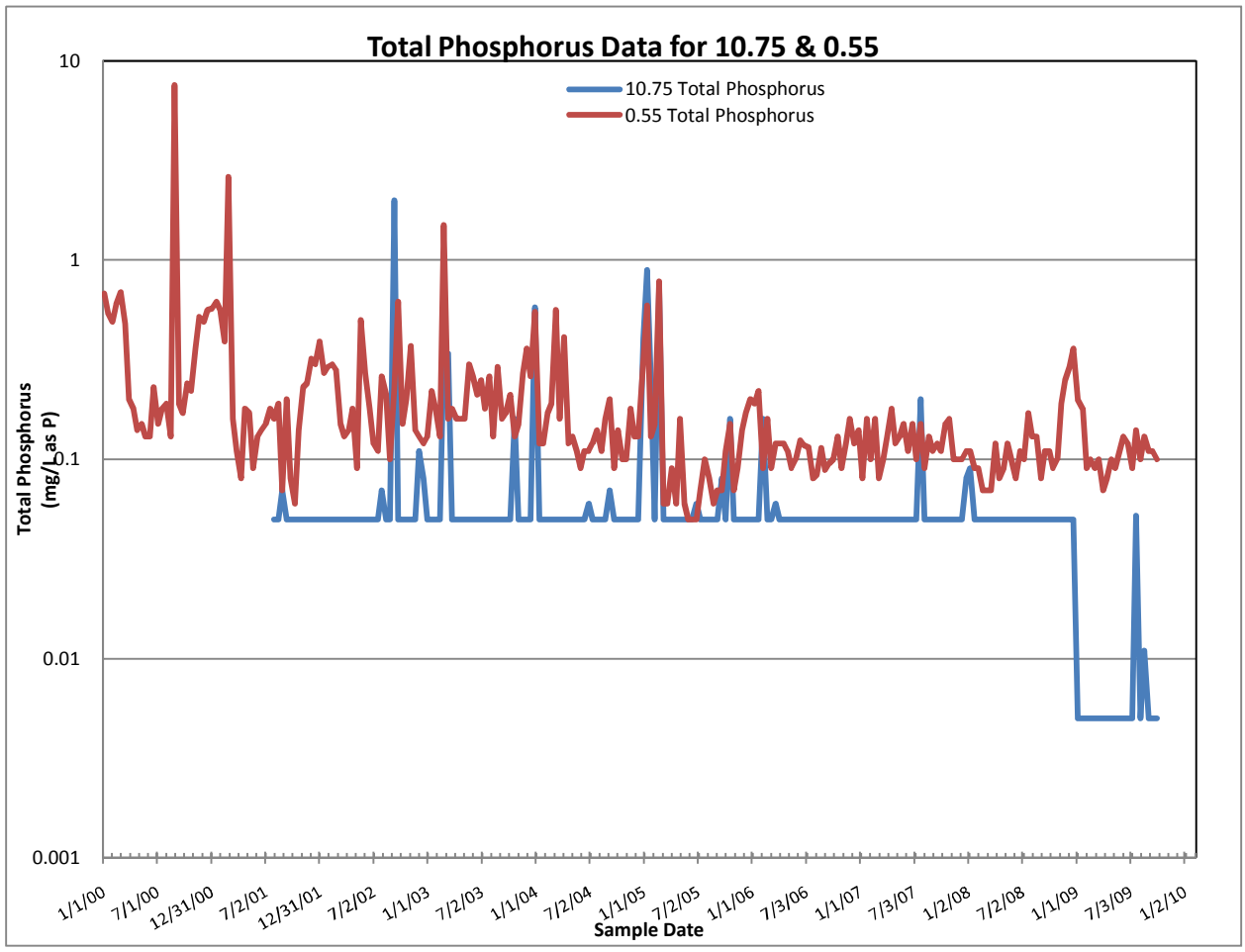
The City of Henderson collects bi-weekly water quality samples from five locations along Las Vegas Wash as part of the wastewater dischargers' obligations under their NPDES permits. Data is contained in the SNWA water quality database for Las Vegas Valley. **Table 6** summarizes median total phosphorus concentrations by year for sampling station 10.75 (upstream of all WWTFs) and sampling station 0.55 (Northshore Rd, below all WWTFs). Data at station 10.75 is representative of flow in the MS4; concentrations are consistently below the detection limit of 0.05 mg/L. **Table 6** supports the reduction in Las Vegas Wash phosphorus concentrations caused by the WWTF phosphorus removal processes.

Because data is collected every two weeks regardless of flow condition, some samples were collected when storm runoff was present in the channel. **Figure 7** shows all total phosphorus data for the period of the City of Henderson database at a location above the wastewater treatment plants (station 10.75) and below Lake Las Vegas (station 0.55). **Figure 8** and **Figure 9** show phosphorus and flow data only for storm runoff conditions in Las Vegas Wash above and below the wastewater treatment plant discharges, respectively. Both plots show how phosphorus concentrations increase during runoff periods.

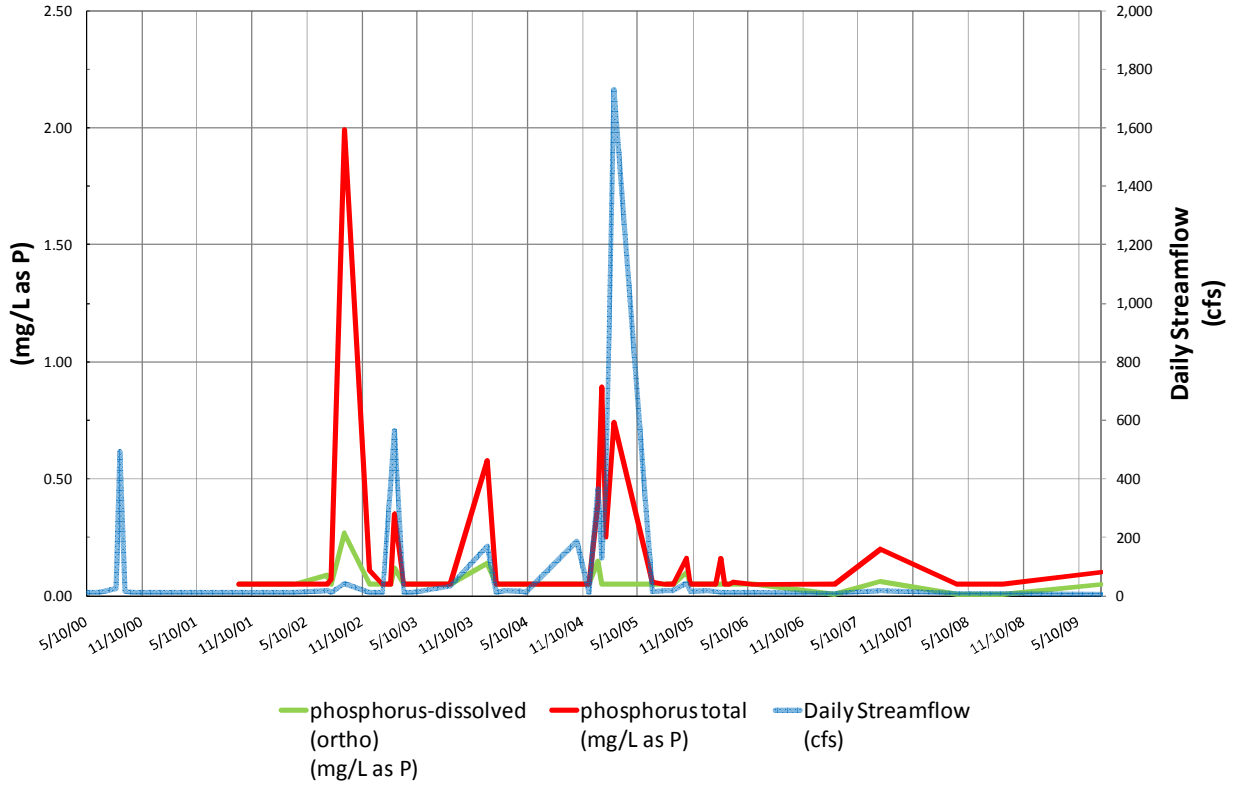
**Table 6. City of Henderson Median Total Phosphorus Data (All Samples) Upstream and Downstream of WWTF Discharges**

| Year | Median TP (mg/L) Concentration – Upstream of WWTF (Sta. 10.75) | Median TP (mg/L) Concentration – Downstream of WWTF (Sta. 0.55) |
|---|---|---|
| 2001 | <0.05 | 0.18 |
| 2002 | <0.05 | 0.19 |
| 2003 | <0.05 | 0.18 |
| 2004 | <0.05 | 0.13 |
| 2005 | <0.05 | 0.10 |
| 2006 | <0.05 | 0.12 |
| 2007 | <0.05 | 0.12 |
| 2008 | <0.05 | 0.11 |
| 2009 | <0.05 | 0.10 |

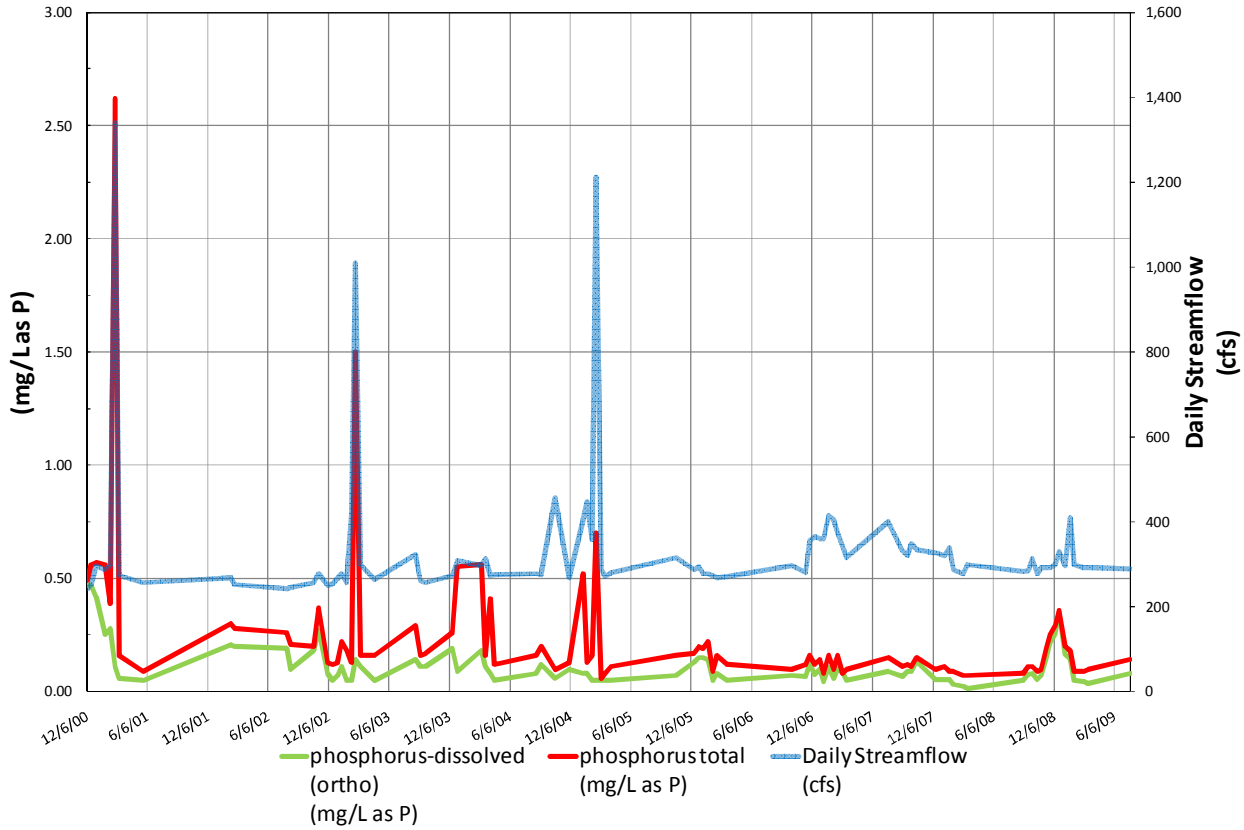
Figure 7. City of Henderson Phosphorus Data for Las Vegas Wash



## Figure 8. LW10.75 Wet Weather Flow and Phosphorus Data



## Figure 9. LW0.55 Wet Weather Flow and Phosphorus Data



## 4.5 Phosphorus Analyses

Additional phosphorus analyses are conducted to compare TP concentrations to both flowrates and total suspended solids. These analyses are summarized in the following subsections.

### 4.5.1 Total Phosphorus vs. Flow

As previously discussed, for the MS4 sampling program, wet weather samples are grabbed at two locations along Las Vegas Wash: above and below the wastewater treatment plants. **Figure 10** shows TP vs. flow data for storm runoff conditions in Las Vegas Wash above and below the wastewater treatment plant discharges. The regression line shows only a slight positive correlation between TP and flow, even though visual observations suggest that flows with higher TP concentrations occurred in storms with higher flow rates. Some of the factors that may contribute to the only slight correlation are summarized as follows:

- The individual TP concentration is the composite concentration of the aliquots from the sample; it is not a concentration of a single point in time.
- The flow data is also an average flow rate, since sampling is conducted on time-weighted intervals between aliquots.
- Due to the limited data available, some of the outlier data points (the samples with TP concentrations greater than 3 mg/L) may impact the results.

As described in the previous subsection, additional data is available from the City of Henderson sampling program. This data is combined with the MS4 data, which is shown in **Figure 11**. **Figure 11** shows only a slight additional increase in correlation between TP and flow.

In order to more conclusively show the correlation between TP and flow, it is recommended that a revised sampling program be initiated to measure TP concentration at known point in time and relate it to the corresponding known flow rate.

### 4.5.2 Total Phosphorus vs. Total Suspended Solids

Similar to TP, the TSS concentration is the concentration in the composite of the aliquots. Since concentrations of both TP and TSS are for the same composite sample, a comparison of the two concentrations can be made to see if there is a correlation.

In addition to the MS4 sampling along the Las Vegas Wash, the historic wet weather characterization program included sampling of the major tributaries to Las Vegas Wash. The entire data set from the MS4 sampling program is use and **Figure 12** shows TP vs. TSS. The general trend is that as TSS increases, TP increases.

Figure 10. Total Phosphorus vs. Flow in Las Vegas Wash (MS4 Sampling Data)

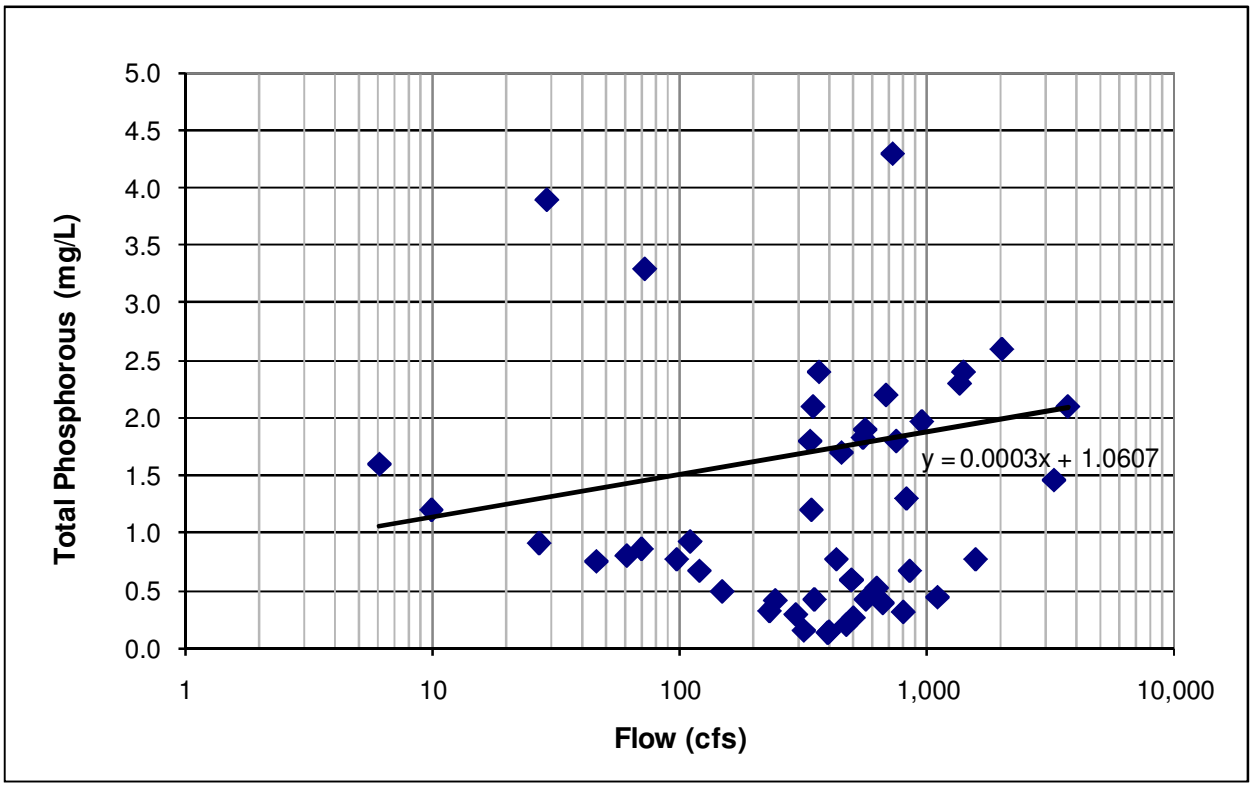



Figure 11. Total Phosphorus vs Flow in Las Vegas Wash (All Data)

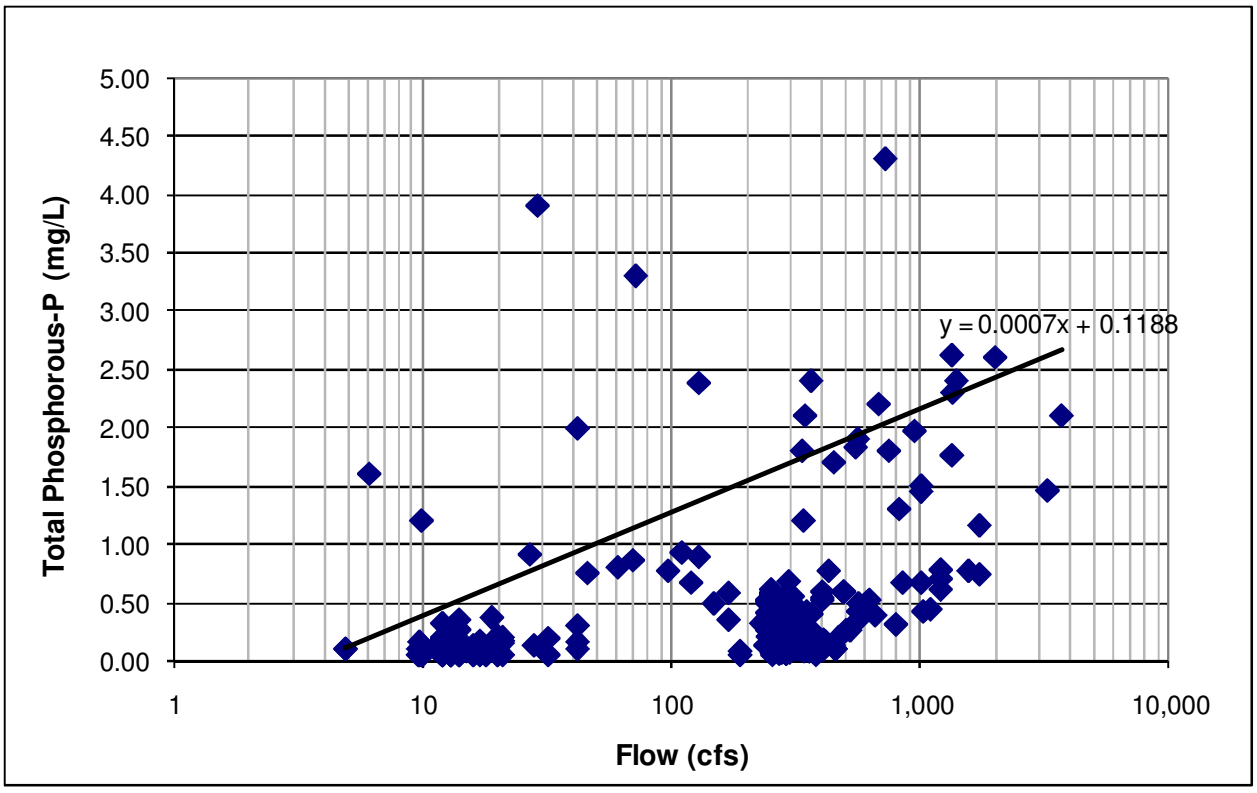
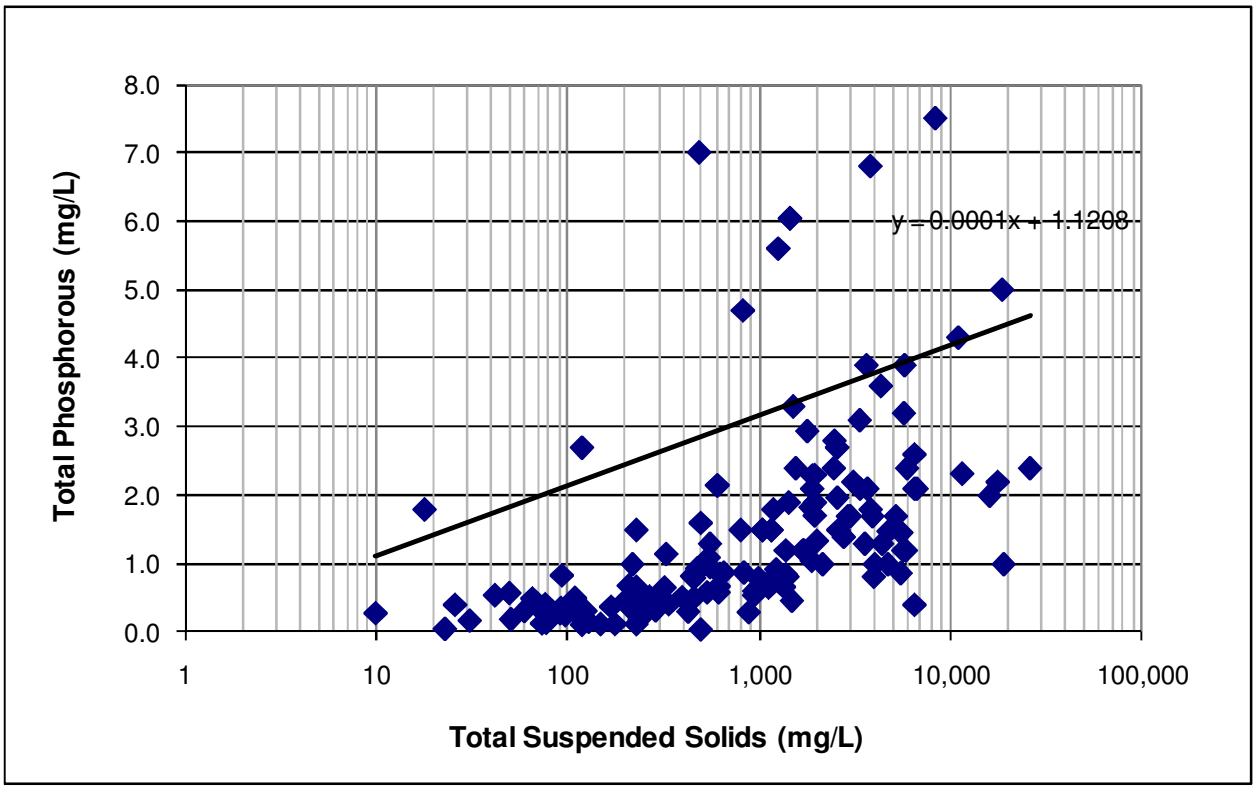


Figure 12. Total Phosphorus vs Total Suspended Solids (All MS4 Data)



## 4.6 Average Annual Loads Based on NPDES Sampling

Based on the water quality data described above, the following typical concentrations were adopted for total phosphorus: 0.05 mg/L in dry weather urban flows and 1.0 mg/L in storm runoff. Based on the flow volumes in **Table 4** and the typical median phosphorus concentrations, very approximate average annual wet and dry weather total phosphorus loads were computed and are summarized in **Table 7**. Because storm flow volume is distributed over a different number of days each year based on the number of storm events, average daily wet weather loads were computed for a range of 10 to 20 storm events per year. Although wet weather annual flow volume is significantly less than the annual volume of dry weather non-wastewater baseflow, the higher wet weather concentration results in storm flow making up the majority of annual phosphorus loading during all but the driest years.

**Table 7. Annual Total Phosphorus Load Estimates**

| Flow Conditions | Average Year TP Load (lb/day) | Wet Year TP Load (lb/day) | Dry Year TP Load (lb/day) |
|---|---|---|---|
| **Wet Weather Load** | | | |
| Averaged over full year | 56 | 244 | 7 |
| Averaged over 10 runoff days | 2,036 | 8,901 | 261 |
| Averaged over 15 runoff days | 1,357 | 5,934 | 174 |
| Averaged over 20 runoff days | 1,018 | 4,451 | 131 |
| **Dry Weather Load (excluding wastewater discharges)** | | | |
| Annual base flow | 11 | 28 | 6 |
| **Total Load** | | | |
| Averaged over full year | 67 | 272 | 13 |
| Averaged over 15 runoff days | 1,368 | 5,962 | 180 |

NDEP allocated a load of 100 lb/day of total phosphorus to nonpoint sources. The above results indicate that if wet weather loads are averaged over the entire year, this allocation is met in dry and average years, but is exceeded in wet years. Results also indicate that this allocation is probably exceeded during nearly all individual days with measureable storm runoff. As noted previously, it is assumed that the TMDL nonpoint LA does not apply during wet weather periods.

The existing MS4 data is insufficient to estimate individual storm loads. With TP and OP data for the course of the full hydrograph, pollutographs and flow-weighted composite concentrations could be developed.

# 5 Implications for Storm Water Management Plan

Based on the foregoing analyses, the MS4 permit requires the Permittees to comply with permit section II.B.2 for phosphorus (because it has an established TMDL) and with permit section II.B.3 for selenium/TDS and naturally-occurring constituents associated with sediment loads (pH, iron, molybdenum).

## 5.1 Permit Compliance for Constituents with TMDLs

This section lists the specific permit requirements for constituents with a TMDL (total phosphorus), and responds to those requirements.

> *II.B.2.a Determine and report whether the approved TMDL is for a pollutant likely to be found in stormwater discharges from the Permittees' MS4;*

Phosphorus is found in stormwater discharges and in dry weather discharges from the MS4.

> *II.B.2.b Determine and report whether the TMDL includes a pollutant wasteload allocation ("WLA") or other performance requirements specifically for stormwater discharge from the Permittees' MS4;*

The TMDL includes a load allocation for all nonpoint sources combined. This includes stormwater, urban flows, groundwater return flows, and any other discharges not originating from the WWTFs. The TMDL does not include a separate load allocation for stormwater.

> *II.B.2.c Determine and report whether the TMDL addresses a flow regime likely to occur during periods of stormwater discharge;*

The TMDL only addresses nonpoint sources in aggregate. Although the TMDL language does not specifically exclude stormwater discharges from compliance, the NDEP computations used to establish the nonpoint load allocation of 100 lb/day excluded data from days of stormwater runoff. Therefore, it is assumed for MS4 permit compliance that the TMDL LA for nonpoint sources does not apply during periods of stormwater runoff.

> *II.B.2.d Assess whether the WLAs are being met through implementation of existing stormwater control measures or if additional control measures are necessary;*

The LA of 100 lb/day for TP is met during dry weather conditions. The LA is not met during wet weather conditions, but as noted above it is assumed that the LA does not apply during runoff conditions. Therefore, existing stormwater control measures are adequate and no additional control measures are necessary.

> *II.B.2.e Document all control measures currently being implemented or planned to be implemented to be consistent with the WLA. Also include a schedule of implementation for all planned controls. Document the calculations or other evidence that shows that the WLA will be met;*

BMPs proposed for the new SWMP that address phosphorus and other nutrients are listed in **Table 8**. These are all existing practices. A separate technical memorandum is being prepared to describe these and other BMPs that address the various pollutants of concern identified for the Las Vegas Valley MS4 program (MWH 2010).

**Table 8. Las Vegas Valley BMPs That Address Phosphorus**

| Pollutant Category | BMP Category | Existing BMP or Other Activity |
|---|---|---|
| Nutrients (Nitrate, Total Phosphorus, Orthophosphate) | Source Control Measures | • Street Sweeping Program<br>• Storm Drain System Maintenance Program<br>• Conservation (Drought) Ordinance<br>• Commercial/Industrial Site Housekeeping<br>• Household Hazardous Waste Collection<br>• Ordinances Prohibiting Non-Stormwater Discharges and Littering<br>• Desert Dumping Controls<br>• Dust Control Measures<br>• Fertilizer, Pesticide and Herbicide Program |
| | Public Education and Outreach | • Public Education - General Stormwater Awareness<br>• Storm Drain Marking Project |
| | Regional Flood Control Projects | • Regional Detention Basins<br>• Regional Detention Basin Retrofits<br>• Las Vegas Wash Stabilization Structures |
| | Site Design Principles | • Floodplain Ordinances |
| | Cooperative Programs | • Southern Nevada Water Authority<br>• Las Vegas Valley Watershed Advisory Committee<br>• Sustainability and Green Building Initiatives<br>• Environmental Permitting |
| | Construction Program | • Local construction ordinances<br>• Construction site inspections<br>• Construction Site BMP Guidance Manual |
| | Industrial Program | • Industrial site inspections<br>• Industrial pretreatment programs |

Sediment is a major source of phosphorus, so BMPs that control sediment also reduce phosphorus. The existing BMPs having the most direct impact on phosphorus concentrations and loads are the conservation/drought programs and the fertilizer management program. The conservation program (landscaping restrictions, turf removal, public education, conservation pricing) has been effective in reducing fertilizer use by reducing turf and other landscaped areas. The fertilizer management program includes public education and outreach, and training of public maintenance crews in proper use and storage of fertilizers. The Las Vegas Valley entities do not have certification programs for their employees involved with fertilizer application. However, they do have training programs for those using fertilizers and require that a certified arborist inspect facilities in order to determine the need for fertilization. The application frequency and type of fertilizer are based on site specific conditions which include type of facility, soil type, species, type of water source used, and other factors. Most of the public facilities in these municipalities are fertilized three times per year. Conservation and fertilizer management programs are described in more detail in the *Description of Existing BMPs* technical memorandum (MWH 2010b). Both programs are considered to be implemented to the maximum extent practicable at the present time.

In addition to these existing BMPs, the entities may decide to upgrade their public education and outreach programs to improve awareness of how residential and commercial use of fertilizers impacts water quality in Las Vegas Wash and Lake Mead. Program enhancements, if adopted, would be implemented with other programs proposed in the new SWMP; this

must be completed within 24 months after approval of the new SWMP by NDEP (currently scheduled for August 2011).

> *II.B.2.f Describe a monitoring program to determine whether the stormwater controls are adequate to meet the WLA; and,*

Dry weather phosphorus loads are lower than the LA for nonpoint sources; thus it is concluded that existing BMPs are adequate to meet the WLA for phosphorus and no additional monitoring of these programs is necessary.

Public education programs may be expanded to more comprehensively address fertilizer use. CCRFCD currently performs a bi-annual survey to assess effectiveness of public outreach programs. Any enhancements to this monitoring measure will be described in the SWMP.

> *II.B.2.g If the evaluation shows that additional or modified controls are necessary, describe the type and schedule for the control additions/revisions, and an analysis that demonstrates the overall effectiveness.*

No additional or modified BMPs are necessary beyond those described above.

## 5.2 Permit Compliance for Constituents Without TMDLs

This section lists the specific permit requirements for constituents without a TMDL (selenium, TDS, iron, molybdenum), and responds to those requirements.

> *II.B.3 When a TMDL has not been established as described in Part II.B.2, the Permittees must include a section in the annual report describing the condition for which the water has been listed, evaluating possible Best Management Practices ("BMPs") that might practicably be implemented, examining whether these BMPs would have a substantial effect on achieving compliance, and identifying any BMPs that are selected for implementation."*

Conditions for which the listed constituents cause impairments have been described in Section 2 of this TM. **Table 9** lists the BMPs proposed for the Las Vegas Valley SWMP that could be beneficial in addressing the listed constituents. BMPs are listed for pollutant categories expected to influence the constituents of interest, including general sediment/erosion and hydromodification. Descriptions of the BMPs in each category are provided in the separate *Description of Existing BMPs* TM (MWH 2010b). These BMPs satisfy the Maximum Extent Practicable standard for BMP implementation under the MS4 permit, and no new BMPs are proposed.

**Table 9. Las Vegas Valley BMPs That Address Pollutants Without a TMDL**

| Pollutant Category | BMP Category | Existing BMP or Other Activity |
|---|---|---|
| Sediment (Sediment, TSS) | Source Control Measures | • Street Sweeping Program<br>• Storm Drain System Maintenance Program<br>• Dust Control Measures |
| | Public Education and Outreach | • Public Education - General Stormwater Awareness |
| | Regional Flood Control Projects | • Regional Detention Basins<br>• Regional Channel Lining<br>• Las Vegas Wash Stabilization Structures |

| Pollutant Category | BMP Category | Existing BMP or Other Activity |
|---|---|---|
| | Site Design Principles | • Open Space and Landscaping Objectives<br>• Hillside Development Ordinances |
| | Cooperative Programs | • Southern Nevada Water Authority<br>• Las Vegas Valley Watershed Advisory Committee<br>• Environmental Permitting |
| | Construction Program | • Local construction ordinances<br>• Construction site inspections<br>• Construction Site BMP Guidance Manual |
| Heavy Metals (Copper, Lead, Zinc, Molybdenum) | Source Control Measures | • Street Sweeping Program<br>• Storm Drain System Maintenance Program<br>• Ordinances Prohibiting Non-Stormwater Discharges and Littering<br>• Desert Dumping Controls<br>• Dust Control Measures |
| | Public Education and Outreach | • Public Education - General Stormwater Awareness |
| | Regional Flood Control Projects | • Regional Detention Basins<br>• Las Vegas Wash Stabilization Structures |
| | Site Design Principles | • Open Space and Landscaping Objectives<br>• Floodplain Ordinances |
| | Cooperative Programs | • Southern Nevada Water Authority<br>• Las Vegas Valley Watershed Advisory Committee<br>• Environmental Permitting |
| Selenium | Source Control Measures | • Conservation (Drought) Ordinance |
| | Public Education and Outreach | • Public Education - General Stormwater Awareness |
| | Cooperative Programs | • Southern Nevada Water Authority<br>• Las Vegas Valley Watershed Advisory Committee<br>• Environmental Permitting |
| Total Dissolved Solids (Salinity) | Source Control Measures | • Conservation (Drought) Ordinance |
| | Public Education and Outreach | • Public Education - General Stormwater Awareness |
| | Cooperative Programs | • Southern Nevada Water Authority<br>• Las Vegas Valley Watershed Advisory Committee<br>• Environmental Permitting |
| pH | Source Control Measures | • Conservation (Drought) Ordinance |
| | Public Education and Outreach | • Public Education - General Stormwater Awareness |
| | Cooperative Programs | • Southern Nevada Water Authority<br>• Las Vegas Valley Watershed Advisory Committee<br>• Environmental Permitting |
| Hydromodification (Low Flows, Flood Flows) | Source Control Measures | • Conservation (Drought) Ordinance |
| | Public Education and Outreach | • Public Education - General Stormwater Awareness |
| | Regional Flood Control Projects | • Regional Detention Basins<br>• Regional Channel Lining<br>• Las Vegas Wash Stabilization Structures |
| | Site Design Principles | • Low Impact Development<br>• Open Space and Landscaping Objectives<br>• Floodplain Ordinances<br>• Preserve Natural Washes |
| | Cooperative Programs | • Southern Nevada Water Authority<br>• Las Vegas Valley Watershed Advisory Committee<br>• Sustainability and Green Building Initiatives<br>• Environmental Permitting |
| | Construction Program | • Local construction ordinances<br>• Construction site inspections<br>• Construction Site BMP Guidance Manual |

As importantly, certain potential BMPs commonly used in other communities should not be implemented to avoid exacerbating existing water quality impairments. TDS impairments in Flamingo Wash, Duck Creek, and Las Vegas Wash upstream of the WWTFs are indicative of the overall salinity problem in the Colorado River Basin. Selenium impairments in Las Vegas Creek, Flamingo Wash, Duck Creek, and Las Vegas Wash upstream of the WWTFs are also indicative of regional problems in the Southwest. Both selenium and TDS originate primarily from the shallow aquifer in lower Las Vegas Valley. This situation has been described separately in Technical Memorandum IV.6 (MWH, 2010a). This TM recommends that stormwater infiltration be discouraged throughout Las Vegas Valley, and that it only be permitted in locations where site-specific geotechnical studies can demonstrate that it is technically feasible and will not adversely affect surface and ground water quality.

# 6 Conclusions

Waterbodies in Las Vegas Valley have been designated as impaired for selenium, TDS, iron, molybdenum and pH. TMDLs in lower Las Vegas Wash have been established for total phosphorus and ammonia. Discharges from the MS4 can contribute significant loads of all of these constituents except ammonia, which is discharged from wastewater treatment plants.

Phosphorus loads from the MS4 are greater during wet weather events than during dry weather events. During dry weather conditions, the load allocation of 100 lb/day between March 1 and October 31 from nonpoint sources is not exceeded. During wet weather conditions, this limit is normally exceeded. However, the load allocation does not apply to wet weather conditions and thus discharges from the MS4 are not responsible for TMDL exceedances.

Numerous existing BMPs are being implemented by the MS4 Permittees and other regional agencies in Las Vegas Valley. These BMPs have been effective in managing concentrations of pollutants that could contribute to water quality impairments identified by NDEP, even with the extensive urban development that has occurred in Las Vegas Valley over the past 20 years. Existing BMP programs will be continued in the future to meet the MEP standard. No new BMPs are required to address pollutants on the current 303(d) list or for which TMDLs have been adopted. Stormwater infiltration must be discouraged as a BMP in Las Vegas Valley to avoid causing or contributing to further selenium and TDS impairments in the local watercourses and the Colorado River.

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# Section 3

MWH

TECHNICAL MEMORANDUM

# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

# STORMWATER MANAGEMENT PLAN DOCUMENTATION

## Technical Memorandum IV.1

## Summary and Evaluation of Las Vegas Valley Water Quality Data

May 2, 2011

*Prepared for*

**Stormwater Quality Management Committee**

*Prepared by*

MWH®

BUILDING A BETTER WORLD

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# 1 Introduction

On February 9, 2010 the Nevada Division of Environmental Protection (NDEP) issued the Las Vegas Valley MS4 Permit (2010-2015 MS4 Permit) for a period of five (5) years. The 2010-2015 MS4 is a "permit for authorization to discharge from municipal separate storm sewer systems to waters of the United States under the National Pollutant Discharge Elimination System." The 2010-2015 MS4 Permit requires the entities evaluate water quality characterization data previously submitted and include additional data collected in the same manner, and evaluate whether existing data collection programs should be modified to improve characterization of stormwater discharges, effects of BMPs, or ambient water quality. This technical memorandum provides a summary of the findings of the previous years' studies and identifies possible gaps based on the 2010-2015 MS4 permit requirements.

# 2 Summary of MS4 Monitoring Program 1991-2010

## 2.1 Wet and Dry Weather Characterization Programs

### 2.1.1 Dry Weather Characterization Program

Dry weather monitoring is conducted by the Southern Nevada Water Authority (SNWA) as part of its Urban Tributary monitoring program. Single grab samples are collected quarterly (January, April, July, October) and analyzed for metals, nutrients, major ions and organic compounds. The dry weather monitoring program for the MS4 permit has two primary objectives:

- To target potential illegal or illicit discharges to the municipal storm sewer system (e.g., from industrial activity).
- To develop a baseline of dry weather surface water quality data against which future changes can be measured and which can be used to compute urban pollutant loading to receiving waters.

From 1991 – 2000 MWH conducted dry weather monitoring for the NPDES stormwater discharge permit. SNWA has been conducting the dry weather monitoring for the NPDES stormwater discharge permit since 2001.

### 2.1.2 Wet Weather Characterization Program

One of the requirements for compliance with the MS4 permit is the performance of a Wet Weather Monitoring Program. Wet weather monitoring is conducted by MWH in conjunction with the United States Geological Survey (USGS). The wet weather monitoring program for the MS4 permit has two primary objectives:

- Characterize the water quality of stormwater runoff in the Las Vegas Valley
- Identify changes in stormwater runoff quality that may indicate changes in watershed conditions, or BMP effectiveness.

### 2.1.3 Sampling Stations

➢ **Dry Weather Sampling Stations**

SNWA currently conducts the dry weather monitoring, analysis, and data tabulation under a cooperative agreement with CCRFCD. Prior to 2000, MWH conducted the dry weather monitoring program for the Permittees. Originally the dry weather sampling program consisted of semi-annual sample collection at locations on the major Las Vegas Wash tributaries. It now consists of quarterly sampling at many of the major tributary outfalls and other locations selected by SNWA. The sampling locations and years they were active are listed below and shown in **Figure 1**.

- Western Tributary at Cheyenne (August 1991 – September 1997)
- Meadows Detention Basin – LVC_2 (October 2000 – present)
- Las Vegas Creek (July 1991 – April 2004)
- Las Vegas Wash at the Desert Rose Golf Course – (September 1997 – present)
- Flaming Wash at Swenson – (June 1991 – September 1997)
- Flamingo Wash at Nellis Blvd – FW_0 (June 1991-September 1997, January 2001-present)
- Sloan Channel at Charleston Blvd – SC_1 (September 1998 – present)
- Monson Channel at Stephanie St – MC_2 (October 2000 – present)
- Burns St Channel – BS_1 (July 2006 – present)
- Duck Creek at Broadbent Blvd – DC_1 (June 1991– present)
- Duck Creek at Patrick (June 1991 – April 2004)

Dry weather samples for all sites are grab samples.

SNWA prepares an annual report, which includes the result from the dry weather monitoring program. The data and results from that report are summarized in the NPDES Annual Report prepared by MWH.

➢ **Wet Weather Sampling Stations**

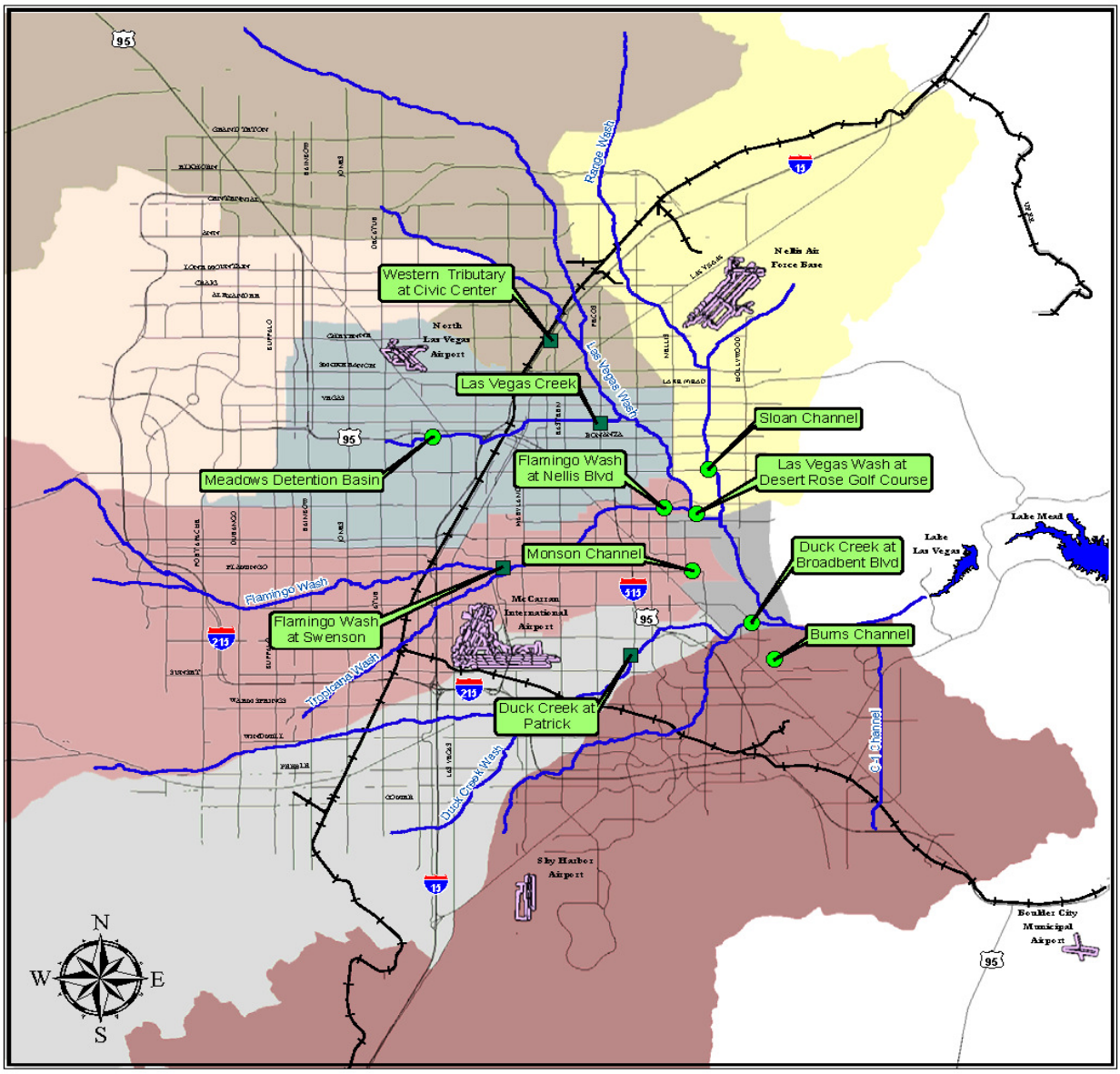
The wet weather monitoring program has been operated by MWH personnel since 1992 in conjunction with the USGS. The wet weather sampling program consists of sampling runoff from significant storm events at the major tributary outfalls. A significant event is defined as having a total rainfall depth of 0.1 inches at any rain gage within the drainage area tributary to a monitoring station. It has been found over time that a storm depth of at least 0.15 inches is required to generate sufficient runoff for sampling. Automated samplers were installed at all monitoring sites for sample collection, however samples are sometimes collected as grab samples, in needed.

Below are the sample locations and the years that they were sampled (**Figure 2**):

- Flamingo Wash at Nellis (October 1992 – August 2004)
- Sloan Channel (October 1992 – October 2004)

- Duck Creek (August 1992 – September 2004)
- C-1 Channel at Warm Springs (August 1992 – November 2004)
- Western Tributary at Civic Center (August 1992 – September 1997)
- Las Vegas Creek (August 1992 – January 2005)
- Las Vegas Wash at Desert Rose Golf Course (April 1997 – present)
- Meadows Detention Basin (February 2002- January 2005
- Las Vegas Wash at Pabco (September 2002-October 2002)
- Monson Channel (February 2003 – October 2004)
- Las Vegas Wash below Lake Las Vegas Dam (February 2003 – February 2010)
- Las Vegas Wash at Rainbow Gardens (June 2010 – present)

## Figure 1. Dry Weather Sampling Locations



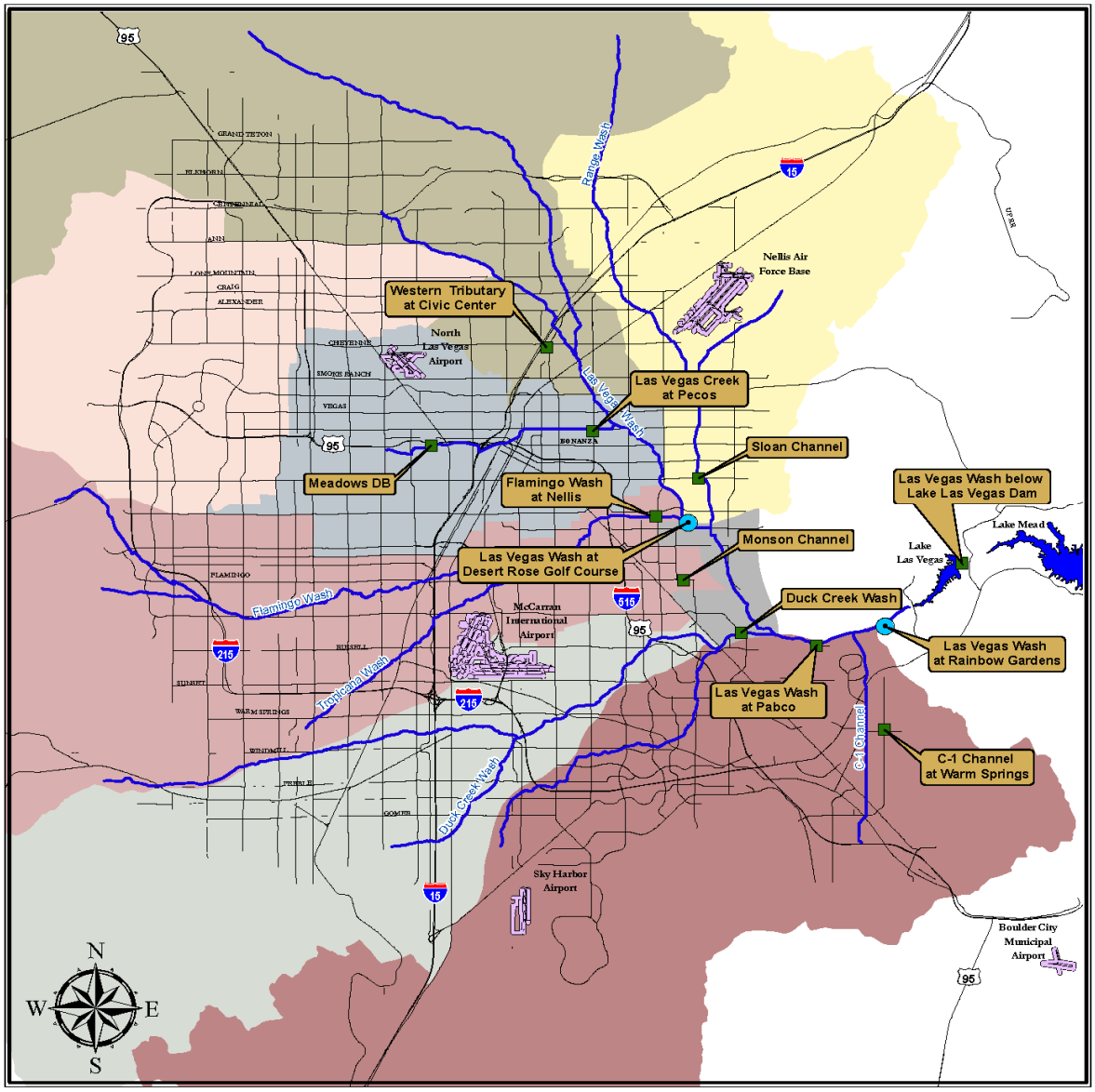

**Legend**

- Active Dry Weather Sampling Point
- Inactive Dry Weather Sampling Point
- Washes
- Railroads
- Streets
- Airports
- Range Wash Watershed
- Pittman / C-1 Watershed
- North Basin Watershed
- Lower Las Vegas Wash Watershed
- Gowan Watershed
- Flamingo / Tropicana Watershed
- Duck Creek Watershed
- Central Watershed

0 1 2 4 6 8 Miles

**DRY WEATHER MONITORING SITES**

## Figure 2. Wet Weather Sampling Locations




**Legend**

- Active Wet Weather Sampling Point
- Inactive Weather Sampling Point
- Washes
- Railroads
- Streets
- Airports
- Range Wash Watershed
- Pittman / C-1 Watershed
- North Basin Watershed
- Lower Las Vegas Wash Watershed
- Gowan Watershed
- Flamingo / Tropicana Watershed
- Duck Creek Watershed
- Central Watershed

0 1 2 4 6 8 Miles

**WET WEATHER MONITORING SITES**

### 2.1.4 Constituents Analyzed

➢ **Constituents Analyzed for Dry Weather Sampling**

The current dry weather monitoring program consists of analyzing the constituents in **Table 1**. This list of constituents has been analyzed since SNWA took over the dry weather monitoring program in 2000. Prior to that, a shorter list of common constituents including major ions, nutrients and metals was analyzed.

**Table 1. Constituents Analyzed in Dry Weather Sampling**

| Heavy Metal | Major Ion | Field Measurements Bacteriological Compositions, and Perchlorate Concentrations | Nutrients |
|---|---|---|---|
| Constituent | | | |
| Aluminum (µg/L) | Calcium (mg/l) | Conductivity (u S/cm) | Ammonia mg N/L |
| Arsenic (µg/L) | Magnesium (mg/l) | DO (mg/L) | Nitrite mg N/L |
| Barium (µg/L) | Sodium (mg/l) | pH (Units) | Nitrate mg N/L |
| Chromium (µg/L) | Potassium (mg/l) | Temperature (°C) | Nitrate-Nitrite mg N/L |
| Copper (µg/L) | Biocarbonate as $HCO_3$ (mg/l) | Turbidity (NTU) | Total Kjeldahl (TKN) mg N/L |
| Iron (µg/L) | Carbonate $CaCO_3$ (mg/L) [1] | Perchlorate (ug/L) | Orthophosphate mg P/L |
| Lead (µg/L) | Sulfate (mg/l) | Ave # FC (MPN/100 mL) | Total Phosphate mg P/L |
| Manganese (µg/L) | Chloride (mg/l) | Ave # E. coli (MPN/100 mL) | |
| Molybdenum (µg/L) | Bromide (mg/l) | | |
| Nickel (µg/L) | Fluoride (mg/l) | | |
| Selenium (µg/L) | Silica (mg/L) | | |
| Selenium (µg/L) | Total Dissolved Solids (mg/l) | | |
| Vanadium (µg/L) | TOC (mg/L) | | |
| Zinc (µg/L) | | | |

## Table 1. Constituents Analyzed in Dry Weather Sampling (Continued)

| Organic Compounds | | | | |
|---|---|---|---|---|
| **Constituent** | | | | |
| 1,1,2,2-Tetrachloroethane | Benzotriazole | Delta-BHC | Heptadecane | Toluene |
| 1,1,1-Trichloropropanone | Beta-BHC | Dibromoacetonitrile | Hexadecane (total) | (DCPA) Mono&Diacid Degradate |
| 1,1-Dichloroethane | BIS(2-ethylhexyl)phthalate | Dibromochloromethane | Hexadecanoic acid | Total Trihalomethanes |
| 1,2-Dichloroethane | Bromodichloromethane | Di(2-Ethylhexyl)phthalate | Lindane | Total THM |
| 1,2,3-Trichlorobenzene | Bromoform | Dichloroiodomethane | Lindane (gamma-BHC) | Tri(2-chloroethyl)phosphate |
| 1,2,4-Trichlorobenzene | Butanal | Dichlorobromomethane | Oxamyl (Vydate) | Trichloroethylene (TCE) |
| 1,2,4,-Trimethylbenzene | Baygon | Dichloromethane | Methylene Chloride | Unknown (Total) |
| 2-Butanone (MEK) | Butylbenzylphthalate | Dichlorprop | Methyl Tert-butylether (MTBE) | Surrogate: DECA(%) |
| 2-(2-(2-butoxyethoxy)ethoxyeth | Caffeine | Diethylphthalate | m-Dichlorobenzene (1,3-DCB) | Surrogate: TCmX(%) |
| 2,4-D | Carbon disulfide | Dicamba | M-Glyoxal (Pyruvic Aldehyde) | Surrogate: Tributylphosphate(%) |
| 2-Butoxyethanol phosphate (3:1) | Chloral hydrate | Di-n-Butylphthalate | Naphthalene (total) | Surrogate: Triphenylphosphate(%) |
| 3,6,9,12-tetraoxahexadecan-1-o | Chlorodibromomethane | Di-N-Octylphthalate | Nonadecane | Undecane (total) |
| 2,3,5,6-Tetrafluorobenzaldehyd | Chloroform | Disulfoton | Octadecane | 2,3,7,8-TCDD |
| 4-Methylphenol | Chloroform (Trichloromethane) | Diuron | Pentadecane | Malathion |
| 4,4' -DDD | Cyclohexane | d-Limonene | p-Dichlorobenzene (1,4-DCB) | N-butyl-benzenesulfonamide |
| Acetaldehyde | Cyclohexanone | Dodecane | Pentachlorophenol | |
| Acetone | Chloroiodomethane | Eicosane (total) | Pentanal | |
| Aldrin | Dalapon | Endrin | Phenanthrene | |
| Alpha-BHC | DCPA | Endrin Aldehyde | Propanal | |
| Baygon | Decane | Formaldehyde | Tetrachloroethylene (PCE) | |
| Benzo (k) Fluoranthene | Diazinon | Glyoxal | Tetradecane | |
| Benzo (a) pyrene | Dieldrin | Glyphosate | Simazine | |

## ➢ Constituents Analyzed for Wet Weather Sampling

The wet weather monitoring program consists of analyzing the constituents in **Table 2**. The basic list of constituents, referred to as NPDES Constituents on **Table 2**, are the constituents that were used for the wet weather sampling prior to 2004. **Table 2** also lists SNWA expansion constituents, which are the constituents that were added to the sampling program in 2004. The current laboratory analysis methods are also shown in **Table 2.**

### Table 2. Constituents Analyzed in Wet Weather Sampling

| | Constituent | Method | Constituent | Method |
|---|---|---|---|---|
| NPDES Constituents | Oil and Grease - Gravimetric | EPA 1664 | Copper, Dissolved, | EPA 200.8 ICAP/MS |
| | Total Dissolved Solids (TDS) | E160.1/SM2540C | Lead, Dissolved | EPA 200.8 ICAP/MS |
| | Total Suspended Solids (TSS) | SM 2540D | Zinc, Dissolved, | EPA 200.8 ICAP/MS |
| | Total Phosphorus-P (T-P) | S4500-PE/365.1 | Boron, Total | |
| | Orthophosphate-P (OPO4) | 4500-E/365.1 | Turbidity | EPA 180.1 |
| | Nitrite, Nitrogen by IC | | Fecal Coliform Bacteria | SM 9221C |
| | Nitrate as N by IC | EPA 300.0 | Fecal Streptococci | SM 9221B |
| | Total Kjeldahl Nitrogen (TKN) | EPA 351.2 | Semivolatile Organic Compounds (SOCs) | |
| | Copper, Total | EPA 200.8 ICAP/MS | Volatile Organic Compounds (VOC) | |
| | Lead, Total | EPA 200.8 ICAP/MS | Pesticides | |
| | Zinc, Total | EPA 200.8 ICAP/MS | Herbicides | |

## Table 2. Constituents Analyzed in Wet Weather Sampling (Continued)

| | Constituent | Method | Constituent | Method |
|---|---|---|---|---|
| SNWA Expansion Constituents | 2-Chloroethylvinylether | | Endothall | EPA 548.1 |
| | Alkalinity in CaCO3 | SM 2320B | Fluoride | SM 4500F-C |
| | Aluminum, Total | EPA 200.8 ICAP/MS | Glyphosate | EPA 547 |
| | Anion Sum, Calculated | SM 1030E | Hardness as CaCO3 | SM 2320B |
| | Antimony, Total | EPA 200.8 ICAP/MS | Hydroxide as OH, Calc | |
| | Arsenic, Total | EPA 200.8 ICAP/MS | Iron, Total | EPA 200.7 ICAP |
| | Barium, Total | EPA 200.8 ICAP/MS | Langelier Index – 25 degree | SM 2330B |
| | Beryllium, Total, ICAP | EPA 200.8 ICAP/MS | Magnesium, Total, ICAP | EPA 200.7 ICAP |
| | Bicarbonate Alkalinity as HCO3 | SM 2330B | Manganese, Total, ICAP | EPA 200.8 ICAP / MS |
| | Bromide | EPA 300.0 | Mercury | EPA 245.1 |
| | Bromate by IC | EPA 300.1 | Nickel, Total, ICAP | EPA 200.8 ICAP / MS |
| | CO2, Free, Calculated | SM 4500 | pH, Lab | SM4500-HB |
| | Carbonate, Calculated | SM 2330B | Potassium, Total | EPA 200.7 ICAP |
| | Cadmium, Total | EPA 200.8 ICAP/MS | Reactive Silica | EPA 200.7 ICAP |
| | Calcium, Total | EPA 200.7 ICAP | Selenium | EPA 200.8 ICAP/MS |
| | Cation Sum, Calculated | SM 1030E | Silver, Total | EPA 200.8 ICAP / MS |
| | Chlorate | EPA 300, IC | Sodium, Total | EPA 200.7 ICAP |
| | Chloride | EPA 300.0 | Specific Conductance | SM 2510B |
| | Chlorite | EPA 300.0 IC | Sulfate | EPA 300.0 |
| | Chromium, Total | EPA 200.8 ICAP/MS | Surfactants | SM 5540C/EPA |
| | Diuron | EPA 532 | Thallium, Total | EPA 200.8 ICAP/MS |
| | Diquat | EPA 549.2 | Total Organic Carbon | SM 5310C/E41.3 |
| | Paraquat | EPA 549.2 | | |

**Table 2. Constituents Analyzed in Wet Weather Sampling (Continued)**

| | Constituent | Method | Constituent | Method |
|---|---|---|---|---|
| | Caffeine | 525mod | Di-n-Butylphthalate | EPA 625 |
| **SOC Detections** | Di(2-ethylhexyl)phthalate | EPA 625 | Diethylphthalate | EPA 625 |
| **VOC Detections** | 1,1-Dichloroethylene | EPA 524.2 | Dichloroacetonitrile | EPA 551.1 |
| | 2-Butanone | EPA 524.2 | Dibromochloromethane | EPA 551.1 |
| | Acetaldehyde | EPA 556 | Dichlorobromomethane | |
| | Acetone | EPA 624 | Formaldehyde | EPA 556 |
| | Benzaldehyde | EPA 556 | Methyl glyoxal | EPA 556 |
| | Bromodichloromethane | EPA 524.2 | Octanal | EPA 556 |
| | Butanal | EPA 556 | Pentanal | EPA 556 |
| | Carbon disulfide | EPA 524.2 | Propanal | EPA 556 |
| | Chlorodibromomethane | EPA 524.2 | Styrene | EPA 524.2 |
| | Chloroform | EPA 551.1 | Toluene | EPA 524.2 |
| | Chloroform (trichloromethane) | EPA 624 | Total THM | EPA 524.2 |
| | Decanal | EPA 556 | | |
| **Pesticide Detections** | Glyoxal | EPA 556 | Diuron | |
| **Herbicide Detections** | 2,4-D | EPA 8151A | Dichlorprop | EPA 8151A |
| | 2,4-DB | EPA 8151A | Pentachlorophenol | EPA 8151A |

### 2.1.5 Storms Sampled for Wet Weather Program

For wet weather sampling, prior to the 2005-2006 permit year up to three wet weather samples were collected at each site, one in the summer/fall and one in the winter/spring. The current wet weather sampling objective is to collect up to 10 samples per year from the two remaining stations at Las Vegas Wash @ Desert Rose and Rainbow Gardens. For the first three sample events, the full suite of constituents is analyzed. For subsequent storms (up to 10), a shorter list of constituents could be

analyzed. Automated samplers were installed at both monitoring sites for sample collection.

## 2.2 Detention Basin Monitoring Program

### 2.2.1 Objective

In the 2004-2005 permit year a Detention Basin Monitoring program was proposed to evaluate the water quality benefits of the existing detention basin and flood control channels in the Las Vegas Valley, because data was not available to show the effectiveness of detention basins in controlling pollutants and sediment discharge. The objective of the program was to determine whether existing regional detention basins in the Las Vegas Valley were effective in reducing pollutant concentrations in storm waters tributary to Las Vegas Wash. To determine the effectiveness of the detention basins, samples were collected from the inflow and outflow to determine the change in constituent concentration attributed to the basins. The monitoring program was conducted for the 2005-2006, 2006-2007 and 2007-2008 permit years.

### 2.2.2 Sampling Locations

The three detention basins selected for the Detention Basin Monitoring Program were the Lower Las Vegas Wash Detention Basin (LLVWDB), Meadows Detention Basin (MDB), and Upper Flamingo Wash Detention Basin (UFWDB) (**Figure 2**). Site selection criteria included:

- Ease of access – to inlet and outlet, all-weather, night and day, vehicular and pedestrian
- Suitable location to set up automatic sampler and take a grab sample
- Sample locations upstream and downstream (a channel or pipe that concentrates inflow and outflow)
- Distance from team member homes
- Basin completely built
- Neighborhood safety
- Outdoor lighting
- Urban basin
- Construction in the upstream watershed

Automated samplers were installed at locations upstream and downstream of these detention basins. If inflow to one of these detention basins occurred from a channel not equipped with an automated sampler, grab samples were taken.

### 2.2.3 Constituents Analyzed

Constituents were selected for analysis to provide an indication of the effectiveness of existing detention basins in removing constituents of concern to downstream

receiving waters. The constituents analyzed for the Detention Basin Monitoring Program are as follows:

- Total Suspended Solids (TSS)
- Total Dissolved Solids (TDS)
- Turbidity
- Total Copper
- Total Lead
- Total Zinc
- Dissolved Copper
- Dissolved Lead
- Dissolved Zinc
- Total Phosphorus
- Orthophosphate
- Nitrate
- Fecal Coliform
- Fecal Streptococci

## 2.3 Bacteria Source Identification Monitoring

### 2.3.1 Objective

The Bacteria Source Identification Monitoring Program was implemented during the 1998 – 1999 permit year. 1991 to 1998 results for wet and dry weather identified that bacteria regularly exceed nationwide averages for urban runoff. The objective of the bacteria source identification monitoring program was to attempt to determine the source of bacteria in the Las Vegas Valley stormwater from the urban watersheds.

### 2.3.2 Sampling Locations

Flamingo Wash was selected as the study area because it was representative of the urban area in the Las Vegas Valley and due to the ease of accessibility for sample collection. Potential monitoring sites along Flamingo Wash were investigated and reviewed. Site selection criteria included:

- Feasibility of sample collection during wet and dry weather periods.
- Travel time between sample sites.
- Size and land use characteristics of contributing drainage areas.
- Unique bacteria source locations.

Based on these criteria, eight sample locations were selected (**Figure 3**). **Table 3** lists the sample sites, distances and flow travel times between sites during dry weather flow (10 cfs) and typical storm flow (500 cfs) conditions.

**Table 3. Flamingo Wash Source Identification Sampling Site**

| Sampling Site | Cumulative Distance Upstream of Las Vegas Wash (ft) | Dry Weather Travel Time from Valley View Blvd. (min) | Wet Weather Travel Time from Valley View Blvd. (min) |
|---|---|---|---|
| Nellis Boulevard | 4,100 | 533 | 142 |
| Boulder Highway | 13,500 | 360 | 102 |
| McLeod Drive | 21,100 | 278 | 80 |
| Spencer Road | 29,650 | 156 | 47 |
| Cambridge Drive | 33,150 | 126 | 38 |
| Swenson Road | 34,400 | 112 | 35 |
| Koval Lane | 39,800 | 62 | 22 |
| Valley View Boulevard | 48,100 | 0 | 0 |

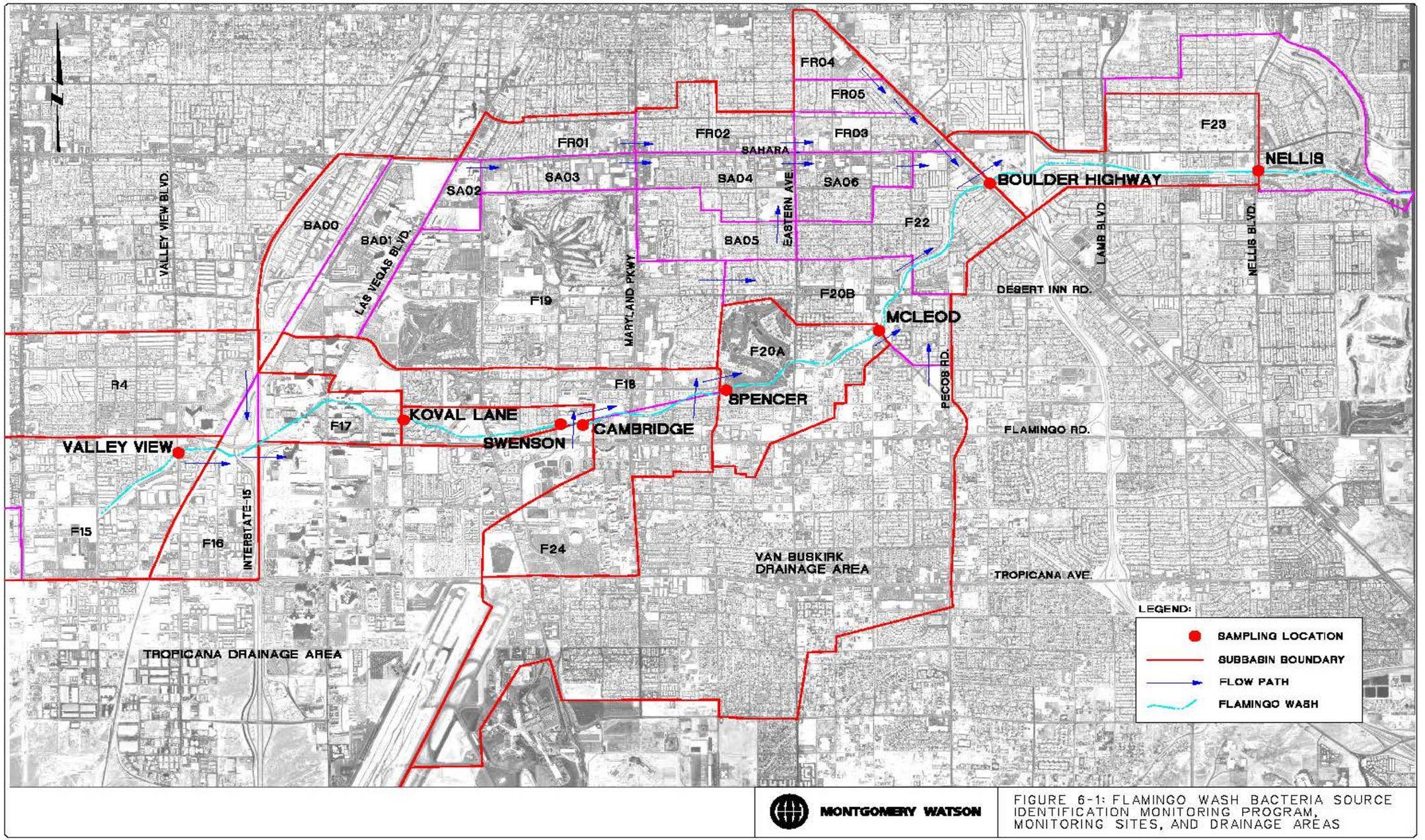
### 2.3.3 Constituents Analyzed

The constituents analyzed in the Bacteria Source Identification Monitoring Program were fecal coliform, fecal streptococcus, and E. coli bacteria. The wet weather monitoring program called for grab sampling for three storm events in Year 1. The dry weather monitoring program called for grab sampling during three dry weather periods in Year 1. A fourth dry weather sample was obtained when laboratory problems resulted in only partial results. Only one wet weather sample was obtained due to lack of representative storms during the permit year. **Table 4** summarizes when the dry and wet weather monitoring activities were conducted. The data summary and results of the program are discussed in Section 5.2.

**Table 4. Summary of 1998-1999 Bacteria Source Identification Monitoring Activities**

| Dates of Dry Weather Monitoring | Dates of Wet Weather Monitoring |
|---|---|
| November 9, 1998 | April 30, 1999 |
| January 26, 1999 | |
| April 20, 1999 (partial data) | |
| May 11, 1999 | |

**Figure 3 Bacteria Source Identification Locations**



# 3 Wet Weather Characterization Program Findings

## 3.1 Wet Weather Monitoring Summary

Monitoring results were complied and analyzed for the wet weather sites listed in Section 2.1.3. The monitoring date provided for each constituent below is representative of when the first monitoring results are provided to the end of 2010. Section 2.1.3 gives the time period that each site was monitored. **Table 5** provides the number of sample results from all sites combined per year for each constituent. For the constituents reported below, the results of the historical data are displayed in the following ways:

- The range of constituent concentrations (as a box plot) at sampling location arranged from upstream to downstream in the Las Vegas Valley. The purpose of these plots is to display spatial differences in wet weather data. The box plot represents the 75$^{th}$ percentile (top line, indicating 75% of results were at or below this value), the median (the middle line and number shown above the box plot) and the 25$^{th}$ percentile (the bottom line indicating 25% of results were at or below this value).
- The constituent concentration versus the growth in population in the Las Vegas Valley over the monitoring period. The purpose of these plots is to identify temporal trends in the wet weather data and determine if increasing urbanization (represented by population) appears to be contributing to higher constituent concentrations.

## Table 5. Wet Weather Number of Sample Results by Constituent for All Sites Combined Per Year

| Year | TSS | TDS | TP | Nitrate | Ortho-p | Lead | Copper | Zinc | Dissolved Lead | Dissolved Copper | Dissolved Zinc | Selenium | Fecal Coliform | Fecal Strep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1992 | 11 | 11 | 11 | 11 | 10 | 11 | 11 | 11 | 0 | 0 | 0 | 0 | 10 | 10 |
| 1993 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 0 | 0 | 0 | 11 | 13 | 13 |
| 1994 | 18 | 18 | 18 | 18 | 15 | 18 | 18 | 18 | 0 | 0 | 0 | 18 | 11 | 11 |
| 1995 | 13 | 13 | 8 | 13 | 13 | 13 | 13 | 13 | 0 | 0 | 0 | 13 | 0 | |
| 1996 | 10 | 10 | 10 | 9 | 10 | 7 | 10 | 10 | 0 | 0 | 0 | 0 | 10 | 10 |
| 1997 | 10 | 8 | 10 | 10 | 10 | 10 | 10 | 10 | 0 | 0 | 0 | 0 | 10 | 10 |
| 1998 | 10 | 8 | 10 | 10 | 8 | 10 | 10 | 10 | 2 | 2 | 2 | 0 | 10 | 10 |
| 1999 | 5 | 3 | 5 | 5 | 0 | 11 | 11 | 11 | 5 | 5 | 5 | 0 | 3 | 3 |
| 2000 | 7 | 5 | 7 | 7 | 0 | 7 | 7 | 7 | 7 | 7 | 7 | 0 | 5 | 5 |
| 2001 | 4 | 2 | 4 | 4 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 0 | 3 | 3 |
| 2002 | 3 | 2 | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 2 |
| 2003 | 21 | 21 | 15 | 21 | 12 | 22 | 22 | 22 | 21 | 21 | 21 | 10 | 22 | 22 |
| 2004 | 11 | 11 | 12 | 12 | 10 | 12 | 12 | 10 | 11 | 11 | 10 | 12 | 12 | 12 |
| 2005 | 6 | 6 | 6 | 5 | 6 | 4 | 5 | 5 | 6 | 6 | 6 | 5 | 6 | 6 |
| 2006 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 |
| 2007 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 2008 | 7 | 7 | 7 | 7 | 6 | 7 | 7 | 7 | 6 | 6 | 6 | 7 | 6 | 6 |
| 2009 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 2010 | 12 | 12 | 12 | 12 | 9 | 12 | 12 | 11 | 12 | 12 | 12 | 8 | 5 | 6 |
| Total | 170 | 159 | 161 | 170 | 131 | 174 | 178 | 175 | 87 | 87 | 86 | 94 | 138 | 139 |

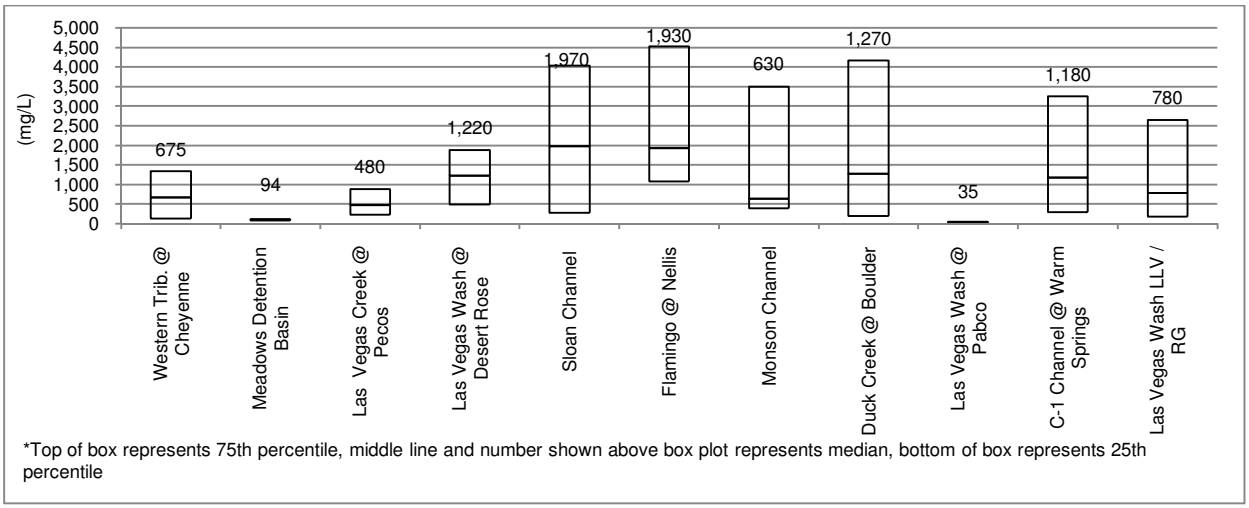
### 3.1.1 Total Suspended Solids, Total Dissolved Solids, and Surfactants

Wet weather data from 1992-2010 was analyzed for total suspended solids, total dissolved solids and surfactants **Table 6** represents the 1992-2010 median for all sites combined and historic range of the constituents. **Figures 4 – 13** display the data as stated in Section 3.1. The data does not show an increase or decrease in trending from upstream to downstream. For TSS, Sloan Channel and Flamingo Wash @ Nellis each had a median over 1,900 mg/L. All other sites were had a median below 1,300 mg/L. TDS is a function of the interactions between groundwater and subsurface minerals. High TDS concentrations in surface water indicate significant contributions from shallow groundwater aquifers. For TDS Duck Creek @ Boulder was the only site to have a median over 1,000 mg/L, at 2,290 mg/L. Las Vegas Creek @ Pecos, one of the most urbanized sites, had the third lowest TSS median and the fourth lowest TDS median of all sites. Higher TDS concentrations at sampling stations lower in the Valley indicate the influence of the shallow groundwater seepage on surface water quality.

**Table 6. Wet Weather Total Suspended Solids, Total Dissolved Solids, and Surfactants**

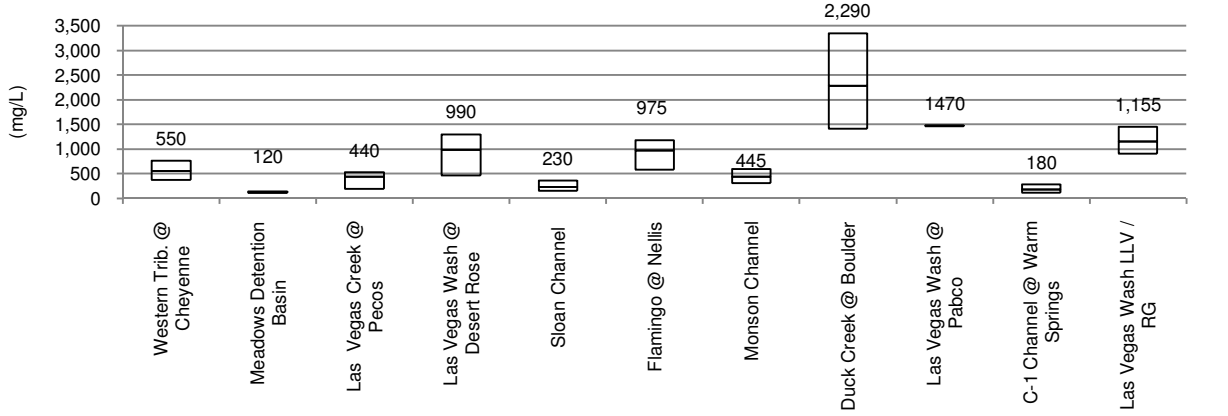
| Constituent | Median Concentration (mg/L) | Historical Range (mg/L) |
|---|---|---|
| TSS | 920 | 10 – 26, 300 |
| TDS | 635 | 47 – 5,210 |
| Surfactants | 0.015 | 0.005 – 2.18 |

**Figure 4. Wet Weather Total Suspended Solids vs. Location 1992 - 2010**



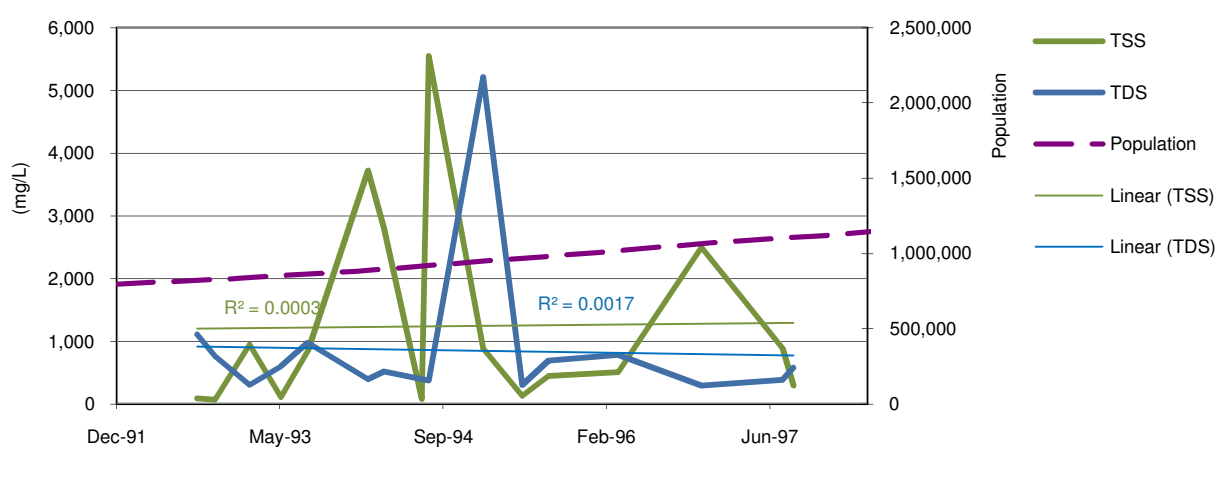

*Top of box represents 75th percentile, middle line and number shown above box plot represents median, bottom of box represents 25th percentile

## Figure 5. Wet Weather Total Dissolved Solids vs Location 1992-2010

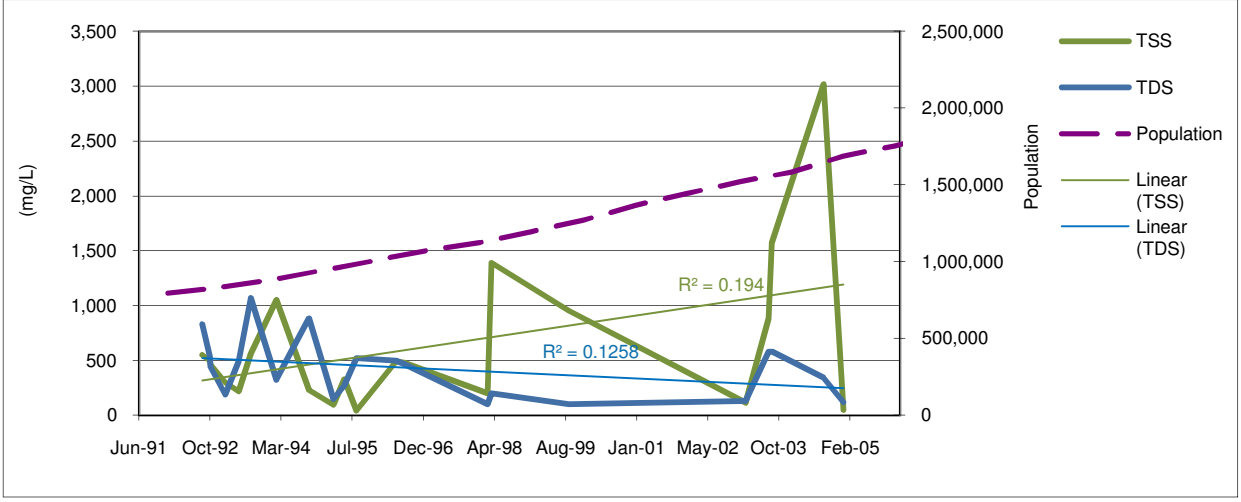



*Top of box represents 75th percentile, middle line and number shown above box plot represents median, bottom of box represents 25th percentile.

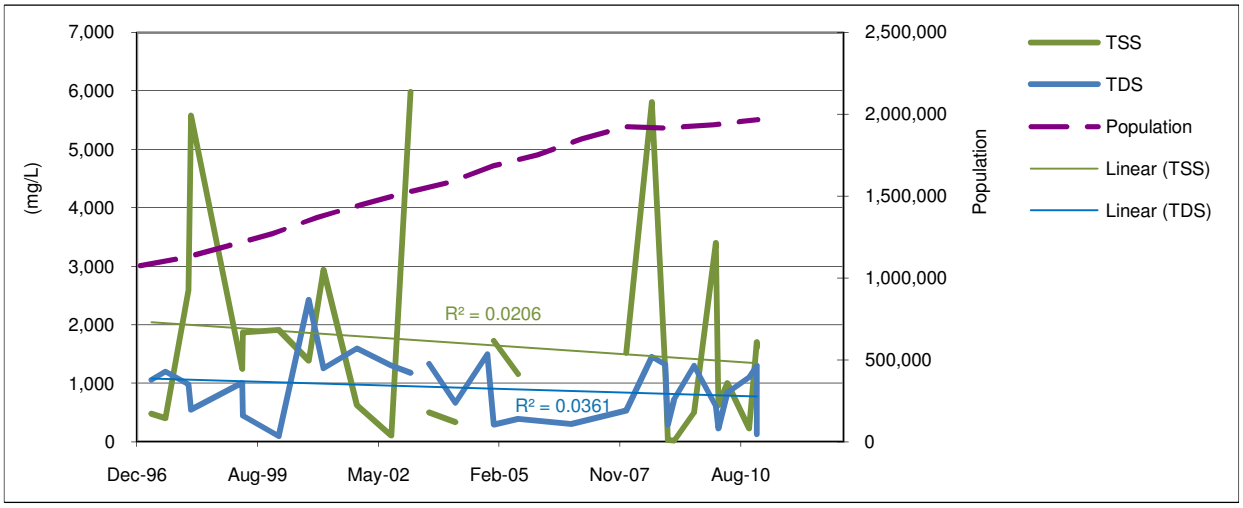
## Figure 6. Western Tributary @ Cheyenne TDS and TSS 1992-1997



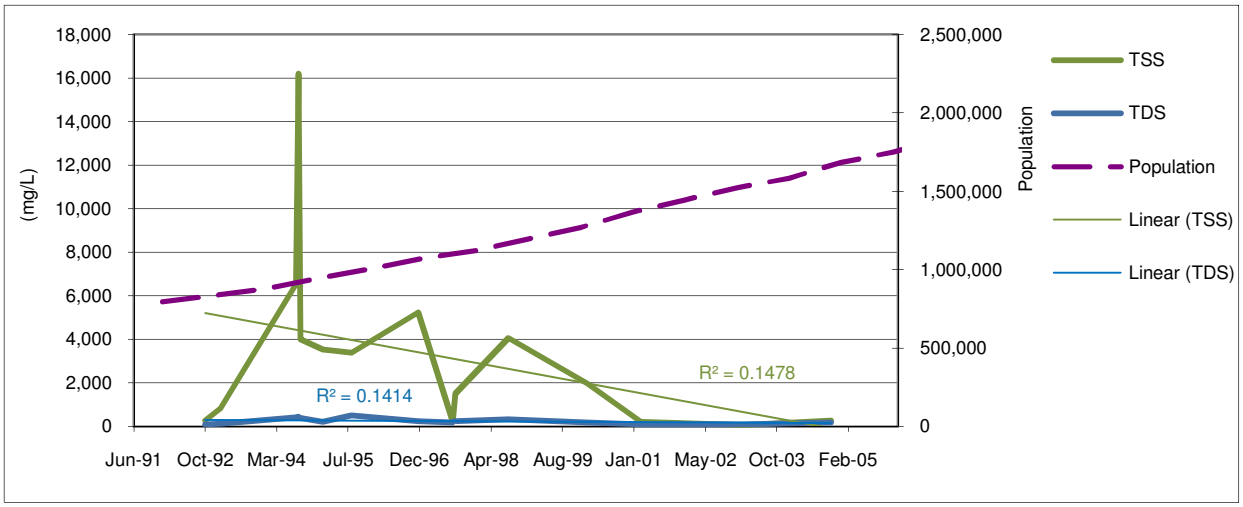

## Figure 7. Las Vegas Creek @ Pecos TDS and TSS 1992-2005



## Figure 8. Las Vegas Wash @ Desert Rose TDS and TSS 1997-2010




## Figure 9. Sloan Channel TDS and TSS 1992-2004




## Figure 10. Flamingo Wash TDS and TSS 1992 - 2004

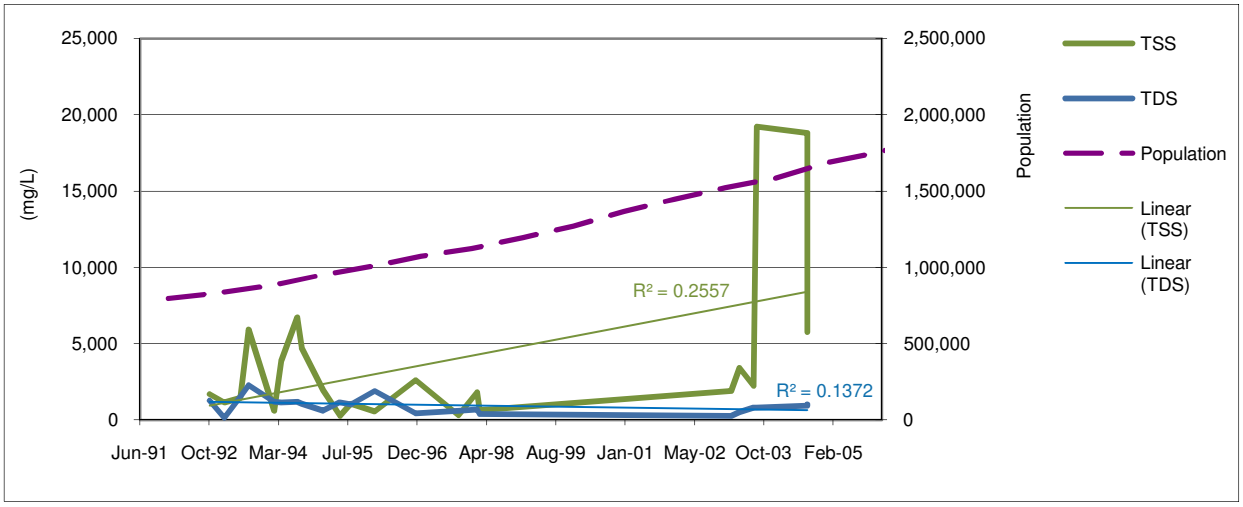


**Figure 11. Duck Creek @ Boulder Hwy TDS and TSS 1992-2004**

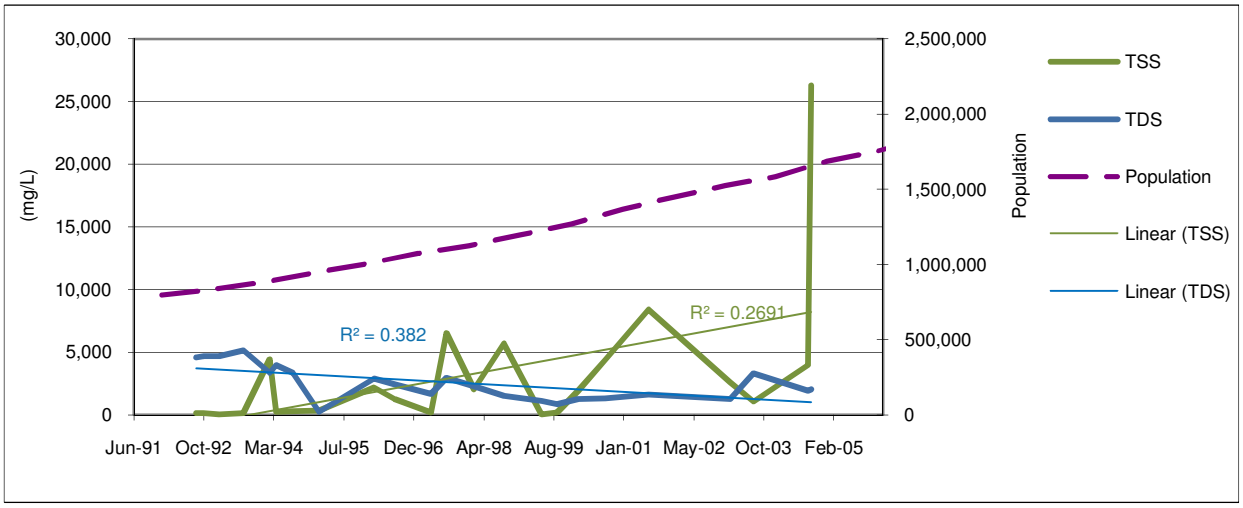



**Figure 12. C-1 Channel TDS and TSS 1992-2004**

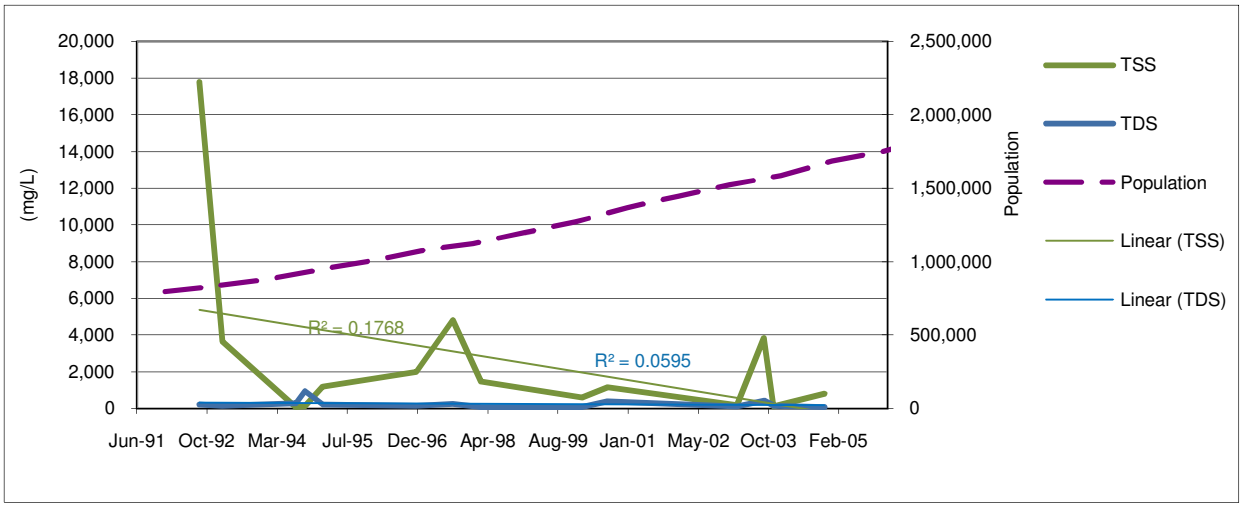
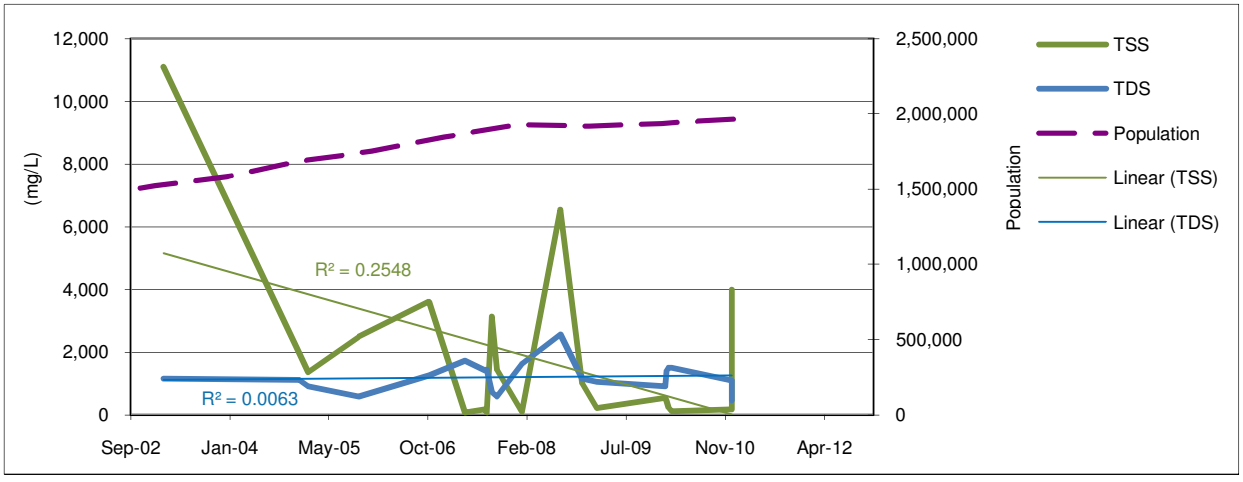



**Figure 13. LVW Below Lake Las Vegas / Rainbow Gardens TDS and TSS 2003-2010**



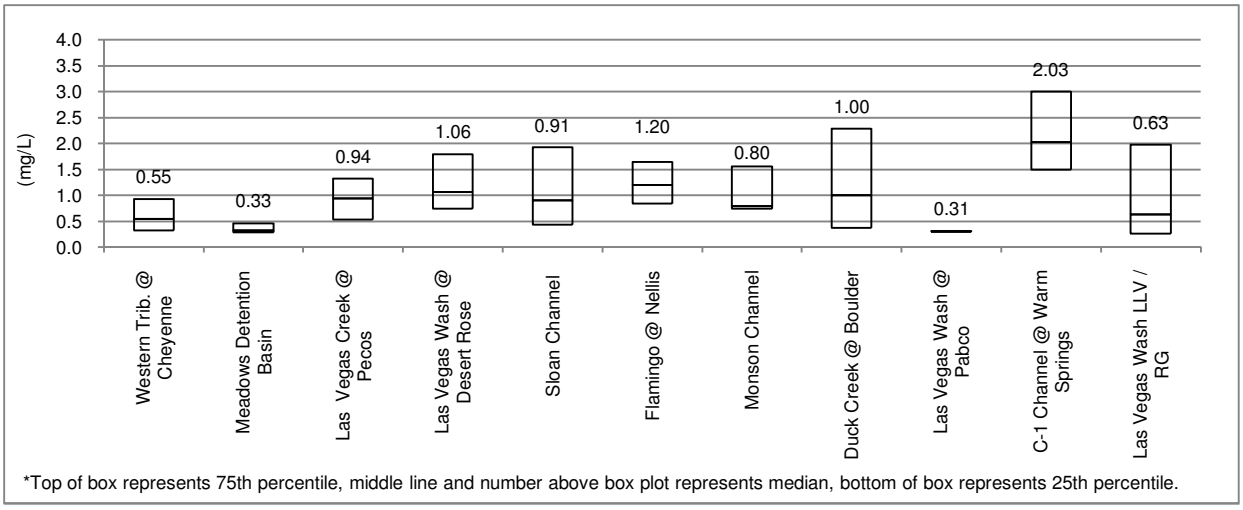
### 3.1.2 Nutrients

Wet weather data from 1992-2010 was analyzed for total phosphorus as P, nitrate as N and orthophosphate as P. **Table 7** represents the 1992-2010 median for all sites combined and historic range of the constituent. **Figures 14 –24** display the data as stated in Section 3.1. The data shows a modest increasing trend for nitrogen and phosphorus from upstream to downstream. This may be due to effects of urbanization. C-1 Channel had the highest median for total phosphorus as P and Orthophosphate as P at 0.63 mg/L and 0.43 mg/L respectively. Las Vegas Wash / Rainbow Gardens had the highest Nitrate as N median at 7.6 mg/L.

**Table 7. Wet Weather Nutrients**

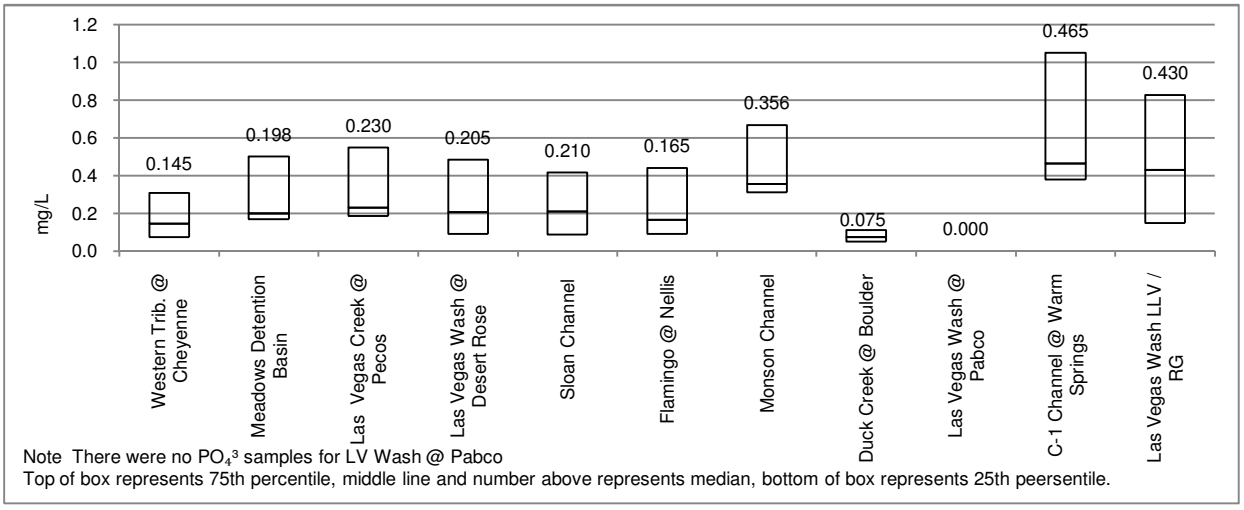
| Constituent | Median Concentration (mg/L) | Historical Range (mg/L) |
|---|---|---|
| Total Phosphorus as P | 0.93 | 0.05 – 7.5 |
| Orthophosphate as P | 0.21 | 0.01 – 6.5 |
| Nitrate as N | 1.80 | 0.1 – 165.0 |

**Figure 14. Wet Weather Total Phosphorus as P vs Location 1992-2010**



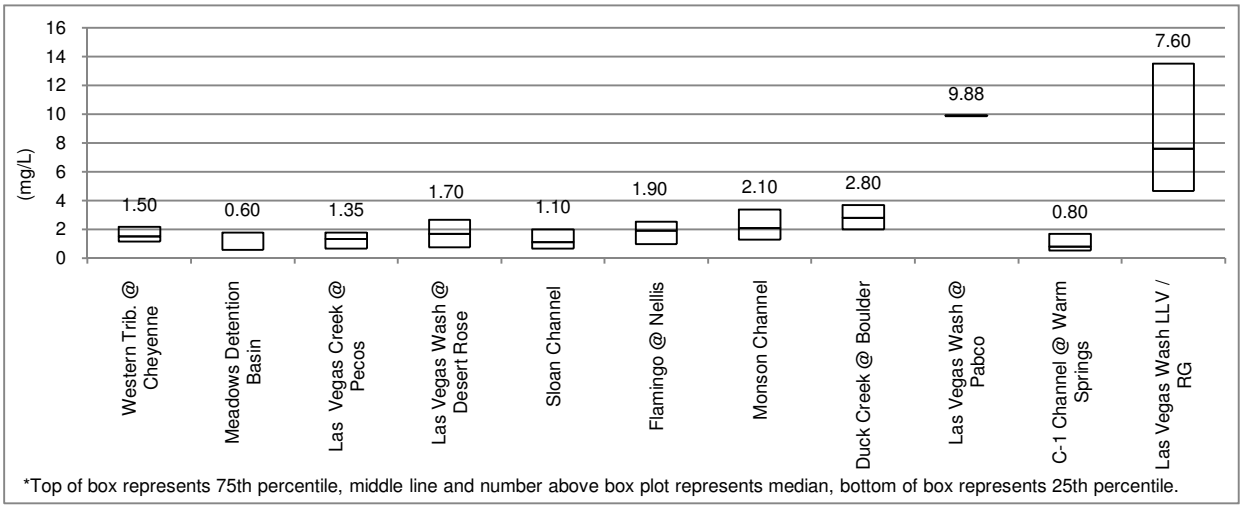

*Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 15. Wet Weather Orthophosphate as P vs Location 1992-2010



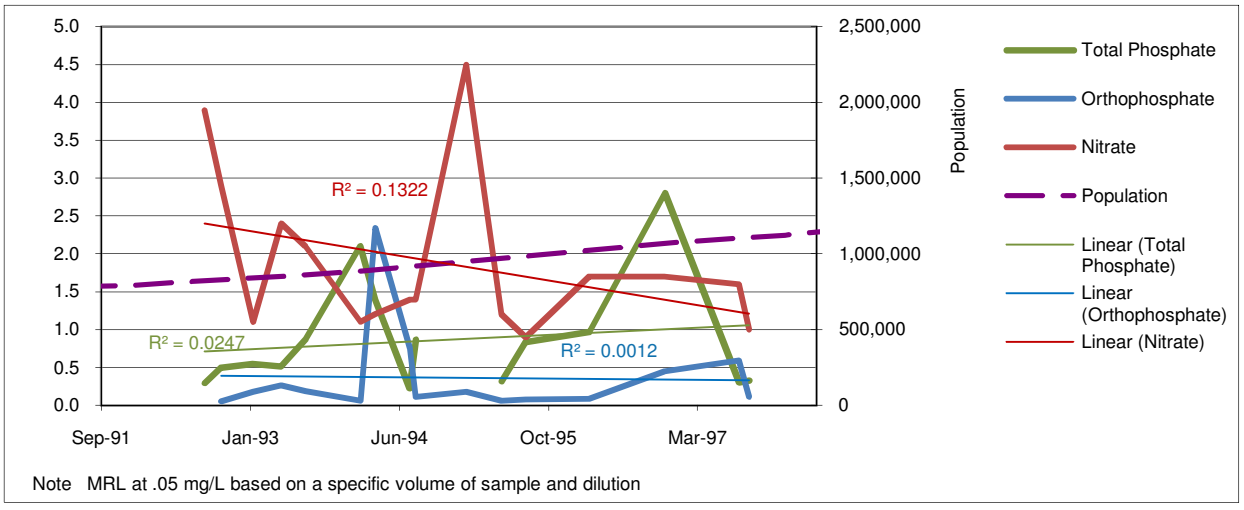

Note There were no $PO_4^3$ samples for LV Wash @ Pabco
Top of box represents 75th percentile, middle line and number above represents median, bottom of box represents 25th peersentile.

## Figure 16. Wet Weather Nitrate as N vs. Location 1992-2010



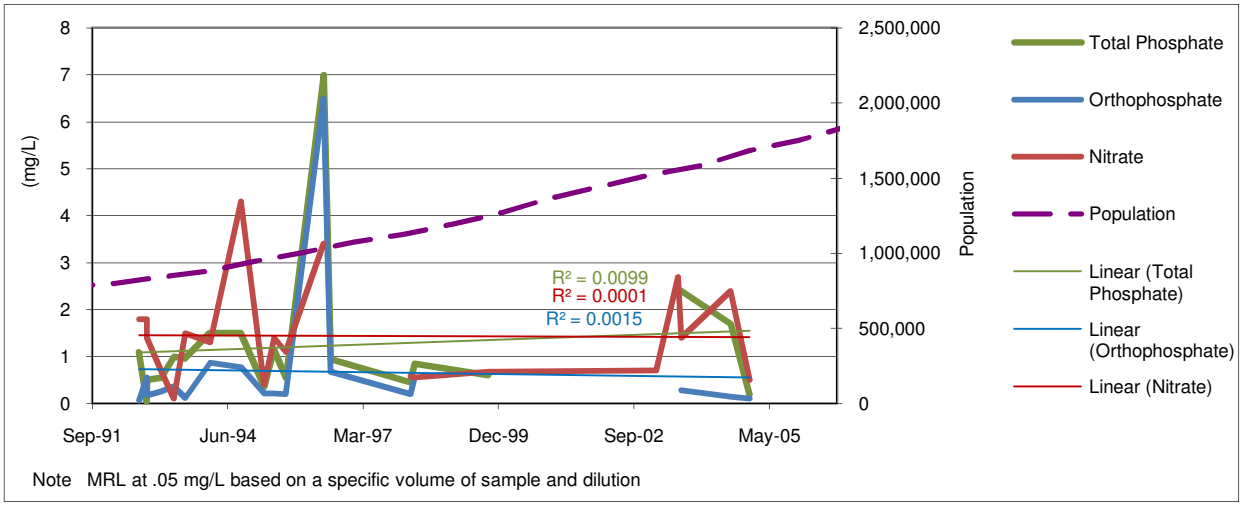

*Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 17. Western Tributary @ Cheyenne Nutrients 1992-1997



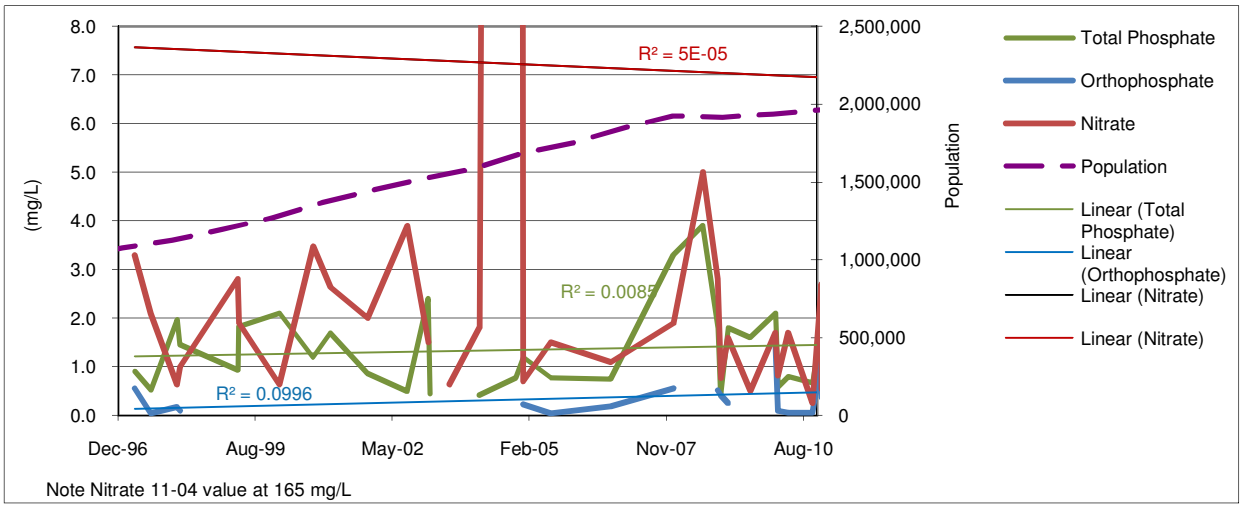

Note MRL at .05 mg/L based on a specific volume of sample and dilution

## Figure 18. Las Vegas Creek @ Pecos Nutrients 1992-2005



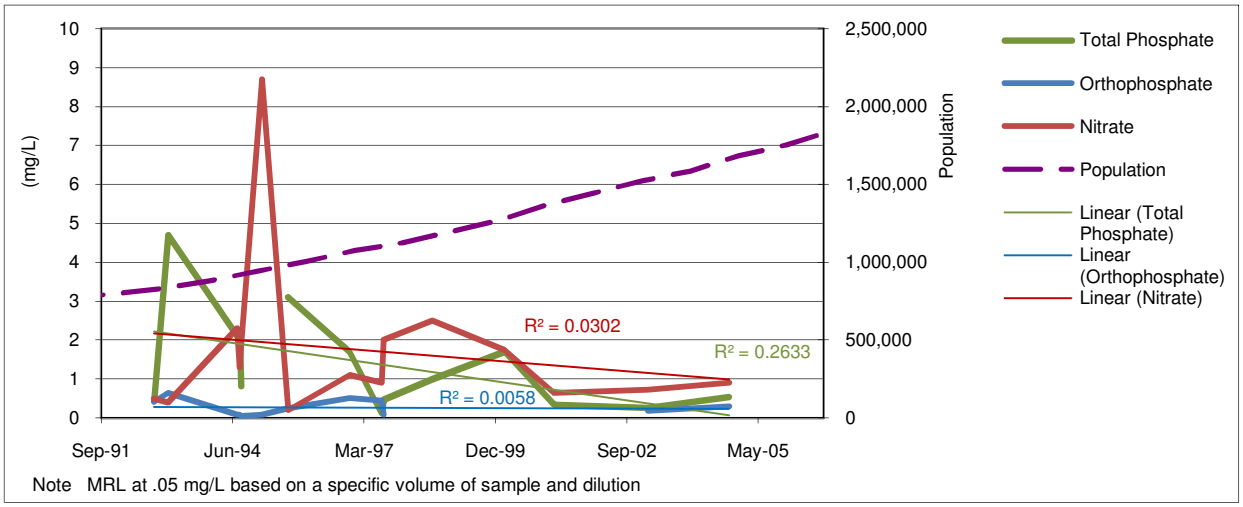

Note MRL at .05 mg/L based on a specific volume of sample and dilution

## Figure 19. Las Vegas Wash @ Desert Rose Nutrients 1997-2010



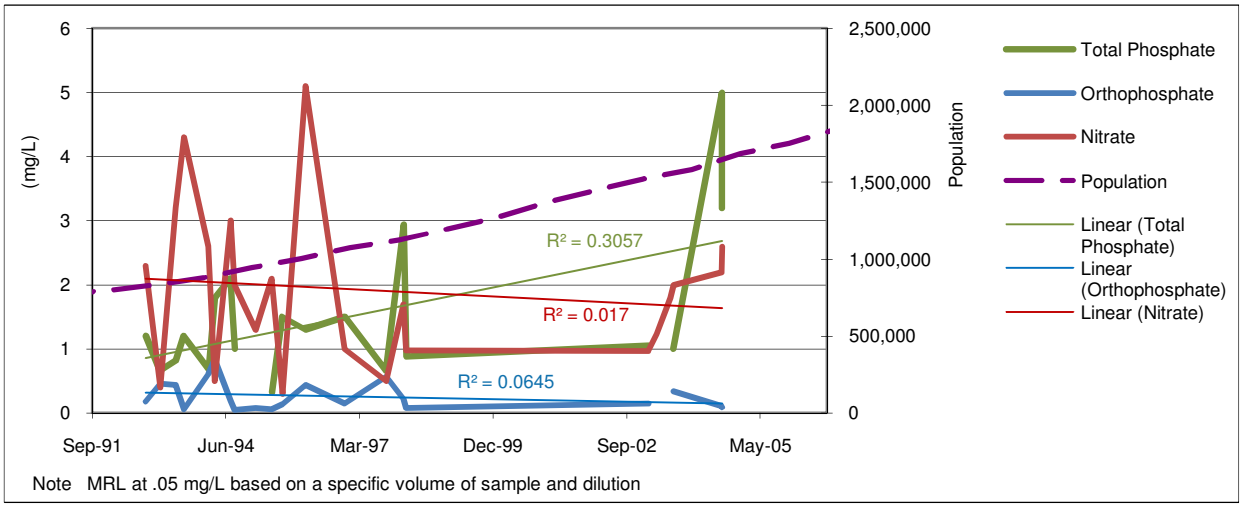

Note Nitrate 11-04 value at 165 mg/L

## Figure 20. Sloan Channel Nutrients 1992-2004

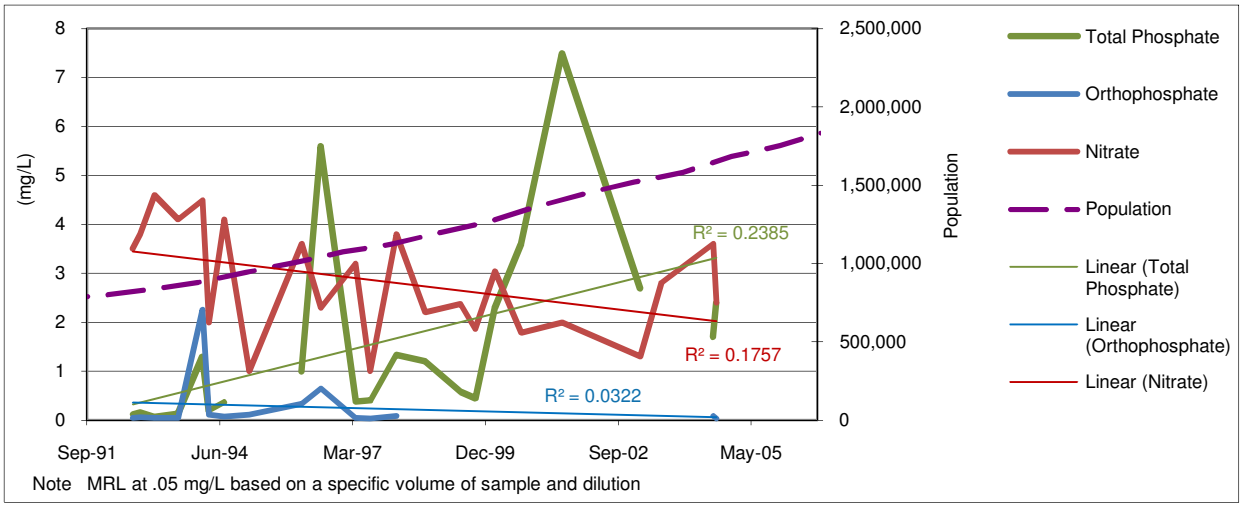



Note MRL at .05 mg/L based on a specific volume of sample and dilution

## Figure 21. Flamingo Wash Nutrients 1992-2004




## Figure 22. Duck Creek @ Boulder Hwy Nutrients 1992-2004




## Figure 23. C-1 Channel Nutrients 1992-2004

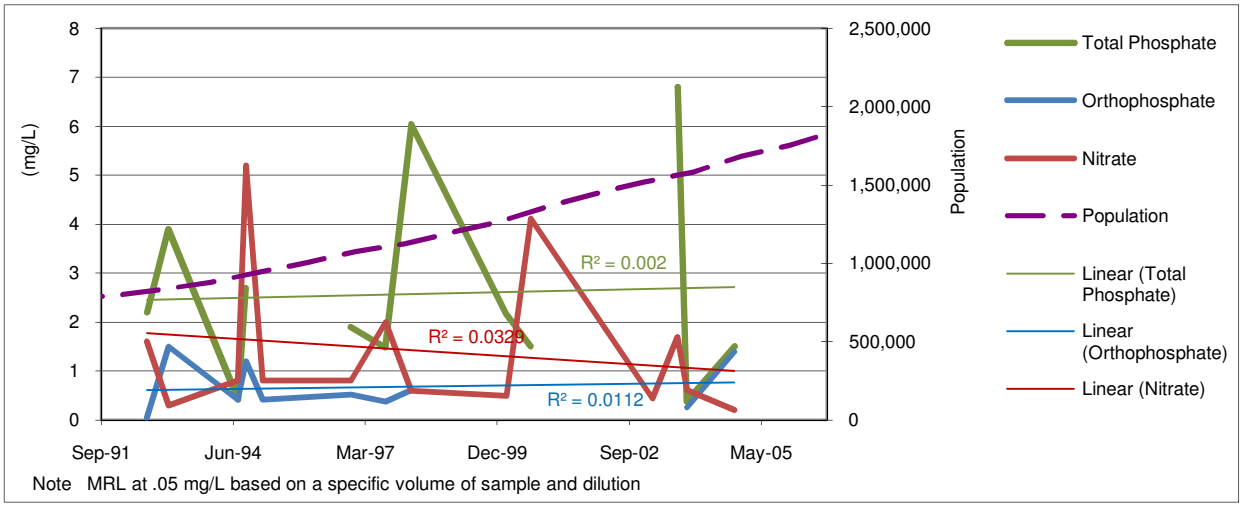
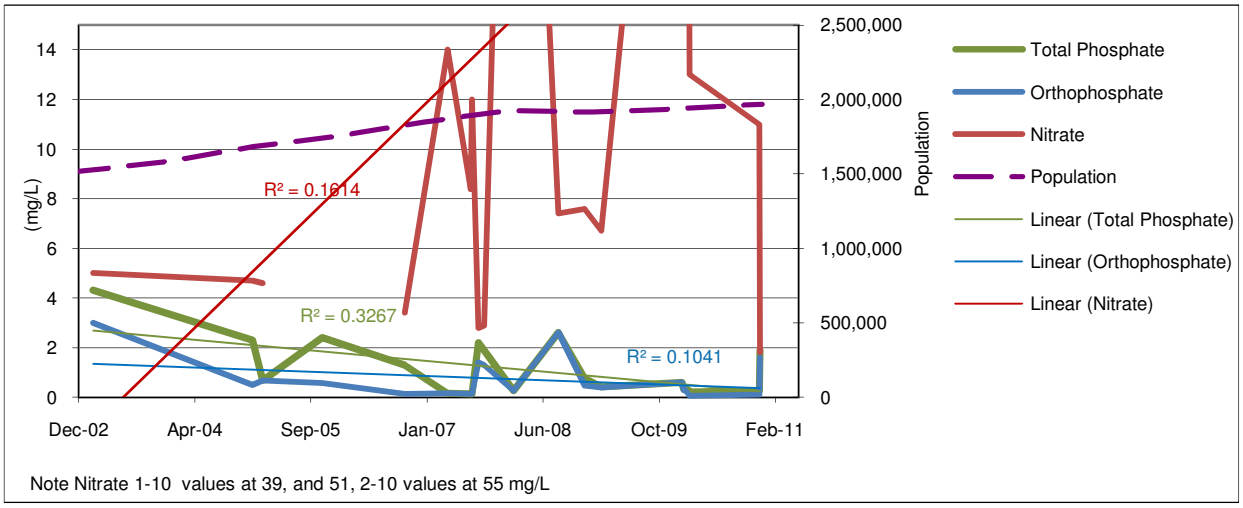


**Figure 24. LVW Below Lake Las Vegas / Rainbow Gardens Nutrients 2003-2010**



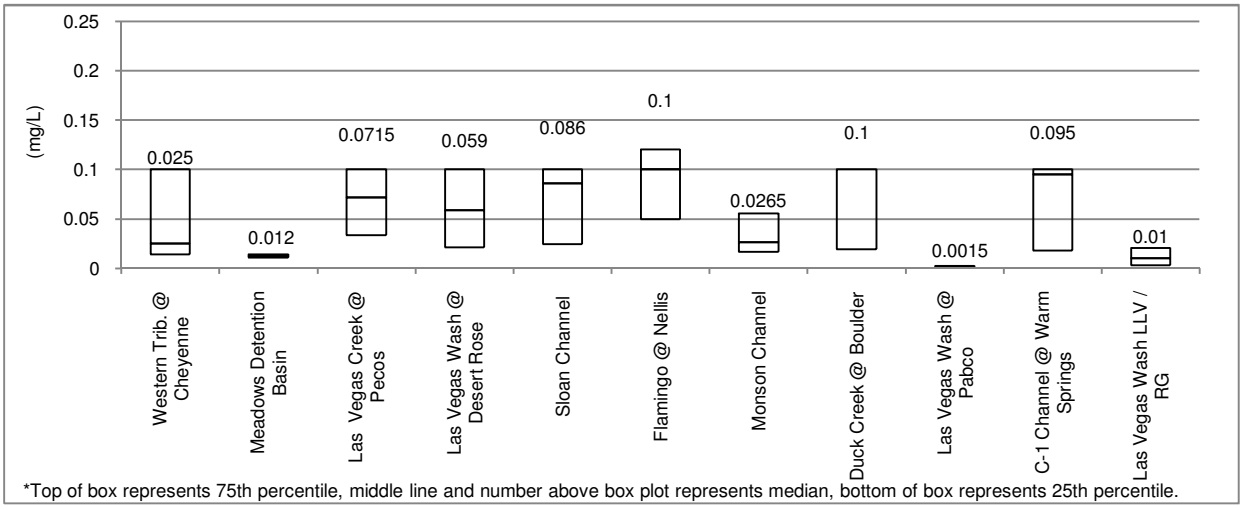

### 3.1.3 Metals

Wet weather data from 1992-2010 was analyzed for total lead, total copper, total zinc, dissolved lead, dissolved copper, dissolved zinc, and selenium. **Table 8** represents the 1992-2010 median for all sites combined and historic range of the constituent. **Figures 25-39** display the data as stated in Section 3.1. The data does not show an increase or decrease in trending from upstream to downstream over time. Flamingo Wash @ Nellis and Duck Creek @ Boulder both had medians at 1 mg/L. Las Vegas Wash @ Pabco had the lowest concentrations for total lead, total copper, and total zinc, however this is most likely influenced by the limited time period that this site was sampled. Las Vegas Wash @ Pecos, Sloan Channel, Flamingo Wash @ Nellis, Duck Creek @ Boulder and C-1 Channel all had medians at 0.1 mg/L for dissolved lead. All other sites were lower. Monson Channel had the highest medians for dissolved copper, dissolved zinc, and selenium at 0.02225 mg/L, 0.0665 and 0.02 respectively.

**Table 8. Wet Weather Metals**

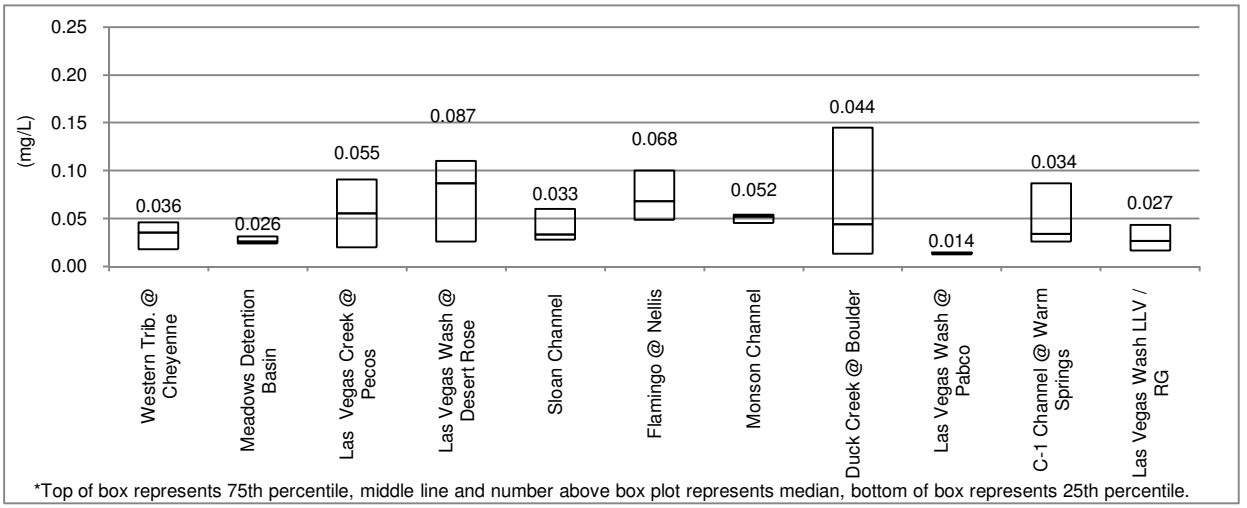
| Constituent | Median Concentration (mg/L) | Historical Range (mg/L) |
|---|---|---|
| Total Lead | 0.05 | 0.0005 - 0.41 |
| Total Copper | 0.044 | 0.003 - 0.69 |
| Total Zinc | 0.21 | 0.01 - 4.2 |
| Dissolved Lead | 0.010 | 0.0021 - 0.53 |
| Dissolved Copper | 0.02 | 0.001 - 0.5 |
| Dissolved Zinc | 0.02 | 0.0035 - 1.9 |
| Selenium | 0.0058 | 0.0010- 0.15 |

## Figure 25. Wet Weather Total Lead vs Location 1992-2010



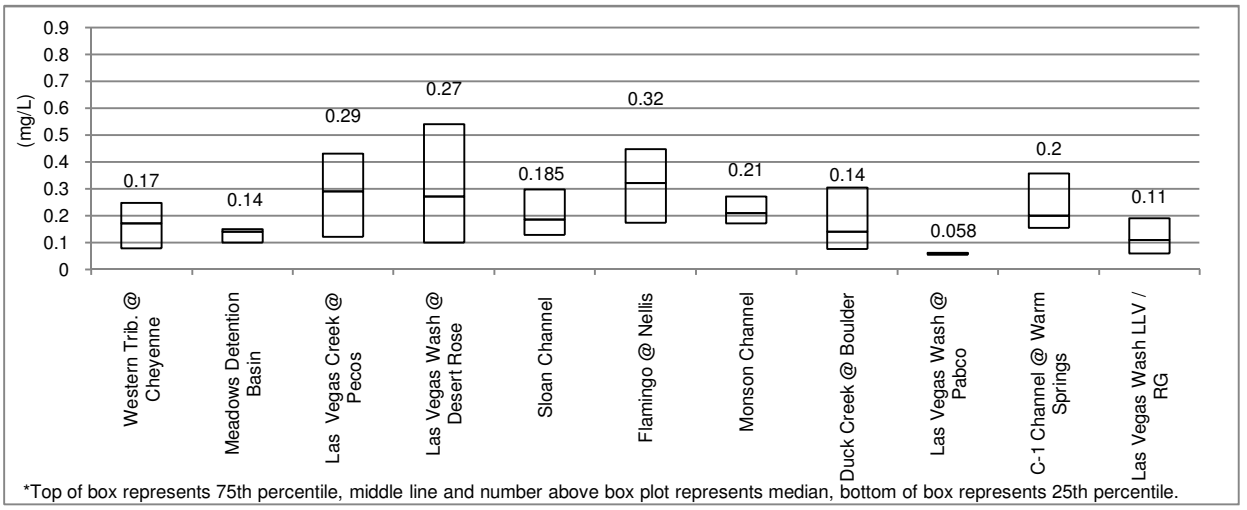

*Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 26. Wet Weather Total Copper vs Location 1992-2010



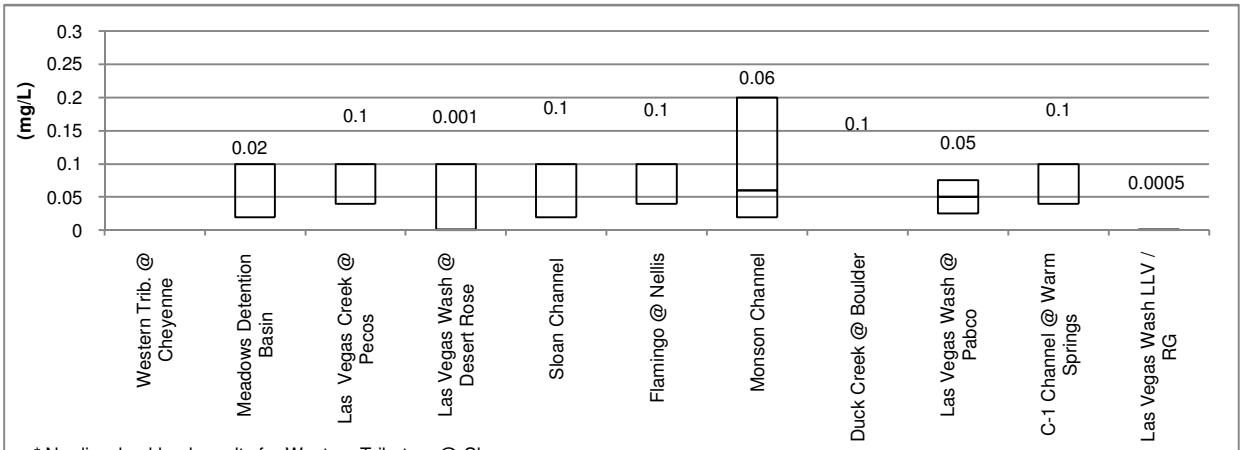

*Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 27. Wet Weather Total Zinc vs Location 1992-2010



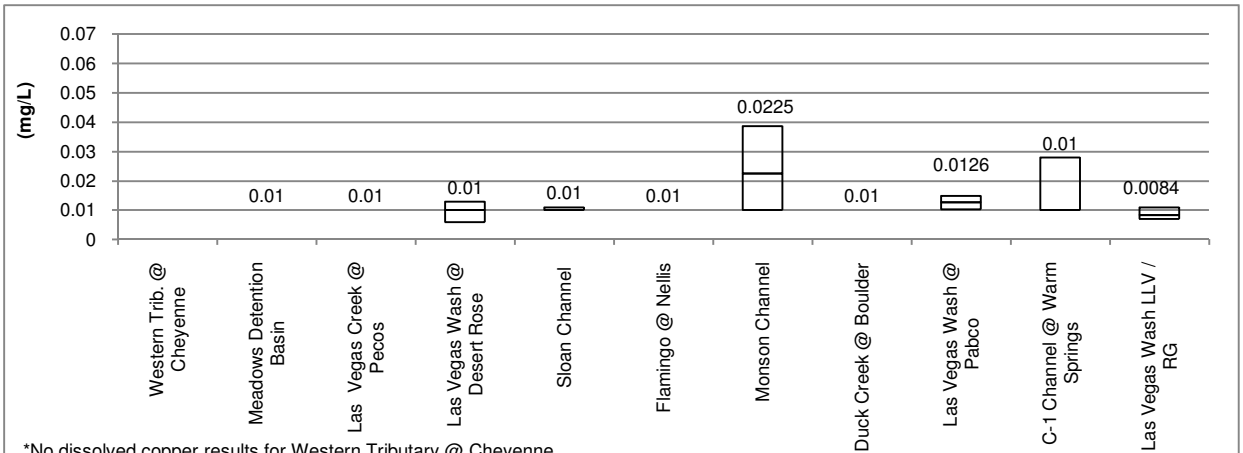

*Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 28. Wet Weather Dissolved Lead vs Location 1992-2010



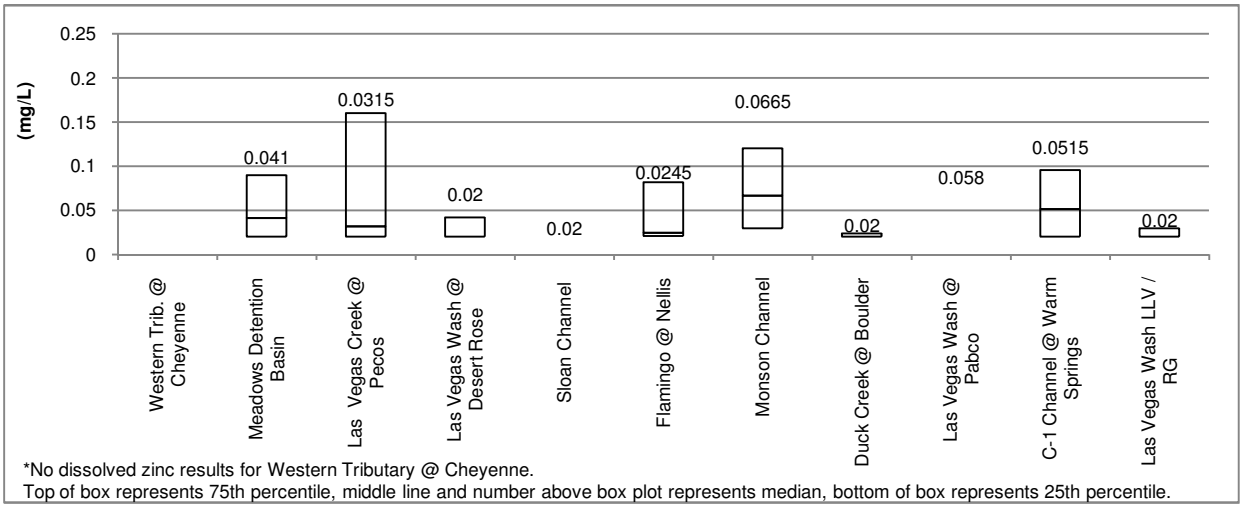

* No dissolved lead results for Western Tributary @ Cheyenne
Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 29. Wet Weather Total Dissolved Copper vs Location 1992-2010



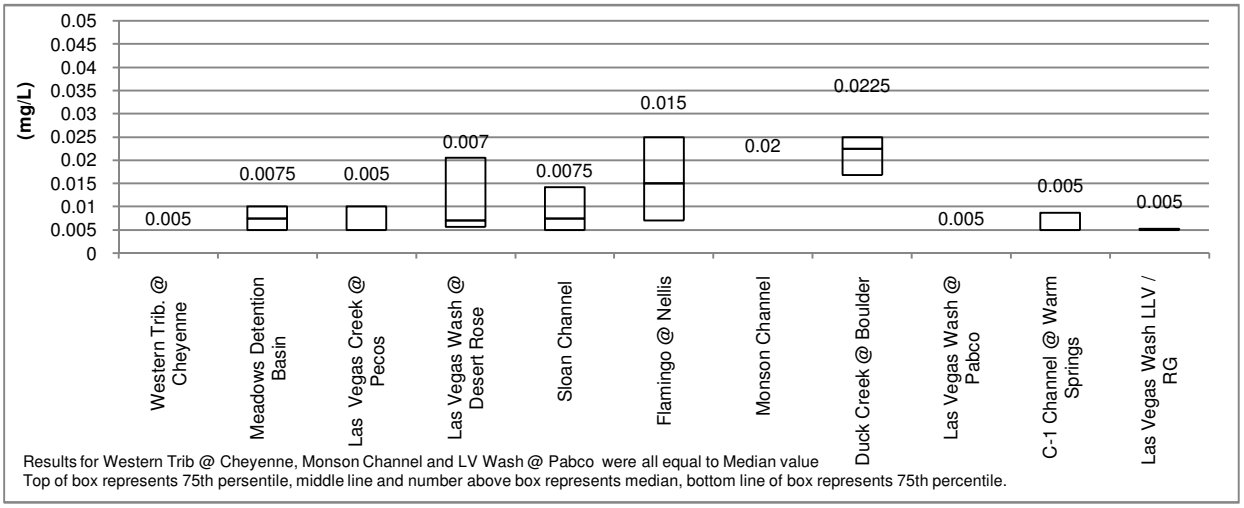

*No dissolved copper results for Western Tributary @ Cheyenne.
Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 30. Wet Weather Dissolved Zinc vs Location 1992-2010



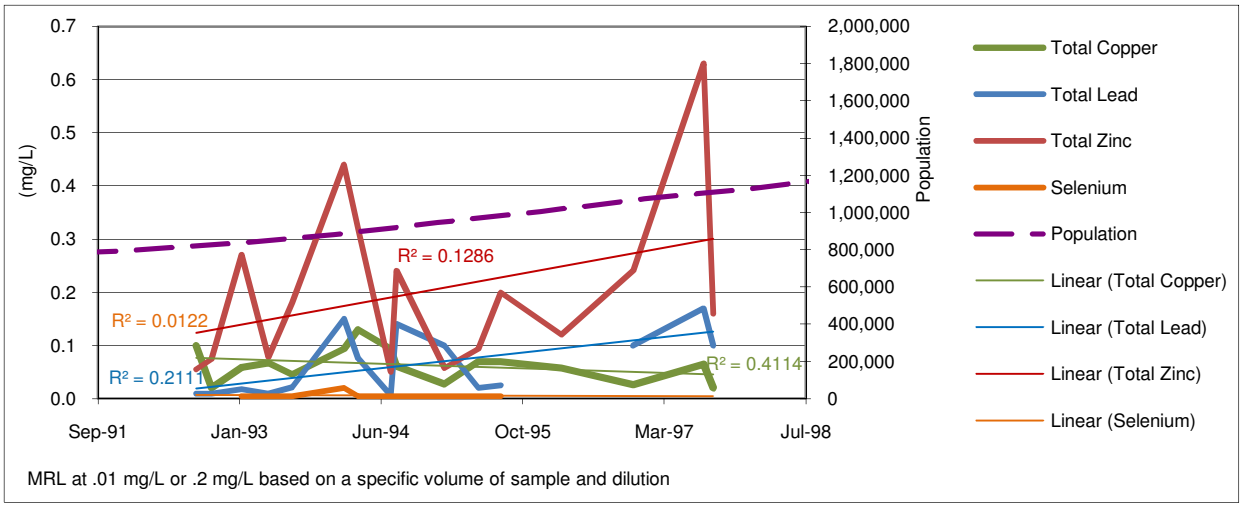

*No dissolved zinc results for Western Tributary @ Cheyenne.
Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 31. Wet Weather Selenium vs Location 1992-2010



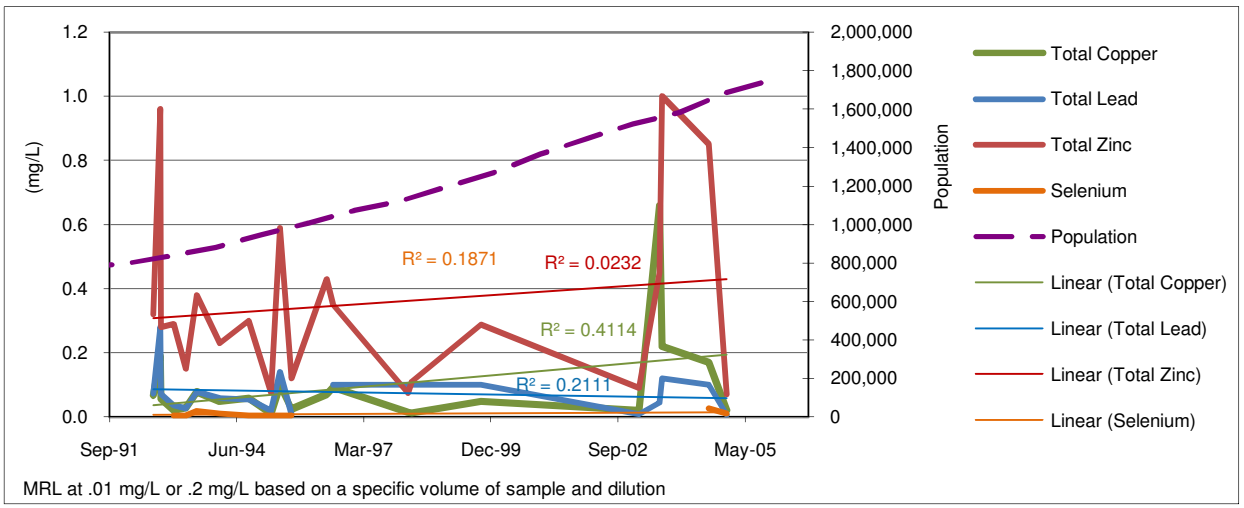

Results for Western Trib @ Cheyenne, Monson Channel and LV Wash @ Pabco were all equal to Median value
Top of box represents 75th persentile, middle line and number above box represents median, bottom line of box represents 75th percentile.

## Figure 32. Western Tributary @ Cheyenne Metals 1992-1997



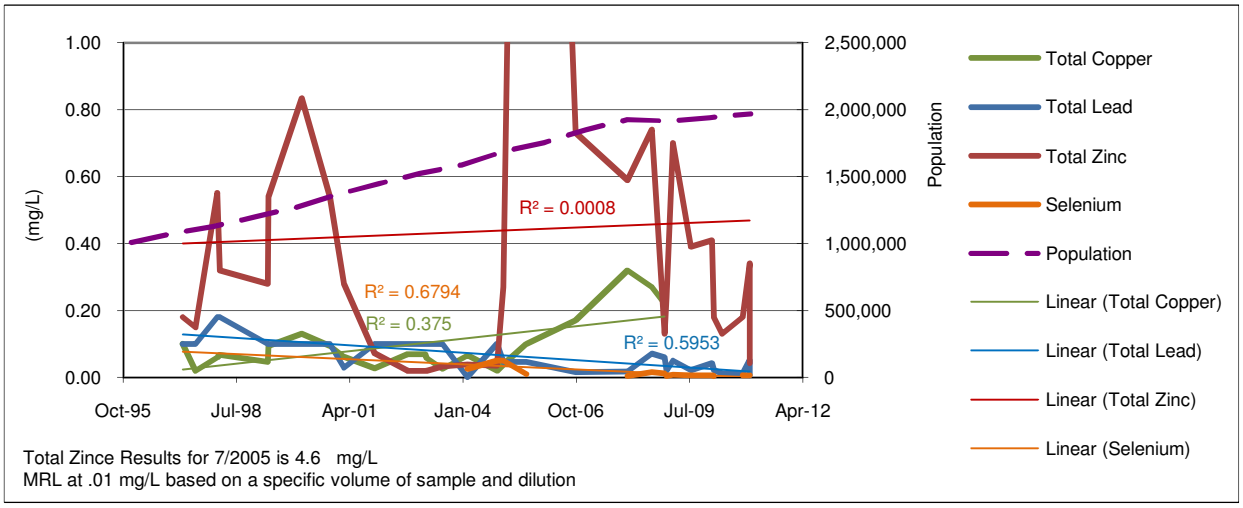

MRL at .01 mg/L or .2 mg/L based on a specific volume of sample and dilution

## Figure 33. Las Vegas Creek @ Pecos Metals 1992-2008



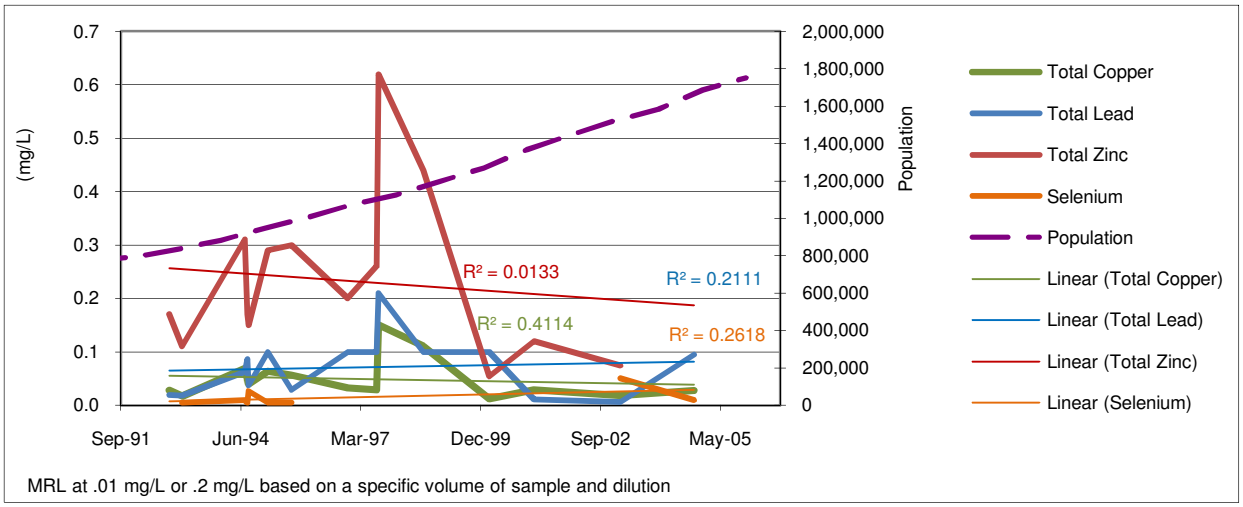

MRL at .01 mg/L or .2 mg/L based on a specific volume of sample and dilution

## Figure 34. Las Vegas Wash @ Desert Rose Metals 1997-2010



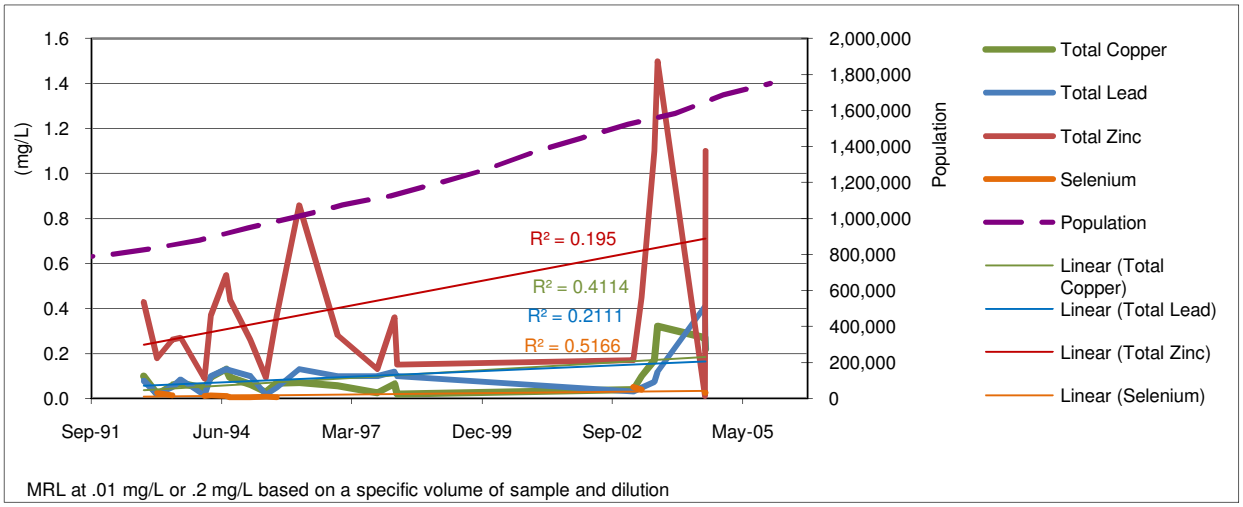

Total Zince Results for 7/2005 is 4.6 mg/L
MRL at .01 mg/L based on a specific volume of sample and dilution

## Figure 35. Sloan Channel Metals 1992-2004



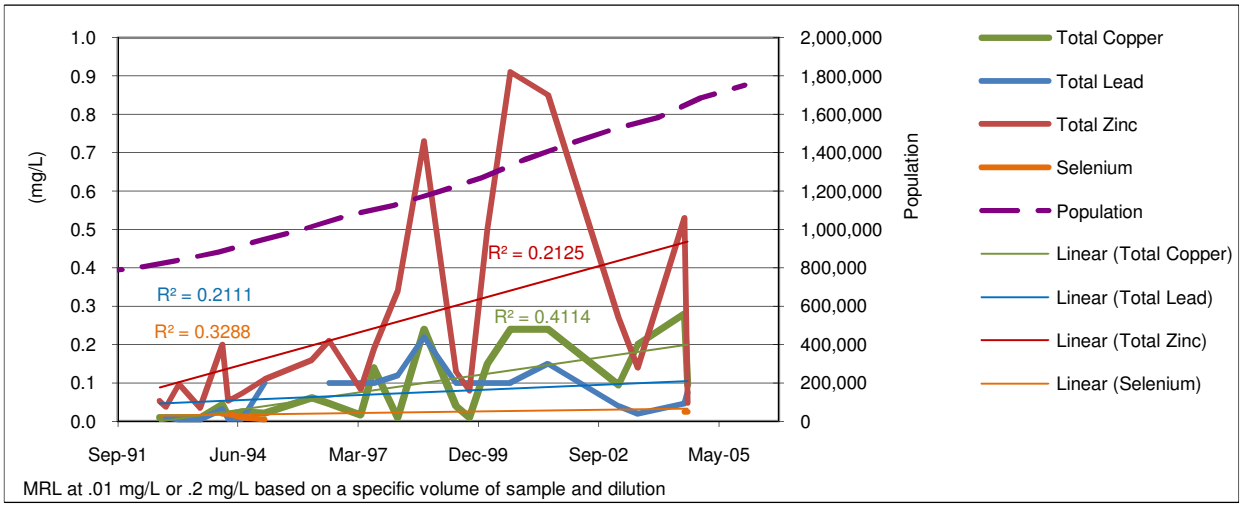

MRL at .01 mg/L or .2 mg/L based on a specific volume of sample and dilution

## Figure 36. Flamingo Wash Metals 1992-2004



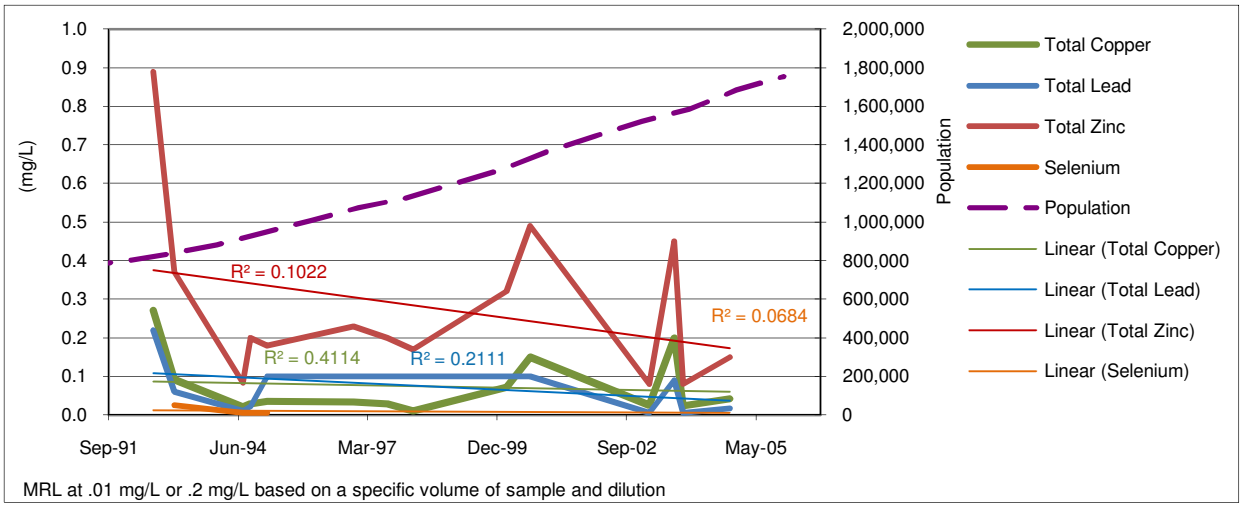

MRL at .01 mg/L or .2 mg/L based on a specific volume of sample and dilution

## Figure 37. Duck Creek @ Boulder Hwy Metals 1992-2004



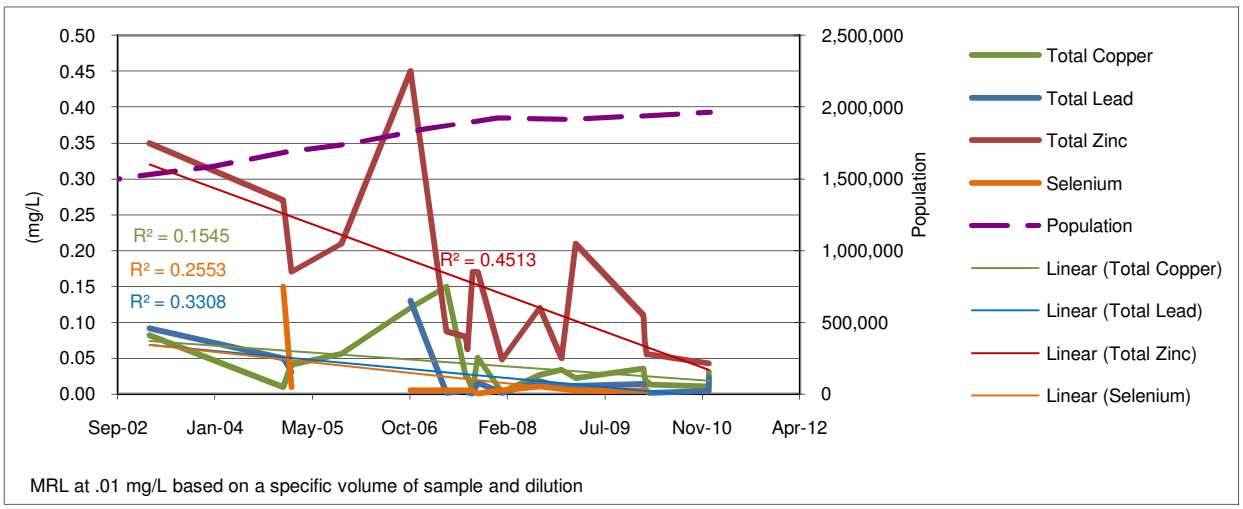

MRL at .01 mg/L or .2 mg/L based on a specific volume of sample and dilution

## Figure 38. C-1 Channel Metals 1992-2004




MRL at .01 mg/L or .2 mg/L based on a specific volume of sample and dilution

## Figure 39. LVW Below Lake Las Vegas / Rainbow Gardens Metals 2003-2010




MRL at .01 mg/L based on a specific volume of sample and dilution

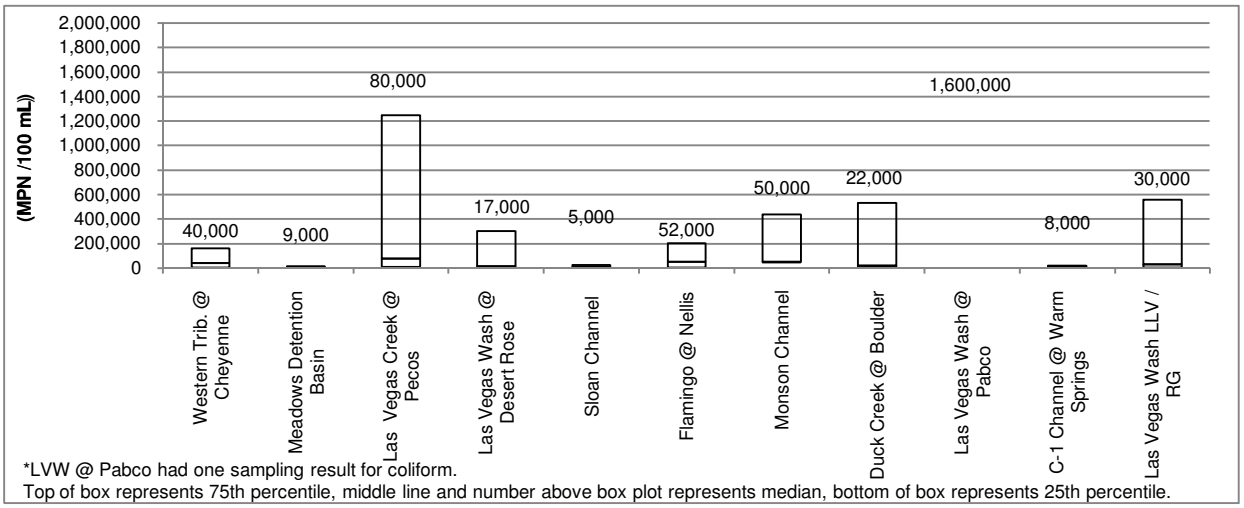
### 3.1.4 Bacteria

Wet weather data from 1992-2010 was analyzed for coliform bacteria and fecal streptococci. **Table 9** represents the 1992-2010 median for all sites combined and historic range of the constituent. **Figures 40-49** display the data as stated in Section 3.1. There was no clear increasing or decreasing trend from upstream to downstream or over time in bacteria. Bacteria concentrations throughout Las Vegas Valley are high, due in part to high air and water temperatures, and difficulty in meeting 6-hour hold times for laboratory analyses. Las Vegas Creek @ Pecos had the highest median at 80,000 MPN/100 mL for coliform bacteria whereas Monson Channel had the highest median at 190,000 MPN/100 mL for Fecal Streptococci.

**Table 9. Wet Weather Bacteria**

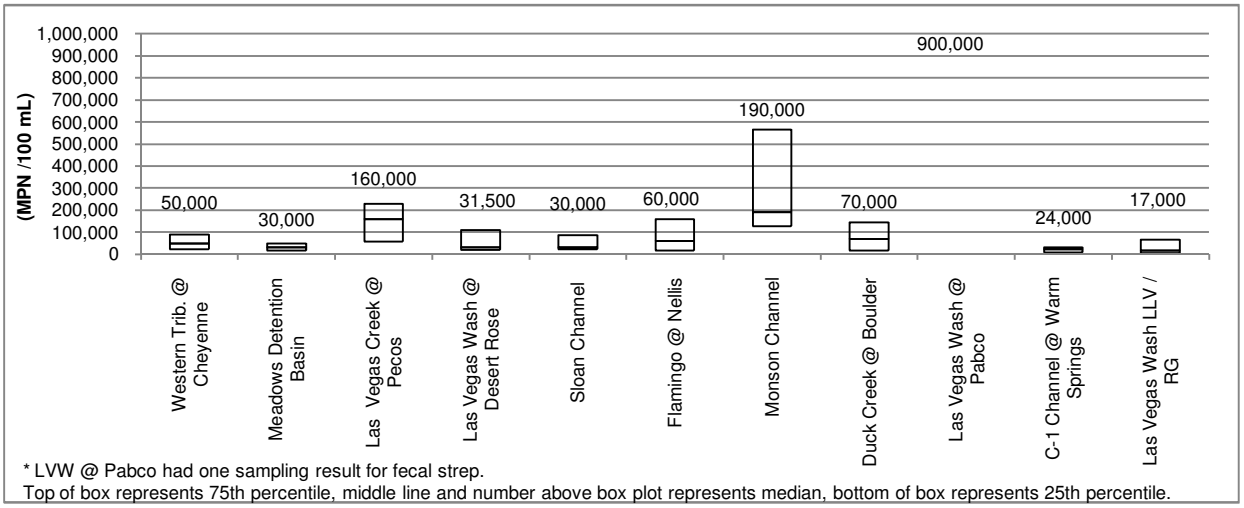
| Constituent | Median Concentration (MPN/100 mL) | Historical Range (MPN/100 mL) |
|---|---|---|
| Coliform Bacteria | 24,000 | 2 – 160,000,000 |
| Fecal Streptococci | 50,000 | 110 – 1,600,000 |

**Figure 40. Wet Weather Coliform Bacteria vs Location 1992-2010**



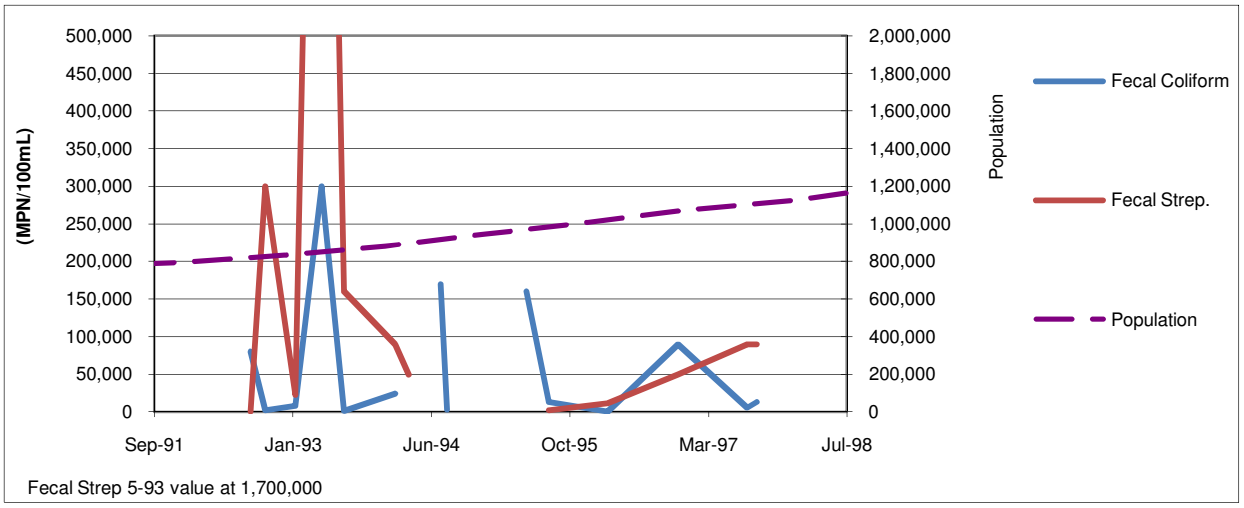

*LVW @ Pabco had one sampling result for coliform.
Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 41. Wet Weather Fecal Streptococci vs Location 1992-2010



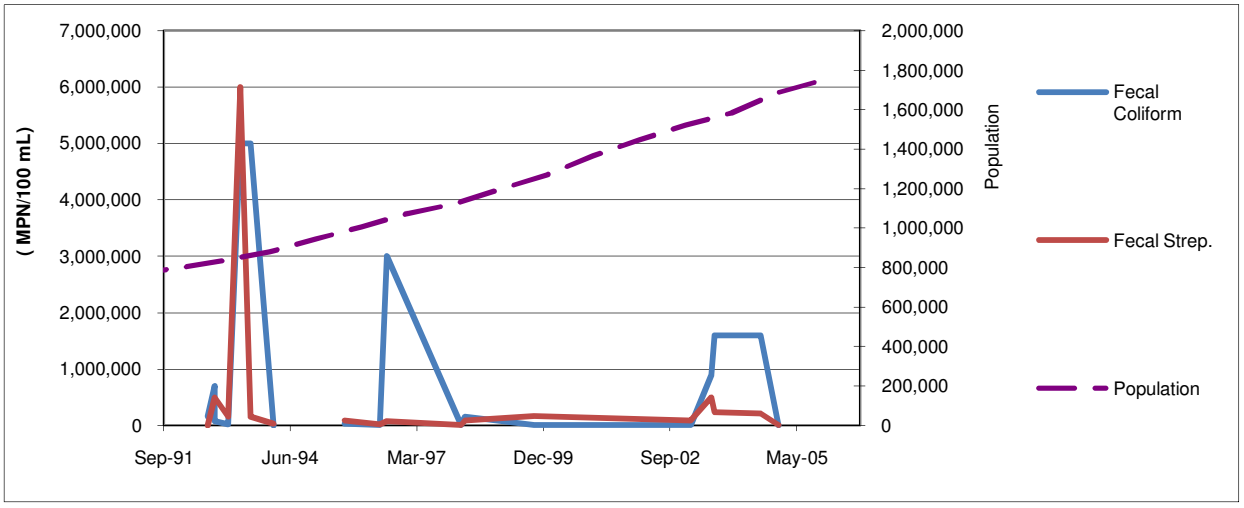

* LVW @ Pabco had one sampling result for fecal strep.
Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 42. Western Tributary @ Cheyenne Bacteria 1992-1997

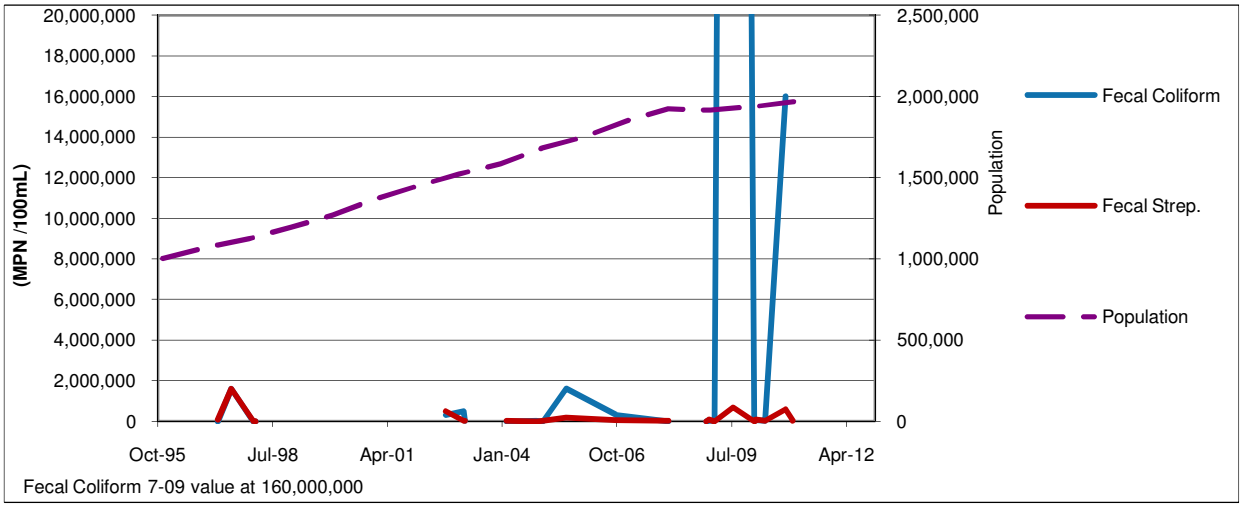



Fecal Strep 5-93 value at 1,700,000

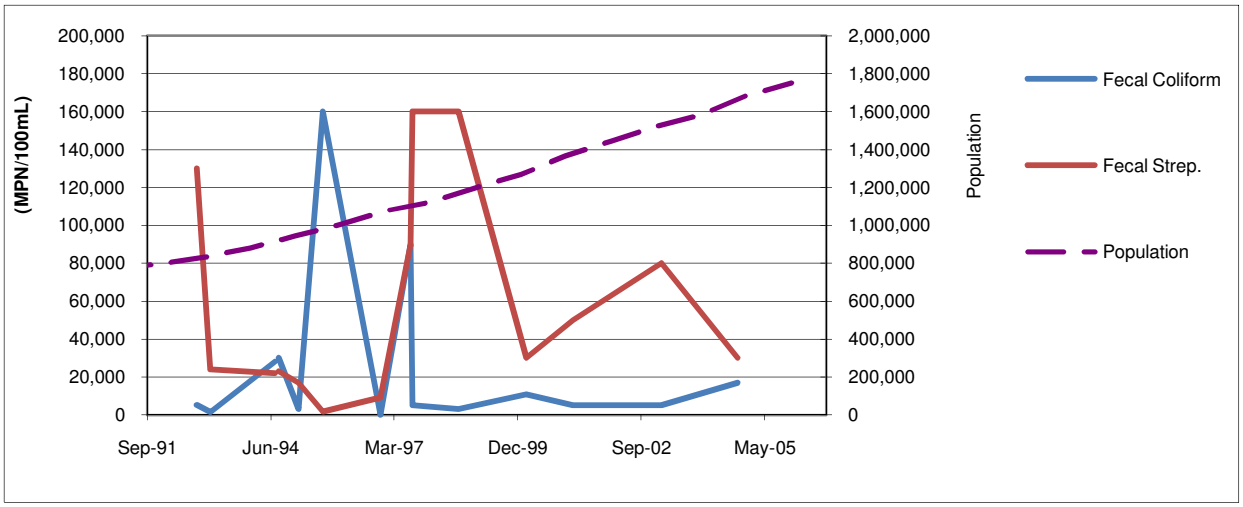
## Figure 43. Las Vegas Creek @ Pecos Bacteria 1992-2005



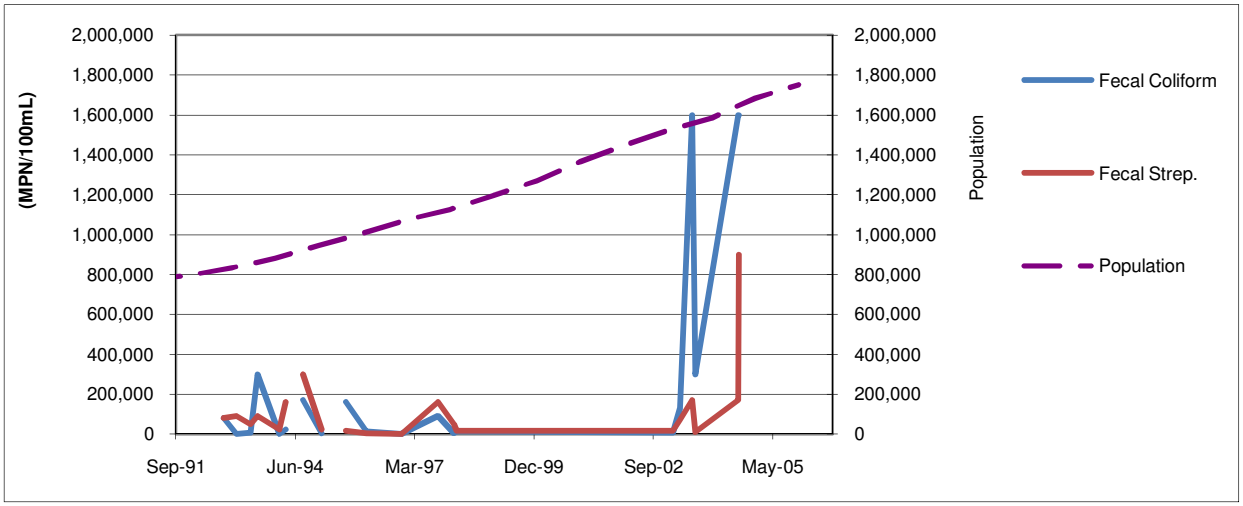
## Figure 44. Las Vegas Wash @ Desert Rose Bacteria 1997-2010



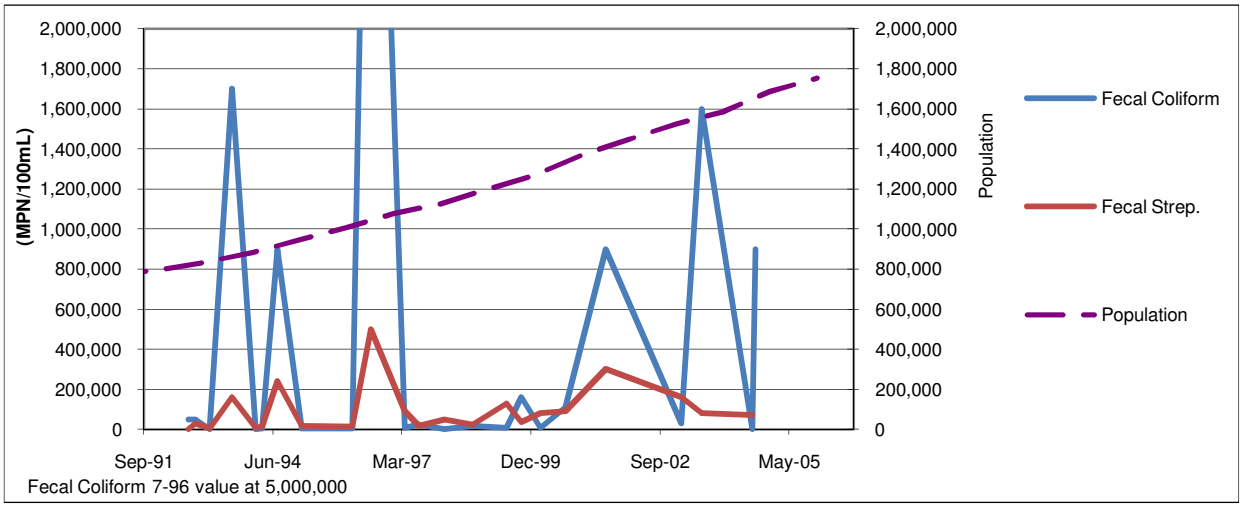

## Figure 45. Sloan Channel Bacteria 1992-2004



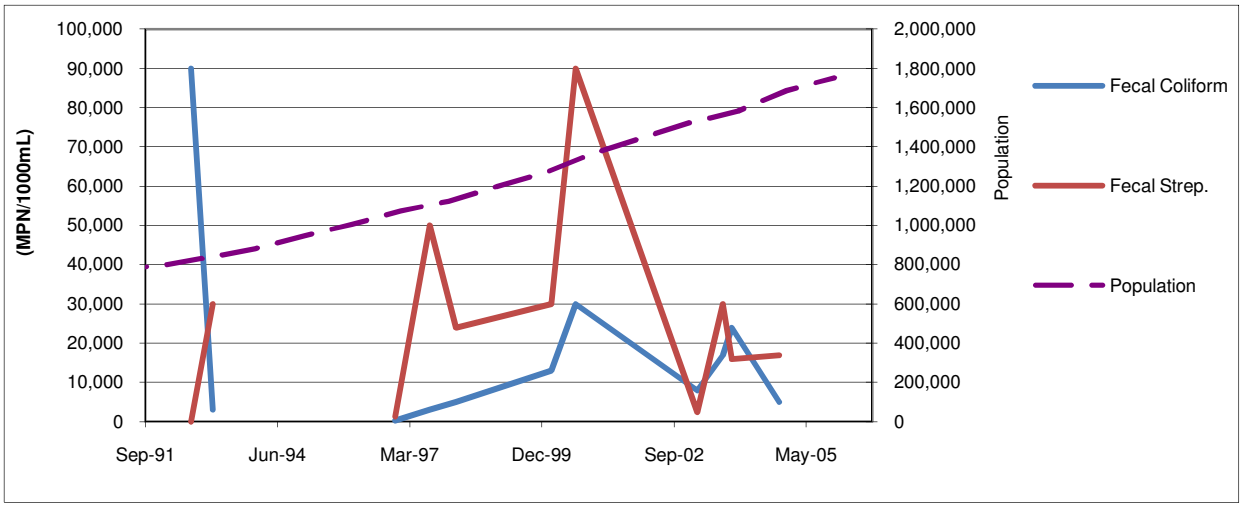

## Figure 46. Flamingo Wash Bacteria 1992-2004



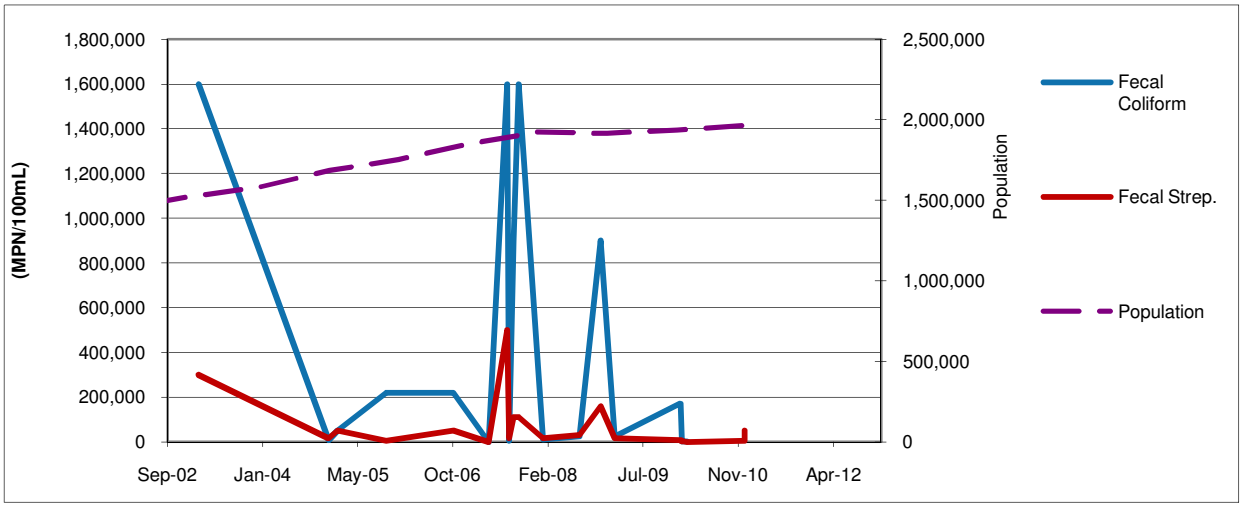
## Figure 47. Duck Creek @ Boulder Hwy Bacteria 1992-2004




## Figure 48. C-1 Channel Bacteria 1992-2004




## Figure 49. LVW Below Lake Las Vegas / Rainbow Gardens Bacteria 2003-2010



### 3.1.5 Semivolatile Organic Compounds and Volatile Organic Compounds

Wet weather data from 1999-2010 was analyzed for semivolatile organic compounds (SOC) and volatile organic compounds (VOC). **Table 10** represents the 1991-2010 median number of detections for all sites combined and historic range of detections for the constituents. For SOC Di(2-ethylhexyl)phthalate, Diethylphthalate, Butylbenzylphthalate, and caffeine were detected most often. For VOC Acetone, Acetaldehyde, Chloriform, Formaldehyde and Total THM were detected most often.

**Table 10. Wet Weather Semivolatile Organic Compounds and Volatile Organic Compounds**

| Constituent | Median # of detections/ year | Historical Range # of detections/ year |
|---|---|---|
| SOC | 2 | 0 – 9 |
| VOC | 1 | 0 - 14 |

### 3.1.6 Pesticides and Herbicides

Wet weather data from 1999-2010 was analyzed for pesticides and herbicides. **Table 11** represents the 1999-2010 median number of detections for all sites combined and historic range of detections for the constituents. For pesticides glyoxal and diuron were detect most often. For herbicides 2, 4-DB and 2, 4-D were detected most often.

**Table 11. Wet Weather Pesticides and Herbicides**

| Constituent | Median # of detections/ year | Historical Range # of detections / year |
|---|---|---|
| Pesticides | 0 | 0 – 4 |
| Herbicides | 0 | 0 - 4 |

### 3.1.7 Water Quality Standards

**Table 12** presents surface waters in Las Vegas Valley that are listed as impaired by the State of Nevada. The table also lists the applicable water quality standards. **Table 13** lists whether the wet weather sampling for the MS4 program showed exceedances of these standards and at what site the standard was exceeded for TDS and selenium. Exceedances for TDS, acute selenium and chronic selenium are based individual samples. The numbers of exceedances are provided over the total amount of samples. TDS standards were exceeded only at Western Tributary @ Cheyenne and Duck Creek @ Boulder. Selenium standards were at most sites either exceed the acute or the chronic exceedance.

TDS standards were not exceeded at Meadows and Flamingo Wash @ Swenson. Selenium standards were not exceeded for acute and chronic samples at Western Tributary @ Cheyenne and Flamingo Wash @ Swenson.

**Table 12. Las Vegas Valley Impaired Waters**

| Stream Segment | Impairments[1] | Water Quality Standards[2] |
|---|---|---|
| Las Vegas Wash – Telephone Line Road to Lake Mead | Iron<br>Molybdenum | 1 mg/L<br>19 ug/L |
| Flamingo Wash – above Las Vegas Wash | Selenium<br><br>TDS | 0.005 mg/L chronic<br>0.020 mg/L acute<br>3,000 mg/L |
| Duck Creek – origin to Las Vegas Wash | Selenium<br><br>TDS | 0.005 mg/L chronic<br>0.020 mg/L acute<br>3,000 mg/L |
| Las Vegas Creek – origin to Las Vegas Wash | Selenium<br><br>pH | 0.005 mg/L chronic<br>0.020 mg/L acute<br>6.5 – 9.0 |
| Las Vegas Wash – upstream of wastewater treatment plants | Selenium<br><br>TDS<br>Iron | 0.005 mg/L chronic<br>0.020 mg/L acute<br>3,000 mg/L<br>1 mg/L |

Notes:

[1] Nevada 303(d) List of Impaired Waters, 2006

[2] Per Nevada Administrative Code 445A

## Table 13. Wet Weather Sample Exceedances of Water Quality Standards for Impaired Water Body Standards

| Site | Years When TDS was Sampled | No. of TDS Exceedances / Total No. of Samples | Years When Selenium was Sampled | No. of Acute Selenium Exceedances / Total No. of Samples | No. of Chronic Selenium Exceedances / Total No. of Samples |
|---|---|---|---|---|---|
| Western Tributary | 1992-1997 | 1/16 | 1993-1995 | 1/9 | 1/9 |
| Meadows | 2003-2005 | 0/5 | 2003-2005 | 0/4 | 2/4 |
| Las Vegas Creek at Pecos | 1992-1996<br>1998-1999<br>2003-2005 | 0/21 | 1993-1995<br>2003-2005 | 1/11 | 4/11 |
| Las Vegas Wash Desert Rose | 1997-2006<br>2008-2010 | 0/29 | 2003-2006<br>2008-2010 | 3/15 | 11/15 |
| Sloan Channel | 1992-1998<br>2000-2001<br>2003-2004 | 0/15 | 1992-1995<br>2003-2004 | 2/8 | 4/8 |
| Flamingo Wash @ Nellis | 1992-1998<br>2003-2004 | 0/22 | 1993-1995<br>2003-2004 | 5/13 | 9/13 |
| Monson | 2003-2004 | 0/4 | 2003-2004 | 0/2 | 2/2 |
| Duck Creek @ Boulder | 1992-2001<br>2003-2004 | 8/23 | 1992-1995<br>2003-2004 | 4/8 | 8/8 |
| Pabco | 2002 | 0/2 | 2002 | 0/1 | 0/1 |
| C-1 Channel | 1992-1998<br>2000, 2003-2004 | 0/14 | 1993-1995<br>2003-2004 | 1/6 | 2/6 |
| LLV / Rainbow Gardens | 2003-2010 | 0/20 | 2004-2010 | 1/16 | 5/16 |

Notes: TDS, Acute Selenium and Chronic Selenium exceedances based on individual samples.

### 3.1.8 Relationship between Concentration and Discharge

A study was conducted in 1992 to analyze the relationships between pollutant concentrations and discharge. In particular, it was of interest to determine whether the so-called "first-flush effect" was evident in the data. **Table 14** summarizes the results of this study.

**Table 14. Relationship Between Concentration and Discharge**

| First-Flush Effect | Correlated to Discharge | Continuously Increasing* |
|---|---|---|
| TDS | TSS | Oil & Grease |
| Boron | Phosphorus | BOD |
| | Metals | COD |
| | Arsenic | Bacteria |
| | Turbidity | |

* Over the initial 3-hour sampling period.

Constituents not listed in the above table do not show a common trend from site to site. Metals are actually more strongly correlated to TSS than to discharge. In general, the evident trends are weak, and may vary from storm to storm and site to site. The strongest trend is the TDS first-flush effect.

The available data suggest that the majority of constituents of concern do not show a strong first-flush effect, but rather are more strongly related to discharge or to the duration of the runoff event. It is possible that the data follow this trend because of the large areas sampled at the monitoring points. Although runoff from individual small portions (subareas) of the urban area may exhibit stronger first-flush tendencies, the mixing of runoff from all these subareas, and the differences in the timing of the runoff, apparently serve to smooth out short-term concentration fluctuations at the major outfalls themselves.

## 3.2 Findings

Of the two sites still currently being sampled, Las Vegas Wash @ Desert Rose (Desert Rose) and Las Vegas Wash Rainbow Gardens (Rainbow Gardens), the data suggest the following for wet weather monitoring.

- The more urbanized watersheds generally have higher concentrations of urban-generated pollutants, but all watersheds contribute pollutant in concentrations exceeding background levels.
- The significant increase in Las Vegas Valley population and area of urban development over past 20 years has not resulted in statistically significant increases in pollutant concentrations. This suggests that the stormwater

management measures that have been applied in the past have been reasonably successful in mitigating many water quality impacts of development.

- Concentrations of most constituents in wet weather runoff show significant variability from storm to storm, but that variability has occurred within a fairly constant range for each constituent during the MS4 monitoring period.
- Constituent concentrations in specific samples are affected at least as much by storm conditions (e.g., intensity, location, areal extent) as by watershed characteristics.

# 4 Dry Weather Characterization Program Findings

## 4.1 Dry Weather Sampling Summary

Monitoring results were compiled and analyzed for the dry weather sites listed in Section 2.1.3. The monitoring data provided for each constituent below is representative of when the first monitoring results are provided to the end of 2010. Section 2.1.3 gives the time period that each site was monitored. **Table 15** provides the number of sample results for all sites combined per year for each constituent. For the constituents reported below, the results of the historical data are displayed in the following ways:

- The range of constituent concentrations (as a box plot) at sampling location arranged from upstream to downstream in the Las Vegas Valley. The purpose of these plots is to display spatial differences in dry weather data. The box plot represents the 75$^{th}$ percentile (top line, indicating 75% of results were at or below this value), the median (the middle line and value represented above the box plot) and the 25$^{th}$ percentile (the bottom line indicating 25% of results were at or below this value).
- The constituent concentration versus the growth in population in the Las Vegas Valley over the monitoring period. The purpose of these plots is to identify temporal trends in the dry weather data and determine if increasing urbanization (represented by population) appears to be contributing to higher constituent concentrations.

## Table 15. Dry Weather Number of Sample Results by Constituent for All Sites Combined Per Year

| Year | TSS | TDS | TP | Nitrate | Ortho -p | Lead | Copper | Zinc | Dissolved Lead | Dissolved Copper | Dissolved Zinc | Selenium | Fecal Coliform | Fecal Strep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1991 | 11 | 6 | 9 | 11 | 11 | 10 | 11 | 11 | 0 | 0 | 0 | 0 | 13 | 11 |
| 1992 | 10 | 5 | 6 | 10 | 6 | 6 | 10 | 6 | 0 | 0 | 0 | 0 | 10 | 6 |
| 1993 | 5 | 8 | 5 | 8 | 6 | 5 | 8 | 5 | 0 | 0 | 0 | 3 | 10 | 6 |
| 1994 | 5 | 10 | 5 | 10 | 6 | 5 | 10 | 5 | 0 | 0 | 0 | 3 | 12 | 6 |
| 1995 | 6 | 12 | 6 | 12 | 6 | 6 | 12 | 6 | 0 | 0 | 0 | 3 | 12 | 12 |
| 1996 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 0 | 0 | 0 | 0 | 6 | 6 |
| 1997 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 0 | 0 | 0 | 0 | 6 | 6 |
| 1998 | 5 | 5 | 5 | 5 | 1 | 5 | 5 | 5 | 4 | 4 | 4 | 0 | 5 | 5 |
| 1999 | 8 | 8 | 8 | 8 | 2 | 8 | 8 | 8 | 6 | 6 | 6 | 0 | 8 | 8 |
| 2000 | 14 | 16 | 19 | 19 | 5 | 19 | 19 | 19 | 11 | 9 | 11 | 2 | 17 | 17 |
| 2001 | 37 | 37 | 23 | 24 | 13 | 12 | 24 | 23 | 0 | 0 | 0 | 4 | 21 | 0 |
| 2002 | 1 | 16 | 15 | 16 | 13 | 12 | 15 | 12 | 0 | 0 | 0 | 11 | 16 | 0 |
| 2003 | 1 | 23 | 17 | 23 | 21 | 15 | 20 | 21 | 0 | 0 | 0 | 12 | 22 | 0 |
| 2004 | 19 | 21 | 14 | 21 | 14 | 21 | 20 | 21 | 0 | 0 | 0 | 14 | 19 | 0 |
| 2005 | 16 | 20 | 22 | 22 | 21 | 20 | 20 | 20 | 0 | 0 | 0 | 17 | 19 | 0 |
| 2006 | 20 | 24 | 14 | 24 | 19 | 24 | 24 | 24 | 0 | 0 | 0 | 18 | 23 | 0 |
| 2007 | 24 | 28 | 28 | 28 | 28 | 18 | 26 | 25 | 0 | 0 | 0 | 24 | 28 | 0 |
| 2008 | 22 | 26 | 28 | 28 | 28 | 28 | 28 | 28 | 0 | 0 | 0 | 25 | 28 | 0 |
| 2009 | 22 | 26 | 28 | 28 | 28 | 27 | 28 | 28 | 0 | 0 | 0 | 27 | 28 | 0 |
| 2010 | 12 | 14 | 14 | 7 | 14 | 14 | 14 | 14 | 0 | 0 | 0 | 14 | 14 | 0 |
| Total | 251 | 318 | 279 | 317 | 255 | 268 | 315 | 294 | 21 | 19 | 21 | 177 | 317 | 83 |

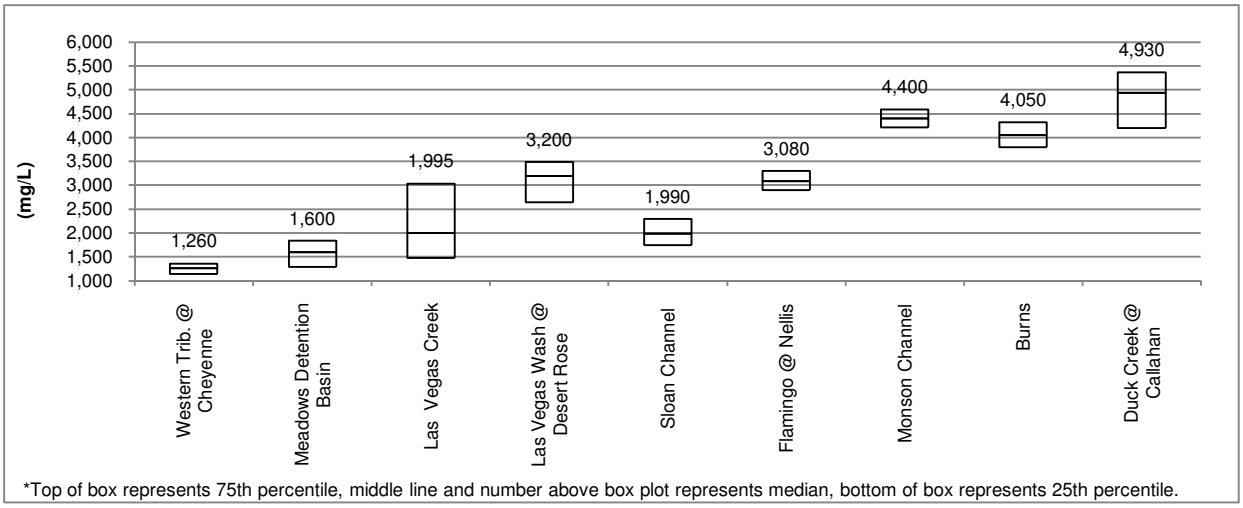
### 4.1.1 Total Dissolved Solids

Dry weather data from 1991-2010 was analyzed for total suspended solids and, total dissolved solids. **Table 16** represents the 1991-2010 median for all sites combined and historic range of the constituents. **Figures 50 – 60** display the data as stated in Section 4.1. Dry weather TDS concentrations show an upward trend from upstream to downstream. This trend is due to greater seepage of groundwater from the shallow aquifer lower in Las Vegas Valley. Dry weather concentrations for TSS also show little variability from upstream to downstream.

**Table 16. Dry Weather Total Suspended Solids and Total Dissolved Solids**

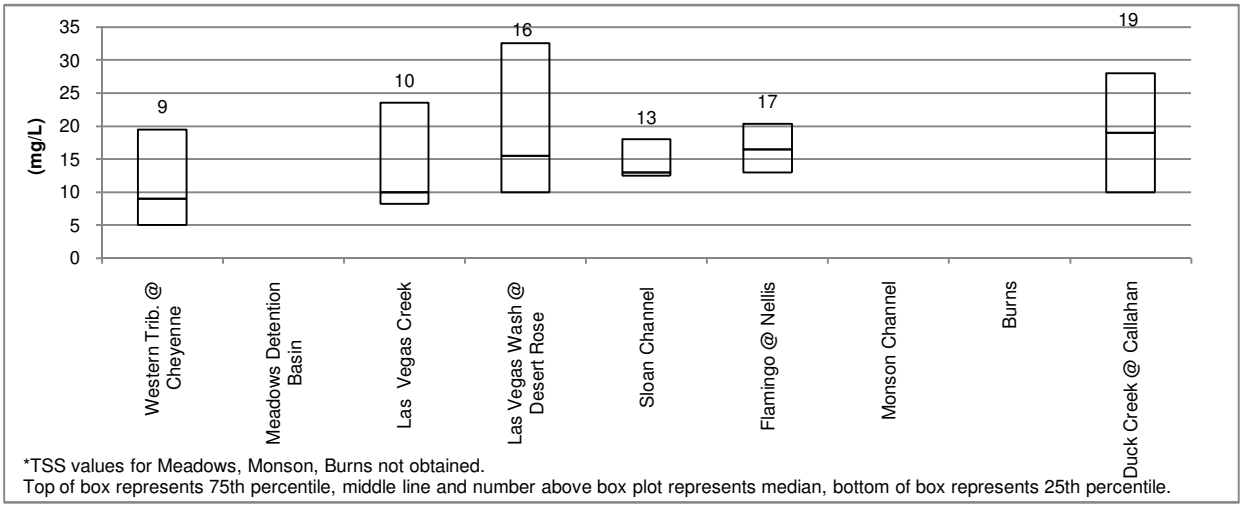
| Constituent | Median Concentration (mg/L) | Historical Range (mg/L) |
|---|---|---|
| TSS | 13 | 3 - 179 |
| TDS | 3,100 | 500-6,760 |

**Figure 50. Dry Weather Total Dissolved Solids vs. Location 1991-2010**



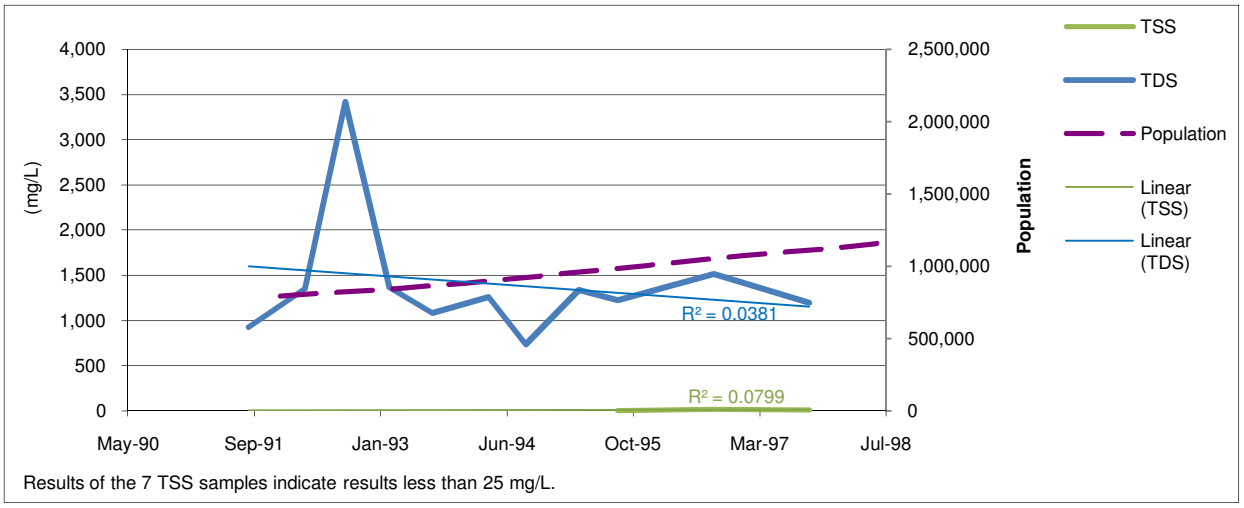

*Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 51. Dry Weather Total Suspended Solids vs. Location 1991-2010



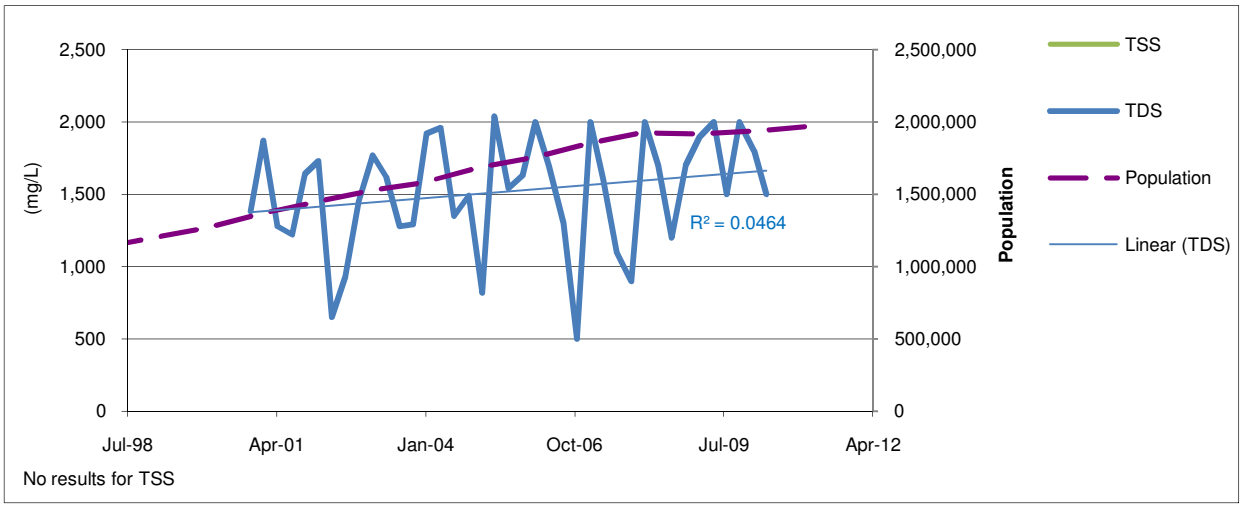

*TSS values for Meadows, Monson, Burns not obtained.
Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 52. Western Tributary @ Cheyenne TDS and TSS 1992-1997



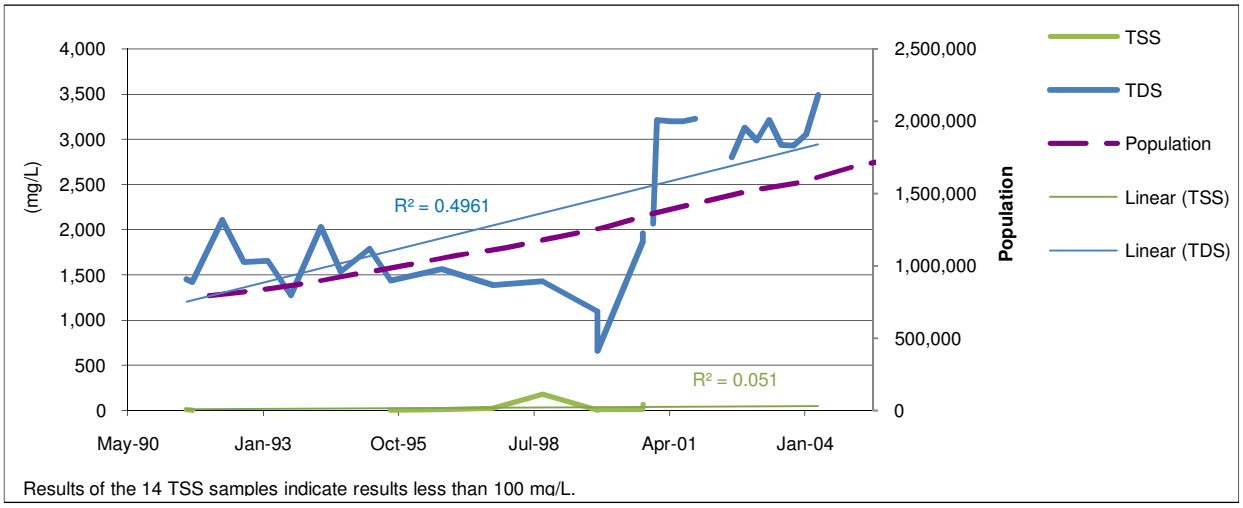

Results of the 7 TSS samples indicate results less than 25 mg/L.

## Figure 53. Meadows Detention Basin TDS and TSS 2000-2010



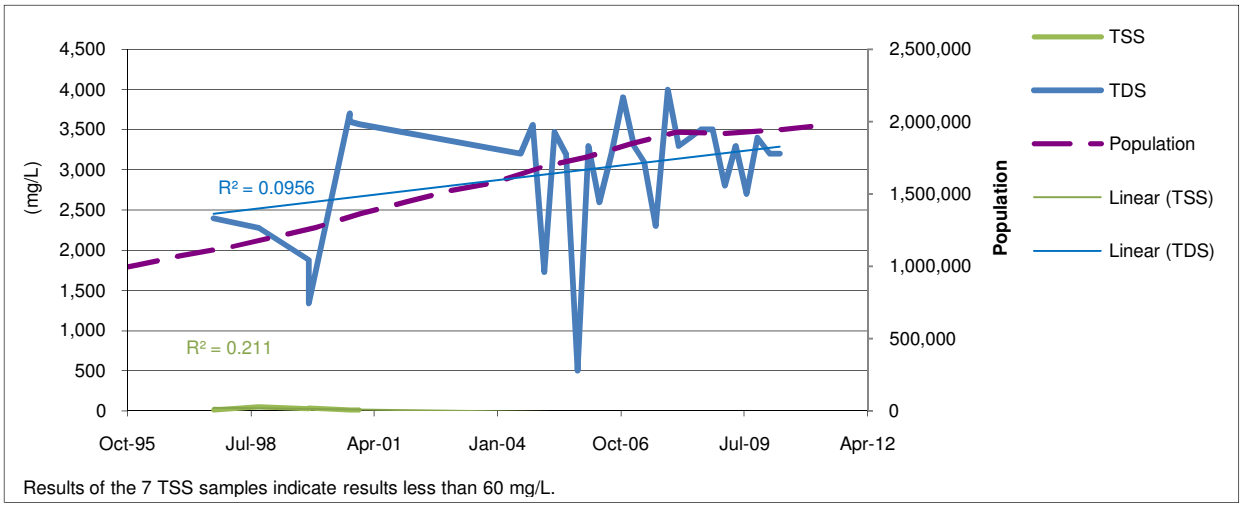

No results for TSS

## Figure 54. Las Vegas Creek TDS and TSS



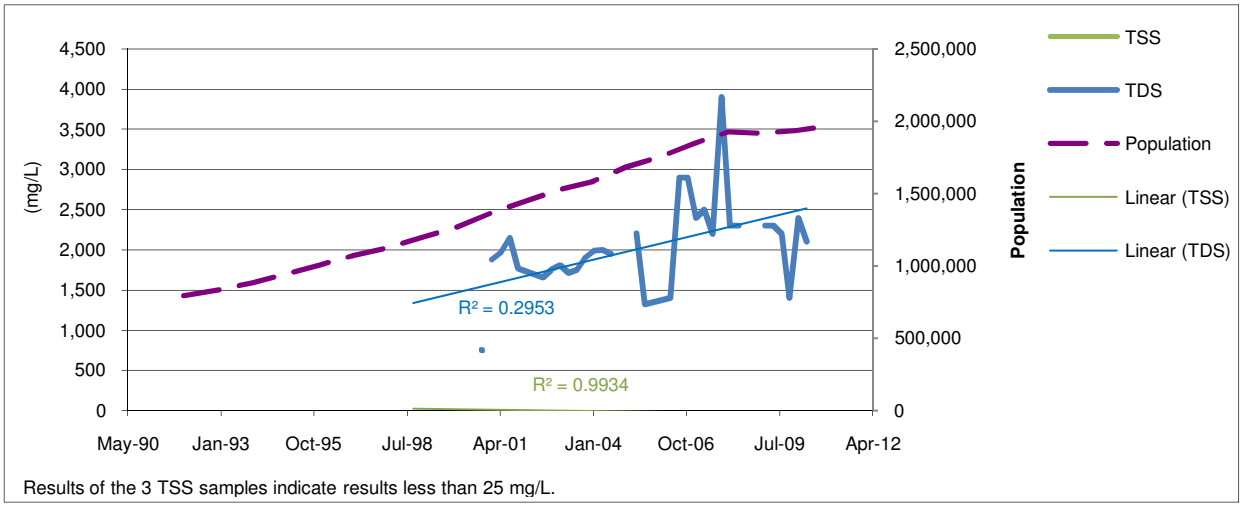

Results of the 14 TSS samples indicate results less than 100 mg/L.

## Figure 55. Las Vegas Wash @ Desert Rose TDS and TSS



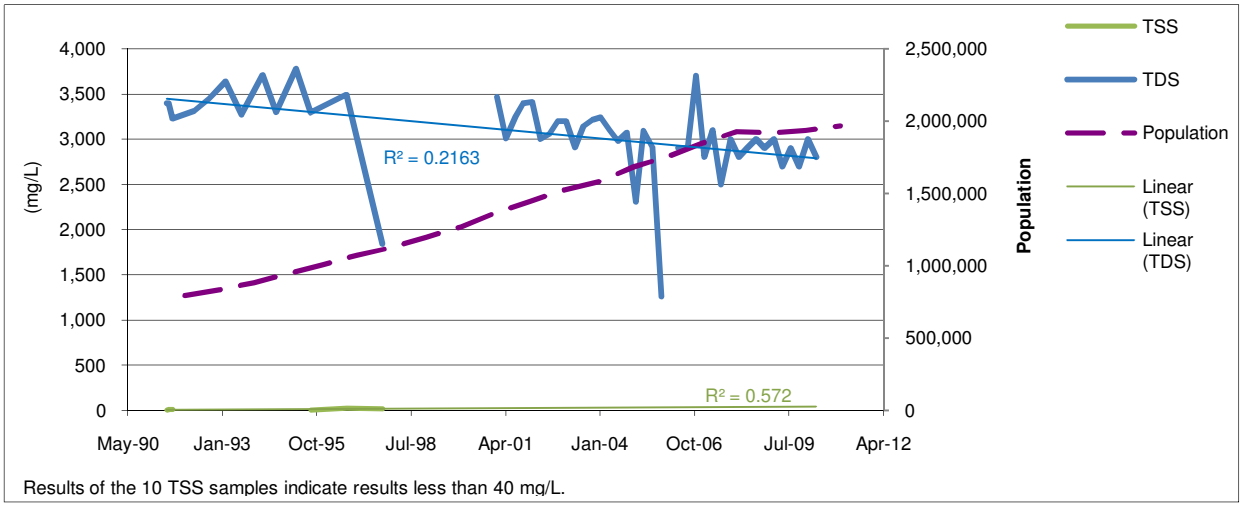

Results of the 7 TSS samples indicate results less than 60 mg/L.

## Figure 56. Sloan Channel TDS and TSS 2000-2010

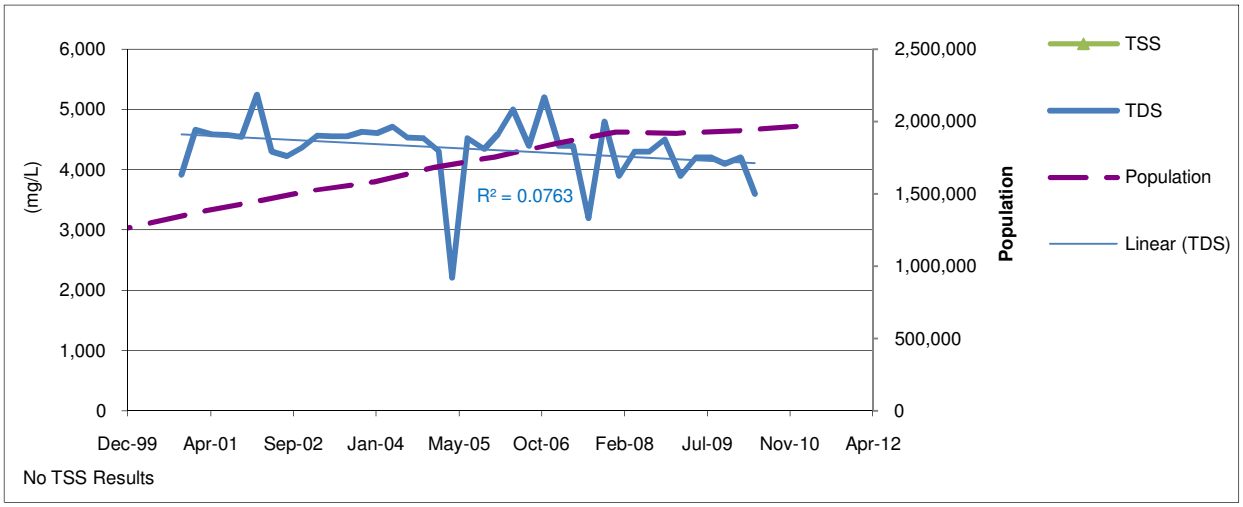



Results of the 3 TSS samples indicate results less than 25 mg/L.

## Figure 57. Flamingo Wash @ Nellis TDS and TSS 1991-1997, 2001-2010




## Figure 58. Monson Channel TDS and TSS 2000-2010




## Figure 59. Burns Channel TDS and TSS 2006-2010

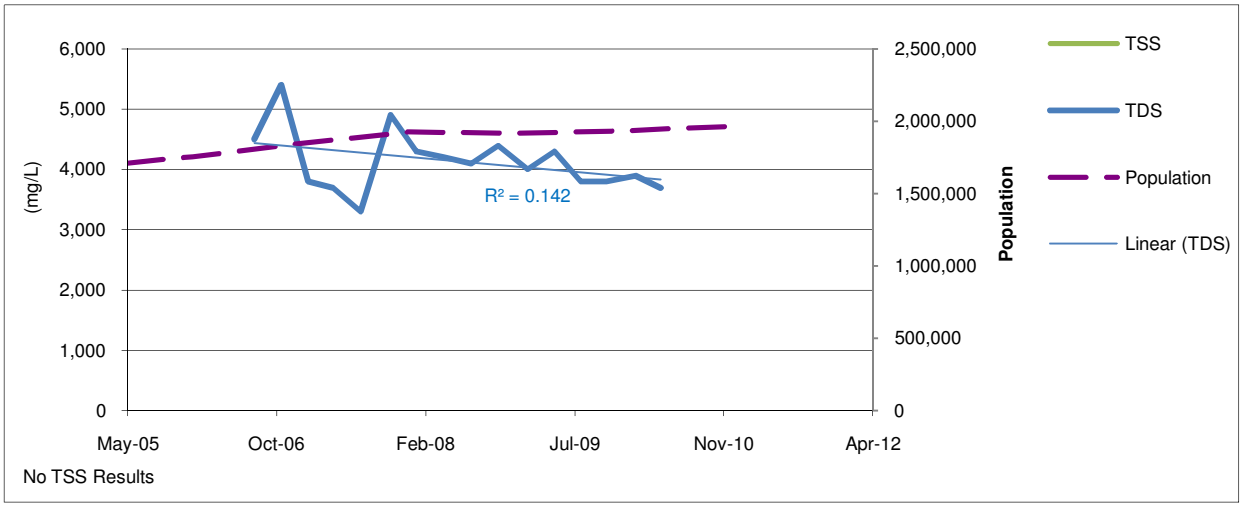
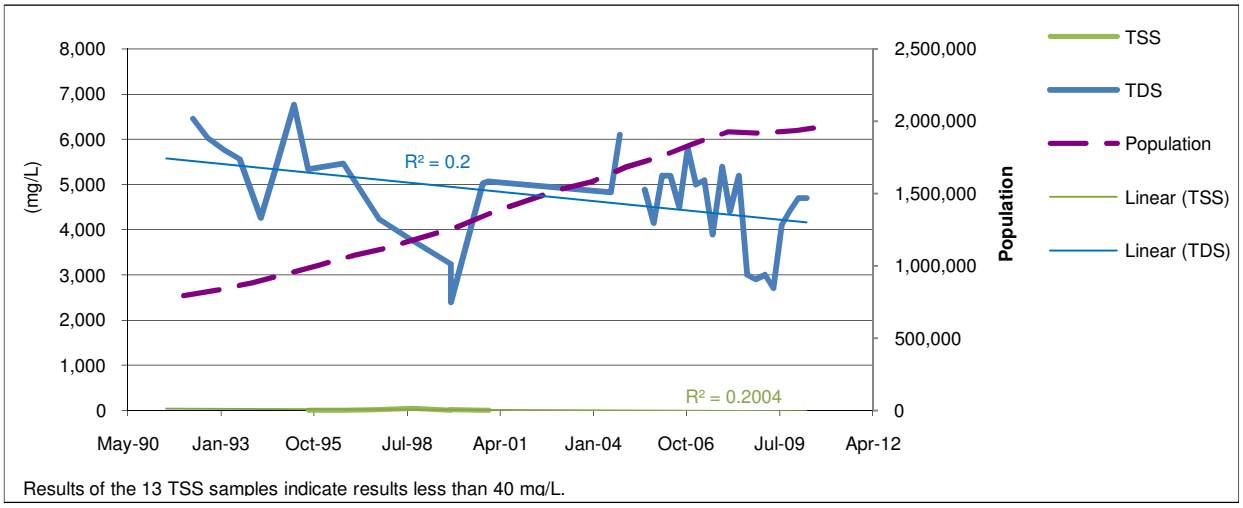


**Figure 60. Duck Creek TDS and TSS 1991-2000, 2004-2010**



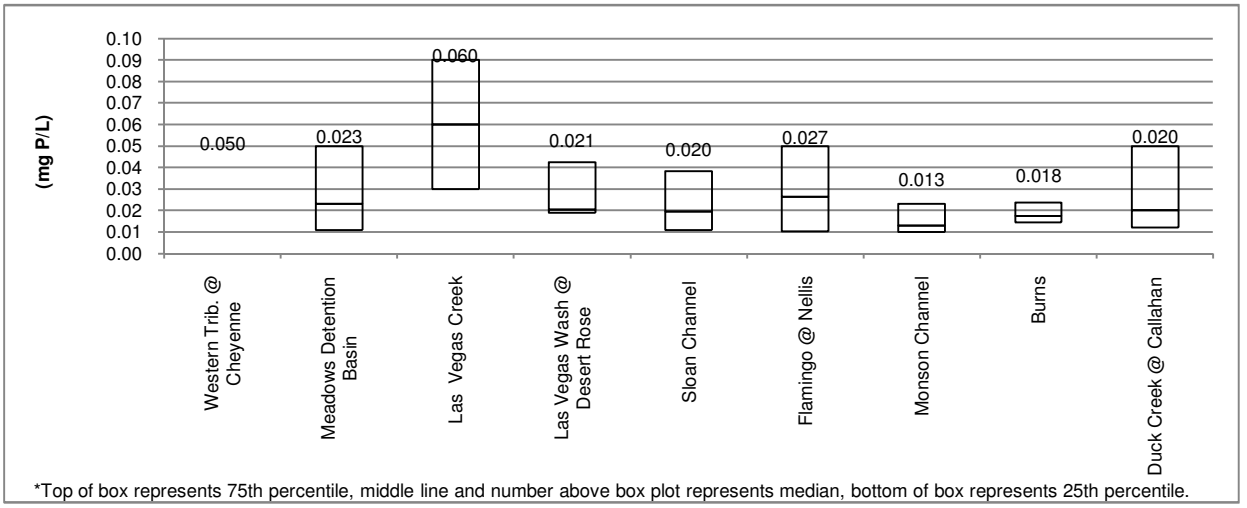

### 4.1.2 Nutrients

Dry weather data from 1991-2010 was analyzed for total phosphorous, orthophosphate, and nitrate. **Table 17** represents the 1991-2010 median for all sites combined and historic range of the constituents. **Figures 61 – 72** display the data as stated in Section 4.1. Data for dry weather does not indicate an increasing or decreasing trend in total phosphorus as P from upstream to downstream. Las Vegas Creek had the highest median of all sites at 0.006 mg/L, with all other sites being 0.05 mg/L or lower. Upstream to downstream medians for orthophosphate are about 0.01 with the exception of Western Tributary @ Cheyenne (0.05 mg/L) and Las Vegas Creek (0.032). Upstream to downstream Nitrate as N results indicates a slight upward trend.

**Table 17. Dry Weather Nutrients**

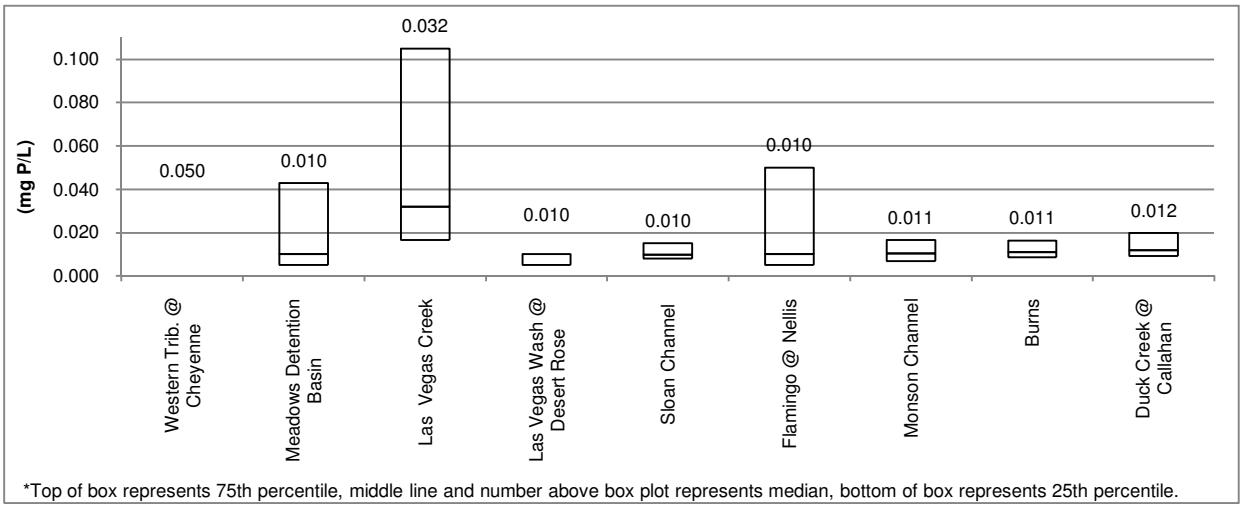
| Constituent | Median Concentration | Historical Range |
|---|---|---|
| TP (mg P/L) | 0.025 | 0.001 - 45.0 |
| O-P (mg. P/L) | 0.012 | 0.002 - 11 |
| Nitrate (mg N/L) | 4.3 | 0.014 - 32.0 |

## Figure 61. Dry Weather Total Phosphorus vs Location 1991-2010



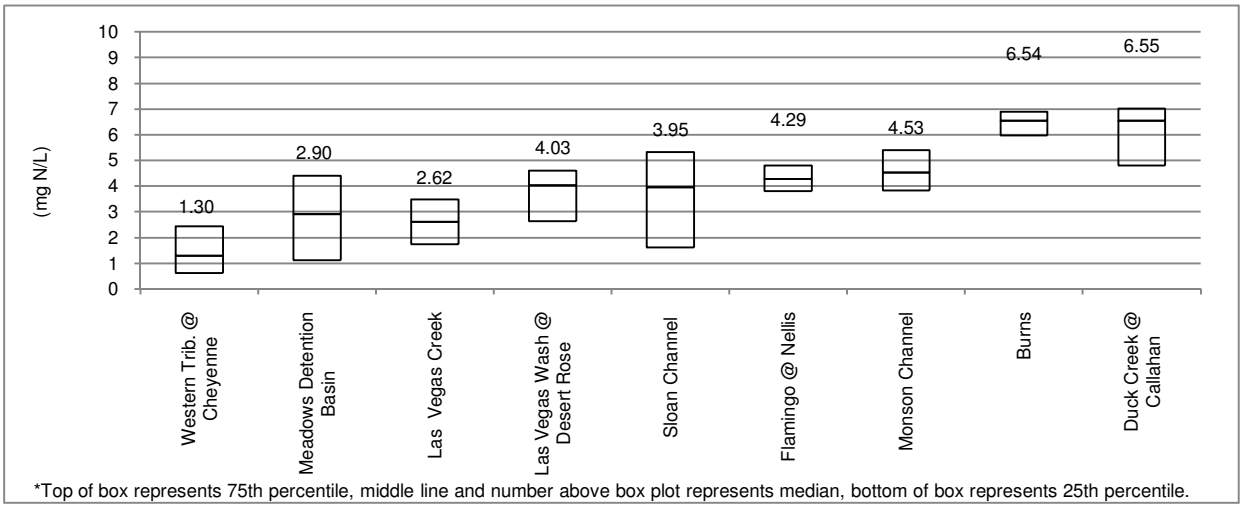

*Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 62. Dry Weather Orthophosphate vs Location 1991-2010



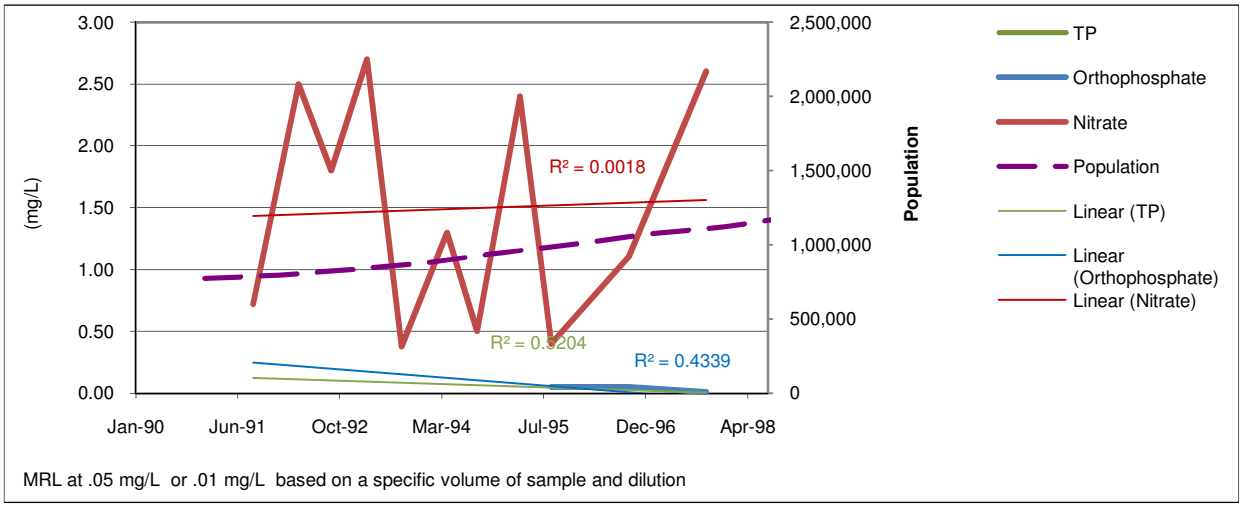

*Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 63. Dry Weather Nitrate vs Location 1991-2010

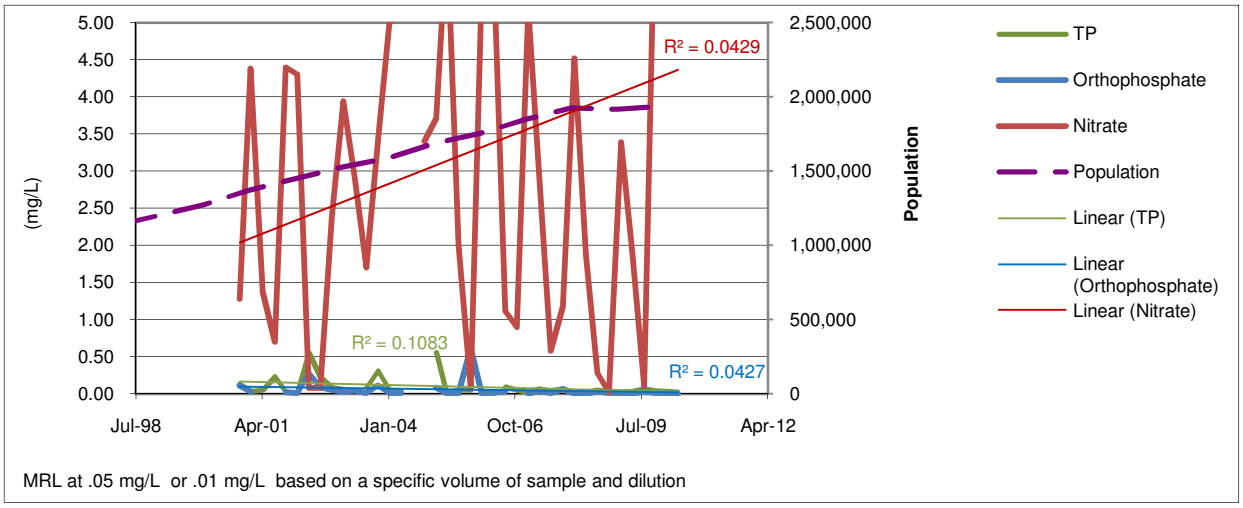



*Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

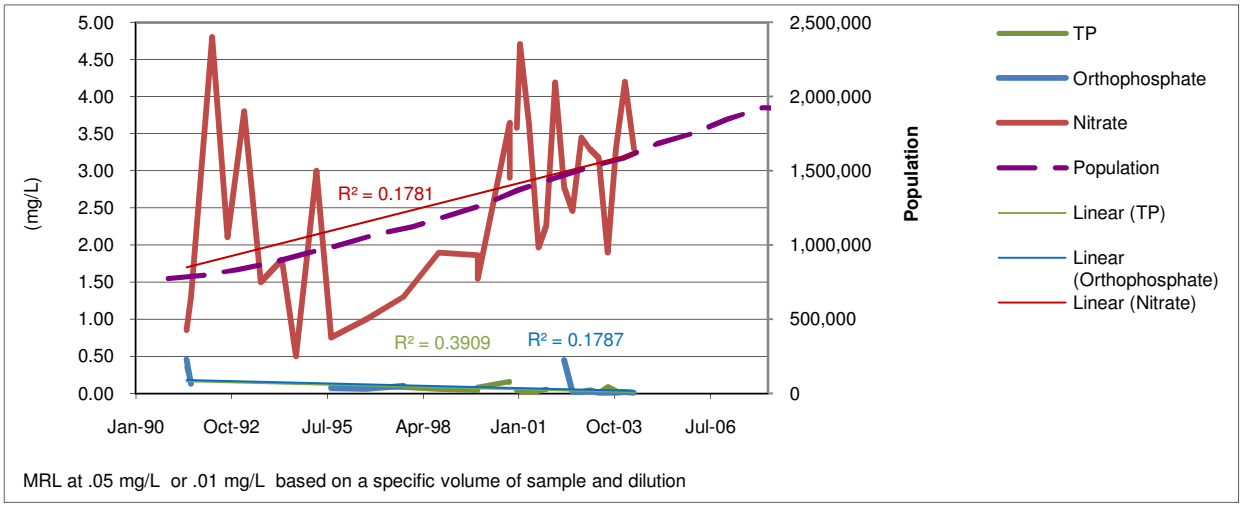
## Figure 64. Western Tributary @ Cheyenne Nutrients 1992-1997



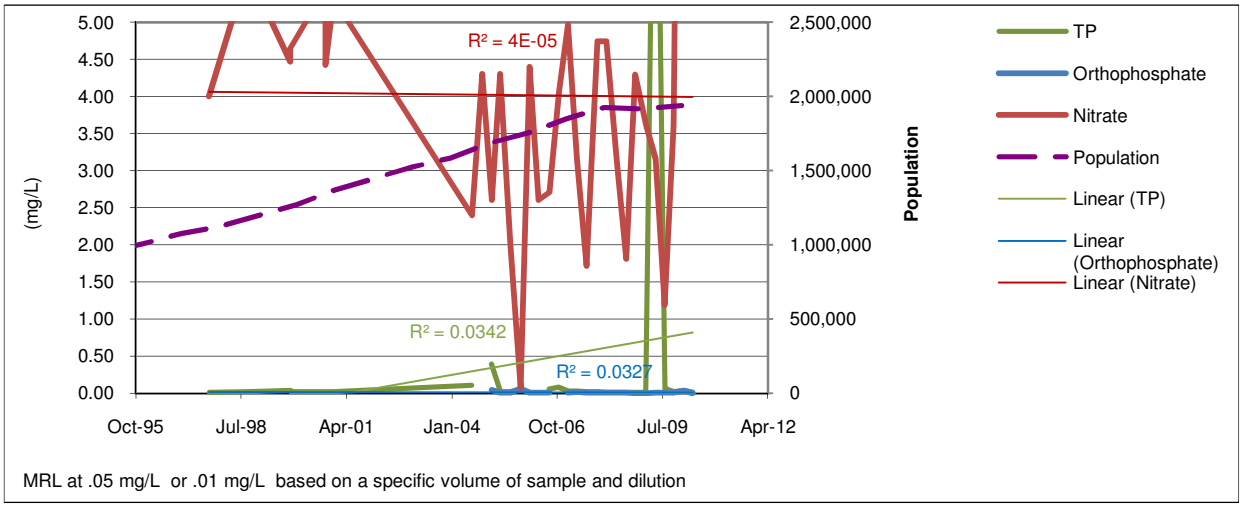

## Figure 65. Meadows Detention Basin Nutrients 2000 – 2010




## Figure 66. Las Vegas Creek Nutrients

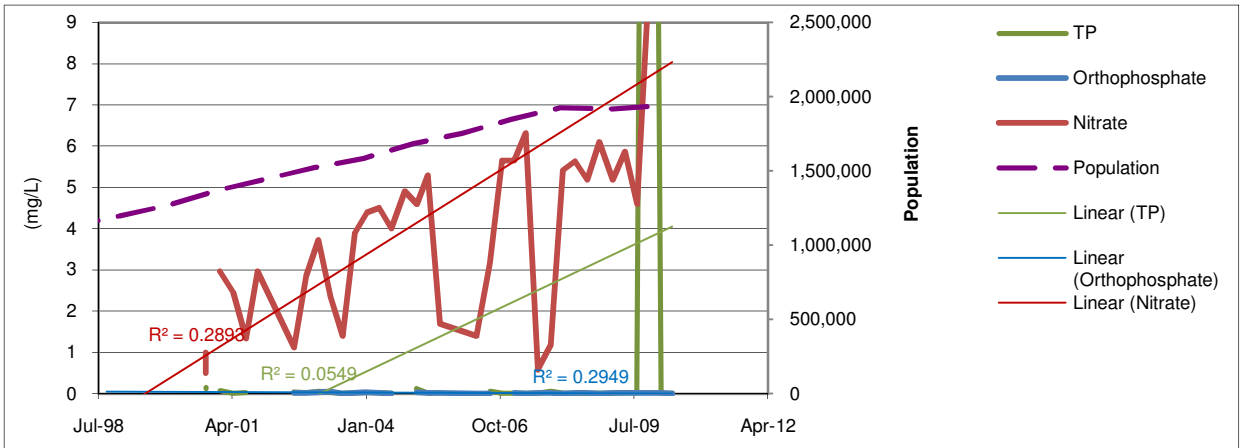


## Figure 67. Las Vegas Wash @ Desert Rose Nutrients



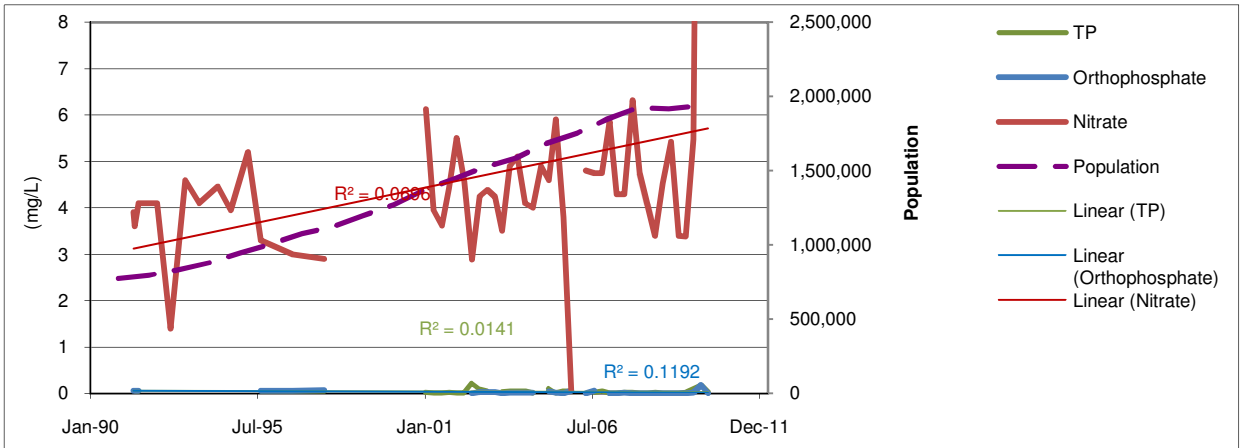

MRL at .05 mg/L or .01 mg/L based on a specific volume of sample and dilution

## Figure 68. Sloan Channel Nutrients 2000 – 2010



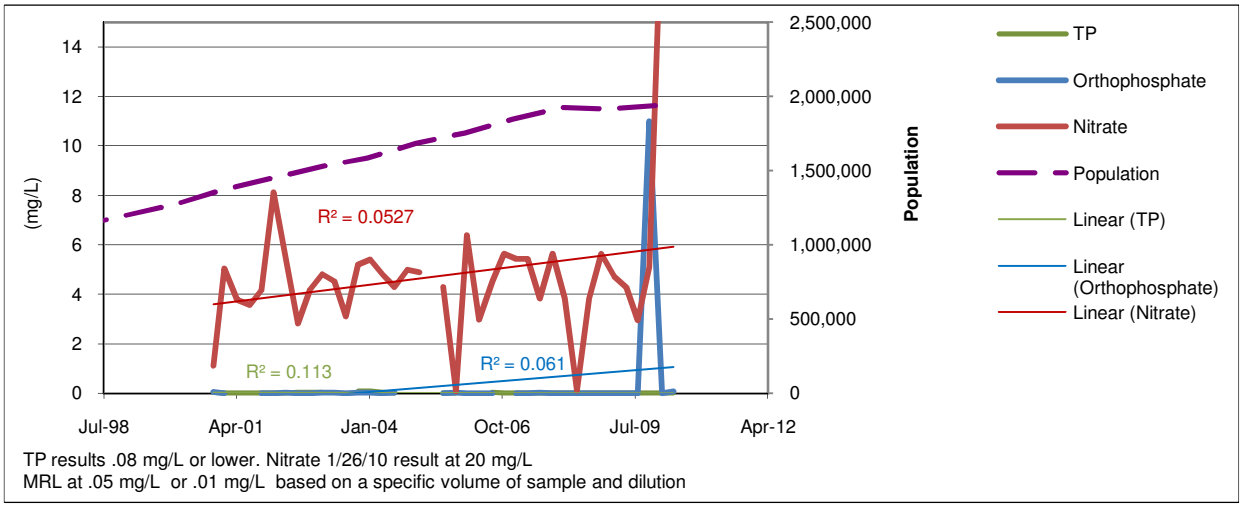

TP for 10/20/09 is 45 mg/L
MRL at .05 mg/L or .01 mg/L based on a specific volume of sample and dilution

## Figure 69. Flamingo @ Nellis Nutrients 1991-1997, 2001-2010



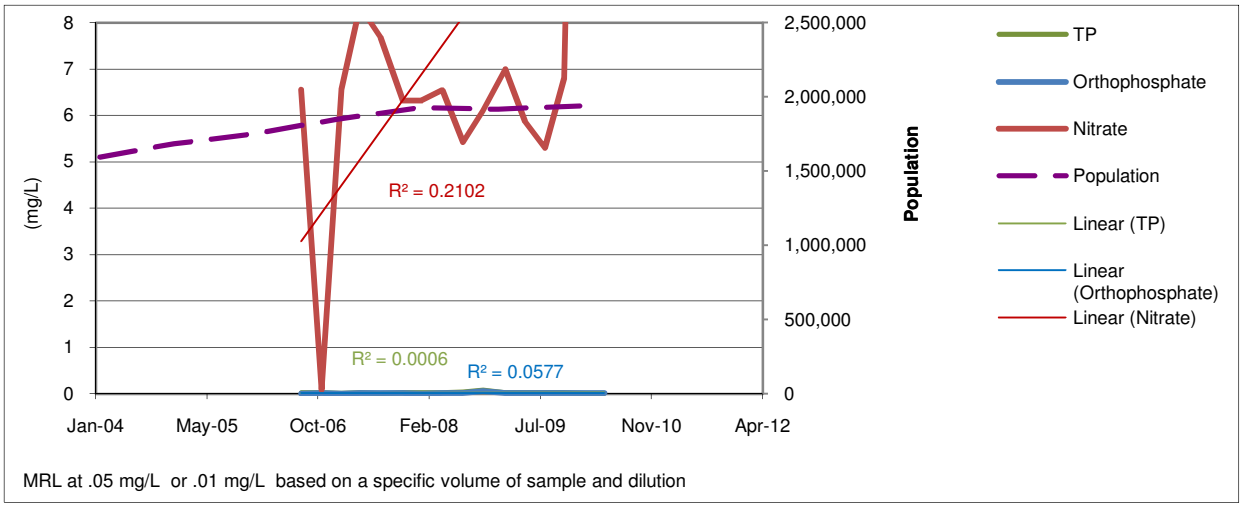

MRL at .05 mg/L or .01 mg/L based on a specific volume of sample and dilution

## Figure 70. Monson Channel Nutrients 2000-2010



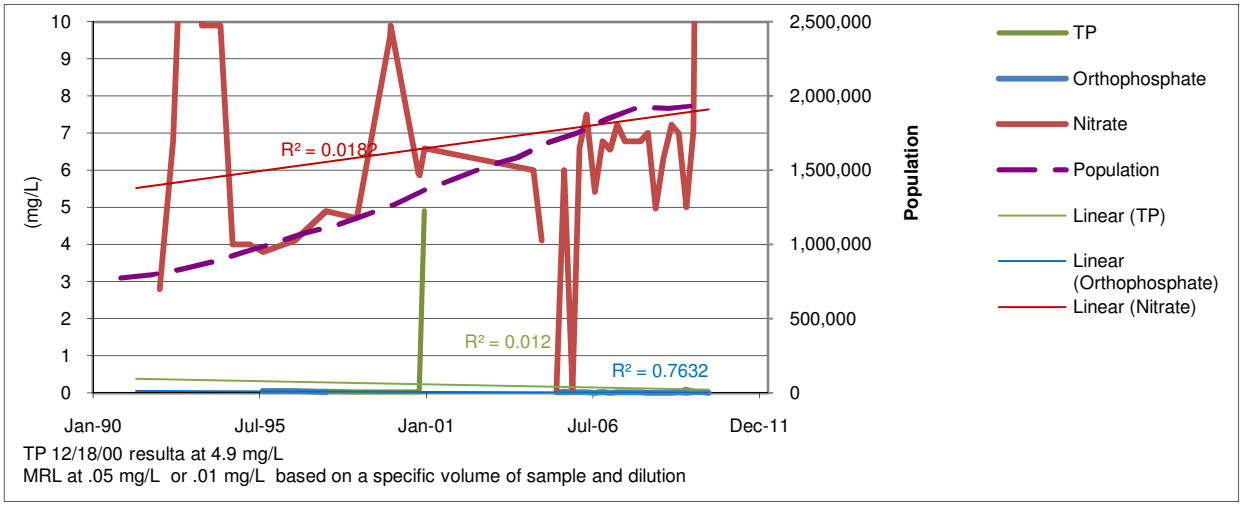

TP results .08 mg/L or lower. Nitrate 1/26/10 result at 20 mg/L
MRL at .05 mg/L or .01 mg/L based on a specific volume of sample and dilution

## Figure 71. Burns Nutrients 2006 – 2010




MRL at .05 mg/L or .01 mg/L based on a specific volume of sample and dilution

## Figure 72. Duck Creek Nutrients 1991-2000, 2004 – 2010




TP 12/18/00 resulta at 4.9 mg/L
MRL at .05 mg/L or .01 mg/L based on a specific volume of sample and dilution

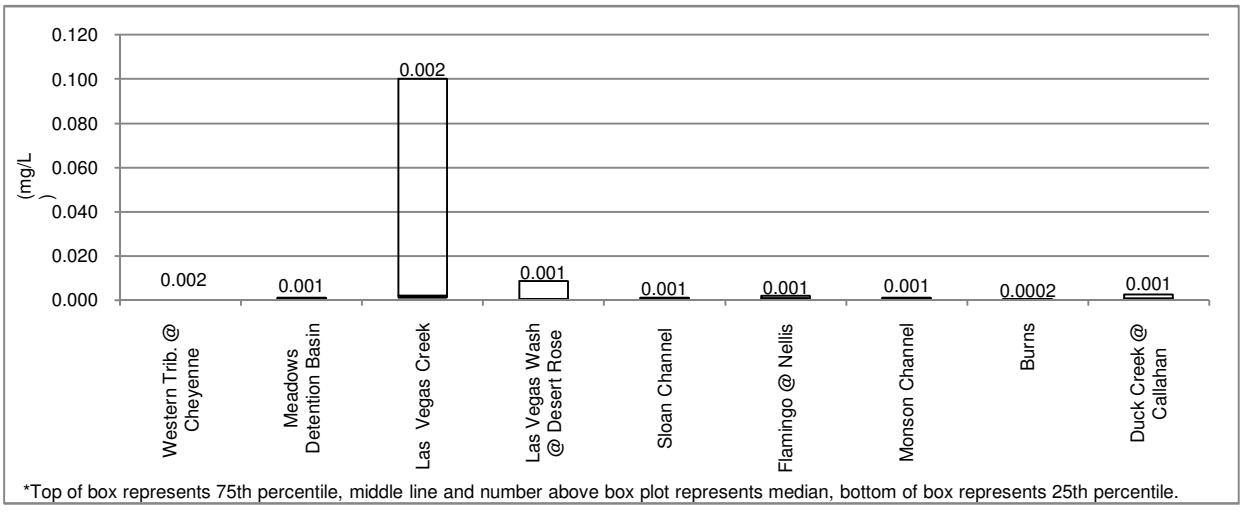
### 4.1.3 Metals

Dry weather data from 1991-2010 was analyzed for total lead, total copper, total zinc and selenium. **Table 18** represents the 1991-2010 median for all sites combined and historic range of the constituents. **Figures 73-85** display the data as stated in Section 4.1. Dry weather data for total lead seems consistent from upstream to downstream with a median of 0.002 mg/L. There is no trend for total copper. Total zinc has a slight downward trend from upstream to downstream possibly attributed to geology. Selenium has a slight upward trend from upstream to downstream, reflecting an increasing influence of shallow groundwater recharge.

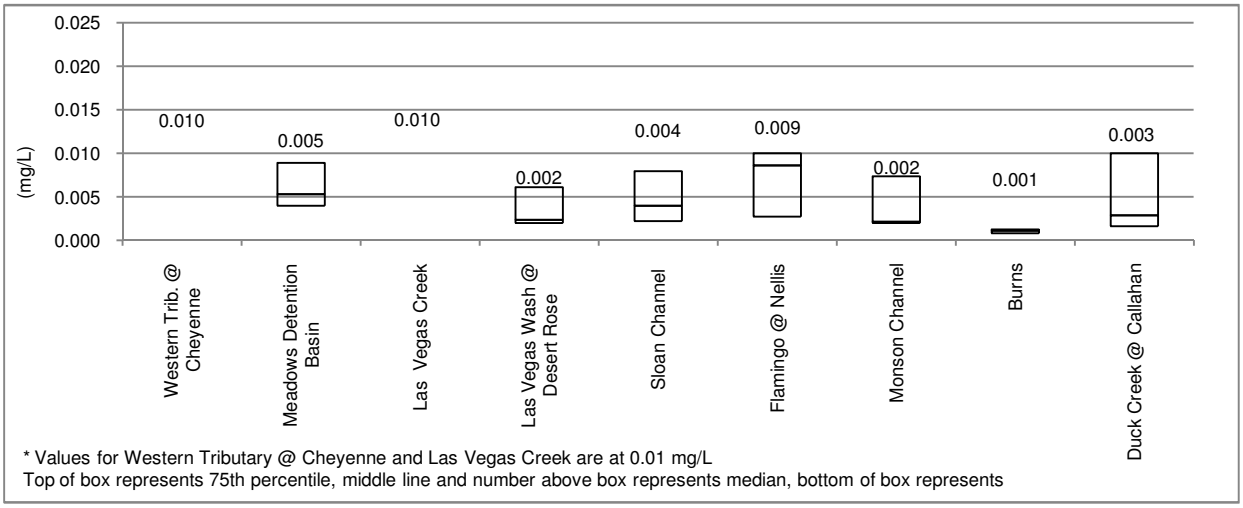
**Table 18. Dry Weather Total Metals**

| Constituent | Median Concentration (mg/L) | Historical Range (mg/L) |
|---|---|---|
| Total Lead | 0.0007 | 0.00002 - 0.1 |
| Total Copper | 0.006 | 0.0007 - 0.15 |
| Total Zinc | 0.02 | 0.0001 - 0.5 |
| Selenium | 0.011 | 0.001 - 0.07 |

**Figure 73. Dry Weather Total Lead vs Location 199-2010**

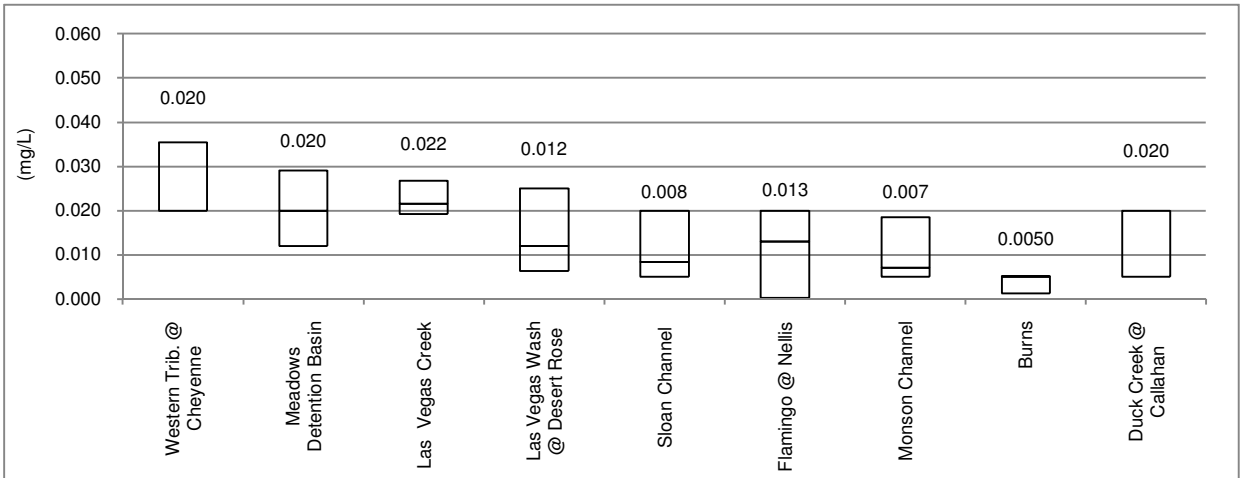


## Figure 74. Dry Weather Total Copper vs. Location 1991-2010



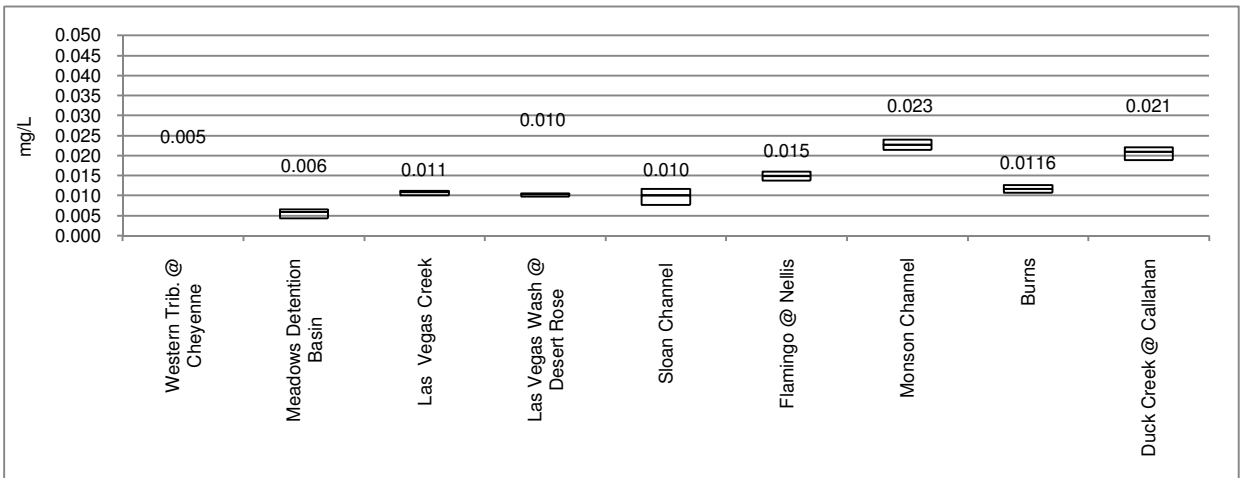

* Values for Western Tributary @ Cheyenne and Las Vegas Creek are at 0.01 mg/L
Top of box represents 75th percentile, middle line and number above box represents median, bottom of box represents

## Figure 75. Dry Weather Total Zinc vs. Location 1991-2010



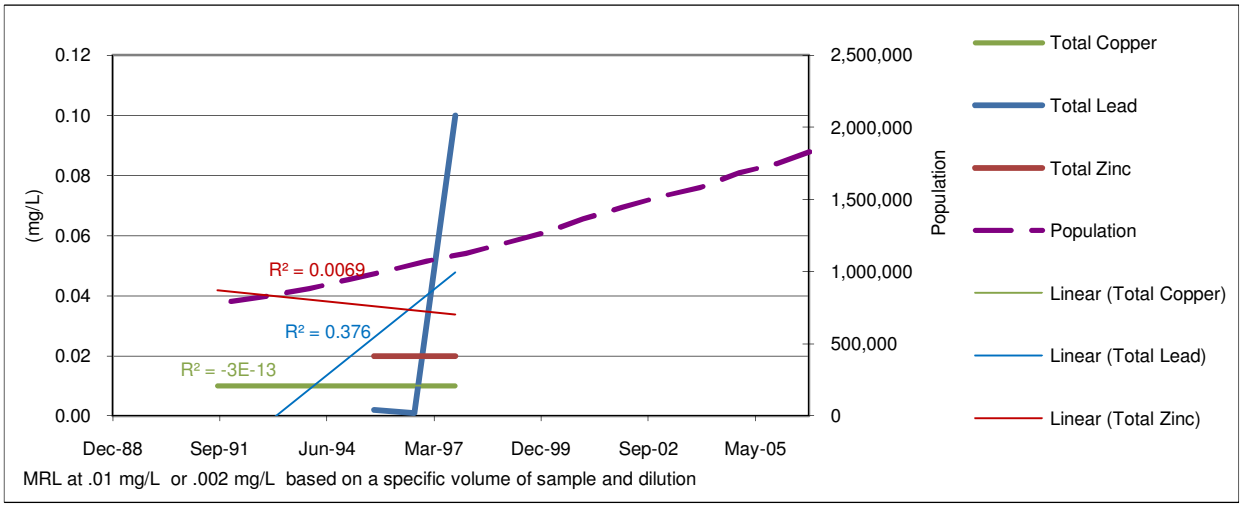

*Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 76. Dry Weather Selenium vs. Location 1991-2010

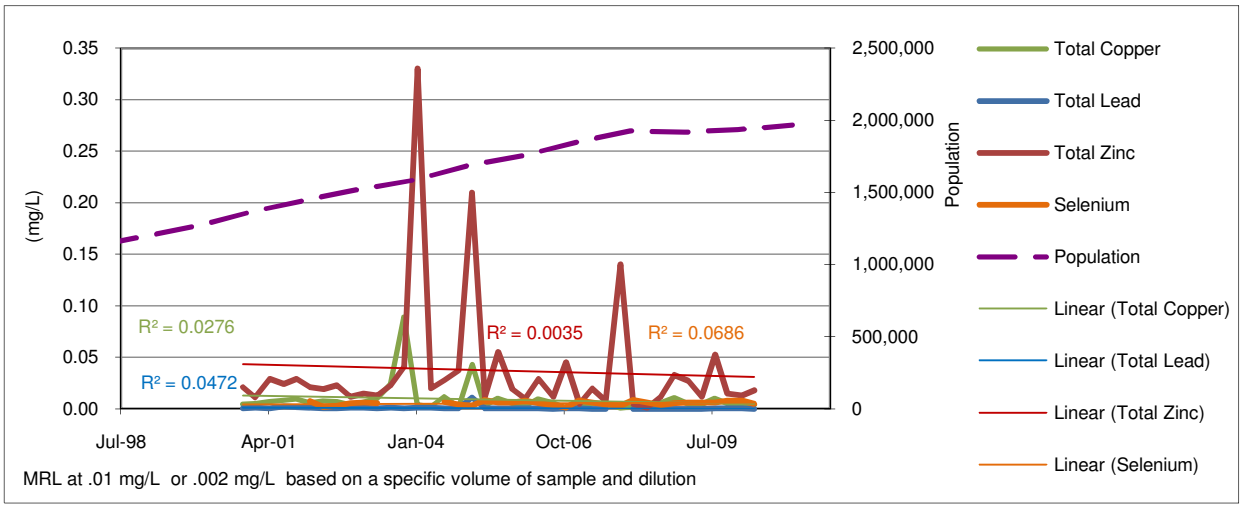



*Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

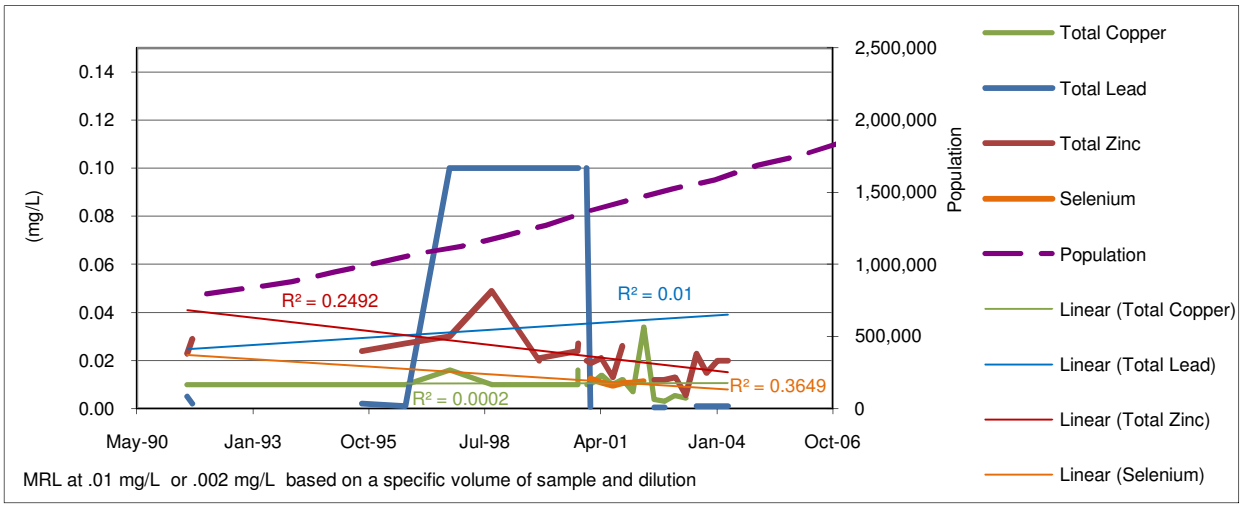
## Figure 77. Western Tributary @ Cheyenne Metals 1992-1997



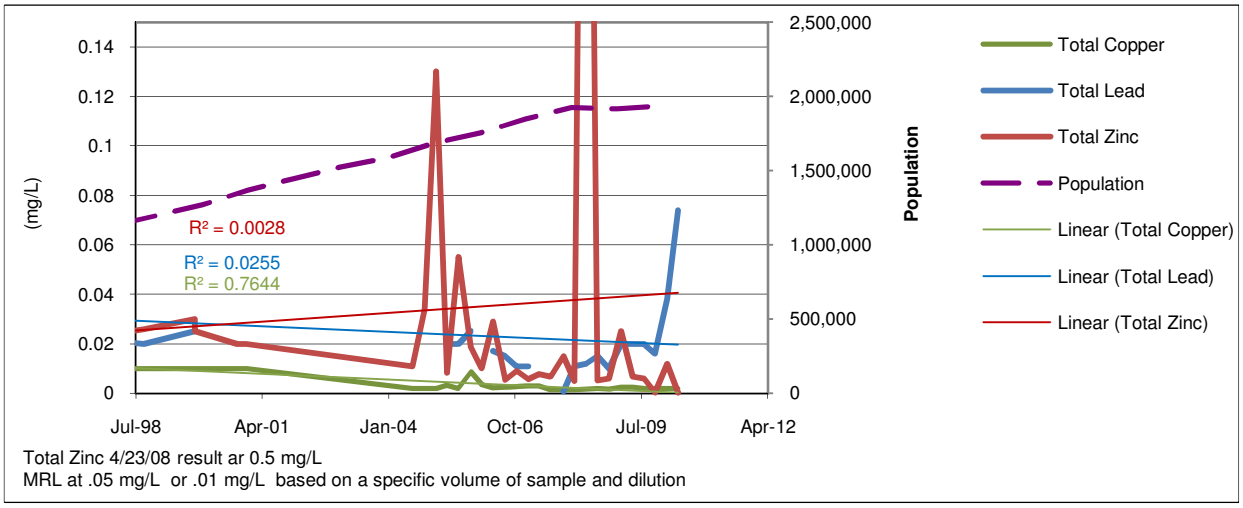

## Figure 78. Meadows Detention Basin Metals 2000 – 2010




## Figure 79. Las Vegas Creek Metals

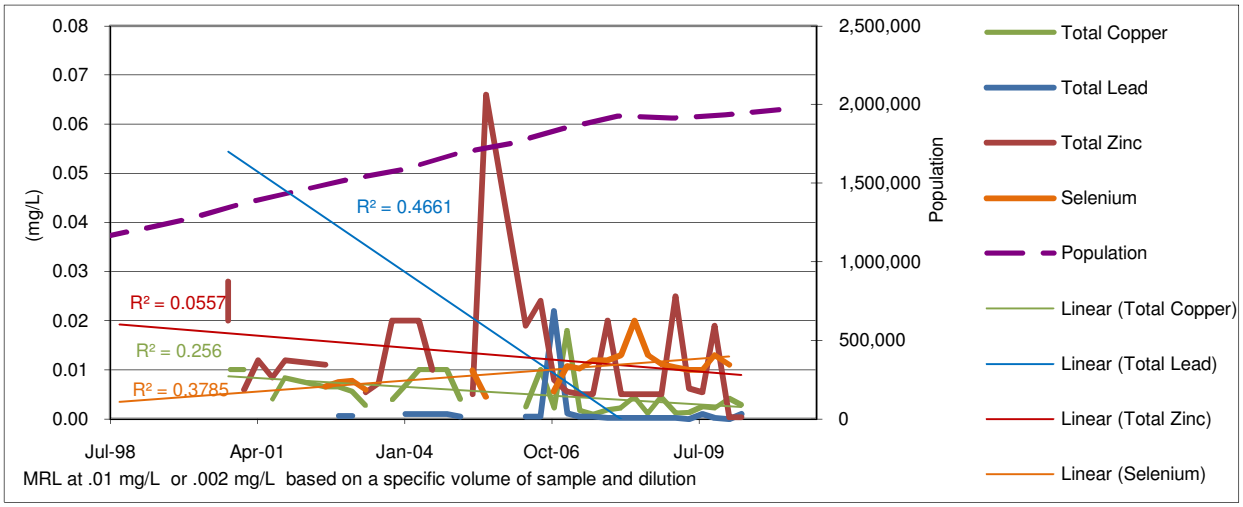


## Figure 80. Las Vegas Wash @ Desert Rose Metals



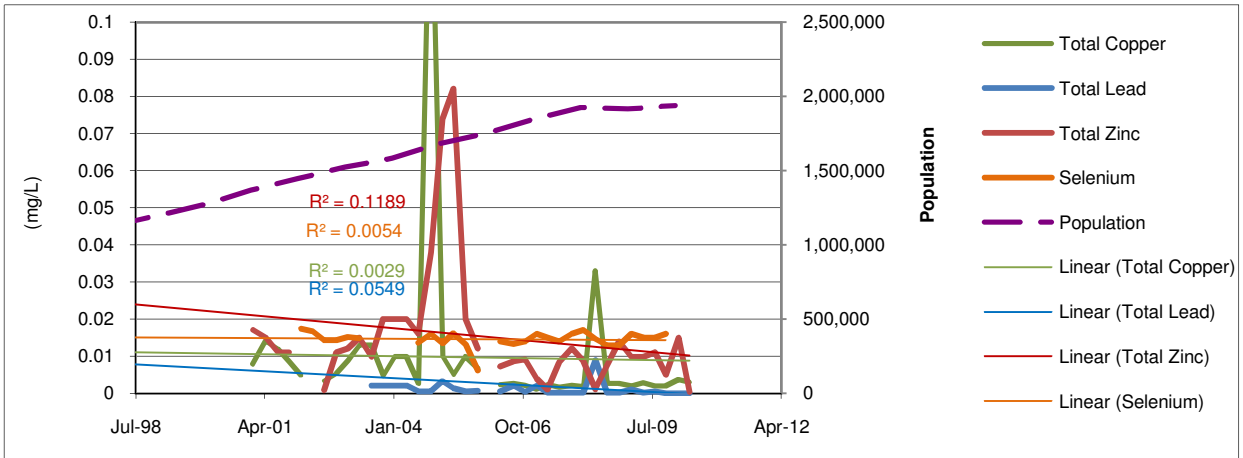

Total Zinc 4/23/08 result ar 0.5 mg/L
MRL at .05 mg/L or .01 mg/L based on a specific volume of sample and dilution

## Figure 81. Sloan Channel Metals 2000 – 2010



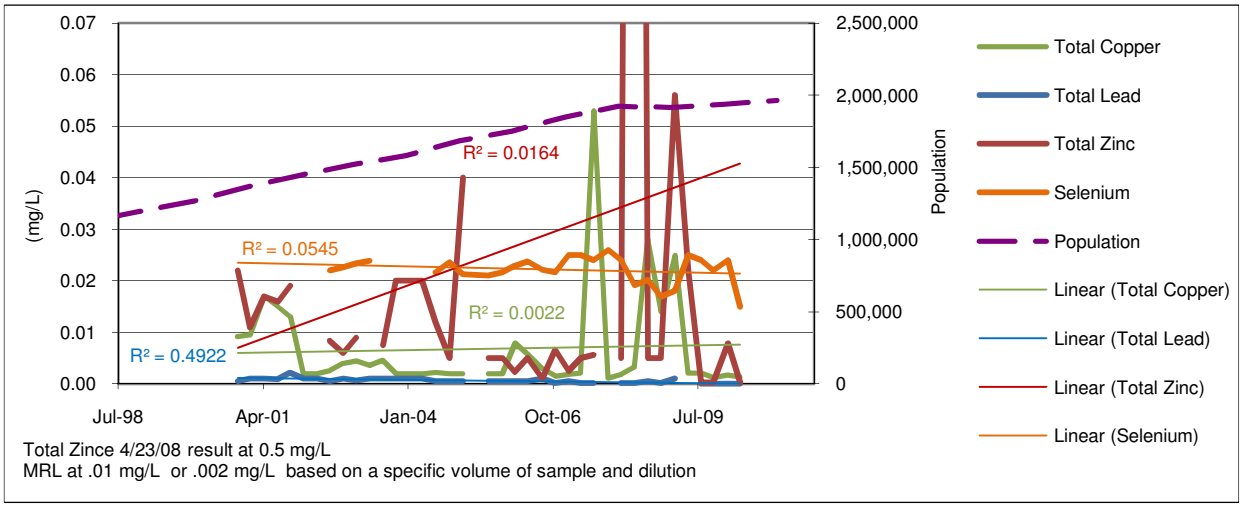

MRL at .01 mg/L or .002 mg/L based on a specific volume of sample and dilution

## Figure 82. Flamingo @ Nellis Metals 1991-1997, 2001-2010



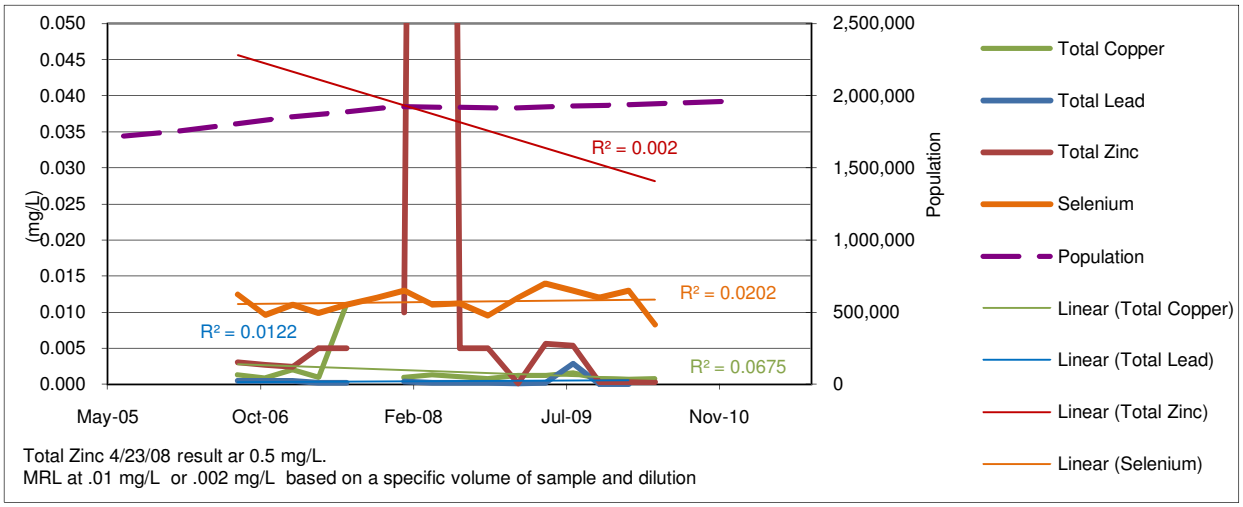

MRL at .05 mg/L or .01 mg/L based on a specific volume of sample and dilution

## Figure 83. Monson Channel Metals 2000-2010



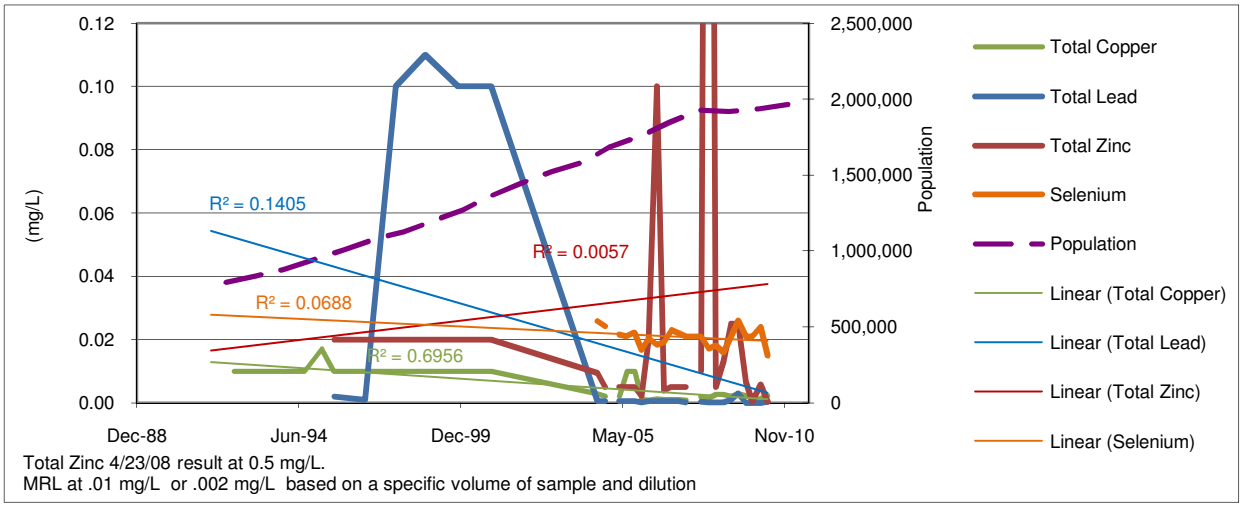

Total Zince 4/23/08 result at 0.5 mg/L
MRL at .01 mg/L or .002 mg/L based on a specific volume of sample and dilution

## Figure 84. Burns Metals 2006 – 2010




Total Zinc 4/23/08 result ar 0.5 mg/L.
MRL at .01 mg/L or .002 mg/L based on a specific volume of sample and dilution

## Figure 85. Duck Creek Metals 1991-2000, 2004 – 2010




Total Zinc 4/23/08 result at 0.5 mg/L.
MRL at .01 mg/L or .002 mg/L based on a specific volume of sample and dilution

### 4.1.4 Bacteria

Dry weather data from 1991-2010 was analyzed for bacteria. **Table 19** represents the 1991-2010 median for all sites combined and historic range of the constituents.

**Table 19. Dry Weather Bacteria**

| Constituent | Median (MPN/100 mL) | Historical Range (MPN/100 mL) |
|---|---|---|
| Fecal Coliform | 665 | 4-80,000 |
| Fecal Strep. | 1,025 | 16-24,000 |

### 4.1.5 Semivolatile Organic Compounds and Volatile Organic Compounds

Dry weather data from 2000-2010 was analyzed for semivolitile organic compounds and volatile organic compounds. **Table 20** represents the 2000-2010 median number of detections for all sites combined and historic range for detections of the constituents. Of the semivolatile organic compounds detected, caffeine, Di-2-(ethylhexyl)phthalate were detected most often. Of the volatile organic compounds detected, formaldehyde, M-glyoxal (pyruvic aldehyde), and acetaldehyde were detected most often.

**Table 20. Dry Weather Semivolatile Organic Compounds and Volatile Organic Compounds**

| Constituent | Median # of detections / year | Historical Range # of detections / year |
|---|---|---|
| SOC | 0 | 0 - 3 |
| VOC | 1 | 0 - 10 |

### 4.1.6 Pesticides and Herbicides

Dry weather data from 2000-2010 was analyzed for pesticides and herbicides. **Table 21** represents the 2000-2010 median number of detections for all sites combined and historic range for detections of the constituents. Of the pesticides, Surrogate: TCmX(%) and Beta-BHC were detected most often. Of the herbicides detected. (DCPA) Mono&Diacid Degradate were detected most often.

**Table 21. Dry Weather Pesticides and Herbicides Compounds**

| Constituent | Median # of detections / year | Historical Range # of detections / year |
|---|---|---|
| Pesticides | 0 | 0 - 3 |
| Herbicides | 0 | 0 - 4 |

### 4.1.7 Water Quality Standards

**Table 22** presents surface waters in Las Vegas Valley that are listed as impaired by the State of Nevada. The table also lists the applicable water quality standards. **Table 23** lists whether the dry weather sampling for the MS4 program showed exceedances of these standards and at what site the standard was exceeded for TDS and selenium. Exceedances for TDS, acute selenium and chronic selenium are based individual samples. The numbers of exceedances are provided over the total amount of samples. TDS standards were not exceeded at Meadows and Flamingo Wash @ Swenson. Selenium standards were not exceeded for acute and chronic samples at Western Tributary @ Cheyenne and Flamingo Wash @ Swenson.

## Table 22. Las Vegas Valley Impaired Waters

| Stream Segment | Impairments[1] | Water Quality Standards[2] |
|---|---|---|
| Las Vegas Wash – Telephone Line Road to Lake Mead | Iron<br>Molybdenum | 1 mg/L<br>19 ug/L |
| Flamingo Wash – above Las Vegas Wash | Selenium<br>TDS | 0.005 mg/L chronic,<br>0.020 mg/L acute<br>3,000 mg/L |
| Duck Creek – origin to Las Vegas Wash | Selenium<br>TDS | 0.005 mg/L chronic<br>0.020 mg/L acute<br>3,000 mg/L |
| Las Vegas Creek – origin to Las Vegas Wash | Selenium<br>pH | 0.005 mg/L chronic<br>0.020 mg/L acute<br>6.5 – 9.0 |
| Las Vegas Wash – upstream of wastewater treatment plants | Selenium<br>TDS<br>Iron | 0.005 mg/L chronic<br>0.020 mg/L acute<br>3,000 mg/L<br>1 mg/L |

Notes:

[1] Nevada 303(d) List of Impaired Waters, 2006

[2] Per Nevada Administrative Code 445A

## Table 23. Dry Weather Sample Exceedances of Water Quality Standards for Impaired Waters

| Site | Years When TDS was Sampled | No. of TDS Exceedances / Total No. of Samples | Years When Selenium was Sampled | No. of Acute Selenium Exceedances / Total No. of Samples | No. of Chronic Selenium Exceedances / Total No. of Samples |
|---|---|---|---|---|---|
| Western Tributary | 1991-1997 | 1/11 | 1993-1995 | 0/3 | 0/3 |
| Meadows | 2000-2010 | 0/41 | 2000-2010 | 1/36 | 23/36 |
| Las Vegas Creek | 1991-2004 | 8/31 | 1993-1995<br>2003-2004 | 0/11 | 5/11 |

| Site | Years When TDS was Sampled | No. of TDS Exceedances / Total No. of Samples | Years When Selenium was Sampled | No. of Acute Selenium Exceedances / Total No. of Samples | No. of Chronic Selenium Exceedances / Total No. of Samples |
|---|---|---|---|---|---|
| Las Vegas Wash Desert Rose | 1997-2010 | 30/45 | 2002-2010 | 0/31 | 31/31 |
| Sloan Channel | 1998, 2000-2010 | 1/37 | 2002-2010 | 1/32 | 28/38 |
| Flamingo Wash @ Swenson | 1991-1997 | 0/11 | 1993-1995 | 0/3 | 0/3 |
| Flamingo Wash @ Nellis | 1991-1997, 2001-2010 | 34/50 | 1993-1995 2002-2004 | 2/34 | 17/34 |
| Monson | 2000-2010 | 38/39 | 2000-2010 | 29/38 | 30/38 |
| Burns | 2006-2010 | 17/17 | 2006-2010 | 0/17 | 17/17 |
| Duck Creek @ Broadbent | 1991-2000 | 48/51 | 1993-1995 2000-2010 | 25/33 | 33/33 |
| Duck Creek @ Patrick | 1991-2003 | 24/25 | 1993-1995 2002-2003 | 7/8 | 7/8 |

Notes: TDS, Acute Selenium and Chronic Selenium exceedance based on individual Samples.

## 4.2 Findings

The data suggest the following for dry weather monitoring.

- TDS concentrations have an increasing trend from upstream to downstream. TSS has a slight increasing trend from upstream to downstream.
- TDS concentrations versus growth in population in the Las Vegas Valley show high and low concentrations overtime. Slight trends could be easily influenced depending on dataset size and variability of results.
- Total phosphorus concentrations do not show a trend upstream to downstream. Orthophosphate concentration trends are generally consistent between sites from upstream to downstream. Nitrate concentrations have an increasing trend from upstream to downstream.
- Nutrient concentrations versus growth in population in the Las Vegas Valley show high and low concentrations overtime. Slight trends could be easily influenced depending on dataset size and variability of results.
- Total lead concentrations from upstream to downstream trends are generally consistent between sites from upstream to downstream. Total copper concentrations do not show a trend upstream to downstream. Total zinc concentrations show a downward trend from upstream to

downstream. Selenium shows an upward trend from upstream to downstream.

- Metal concentrations versus growth in population in the Las Vegas Valley show high and low concentrations overtime. Slight trends could be easily influenced depending on dataset size and variability of results.

Based on this data review, the following conclusions can be made.

- Despite some minor temporal trends in some constituents, the overall data indicates that dry weather pollutant concentrations have not increased over the past 20 years despite significant increases in population and urban development in the watersheds. This suggests that the stormwater management measures targeting dry weather flows have been reasonably successful at mitigating water impacts of urban development in Las Vegas Valley.
- The most significant spatial trends are associated with the influence of seepage from the shallow groundwater aquifer in Lower Las Vegas Wash and its tributaries.
- Water quality standard exceedances of TDS and selenium in dry weather flows is due primarily to seepage from the shallow groundwater aquifer rather than urban runoff. Management practices that reduce infiltration of stormwater or applied irrigation water to the shallow aquifer would help mitigation this condition.
- The variability in dry weather constituent concentrations is typically much less than in the wet weather monitoring program.
- Because the volume of wastewater effluent discharge is much greater than the dry weather urban runoff volume, dry weather constituent concentrations in Las Vegas Wash downstream of the wastewater treatment plant discharges are more strongly affected by the wastewater effluent quality than by urban runoff quality.

# 5 Findings of Special Studies

## 5.1 Detention Basin Monitoring

The detention basin monitoring program was implemented in the 2005-2006 permit year. The program was suspended during the 2008-2009 permit year because the Co-Permittees determined that more rigorous and expensive sampling methods would be needed to get defensible results. Although there is not enough data to perform significant statistical analyses some overall conclusions can be made. Detention Basin Monitoring Events and Data Summary

Samples were collected from three storms per basin per permit year. **Table 24** below summarizes the sampling location date, type of sample, and results for each constituent for the program. **Table 25** lists the detention basin most effective at reducing concentrations of each constituent. In the case of dissolved copper, dissolved lead, orthophosphorus and fecal coliforms, none of the detention basins showed any consistent effectiveness in pollution removal.

## Table 24. 2005 – 2008 Detention Basin Monitoring Program Data Summary

| | | TDS (mg/L) | | TSS (mg/L) | | Turbidity (NTU) | | Total Copper (mg/L) | | Dissolved Copper (mg/L) | | Total Lead (mg/L) | | Dissolved Lead (mg/L) | | Total Zinc (mg/L) | | Dissolved Zinc (mg/L) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Basin | Inflow | Outflow | Inflow | Outflow | Inflow | Outflow | Inflow | Outflow | Inflow | Outflow | Inflow | Outflow | Inflow | Outflow | Inflow | Outflow | Inflow | Outflow |
| 10/18/05 | Lower Las Vegas | 180 | 150 | 1,090 | 1,220 | 1,100 | 1,070 | 0.033 | 0.023 | 0.022 | 0.0043 | 0.014 | 0.0089 | 0.013 | <0.0005 | 0.13 | 0.08 | 0.094 | <0.005 |
| 6/7/06 | Lower Las Vegas | 404 | 384 | 257 | 403 | 285 | 420 | 0.042 | 0.0051 | 0.036 | 0.046 | 0.0072 | 0.0088 | 0.0062 | 0.0082 | 0.17 | 0.14 | 0.17 | 0.13 |
| 10/5/06 | Lower Las Vegas | 436 | 268 | 191 | 219 | 174 | 173 | 0.029 | 0.036 | 0.0026 | 0.013 | 0.0036 | 0.0046 | <0.0005 | <0.0005 | 0.094 | 0.13 | 0.011 | 0.009 |
| 10/14/06 | Lower Las Vegas | 144 | 246 | 1,990 | 2,500 | 2,140 | 2,030 | 0.038 | 0.041 | 0.0033 | 0.0034 | 0.019 | 0.031 | <0.0005 | <0.0005 | 0.16 | 0.18 | <0.005 | <0.005 |
| 4/16/07 | Lower Las Vegas | 256 | 260 | 105 | 165 | 156 | 143 | 0.035 | 0.036 | 0.024 | 0.019 | 0.0034 | 0.0035 | <0.0005 | <0.0005 | 0.076 | 0.076 | 0.026 | 0.023 |
| 7/24/07 | Lower Las Vegas | 526 | 516 | 218 | 466 | 474 | 492 | 0.023 | 0.023 | 0.013 | 0.013 | 0.0081 | 0.0091 | <0.0050 | <0.0050 | 0.059 | 0.067 | <0.005 | <0.005 |
| 8/1/07 | Lower Las Vegas | 162 | 260 | 1760 | 1230 | 1170 | 524 | 0.089 | 0.028 | 0.0074 | 0.0083 | 0.016 | 0.0029 | <0.00050 | <0.00050 | 0.210 | 0.081 | <0.005 | 0.0077 |
| 7/29/05 | Meadows Detention Basin | 210 | 300 | 300 | 140 | 131 | 100 | 0.16 | 0.087 | <0.002 | 0.0048 | 0.05 | 0.015 | <0.0005 | <0.0005 | 0.45 | 0.23 | 0.0059 | 0.018 |
| 10/18/05 | Meadows Detention Basin | 51 | 110 | 110 | 76 | 70 | 43 | 0.033 | 0.046 | 0.038 | 0.042 | 0.022 | 0.0074 | 0.022 | 0.0064 | 0.015 | 0.11 | 0.145 | 0.105 |
| 10/14/06 | Meadows Detention Basin | 72 | 474 | 194 | 44 | 115 | 42 | 0.062 | 0.017 | 0.0073 | 0.005 | 0.032 | 0.0036 | <0.0005 | <0.0005 | 0.28 | 0.058 | 0.011 | 0.026 |
| 8/1/07 | Meadows Detention Basin | 162 | 250 | 240 | 194 | 165 | 153 | 0.042 | 0.040 | 0.0086 | 0.012 | 0.0088 | 0.0086 | 0.00057 | 0.00068 | 0.17 | 0.150 | 0.039 | 0.051 |
| 8/27/07 | Meadows Detention Basin | 364 | 174 | 519 | 256 | 0.029 | 0.023 | 0.011 | 0.009 | 0.0036 | 0.014 | 0.0012 | 0.0005 | 0.0013 | 0.001 | 0.49 | 0.18 | 0.029 | 0.023 |
| 10/18/05 | Upper Flamingo Wash | 82 | 150 | 140 | 170 | 129 | 199 | 0.04 | 0.026 | 0.034 | 0.042 | 0.0041 | 0.0036 | 0.0034 | 0.003 | 0.22 | 0.065 | 0.215 | 0.057 |
| 10/25/05 | Upper Flamingo Wash | 150 | 150 | 460 | 350 | 434 | 472 | 0.038 | 0.021 | 0.0074 | 0.0053 | 0.0063 | 0.0067 | <0.0005 | <0.0005 | 0.061 | 0.058 | <0.005 | <0.005 |
| 7/18/06 | Upper Flamingo Wash | 770 | 354 | 5,830 | 27 | 2,090 | 26 | 0.036 | 0.0088 | 0.0028 | 0.0088 | 0.022 | <0.0005 | <0.00005 | <0.00005 | 0.18 | 0.017 | <0.005 | 0.011 |
| 10/14/06 | Upper Flamingo Wash | 174 | 122 | 886 | 960 | 728 | 778 | 0.023 | 0.043 | 0.0036 | 0.0038 | 0.013 | 0.013 | <0.0005 | <0.0005 | 0.095 | 0.11 | <0.005 | <0.005 |
| 4/16/07 | Upper Flamingo Wash | 342 | 468 | 210 | 160 | 78 | 127 | 0.07 | 0.089 | 0.017 | 0.022 | 0.0056 | 0.0064 | <0.0005 | <0.0005 | 0.210 | 0.270 | 0.063 | 0.096 |
| 8/1/07 | Upper Flamingo Wash | 266 | 226 | 2,690 | 696 | 1770 | 566 | 0.0072 | 0.018 | 0.0055 | 0.043 | 0.0011 | 0.0088 | <0.005 | <0.0005 | <0.020 | 0.08 | 0.017 | <0.005 |
| 8/27/07 | Upper Flamingo Wash | 198 | 160 | 1,340 | 129 | 964 | 151 | 0.007 | 0.006 | 0.0049 | 0.0037 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.024 | 0.025 | <0.0005 | <0.0005 |
| 9/22/07 | Upper Flamingo Wash | 104 | 110 | 315 | 1,800 | 207 | 1252 | 0.018 | 0.014 | 0.0130 | 0.016 | 0.004 | 0.0038 | 0.0036 | 0.011 | 0.064 | 0.042 | 0.059 | 0.080 |
| 1/5/08 | Upper Flamingo Wash | 60 | 180 | 194 | 288 | 55 | 173 | 0.034 | 0.057 | 0.011 | 0.024 | 0.0032 | 0.0052 | <0.0005 | <0.0005 | <0.1 | 0.130 | <0.0020 | <0.020 |

| | | Nitrate-N (mg/L) | | Ortho-P (mg/L) | | Total P (mg/L) | | F. Coliform (MPN/100 mL) | | F. Strep (MPN/100 mL) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Basin | Inflow | Outflow | Inflow | Outflow | Inflow | Outflow | Inflow | Outflow | Inflow | Outflow |
| 10/18/05 | Lower Las Vegas | 1.5 | 1.3 | 0.156 | 0.183 | 0.79 | 0.72 | 22,000 | 30,000 | 90,000 | 110,000 |
| 6/7/06 | Lower Las Vegas | 4.6 | 4.3 | 0.056 | 0.37 | 0.51 | 0.42 | 2,400 | 800 | 90,000 | 30,000 |
| 10/5/06 | Lower Las Vegas | 16 | 1.4 | 0.36 | 0.45 | 0.3 | 0.34 | 24,000 | 3,000 | 24,000 | 24,000 |
| 10/14/06 | Lower Las Vegas | 0.9 | 1.8 | 0.04 | 0.03 | 1.2 | 1.2 | 16,000 | 22,000 | 110,000 | 22,000 |
| 4/16/07 | Lower Las Vegas | 1.80 | 1.80 | 0.29 | 0.47 | 0.4 | 0.45 | 50 | 1,600 | 24,000 | 2,400 |
| 7/24/07 | Lower Las Vegas | 4.0 | 4.0 | 1.25 | 1.45 | 1.3 | 0.57 | >1,600,000 | >1,600,000 | 240,000 | 50,000 |
| 8/1/07 | Lower Las Vegas | 1.5 | 1.8 | 1.90 | 0.88 | 0.96 | 0.61 | 160000 | 240000 | 170000 | 90,000 |
| 7/29/05 | Meadows Detention Basin | 0.15 | <0.1 | 0.015 | 0.071 | 0.58 | 0.55 | >1,600,000 | >1,600,000 | 11,000 | 30,000 |
| 10/18/05 | Meadows Detention Basin | 0.22 | 0.51 | 0.072 | 0.084 | 0.24 | 0.38 | 30,000 | >1,600,000 | 17,000 | 90,000 |
| 10/14/06 | Meadows Detention Basin | 0.6 | 0.5 | 0.22 | 0.11 | 0.59 | 0.28 | 30,000 | 50,000 | 30,000 | 170,000 |
| 8/1/07 | Meadows Detention Basin | 2.3 | 2.2 | 0.71 | 0.67 | 0.76 | 0.75 | 110000 | 160000 | 17,000 | 160,000 |
| 8/27/07 | Meadows Detention Basin | <0.44 | 1.10 | 0.48 | 0.66 | 0.82 | 0.84 | >1,600,000 | >1,600,000 | NA | NA |
| 10/18/05 | Upper Flamingo Wash | 0.34 | 0.61 | 0.069 | 0.075 | 0.29 | 0.29 | 500 | 9,000 | 28,000 | 11,000 |
| 10/25/05 | Upper Flamingo Wash | 1.5 | 1.2 | 0.102 | 0.08 | 0.4 | 0.3 | 24,000 | 2,400 | 9,000 | 5,000 |
| 7/18/06 | Upper Flamingo Wash | 2.7 | 1.2 | 0.22 | 0.02 | 1.7 | 0.19 | 2,400 | 160,000 | 500 | 90,000 |
| 10/14/06 | Upper Flamingo Wash | 0.8 | 0.5 | 0.26 | 0.11 | 1 | 0.75 | 17,000 | 50,000 | 30,000 | 5,000 |
| 4/16/07 | Upper Flamingo Wash | 2.2 | 3.0 | 0.58 | 0.41 | 0.89 | 0.88 | 1,600 | 300 | 30,000 | 17,000 |
| 8/1/07 | Upper Flamingo Wash | 1.2 | 1.3 | 3.1 | 0.93 | 2.1 | 0.74 | 30,000 | 16,000 | 300,000 | 50,000 |

## Table 24. 2005-2008 Detention Basin Monitoring Program Data Summary (Continued)

| | | Nitrate-N (mg/L) | | Ortho-P (mg/L) | | Total P (mg/L) | | F. Coliform (MPN/100 mL) | | F. Strep (MPN/100 mL) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Basin | Inflow | Outflow | Inflow | Outflow | Inflow | Outflow | Inflow | Outflow | Inflow | Outflow |
| 8/27/07 | Upper Flamingo Wash | 1.5 | 1.3 | 0.156 | 0.183 | 0.79 | 0.72 | 22,000 | 30,000 | 90,000 | 110,000 |
| 9/22/07 | Upper Flamingo Wash | 4.6 | 4.3 | 0.056 | 0.37 | 0.51 | 0.42 | 2,400 | 800 | 90,000 | 30,000 |
| 1/5/08 | Upper Flamingo Wash | 16 | 1.4 | 0.36 | 0.45 | 0.3 | 0.34 | 24,000 | 3,000 | 24,000 | 24,000 |

Assumptions: concentrations reported as less than the method detection limit were assumed to be equal to the method detection limit for statistical analyses.

## Table 25. 2005-2008 Most Effective Detention Basin by Constituent

| Constituent | Detention Basin with Most Effective Concentration Reduction Performance |
|---|---|
| TSS | Meadows |
| TDS | Lower Las Vegas Wash |
| Turbidity | Meadows |
| Total Copper | Meadows |
| Dissolved Copper | None |
| Total Lead | Meadows |
| Dissolved Lead | None |
| Total Zinc | Meadows |
| Dissolved Zinc | Lower Las Vegas Wash |
| Nitrate | Lower Las Vegas Wash |
| Orthophosphorus | None |
| Total Phosphorus | Meadows |
| Fecal Coliform | None |
| Fecal Strep. | Low Las Vegas Wash, Upper Flamingo Wash |

- Detention basin monitoring data for permit years 2005-2006 through 2007-2008 suggests that existing regional detention basins provide moderate benefits for reducing certain constituent concentrations. These benefits apply more significantly to constituents occurring primarily in particulate form, but results can vary widely from storm to storm and from site to site. The detention basin monitoring program did not sample for reduction in sediment load between inflows and outflows. However, detention basin maintenance demonstrates that the basins are effective in retaining sediment and preventing it from being conveyed into Las Vegas Wash and Lake Mead.

- Overall, the three existing detention basins sampled to date are somewhat effective at reducing concentrations of the constituents analyzed.

- As expected, data demonstrates that detention basins are more effective at removing particulate constituents than dissolved constituents. Concentrations of primarily particulate constituents were reduced in 54 percent of the sample events, whereas concentrations of primarily dissolved constituents were reduced in only 41 percent of the sample events.

- Detention basins reduced the total metal concentrations in half of the sample sets while the dissolved metal concentrations were only reduced in 33 percent of the samples sets.

- Surprisingly, sediment-related constituents (TSS and turbidity) were only reduced in 54 percent of the sample sets. This may be related in part to gravel mining in Upper Flamingo Detention Basin. Based on inspection and maintenance reports, detention basins are effective in removing sediment from inflows. However, the initial sampling data suggests that suspended (fine) sediment and associated particulates are not removed as effectively, possibly due to resuspension of previously deposited material.

- Meadows Detention Basin and Upper Flamingo Wash Detention Basin reduced constituent concentrations in approximately half of the sample sets. However, Meadows Detention Basin had a higher percentage of increasing the constituent concentrations (43 percent) than did Upper Flamingo Wash Detention Basin (37 percent). Storms occurring one week apart were sampled at Upper Flamingo Wash Detention Basin. The basin showed significantly better performance in reducing constituent concentrations during the second storm; 12 constituents showed reduced concentrations or no change in the second storm, compared to 6 constituents showing reduced concentrations or no change in the first storm. This difference in performance may be evidence of the first flush effect during the first storm, or it may be due to differing effects of gravel mining occurring in the basin area.

## 5.2 Bacterial Source Identification Monitoring

### 5.2.1 Data Summary

Average wet and dry weather bacteria concentrations for all samples collected for the Source Identification program are summarized in **Table 26** and represented in **Figures 86-88**. Wet weather concentrations are about an order of magnitude greater than dry weather concentrations. This is consistent with data collected over the past seven years as part of the water quality characterization monitoring program.

**Table 26. Bacteria Concentrations from All Samples in 1998-1999 Source Identification Monitoring Program.**

| Bacteria | Dry Weather Samples (MPN/100 ml) | | Wet Weather Samples (MPN/100 ml) | |
|---|---|---|---|---|
| | Range | Average | Range | Average |
| Fecal Coliform | 23 – 6,400 | 880 | 3,300 – 18,000 | 8,500 |
| Fecal Streptococcus | 40 – 13,000 | 1,800 | 4,900 – 79,000 | 23,000 |
| E. Coli | 5 – 2,800 | 480 | 3,300 – 11,000 | 5,900 |

**Figure 86. Dry Weather Fecal Coliform Data Summary**

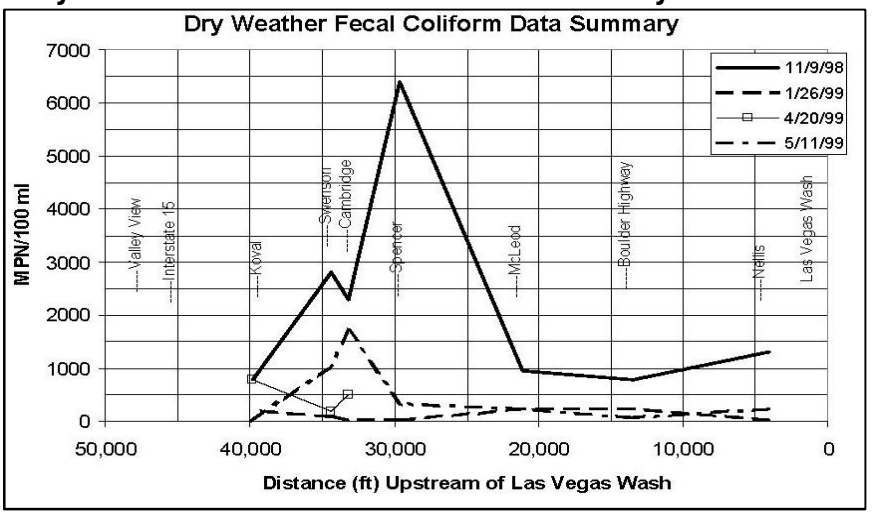


**Figure 87. Dry Weather Fecal Strep. Data Summary**

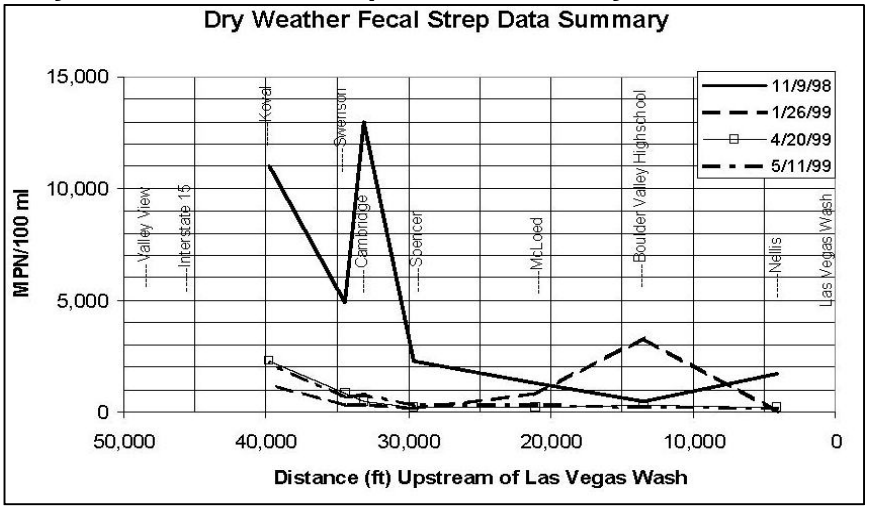
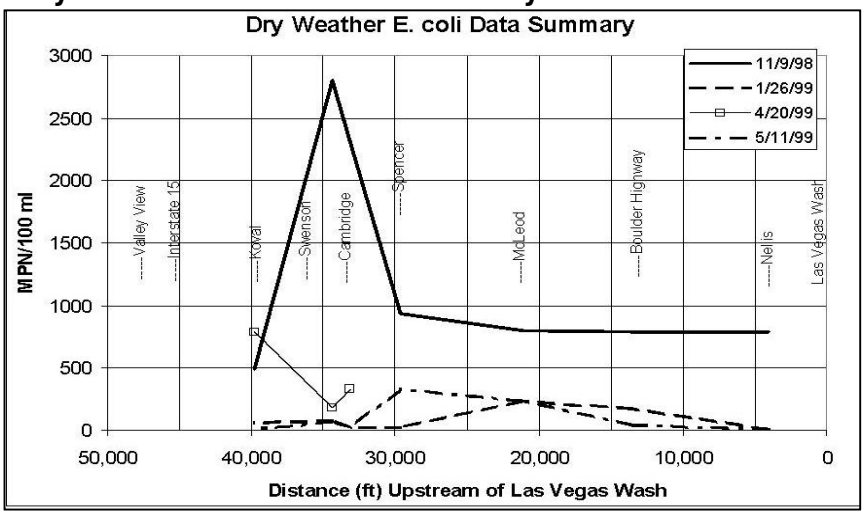



**Figure 88. Dry Weather E. coli Data Summary**




Results of the wet and dry weather bacteria concentrations for all samples collected for the Source Identification program indicate wet weather concentrations are about an order of magnitude greater than dry weather concentrations. This is consistent with data collected over the past seven years as part of the water quality characterization monitoring program.

There are no clear trends in the spatial distribution of bacteria concentrations along the portion of Flamingo Wash which was sampled. Dry weather concentrations tend to be higher downstream of the dense commercial area around Las Vegas Boulevard, but this is not a consistent occurrence.
The high degree of variability in the data does not allow specific source areas of bacteria to be isolated.

Human contributions to wet and dry weather bacteria concentrations appear to be small compared to non-human contributions. Specific non-human contributors (e.g.,

wildlife, pets) could not be identified. Bacteria sources appear to be ubiquitous in the Flamingo Wash watershed.

## 5.3 Pollutant Loads

Pollutant load is the product of flow volume and pollutant concentration. Pollutant loads in lower Las Vegas Wash were computed for 2003 to 2009 from wet and dry weather flow conditions as shown in **Table 27** and **Figures 89 through 97.** Wet weather loads were calculated using the median concentration from the samples collected from 2003 – 2009 for Las Vegas Wash below Lake Las Vegas Dam. Dry weather loads were calculated using the average of the medians of all the dry weather sites, except Meadows Detention Basin. The process for estimating the dry and wet weather flow volumes consisted of the following steps.

- Hydrologic data from 2003-2009 was used to estimate annual storm flow volumes.
- Daily streamflow data was obtained for USGS stream gages on Las Vegas Wash at Three Kids Wash and Pabco Road (depending on the year).
- Wastewater discharges from the WWTFs, as reported by the dischargers, was subtracted from the total daily streamflow to determine the total daily nonpoint flow.
- Plots of daily nonpoint streamflow were created and a typical baseflow value was selected for each day by subtracting obvious storm runoff. This baseflow represented the dry weather component of the daily nonpoint flow. Daily baseflow volumes were summed to compute the annual dry weather flow volume.
- Storm flow volumes for each day were summed for the year to compute the annual wet weather flow volume.

Some pollutants are strongly correlated to runoff rate (positive or negative), but most are not. As runoff volume increases, pollutant loads increase, even when concentrations are unchanged or even decrease Reducing runoff volume can be a means of improving downstream water quality for those constituents positively correlated to streamflow (e.g., TSS, phosphorus, total metals).

## Table 27. Pollutant Load Data Summary

| Year | Constituent | Wet Weather Median Conc. (mg/L) | Annual Load (tons) | Dry Weather Median Conc. (mg/L) | Annual Load (tons) |
|---|---|---|---|---|---|
| **2003** | Annual Flow Volume (ac-ft) | 6,490 | | 195,012 | |
| | TSS | 11,100 | 97,887 | N/A | N/A |
| | TDS | 1,160 | 10,230 | 3,200 | 847,944 |
| | Total Phosphorus | N/A | N/A | 0.05 | 12.02 |
| | Orthophosphate | N/A | N/A | 0.02 | 4.40 |
| | Nitrate | 5.02 | 44.27 | 3.90 | 1,033 |
| | Selenium | N/A | N/A | 0.02 | 3.97 |
| | Total Copper | 0.082 | 0.723 | 0.005 | 1.351 |
| | Total Lead | 0.092 | 0.811 | 0.001 | 0.254 |
| | Total Zinc | 0.350 | 3.087 | 0.010 | 2.544 |
| **2004** | Annual Flow Volume (ac-ft) | 34,100 | | 233,482 | |
| | TSS | 1,970 | 91,280 | N/A | N/A |
| | TDS | 1,120 | 51,895 | 3,240 | 1,027,908 |
| | Total Phosphorus | 2.30 | 107 | 0.02 | 6.35 |
| | Orthophosphate | 0.49 | 22.70 | 0.01 | 4.28 |
| | Nitrate | 4.70 | 218 | 4.35 | 1,380 |
| | Selenium | 0.150 | 6.950 | 0.016 | 5.076 |
| | Total Copper | 0.050 | 2.317 | 0.003 | 0.920 |
| | Total Lead | 0.050 | 2.317 | 0.001 | 0.165 |
| | Total Zinc | 0.270 | 12.510 | 0.012 | 3.807 |
| **2005** | Annual Flow Volume (ac-ft) | 5000 | | 244417 | |
| | TSS | 1,920 | 13,044 | N/A | N/A |
| | TDS | 750 | 5,095 | 3200 | 1,062,765 |
| | Total Phosphorus | 1.54 | 10.43 | 0.04 | 12.29 |
| | Orthophosphate | 0.75 | 5.13 | 0.01 | 3.65 |
| | Nitrate | 3.25 | 22.08 | 4.45 | 1,478 |
| | Selenium | 0.010 | 0.068 | 13.400 | 4450 |
| | Total Copper | 0.041 | 0.279 | 0.006 | 1.943 |
| | Total Lead | 0.044 | 0.296 | 0.003 | 0.897 |
| | Total Zinc | 0.114 | 0.771 | 0.040 | 13.285 |

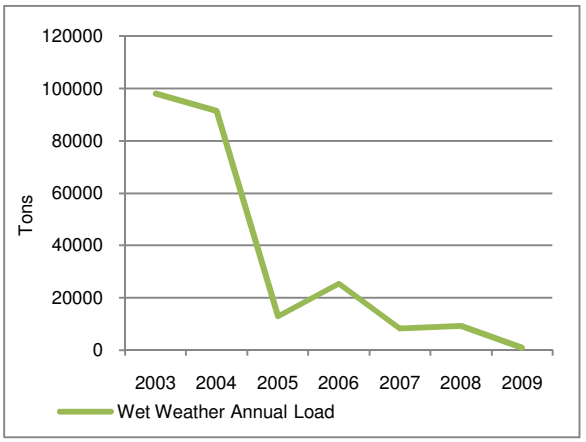
## Table 27. Pollutant Load Data Summary (Continued)

| Year | Constituent | Wet Weather Median Conc. (mg/L) | Annual Load (tons) | Dry Weather Median Conc. (mg/L) | Annual Load (tons) |
|---|---|---|---|---|---|
| **2006** | Annual Flow Volume (ac-ft) | 5200 | | 216527 | |
| | TSS | 3600 | 25,437 | N/A | N/A |
| | TDS | 1250 | 8,832 | 3800 | 1,118,025 |
| | Total Phosphorus | 1.30 | 9.19 | 0.03 | 9.71 |
| | Orthophosphate | 0.13 | 0.92 | 0.01 | 1.59 |
| | Nitrate | 3.40 | 24.02 | 4.74 | 1,395 |
| | Selenium | ND | ND | 0.014 | 4.104 |
| | Total Copper | 0.120 | 0.848 | 0.002 | 0.633 |
| | Total Lead | 0.130 | 0.919 | 0.000 | 0.079 |
| | Total Zinc | 0.450 | 3.180 | 0.008 | 2.354 |
| **2007** | Annual Flow Volume (ac-ft) | 7,500 | | 245324 | |
| | TSS | 809 | 8,245 | N/A | N/A |
| | TDS | 1,076 | 10,965 | 3500 | 1,166,712 |
| | Total Phosphorus | 1.02 | 10.39 | 0.02 | 5.67 |
| | Orthophosphate | 0.78 | 7.95 | 0.01 | 4.17 |
| | Nitrate | 5.65 | 57.58 | 5.76 | 1,920 |
| | Selenium | 0.005 | 0.051 | 0.015 | 4.834 |
| | Total Copper | 0.025 | 0.250 | 0.002 | 0.600 |
| | Total Lead | 0.004 | 0.042 | 0.000 | 0.067 |
| | Total Zinc | 0.125 | 1.274 | 0.006 | 1.850 |
| **2008** | Annual Flow Volume (ac-ft) | 5,400 | | 218,247 | |
| | TSS | 1,270 | 9,319 | N/A | N/A |
| | TDS | 1,385 | 10,161 | 3,700 | 1,097,250 |
| | Total Phosphorus | 1.69 | 12.36 | 0.01 | 3.56 |
| | Orthophosphate | 0.52 | 3.78 | 0.01 | 2.16 |
| | Nitrate | 7.50 | 55.03 | 5.08 | 1,505 |
| | Selenium | 0.007 | 0.048 | 0.013 | 3.855 |
| | Total Copper | 0.031 | 0.224 | 0.002 | 0.460 |
| | Total Lead | 0.014 | 0.099 | 0.000 | 0.059 |
| | Total Zinc | 0.085 | 0.624 | 0.006 | 1.824 |

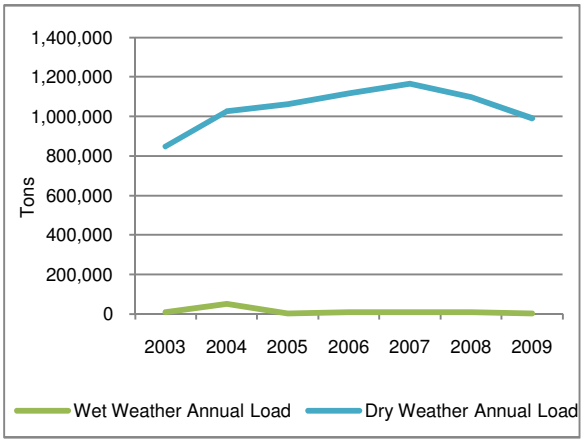
## Table 27. Pollutant Load Data Summary (Continued)

| Year | Constituent | Wet Weather Median Conc. (mg/L) | Annual Load (tons) | Dry Weather Median Conc. (mg/L) | Annual Load (tons) |
|---|---|---|---|---|---|
| **2009** | Annual Flow Volume (ac-ft) | 3,205 | | 202,357 | |
| | TSS | 206 | 897 | N/A | N/A |
| | TDS | 1,050 | 4,573 | 3,600 | 989,866 |
| | Total Phosphorus | 0.42 | 1.83 | 0.02 | 5.91 |
| | Orthophosphate | 0.39 | 1.70 | 0.01 | 2.25 |
| | Nitrate | 6.70 | 29.18 | 5.15 | 1,415 |
| | Selenium | 0.005 | 0.022 | 0.015 | 3.987 |
| | Total Copper | 0.005 | 0.021 | 0.002 | 0.577 |
| | Total Lead | 0.012 | 0.052 | 0.001 | 0.275 |
| | Total Zinc | 0.210 | 0.915 | 0.010 | 2.695 |

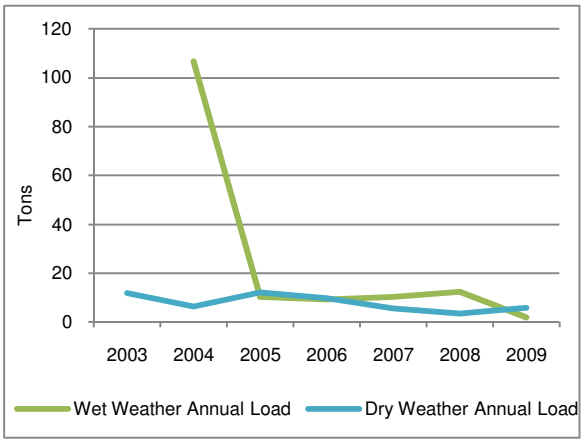
## Figure 89. Total Suspended Solids Pollutant Load 2003-2009



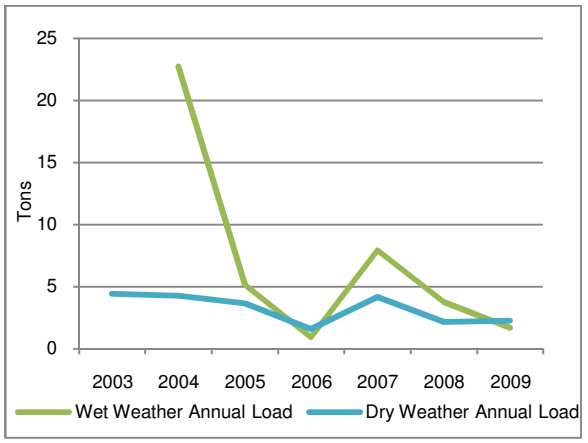

## Figure 90. Total Dissolved Solids Pollutant Load 2003-2009



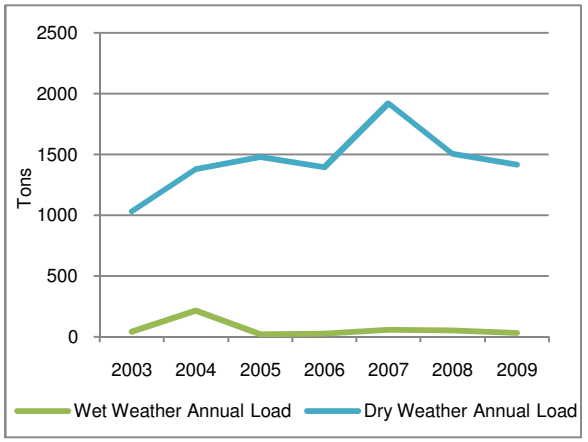

## Figure 91. Total Phosphorus Pollutant Load 2003 – 2009




## Figure 92. Orthophosphate Pollutant Load 2003 – 2009




## Figure 93. Nitrate Pollutant Load 2003 – 2009




## Figure 94. Total Lead Pollutant Load 2003 – 2009

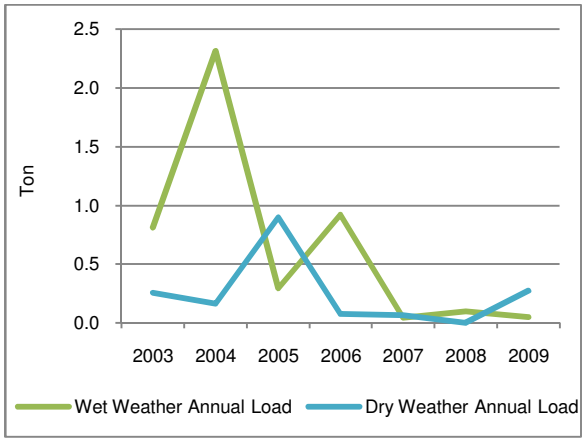


**Figure 95. Total Copper Pollutant Load 2003 – 2009**

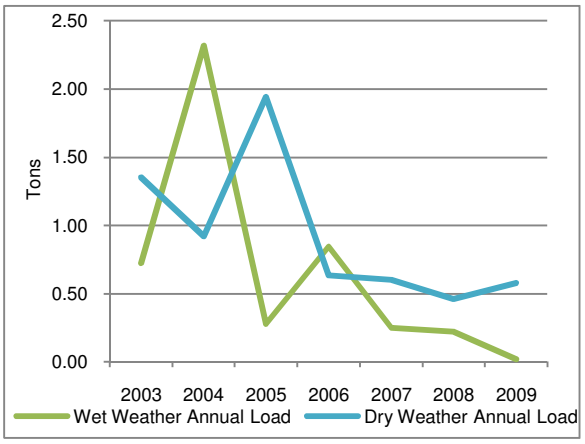



**Figure 97 Selenium Pollutant Load 2003 – 2009**

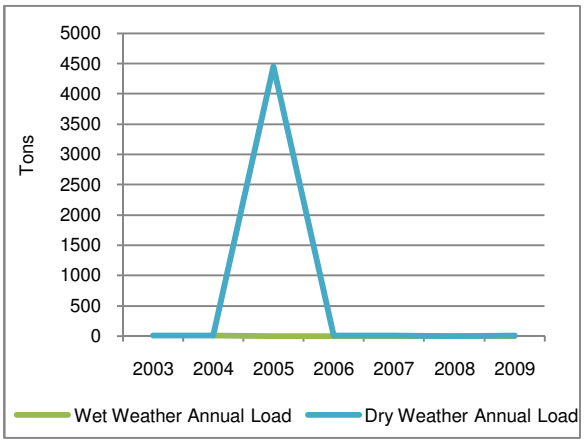
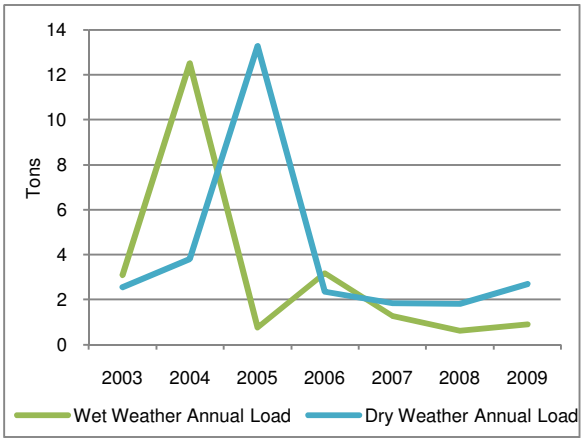



**Figure 96. Total Zinc Pollutant Load 2003 – 2009**



## 5.4 Phosphorus Analyses

Phosphorus (total phosphorus, ortho-phosphate) and ammonia are not on the current 303(d) list for Las Vegas Valley. However, previous 303(d) lists included impairments for phosphorus and ammonia in lower Las Vegas Wash downstream of the wastewater treatment facility (WWTF) discharges. As a result of these impairments, TMDLs for these constituents were developed by Nevada Division of Environmental Protection and management plans were implemented by local wastewater dischargers. Based on the effectiveness of the TMDL program implementation, these constituents were removed from the 303(d) list.

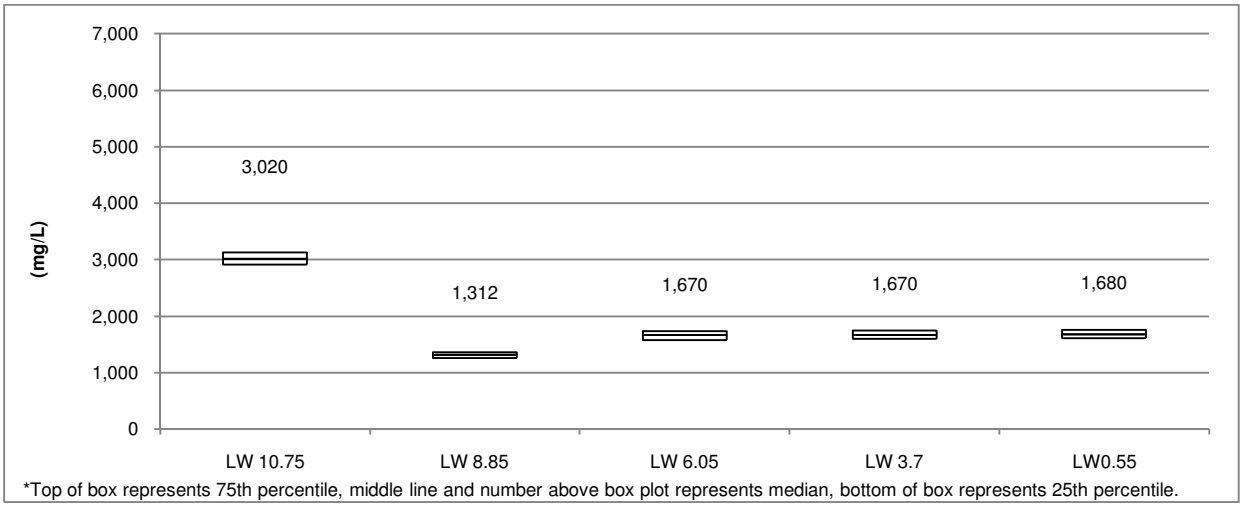
Phosphorus loads from the MS4 are greater during wet weather events than during dry weather events. During dry weather conditions, the load allocation of 100 lb/day between March 1 and October 31 from nonpoint sources is not exceeded. During wet weather conditions, this limit is normally exceeded. However, the load allocation does not apply to wet weather conditions and thus discharges from the MS4 are not responsible for TMDL exceedances. The analysis of phosphorus is described in detail in *Technical Memorandum II.1 Stormwater Contributions to Impaired Waters and TMDLs in Las Vegas Valley*.

# 6 Other Data Sources

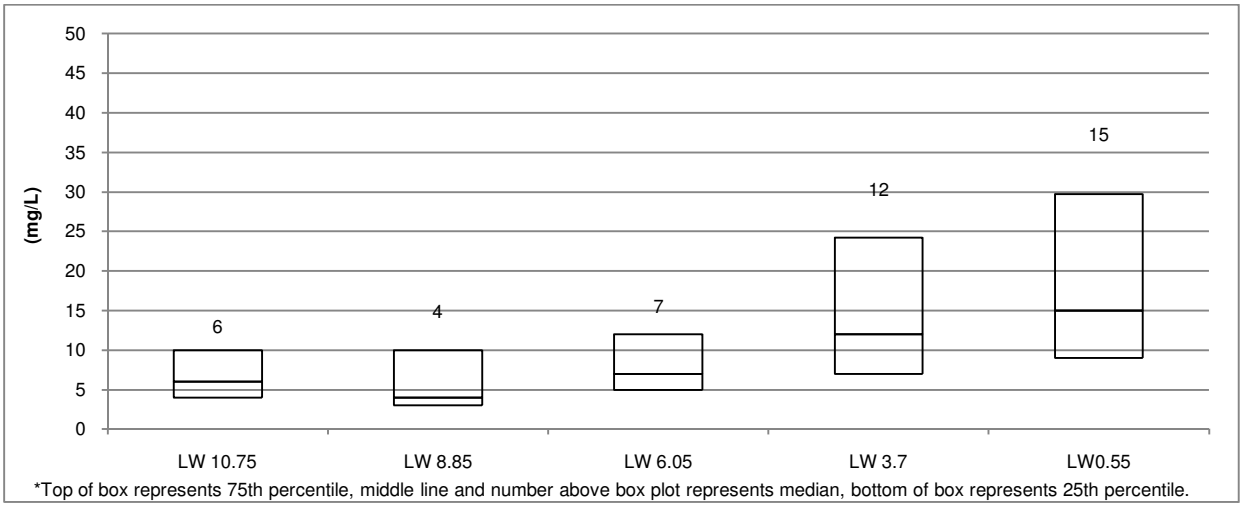
## 6.1 City of Henderson Wastewater Permit Data for LVW

The City of Henderson conducts monitoring for constituents and stream flow at sites on Las Vegas Wash upstream of the City of Las Vegas waste water pollution control facility (LW 10.75), upstream of Duck Creek (LW 8.85), upstream of Pabco Road erosion control structure (LW 6.05), downstream of the demonstration weir (LW 3.7), and at Northshore Road Bridge (LW 0.55). The City of Henderson samples the sites during the middle and at the end of each month regardless of the flow on the scheduled date for sampling. Thus the data set represents a mixture of dry and wet weather conditions. For constituents reported below, the results of the historic data are displayed by the range of constituent concentrations (as a box plot) at sampling locations arranged from upstream to downstream along the Las Vegas Wash **(Figures 98-104).** Site LW 10.75 and 3.7 were selected to display the constituent concentration versus flow (**Figures 105-110)** because LW 10.75 is upstream of the wastewater treatment plant and LW 3.7 is downstream of the wastewater treatment plant. Data for TDS does not indicate an upward or downward trend from upstream to downstream. LW 10.75 has the highest median at 3,20 mg/L. LW 8.85 had the lowest median at 1,312 mg/L, with the remaining three sites had consistent results with the median being approximately 1,670 mg/L. Data for TSS does indicate an upward trend from upstream to downstream. With the exception of site LW 10.75 all other sites appear consistent in regards to total phosphorus, ortho-phosphorus, and nitrate as N. Bacteria trends show site LW 10.75 having the highest median for total coliform and fecal coliform and LW 8.85 having the lowest median. The data shows that as stream flow increases, generally TSS increases and TDS decreases.

**Figure 97. Total Dissolved Solids vs. Location 2000-2009 (COH Data)**

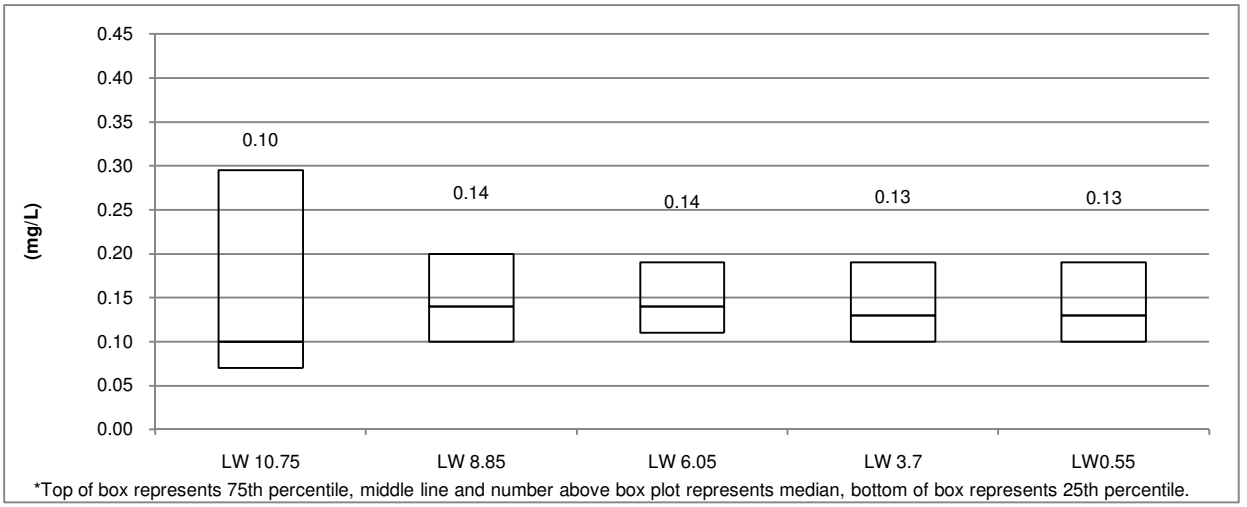


## Figure 98 .Total Suspend Solids vs Location 2000-2009 (COH Data)



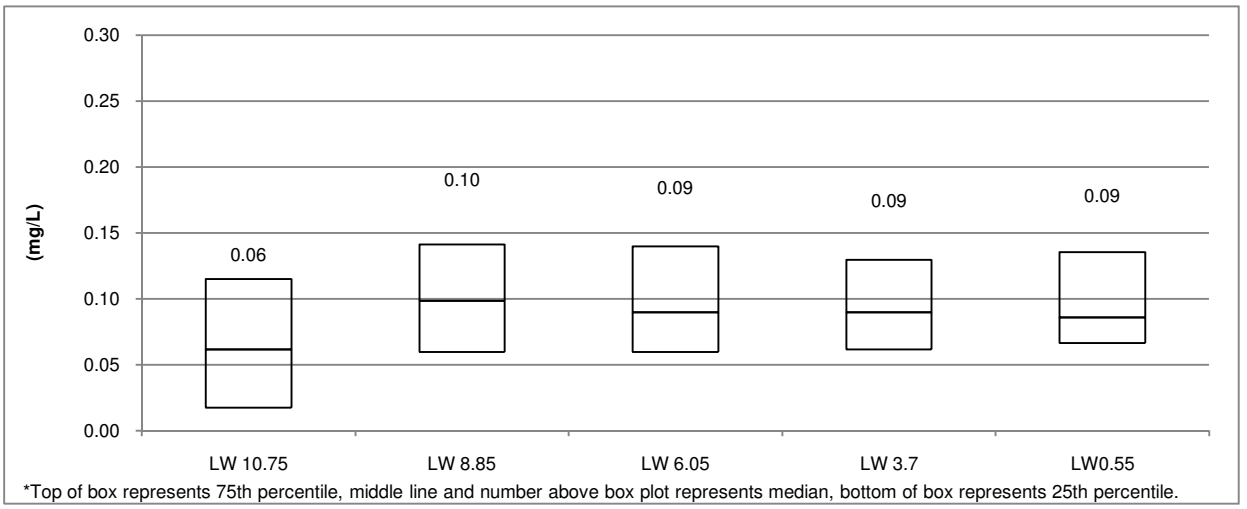

*Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 99. Total Phosphorus as P vs. Location 2000-2009 (COH Data)



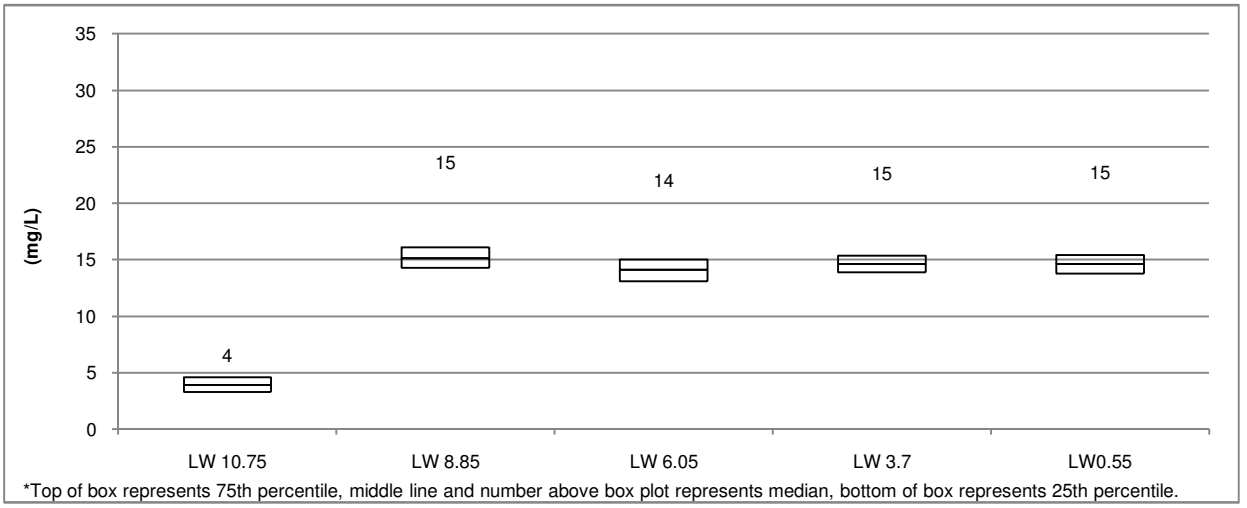

*Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 100. Orthophosphate vs. Location 2000-2009 (COH Data)



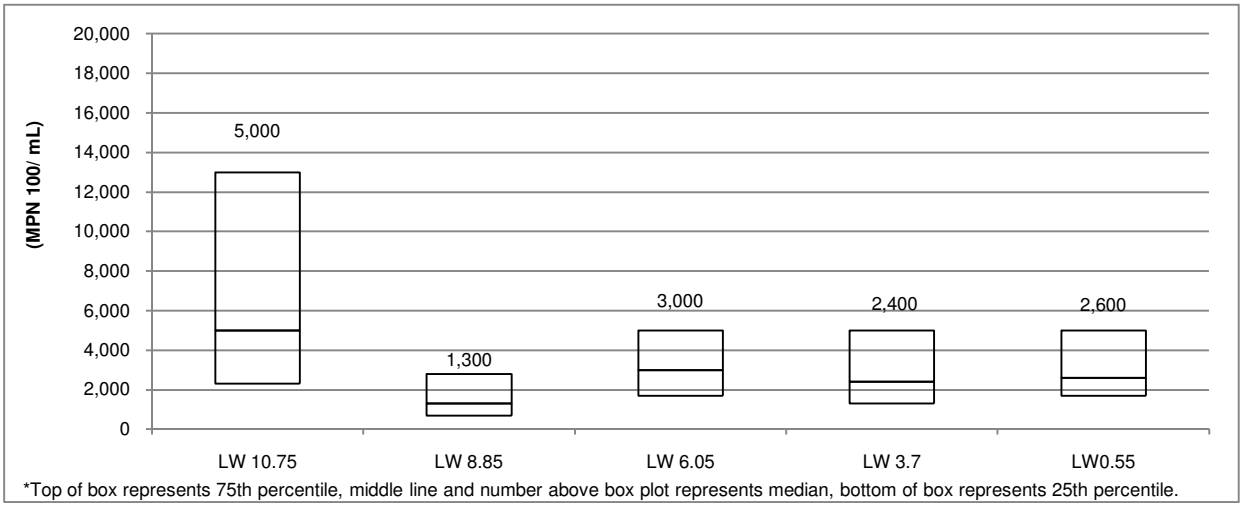

*Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 101. Nitrate as N vs. Location 2000-2009 (COH)



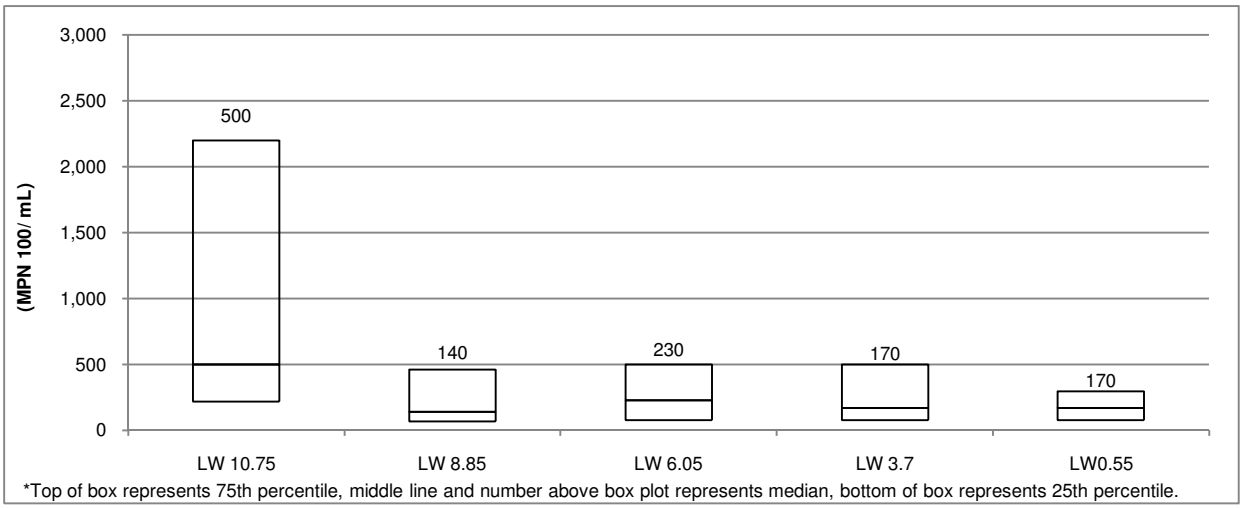

*Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 102. Coliform vs. Location 2000-2009 (COH Data)




*Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

## Figure 103. Fecal Coliform vs Location 2000-2009 (COH Data)




*Top of box represents 75th percentile, middle line and number above box plot represents median, bottom of box represents 25th percentile.

**Figure 104. Site LW 10.75 TDS & TSS 2000 – 2009 (COH Data)**

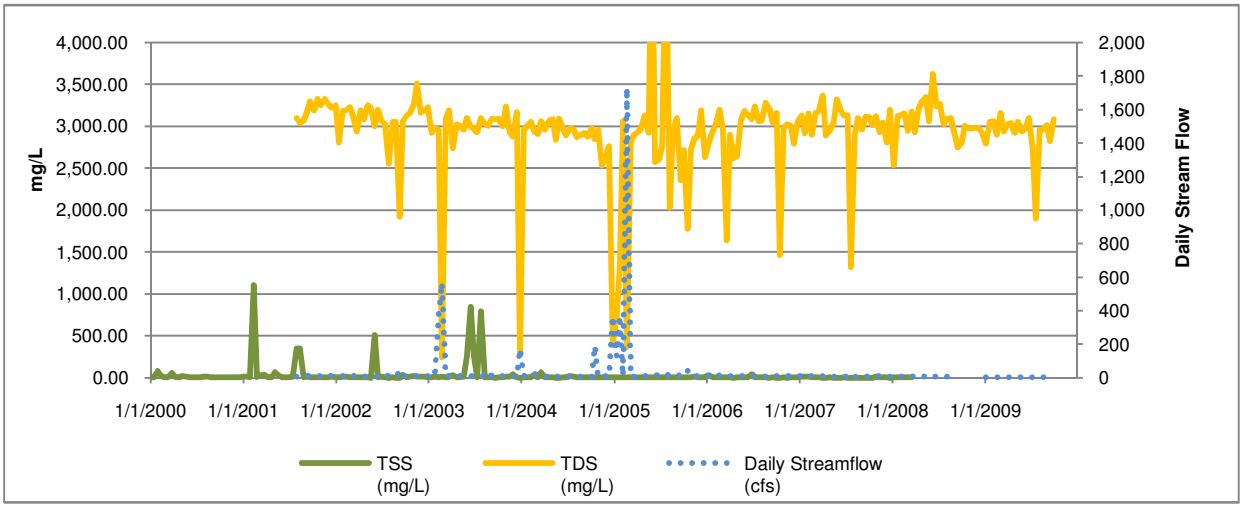



**Figure 105. LW 10.75 Total Phosphorus as P & Ortho-phosphorus 2000 – 2009 (COH Data)**

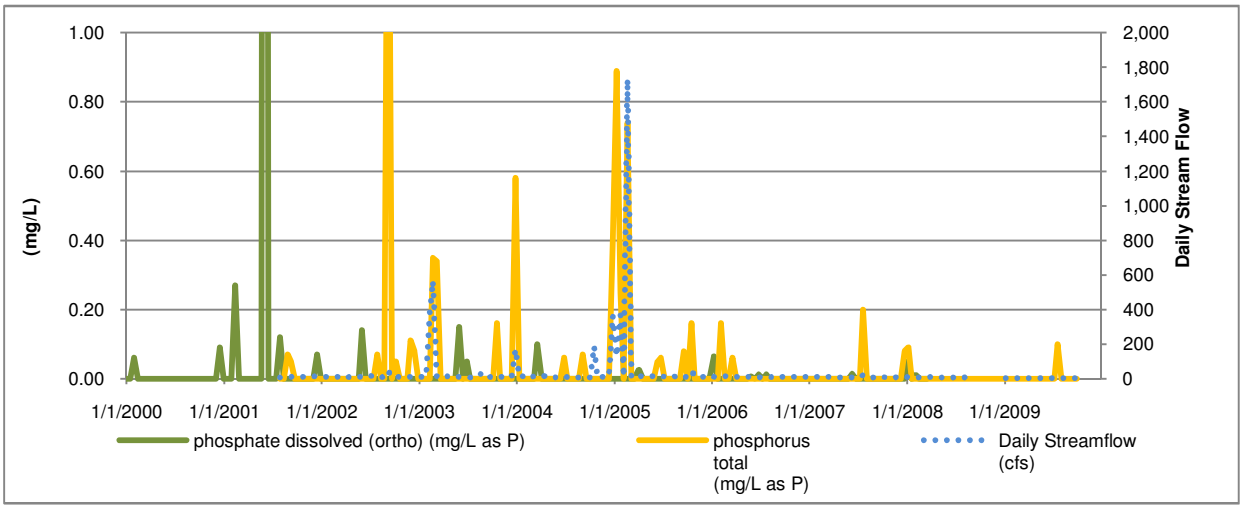
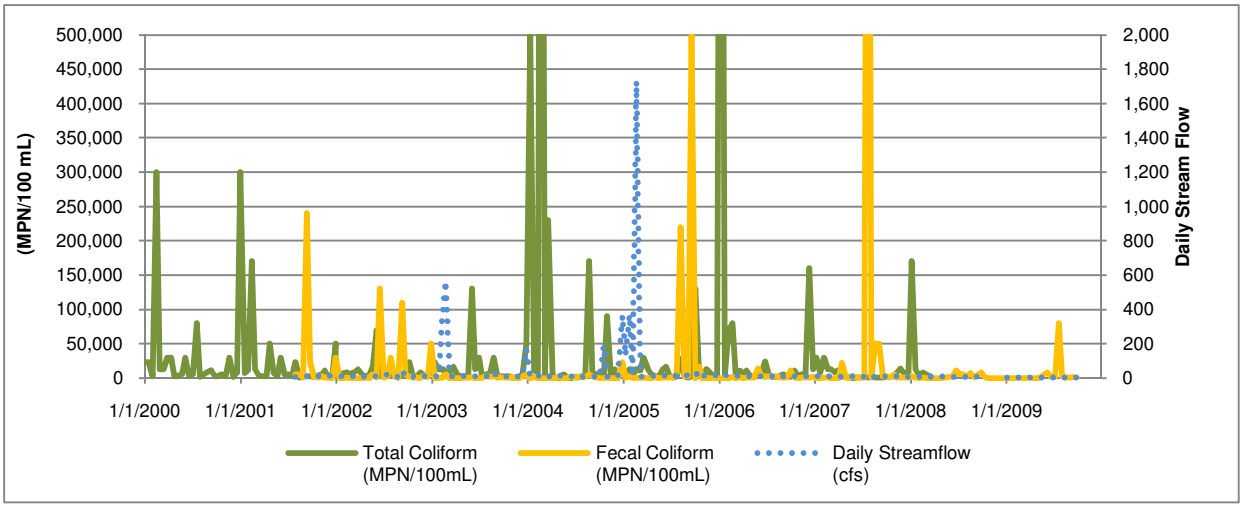
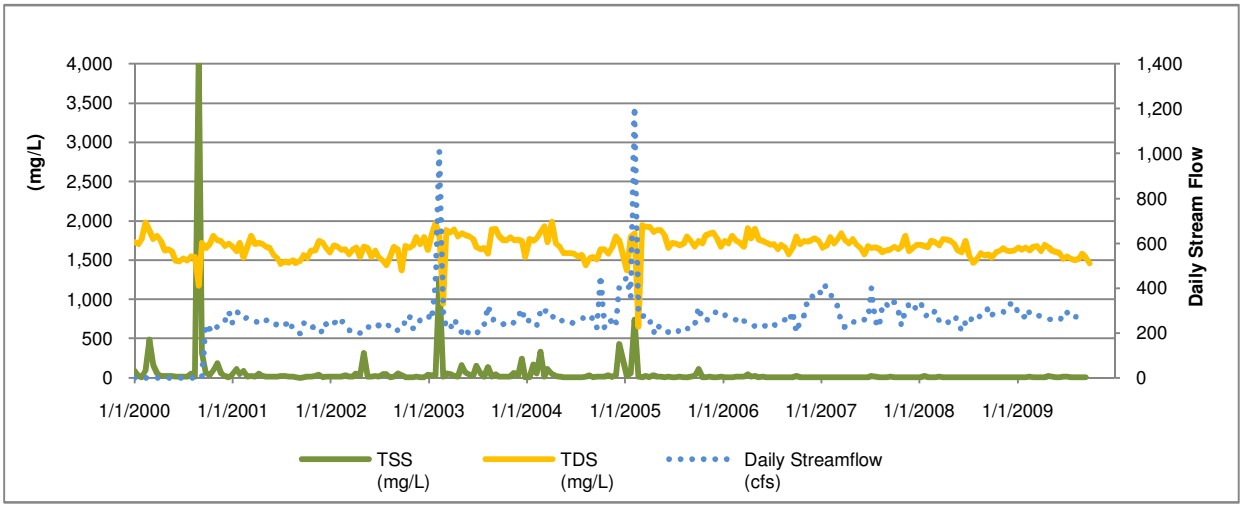


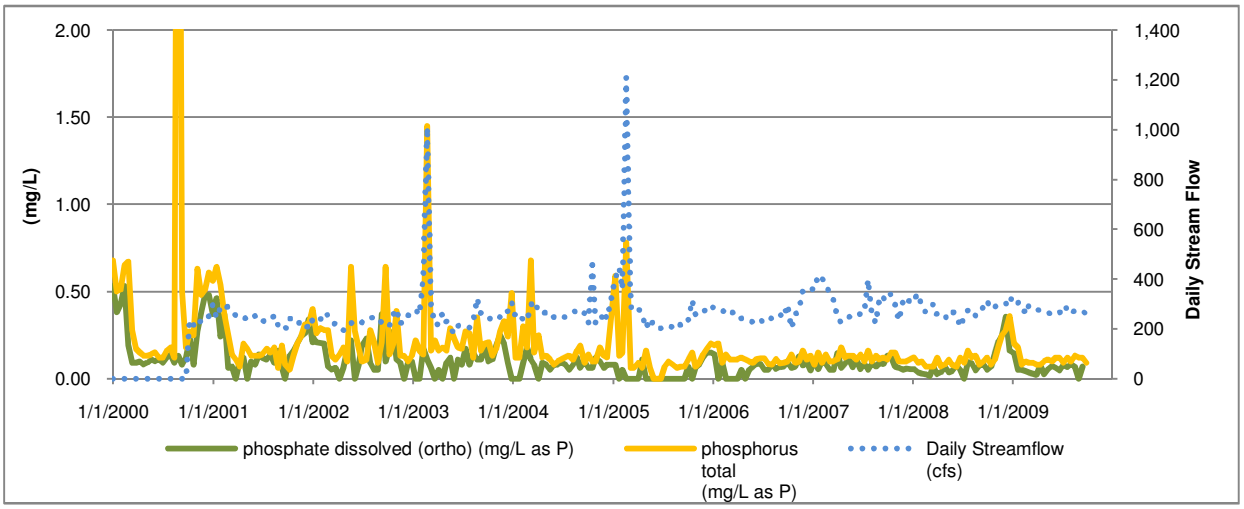

**Figure 106. LW 10.75 Bacteria 2000 – 2009 (COH Data)**



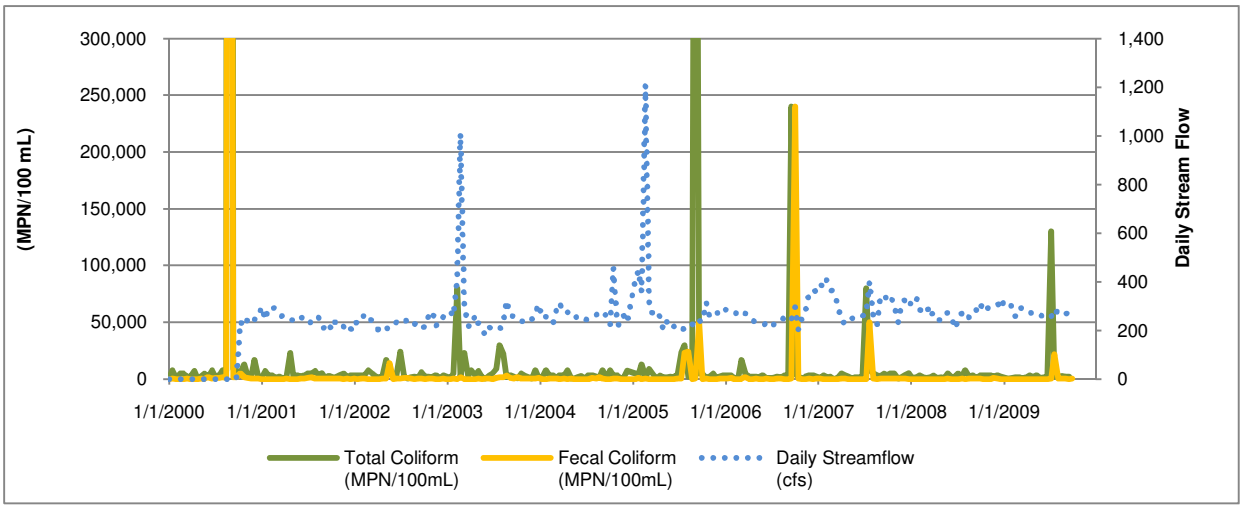
## Figure 107. LW 3.7 TSS & TDS 2000 – 2009 (COH Data)




## Figure 108. LW 3.7 Total Phosphorus as P & Orthophosphate 2000 – 2009 (COH Data)




## Figure 109. LW 3.7 Bacteria 2000 – 2009 (COH Data)



The data suggest the following for City of Henderson's monitoring program:

- Concentrations from upstream to downstream generally show that sites downstream of the wastewater treatment plant tend to display similar spatial difference and have medians that are similar than compared to the site upstream of the wastewater treatment plant. TSS concentrations from upstream to downstream does not follow this trend.
- Comparison between Site LW 10.75 and LW 3.7 indicates concentrations of TDS and bacteria are higher upstream of the wastewater treatment plant, whereas concentrations of phosphorous and orthophosphate are generally higher downstream of the wastewater treatment plant.
- Nitrate trends for the MS4 monitoring program (wet and dry weather), and data from COH monitoring program suggest nitrate trends are increasing from upstream to downstream.
- Phosphorus trends for the MS4 monitoring program (dry weather), and data from COH monitoring program suggests a decreasing trend in phosphorous from upstream to downstream.

## 6.2 USGS Data for Water Quality Stations

The USGS has available on their website water quality data for approximately 15 sites. Data for Las Vegas Wash below Flamingo Wash confluence and Las Vegas Wash Three Kids below Henderson was obtained to analyze water quality. **Table 28** below lists the constituents that were analyzed and how the lab analyzed the data. The data is displayed (**Figure 111-115**) as the constituent versus growth in population in the Las Vegas Valley for the time period sample results are given.

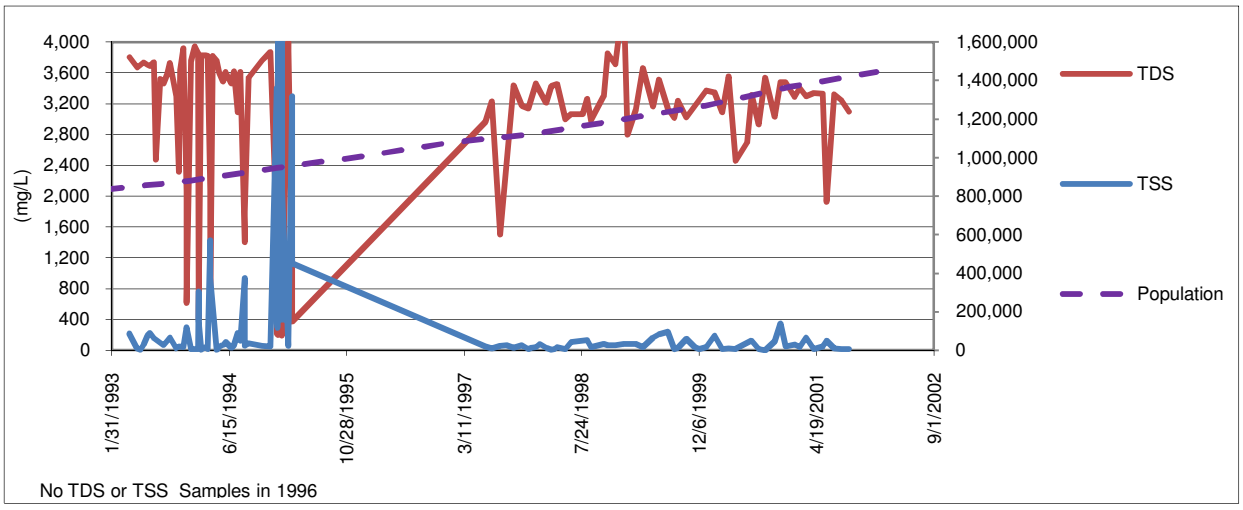
## Table 28. USGS Data Constituents and Tests

| Site | Constituent | Test |
|---|---|---|
| Las Vegas Wash Below Flamingo Wash Confluence | TDS | 703000 Dissolved solids at 180° C, water filtered, mg/L |
| Las Vegas Wash Below Flamingo Wash Confluence | TSS | 80154 Suspended sediment concentration, mg/L |
| Las Vegas Wash Below Flamingo Wash Confluence | Lead, copper, zinc, selenium | 1049, 1040, 1090, 1145 Filtered µg/L* |
| Las Vegas Wash Below Flamingo Wash Confluence & Las Vegas Wash Three Kids below Henderson | Phosphorus, orthophosphate | 666, 6671 filtered as P |
| Las Vegas Wash Below Flamingo Wash Confluence & Las Vegas Wash Three Kids below Henderson | Nitrate | 618 Filtered as N |

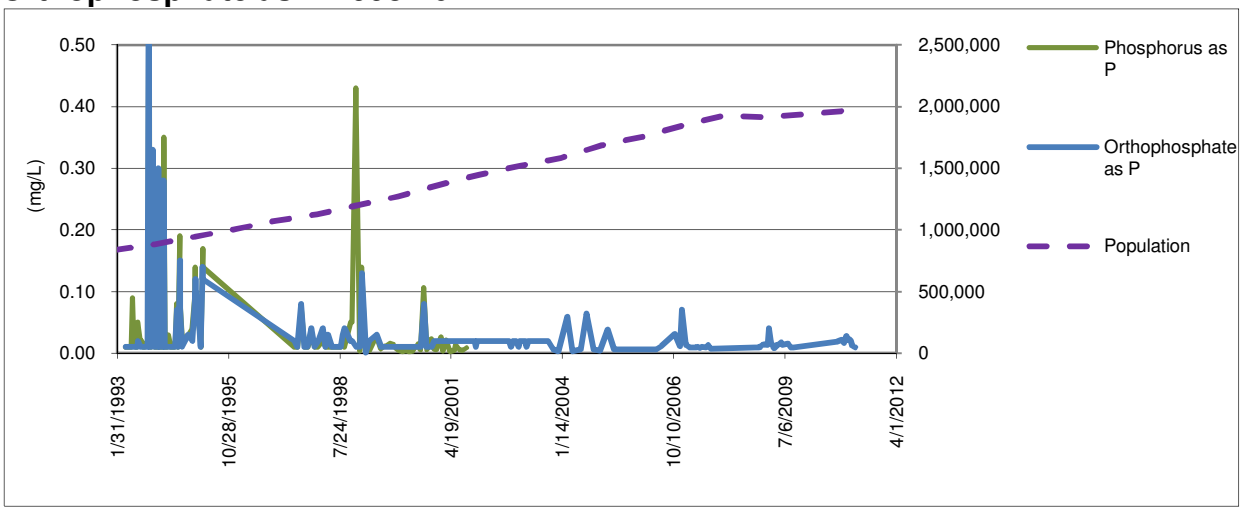
Note: Lead, copper, zinc, and selenium data for 3 kids was biota, tissue, recoverable, dry weight, and not analyzed. Data was not available for TDS and TSS.

Data was converted to mg/L to conform with data results in Annual report.

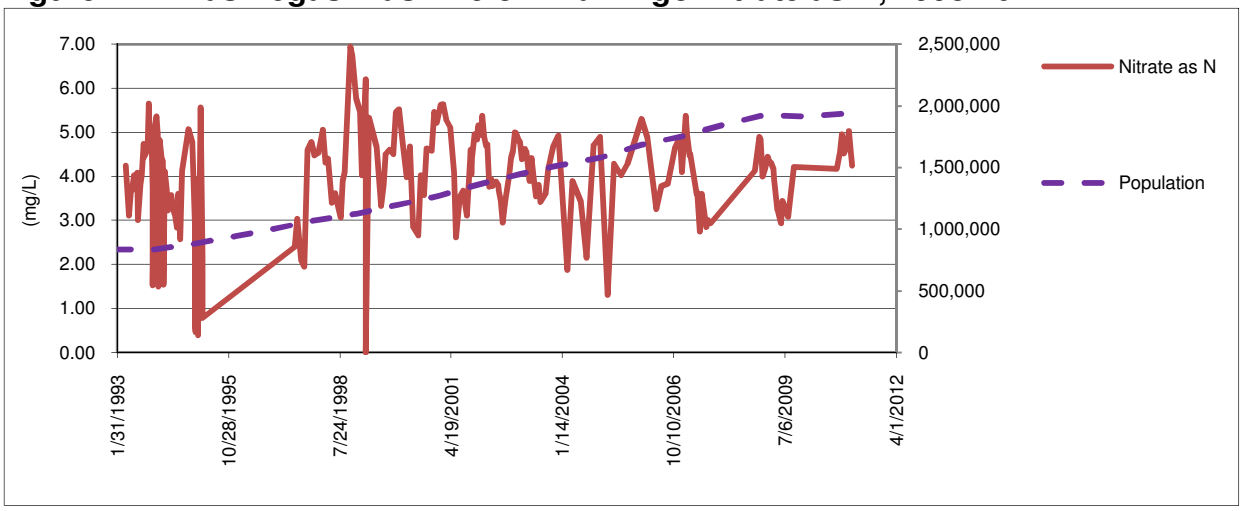
## Figure 110. Las Vegas Wash Below Flamingo TDS and TSS 1993-2001



## Figure 111. Las Vegas Wash Below Flamingo Phosphorus as P, 2003-2001 and Orthophosphate as P 1993-2011




## Figure 112. Las Vegas Wash Below Flamingo Nitrate as N, 1993-2011




## Figure 113. Las Vegas Wash Below Flamingo Metals, 1994-1995

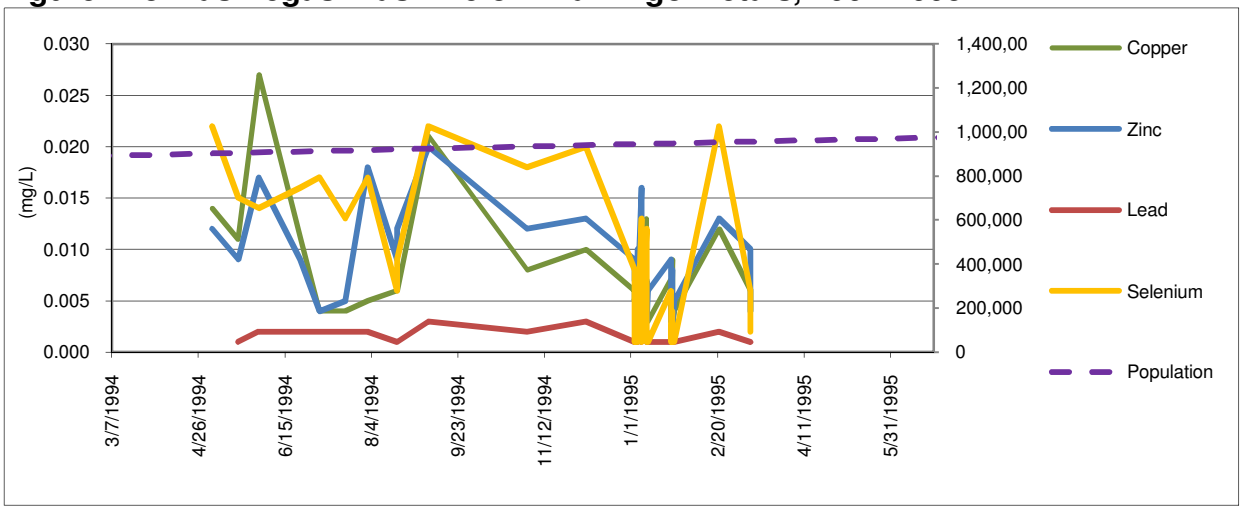
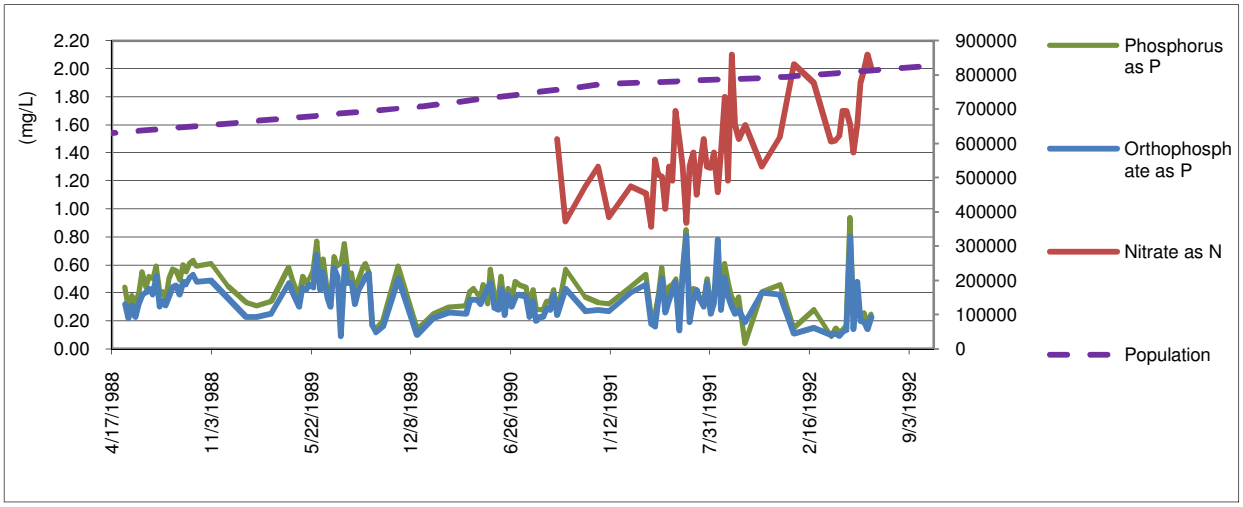


**Figure 114. Las Vegas Wash at Three Kids below Henderson Nutrients 1988-1992**




Review of the USGS water quality data shows that similar variability in data is found in this data set as has been found in the MS4 program sampling. The USGS data confirms the finding from the review of the MS4 data that the rapid rate of growth in Las Vegas Valley over the past two decades has not resulted in an increase in concentrations of the constituents analyzed.

# 7 Conclusions

Data analyses for wet weather monitoring does not showing and increase or decreasing trend from upstream to downstream. It also did not show a consistent increase in constituent concentrations with an increase in population. Data analyses for dry weather indicate increasing, decreasing and consistent trends for the constituents. TSS, Total phosphorus, and total copper do not show a trend upstream to downstream. Orthophosphate and total lead, trends are generally consistent between sites from upstream to downstream. TDS, Nitrate, and selenium have an increasing trend from upstream to downstream. Total zinc generally shows a decreasing trend from upstream to downstream. The following conclusions were determined:

- The more urbanized watersheds generally have higher concentrations of urban-generated pollutants, but all watersheds contribute pollutant in concentrations exceeding background levels
- Significant increase in Las Vegas Valley population over past 20 years has not resulted in statistically significant increases in pollutant concentrations
- Some pollutants are strongly correlated to runoff rate (positive or negative), but most are not.
- As runoff volume increases, pollutant loads increase, even when concentrations are unchanged or even decrease.
- Reducing runoff volume can be a means of improving downstream water quality for those constituents positively correlated to streamflow (e.g., TSS, phosphorus, total metals
- Data results from historic information from USGS indicates that constituents have highly variable concentrations but no chronological trends corresponding to urban growth in Las Vegas Valley, which is consistent with the data from the monitoring programs for the MS4 permit and data from City of Henderson.

# Section 4

MWH

TECHNICAL MEMORANDUM

# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

# STORMWATER MANAGEMENT PLAN DOCUMENTATION

## Technical Memorandum IV.4

## Proposed Structural and Source Control Measure Program for Las Vegas Valley

November 19, 2010

*Prepared for*

**Stormwater Quality Management Committee**

*Prepared by*

MWH®

BUILDING A BETTER WORLD

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# 1 Introduction

On February 9, 2010 the Nevada Division of Environmental Protection (NDEP) issued the Las Vegas Valley Municipal Separate Storm Sewer System Permit Renewal (MS4 Permit) for a period of five years. The 2010-2015 MS4 Permit is a "permit for authorization to discharge from municipal separate storm sewer systems to waters of the United States under the National Pollutant Discharge Elimination System." The MS4 Permit requires a structural and source control measure program for existing and new development to mitigate the impacts of urbanization on stormwater quality. This technical memorandum (TM) outlines the Permittees' proposed response to these permit requirements.

The purpose of this TM is to describe the measures proposed by the Permittees to comply with the MS4 Permit structural and source control program to mitigate urbanization effects on stormwater quality. The Permittees include the City of Las Vegas, City of North Las Vegas, City of Henderson, Clark County, and the Clark County Regional Flood Control District. This TM includes the permit requirements in the MS4 Permit, describes the existing programs being implemented by the Permittees, identifies gaps between the MS4 Permit and the existing program, and discusses programs that will be implemented to address the new permit requirements.

# 2 MS4 Permit Requirement

The renewed 2010-2015 MS4 Permit for Las Vegas Valley includes the following requirements to reduce pollutants in stormwater runoff from commercial and residential areas

> *"IV.E.1 The updated SWMP shall include a description of structural and source control measures expected to reduce pollutants from stormwater runoff from commercial and residential areas that are discharged into the MS4. This section shall also discuss the basis for the expected reduction of pollutant loads and a proposed schedule for implementing such controls. At a minimum, the description shall include:*
>
> > *IV.E.1.a A description of maintenance activities and a maintenance schedule to reduce pollutants in discharges from MS4's;*
> >
> > *IV.E.1.b A description of practices for operating and maintaining public streets, roads and highways and procedures for reducing the impact on receiving waters of discharges from the MS4's;*
> >
> > *IV.E.1.c A description of a program to evaluate, monitor and reduce pollutants in runoff from operating or closed municipal landfills or other treatment, storage or disposal facilities for municipal waste;*
> >
> > *IV.E.1.d A description of a program to evaluate and reduce pollutants in discharges from MS4s associated with the application of pesticides, herbicides, and fertilizer."*

The following sections describe existing and new best management practices (BMPs) to meet these requirements. The focus of this part of the permit is pollution prevention, i.e., preventing pollutants from entering the MS4 system. The measures to accomplish this goal could be structural or non-structural. In preparing a program to respond to the permit requirements, the Permittees have emphasized measures that would be applied to areas of existing development. Similar measures are proposed for areas of new development, as described in the New Development and Significant Redevelopment Program (MWH 2010b).

# 3 Existing Source Control Program

This section describes the existing source control activities currently being implemented by the Permittees.

## 3.1 Existing Maintenance Activities and Schedules

Sections *IV.E.1.a* and *IV.E.1.b* of the MS4 Permit require maintenance activities to be performed by the Permittees. The Permitees developed and follow maintenance objectives to reduce pollutants in stormwater runoff from public streets and the storm drain system. The street sweeping program is implemented to remove pollutants from street surfaces before they are introduced to the storm drain system. The storm drain system maintenance program includes cleaning of drain inlets to remove pollutants before they are transported through the MS4. The next line of defense in pollutant prevention is the detention basin program. Regional detention basins capture runoff from developed areas, allowing sediment and associated pollutants to drop out. One purpose of the detention basin program is to remove sediment and other pollutants from the detention basin, so that they are not transported through the MS4. To the extent possible, the objectives were made consistent for each Permittee. The Permittees have developed storm drain system maintenance and street sweeping objectives for the benefit of stormwater quality and standard practice and track information each year. This subsection provides a brief summary of the existing maintenance activities and schedule.

Street maintenance includes street sweeping of paved streets with curb and gutter. The goal of the municipal street sweeping program is to sweep all public streets with curb-and-gutter once every 30 days in the urban area and as needed in the rural areas of Clark County. The Permittees track the number of lane miles and the number of times the lanes are swept each year. In addition, the number of truckloads of material hauled to the landfill is tracked. The street sweeping program applies to public streets under the jurisdiction of the local entities. State highway and freeway maintenance is the responsibility of the Nevada Department of Transportation, which has its own MS4 permit. Maintenance of private streets is the responsibility of the private owner.

For drain inlet maintenance, the Permittees inspect and track the number of drain inlets in their jurisdiction and how often they are cleaned. The goal of the drain inlet BMP is to inspect and clean 20 percent of drain inlets a minimum of once per year.

Detention basins are inspected on a semi-annual basis and after major storms, and then cleaned as appropriate. When inspected, the sediment, debris and trash found during inspections are noted, maintenance is scheduled, then the basin is cleaned and the amount of removed material is tracked.

**Table 1** summarizes the current maintenance programs and goals for the Permittees.

**Table 1. Maintenance Goals for Municipal Permittees**

| Entity | Street Sweeping | Drain Inlet Cleaning | Detention Basin Maintenance |
|---|---|---|---|
| **Clark County** | Sweep curbed-and-paved public city streets in urban area once every 30 days[1]; as-needed in rural areas | Inspect/clean 20 percent of drain inlets a minimum of once per year; clean as appropriate[2] | Inspect during semi-annual channel inspections and after major storms[3]; clean as appropriate |
| **City of Las Vegas** | Sweep curbed-and-paved public city streets once every 30 days[4] | Inspect/clean 20 percent of drain inlets a minimum of once per year; clean as appropriate | Inspect during semi-annual channel inspections and after major storms; clean as appropriate |
| **City of North Las Vegas** | Sweep curbed-and-paved public city streets once every 30 days[5] | Inspect/clean 20 percent of drain inlets a minimum of once per year; clean as appropriate | Inspect during semi-annual channel inspections and after major storms; clean as appropriate |
| **City of Henderson** | Sweep curbed-and-paved public city streets once every 30 days | Inspect/clean 20 percent of drain inlets a minimum of once per year; clean as appropriate | Inspect during semi-annual channel inspections and after major storms; clean as appropriate |

Notes:
[1] Clark County sweeps most urban public streets on a 7- to 10-day schedule.
[2] Unincorporated Clark County is divided into nine zones. The Maintenance Management Division estimates it will take 8 to 10 weeks to complete a full rotation through all nine zones. Therefore, most inlets will be inspected/cleaned four times per year.
[3] Clark County also currently routinely inspects all detention basins two times per year.
[4] City of Las Vegas sweeps most urban public streets on a 14-day schedule.
[5] City of North Las Vegas sweeps public roadways and City of North Las Vegas parking lots every three weeks.

## 3.2 Existing Maintenance Activities for Landfills for Municipal Waste

Section *IV.E.1.c* of the MS4 Permit requires the Permittees to evaluate, monitor and reduce pollutants in runoff from operating or closed landfills, storage or disposal facilities for municipal waste. The only landfill within the Las Vegas Valley is the Sunrise Landfill, which has been closed since 1993. The Apex Regional Landfill is currently the only active local landfill, but is located outside of the Las Vegas Wash Watershed. As a result, no municipal landfills are covered under the MS4 Permit requirements since there are no active municipal landfills in the Las Vegas Wash drainage area.

## 3.3 Fertilizer, Pesticide, and Herbicide Management Program

Section *IV.E.1.d* of the MS4 Permit requires the Permittees to describe the program to evaluate and remove pollutants associated with the application of fertilizer, pesticides, and herbicides. Permittees have various existing programs to minimize the impacts of fertilizer, pesticide and herbicide use on water quality, although they have not all been documented in previous Las Vegas Valley NPDES MS4 Permit Annual Reports. In addition, many of the effective measures and programs are not directly associated with managing use of these products, but with reducing the amount of turf and landscaping areas on which they could be applied, and reducing the use of landscape irrigation water that could convey these products into the MS4 during dry weather conditions. Water quality data for Las Vegas

Valley indicates that the vast majority of loadings for pollutants associated with these products occur during storm runoff periods, not during dry weather periods. For example, common fertilizers contain significant amounts of phosphorus, and the typical phosphorus concentration in wet weather flows is about 1.0 mg/l as compared to <0.05 mg/l in dry weather flows.

Elements of local fertilizer, pesticide and herbicide management programs include:

- **Water conservation ordinances –** Each entity has a water conservation ordinance designed to reduce use of water outdoors. The water conservation ordinances adopted by the entities include restrictions on new turfed areas, particularly in front yards, and incentives for removal of existing turf. Turf areas are the largest recipients of fertilizers. Significant reductions in existing turf areas and avoidance of new turf installations have substantially reduced the areas where fertilizers would potentially be used. Associated with turf restrictions is the requirement to use xeriscaping for new landscaped areas whenever possible. Use of native and drought tolerant plants, combined with extensive use of rock and non-vegetative landscaping treatments, reduces the need for use of fertilizers, pesticides and herbicides to manage plant growth.
- **Turf conversion program –** Southern Nevada Water Authority (SNWA) has a turf conversion program, sometimes called "cash for grass," that offers a rebate for removal of existing turf areas. The Water Smart Landscapes rebate helps property owners convert water-thirsty grass to desert landscaping. SNWA will rebate customers $1.50 per square foot of grass removed and replaced with desert landscaping up to the first 5,000 square feet converted per property, per year. Beyond the first 5,000 square feet, SNWA will provide a rebate of $1.00 per square foot. Every square foot of grass replaced with water-smart trees, shrubs and flowers saves an average of 55 gallons of water per year. It also reduces the potential for lawn care chemicals to be washed into the MS4.
- **Public employee supervisor certification –** Permittees require supervisors responsible for personnel who commonly use fertilizers, pesticides and herbicides to be certified through the state certification program. This primarily includes Parks and Recreation Department personnel responsible for landscaping maintenance. At this time there is no requirement for private landscaping companies to use personnel certified in handling and application of fertilizers, pesticides and herbicides.
- **Use of alternate products –** All Permittees are experimenting with or transitioning to use of "green" products to replace traditional fertilizers, pesticides and herbicides. For example, the City of Las Vegas is encouraging use of more organic pesticides and herbicides. The City of Henderson is using pelletized corn meal as a herbicide to control pre-emergent vegetation. The City of North Las Vegas is looking into using green herbicides on a pilot program.
- **Public education –** The Permittees, through CCRFCD, prepared and aired a public service announcement on proper use and disposal of fertilizer, pesticides, herbicides and other household chemicals.

Sports complexes incorporated into detention basins have potential adverse effects from fertilizers, pesticides, and herbicides. A program to mitigate impacts of this on receiving waters may need to be developed.

# 4 Proposed Structural and Source Control Program

This section describes the proposed structural and source control program to meet the requirements in the MS4 Permit.

**Table 2** lists the proposed program elements, responsible parties, measurable goals, and data to be monitored and tracked for each element. It is noted that all the program elements are non-structural. This approach is adopted for the following reasons.

- It is consistent with existing measures and programs that, based on review of local water quality data, have been found to be effective (MWH, 2010a).
- It avoids the need for structural measures that require ongoing maintenance, inventorying and tracking, and agreements with private property owners.

## Table 2. Proposed Structural and Source Control Program for Las Vegas Valley

| MS4 Permit Section | MS4 Permit Requirements | Proposed Measures | Responsible Party | Monitoring and Tracking Information | Measurable Goals |
|---|---|---|---|---|---|
| IV.E.1.a | A description of maintenance activities and a maintenance schedule to reduce pollutants in discharges from MS4's. | **Drain Inlet Cleaning –**Inspect and, as needed, remove sediment, debris and trash from storm drain inlets and catch basins in the public MS4 system. Maintenance is performed to assure proper hydraulic performance and to remove potential sources of pollution. | **Inspection and Maintenance Activities –** CLV, CNLV, COH and CC | • Number of drain inlets and catch basins inspected and cleaned<br>• Quantity/volume of material removed | Inspect/Clean 20% of inlets a minimum of once per year |
| | | **Detention Basin Maintenance –** Inspect and, as needed, remove sediment, debris and trash from detention basins that are part of the MS4 system. Maintenance is performed to preserve flood storage capacity, assure proper hydraulic performance, and remove potential sources of pollution. | **Cost of Maintaining Regional Flood Control Facilities –** CCRFCD | • Number of detention basins inspected and cleaned<br>• Quantity/volume of material removed | Inspect on semi-annual basis and after a major storm; clean as appropriate |
| | | **Maintenance of Public Facilities –** Clark County: Real Property Management Department manages County property and cleans parking lots as needed; Department of Aviation manages McCarran Airport, Henderson Airport, North Las Vegas Airport and McCarran Bus Facility, all of which have individual SWPPPs. | **Cost of Maintaining Local Drainage Facilities –** CLV, CNLV, COH, CC | | |
| | | **CNLV –** City parking lots are swept every 3 weeks; washing bay at City Central Garage is cleaned daily. | | | |
| | | | | | |

| MS4 Permit Section | MS4 Permit Requirements | Proposed Measures | Responsible Party | Monitoring and Tracking Information | Measurable Goals |
|---|---|---|---|---|---|
| IV.E.1.b | A description of practices for operating and maintaining public streets, roads and highways and procedures for reducing the impact on receiving waters of discharges from the MS4's. | **Street Sweeping –** Sweep public streets on a regular basis to remove accumulated sediment, debris, trash, hydrocarbons, and other chemicals | CLV, CNLV, COH and CC | • Number of lane miles swept<br>• Quantity/volume of material removed | Sweep all public streets in urban area every 30 days |
| | | **Drain Inlet Cleaning –** Inspect and, as needed, remove sediment, debris and trash from storm drain inlets and catch basins in the public MS4 system. Maintenance is performed to assure proper hydraulic performance and to remove potential sources of pollution. | | • Number of drain inlets and catch basins inspected and cleaned<br>• Quantity/volume of material removed | Inspect/Clean 20% of inlets a minimum of once per year |
| IV.E.1.c | A description of program to evaluate, monitor and reduce pollutants in runoff from operating or closed municipal landfills or other treatment, storage or disposal facilities for municipal waste. | There are no active landfills in Las Vegas Valley. If a new landfill is opened in the future, appropriate stormwater management measures will be implemented. | None | None | None |
| | | Sunrise Landfill is a closed landfill in Las Vegas Valley. It is being completely capped and stabilized with channels and retention basins to manage runoff. | | | |

| MS4 Permit Section | MS4 Permit Requirements | Proposed Measures | Responsible Party | Monitoring and Tracking Information | Measurable Goals |
|---|---|---|---|---|---|
| IV.E.1.d | A description of a program to evaluate and reduce pollutants in discharges from MS4s associated with the application of pesticides, herbicides, and fertilizer. | **Water conservation ordinances –** Entities will enforce existing water conservation ordinances that discourage water waste, limit new turf and landscaping areas, and promote xeriscaping. | CLV, CNLV, COH and CC | Trends in dry weather flow at key stream gages | • Maintain or strengthen current conservation ordinances<br>• no significant increase in dry weather flow at key stream gages |
| | | **Turf Conversion Program –** SNWA will offer financial incentives for removal of existing turf areas and replacement with low water use landscaping. | SNWA | Square feet of turf "purchased" by SNWA annually | Goals and funding levels established by SNWA |
| | | **Public Employee Supervisor Certification –** Municipalities will require supervisors of landscape maintenance employees to be certified in proper application of fertilizers, pesticides and herbicides. | CLV, CNLV, COH, CC | Annual verification that Parks and Recreation landscaping crews have certified supervisors | • All current supervisors are trained within 24 months<br>• all new supervisors are trained within 12 months of hire |
| | | **Use of Alternate Products –** Entities will research alternate "green" products for fertilizers, pesticides and herbicides that have less environmental impact, and will adopt use of those products when feasible and cost-effective. | CLV, CNLV, COH, CC | Annual description of alternate products being tested or adopted | At least one entity investigate use of at least one alternate product or procedure each year |
| | | **Public Education –** Permittees will conduct a public education program that includes messages directed toward homeowners to properly use and dispose of fertilizers, pesticides and herbicides. This will be integrated into the overall Public Education and Outreach Program developed by the Permittees to comply with the MS4 permit. | CCRFCD, CC | Annual description of public education activities performed as part of the overall Public Education and Outreach program | • Current information on proper fertilizer, pesticide and herbicide use posted in lvstormwater.com<br>• One public service announcement or other media release at least once every 3 years (in rotation with other topics) |
| | | **Household Hazardous Waste Collection –** Permittees will contract with a vendor (currently Republic Services) to provide household hazardous waste collection services (e.g., unused fertilizer, pesticides and herbicides) for all residents in Las Vegas Valley. This will include hazardous waste drop-off locations, and occasional curb-side pickup opportunities. | CLV, CNLV, COH, CC | Annual description of services provided by Republic Services and any future vendors | Hazardous waste drop-off locations available at least 3 days/week |

# 5 Conclusion

The MS4 Permit which took effect on February 9, 2010 includes requirements for a structural and source control measure program to mitigate the impacts of urbanization on stormwater quality. **Table 2** in Section 4 of this TM shows that the Permittees have identified numerous non-structural measures, most of which are current activities, to satisfy the permit requirements. Measurable goals and monitoring and tracking requirements are identified, as are the entities responsible for implementing each measure. The proposed Structural and Source Control Program will be incorporated into the Las Vegas Valley Storm Water Management Plan.

# 6 References


MWH. *2008-2009 Annual Report, Las Vegas Valley Municipal Separate Storm Sewer System.* September 2009.

MWH. *Technical Memorandum No. IV.1 – Summary and Evaluation of Las Vegas Valley Water Quality Data.* Prepared for Las Vegas Valley Stormwater Quality Management Committee. 2010a.

MWH. *Technical Memorandum No. IV.12 – Proposed New Development and Significant Development Program for Las Vegas Valley.* Prepared for Las Vegas Valley Stormwater Quality Management Committee. 2010b.

Nevada Division of Environmental Protection. *2010 Las Vegas Valley MS4 Permit NV0021911.* February 2010.

# Section 5

MWH

TECHNICAL MEMORANDUM

# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

## STORMWATER MANAGEMENT PLAN DOCUMENTATION

## Technical Memorandum IV.5

## Unique Factors Influencing the Las Vegas Valley Municipal Separate Storm Sewer System Permit Program

July 23, 2010

*Prepared for*

**Stormwater Quality Management Committee**

*Prepared by*

MWH®

BUILDING A BETTER WORLD

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# 1 Executive Summary

The Environmental Protection Agency (EPA) has applied standard approaches to developing requirements for municipal separate storm sewer system (MS4) permit programs throughout the United States. This includes requirements for programs to manage runoff from areas of new development and significant redevelopment, also referred to as "post-construction programs." EPA seeks to apply these same criteria to the MS4 permit for Las Vegas Valley. However, local conditions in Las Vegas Valley are unique compared to the rest of the country, and require a different approach for setting and complying with MS4 permit requirements. This document describes the factors that make Las Vegas Valley unique compared to other large metropolitan areas in the U.S., and identifies the implications of these unique factors on developing an appropriate MS4 program.

Unique factors are discussed for the following categories: Climate, Hydrology, Watershed and Land Use, Geology, Hydrogeology, Urban Runoff Quality, Legal, and Stormwater Management Approach. Following are unique factors in these categories that affect development of MS4 permit programs in Las Vegas Valley.

## 1.1 Climatic Factors

- With a mean annual rainfall of 4.2 inches, Las Vegas Valley is the driest large MS4 in the nation (as indicated in **Table 1-1**).
- Depending on soil and site conditions, developed areas and construction sites have the potential to produce measurable runoff on an average of only 6 to 11 days per year.
- Most runoff-producing events are short-duration (less than 3 hours) thunderstorms of limited areal extent.
- The median number of dry days between rainfall events that produce runoff (greater than 0.2 inches) at the McCarran Airport gage is 22 days. This is representative of any given location in Las Vegas Valley.

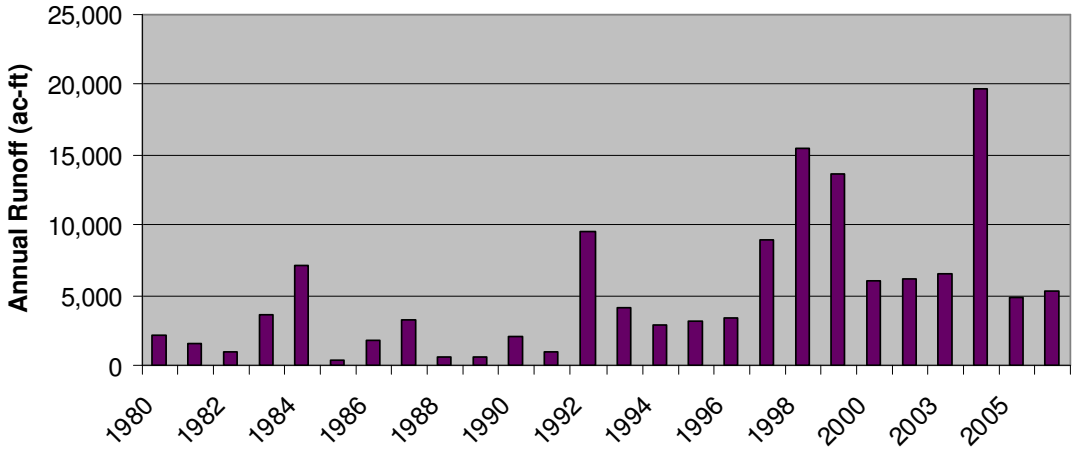
**Table 1-1. Mean Annual Rainfall in Western United States Cities**

| Community | Mean Annual Rainfall (inches) |
|---|---|
| Las Vegas, NV | 4.2 |
| Reno, NV | 7.5 |
| Phoenix, AZ | 7.7 |
| Riverside, CA | 10 |
| San Diego, CA | 11 |
| Tucson, AZ | 12 |
| Los Angeles, CA | 12 |
| San Bernardino, CA | 16 |
| Sacramento, CA | 18 |
| San Francisco, CA | 21 |
| Seattle, WA | 35 |
| Portland, OR | 40 |

## 1.2 Hydrologic Factors

- Lower Las Vegas Wash is the receiving water for all storm runoff and other flows in Las Vegas Valley. It is an effluent dominated stream, with 90 percent of annual flow coming from wastewater effluent. Only 4 percent of average annual flows are due to storm runoff, and 6 percent of average annual flows are due to urban dry weather contributions.
- In lower portions of tributaries to Las Vegas Wash, annual flow volumes are comprised of about 50 percent dry weather baseflows and 50 percent storm runoff. Most parts of the MS4 system in Las Vegas Valley are dry for the entire year except in response to direct rainfall. When storm runoff does occur, it is typically of very short duration (e.g., a few hours).
- Annual volumes of storm runoff and dry weather flow have increased over the past 18 years of the MS4 permit due to urbanization (see **Figure 1-1**), however pollutant concentrations have remained within a constant range.
- In recent years water conservation measures adopted by Southern Nevada Water Authority (SNWA) and all the entities have reduced dry weather return flows to the MS4 from landscape irrigation and other normal urban uses.

**Figure 1-1. Annual Storm Runoff in Las Vegas Wash**




## 1.3 Watershed and Land Use Factors

- High rates of erosion and sediment transport occur naturally in the Las Vegas Valley watershed, and are primarily associated with high flow events (greater than the 2-yr event).
- Land development in Las Vegas Valley tends to stabilize the watershed surface and reduce soil loss compared to native conditions (see **Figure 1-2**).
- Las Vegas Valley is one of the fastest growing urban areas in the nation. Almost 1.5 million people moved to the area between 1980 and 2008, a 300 percent increase in population.

- New development is occurring in an outward pattern from the valley center, in nearly all directions. The majority of new development consists of residential housing and associated commercial development, and large hotel/casinos.
- The majority of significant redevelopment consists of new hotel/casinos and high-rise residential development in the vicinity of the Las Vegas Strip and Interstate 15 in the central valley area.
- Las Vegas Valley hosts over 40 million visitors per year, highlighting the importance of the hotel/casino and tourism industries to the local economy and landscape.

**Figure 1-2. Aerial Photograph of New Development Adjacent to Undisturbed Area**



## 1.4 Geologic Factors

- Caliche, expansive soils and collapsible soils are prevalent throughout Las Vegas Valley, and compromise the effectiveness of standard infiltration best management practices (BMPs).
- Mapping is available for expansive and collapsible soils, but caliche deposits are not mapped and can be encountered anywhere within the alluvial fans and valley floor.

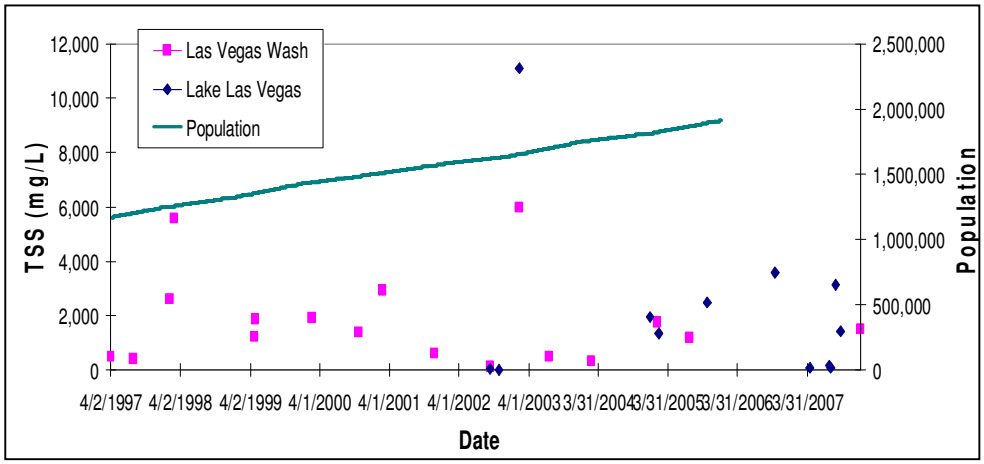
## 1.5 Hydrogeologic Factors

- The Las Vegas Wash aquitard creates a shallow alluvial aquifer and areas of perched groundwater that are of poor quality and are not beneficially used.
- A separate deep aquifer is used as a source of local water supply. Virtually all recharge to the deep aquifer occurs along the mountain front of the Spring Mountains, located on the western side of the valley.
- The Las Vegas Wash aquitard forces groundwater to the surface in tributaries near Las Vegas Wash. The aquitard tends to direct most infiltration in the Valley toward Las Vegas Wash.
- Flow of infiltrated surface water through native soils significantly increases TDS and selenium concentrations. Shallow groundwater is high in TDS and selenium, and is responsible for stream segments being listed on the State's 303(d) list of impaired waters. Infiltration BMPs would aggravate this condition.

## 1.6 Urban Runoff Quality Response to Development

- Significant urbanization in Las Vegas Valley over the past 15 years has not resulted in an increase in concentration of most constituents in wet or dry weather flows (see **Figure 1-3**).
- Although concentrations have not increased significantly, pollutant loads to lower Las Vegas Wash have increased over the period of the MS4 permit due to increases in wet and dry weather flow volumes.
- Pollutants more strongly associated with wet weather flows (e.g., TSS, phosphorus, metals) have experienced a greater increase in loads than those more strongly associated with dry weather flows (e.g., TDS, nitrate).

**Figure 1-3. Total Suspended Solids Wet Weather Trends for Two Las Vegas Wash Sites (above and below Lake Las Vegas)**



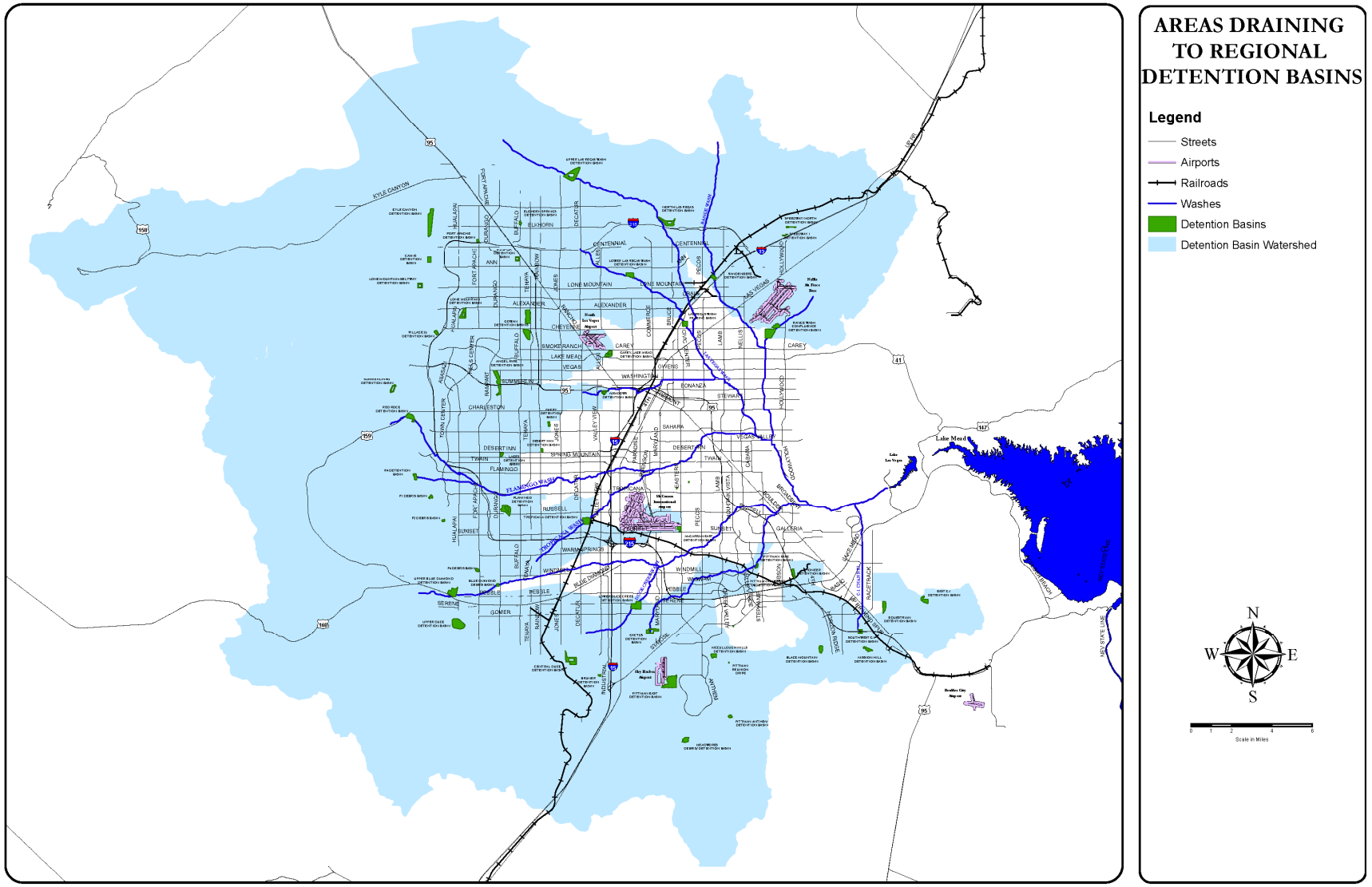
## 1.7 Stormwater Management Approach

- All regional facilities are designed to control the runoff from the 100-year storm occurring under full build-out conditions in the upstream watershed, with no assumption of onsite peak or volume reductions in new development.
- Runoff management is primarily accomplished using large regional detention basins that capture runoff from large watershed areas and capture runoff from the majority of Las Vegas Valley (see **Figure 1-4**). These basins have been shown to capture significant sediment volumes but are only marginally effective at reducing concentrations of other pollutants.
- Most regional conveyance facilities are concrete lined to manage erosion.
- Current CCRFCD policy and local development codes require new development to stabilize and prevent erosion from any waterways within the development and mitigate downstream erosion attributable to the development.
- Las Vegas Wash has experienced significant erosion and loss of wetlands over the past 40 years. SNWA is implementing an erosion control structure program in lower Las Vegas Wash consisting of 22 structures, 11 of which have been constructed to date. Erosion and sediment transport in lower Las Vegas Wash have been reduced dramatically by the existing structures.

## 1.8 Legal and Water Right Factors

- The Nevada State Engineer's Office requires permits for capture of surface waters that are put to beneficial use, and must demonstrate that current water rights holders are not injured by the proposed diversion. At present, new developments that desire to implement onsite stormwater retention would be required to contact the State Engineer to determine if a surface water permit would be required.
- Stormwater retention combined with beneficial use onsite would have the support of Colorado River Commission (CRC) and Southern Nevada Water Authority (SNWA). Retention without beneficial use would be opposed by CRC. Retention that induced infiltration that would have adverse impacts on water quality would be opposed by both CRC and SNWA.
- Infiltration of stormwater such that it increases concentrations or loads of selenium and TDS in Las Vegas Wash or the Colorado River would violate state and federal water quality regulations and the objectives of the Colorado River Basin Salinity Control Program.

## Figure 1-4. Areas Draining to Regional Detention Basins



## 1.9 Conclusions

The unique factors summarized above lead to several important implications for developing stormwater management programs and specific BMPs and control measures to comply with the Las Vegas Valley MS4 permit.

Due to the unique environmental factors present in the arid Las Vegas Valley, post-construction programs that rely heavily on local detention/retention of stormwater flows at the on-site development scale and infiltration of stormwater are not practical. Rainfall events are localized and occur infrequently with the result that onsite development-level stormwater controls could go months or even years without seeing significant runoff. For this reason, regional watershed-level controls that capture stormwater from large drainage areas would be more effective and more cost-effective. Because these regional detention basins are downstream of virtually all new development, using this existing public infrastructure to manage stormwater runoff quality would be less maintenance intensive for the overall community than implementing individual development-level controls, many of which would be located on private property. Additionally, BMPs must remain effective even after long periods with no rainfall. Considering the mean annual rainfall of the Las Vegas Valley is 4.2 inches, any BMP that relies on constant or frequent water flows for pollutant removal effectiveness or reasonable maintenance frequency, such as wetlands or extended detention basins, are not feasible in this environment. Most redevelopment is high-density residential and hotel/casino properties near the valley center. Ultra-urban BMPs that require very little land area would be required to address stormwater management onsite. Regional solutions would be better adapted to this situation.

Infiltration-based BMPs are not feasible in new development or redevelopment areas underlain by caliche, expansive clays, or collapsible soils. Poor soil conditions occur across large portions of Las Vegas Valley. No caliche maps of the valley are available and the presence of any of these geologic conditions must be evaluated on a site-specific basis through geotechnical evaluations.

Undeveloped land in the Las Vegas Valley produces naturally high sediment loads when runoff occurs due to minimal vegetation cover, erosive soils and highly shifting natural channels. This is evidenced by the large volumes of sediment captured by detention basins located in undeveloped drainage areas. Contrary to less arid parts of the country where development tends to be the cause of higher sediment loads from watershed surfaces, land development in the Las Vegas Valley stabilizes soil surfaces; however it does increase the potential for downstream channel erosion. Therefore channel stability, not onsite controls, should be the focus of BMPs designed to treat erosion impacts of development. At this time, most regional conveyance facilities are concrete lined to manage erosion and the CCRFCD design manual requires all channels to be stabilized in some manner, effectively addressing the primary erosion issues associated with urban runoff and reducing the need for onsite controls.

Approximately 70 percent of the Las Vegas Valley's drinking water supply is obtained from Lake Mead, which is part of the Colorado River system. The Colorado River system has

been experiencing an historical drought for over 10 years. As a result, local municipalities and SNWA have implemented drought and conservation measures to reduce water use. Many standard BMP and Low Impact Development (LID) designs rely on vegetation (e.g. thick turf or wetlands) for all or part of their treatment process. In the Las Vegas Valley, these areas occur very rarely under natural conditions and would require extensive artificial irrigation if they were to be maintained as part of site landscaping. Additional dry weather flow may be generated from irrigated areas, which is contrary to local water management objectives. Creation of these types of BMPs would be inconsistent with the water conservation objectives of SNWA and the ordinances established by the local municipalities. Actually, increased stormwater runoff of acceptable quality into Lake Mead is a benefit to the valley's drinking water supplies.

Nevada water law was reviewed and the Nevada State Engineer's Office, SNWA, and the Colorado River Commission were contacted to determine potential legal and water rights issues that could affect use of stormwater management facilities in Las Vegas Valley. Stormwater retention without onsite beneficial use (infiltration and evaporation losses only) would contradict local agency policies and potentially exacerbate existing water quality problems, and is not recommended. Proposed stormwater retention with onsite beneficial use (e.g., for irrigation water) would have agency support but would have to be submitted to the State Engineer for approval; approval is not certain due to potential impacts on Lake Las Vegas and other water rights holders. Therefore, stormwater retention cannot be relied on for the MS4 program, and should not be part of mandatory programs developed by the permittees.

In conclusion, standard approaches promoted by EPA for stormwater quality management in urban areas are not applicable to Las Vegas Valley due to unique locatl conditions. Rare and limited rainfall in Las Vegas Valley dictates that regional management mreasures will be more practical and cost-effective than onsite controls. Predevelopment conditions in the Las Vegas Valley include high rates of erosion and sediment transport, meaning that programs designed to eliminate sediment discharges may not result in preserving natural conditions. Infiltration of stormwater in the Las Vegas Valley is often not feasible due to soil conditions, and where feasible, may not be desirable due to the increase in groundwater levels and pollution (including possible exceedances of selenium standards) that results. Existing BMPs, such as the water conservation and drought management programs, have been effective in significantly reducing sources of dry weather flows from areas of new and existing development.

# 2 Introduction

EPA has applied standard approaches to developing requirements for municipal separate storm sewer system (MS4) permit programs throughout the United States. This includes requirements for programs to manage runoff from areas of new development and significant redevelopment, also referred to as "post-construction programs." Standard EPA approaches for post-construction programs include heavy emphasis on local detention/retention basins

and onsite development-level controls that capture site runoff and dissipate it through infiltration. The ultimate goal of these approaches is to minimize or eliminate any post-development stormwater flows over pre-development, or natural, conditions. These approaches were largely developed in the East, Midwest, and Pacific Northwest regions that experience frequent storms and significant annual rainfall amounts.

EPA seeks to apply these same criteria to the MS4 permit for Las Vegas Valley. However, local conditions in Las Vegas Valley are unique compared to the rest of the country, and require a different approach for setting and complying with MS4 permit requirements. Situated in the Mojave Desert, Las Vegas Valley is a unique community with a unique climate, hydrology, watershed, hydrogeology, land uses and economy. Las Vegas Valley is the most arid MS4 community in the United States. Channels are normally dry, and flow only briefly in response to short-duration storm events. Soils in many areas in Las Vegas Valley have poor infiltration properties.

Developing in a desert environment and dealing with persistent drought conditions over the past several years has resulted in adoption of unique approaches to addressing water resources and stormwater management issues. An extremely aggressive drought management program, including strict lawn watering and turf area restrictions, has been adopted permanently. Because Lake Mead is the major source of the community's drinking water, maximizing stormwater runoff to Lake Mead has benefits to the region's water supply.

The Las Vegas Wash channel drains all of Las Vegas Valley to Lake Mead. Flow in Las Vegas Wash consists of urban runoff, resurfacing shallow groundwater, stormwater, and highly treated effluent from wastewater treatment facilities. The total Las Vegas Wash contributing drainage area at Lake Mead is about 1,600 square miles, and the developed area currently comprises about one third of this area. Although locally important, Las Vegas Wash contributes less than 2 percent of the average annual flow to Lake Mead. Historically, Las Vegas Wash was supported primarily by spring flow and intermittent storm runoff, and created a broad wetland area in the southeast part of the Valley. Over the past 40 years, changes in development and hydrology led to increased flood frequency and significant erosion in Las Vegas Wash and tributaries. As a result, flood control and water management agencies have implemented a unique stormwater and erosion management program consisting of controlling peak discharges using regional detention basins and stabilizing channels using concrete lining and large erosion control structures. The nature of the existing stormwater management system should influence the types of water quality measures considered appropriate.

In 2007, the Las Vegas Valley MS4 permittees convened a group of local stakeholders to assist in preparing enhancements to the existing construction site runoff management and post-construction runoff management (for new development and significant redevelopment) programs. The stakeholder group included representatives from Clark County and the cities of Las Vegas, North Las Vegas and Henderson; local development groups; local trade associations; and the local engineering community. Local environmental groups were invited but chose not to participate. The stakeholder group agreed on the following mission statement:

Our goal is to comply with the MS4 permit by developing construction and post-construction program enhancements that are:

- clear, simple and effective
- consistent
- cost-effective
- consensus-based
- fiscally and environmentally responsible
- sensible for the Las Vegas Valley

This mission statement continues to guide the local MS4 permittees in developing and implementing programs to comply with the MS4 permit. Its principles are recommended to Nevada Division of Environmental Protection (NDEP) and EPA when considering appropriate control measures and best management practices for Las Vegas Valley.

Unique local factors must be considered when developing MS4 permit program requirements that are sensible for this community and satisfy EPA's maximum extent practicable (MEP) criterion. This document describes the factors that make Las Vegas Valley unique compared to other large metropolitan areas in the U.S., and identifies the implications of these unique factors on developing an appropriate MS4 program.

Much of the information in this document has been presented in different forms in previous Las Vegas Valley MS4 Annual Reports and permit-related submittals to NDEP. It is assembled here in one document to present a comprehensive overview of the unique Las Vegas Valley stormwater conditions that affect development of a reasonable and sensible MS4 program.

# 3 Climatic Factors

## 3.1 Unique Climate Conditions

Las Vegas Valley is located in the arid Mojave Desert, and is the driest city of over 100,000 people in the United States. Daily precipitation from the Las Vegas McCarran Airport gage (station number 264436) was obtained from the Western Regional Climate Center. Data from this gage dates back to February 1937. Annual rainfall totals for 1938 through 2006 are summarized in **Figure 3-1**. Average annual rainfall is 4.2 inches, median annual rainfall is 4.1 inches, and total annual rainfall over this historical period varied from 0.4 inches to 10.7 inches. **Table 3-1** compares Las Vegas annual rainfall to other large metropolitan areas in the Western United States.

## Figure 3-1. Annual Total Precipitation at Las Vegas Airport Gage

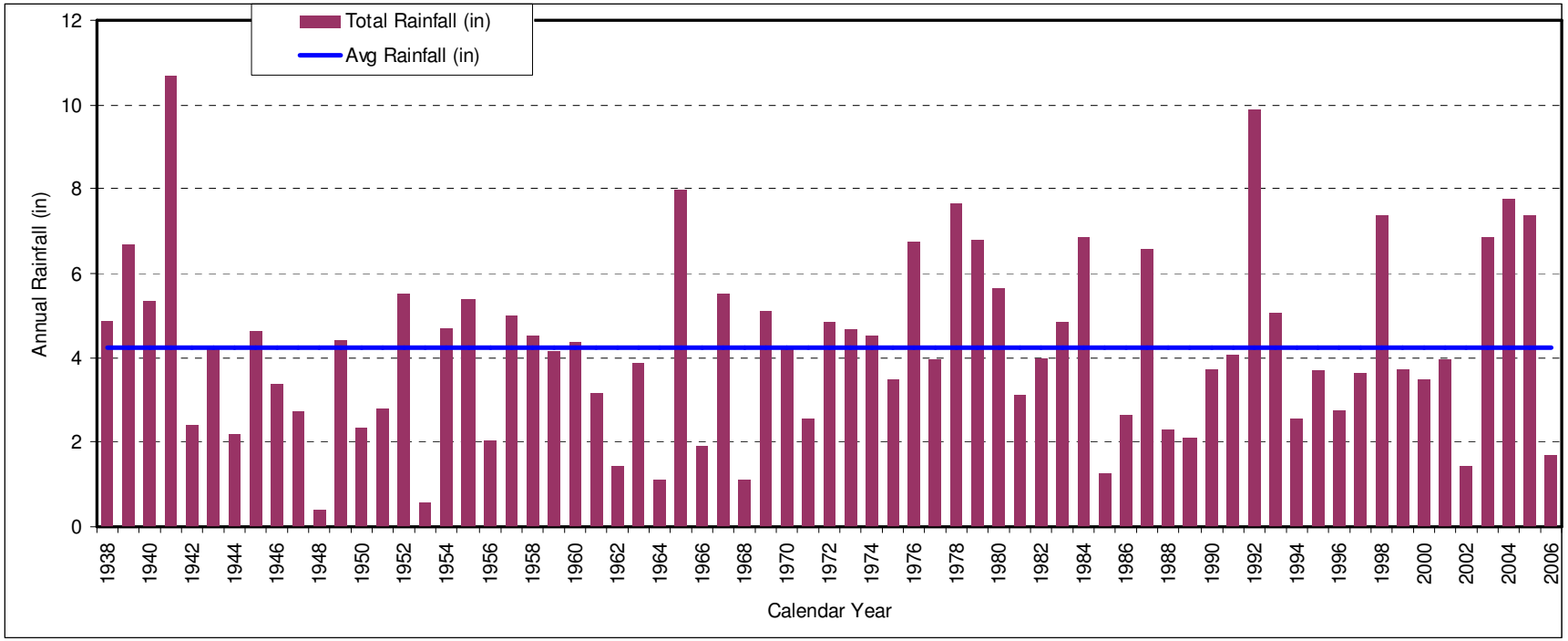


**Table 3-1. Mean Annual Rainfall in Large MS4 Communities in the Western United States**

| Community | Mean Annual Rainfall (inches) |
|---|---|
| Las Vegas, NV | 4.2 |
| Reno, NV | 7.5 |
| Phoenix, AZ | 7.7 |
| Riverside, CA | 10 |
| San Diego, CA | 11 |
| Tucson, AZ | 12 |
| Los Angeles, CA | 12 |
| San Bernardino, CA | 16 |
| Sacramento, CA | 18 |
| San Francisco, CA | 21 |
| Seattle, WA | 35 |
| Portland, OR | 40 |

Notes:
[a] Source: Western Regional Data Climate Center.
[b] Source: Watershed Protection Techniques. Article 66. Stormwater Strategies for Arid and Semi-Arid Watersheds.
[c] Source: worldclimate.com

Depending on soil conditions and location, experience of the MS4 permittees in performing stormwater monitoring since 1991 has shown that 0.1 to 0.2 inches of rainfall are needed to produce substantial runoff. This is consistent with findings from other arid and semi-arid areas as reported in The Practice of Watershed Protection by the Center for Watershed Protection (2000). **Figure 3-2** summarizes the historical number of days with rainfall capable of producing substantial runoff. The average annual number of days with rainfall of at least 0.1 inches is 11. The average annual number of days with rainfall of at least 0.2 inches is six.

**Figure 3-3** summarizes the number of days per month capable of producing runoff as well as the historical average monthly precipitation. June tends to be the driest month with only 0.1 inches of rain and an average of 1 day every 5 years with rainfall greater than 0.1 inches. January tends to have the most days of rainfall capable of producing runoff, but February has the greatest average precipitation of 0.6 inches. The figure shows that rainfall and storm frequency are minimal throughout the year.

**Figure 3-4** shows a daily rainfall depth frequency curve for the period of record. **Table 3-2** summarizes storm depth percentiles. About 60 percent of the days with measurable rainfall have a depth of less than 0.1 inches; insignificant runoff would occur for those rainfall amounts. The 85$^{th}$ percentile storm depth, which is often used for determination of water quality capture volumes in designing stormwater BMPs, is 0.32 inches. In some communities, the 80$^{th}$ percentile storm depth is used; for Las Vegas Valley that depth is 0.25 inches. Another common approach to selecting a BMP design storm is to adopt the value at the inflection point or "knee of the curve" of daily rainfall depths; at the McCarran Airport gage this value is about the 90$^{th}$ percentile storm depth of 0.43 inches.

## Figure 3-2. Annual Days of Rainfall Capable of Producing Runoff at Las Vegas Airport Gage

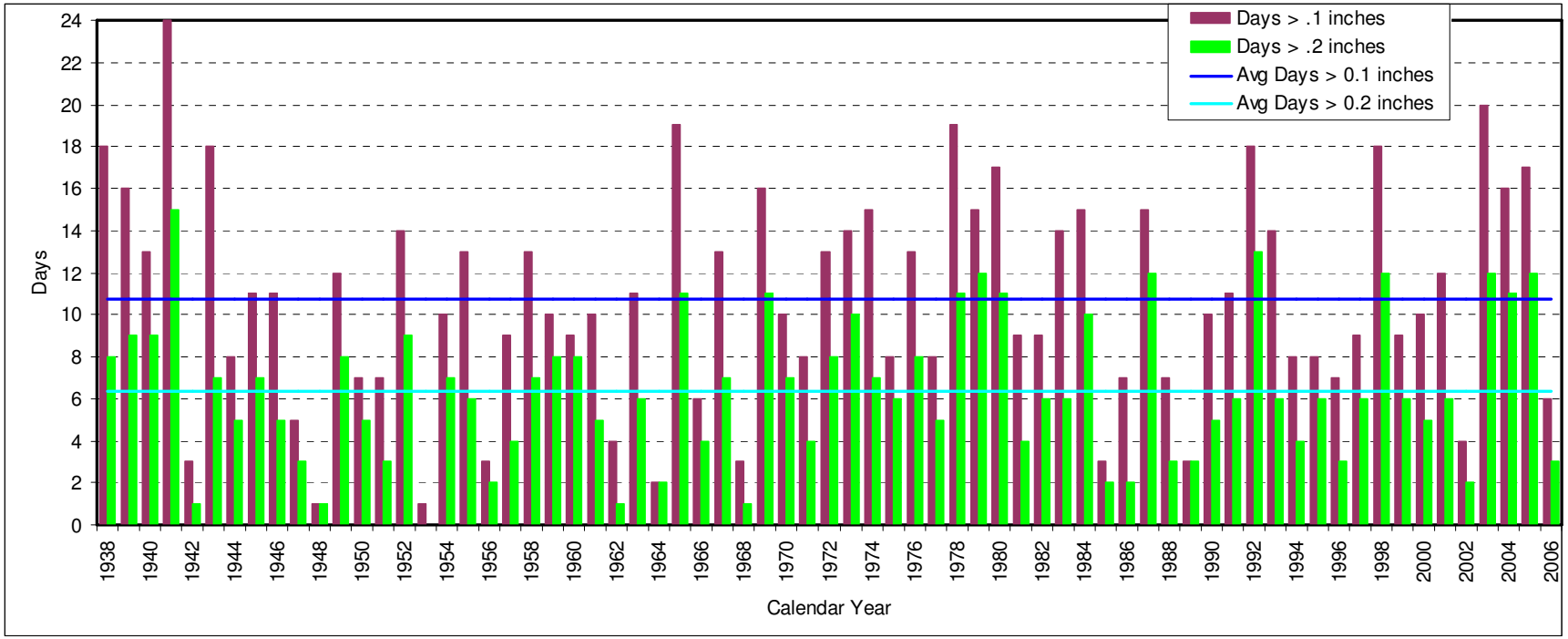


**Figure 3-3. Average Monthly Rainfall and Days of Rainfall Capable of Producing Runoff, by Calendar Month**

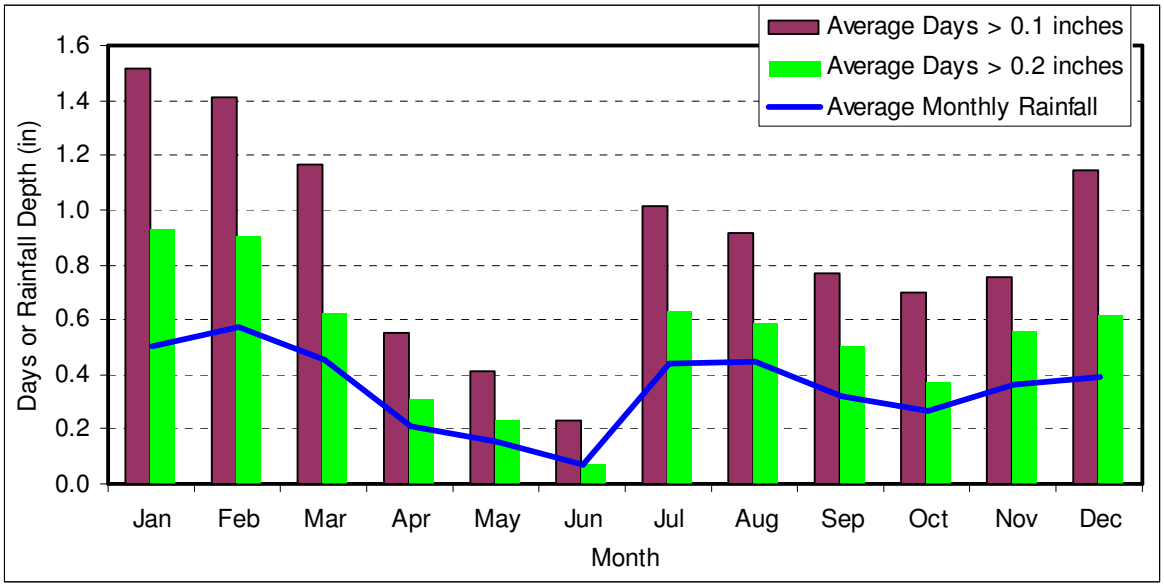



**Figure 3-4. Daily Rainfall Depth Frequency for Days with Measurable Rainfall**

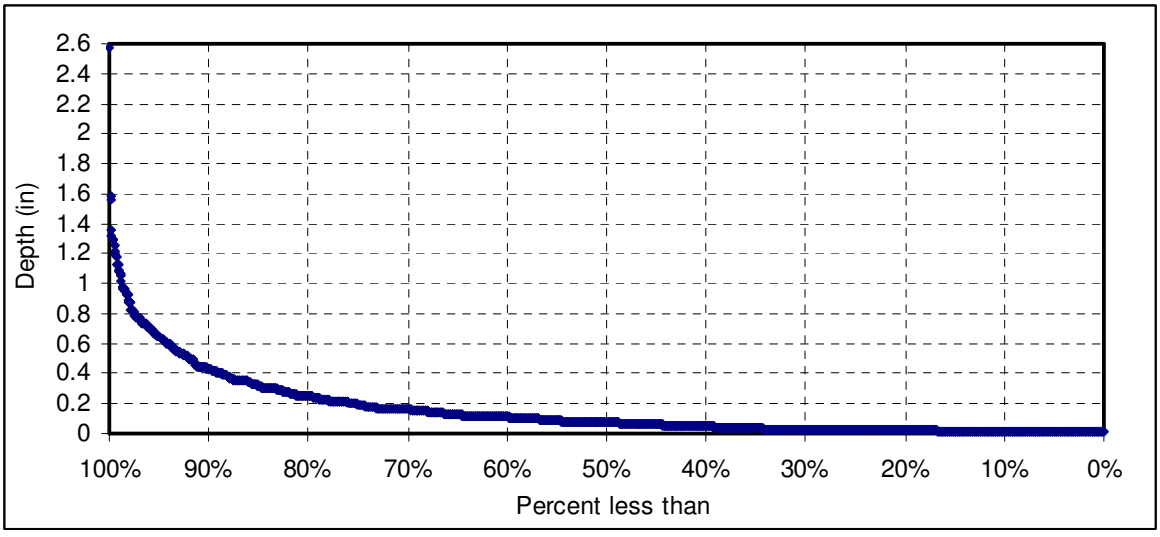


**Table 3-2. Daily Rainfall Depth Percentiles**

| Percentile | Days |
|---|---|
| 10 | 0.01 |
| 20 | 0.02 |
| 30 | 0.03 |
| 40 | 0.05 |
| 50 | 0.07 |
| 60 | 0.11 |
| 70 | 0.16 |
| 80 | 0.25 |
| 85 | 0.32 |
| 90 | 0.43 |

There are typically many dry days or weeks between rainfall events in Las Vegas. **Figure 3-5** shows a frequency plot of the number of days between storms of at least 0.2 inches of rainfall at the Las Vegas airport rain gage. The median number of dry days at any given location in the Valley is 22. **Table 3-3 s**ummarizes the percentiles of the duration of these dry periods. The 85th percentile is a dry period (no rainfall greater than 0.2 inches) of 125 days. This demonstrates that rainfall events are infrequent, and the spacing between significant storm events is substantial. Stormwater BMPs must be selected with these extended dry periods in mind.

**Figure 3-5 Dry Days between Runoff-Producing Rainfall Frequency**

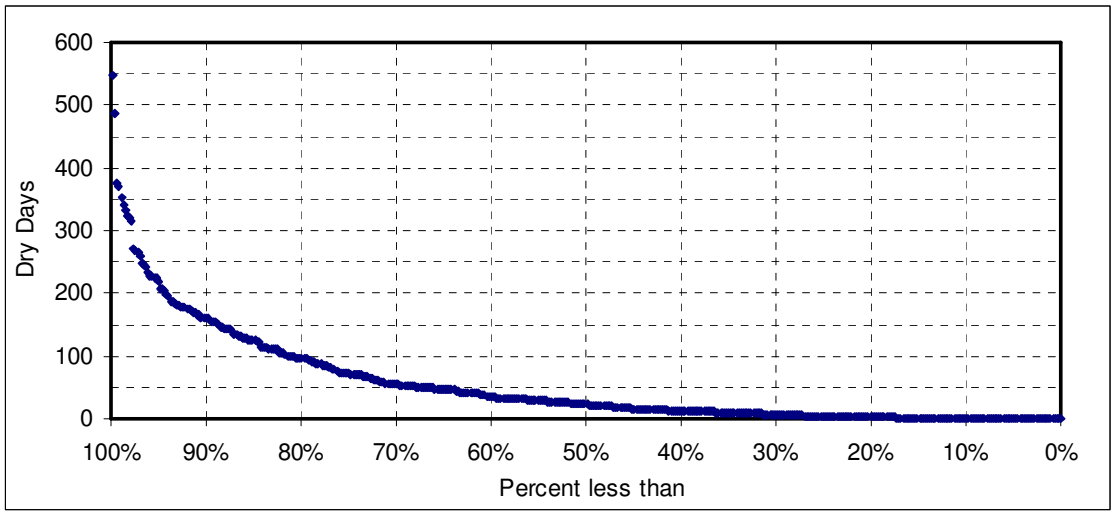


**Table 3-3. Dry Days Between Runoff-Producing Rainfall Percentiles**

| Percentile | Days |
|---|---|
| 10 | 0 |
| 20 | 2 |
| 30 | 6 |
| 40 | 13 |
| 50 | 22 |
| 60 | 35 |
| 70 | 54 |
| 80 | 96 |
| 90 | 159 |

In 1991, MWH analyzed precipitation data for the Las Vegas Valley as part of the original NPDES MS4 discharge permit application. In addition to evaluating daily rainfall data, this analysis considered individual storm events over shorter durations. Significant conclusions from that analysis were:

- Two types of storms of storms commonly occur in Las Vegas Valley – thunderstorms and general storms.
- Most thunderstorms in Las Vegas cover a limited aerial extent (one square mile to 200 square miles) with intense rainfall for brief periods (typically less than 3 hours, but up to 6 hours).
- General storms typically occur in the winter. They cover larger areas and last between several hours and two days, but have less intense rainfall than summer thunderstorms.
- General storms may produce greater runoff volume, but annual peak discharges nearly always result from summer thunderstorms.
- Flood control facilities in Las Vegas Valley are designed for a 6-hour thunderstorm event, per CCRFCD design criteria. This was based on an extensive review of historical storms by CCRFCD.
- Individual locations in Las Vegas Valley are subject to an average of about 22 days of measurable rainfall per year, occurring as a result of 15 separate storm series events having an average precipitation depth of 0.27 inches.

## 3.2 Implications for MS4 Program

With a mean annual rainfall of 4.2 inches, Las Vegas Valley is the driest large MS4 in the nation. Depending on soil and site conditions, developed areas and construction sites have the potential to produce measurable runoff an average of 6 to 11 days per year. Most runoff-producing events are thunderstorms of limited areal extent. The median number of dry days between rainfall events that produce runoff (greater than 0.2 inches) is 22 days. Implications of these climatic conditions for developing an appropriate MS4 program include the following.

- Because rainfall is so infrequent, large investments in extensive stormwater quality controls are not warranted, and would not pass any reasonable practicability test.

- Because rainfall for intense, runoff-producing events is often very localized, onsite development-level stormwater controls could go many months or even years without seeing significant runoff. In this situation, regional watershed-based controls that capture water from larger drainage areas are a more reasonable and cost-effective approach.
- Many standard BMP and LID designs rely on vegetation (e.g., thick turf or wetlands) for all or part of the treatment process. In Las Vegas Valley, these areas occur very rarely in natural conditions, and require extensive artificial irrigation to be maintained as part of site landscaping. Other BMPs such as extended detention basins require a permanent pool for maximum treatment benefits, which is also not practical in Las Vegas Valley. Creation of these types of BMPs would not be consistent with the water conservation objectives of SNWA and each local entity, including the Water Conservation and Drought Ordinance adopted by each entity (see Section 4), and could increase the potential for undesirable runoff of excess irrigation water.
- BMPs must be designed to remain effective even after long periods with no rainfall. BMPs that rely on constant or frequent flows of water for pollutant removal effectiveness or reasonable maintenance frequency – such as continuous deflector systems like Stormceptor – will not be feasible in this environment. The City of Las Vegas has abandoned a Stormceptor device because of excessive maintenance due to lack of flushing flows.

# 4 Hydrologic Factors

## 4.1 Unique Hydrologic Conditions

Lower Las Vegas Wash is an effluent-dominated stream for the entire reach downstream of the City of Las Vegas Wastewater Treatment Plant. **Figure 4-1** shows the locations of the wastewater treatment facilities in Las Vegas Valley. In an average hydrologic year, up to 90 percent of annual flow in lower Las Vegas Wash (downstream of the wastewater treatment plants) and entering Las Vegas Bay and the Las Vegas arm of Lake Mead is comprised of wastewater effluent. The remaining 10 percent is divided into approximately 4 percent stormwater runoff and 6 percent dry weather flows (miscellaneous urban drainage, resurfacing groundwater, and discharges from dewatering operations). This is depicted in **Figure 4-2**.

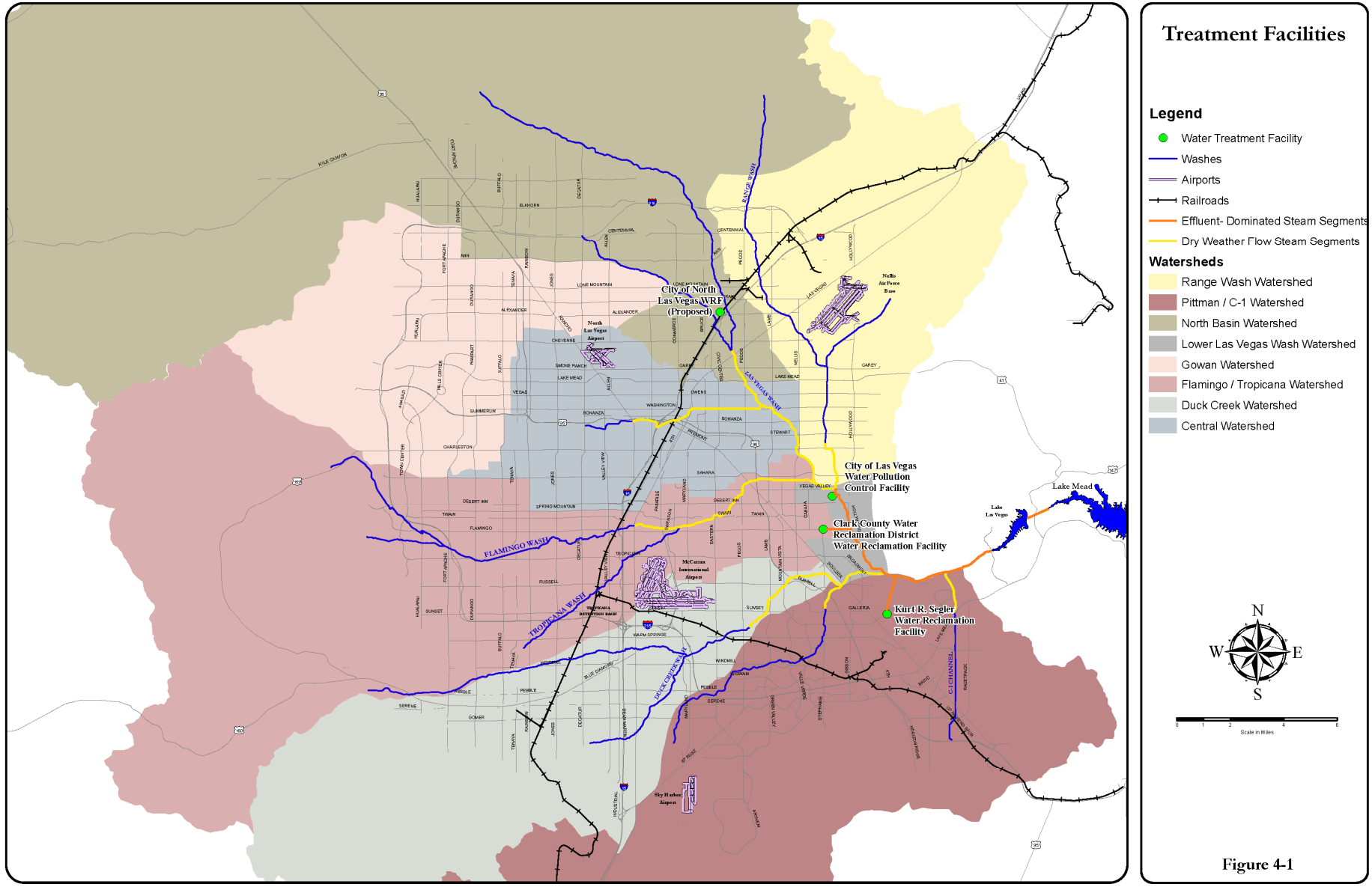
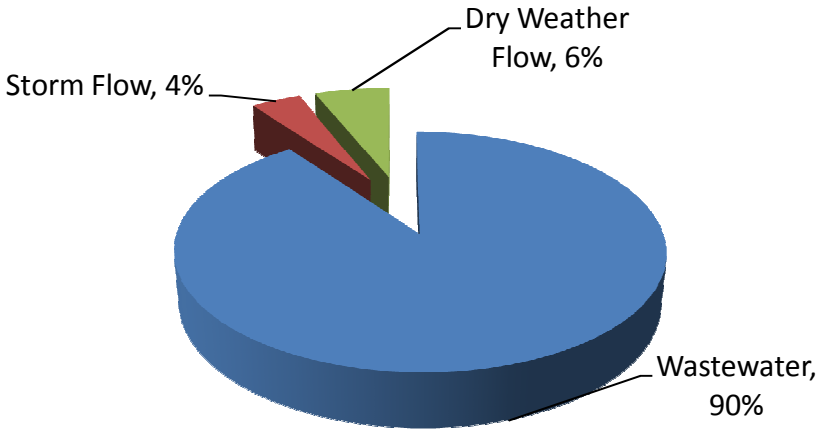

Treatment Facilities
Legend
Water Treatment Facility
Washes
Airports
Railroads
Effluent- Dominated Steam Segments
Dry Weather Flow Steam Segments
Watersheds
Range Wash Watershed
Pittman / C-1 Watershed
North Basin Watershed
Lower Las Vegas Wash Watershed
Gowan Watershed
Flamingo / Tropicana Watershed
Duck Creek Watershed
Central Watershed
City of North Las Vegas WRF (Proposed)
City of Las Vegas Water Pollution Control Facility
Clark County Water Reclamation District Water Reclamation Facility
Kurt R. Segler Water Reclamation Facility
Lake Mead
Nellis Air Force Base
North Las Vegas Airport
McCarran International Airport
Sky Harbor Airport
FLAMINGO WASH
TROPICANA WASH
LAS VEGAS WASH
RANGE WASH
DUCK CREEK WASH
C-1 CHANNEL
N
W
E
S
Scale in Miles

Figure 4-1

**Figure 4-2. Distribution of Annual Average Flow Volume in Lower Las Vegas Wash**




In the reach of Las Vegas Wash upstream of the wastewater treatment plant discharges, annual flow volume is much smaller than downstream of the treatment plants. In this reach and in lower portions of the tributaries in the southeast portion of the Valley (Duck Creek, Pittman Wash, Flamingo Wash and smaller tributaries), annual flow volumes are comprised of about 50 percent dry weather baseflows and 50 percent storm runoff. In the middle and upstream reaches of Las Vegas Wash and its tributaries, no significant dry weather flows exist and all annual runoff volume originates from stormwater. **Figure 4-1** shows the general location of these three hydrologic conditions: (1) effluent dominated stream; (2) dry weather and storm flows; and (3) storm flows only.

The area of urban development in Las Vegas Valley has increased significantly in the past 20 years (see Section 5). This would, in theory, increase the rates and volumes of streamflow occurring during both wet weather and dry weather conditions. Average annual streamflow at the United States Geological Survey (USGs) streamgages in Las Vegas Wash near Lake Las Vegas and in Flamingo Wash near the confluence with Las Vegas Wash was plotted to see if trends could be observed. These plots are shown in **Figures 4-3** and **4-4**.

**Figure 4-3. Average Annual Discharge for Las Vegas Wash at Henderson (WY1975-2006)**

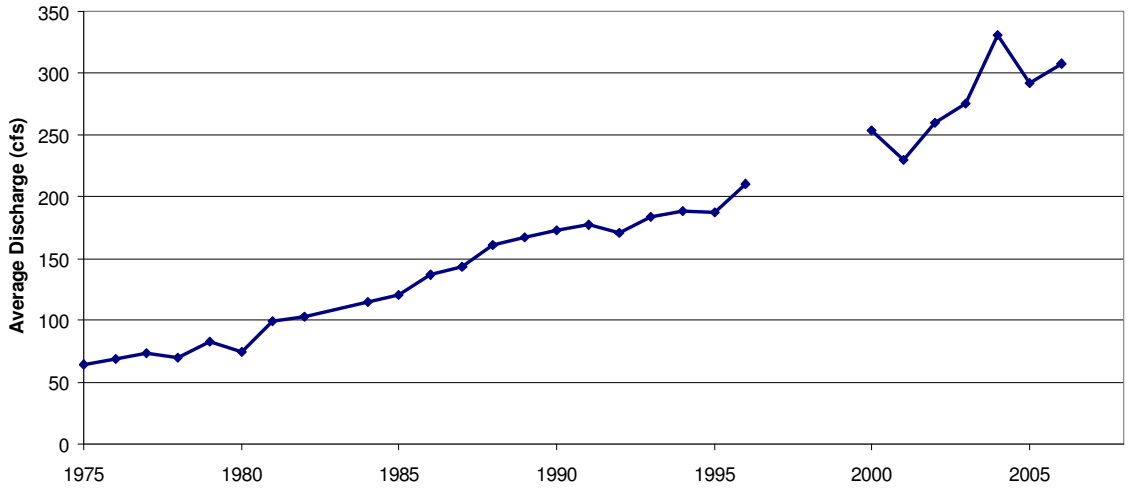
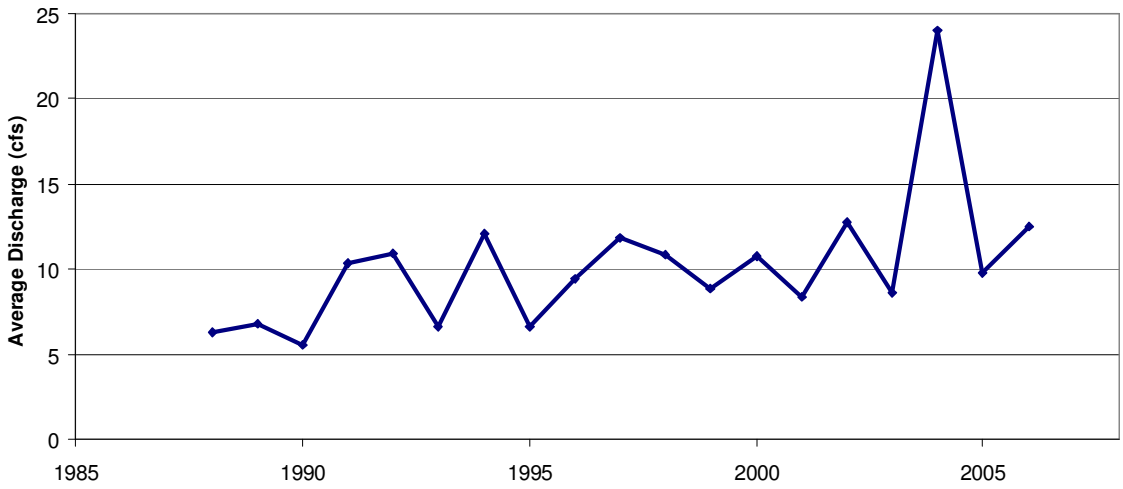



**Figure 4-4. Average Annual Discharge for Flamingo Wash at Nellis (WY1988-2006)**

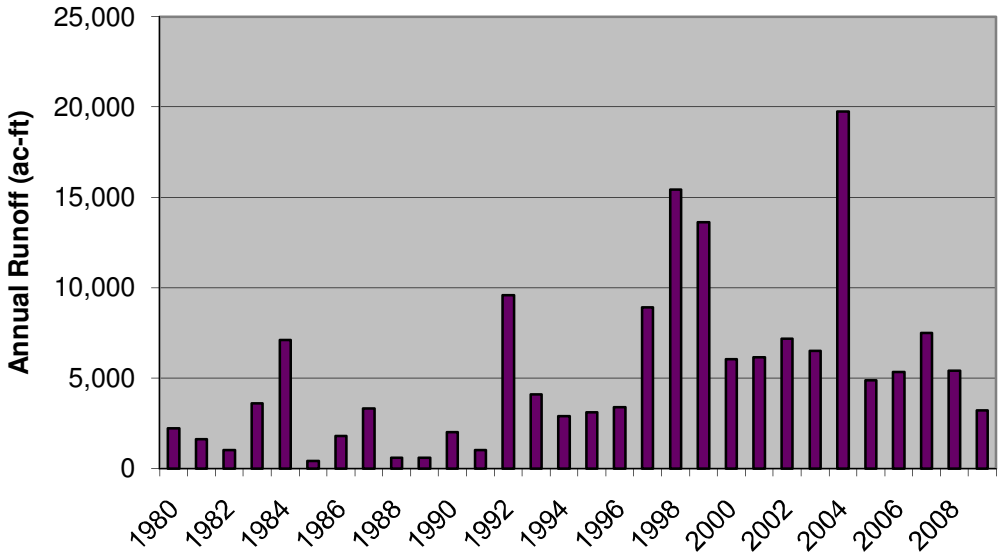



At both locations average annual streamflow is shown to have increased significantly over time. Average annual streamflow is comprised of a combination of storm runoff, dry weather flows from urban and other sources, resurfacing groundwater, and in the case of lower Las Vegas Wash, wastewater treatment plant effluent. Wastewater treatment plant effluent has increased in direct response to population growth. Resurfacing groundwater has increased in areas adjacent to Las Vegas Wash, particularly in the Henderson area, as a result of increased applied water for landscape irrigation. This factor strongly influences dry weather streamflows at the lower Las Vegas Wash gage locations, lower Flamingo Wash, lower Duck Creek and lower Pittman Wash. Urbanization can increase dry weather flows due to miscellaneous factors such as over-watering of lawns, car washing, pool draining,

dewatering for construction, and similar activities. (It is noted that draining pools into the storm drain system is prohibited in Clark County unless the flow is dechlorinated; otherwise pools must be drained into the sanitary sewer system.) This influence may be contributing to the trends seen in the USGS streamflow data plotted in **Figures 4-3** and **4-4**. It is noted that despite the historical increase in Las Vegas Wash streamflow, the Las Vegas Wash watershed still contributes less than 1 percent of the annual inflow to Lake Mead and the Colorado River system.

Annual storm runoff volumes in Lower Las Vegas Wash from 1980 to 2006 have been estimated by SNWA and MWH by subtracting wastewater effluent volumes and baseflow volumes from total discharges recorded at USGS streamgages. Results are shown in **Figure 4-5**. They show that the annual volume of storm runoff has generally been increasing over this period. A comparison of annual rainfall to annual runoff showed that this increase is not due to an increase in annual rainfall amounts, so it must be due to changes in watershed factors such as additional impervious areas and lining of flood control channels. Adverse effects from this hydrologic change are being addressed by the measures described in Section 9 - Stormwater Management Strategy. These measures include concrete lining nearly all regional flood channels, constructing erosion control structures in lower Las Vegas Wash, and adopting CCRFCD policies for site design that require mitigation of onsite and downstream erosion impacts due to new development.

**Figure 4-5. Annual Storm Runoff in Las Vegas Wash**




A positive benefit of the additional runoff is that more water is being delivered to Lake Mead, which is the primary source of drinking water for Las Vegas Valley. Although SNWA, the regional water provider for all the entities in Las Vegas Valley, does not get "credit" for this additional stormwater (as it does for wastewater return flows), the additional inflows to

Lake Mead and the Colorado River system benefit all users of Lower Colorado River water, including SNWA and its member agencies.

**Figures 4-6** through **4-11** show daily streamflow data for selected USGS streamgages in Las Vegas Valley over a recent 12 month period (mid April 2008 – mid April 2009). These figures demonstrate the intermittent nature of storm runoff in Las Vegas Valley channels, even in channels draining several hundred square miles of watershed area. They also demonstrate how rapidly flows typically increase and then subside, reflecting the response to short-duration storm events.

Figure 4-6. Sloan Channel Streamflow (Drainage Area = 140 sq mi; No dry weather flow; 2 runoff events in last 12 months)

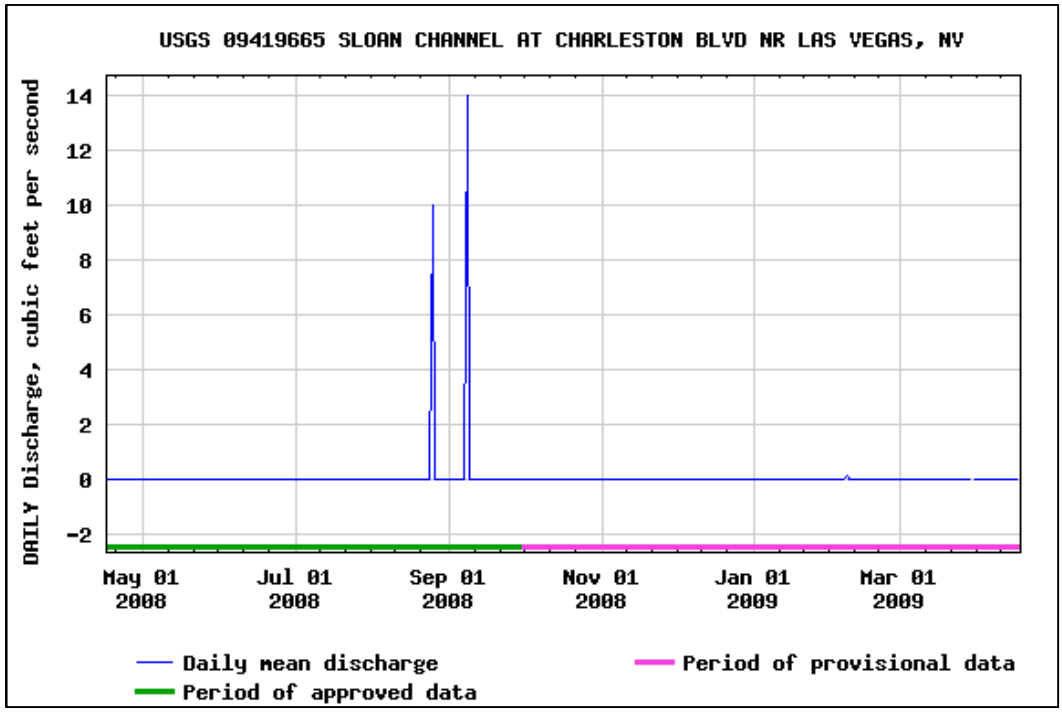



Figure 4-7. Flamingo Wash Streamflow (Drainage Area = 215 sq mi; Dry weather flow = 5-15 cfs; 8 runoff events in last 12 months)

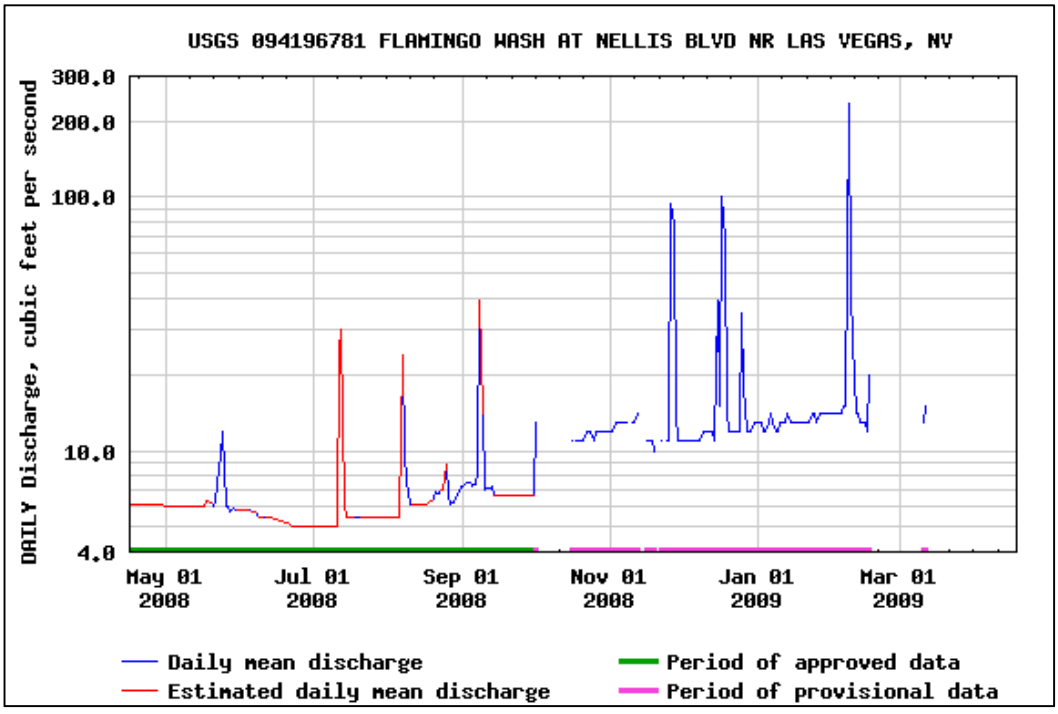


Figure 4-8. Duck Creek Streamflow (Drainage Area = 133 sq mi; Dry weather flow = 2-10 cfs; 5 runoff events in last 12 months)

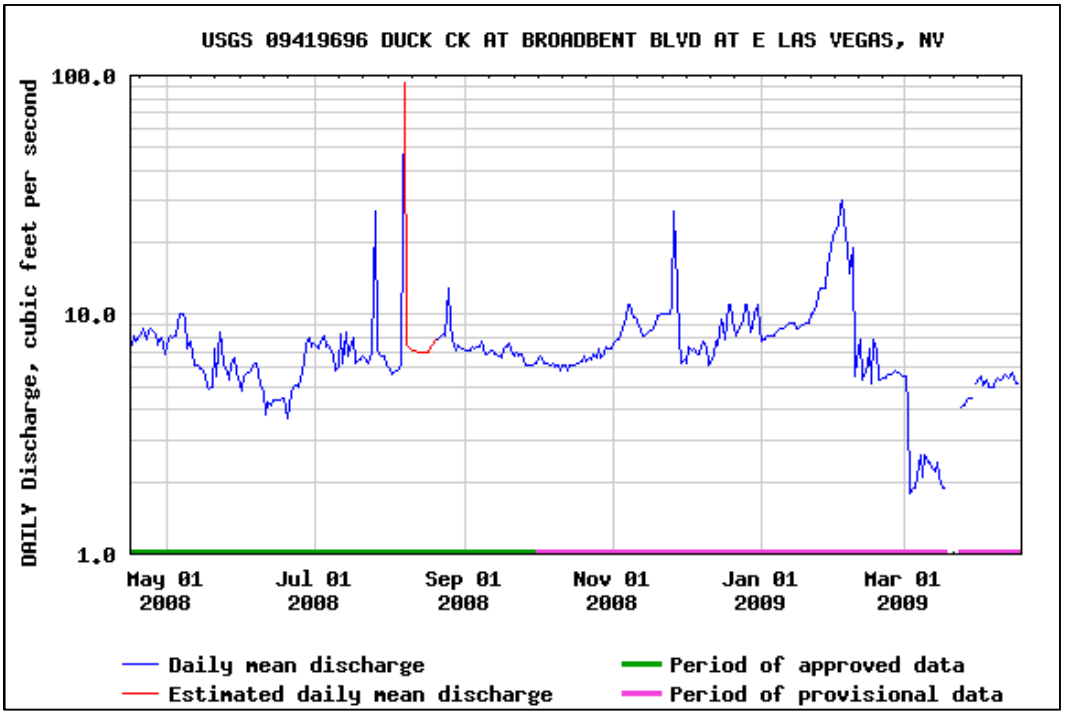



Figure 4-9. C-1 Channel Streamflow (Drainage Area = 3.8 sq mi; No dry weather flow; 5 runoff events in last 12 months)

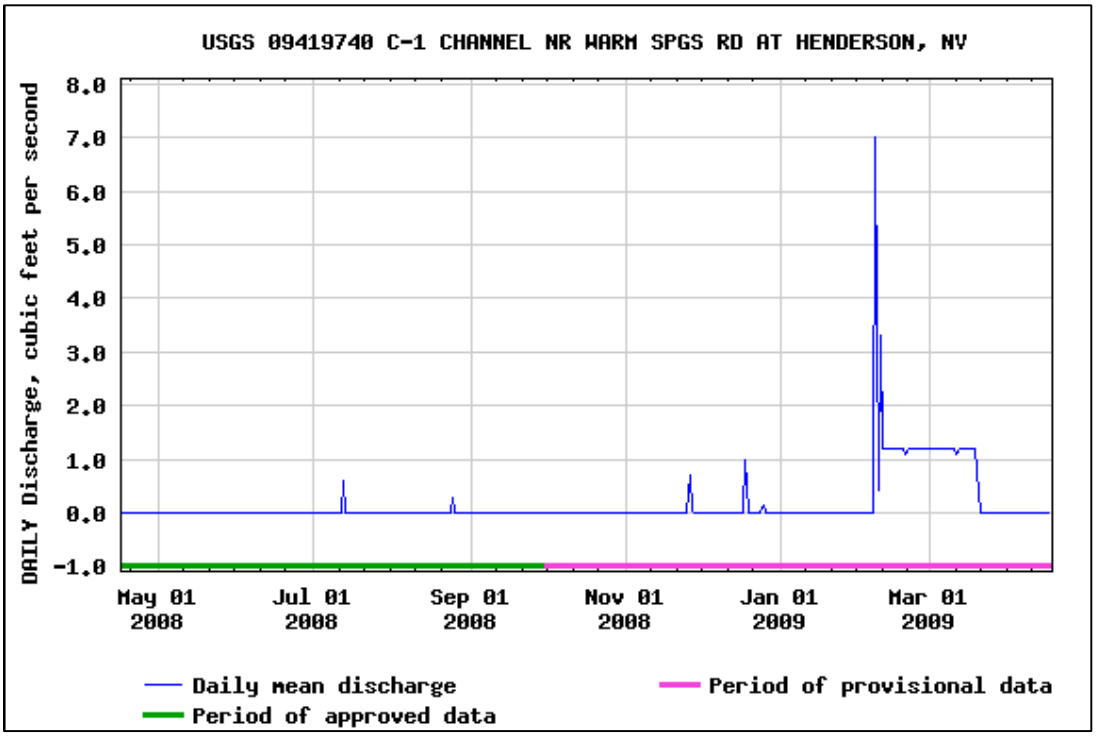


Figure 4-10. Las Vegas Wash Streamflow Above Wastewater Discharges (Drainage Area = 1,352 sq mi; Dry Weather Flow = 5-10 cfs; 11 runoff events in last 12 months)

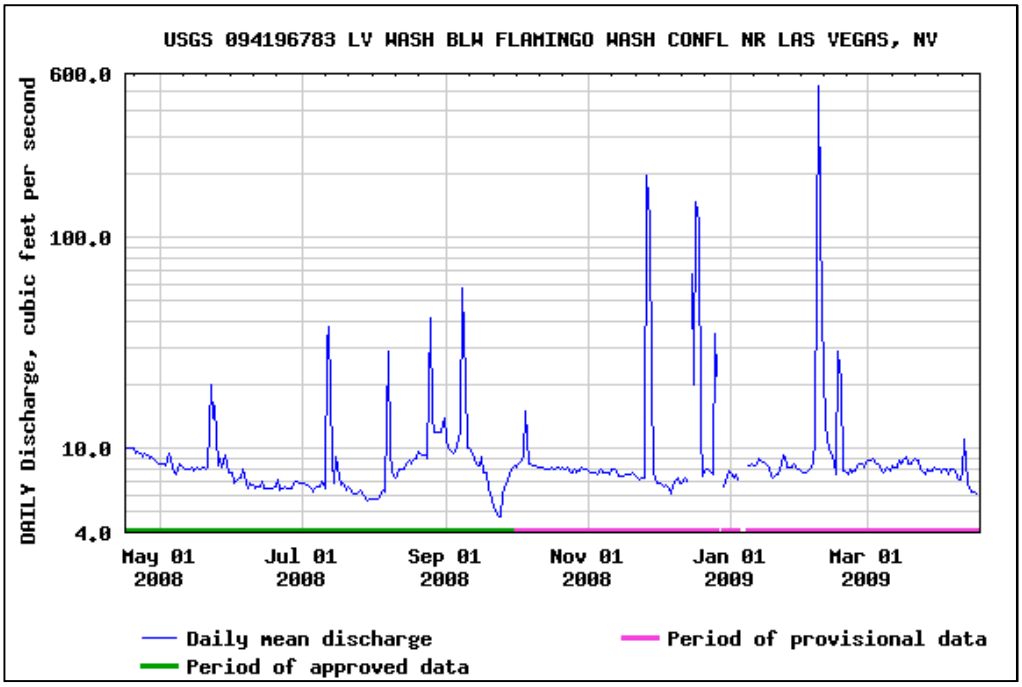
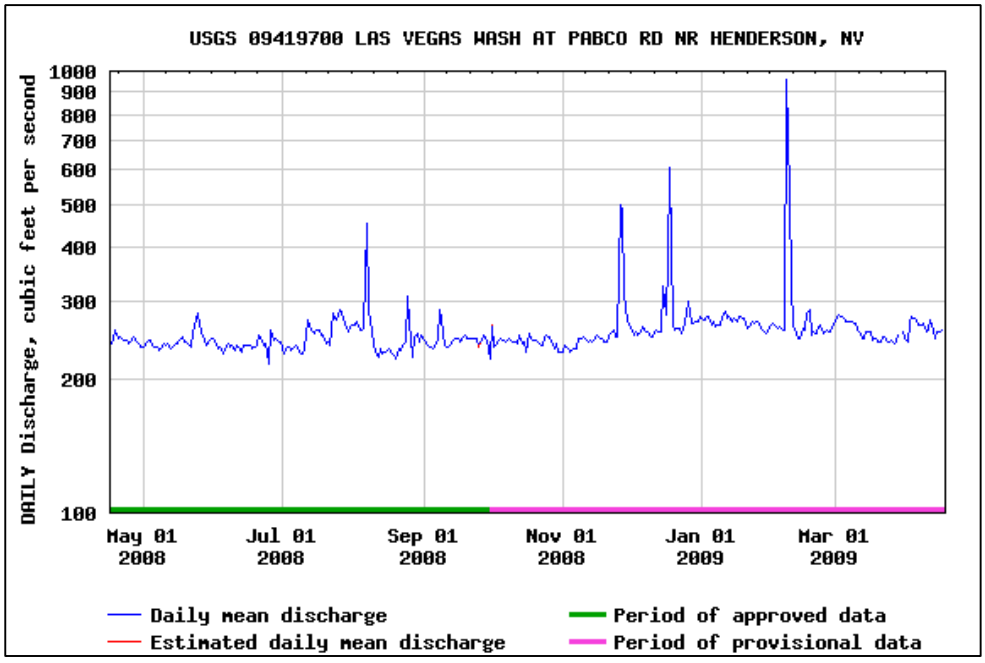



Figure 4-11. Las Vegas Wash Streamflow Below Wastewater Discharges (Drainage Area = 2,125 sq mi; Dry weather flow = 250 – 280 cfs; 9 significant runoff events in last 12 months)



The Colorado River system, including Las Vegas Valley, is experiencing a historical drought, and since 2000 the water level of Lake Mead has dropped over 100 ft. Because of this, local municipalities and agencies in Las Vegas Valley have adopted drought and conservation measures to reduce water use. These measures include but are not limited to public education and outreach, water waste prohibitions, new grass turf restrictions, and incentives for business owners and residents to convert grass turf to water efficient landscaping. SNWA has been effective in reducing water consumption by approximately 21 billion gallons from 2002 to 2008. In addition, SNWA has set a goal to reduce consumption from 254 gallons per capita per day (gpcd), as recorded in 2008, to 199 gpcd by 2035.

Reducing water use has resulted in less return flow from new and existing development to the MS4 system. This can be seen by reviewing dry weather streamflow data at selected Las Vegas Valley stream gages near the confluences of major tributaries with lower Las Vegas Wash, as shown in **Figures 4-12** to **4-16**. These figures plot 30-day moving averages of dry weather flow (i.e., gaged flows with storm water contributions removed); the moving averages are plotted to smooth out influences of isolated events and to better visualize possible trends. Data demonstrates that despite the significant population increase over the past 10-20 years, dry weather flows have not increased proportionally. This validates the effectiveness of turf reduction, outdoor watering restrictions and other conservation measures in reducing urban nuisance flows in the MS4. Thus while not intended as a MS4 program BMP, water conservation and drought management measures have resulted in significant reductions in dry weather flows and associated pollutant loads.

Figure 4-12. Las Vegas Wash at Desert Rose Dry Weather Flow 30-Day Moving Average

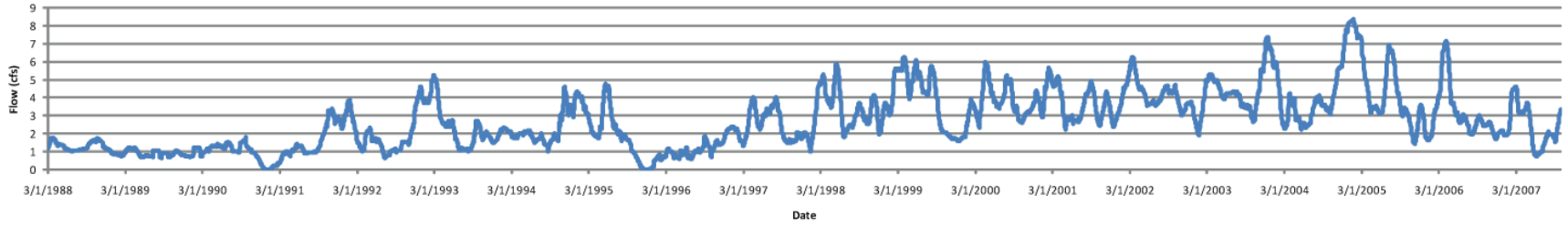



Figure 4-13. Flamingo Wash Dry Weather Flow 30-Day Moving Average

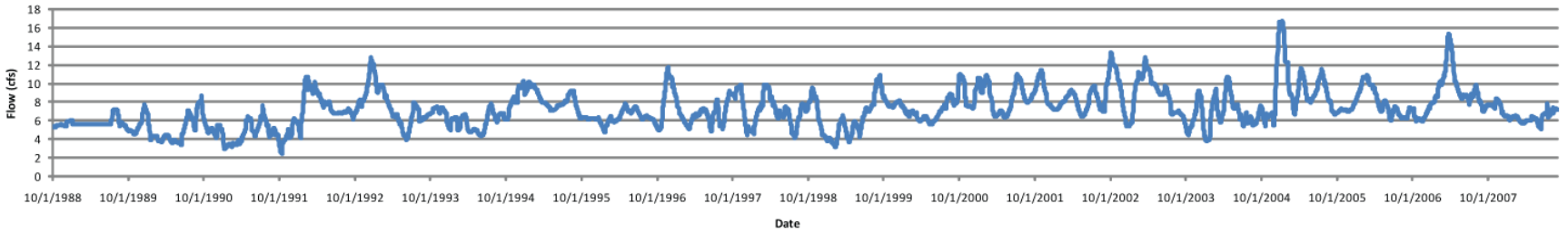
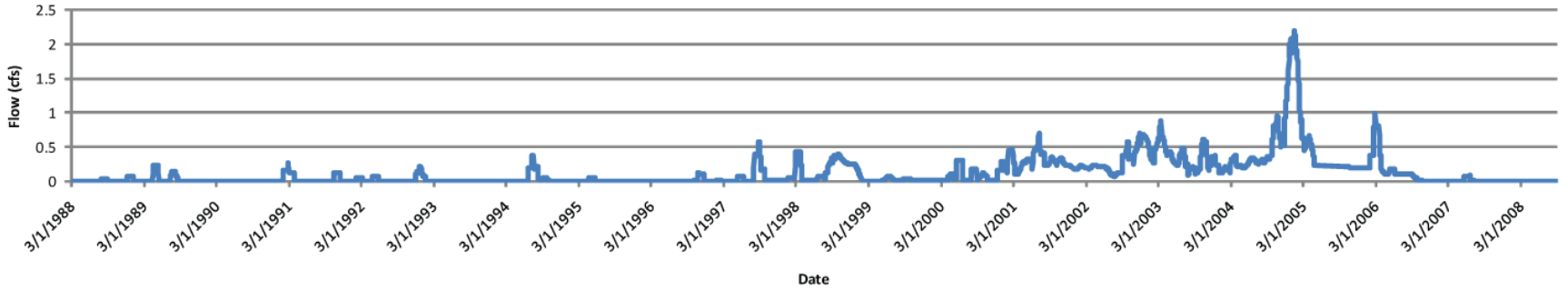
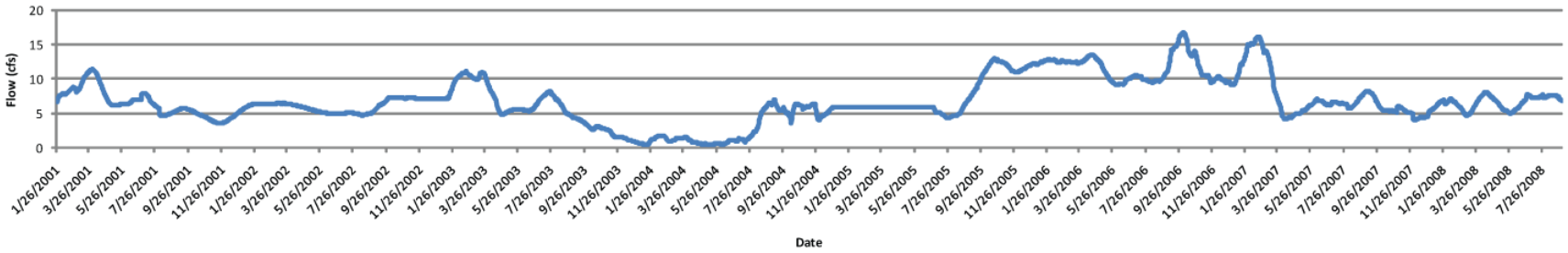


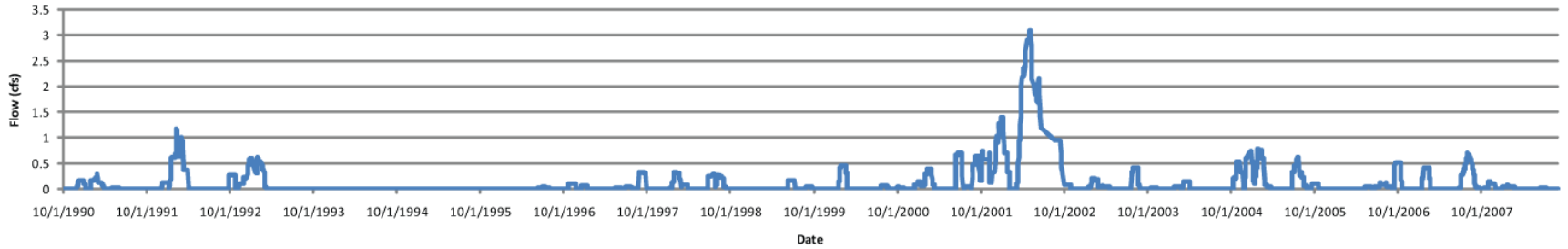

Figure 4-14. Sloan Channel Dry Weather Flow 30-Day Moving Average



## Figure 4-15. Duck Creek Dry Weather Flow 30-Day Moving Average




## Figure 4-16. C-1 Channel Dry Weather Flow 30-Day Moving Average



## 4.2 Implications for MS4 Program

- Because storm runoff represents only 4 percent of the total runoff volume in Las Vegas Wash, even eliminating it entirely would have little impact on the loads of many pollutants delivered to downstream receiving waters (Las Vegas Bay, Lake Mead). See Section 8 for a discussion of Las Vegas Valley water quality data.
- Wastewater effluent contributes significantly to erosion in lower Las Vegas Wash. SNWA's channel stabilization structures are being implemented to address this problem.
- Rare and intermittent runoff events mean that onsite stormwater BMPs would rarely be used, and more regional, watershed-based approaches will be more cost-effective.
- Extended dry periods between runoff events require that BMPs must be designed to remain effective even after long dry periods. As noted previously, devices such as Stormceptors have been found to perform poorly in the Las Vegas climate.
- Storm runoff has increased in response to development in Las Vegas Valley. However, adverse impacts of that runoff, e.g. on channel erosion, are being addressed on a regional rather than onsite basis by CCRFCD, SNWA and other regional agencies. Increased stormwater runoff to Lake Mead is a benefit to drinking water supplies.
- Various water conservation and drought management programs have been effective in significantly reducing sources of dry weather flows from areas of new and existing development. This has proven to be an effective BMP for urban dry weather flows, and reduces the need for other more traditional approaches for managing non-stormwater discharges in the MS4.

# 5 Watershed and Land Use Factors

## 5.1 Unique Watershed Conditions

Las Vegas Valley is a large bowl comprised of a valley floor surrounded by active alluvial fans transitioning to steep mountain ranges. The current topography has been formed by thousands of years of erosion, with large volumes of sediment being transported from the steep mountains bordering the valley to alluvial slopes and the valley bottom. Undeveloped land surrounding areas of existing development is desert terrain on alluvial fans, which produces naturally high sediment loads when runoff occurs due to minimal vegetation cover, erodible soils and highly shifting natural channels. Evidence of the natural erosion potential in native watershed conditions is provided by the large amount of sediment trapped by regional detention basins located at the apex of alluvial fans. For example, an estimated 67,500 cubic yards of sediment was captured in Red Rocks Detention Basin prior to 2006, primarily as the result of a small number of high flow events. All the area upstream of the

basin is undeveloped, and all the eroded sediment captured in the basin was naturally occurring. Because of high evapotranspiration and infiltration rates, small rainfall events of the type commonly addressed by stormwater quality programs (e.g., 2-yr frequency and smaller) rarely produce significant runoff from undisturbed desert watersheds. The large majority of sediment transport occurs for high flow events (e.g., 10-yr and larger) that exceed the design frequency of most stormwater quality management facilities.

**Figure 5-1** shows typical channel areas on alluvial fans in Southern Nevada. The highly erodible conditions in the natural environment are evident. **Figure 5-2** is an aerial photograph showing typical alluvial fan areas into which new development is encroaching. Contrary to conditions in many other parts of the country, developed land in this environment can stabilize the watershed surface and reduce soil loss compared to native conditions. Concentration of flows in alluvial channels and resulting increased channel erosion is described in Section 9 - Stormwater Management Approach.

### Figure 5-1. Photos of Typical Channels in Alluvial Fan Areas in Southern Nevada



Figure 5-2. Aerial Photograph of New Development Adjacent to Undisturbed Area



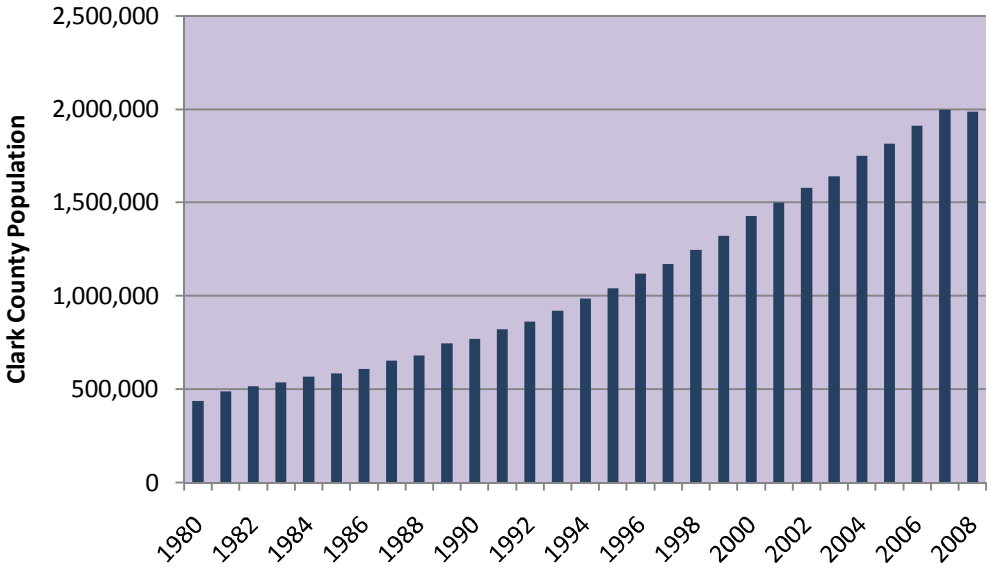
## 5.2 Unique Land Use Conditions

Prior to the recent economic slow-down, Las Vegas Valley was one of the fastest growing urban areas in the nation, with approximately 6,000 new residents moving to the area every month. **Figure 5-3** shows the population increase in Clark County (of which Las Vegas Valley population comprises over 90 percent) between 1980 and 2006. Almost 1.5 million people moved to Las Vegas Valley in that period.

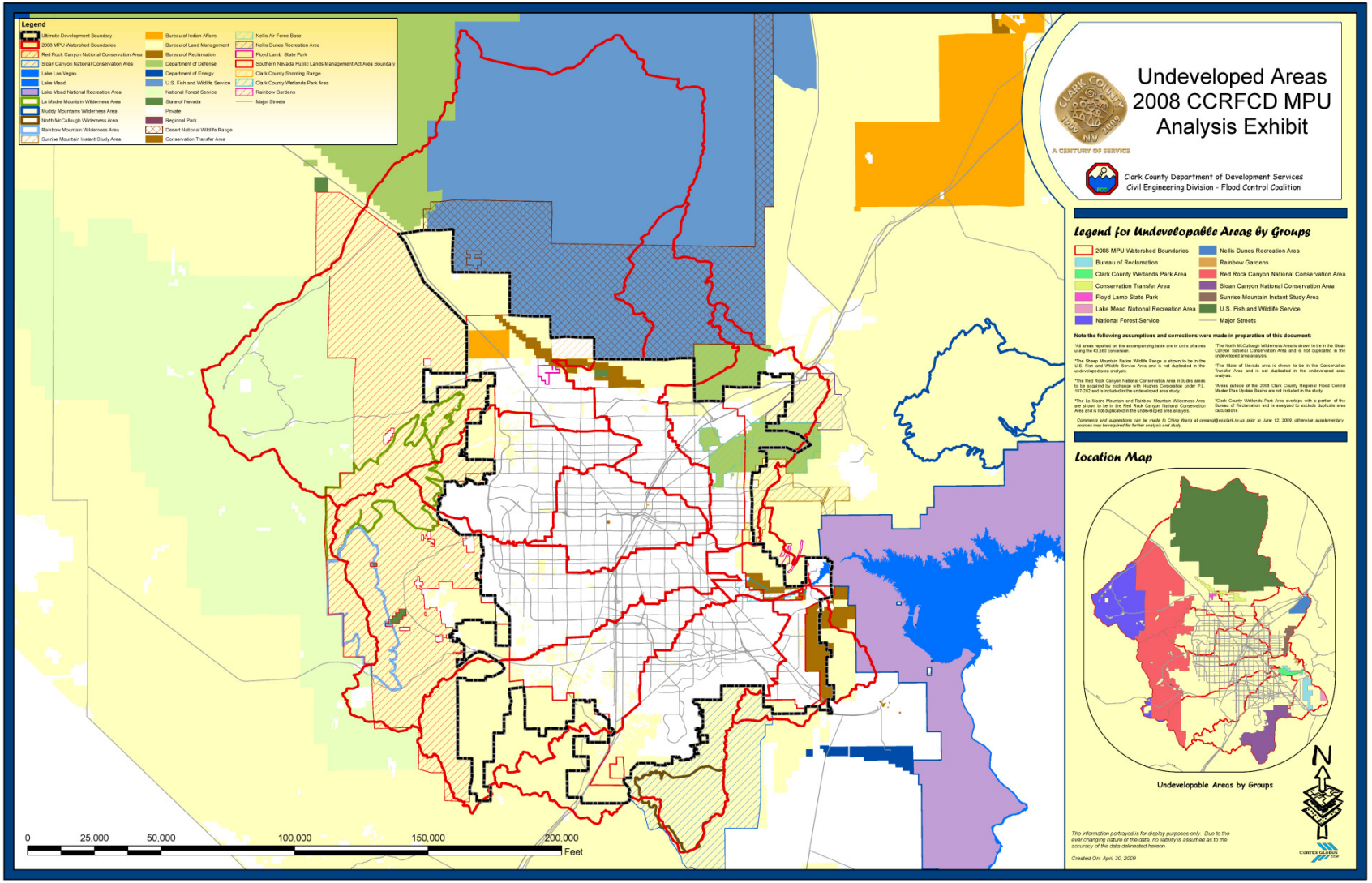
New development is occurring in an outward pattern from the valley center, in nearly all directions. The majority of new development consists of residential housing and associated commercial development, and large hotel/casinos. The majority of significant redevelopment consists of new hotel/casinos and high-rise residential development in the vicinity of the Las Vegas Strip and Interstate 15 in the central valley area. Las Vegas Valley hosts over 40 million visitors per year, highlighting the importance of the hotel/casino and tourism industries to the local economy and landscape.

Superimposed on this rapid development is the fact that much of the currently undeveloped land in the Valley is undevelopable for reasons related to land ownership or slope. **Figure 5-4** and **Table 5-1** were prepared by Clark County to show the amount of land in the Las Vegas Valley watershed that is held by BLM or is in various Conservation Areas, Recreation Areas, and Wilderness Areas. These holdings, which represent about 75 square miles, will significantly constrain future development and prevent it from spreading into the mountains surrounding the Valley.

Figure 5-3. Clark County Population (1980-2008)



## Figure 5-4. Undevelopable Areas in Las Vegas Valley



## Table 5-1. Undevelopable Land in Las Vegas Valley by Watershed and Owner

| Land Ownership Category | Land Ownership Area (acres) by Watershed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | C1 Channel | Central Basin | Duck Creek | Flamingo/ Tropicana Wash | Gowan Basin | Lower Las Vegas Wash | Lower Northern Basin | Pittman Wash | Range Wash | Upper Northern Basin | Grand Total |
| Total Basin Area | 31,675 | 35,887 | 84,501 | 140,976 | 53,450 | 15,861 | 67,687 | 99,581 | 62,527 | 409,932 | 1,002,077 |
| Undevelopable Areas | | | | | | | | | | | |
| Bureau of Reclamation | 566 | 4 | | | | 175 | | 0 | | | 745 |
| Clark County Wetlands Park Area | 30 | | | | | 222 | | 16 | | | 267 |
| Conservation Transfer Area | | | | | | | 223 | | | 239 | 462 |
| Floyd Lamb State Park | | | | | | | | | | 66 | 66 |
| Lake Mead National Recreation Area | 115 | | | | | | | | | | 115 |
| National Forest Service | | | 1 | 210 | | | | | | 5,968 | 6,179 |
| Nellis Dunes Recreation Area | | | | | | | | | 560 | | 560 |
| Rainbow Gardens | | | | | | 28 | | | | | 28 |
| Red Rock Canyon National Conservation Area | | | 1,093 | 6,267 | 844 | | | | | 8,046 | 16,250 |
| Sloan Canyon National Conservation Area | 246 | | | | | | | 2,436 | | | 2,682 |
| Sunrise Mountain Instant Study Area | | | | | | 47 | | | 368 | | 414 |
| U.S. Fish and Wildlife Service | | 1 | | | | | 2,709 | | 241 | 17,551 | 20,502 |
| Total Undevelopable Area | 957 | 5 | 1,094 | 6,477 | 844 | 471 | 2,933 | 2,452 | 1,169 | 31,870 | 48,271 |
| Total Undevelopable Area (square miles) | 1.5 | 0.0 | 1.7 | 10.1 | 1.3 | 0.7 | 4.6 | 3.8 | 1.8 | 49.8 | 75.4 |
| Source: Clark County Department of Development Services. | | | | | | | | | | | |

Most new urban landscaping consists primarily of xeriscape, with limited use of turf and limitations to outdoor watering imposed by each local entity in response to drought and conservation measures adopted by SNWA. Current development codes prohibit use of turf in front yards of new residential properties, and allow only 50 percent of the back yard to be in turf. This is contrary to landscaping provisions in most other communities in the U.S, and is indicative of the region's commitment to efficiently managing all of its water resources. In addition to reducing water use, this situation significantly reduces runoff of landscape irrigation water and associated pollutants such as fertilizers and pesticides. Anecdotal reports indicate that in some areas dry weather flows in streets and storm drain systems are decreasing as a result of this change in landscaping practices. Data on dry weather flows shown in Section 4.1 indicates that non-storm flows in Las Vegas Valley channels have not increased significantly in the past 10-20 years, despite the large population increase. This evidence supports the effectiveness of the drought management and outdoor water efficiency practices in reducing or eliminating dry weather flows and their associated pollutant loads.

## 5.3 Implications for MS4 Program

- High rates of erosion and sediment transport occur naturally in the Las Vegas Valley watershed, and are primarily associated with high flow events (greater than the 2-yr event). BMP programs to address sediment should keep in mind that pre-development conditions include high rates of erosion and sediment transport. Programs to eliminate sediment discharges may not result in preservation of conditions that would have occurred naturally.
- Land development in Las Vegas Valley stabilizes soil surfaces but increases channel erosion. Therefore channel stability, not onsite controls, should be the focus of BMPs designed to treat erosion impacts of development.
- Most redevelopment is high-density residential and hotel/casino properties near the valley center. Ultra-urban BMPs (i.e., those that can be installed in very small areas) would be required to address stormwater management onsite. Regional solutions would be better adapted to this situation.

# 6 Geologic Factors

## 6.1 Unique Geologic Conditions

The Las Vegas Valley is located between the Great Basin and the Mojave Desert, and the surficial sediments predominantly consist of coarse materials, silts, and clays. In the Las Vegas Valley, three geologic conditions occur that are potential problems for infiltration-based BMPs: caliche, expansive clays, and collapsible soils. Caliche is sedimentary rock consisting of, but not limited to, clays, soils, and gravel cemented together by calcium carbonate; thus, caliche is a hardpan material that water cannot easily infiltrate. Expansive soils refer to a category of soils that expand when water content is increased. Conversely, collapsible soils experience a decrease in volume when water content is increased. Both of these types of soil conditions can have adverse impacts on foundations, buildings, pavement, and buried infrastructure when exposed to water. These three geologic factors are common in arid regions and are found extensively within the Las Vegas Valley.

The Clark County Soil Guidelines Map was created by the Clark County Building Department with information from the Nevada Bureau of Mines and Geology, the United States Geological Survey (USGS), and CCRFCD. This is shown in **Figure 6-1**. The purpose of the map is to show general trends of near-surface soil conditions, such as expansive and collapsible potential, within the Las Vegas Valley.

The categories on **Figure 6-1** that are of importance for stormwater management are the special geotechnical considerations designated by yellow, brown, and pink shading. Yellow and brown areas have expansive and collapsible potential. The areas marked with yellow shading contain the areas along the main tributaries to the Las Vegas Wash and the Las Vegas Wash, referred to on the map as the Drainage Zone. The brown shaded areas, referred to as the Special Geotechnical Consideration Zone, are predominantly on the east side of the Las Vegas Valley (east of Decatur Boulevard). Both of these areas have clay swell, expansive, and/or hydro-collapsible potential. The pink area is also a Special Geotechnical Consideration Zone due to the presence of steep slopes and shallow bedrock that would be problematic for infiltration BMPs.

Caliche deposits are distributed throughout Las Vegas Valley, and are highly variable in location, extent and depth. No caliche map has been prepared; site specific investigations are necessary to determine the presence of caliche at a given development site.

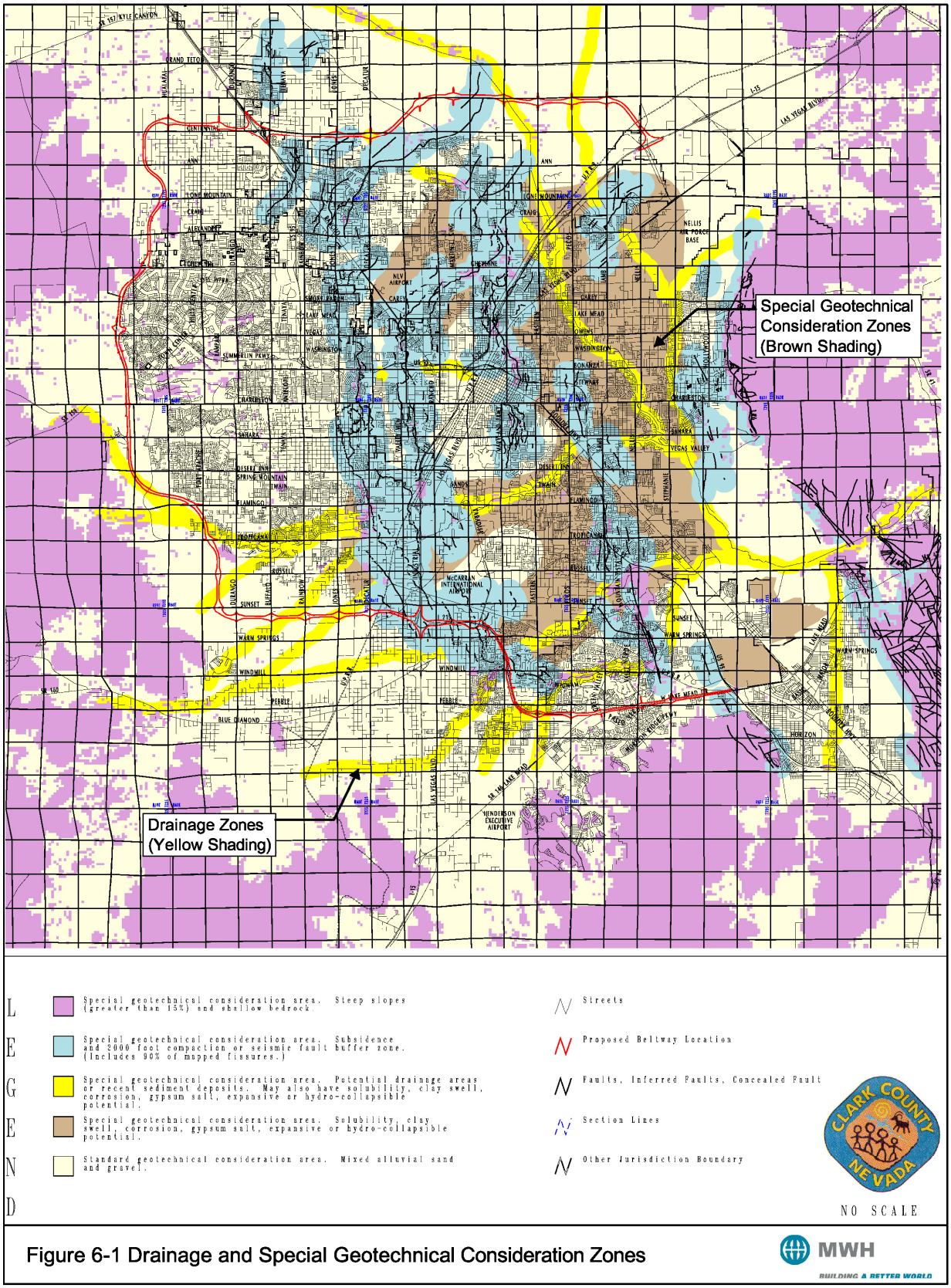



Figure 6-1 Drainage and Special Geotechnical Consideration Zones

## 6.2 Implications for MS4 Program

Following are implications of the previously discussed geologic conditions related to the appropriateness of using infiltration-based BMPs in Las Vegas Valley.

- Infiltration-based BMPs are not feasible in new development or redevelopment areas underlain by caliche deposits. Caliche can be located virtually anywhere in the Las Vegas Valley and caliche mapping is not available. Specific geotechnical explorations would need to be conducted to determine if caliche is in a specific area of new development or redevelopment.
- Infiltration-based BMPs are not feasible in new development or redevelopment areas underlain by expansive or collapsible soils. Any developments located within and near to the Drainage and Special Geotechnical Consideration Zones, as per the Clark County Soil Map, may contain expansive and/or collapsible soils. Specific geotechnical explorations would be necessary to determine if the soil has expansive and collapsible potential.
- Infiltration-based BMPs must be prohibited in large portions of Las Vegas Valley that are subject to these common geologic conditions. A separate technical memorandum has been prepared to more fully investigate stormwater infiltration suitability issues (MWH, 2010).Hydrogeologic Conditions

# 7 Hydrogeologic Conditions

## 7.1 Hydrogeology of the Las Vegas Valley

The Las Vegas Valley consists of three main aquifers: the Las Vegas Springs aquifer, the Duck Creek aquifer, and the Las Vegas Wash aquitard. An aquitard is a layer of rock that has low permeability but that still can transmit groundwater at a low rate. A simplified conceptual diagram of the aquifers and aquitard in the Las Vegas Valley was prepared by SNWA and is shown in **Figure 7-1**. A similar conceptual hydrogeologic cross section was prepared by MWH to illustrate the main hydrogeologic features as they relate to the stormwater program. This is shown in **Figure 7-2**. Las Vegas Valley Water District has production wells in the two aquifers that provide about 30 percent of the water supply for Las Vegas Valley. Virtually all recharge to the deep aquifer occurs along the mountain front of the Spring Mountains, located on the western side of the valley.

## Figure 7-1. Hydrostratigraphic Units in the Las Vegas Valley

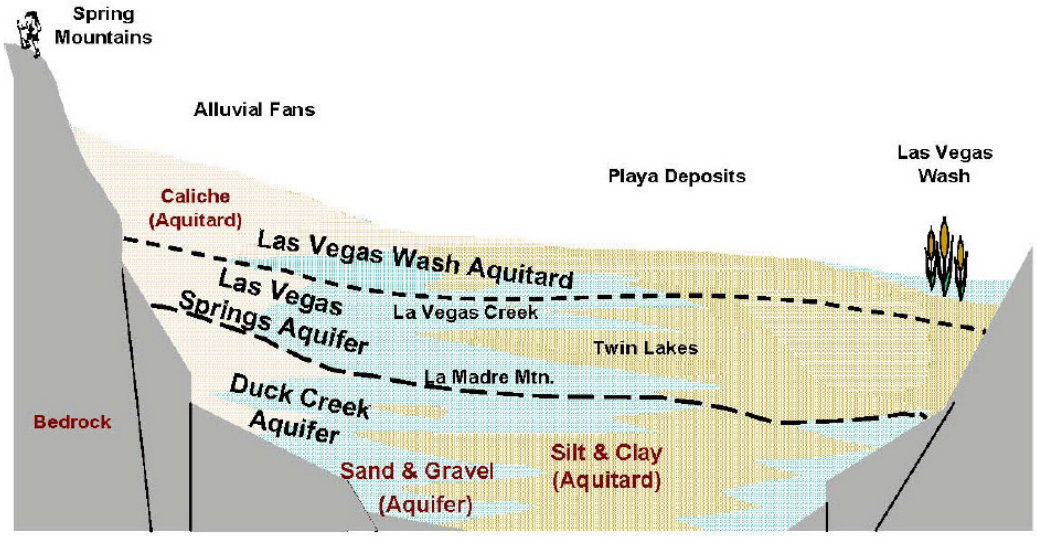
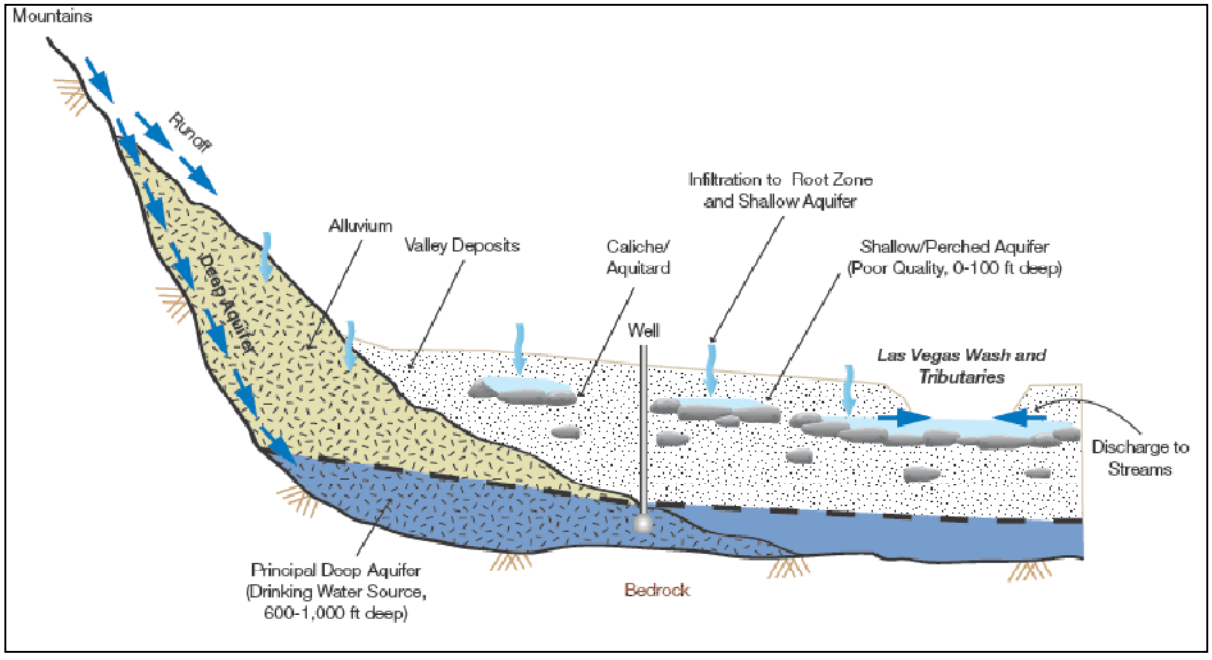



**Exhibit C. Hydrostratigraphic Units in the Las Vegas Valley (after Donovan, 1996).**
Each hydrostratigraphic unit extends across the Valley and transects multiple rock types. The most important producing units is the Las Vegas Springs Aquifer. Whether these units extend the full width of the Valley is not yet known.

## Figure 7-2. Hydrogeologic Schematic of Las Vegas Valley



The Las Vegas Wash aquitard extends across the Las Vegas Valley and the general gradient of shallow groundwater flow is from the northwest to the southeast. The aquitard is not a continuous layer across the valley; fractures in the layer allow some shallow groundwater to percolate to the underlying aquifers or allow underlying water from the aquifers to move upward to the shallow groundwater. The general movement of groundwater is downward until an impermeable or semi-impermeable layer (such as caliche or the aquitard) is reached, then the groundwater is either stored in place or flows along the horizontal gradient in the general direction of Las Vegas Wash. In areas in the east and southeast portion of the Las Vegas Valley, groundwater flow daylights in the Las Vegas Wash, its tributaries and seeps.

Historically, the shallow groundwater was supplied primarily by upward flow from the underlying aquifers. As the development in the Las Vegas Valley increased, the pumped water from the underlying aquifer caused a decrease in the upward flow to the aquitard; however, the shallow groundwater supply has increased as a result of the development, predominantly due to infiltration of water used for irrigation of landscaping.

SNWA retains information on the depth to groundwater throughout Las Vegas Valley. A map of depth to groundwater contours is shown in **Figure 7-3**. It is important to note that groundwater levels, especially in shallow aquifers, can vary over the course of a year and also over the course of several years based on hydrologic conditions.

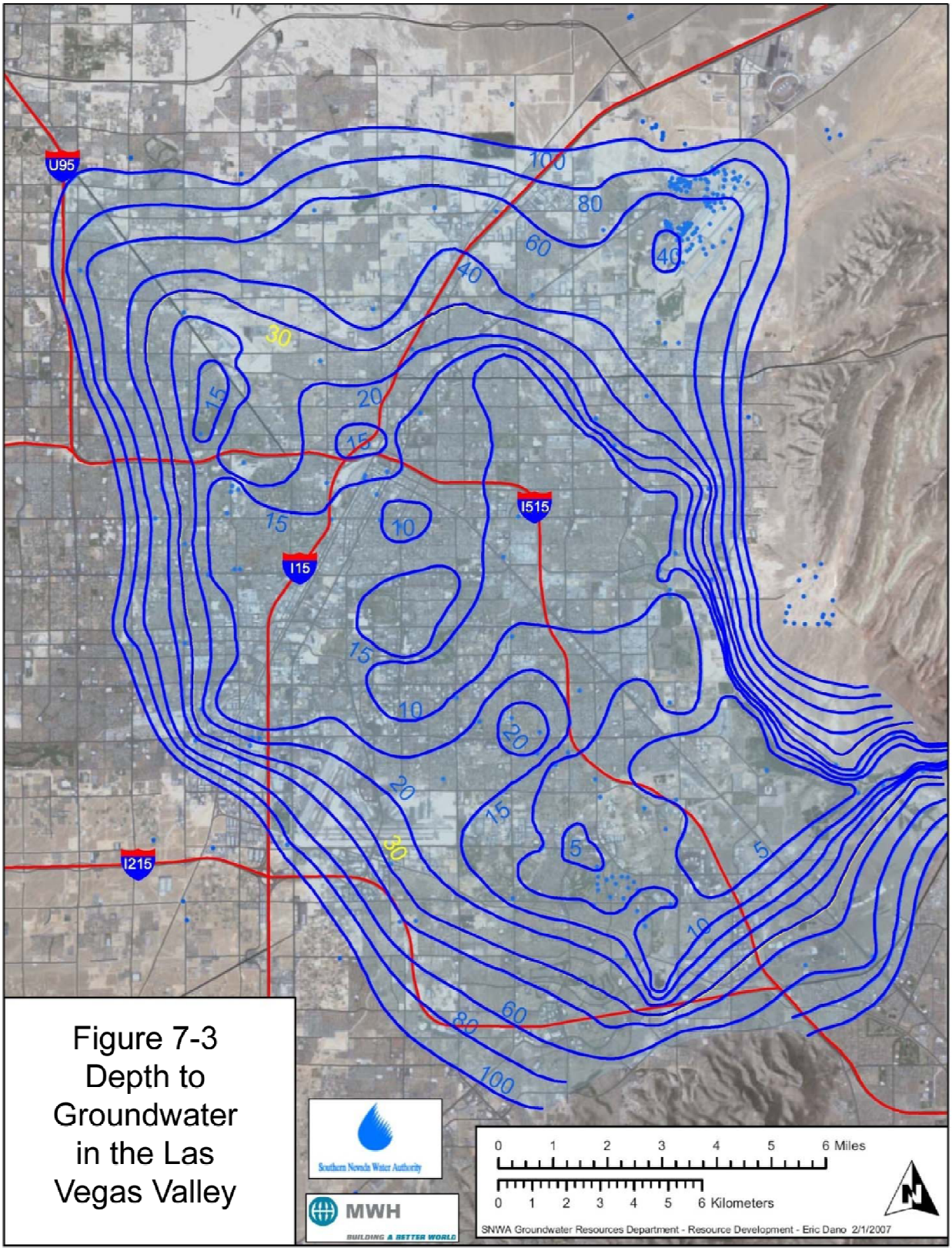
Because of the presence of the aquitard and variable geologic conditions across Las Vegas Valley, there is concern that stormwater infiltration in any location could contribute to higher water levels in the shallow aquifer or small perched aquifer zones. Over time this could aggravate the problems with high groundwater currently being experienced along lower Las Vegas Wash and its tributaries, and create other problem areas where perched water could accumulate close to the ground surface.

## 7.2 Groundwater Quality of the Las Vegas Valley

Shallow groundwater in the Las Vegas Valley is typically viewed to be a nuisance and of poor quality. SNWA prepared a report in 1996 entitled "Extent and Potential Use of the Shallow Aquifer and Wash Flow in Las Vegas, Nevada" (SNWA, 1996) which mentioned that shallow groundwater can cause unpleasant odors and may cause unwanted vegetative growth (which may not be aesthetically pleasing and may restrict flood flows in channels).

Over-irrigation of landscape has contributed to the poor quality of the groundwater. The SNWA (1996) report mentions that over-irrigation (irrigation that is not consumptively used by landscape vegetation) has the potential to pick up contaminants such as fertilizers, organics, soluble salts, and leachate from septic systems. As discussed in the previous subsection, the over-irrigation runoff may either infiltrate into the ground or run off to a drainageway. Evapotranspiration of this shallow groundwater can further contribute to poor water quality by concentrating the contaminants.

Figure 7-3. Depth to Groundwater in the Las Vegas Valley



The influence of poor quality groundwater can be seen in surface water samples from channels in the southeast part of Las Vegas Valley (e.g., Duck Creek, Pittman Wash, Monson Channel, Flamingo Wash) where the shallow groundwater daylights. Surface water constituent concentrations at these locations are very similar to groundwater quality, indicating the presence of resurfacing groundwater. Surface water at these locations is of quality that is too poor for most urban or agricultural uses. Any activities that would raise shallow groundwater levels or degrade surface water quality in those tributaries should be discouraged or prohibited. Specific water quality concerns are described in the following paragraphs.

### 7.2.1 Total Dissolved Solids

SNWA conducts monitoring to determine the quality of water in the shallow aquifer. Appendix B of SNWA (1996) lists water quality of the monitoring wells and shows that total dissolved solids (TDS) concentrations range between 550 mg/L and 7,000 mg/L. By comparison, the secondary maximum contaminant level (MCL) for TDS in drinking water is 500 mg/L. The general trend is an increase in shallow groundwater TDS concentrations in an easterly direction in the Las Vegas Valley.

### 7.2.2 Selenium

Besides TDS, another constituent of concern in the shallow groundwater is selenium. In addition to resurfacing groundwater and untreated urban runoff (including stormwater runoff), other sources of selenium may be from dewatering from basements, construction areas, and foundations. Selenium concentrations in the Las Vegas Wash and some tributaries have been observed to exceed the current chronic surface water quality standard of 5 mg/L and the following stream segments are included in the State's current list of proposed impaired water bodies (303(d) List):

- Las Vegas Wash above the wastewater treatment facilities
- Flamingo Wash
- Sloan Channel
- Monson Channel
- Duck Creek
- Las Vegas Creek

The Clean Water Coalition (CWC) was the agency responsible for the proposed Systems Conveyance and Operations Program (SCOP)[1] which would have conveyed the highly treated wastewater effluent from the municipal wastewater treatment facilities (which currently discharge to Las Vegas Wash) to Lake Mead, thus reducing dry weather flows in lower Las Vegas Wash. The CWC developed the Las Vegas Wash Selenium Management Plan, which was a requirement from the Record of Decision for the SCOP Environmental Impact Statement. The Draft Las Vegas Wash Selenium Management Plan Summary Report

[1] The feasibility of the SCOP project is currently being revisited by CWC in light of recent reductions in growth and revenue.

(CWC, 2009) states that goal of the plan is to manage selenium concentrations in the Las Vegas Wash at low levels to protect razor back suckers and meet water quality standards.

Although the SCOP project has been suspended and the Selenium Management Plan is not currently being implemented, selenium is still a key pollutant of concern in lower Las Vegas Wash. Any enhancements to the Las Vegas Valley stormwater program will need to be implemented so that they do not negatively impact the goals of the Las Vegas Wash Selenium Management Plan. Infiltration in certain areas of the Las Vegas Valley, such as areas with high ground levels or areas in close proximity to water bodies listed for selenium, would increase shallow groundwater levels and would have to be prohibited or discouraged. MWH prepared a memorandum on Infiltration-Based Post-Construction BMPs and Selenium Impact Areas in the Las Vegas Valley, which further discusses this topic and is included in **Attachment A**. This topic is also discussed in the previously mentioned infiltration suitability TM (MWH 2010b).

### 7.2.3 Infiltration and Injection Well Restrictions

The Nevada Administrative Code and Nevada Revised Statutes (NAC 445A) prohibits use of wells and drywells for injection of water that would degrade existing aquifer water quality. In most cases this would include stormwater. NAC 445A could be interpreted to prohibit intentional infiltration of stormwater in infiltration basins if it would result in degradation of ground or surface water quality.

## 7.3 Implications for MS4 Program

- Infiltration of stormwater into shallow groundwater can adversely impact overall water quality by: (1) degrading the water quality of the underlying potable aquifers by percolating through fractures, or (2) degrading surface water quality by resurfacing into the Las Vegas Wash or its tributaries.
- Infiltration BMPs that would recharge shallow high-selenium aquifers and cause an increase in selenium concentrations and loads in surface waters would cause or contribute to exceedances in water quality standards, and thus be in violation of Nevada water quality regulations.
- The Stormwater Quality Management Committee will have to coordinate with other agencies and committees in the Las Vegas Valley, prior to determining if or how infiltration BMPs should be implemented in Las Vegas Valley.

# 8 Urban Runoff Quality Response to Development

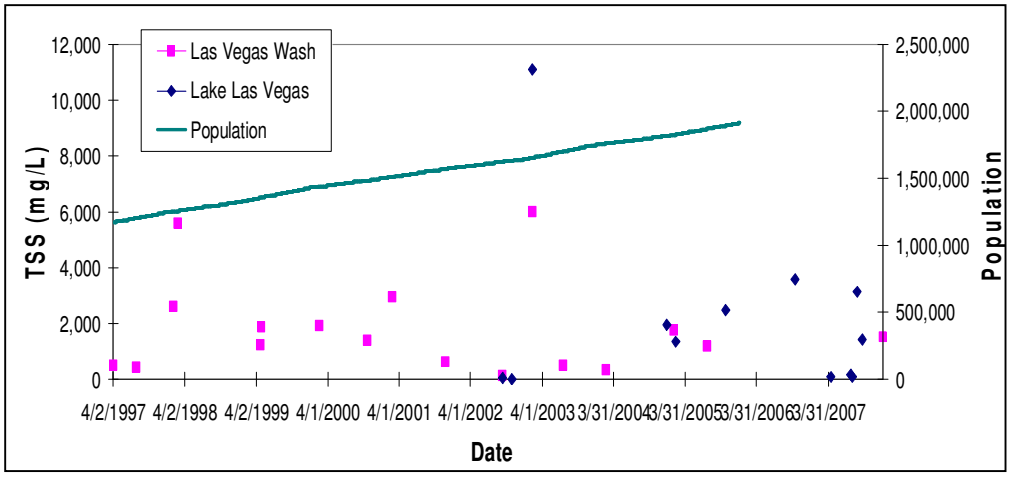
This section summarizes selected water quality data collected during the MS4 permit period. All data and additional analysis can be found in the previous MS4 Annual Reports. In addition, a separate technical memorandum is being prepared to summarize all past water quality data collected for the MS4 program, in response to a requirement in the new MS4 permit (MWH, 2010a)

## 8.1 Runoff Quality Data

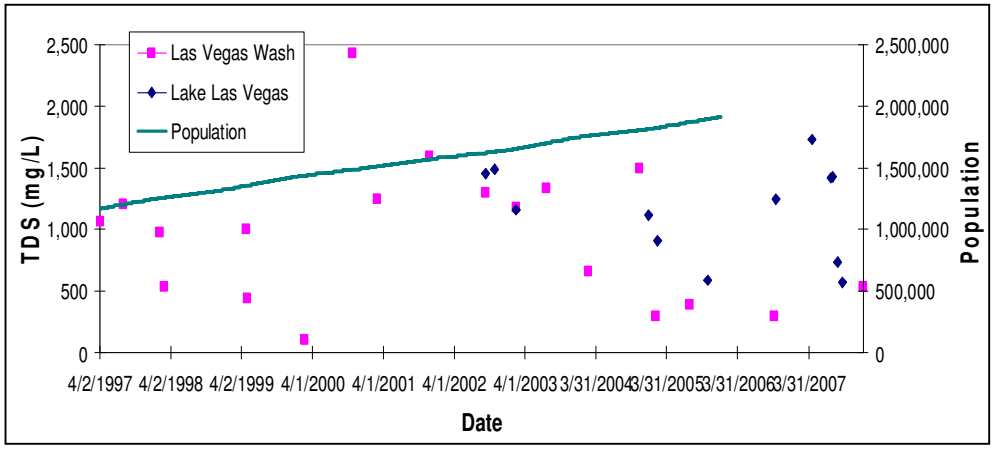
### 8.1.1 Relationship Between Wet Weather Concentration and Development

Concentrations of selected urban pollutants from samples collected at two stations on Las Vegas Wash were plotted against time and population to determine whether concentrations have increased as development has increased. **Figures 8-1** to **8-5** show these plots, and show that the significant increase of development in Las Vegas Valley over the past 15 years has not resulted in an increase in concentration of any of the constituents investigated. (Note: In these graphs, "Las Vegas Wash" refers to sampling points on lower Las Vegas Wash near the Three Kids USGS sampling station; "Lake Las Vegas" refers to sampling points immediately upstream and downstream of Lake Las Vegas.)

**Figure 8-1. Total Suspended Solids Wet Weather Trends**



## Figure 8-2. Total Dissolved Solids Wet Weather Trends




## Figure 8-3. Total Phosphate Wet Weather Trends

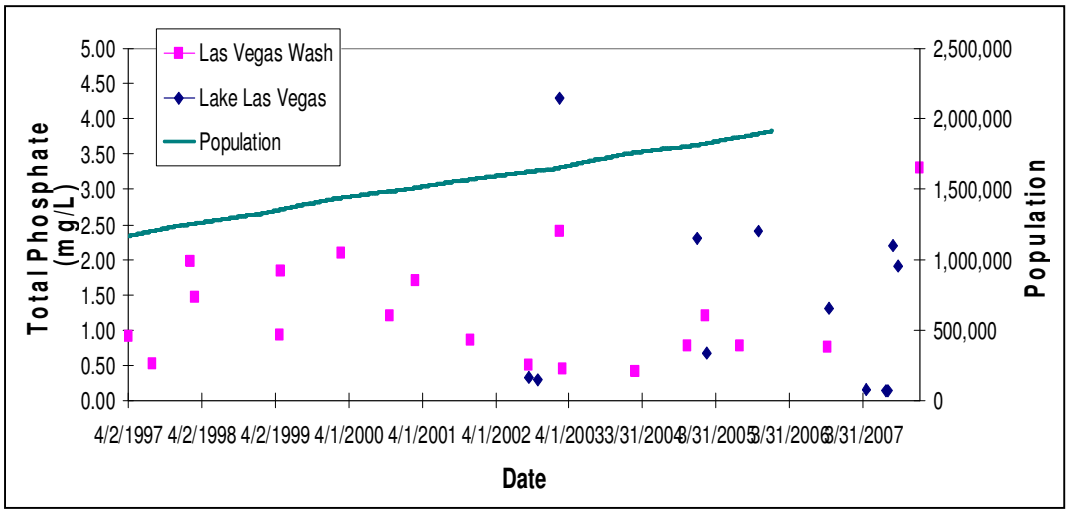


Figure 8-4. Total Nitrate Wet Weather Trends

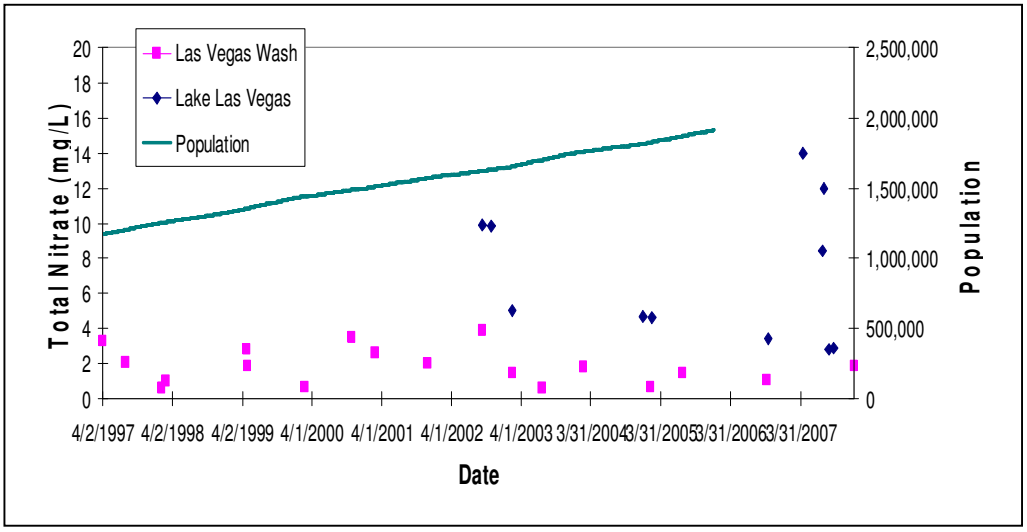
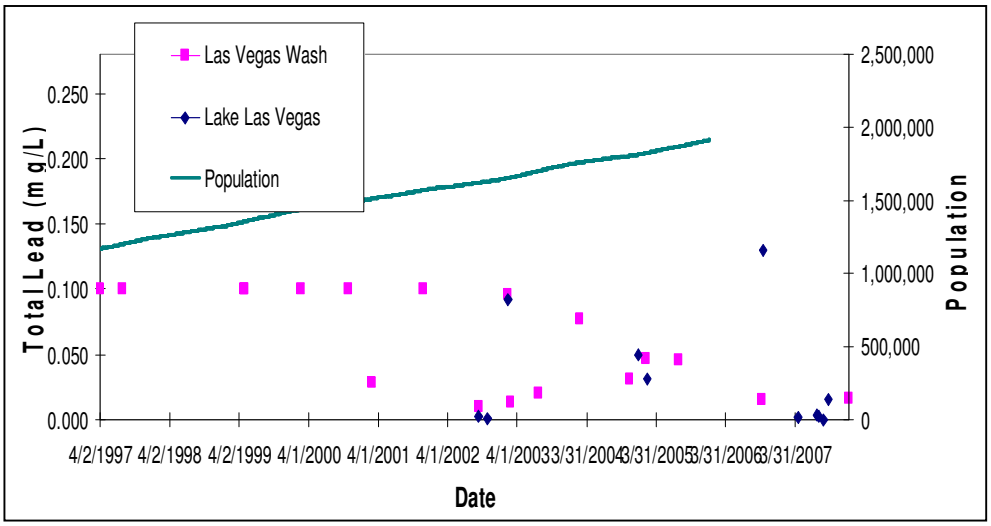


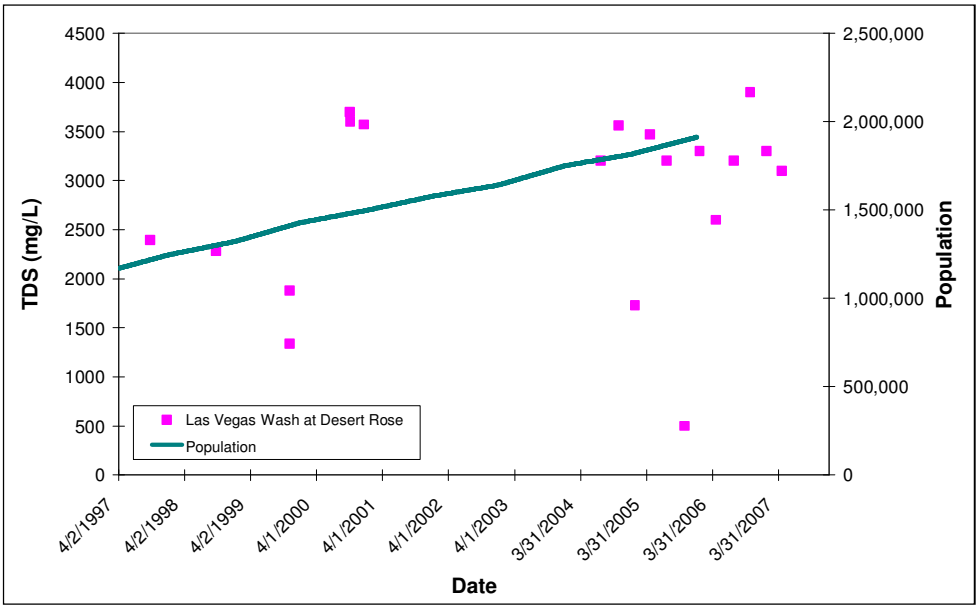

Figure 8-5. Total Lead Wet Weather Trends




### 8.1.2 Dry Weather Concentration Trends with Development

Dry weather concentration data collected for Las Vegas Wash at Desert Rose was plotted against time and Clark County population to determine whether the data demonstrates an effect of increased urban development in the Las Vegas Valley watershed. The Desert Rose site was selected because it is upstream of the influence of wastewater discharges and most resurfacing groundwater. Representative results are shown in **Figures 8-6** to **8-8**. None of the 6 representative constituents analyzed (TSS, TDS, total phosphorus, nitrate, total lead, and total zinc) showed a significant positive correlation between concentration and population. TDS shows a slight upward trend, possibly reflecting impacts of development on increasing groundwater levels and resulting discharge of high TDS water to drainage channels.

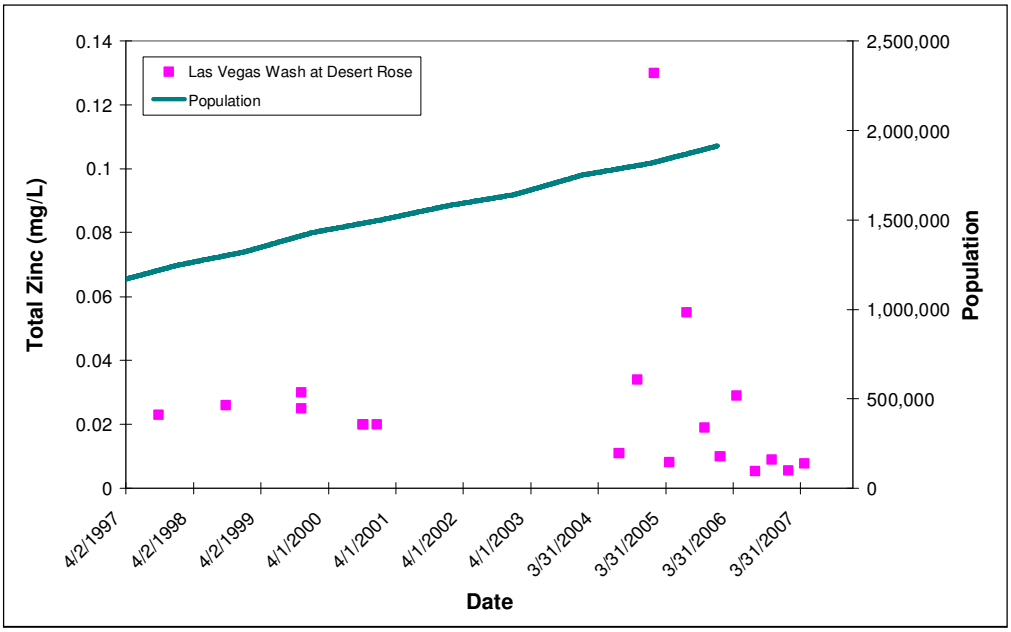
## Figure 8-6. TDS Dry Weather Trend




## Figure 8-7. Total Nitrate Dry Weather Trend



Figure 8-8. Total Zinc Dry Weather Trend




### 8.1.3 Pollutant Load Increases With Increased Development

Preceding sections show that: (1) dry weather and wet weather concentrations have remained fairly consistent over the past 15 years despite over 100 percent increase in urban development in the Las Vegas Valley watershed; and (2) dry weather and wet weather flows have increased in response to this increase in development. Thus, although concentrations have not increased, pollutant loads delivered to lower Las Vegas Wash, Las Vegas Bay and Lake Mead have increased.

Increases in average pollutant loads delivered by Lower Las Vegas Wash were estimated by computing theoretical pollutant loads in 1991 and 2007 for dry and wet weather conditions. These are called "theoretical" loads because:

- wet weather flows were estimated assuming average hydrologic conditions based on Figure 4-5;
- dry weather flows were estimated as the difference between total annual flows from Figure 4-3 and wet weather flows; and
- pollutant concentrations were estimated using the median value for the entire period of record at all sites.

Calculations of estimated flow volumes in Lower Las Vegas Wash in 1991 and 2007 are provided in **Table 8-1**. Calculations of estimated pollutant loads in 1991 and 2007 are provided in **Table 8-2**. Load calculations are only estimates, and provide the order of magnitude of annual pollutant loads and the change in load that has occurred during the period of the MS4 permit.

The following conclusions can be drawn from this analysis:

- Although concentrations have not increased significantly, pollutant loads to lower Las Vegas Wash have increased significantly over the period of the MS4 permit due to increases in wet and dry weather flow volumes.
- Pollutants more strongly associated with wet weather flows (e.g., TSS, phosphorus, metals) have experienced a greater increase in loads than those more strongly associated with dry weather flows (e.g., TDS, nitrate).

**Table 8-1. Summary of Lower Las Vegas Wash Flows, 1991 and 2007**

| Parameter | 1991 | 2007 |
|---|---|---|
| Total Average Annual Flow (cfs) | 180 | 330 |
| Total Average Annual Flow (af) | 130,320 | 238,920 |
| % Increase in Total Flow | | 83% |
| Total Storm Runoff in an Average Hydrologic Year (af) | 2,500 | 7,500 |
| % Increase in Storm Flow | | 200% |
| Total Dry Weather Flow (af) | 127,820 | 231,420 |
| % Increase in Dry Flow | | 81% |

**Table 8-2. Calculation of Lower Las Vegas Wash Pollutant Loads, 1991 and 2007**

| | Wet Weather | | | Dry Weather | | | Total | |
|---|---|---|---|---|---|---|---|---|
| Constituent | Median Conc. (mg/l) | 1991 Annual Load (lbs) | 2007 Annual Load (lbs) | Median Conc. (mg/l) | 1991 Annual Load (lbs) | 2007 Annual Load (lbs) | 1991 Annual Load (lbs) | 2007 Annual Load (lbs) |
| TSS | 950 | 45,000 | 135,000 | 13 | 31,000 | 57,000 | 76,000 | 192,000 |
| TDS | 580 | 27,000 | 82,000 | 3,140 | 7,600,000 | 13,000,000 | 7,630,000 | 13,800,000 |
| Total Phosphorus | 0.96 | 45 | 140 | 0.03 | 73 | 130 | 120 | 270 |
| OrthoPhosphate | 0.2 | 9 | 28 | 0.016 | 39 | 70 | 50 | 100 |
| Nitrate | 1.6 | 76 | 230 | 4.2 | 10,200 | 18,400 | 10,300 | 18,600 |
| Total Copper | 0.044 | 2 | 6 | 0.01 | 24 | 44 | 26 | 50 |
| Total Lead | 0.071 | 3 | 10 | 0.001 | 2 | 4 | 6 | 14 |
| Note: Detection limit is shown for Copper and Lead; median is less than detection limit. Calculated values are rounded. | | | | | | | | |

## 8.2 Implications for MS4 Program

- Concentrations of most pollutants analyzed for the MS4 program have not increased in response to the dramatic growth in Las Vegas Valley over the past 15 years. Existing BMPs and other regional activities and programs have been successful in preventing increases in pollutant concentrations in wet and dry weather flows in the MS4 system. These existing programs should be continued.
- Pollutant loads have increased as a result of increased wet and dry weather streamflows. Therefore, addressing pollutant loads due to urbanization would most appropriately be based on measures that mitigate increases in impacts of development on hydrology (i.e., hydromodification).

- The primary constituent of concern in lower Las Vegas Wash and its tributaries is selenium. Past studies have found a strong correlation between TDS and selenium. Table 8-2 shows that annual TDS loads – and by extension selenium loads - are much higher in dry weather than wet weather flows. Measures to address selenium should therefore address non-storm flows in the MS4 system.

# 9 Stormwater Management Approach

## 9.1 Unique Drainage and Flood Control Approach

The stormwater and flood control management approach for Las Vegas Valley is established by the policies and procedures of CCRFCD. All entities in the Valley are member agencies in CCRFCD and have adopted its criteria for facility design and maintenance. CCRFCD has developed a Flood Control Master Plan for Las Vegas Valley that presents a program for addressing existing and future flood control needs. It is updated every 5 years.

In response to the unique climatic, hydrologic and watershed conditions summarized in previous sections, CCRFCD has developed a unique regional approach to drainage and flood control management as summarized below. This approach is supported by the community, and is funded by a ¼ cent sales tax and bonds to finance CCRFCD programs.

All regional facilities are designed to control the runoff from the 100-year storm occurring under full build-out conditions in the upstream watershed, with no assumption of onsite peak or volume reductions in new development. Thus existing and proposed flood control facilities are sized to accommodate all new development and significant redevelopment without relying on possible flow reductions from onsite hydrologic controls.

Runoff management is accomplished using large regional detention basins that capture runoff from large watershed areas. This is considered more effective than having a highly distributed system of small neighborhood-scale facilities due to the infrequency, randomness and localized nature of most storm events. Regional detention basins capture and regulate more runoff events than local facilities would, and concentrate the need for maintenance in fewer facilities. **Figure 9-1** shows the location of existing and proposed regional detention basins, and the large portion of the Valley that is upstream of one or more of these basins.

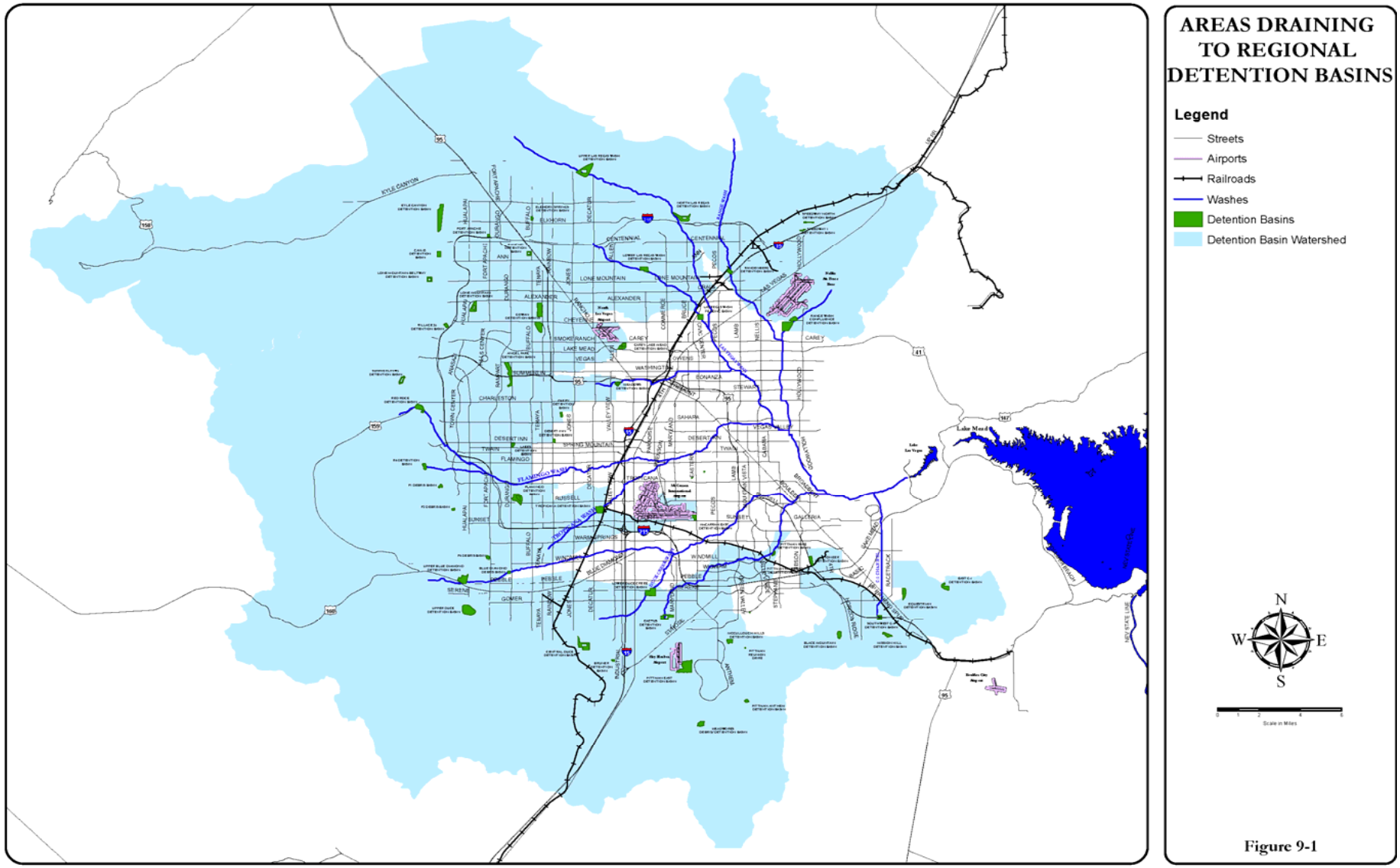
All regional detention basins are designed with a sediment storage volume in addition to the flood control volume as an allowance for capturing sediment transported from upstream watershed areas. CCRFCD policy is to design sediment storage capacity equal to the computed inflow sediment volume of five 5-year storms plus one 100-year storm. This is more than sufficient to capture the sediment load associated with the typical frequent storms normally addressed by stormwater quality management programs (e.g., the 2-year event).

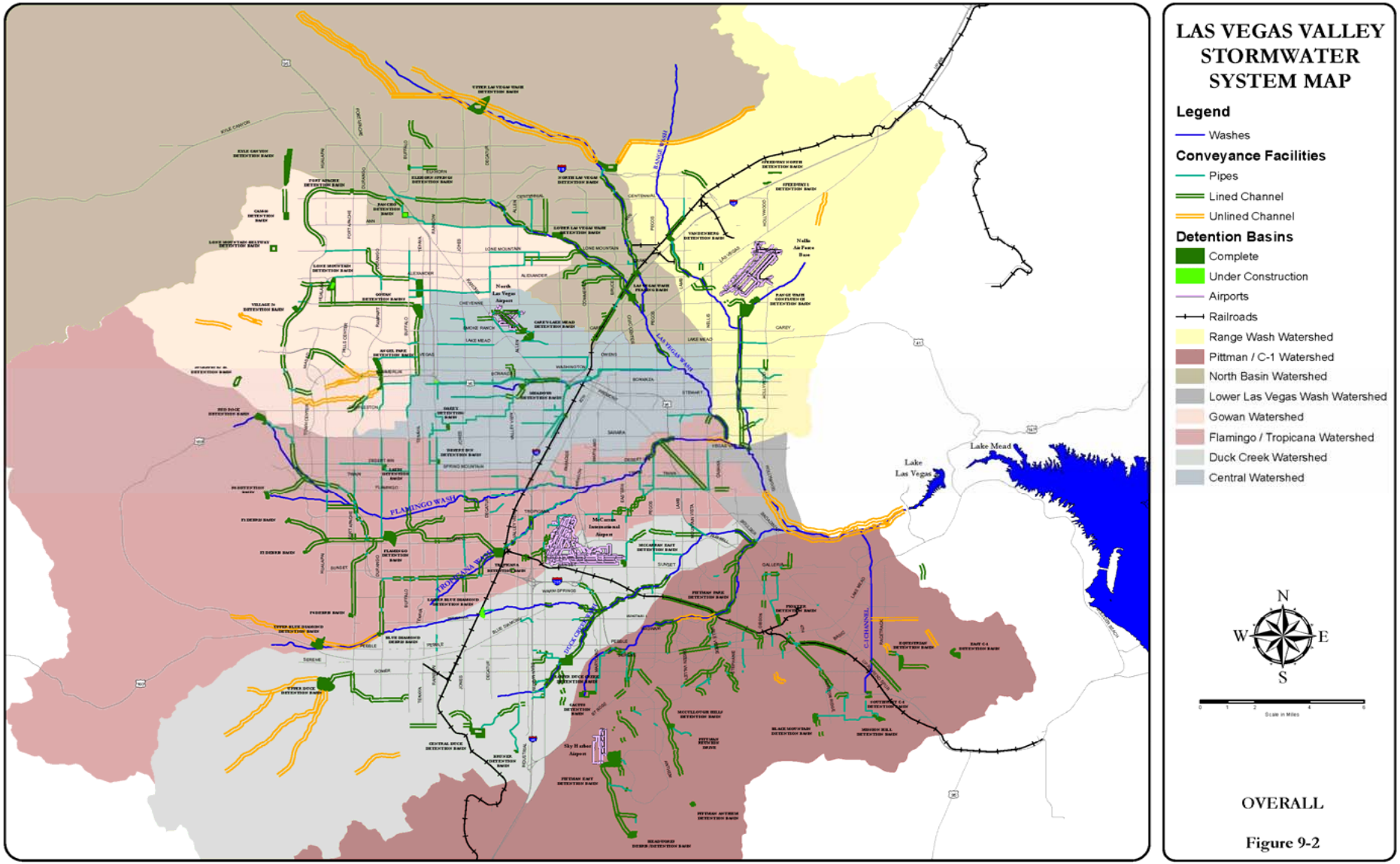
Regional detention basins in Las Vegas Valley have been shown to capture significant sediment volumes and reduce sediment delivered to downstream channels, but are only marginally effective at reducing other pollutants. The MS4 permittees have developed a draft

plan and schedule for investigating the feasibility of retrofitting certain regional detention basins to improve their pollutant removal effectiveness. This plan will be implemented in accordance with a schedule to be approved by NDEP.

Most regional conveyance facilities are concrete lined to manage erosion. The CCRFCD design manual requires all channels to be stabilized in some manner. Because slopes in Las Vegas Valley are generally steep, velocities are high, and soils are erodible, most channels are stabilized using concrete lining. Some channels are stabilized using riprap, gabions, grade control structures, or grass (most often in golf courses). As a result, very few channels within the developed area are unlined. **Figure 9-2** shows the extent of concrete lined channels, unlined stabilized channels, and natural channels in the Las Vegas Valley developed area. There are very few segments of large unlined channels remaining. Attachment B provides a "scrapbook" of photos of representative channel locations throughout Las Vegas Valley to provide a perspective on the nature of typical elements of the MS4 system.

Figure 9-1. Areas Draining to Regional Detention Basins




LAS VEGAS VALLEY STORMWATER SYSTEM MAP
Legend
Washes
Conveyance Facilities
Pipes
Lined Channel
Unlined Channel
Detention Basins
Complete
Under Construction
Airports
Railroads
Range Wash Watershed
Pittman / C-1 Watershed
North Basin Watershed
Lower Las Vegas Wash Watershed
Gowan Watershed
Flamingo / Tropicana Watershed
Duck Creek Watershed
Central Watershed
N
W
E
S
Lake Mead
Lake Las Vegas
FLAMINGO WASH
TROPICANA WASH
LAS VEGAS WASH
OVERALL
Figure 9-2

Current CCRFCD policy and local development codes require new development to stabilize and prevent erosion from any waterways within the development area. If significant erosion hazards are created downstream, new development must mitigate those conditions as well. Thus as new development occurs, it is required to mitigate any impacts of onsite and offsite erosion through compliance with current development regulations.

Over the past 40 years, erosion in the Las Vegas Wash has reduced wetlands areas from approximately 2,000 acres to 200 acres (LVWCC, 1999). In order to address this issue, the Las Vegas Wash Coordination Committee was formed in 1998 to prepare and implement a management strategy for the Las Vegas Wash. SNWA, through the Las Vegas Wash Coordination Committee, has a well-funded program for stabilizing lower Las Vegas Wash through construction of a series of erosion control structures (see **Figure 9-2**). Erosion of the Lower Las Vegas Wash channel and floodplain is estimated to have deposited 11.2 million tons of sediment in Las Vegas Bay between 1934 and 2001, as well as contributing to water quality degradation and loss of critical habitat. Eleven structures have been constructed, and 11 more are planned in the sections between the City of Las Vegas wastewater plant and Lake Las Vegas. In addition, another 6 erosion control structures are now proposed between Lake Las Vegas and Las Vegas Bay of Lake Mead. These structures are downstream of essentially all possible new development and significant redevelopment in the Valley. These structures provide water quality benefits by (1) creating wetlands which can filter the water and (2) reducing the velocity of water in the Las Vegas Wash to allow sediment to settle out upstream of the erosion control structures. Existing structures have significantly reduced the effects of scour and erosion, reducing sediment transport in the lower Wash by 60-80 percent. They have also re-established 165 acres of riparian wetlands between the Clark County Wetlands Park visitor center and Lake Las Vegas. Both of these changes have resulted in water quality improvements in the lower Wash and Lake Mead. This program has received awards of recognition from EPA, the State of Nevada, and professional engineering and environmental associations.

## 9.2 Implications for MS4 Permit Program

- Concrete lining or otherwise stabilizing regional channels addresses the primary erosion issues associated with urban runoff, and reduces the need for onsite controls.
- Existing regional detention basins are downstream of virtually all new development. Using this existing public infrastructure to manage stormwater runoff is more cost-effective and less maintenance-intensive for the overall community than implementing individual development-level controls, many of which would be on private property.
- Onsite runoff controls would not reduce the size of flood control and drainage structures, which must be designed to control the 100-year, fully developed runoff hydrograph per CCRFCD policy.
- The CCRFCD flood control program addresses flood control on a watershed basis. The stormwater quality program should be implemented on the same scale and make use of as many of the same facilities as possible.

# 10 Legal and Water Rights Factors

## 10.1 Unique Legal and Water Rights Factors

EPA is strongly promoting onsite stormwater retention as a BMP for areas of new development and significant redevelopment. The new MS4 permit issued to Las Vegas Valley municipal entities by NDEP requires a review of low impact development measures, including onsite retention. Nevada water law was reviewed and the Nevada State Engineer's Office, SNWA, and the Colorado River Commission were contacted to determine potential legal and water rights issues that could affect use of stormwater retention facilities in Las Vegas Valley. Results of that investigation are presented in Technical Memorandum No. IV.7 – Potential Legal and Water Rights Issues Associated with Onsite Retention of Stormwater (MWH, 2010c), and are summarized below.

The Nevada State Engineer's Office (SEO) administers use of the state's surface and ground waters under the prior appropriation doctrine (first in time, first in right). The SEO requires permits for capture of surface waters that are put to beneficial use, and must demonstrate that current water rights holders are not injured by the proposed diversion. At present, new developments that desire to implement onsite stormwater retention would be required to contact the State Engineer to determine if a surface water permit would be required. The State Engineer would have to determine whether the proposed project would injure other downstream water right holders, primarily Lake Las Vegas which has a right to capture any available surface water up to 2,000 AFY (a pending application by the Colorado River Commission would remove the upper limit on annual storage). Current State water law and public agency policies generally discourage but do not necessarily prohibit onsite stormwater retention. Stormwater retention accompanied by onsite beneficial use would not conflict with State water law or agency policies during small storms when Las Vegas Wash flows do not exceed 1,160 cfs (the maximum flow that does not spill into Lake Las Vegas), and during large storms when Las Vegas Wash flows contribute well over 2,000 ac-ft to Lake Las Vegas.

Southern Nevada Water Authority manages the region's water resources, and has a preference for maximizing stormwater runoff into Lake Mead, where it can be pumped and treated by SNWA and delivered to Las Vegas Valley for municipal supply. The Colorado River Commission (CRC) has responsibility for managing water resources in the Colorado River Basin under the Colorado River Compact, and also seeks to maximize good quality surface water in Lake Mead. Stormwater retention combined with beneficial use onsite would have the support of CRC and SNWA. Retention without beneficial use would be opposed by CRC. Retention that induced infiltration that would have adverse impacts on water quality would be opposed by both CRC and SNWA. If CRC is successful in acquiring a surface water permit for all remaining runoff in Las Vegas Valley, it would have enhanced legal standing to oppose non-beneficial use stormwater retention.

Stormwater retention would not affect potable water supplies derived from local deep aquifers, but could increase recharge to shallow aquifers. These aquifers contribute to poor water quality in surface drainages in the lower portion of Las Vegas Valley that are currently impaired for selenium and TDS, and in the Colorado River downstream of Lake Mead

which is the focus of the Colorado River Basin Salinity Control Program. The Salinity Control Program has spent millions of dollars attempting to keep salts out of the Colorado River system, and would object to stormwater measures that led to increased surface water salinity.

### 10.2 Implications for MS4 Permit Program

Stormwater retention without onsite beneficial use (infiltration and evaporation losses only) would contradict local agency policies and potentially exacerbate existing water quality problems, and is not recommended. Proposed stormwater retention with onsite beneficial use (e.g., for irrigation water) would have agency support but would have to be submitted to the State Engineer for approval; approval is not certain due to potential impacts on Lake Las Vegas and other water rights holders. Therefore, stormwater retention cannot be relied on for the MS4 program, and should not be part of mandatory programs developed by the permittees.

## 11 Arid Region Stormwater Research

The Center for Watershed Protection researched unique factors associated with stormwater quality management in arid communities. Results were published in an article in *The Practice of Watershed Protection* (2000). Several findings and recommendations from this research are very applicable to the conditions in Las Vegas Valley, and reinforce the findings and conclusions discussed previously. These are summarized briefly below.

- Water quality management objectives for dry washes and ephemeral streams are driven more by flood control or distant downstream receiving water concerns rather than in-stream issues.
- Evaporation rates greatly exceed rainfall rates, making it impossible to maintain wet ponds, wetlands, or grassed swales without a supplemental water source.
- Pollutants have more time to build up on watershed surfaces between storms, accentuating the importance of source controls (pollution prevention, street sweeping, storm drain inlet cleaning).
- Vegetative cover in watersheds and channels is sparse, contributing to high natural soil erosion rates.
- Dry weather flows are due almost entirely to urban sources.
- Better site design including minimization of directly connected impervious areas, better street design, and water harvesting should be considered.
- Infiltration practices should be viewed carefully to avoid adverse impacts on groundwater quality, and should be designed to prevent clogging under high sediment loads.

- Designing stormwater practices to minimize downstream channel erosion is critical, but bioengineering options to stabilize downstream channels in arid watersheds are limited.

EPA recently published a document entitled "Green Infrastructure in Arid and Semi-Arid Climates" (EPA 2010). It describes the many benefits of green infrastructure as applied to stormwater management, but points out challenges or constraints in to applications in arid areas like Las Vegas Valley.

- Measures that involve landscaped areas (e.g., rain gardens, swales, buffer strips) must be designed with low water use plants and efficient irrigation systems.
- Cisterns or rain barrels with onsite beneficial use may not be cost effective due to the infrastructure costs relative to the small amount of annual rainfall.
- Green roofs would have to be irrigated, an arguable use of water in an arid climate. Alternative sources of water include air conditioner condensate or harvested stormwater.
- Green streets (e.g., narrower paved areas, fewer cul de sacs, less curb and gutter) and watershed-scale riparian buffers are promoted for arid climates.
- Rainwater harvesting and onsite retention may be in conflict with state water law in prior appropriation doctrine states like Nevada.

# 12 Conclusion

Las Vegas Valley is unique among large MS4 communities in the U.S. This uniqueness has several important consequences for developing stormwater quality management programs that are effective, reasonable, and cost-effective. This technical report presents the following conclusions.

- Las Vegas Valley is the driest MS4 in the U.S., with only 4.2 inches of annual precipitation and less than 10 runoff-producing storms per year. Traditional stormwater quality management approaches are not cost-effective in this environment. Traditional BMP techniques requiring vegetation, permanent pools, and flushing flows are not feasible in this region due to the climate.
- Storm runoff events generally last for only a few hours, and originate from storms of very small areal extent. The main receiving water – Las Vegas Wash – is an effluent dominated stream in which only 4 percent of mean annual flow is from storm runoff and 6 percent is from other urban sources. Due to the minor contribution of stormwater to overall flow, watershed-based management approaches are more reasonable than parcel-level approaches.
- Undeveloped watersheds are comprised of desert soils with high erosion and sediment transport rates. Urban development generally stabilizes these surfaces. Thus addressing erosion and sediment control in developed areas is not as critical as in other regions. CCRFCD and SNWA have extensive

programs for controlling erosion in channels downstream of development and in lower Las Vegas Wash.

- Infiltration, which is a common treatment and disposal process in many stormwater BMPs, is problematic in Las Vegas Valley due to soil conditions (caliche, expansive and collapsible soils) and potential impacts on selenium and TDS concentrations in the lower valley. Any BMPs that increase selenium discharges from groundwater to surface water would cause or contribute to exceedances of the water quality standard for selenium. BMPs that promote infiltration should generally be avoided.
- Significant urbanization in the past 15 years has not increased pollutant concentrations for most constituents at most locations, but pollutant loads have increased due to increases in dry weather and wet weather flow volumes. Thus existing BMP programs have been effective and should be continued, and additional regional measures to address flow volumes should be considered.
- State water law prohibits capturing stormwater and putting it to a beneficial use without a permit. Regional water resources agencies including SNWA and Colorado River Commission want to maximize delivery of good quality runoff from the Las Vegas Wash watershed to Lake Mead. These policies discourage use of onsite stormwater retention BMPs.
- The current regional flood control approach consists of lining channels to prevent erosion and constructing large regional detention basins to manage flow rates. The resulting infrastructure is also effective for sediment management and other control of other pollutants associated with sediment.

# 13 References


Environmental Protection Agency, May 2010. Green Infrastructure in Arid and Semi-Arid Climates. EPA-833-B-10-002.

Las Vegas Wash Coordination Committee, 1999. Las Vegas Wash Comprehensive Adaptive Management Plan.

MWH, 2010a. Technical Memorandum No. IV.1 – Summary and Evaluation of Las Vegas Valley Water Quality Data. Prepared for Las Vegas Valley Stormwater Quality Management Committee.

MWH, 2010b. Technical Memorandum No. IV.6 – Limitations on Use of Infiltration-Based BMPs for New Development and Significant Redevelopment in Las Vegas Valley. Prepared for Las Vegas Valley Stormwater Quality Management Committee.

MWH, 2010c. Technical Memorandum No. IV.7 – Potential Legal and Water Rights Issues Associated with Onsite Retention of Stormwater. Prepared for Las Vegas Valley Stormwater Quality Management Committee.

Southern Nevada Water Authority, 1996. Extent and Potential Use of the Shallow Aquifer and Wash Flow in Las Vegas, Nevada.

*The Practice of Watershed Protection,* 2000. T. Schueler and H. Holland, eds. Center for Watershed Protection. Ellicott City, MD.

# Attachment A – TM IV.6 Limitations on Use of Infiltration-Based BMPs for New Development and Significant Redevelopment in Las Vegas Valley

TM IV.6 Limitations on Use of Infiltration-Based BMPs for New Development and Significant Redevelopment in Las Vegas Valley (October 19, 2010) is not attached to this TM. It is included in Section 6 of Volume II Technical Appendix of the Storm Water Management Plan.

# Attachment B –
# Photographs of Representative Regional Channels in Las Vegas Valley



**1). Flamingo Wash at Valley View**

Unlined stabilized channel
Typical dry weather conditions



**2). Flamingo Wash at Nellis Blvd.**

Unlined stabilized channel
Typical dry weather conditions



**3). Flamingo Wash Upstream of Las Vegas Wash Confluence**

Unlined Stabilized Channel
Typical dry weather conditions



**4). Flamingo Wash at Paradise Rd.**

Concrete-lined / Natural Channel
Typical dry weather conditions



**5). Flamingo Wash**

Concrete-lined Channel
Typical dry weather conditions




**6). Flamingo Wash Downstream of Upper Flamingo Detention Basin**

Concrete-lined Channel
After recent storm event



**7). Flamingo-Tropicana Diversion Channel Upstream of Tropicana Detention Basin**

Concrete-lined Channel
Typical dry weather conditions



**8). Duck Creek Wash near Stephanie Rd.**

Concrete-lined Channel
Wet weather condition




**9). Duck Creek Wash Downstream of Duck Creek Detention Basin**

Concrete-lined Channel
Typical dry weather conditions




**10). Duck Creek at Paradise**

Concrete-lined Channel
Typical dry weather conditions



**11). Range Wash Upstream of Vandenberg Detention Basin**

Concrete-lined Channel
Typical dry weather conditions




**12). A-Channel**

Concrete-lined Channel
After recent storm event




**13). F-2 Channel**

Concrete-lined Channel
Typical dry weather conditions



**14). Downstream of R-4 Detention Basin**

Concrete-lined Channel
Typical dry weather conditions



**15). Las Vegas Wash at Craig Road**

Stabilized Channel
Typical dry weather conditions




**16). Las Vegas Wash Downstream of Lower Las Vegas Detention Basin**

Concrete-lined Channel
Typical dry weather conditions



**17). Las Vegas Wash Downstream of Flamingo Wash Confluence**

Concrete-lined Channel
Typical dry weather conditions




**18). Las Vegas Wash Upstream of Lower Las Vegas Detention Basin**

Concrete-lined Channel
Typical dry weather conditions



**19). Blue Diamond Wash Upstream of Lower Blue Diamond Detention Basin**

Concrete-lined Channel
Typical dry weather conditions




**20.) Pittman Pecos Channel at I-215**

Concrete-lined Channel
Typical dry weather conditions



**21). Pittman Pecos Channel Near Eastern Blvd.**

Concrete-lined Channel
Typical dry weather conditions



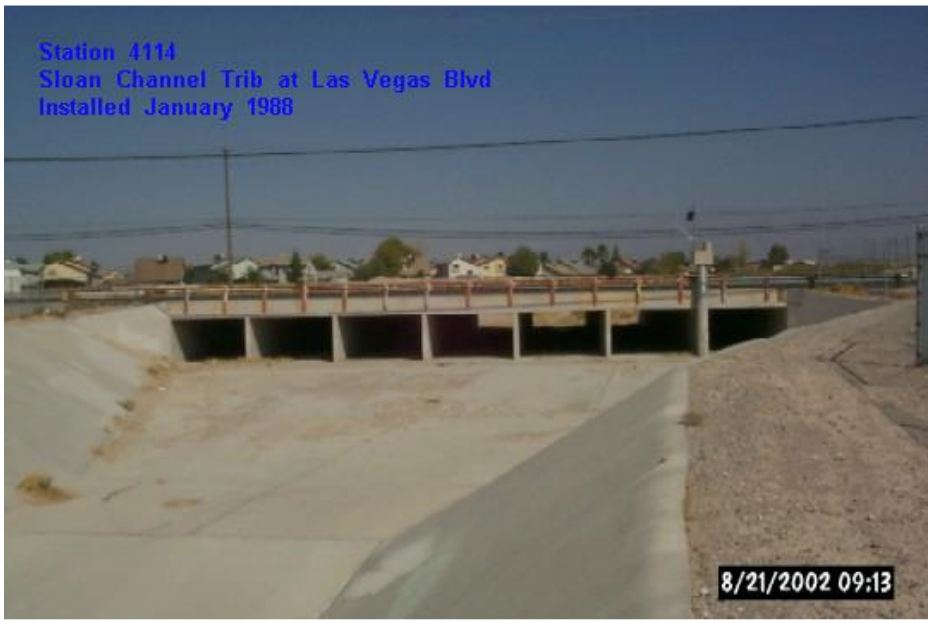
**22). Channel near Gowan Detention Basin**

Concrete-lined Channel
After recent storm event




**23). Gowan North Channel – along West Cheyenne Ave.**

Concrete-lined Channel
Typical dry weather conditions



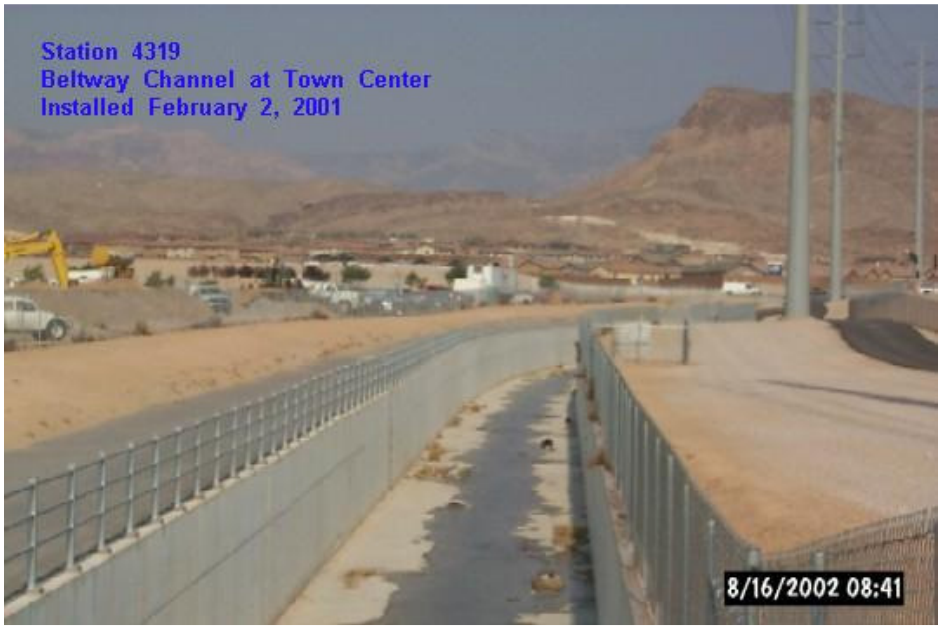

**24). Sloan Channel at Las Vegas Blvd**

Concrete-lined Channel
Typical dry weather conditions




**25). Sloan Channel at Charleston Blvd**

Concrete-lined Channel
Typical dry weather conditions



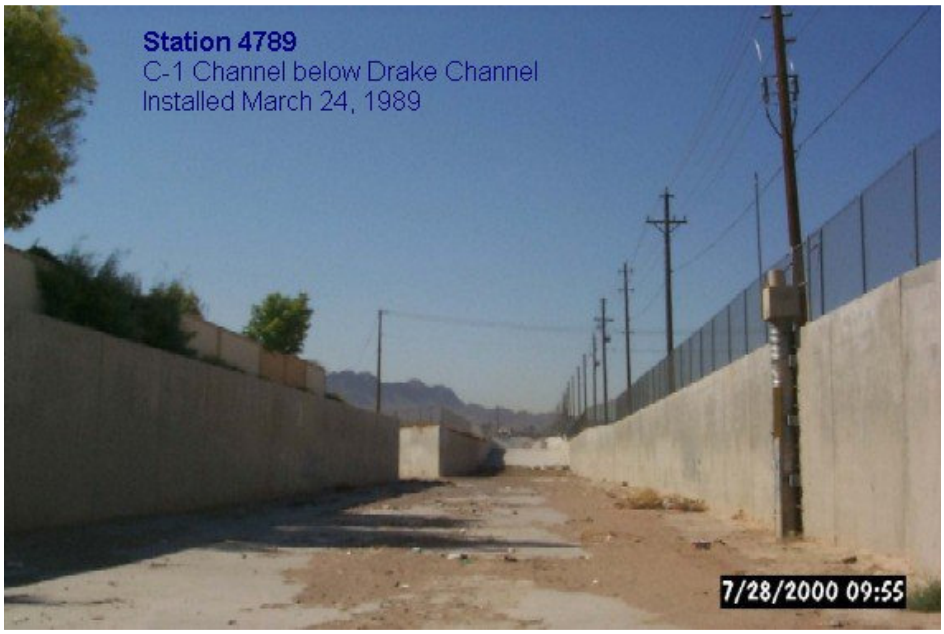

**26). Beltway Channel at Town Center**

Concrete-lined Channel
Typical dry weather conditions



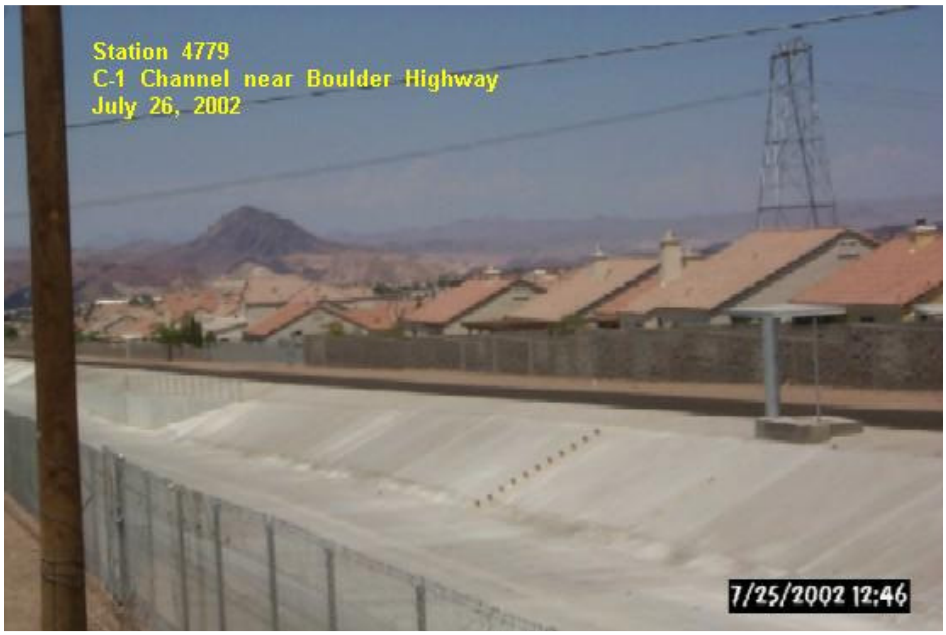

**27). Beltway Channel at Peace Way**

Concrete-lined Channel
Typical dry weather conditions




**28). C-1 Channel below Drake Channel**

Concrete-lined Channel
Typical dry weather conditions




**29). C-1 Channel near Boulder Highway**

Concrete-lined Channel
Typical dry weather conditions



**30). Las Vegas Creek Upstream of Meadows Detention Basin**

Concrete-lined Channel
Wet weather condition



**31). Monson Channel at Stephanie Street**

Unlined channel
Typical dry weather conditions



**32). Downstream of Mission Hills Detention Basin**

Concrete-lined Channel
Typical dry weather conditions



**33). Duck Creek Wash Channel: unlined channel- South of Nellis Blvd.**

Unlined channel
Typical dry weather conditions



**34). Duck Creek Wash Channel: Stephanie St. /East Hacienda Ave.**

Stabilized channel
Typical dry weather conditions



**35). Duck Creek Wash Channel: S. Nellis Blvd. / E. Hacienda Ave.**

Stabilized channel
Typical dry weather conditions



**36). Duck Creek Wash Channel: Patrick Lane / North of Green Valley Pkwy**

Stabilized channel
Typical dry weather conditions



**37). Duck Creek Wash Channel: S. Eastern Ave. / West Warm Springs Rd.**

Stabilized channel
Typical dry weather conditions



**38). Duck Creek Wash Channel: Pebble Rd. / Bermuda Rd.**

Concrete channel
Typical dry weather conditions

# Section 6

MWH

TECHNICAL MEMORANDUM

# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

## STORMWATER MANAGEMENT PLAN DOCUMENTATION

## Technical Memorandum IV.6

## Limitations on Use of Infiltration-Based BMPs for New Development and Significant Redevelopment in Las Vegas Valley

October 19, 2010

*Prepared for*

**Stormwater Quality Management Committee**

*Prepared by*

MWH®

BUILDING A BETTER WORLD

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## Executive Summary

EPA is promoting use of onsite stormwater retention and infiltration for managing stormwater runoff from new development and significant redevelopment. The suitability of infiltrating stormwater in Las Vegas Valley was reviewed based on soil conditions, slopes, shallow groundwater, water quality, contaminated soils, presence of industrial facilities, and regulatory factors. Superimposing areas where infiltration could be infeasible due to one of these limiting factors led to the conclusion that stormwater infiltration is not a generally practical option for stormwater disposal in Las Vegas Valley and should be discouraged by the MS4 Permittees. If a land developer wishes to use stormwater retention and infiltration as a BMP, a site-specific geotechnical study will be required to demonstrate that infiltration is technically feasible and will not adversely affect ground or surface water quality.

# 1 Introduction

The Development Guidelines Working Group of the Las Vegas Valley Stormwater Quality Management Committee (SQMC) has been tasked with researching possible Best Management Practices (BMPs) for new development and significant re-development in the Las Vegas Valley. The use of infiltration BMPs was considered in Las Vegas Valley due to heavy emphasis on this technique by EPA and extensive use of this approach in other communities. However, certain geologic conditions, surface soil conditions, groundwater quality, land slope, and other factors may require limiting the use of infiltration BMPs in certain areas in Las Vegas Valley. This memorandum was prepared to: (1) identify conditions and locations in which infiltration of stormwater should be limited or prohibited; and (2) make recommendations regarding areas where further investigation should be required by site owners or developers if infiltration BMPs are planned.

For purposes of this discussion, infiltration BMPs are defined to be structural measures designed specifically to capture and infiltrate stormwater. Examples of infiltration BMPs include retention ponds, extended dry detention basins, infiltration basins, infiltration trenches, and porous pavement. BMPs incorporated into landscape design such as swales, depressed medians, buffer strips, etc. are not considered infiltration BMPs for this discussion. Although they can involve a minor amount of increased stormwater infiltration compared to natural conditions, the small quantity of stormwater infiltrated using these BMPs would be mostly evaporated in the upper soil layer (vadose zone) and would not reach the shallow aquifer system.

The following sections discuss each of the factors affecting the suitability of infiltration as a stormwater disposal measure. In the final section, recommendations are made for addressing potential incorporation of infiltration BMPs in the Storm Water Management Plan (SWMP) currently being prepared by the Las Vegas Valley stormwater permittees in compliance with the new municipal stormwater permit.

# 2 Geologic Factors

The geologic factors in Las Vegas Valley that were identified as being potential problems for infiltration are the presence of caliche, expansive clays, and collapsible soils. Caliche is sedimentary rock consisting of, but not limited to, clays, soils, and gravel cemented together by calcium carbonate; thus, caliche is a hardpan material through which water cannot easily infiltrate. Infiltration BMPs installed in caliche soils will not drain effectively, and may create perched groundwater conditions with poor water quality that can exfiltrate to drainage channels and degrade surface water quality. Expansive soils refer to a category of soils that expand when water content is increased. Conversely, collapsible soils experience a decrease in volume when water content is increased. Both of these types of soil conditions can have adverse impacts on foundations, buildings, pavement, and buried infrastructure when exposed to water.

These three geologic factors are common in arid regions and are found extensively within Las Vegas Valley.

## 2.1 Geologic Impact Area Mapping

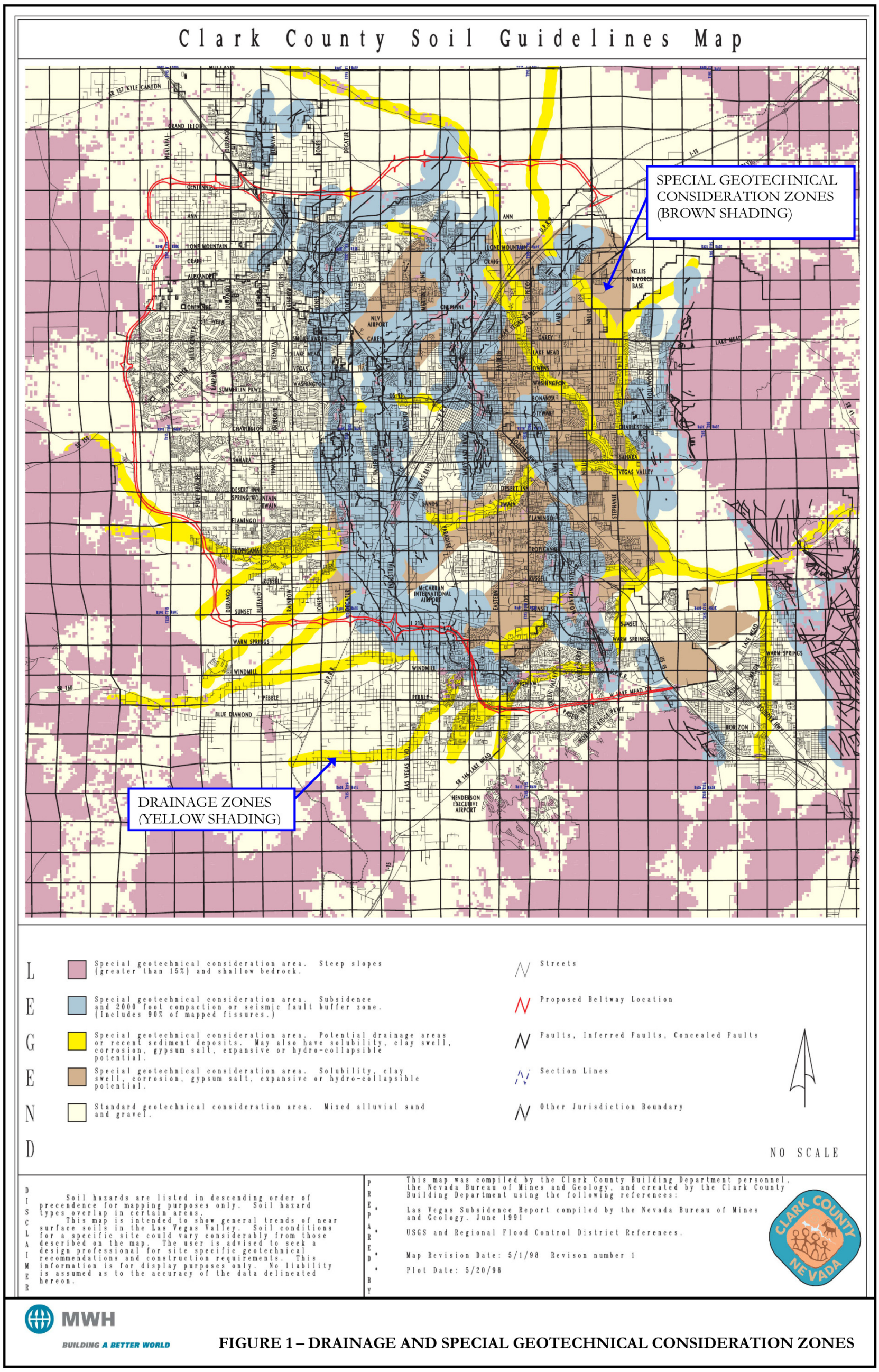
Clark County publishes information on soil conditions within Las Vegas Valley and this information is available in both PDF and geographic information system (GIS) format on the Clark County GIS Management Office (GISMO) website. The Clark County Soil Guidelines Map was created by the Clark County Building Department with information from the Nevada Bureau of Mines and Geology, the United States Geological Survey (USGS), and the Clark County Regional Flood Control District (CCRFCD). This map is shown in **Figure 1**. The purpose of the map is to show general trends of near-surface soil conditions, such as expansive and collapsible potential, within Las Vegas Valley.

The categories on **Figure 1** that are of importance for this study are the special geotechnical considerations designated by yellow, brown and pink shading. Yellow and brown areas have expansive and collapsible potential. The areas marked with yellow shading contain the areas along the main tributaries to the Las Vegas Wash and the Las Vegas Wash, referred to herein as the Drainage Zone. These areas could present problems for infiltration due to shallow groundwater conditions near channels and washes. The brown shaded areas, referred to herein as the Special Geotechnical Consideration Zone, are predominantly on the east side of Las Vegas Valley (east of Decatur Boulevard). Both of these areas have clay swell, expansive, and/or hydro-collapsible potential. The pink area is also a Special Geotechnical Consideration Zone due to the presence of steep slopes and shallow bedrock that would be problematic for infiltration BMPs. No specific mapping of the occurrence of caliche was found for Las Vegas Valley.

## 2.2 City of North Las Vegas Policy

Because of the extensive occurrence of poor soil conditions in the City of North Las Vegas, the city has adopted a policy prohibiting use of infiltration basins or other infiltration measures for disposal of stormwater.

Figure 1. Geologic Map



# 3 Selenium Factors

Selenium is a source of water quality impairment for several surface water bodies in Las Vegas Valley, as identified by Nevada Division of Environmental Protection (NDEP) in its most recent (2006) list of impaired streams (303(d) List). Detailed analyses of sources of selenium in Las Vegas Valley were conducted by the Clean Water Coalition (CWC) in association with developing a Valley-wide Selenium Management Plan. In addition, CWC developed alternatives to control selenium concentrations in the Las Vegas Wash. It is generally believed that the primary source of selenium is resurfacing groundwater, and that urban activities that have increased infiltration into the shallow aquifer system (e.g., landscape irrigation) have contributed to an increase in surface water selenium concentrations and loads. As a result, the approach in this study is to assume that applying infiltration-based BMPs in areas where shallow groundwater and selenium-rich geologic deposits are present could adversely impact surface water quality and should be limited or prohibited.

## 3.1 Background Information

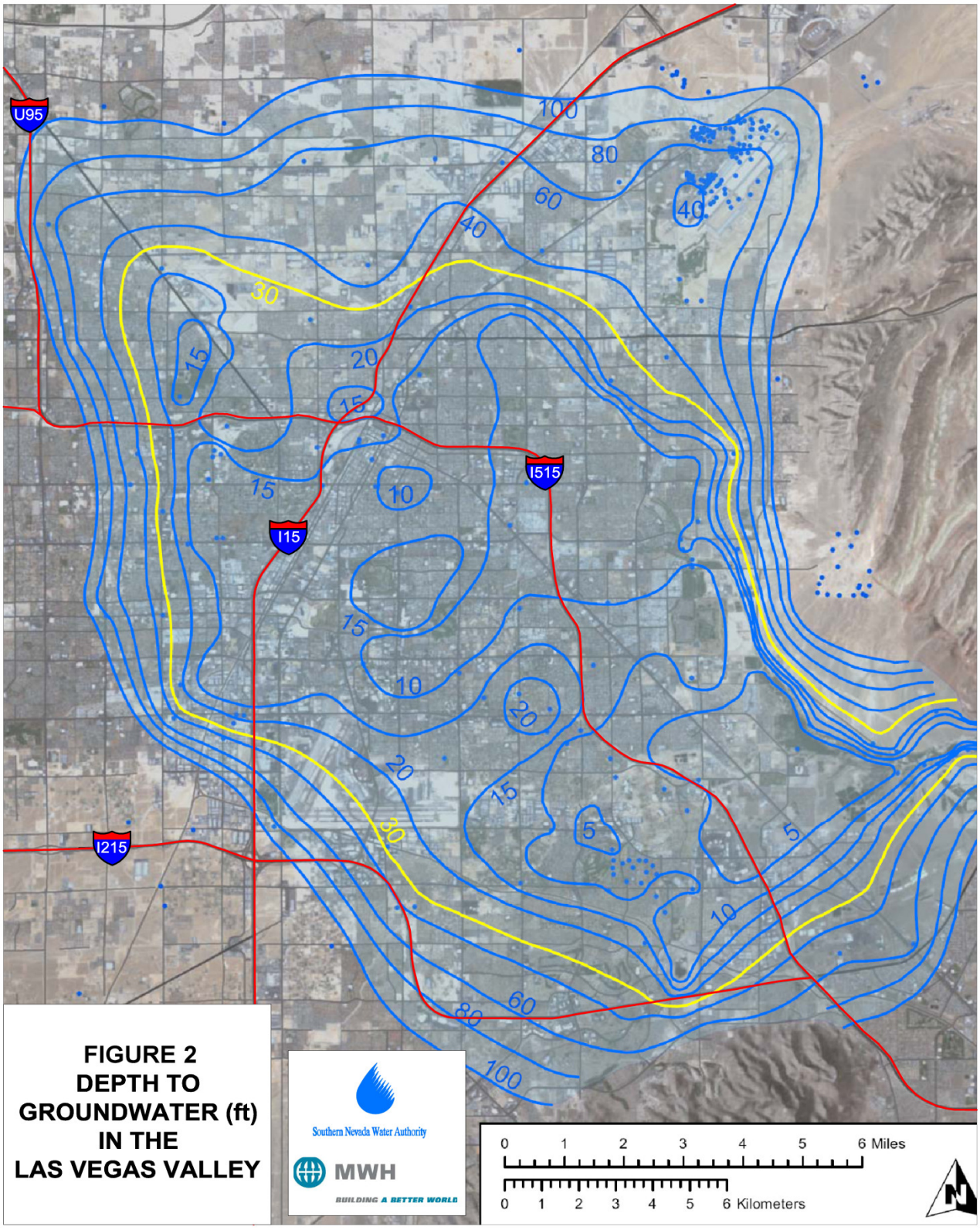
In recent years, elevated selenium concentrations have been noted in washes in Las Vegas Valley in areas with shallow groundwater aquifers. In Las Vegas Valley, selenium is transported to the tributaries and Las Vegas Wash by the subsurface interconnections with shallow groundwater aquifers and surface connections from urban drainage, irrigation runoff, and rainfall runoff.

High concentrations of selenium have been monitored by SNWA in Flamingo Wash, Duck Creek and Monson Channel, and are likely to occur in other minor tributaries and seeps in southeast Las Vegas Valley. The following stream segments are included in the State's current list of impaired water bodies (303(d) List) for impairment due to selenium concentrations:

- Las Vegas Wash above the wastewater treatment facilities
- Flamingo Wash
- Sloan Channel
- Monson Channel
- Duck Creek
- Las Vegas Creek

SNWA has collected information on the depth to groundwater (distance from the ground surface to the top of the groundwater table) throughout Las Vegas Valley. A map of depth to groundwater contours was provided to MWH for use in this study, which is shown in **Figure 2**. It is important to note that groundwater levels, especially in shallow aquifers, can vary over the course of a year and also over the course of several years, so there may be some fluctuation of these depths to groundwater.

Figure 2. Depth to Ground Water (ft) in the La Vegas Valley



## 3.2 Geologic Factors Associated with Selenium

Past geologic studies in Las Vegas Valley were reviewed to determine whether certain geologic conditions or formations are more likely to contain large amounts of selenium that could be mobilized by contact with groundwater. No definitive studies were found. To be conservative at this stage, it was assumed that all geologic formations underlying the Las Vegas Valley floor could be potential sources of selenium. Therefore, the only critical parameter in determining whether increased infiltration could affect selenium concentrations in downstream channels is depth to groundwater.

## 3.3 Critical Selenium Impact Areas Mapping

The depth to groundwater contours were overlaid on a map of the major washes and watersheds to determine where areas of shallow groundwater intersect with the Las Vegas Wash and its tributaries, as shown on **Figure 3**. Areas with a depth to groundwater level of 5 feet are located in the downstream-most portions of the following watersheds:

- Duck Creek
- Flamingo Wash
- Lower Las Vegas Wash
- Pittman Wash/C-1 Channel

These shallow groundwater areas are consistent with areas of the Las Vegas Wash and the tributaries that have recently shown elevated levels of selenium in samples gathered by SNWA. It is recommended that these areas be designated as "Critical Selenium Impact Areas," as shown on **Figure 4**, for purposes of infiltration BMP planning. These are the areas in Las Vegas Valley where the SWMP should consider prohibiting or strictly regulating infiltration BMPs.

The watersheds that contain areas with depth to groundwater levels between 5 feet and 10 feet include the watersheds listed above and also Central, North Basin and Range Wash watersheds (as shown on **Figure 3**). These zones are designated as "Selenium Areas of Concern" and it is suggested that the use of infiltration BMPs should be strongly discouraged in these areas, but not necessarily prohibited. In these areas, there could be mitigating circumstances as to why infiltration BMPs could be used, such as no other drainage opportunity is available or there is substantial fill on site and the depth to groundwater is greater than 10 feet. The use of infiltration BMPs in these areas may have to be addressed on a case-by-case basis. A design condition for infiltration BMPs located within the "Selenium Areas of Concern" could be that infiltration volumes after installation of the infiltration BMPs cannot exceed the original infiltration volumes prior to installation.

Groundwater depths from 10 feet to 15 feet are also shown on **Figure 4**, and are used to delineate "Selenium Areas of Minimal Concern." These areas are identified in case local entities want to adopt infiltration BMP controls stricter than those adopted at the regional level.

Figure 3. Depth to Groundwater (ft) in Watersheds of the Las Vegas Valley

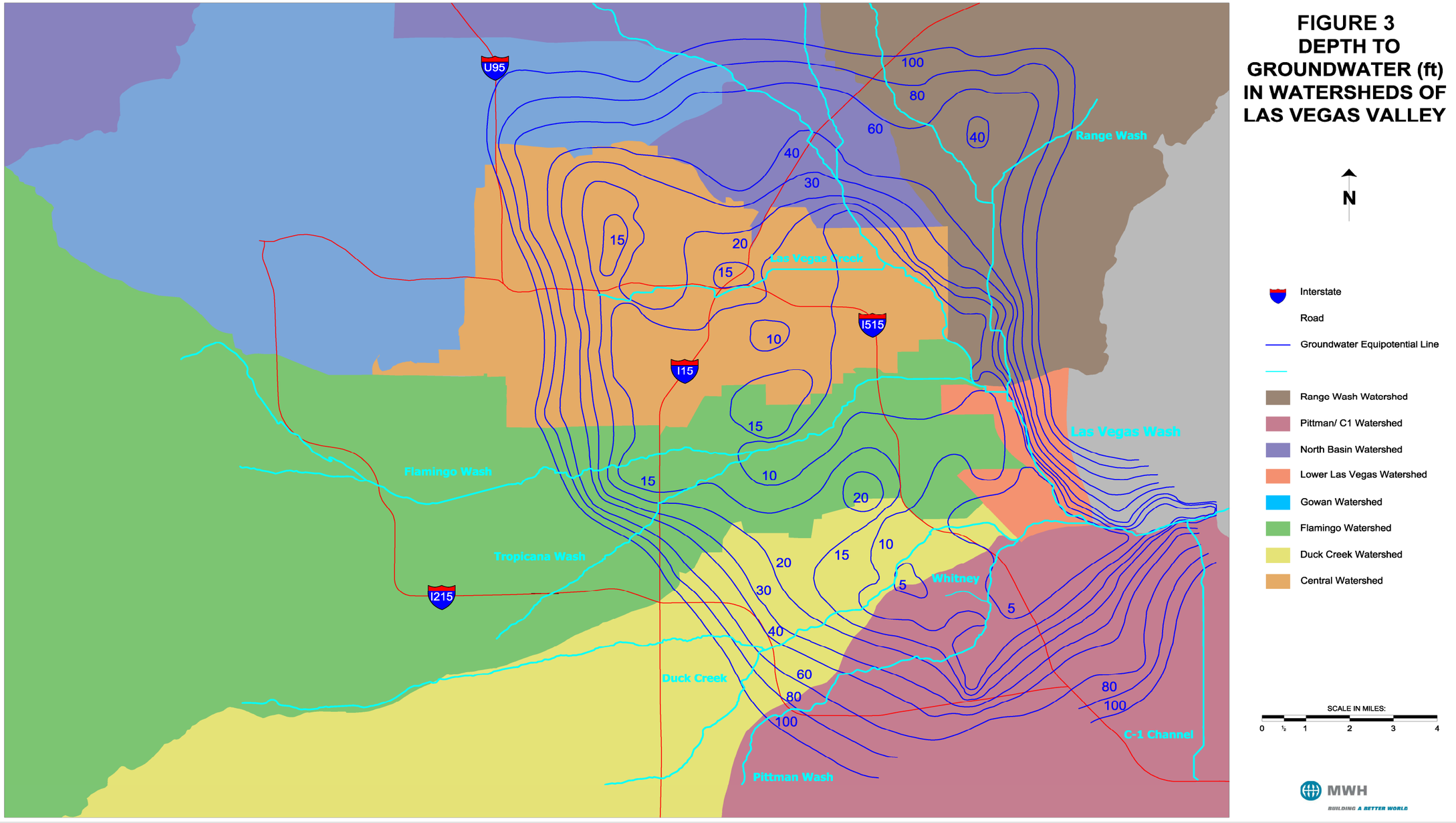
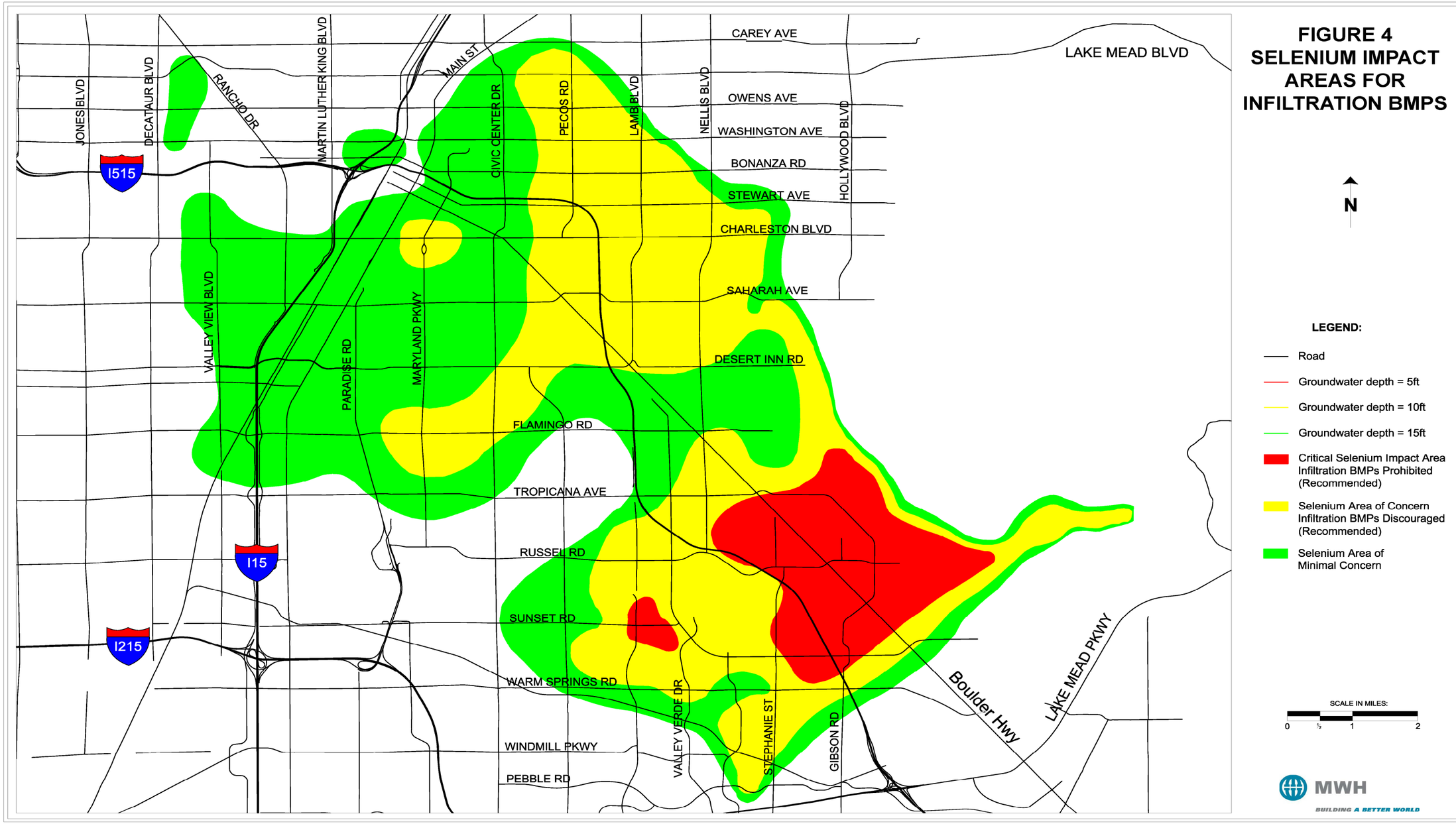


Figure 4. Selenium Impact Areas For Infiltration BMPs



# 4 Salinity Factors

Salinity has long been a water quality concern in Las Vegas Valley and the Colorado River Basin. The Colorado River Basin Salinity Control Program (CRBSCP) was authorized by Congress to address salinity concerns in the Colorado River watershed (see Appendix A for background on the Colorado River Basin Salinity Control Program). Las Vegas Wash was identified as a key source of salinity in the Lower Colorado River Basin. The U.S. Bureau of Reclamation (USBR) determined that shallow groundwater was the primary source of salinity in Las Vegas Wash, and selected "groundwater prevention" (i.e., preventing surface flows from infiltrating to the shallow aquifer) as the preferred management strategy. EPA established a numerical water quality standard of 723 mg/l TDS (flow-weighted annual average) for the Colorado River below Hoover Dam as a means of enforcing salinity control measures.

Infiltration of stormwater in Las Vegas Valley that would increase recharge to, and subsequent discharge from, the poor quality shallow aquifer would increase salt loads to the Colorado River. This method of stormwater disposal would be contrary to the objectives of the federal CRBSCP, and particularly USBR's preferred "groundwater prevention" management strategy. Engaging in stormwater infiltration into high-alkalinity soils when the CRBSCP is spending millions of dollars annually to prevent contact of surface water with those types of soils is counter-productive. Increased salt loads could cause or contribute to an exceedance of the Colorado River TDS standard, putting local agencies in jeopardy of violating the Clean Water Act.

Under these conditions, infiltration of stormwater should be prevented in any areas where it could be intercepted by the shallow alluvial aquifer or by perched poor quality groundwater that could resurface downstream. Stormwater infiltration in areas of known shallow groundwater (less than 15 feet) as shown in **Figure 3** should be prevented. Infiltration in localized areas of shallow caliche or other impermeable soils should also be avoided.

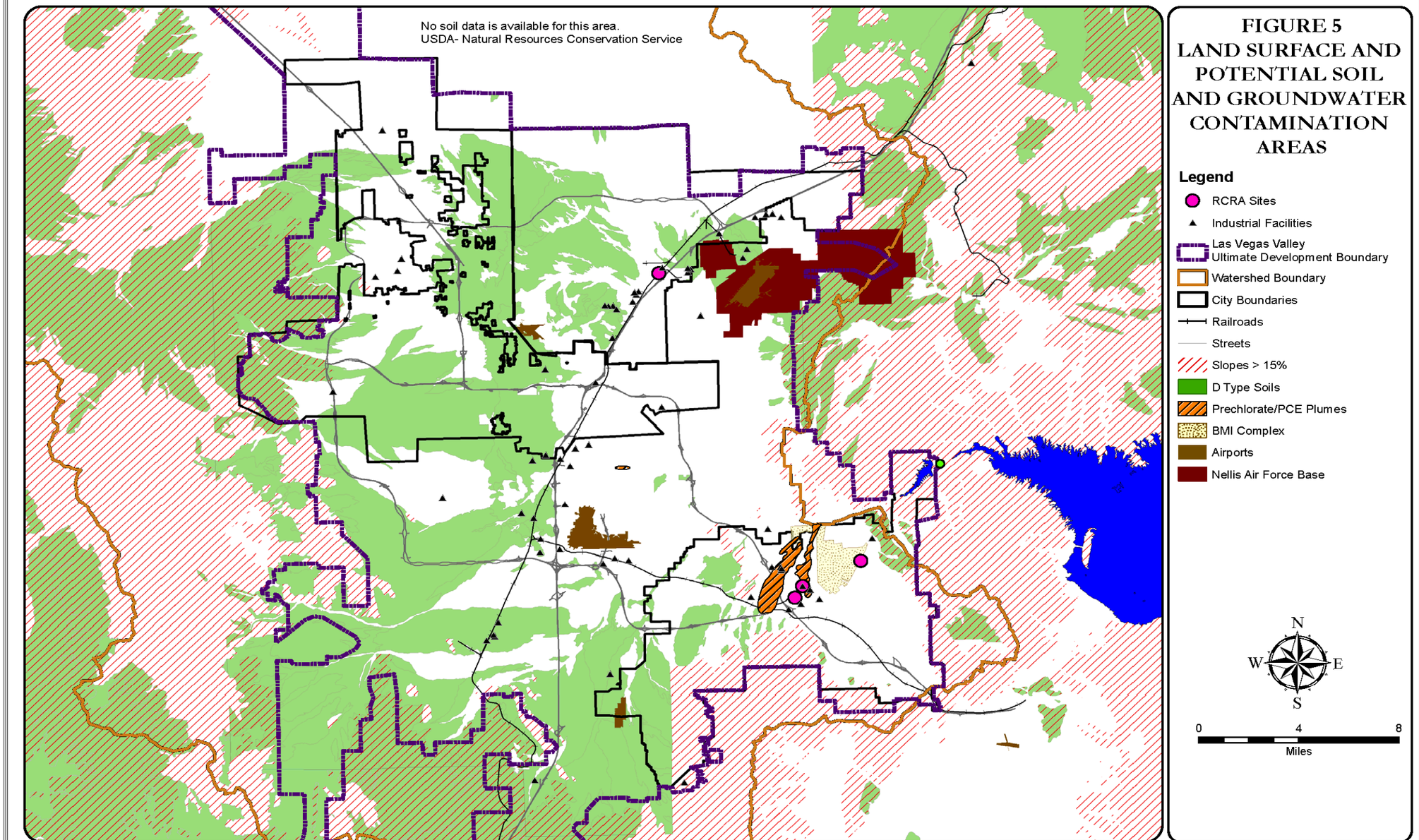
# 5 Surficial Soil Conditions

Surface soil conditions have a significant impact on the effectiveness of infiltrating stormwater. Two land surface conditions affecting infiltration suitability were documented: land slope and hydrologic soil group.

## 5.1 Land Slope

Hillsides and steep slope areas have generally poor infiltration conditions due to rapid runoff rates and rocky soils. They are also poor candidates for infiltration BMPs because they are more susceptible to slope failures when soils become saturated. For land use planning, communities often designate steep slopes and hillsides as those with over 15% slope. USGS topographic maps were used to define areas with slopes of over 15%. These areas are shown in **Figure 5**. The SWMP should assume that infiltration BMPs will not be feasible in hillside areas and areas with over 15% slope.

Figure 5. Land Surface and Potential Soil and Groundwater Contamination Areas



## 5.2 Hydrologic Soil Group

The Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS), has divided all soil types into four hydrologic soil groups – A, B, C and D – based on their runoff potential. Soils with the greatest runoff potential also have the least permeable characteristics and thus would be poor candidates for infiltration BMPs. Hydrologic soil group D has the greatest runoff potential and therefore the least infiltration potential. D soils have been mapped by NRCS; these maps are reproduced by CCRFCD to support rainfall-runoff analyses for designing flood control facilities. **Figure 5** shows locations of D soils in Las Vegas Valley. The SWMP should assume that infiltration BMPs should not be used in areas dominated by D soils due to poor infiltration properties.

# 6 Potential Soil and Groundwater Contamination

Stormwater infiltration should not be promoted in areas where soil or groundwater contamination is present. Infiltrating stormwater into contaminated soils may transfer that contamination to the groundwater system or to downstream surface water when shallow groundwater exfiltrates. Infiltrating stormwater into areas overlying contaminated shallow groundwater aquifers will increase the potential for that groundwater to resurface in drainages or seeps and adversely affect surface water quality.

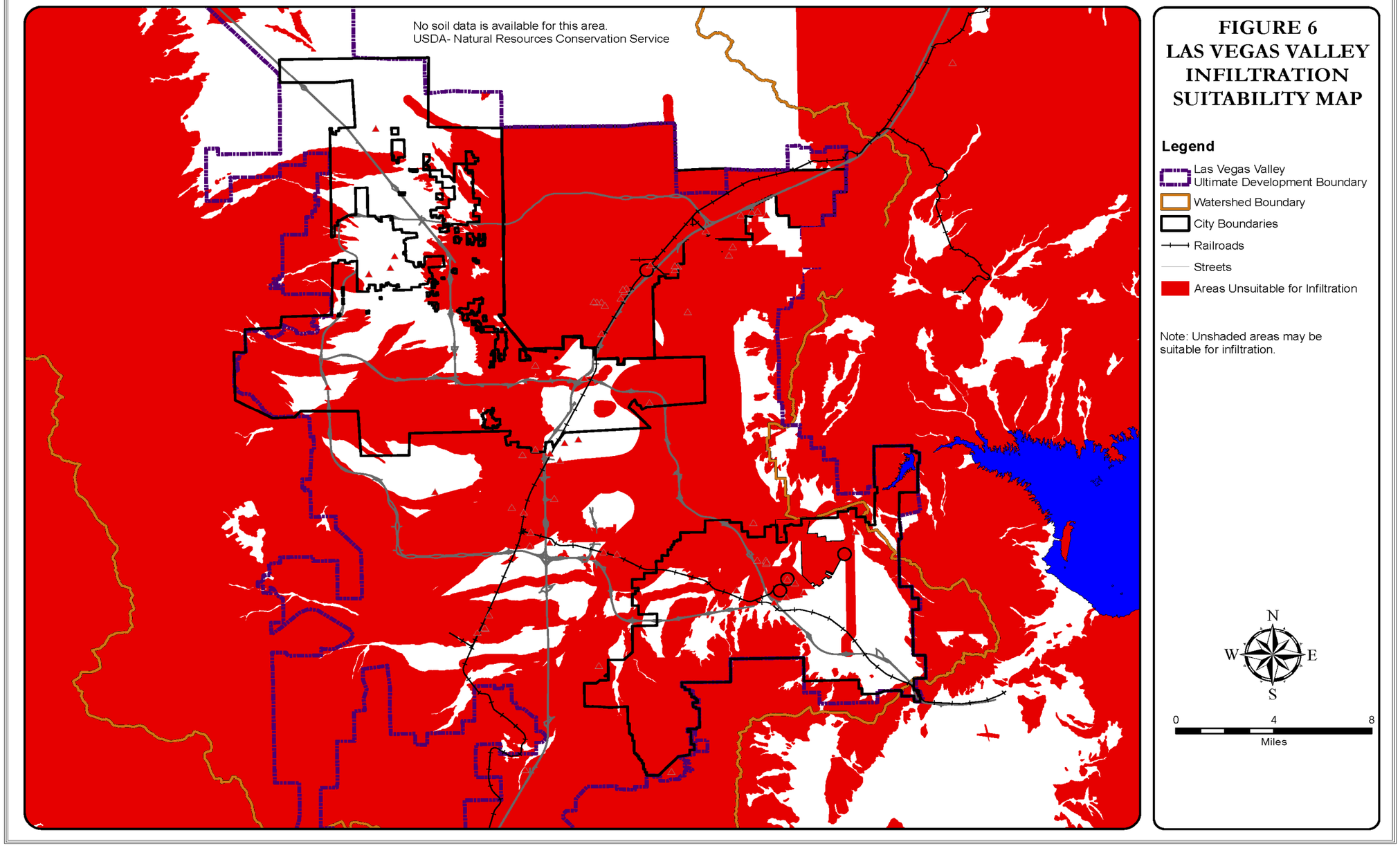
Groundwater contamination due to perchlorate and PCE has been documented in the southeast part of the Valley. The plume of contaminated groundwater has been mapped and extensively studied by NDEP and others. The extent of contaminated groundwater is shown in **Figure 5**. Potential soil contamination could be associated with commercial and industrial activities at which toxic chemicals, fuels, and other hazardous materials are used. Examples are the BMI Complex in Henderson; McCarran Airport and other general aviation airports; Nellis Air Force Base; Resource Conservation and Recovery Act (RCRA) sites; and industrial facilities in categories identified by the EPA as being potential sources of stormwater pollution. These areas of known and potential soil or groundwater contamination are shown in **Figure 5,** and are areas where use of stormwater infiltration BMPs should be prohibited in the SWMP. In addition, infiltration adjacent to underground storage tanks (USTs) should be prohibited in case the tanks leak. Site-specific investigations would be needed to determine if USTs are present near areas of proposed stormwater infiltration.

In addition, the Permittees prepared a an analysis of stormwater capture and subsurface injection. Shallow dry wells would not be an option in many locations since water injected just below the ground surface tends to pick up metals and salts and often does not penetrate the underlying caliche resulting in low-quality shallow perched aquifers. Deep injection wells drilled so that the stormwater would be injected directly into the deeper drinking water aquifers is not an option. Treatment prior to injection would be necessary to prevent water quality degradation in the aquifer. This is published separately as *Technical Memorandum No. IV.7 - Potential Legal and Water Rights Issues Associated with Onsite Retention of Stormwater.*

# 7 Infiltration Suitability Mapping

Stormwater infiltration is considered suitable in areas not affected by one of the limiting factors described in the previous sections. **Figure 6** is a composite of the preceding maps of factors causing concern over suitability of infiltration measures. This map combines areas of geologic problems, shallow groundwater (<10 ft), steep slopes, D soils, and known or potential areas of soil or groundwater contamination. The vast majority of the valley is in the "unsuitable" category. Areas not affected by one of these limiting factors could be suitable for stormwater infiltration. However, even in these areas site specific problems such as caliche layers or locally poor soil conditions could make infiltration infeasible, and geotechnical investigations would be necessary to verify that infiltration is a feasible stormwater disposal approach.

Figure 6. Las Vegas Valley Infiltration Suitability Map



# 8 Management Options and Recommendations

The SWMP could consider several options for addressing concerns with use of infiltration BMPs.

- **Local versus Regional.** The SWMP could leave decisions on use of infiltration BMPs to the local cities and Clark County. Or, the SWMP could establish regional guidelines for use of infiltration BMPs that apply to all entities in the Valley.
- **Limitations versus Prohibitions.** The SWMP could prohibit use of infiltration BMPs in certain areas (or throughout the Valley) where it is believed that they would be ineffective or would have adverse effects such as threatening foundation or pavement stability. Or, the SWMP could limit use of infiltration BMPs by requiring site owners or developers to demonstrate that infiltration BMPs would be safe and effective on their specific property.

Each of these options is discussed below.

## 8.1 Local Versus Regional Implementation

It is recommended that regional guidelines be established for use of infiltration BMPs in Las Vegas Valley. Standardization of criteria is compatible with the desire of the SQMC Stormwater Stakeholders Working Group to have consistent guidelines for the stormwater program throughout the Valley. It is also reasonable to use the Valley-wide infiltration suitability map as a basis for BMP planning. Local entities could adopt more stringent guidelines for use of infiltration BMPs in specific applications if desired.

## 8.2 Limitations Versus Prohibitions

It is recommended that stormwater infiltration in the "unsuitable" areas in **Figure 6** be prohibited unless site specific geotechnical investigations demonstrate that infiltration is physically feasible and would not adversely affect surface or ground water quality.

Because caliche can be located virtually anywhere in the Las Vegas Valley, and because caliche mapping is not available, it is recommended that any development that is considering the use of infiltration BMPs in the "suitable" area in **Figure 6** should be required to conduct specific geotechnical explorations for caliche in the area of the proposed infiltration BMP. If caliche is found, use of infiltration BMPs should be prohibited. In addition, hydrogeologic studies should be required to assure that stormwater infiltration will not adversely impact downstream surface water quality by increasing exfiltration of poor quality shallow groundwater.

# 9. Summary and Recommendations

Based on the investigations conducted for this TM and the compilation of existing geotechnical reports, groundwater contamination studies, and shallow aquifer studies, the use of infiltration BMPs is at best a limited option in Las Vegas Valley for the New Development and Significant Redevelopment stormwater management program currently under development. Infiltration BMPs may be ineffective or cause adverse impacts if installed in areas with certain geologic factors such as caliche, expansive clays, and collapsible soils; hillsides and steep slopes; D soil types; shallow groundwater; high groundwater selenium and TDS concentrations; and known or potential soil and groundwater contamination. It is recommended that the SWMP consider a policy whereby:

1. Guidance related to permissibility and selection of infiltration BMPs will be established at the regional level, with more stringent guidelines allowable at the local level.
2. Stormwater infiltration is discouraged throughout Las Vegas Valley, and is permitted only if a detailed infiltration feasibility study is provided.

**Figure 6** shows that virtually all of Las Vegas Valley has the potential to be unsuitable for effective and safe stormwater infiltration. However, mapping of the various problem areas is not precise. Therefore, to be conservative, it is recommended that stormwater infiltration be discouraged throughout the valley, and that it be permitted only for those projects that prepared a detailed infiltration feasibility study. This study must be prepared by a registered engineer or geologist in the State of Nevada, and must certify the following:

- Stormwater infiltration in the onsite soil conditions is feasible at the rates required to handle site runoff.
- Infiltrated stormwater will not adversely affect selenium or TDS concentrations in lower Las Vegas Wash and its tributaries.
- Infiltrated stormwater will not recharge shallow aquifers that seep back into surface water channels with degraded water quality.

Infiltrated stormwater will not come into contact with potentially contaminated ground water and soils.

# ATTACHMENT A

## Colorado River Basin Salinity Control Program Background

Salinity has long been a critical water quality problem in the Lower Colorado River Basin. High salinity concentrations due to agricultural return flows and other sources make it difficult to grow fruits and vegetables. Salt in water systems plugs and destroys municipal and household pipes and fixtures. Damages in Mexico are unquantified, but damages in the United States are about $400 million per year (USBR, *Quality of Water, Colorado River Basin, Progress Report No. 23*, 2009).

In response to negotiations between the United States and Mexico over the quality of Colorado River water at the international border, Congress passed the Colorado River Basin Salinity Control Act in 1974. The Act authorized the U.S. Bureau of Reclamation (USBR) and other federal agencies to establish the Colorado River Basin Salinity Control Program (CRBSCP) to fund projects to reduce the salt load delivered to the Lower Colorado River in order to meet a target salinity concentration for water delivered to Mexico. The Act directs the Environmental Protection Agency and other federal agencies to "cooperate and coordinate their activities effectively to carry out the objective of this title." In response, EPA worked with the Colorado River Basin States to adopt numerical water quality standards for TDS as follows:

- 723 mg/L TDS (flow-weighted annual average) below Hoover Dam
- 747 mg/L TDS (flow-weighted annual average) below Parker Dam
- 879 mg/L TDS (flow-weighted annual average) at Imperial Dam

Since 1974 several hundred million dollars have been spent on federal salinity control projects in the basin and millions of dollars in grants have been given to state and local projects. Current salinity control projects prevent or remove about 1.2 million tons of salt from the Colorado River annually. USBR and the Department of Agriculture will spend a combined $35 million/year to remove an additional 700,000 tons/year by 2030 (USBR, *Quality of Water, Colorado River Basin, Progress Report No. 23*, 2009).

Las Vegas Wash was identified in the Act as a source of salinity to the Colorado River. The primary source of high salinity is resurfacing shallow groundwater, which originates as urban runoff from stormwater and non-stormwater sources (e.g., lawn watering, vehicle washing, pool maintenance). Typical concentrations of total dissolved solids in Las Vegas Wash and its tributaries during dry weather conditions are (MWH, 2008-2009 MS4 Annual Report):

- Las Vegas Creek/Meadows Detention Basin – 1,500 to 2,000 mg/L
- Flamingo Wash – 2,500 to 3,000 mg/L
- Sloan Channel – 2,000 to 2,500 mg/L
- Monson Channel – 3,900 to 4,500 mg/L
- Burns Street Channel – 4,000 to 4,400 mg/L
- Duck Creek – 4,000 to 5,000 mg/L

By contrast, TDS concentrations during storm runoff periods vary from less than 200 mg/L to over 2,000 mg/L. The median TDS concentration for all wet weather samples collected for the MS4 sampling program is 600 mg/L. NDEP has determined that Flamingo Wash, Duck Creek, and Las Vegas Wash upstream of the wastewater treatment plant discharges are impaired for TDS (Nevada Division of Environmental Protection, Bureau of Water Quality Protection, *Nevada's 2006 303(d) List of Impaired Waters*, 2009). TDS concentrations in the Colorado River below Hoover Dam are in the range of 500 to 700 mg/L (http://www.usbr.gov/uc/progact/salinity/pdfs/CRBannual_salinity_data.pdf). The Colorado River in Nevada has not been designated as impaired for TDS by NDEP. TDS concentrations below Hoover Dam have not exceeded the 723 mg/l annual average numerical standard adopted by EPA since the CRBSCP was established in 1974.

The CRBSCP established the Las Vegas Wash Unit to focus on projects to reduce salinity loads from the Las Vegas Wash watershed. USBR evaluated the following four strategies for salinity control in Las Vegas Valley: groundwater collection, groundwater prevention, groundwater flow reduction, and no action. Groundwater prevention proved to be the best solution, as it prevents surface flows from ever coming in contact with high-alkaline soils. USBR constructed the Pittman Bypass Pipeline to separate wastewater discharges from highly saline soils by diverting industrial return flow from an open, unlined ditch. The project removes about 3,800 tons of salt per year. Additional projects were proposed but were not found to be cost effective and did not receive sufficient local support. In 1989, Reclamation ceased all salinity control efforts in the Las Vegas Wash Unit.

# Section 7

MWH

TECHNICAL MEMORANDUM

# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

## STORMWATER MANAGEMENT PLAN DOCUMENTATION

## Technical Memorandum IV.7

## Potential Legal and Water Rights Issues Associated with Onsite Retention of Stormwater

October 19, 2010

*Prepared for*

**Stormwater Quality Management Committee**

*Prepared by*

MWH®

BUILDING A BETTER WORLD

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## Executive Summary

EPA is strongly promoting onsite stormwater retention as a best management practice (BMP) for areas of new development and significant redevelopment. The new MS4 permit issued to Las Vegas Valley municipal entities by NDEP requires a review of low impact development measures, including onsite retention. Nevada water law was reviewed and the Nevada State Engineer's Office, SNWA, and the Colorado River Commission were contacted to determine potential legal and water rights issues that could affect use of stormwater retention facilities in Las Vegas Valley.

Stormwater retention without onsite beneficial use (infiltration and evaporation losses only) would contradict local agency policies and potentially exacerbate existing water quality problems, and is not recommended. Due to the subsurface geology in the Las Vegas Valley, shallow dry wells would not be an option in many locations. Water injected just below the ground surface tends to pick up metals and salts and often does not penetrate the underlying caliche resulting in low-quality shallow perched aquifers. Another option would be to drill the injection wells deep enough that the stormwater would be injected directly into the deeper drinking water aquifers. Treatment prior to injection would be necessary to prevent water quality degradation in the aquifer. This is not considered to be a viable stormwater management option.

Proposed stormwater retention with onsite beneficial use (e.g., for irrigation water) would have agency support but would have to be submitted to the State Engineer for approval; approval is not certain due to potential impacts on Lake Las Vegas and other water rights holders. Therefore, stormwater retention cannot be relied on for the MS4 program, and should not be part of mandatory programs developed by the permittees.

# 1 Introduction

The Development Guidelines Working Group has been tasked with researching potential Low Impact Development (LID) criteria for new development and significant redevelopment within the Las Vegas Valley. The new Municipal Separate Storm Sewer System (MS4) permit to be issued by Nevada Division of Environmental Protection (NDEP) shortly requires the permittees to review potential LID measures and describe an LID program for Las Vegas Valley. Many typical LID measures are based on use of onsite retention in one of several forms. Onsite retention could reduce the quantity of stormwater runoff and flow within the Las Vegas Wash and its main tributaries. Although this could have positive surface water quality impacts, further exploration is necessary to determine whether this could violate state water law by having adverse effects on downstream users with surface water rights along the Las Vegas Wash and its main tributaries.

This memorandum is prepared to: (1) summarize state water law as it relates to stormwater retention; (2) identify the parties who currently hold or have applications pending for surface water rights and quantify the surface water rights along the Las Vegas Wash and its main

tributaries; and (3) determine possible conflicts between state water law and concepts of onsite stormwater retention.

# 2 Background Information

Onsite retention of stormwater is currently being emphasized by the Environmental Protection Agency (EPA) as a preferred method of managing stormwater runoff for purposes of minimizing water quality impacts. EPA is promoting this approach because it reduces the rate and volume of water discharged from a development, and reduces storm flows and volumes in downstream channels. Onsite retention is a key component of LID or "green infrastructure" measures. Retained stormwater can be disposed of through infiltration, evaporation, or beneficial use (e.g., outdoor landscape irrigation).

Like in most western states, Nevada water law is based on the prior appropriation doctrine (first in time, first in right). A system of surface and ground water rights has been developed wherein those desiring to put the state's water resource to beneficial use must obtain a permit from the State Engineer. In reviewing new permit applications, the State Engineer must determine that the proposed water diversion or withdrawal will not adversely affect the ability of all current water rights holders to fully exercise their permitted withdrawals. There may be a conflict between Nevada water law and stormwater BMPs that utilize onsite retention. Retaining stormwater onsite that otherwise would have flowed in downstream channels and been available to current water rights holders may violate their water rights. This technical memorandum investigates these potential issues.

In addition, regional water resource agencies may have concerns over BMPs that change runoff volumes. For example, Southern Nevada Water Authority (SNWA) provides the water supply for Las Vegas Valley, and could have concerns with changes in surface runoff characteristics. Colorado River Commission (CRC) manages Nevada's apportionment of Colorado River water, and may also have concerns with changes in the volume of water delivered to Lake Mead. These agencies were contacted to see if they would have objections to stormwater BMPs that rely on onsite capture and storage of runoff.

# 3 Overview of Nevada State Water Law

As mentioned previously, Nevada water law is based on the prior appropriation doctrine, which is summarized as "first in time, first in right." Those desiring to put surface waters of the state to beneficial use must first obtain a water right. Water is allocated on the basis of seniority, with the oldest rights being satisfied fully first before junior water rights are permitted to divert. The State Engineer's Office, part of the Division of Water Resources, is given authority to administer the Nevada water rights system. State water law is defined primarily in Nevada Revised Statutes (NRS) section 533. Relevant NRS paragraphs are cited below.

- **NRS 533.025 Water belongs to public.** The water of all sources of water supply within the boundaries of the State whether above or beneath the surface of the ground, belongs to the public.

- **NRS 533.030 Appropriation for beneficial use.** Use for recreational purpose declared beneficial; limitations and exceptions.

  1. Subject to existing rights, and except as otherwise provided in this section, all water may be appropriated for beneficial use as provided in this chapter and not otherwise.
  2. The use of water, from any stream system as provided in this chapter and from underground water as provided in NRS 534.080, for any recreational purpose, is hereby declared to be a beneficial use.
  3. Except as otherwise provided in subsection 4, in any county whose population is 400,000 or more:
     a) The board of county commissioners may prohibit or restrict by ordinance the use of water and effluent for recreational purposes in any man-made lake or stream located within the unincorporated areas of the county.
     b) The governing body of a city may prohibit or restrict by ordinance the use of water and effluent for recreational purposes in any man-made lake or stream located within the boundaries of the city.
     c) In any county whose population is 400,000 or more, the provisions of subsection 1 and of any ordinance adopted pursuant to subsection 3 do not apply to:
     d) Water stored in a man-made reservoir for use in flood control, in meeting peak water demands or for purposes relating to the treatment of sewage;

- **NRS 533.040 Water used for beneficial purposes to remain appurtenant to place of use; exceptions.**

  1. Except as otherwise provided in this section, any water used in this State for beneficial purposes shall be deemed to remain appurtenant to the place of use.
  2. If at any time it is impracticable to use water beneficially or economically at the place to which it is appurtenant, the right may be severed from the place of use and be simultaneously transferred and become appurtenant to another place of use, in the manner provided in this chapter, without losing priority of right.

- **NRS 533.045 Right to divert ceases when necessity for use does not exist.** When the necessity for the use of water does not exist, the right to divert it ceases, and no person shall be permitted to divert or use the waters of this State except at such times as the water is required for a beneficial purpose.
- **NRS 533.070 Quantity of water appropriated limited to amount reasonably required for beneficial use; duties of State Engineer in connection with water diverted or stored for purpose of irrigation.**

1. The quantity of water from either a surface or underground source which may hereafter be appropriated in this state shall be limited to such water as shall reasonably be required for the beneficial use to be served.

- **NRS 533.3703 Consideration of consumptive use of water right and proposed beneficial use of water.**

  1. The State Engineer may consider the consumptive use of a water right and the consumptive use of a proposed beneficial use of water in determining whether a proposed change in the place of diversion, manner of use or place of use complies with the provisions of subsection 5 of NRS 533.370.

- **NRS 533.435 Fees of State Engineer.**

  1. The State Engineer shall collect the following fees:
     e) For examining and filing an application for a permit to appropriate water $250.00

- **NRS 533.530 Unlawful diversion and waste of water; penalty.**

  2. It is an unlawful use and waste of water for any person during the irrigating season:
  3. To divert and conduct the water, or portion thereof, of any river, creek, or stream into any slough, dam or pond and retain, or cause the water to be held or retained therein, without making any other use of the water;

In considering the foregoing statements on beneficial use, it should be noted that the State Engineer does not consider infiltration to be a beneficial use.

Summarizing the above NRS paragraphs, stormwater retention as a BMP could be affected by the Nevada water rights system in two possible ways:

1. Stormwater retained and then put to beneficial use (e.g., outdoor landscape watering, dust control, cooling water, or industrial uses) would require a permit to appropriate water because of the beneficial use involved. Stormwater retention without an associated beneficial use (e.g., retention for infiltration or evaporation only) would not require a permit under current statutes, but also would not be allowed under a strict interpretation of the NRS language.
2. Any stormwater retention, either with or without beneficial use, could only be permitted if no downstream senior surface water permit holders would be injured

The person or entity putting the water to beneficial use must hold the surface water permit. For a stormwater retention facility this could be an individual homeowner where water is used on site, or a homeowners association for a subdivision-level retention project used for common landscape irrigation.

# 4 Water Rights Database Search

The Nevada Division of Water Resources maintains a database of former, active and pending surface water rights permits for the Las Vegas Valley. **Table 1** is a summary of search results for the Las Vegas Wash and its main tributaries. The search criteria returned eight water rights permits of concern that were either in certified, permit or application status. "Application" status refers to surface water rights that have been applied for through the State Engineer but have not been granted rights. "Permit" status refers to an application that has been approved for surface water rights but the applicant has not yet proven beneficial use of the water rights granted under the permit. "Certification" status means the State Engineer has approved the beneficial use of the water under the water rights permit. The permittee may continue to divert waters for as long as the diverted flow provides beneficial use. **Figure 1** shows the location of the point of diversion associated with each of the permits listed in **Table 1**.

The largest water rights permit, filled in 1975, is held by the CRC. The permit is for 638 cubic feet per second (cfs) with no annual duty balance. The purpose of the diversion is for municipal, industrial and residential use for the residents of Southern Nevada. The permit is for waters of the Las Vegas Wash although the point of diversion is the SNWA intake structure located in Boulder Harbor in Lake Mead (number 1 in **Figure 1**). This permit is used to administer return flow credits for wastewater returned to Lake Mead.

The Clark County Department of Parks and Recreation (CCP&R) holds two permits, filed in 2000, with a maximum diversion rate of 34 cfs and a combined duty balance of 4,000 acre feet per year (AFY). The purpose of these permits is for Wildlife use in the Wetlands Park, which is located adjacent to the Las Vegas Wash upstream from Lake Las Vegas. The construction works associated with the permit include erosion control structures which have been and continue to be built in the existing Las Vegas Wash. The estimated time to completion of the structures at the time of filing was 2020. The diversion points are located on the Las Vegas Wash (number 2 in **Figure 1**) and Duck Creek (number 8 in **Figure 1**). The permits held by CCP&R are subject to the provision that they do not infringe on the primary purpose of the permit held by the CRC detailed above.

## Figure 1. Surface Water Rights Permits: Point of Diversion Locations

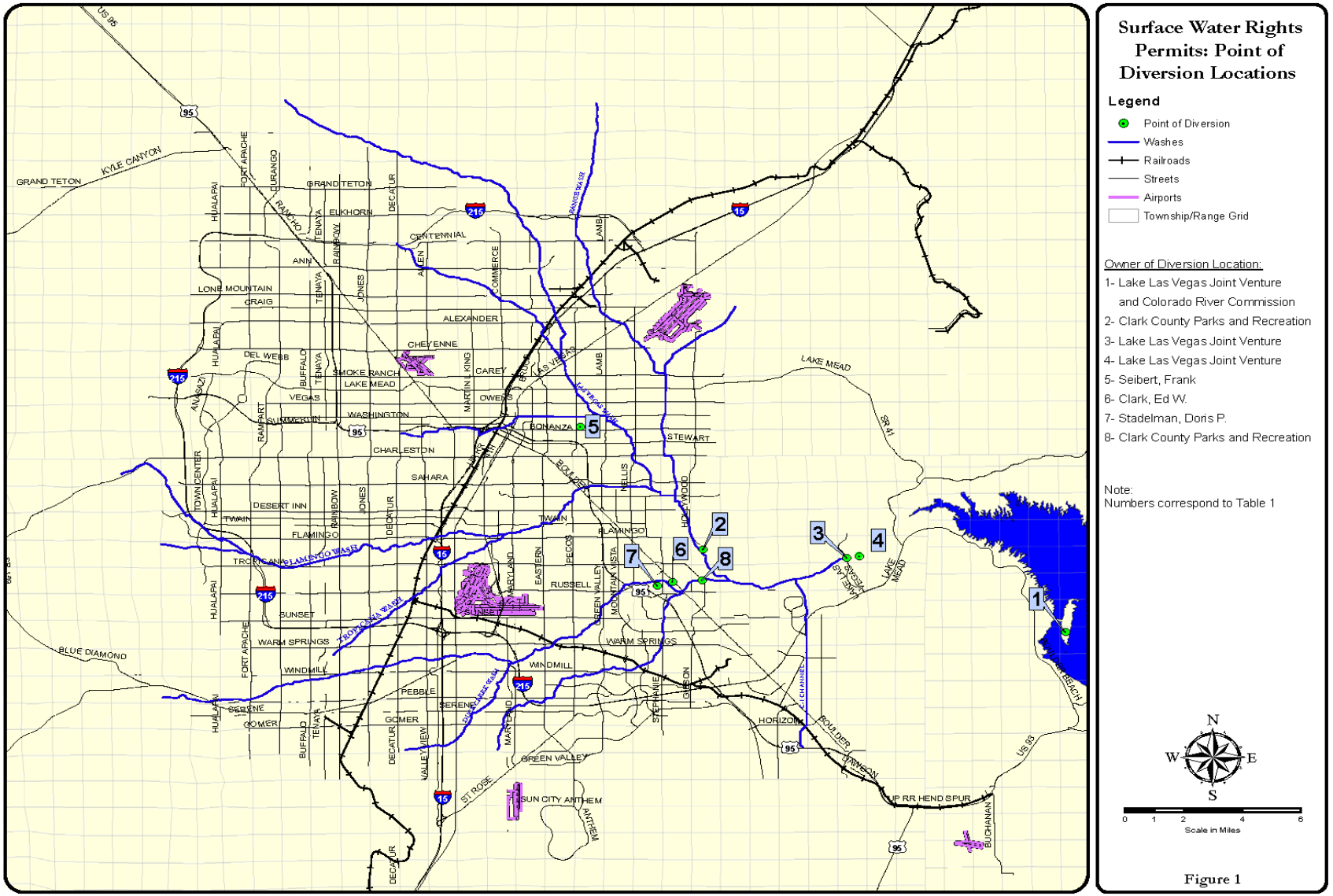


**Table 1.** Active and Pending Surface Water Rights Permits in Las Vegas Valley

| No. (Figure 1) | Water Body | Basin | Permit Number | File Date | Application Status | Owner Name | Source | Use | Diversion Rate (cfs) | Duty Balance (AFY) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Las Vegas Wash | 215 | 29814 | 11/28/75 | Permit | Colorado River Commission | River | Municipal | 638 | None |
| 2 | Las Vegas Wash | 212 | 65963 | 1/28/00 | Permit | Clark County Parks and Recreation | Stream | Wildlife | 34 | 4,000 |
| 3 | Las Vegas Wash | 215 | 58390 | 12/11/92 | Certification | Lake Las Vegas Joint Venture | Other Surface Water | Quasi-municipal | As Needed | 2,029 |
| 4 | Las Vegas Wash | 215 | 70863 | 2/2/04 | Application | Lake Las Vegas Joint Venture | Other Surface Water | Quasi-municipal | As Needed | 2,000 |
| 5 | Las Vegas Creek | 212 | 11511 | 3/8/46 | Certification | Seibert, Frank | Stream | Irrigation | 0.4 | 240 |
| 6 | Duck Creek | 212 | 2299 | 12/25/11 | Certification | Clark, Ed W. | Stream | Irrigation | 0.4 | 160 |
| 7 | Duck Creek | 212 | 5395 | 2/20/19 | Certification | Stadelman, Doris P. | Stream | Irrigation and Domestic | 0.7 | 474 |
| 8 | Duck Creek | 212 | 65962 | 1/28/00 | Permit | Clark County Parks and Recreation | Stream | Wildlife | 13 | 4,000 |

**Note:** “Application" = surface water rights applied for but not granted. “Permit" = application approved but the applicant has not yet proven beneficial use of the water rights. “Certification" = the State Engineer has approved the beneficial use of the water under the water rights permit.

**Source:** Nevada Division of Water Resources

Database of Water Rights Permits in Nevada Available At: http://water.nv.gov/water%20Rights/permitdb/hyd_abs1.cfm?CFID=385032&CFTOKEN=29235735

The Lake Las Vegas Joint Venture holds one certified permit filed in 1992 and one permit application filed in 2004 for incidental stormwater flows in the Las Vegas Wash in excess of the Lake Las Vegas bypass conduit capacity (originally rated at 1,760 cfs, but now estimated to be 1,160 cfs). The primary purpose of the 1992 permit was the filling of Lake Las Vegas. The excess flows were diverted from the Las Vegas Wash into the reservoir by means of an inlet weir just upstream of Lake Las Vegas (number 3 in **Figure 1**). The permit was certified as water put to beneficial use by the State Engineer in 1996. The Lake Las Vegas Joint Venture in combination with CRC currently holds an application for all stormwater flows in the Las Vegas Wash not to exceed a Probable Maximum Flood. The duty balance for this permit is 2,000 AFY. The primary point of diversion is within Lake Las Vegas (number 4 in **Figure 1**). The pending permit would give the Lake Las Vegas Joint Venture and CRC water rights to divert all additional stormwater flows in excess of the currently held water rights permits subject to a maximum of 2,000 AFY. (In fact Lake Las Vegas already stores stormwater during periods of high flow on Las Vegas Wash.) CRC and Lake Las Vegas are partners in the permit because any stormwater captured by Lake Las Vegas reduces the demand for makeup water delivered from the Colorado River system (i.e., Lake Mead) to keep the lake at its normal operating level and manage salinity concentrations. Makeup water required to compensate for evaporation losses is provided to Lake Las Vegas from the main raw water line from Lake Mead to Las Vegas Valley.

Of the eight permits listed in **Table 1**, three (numbers 5, 6, and 7) have a diversion rate of less than 0.7 cfs and duty balance of less than 500 AFY. These permits were designated for irrigation and domestic use. It is not known whether these permits are currently used.

# 5 Discussions with Agencies

Discussions were held with the Nevada State Engineer's Office, a representative of SNWA, and representatives of CRC regarding the likely effects of implementing stormwater retention measures in new development in the Las Vegas Valley.

The discussion with the State Engineer's office focused on the legality and permitting considerations applied to onsite stormwater retention measures. According to the State Engineer's Office a permit would be required if stormwater retained onsite would be put to beneficial use. In an effort to avoid a large number of permit applications the State Engineer would likely not require a permit for water amounts that would have diminimus impacts to downstream users. Onsite infiltration would not require a water rights permit as long as it does not adversely affect the downstream users on the Las Vedas Wash. The State Engineer's Office made note that they have not yet made a formal consideration of the implications of stormwater retention measures and may change it's approach to the permitting requirements in the future.

The discussion with the SNWA focused on potential impacts to the water rights permit filed on their behalf by the Colorado River Commission. The CRC permit flow of 638 cfs was established to guarantee that return flows from Las Vegas Valley wastewater treatment plants and non-sewered return flows cannot be diverted by other users prior to reaching Lake Mead. This water right is what allows return flows to be credited towards the Southern

Nevada allotment from the Colorado River via Lake Mead intakes. SNWA does accounting for return flows to Lake Mead by assuming all flows over a specified amount are storm flows, and the remainder are sewered or non-sewered wastewater return flows. This value tends to be set a little high to be conservative for return flow accounting. This means some storm flow is probably counted as return flow during wet weather events. If storm flows are reduced, for example due to stormwater retention, SNWA could lose some of its return flow credits, but SNWA believes it would probably make a negligible difference. For small amounts of stormwater retention, SNWA would not object to this approach to stormwater management. However, if the approach were used on a broad basis throughout the Valley and would significantly reduce streamflows in lower Las Vegas Wash, SNWA could be concerned.

SNWA considers stormwater to be "resource neutral" in terms of water quantity. As such, SNWA would not object to stormwater retention from the perspective of impacts to runoff volume. However, SNWA is very concerned about protecting the quality of water returning to Lake Mead and subsequently captured in the water supply intake system. Of particular importance is salinity, since conventional water treatment processes do not reduce salinity.

The CRC is concerned with effects of stormwater retention on inflows to Lake Mead and the Colorado River. To the extent that onsite stormwater retention would be beneficially used and would reduce demand for Lake Mead water, CRC would not object to it. However, staff members believe that with such little rainfall in Las Vegas Valley, stormwater retention for beneficial use would not appear cost effective. CRC would protest onsite retention for purposes of infiltration or evaporation. It has taken this stand against a recent proposed project in the City of Henderson (Village 26). CRC wants to protect its Colorado River water resource to the maximum extent practical. Anything that would reduce inflows to Lake Mead without reducing demands on Lake Mead would be of concern. Stormwater retention for the purpose of infiltration or evaporation would be in that category. CRC concerns would apply to both total developed site runoff and the difference between post-development and pre-development runoff. A project that would reduce potential flow to Lake Mead without putting the retained water to beneficial use and thereby offset withdrawals from Lake Mead would be opposed.

CRC has filed a surface water right permit application with the State Engineer for "all remaining stormwater in Las Vegas Valley." The permit has not been certified by the State, and CRC has been "sitting on it" for a while, but CRC may now move forward with it. This permit would allow CRC to protest any future permit application for water storage or use that would reduce flows from Las Vegas Valley to Lake Mead, claiming injury under its water right. The intent would be to work with developers or entities who want to capture stormwater to be sure that water is put to beneficial use to reduce withdrawals from Lake Mead.

# 6 Analysis of Potential Impact of Water Rights Issues On Stormwater Retention BMPs

Based on the existing surface water rights data and agency input, water rights issues may affect the ability of Las Vegas Valley entities to implement stormwater BMPs that rely on onsite stormwater retention. These issues are discussed below.

**Lake Las Vegas Water Right.** Lake Las Vegas, in cooperation with CRC, has a right to store 2,000 AFY in its reservoir. In order to take this water, the flow in Las Vegas Wash must exceed the capacity of the bypass conduits under the lake (1,160 cfs). Analysis of streamflow data at the Las Vegas Wash at Three Kids USGS gage station upstream of Lake Las Vegas shows that the base flow (dry weather flow) from 2005 to 2009 has varied between 250 cfs and 300 cfs (see **Figure 2**). The majority of the base flow is comprised of wastewater effluent, which is currently about 190 mgd (295 cfs) and is expected to increase to about 340 mgd (525 cfs) by 2030. Historically, Lake Las Vegas has not taken 2,000 AF into storage from Las Vegas Wash every year. **Table 2** summarizes estimated annual Lake Las Vegas inflows from 1992 to 2005. During this 14-year period, 40 storms caused inflows to the lake but only 9 storms delivered at least 2,000 AF into the lake. It is possible that the cumulative effect of widespread future upstream onsite stormwater retention could reduce storm flows and volumes in Las Vegas Wash to the point where the magnitude and frequency of streamflows exceeding 1,160 cfs could be reduced, and inflows to Lake Las Vegas could be adversely affected. This would violate the existing Lake Las Vegas water right and require action on the part of the State Engineer. This could occur when retention prevented Las Vegas Wash flow from exceeding the bypass conduit capacity of 1,160 cfs. During small storms when Las Vegas Wash flows would not have exceeded 1,160 cfs even without retention, stormwater retention would not affect the Lake Las Vegas water right. The same would be true for large storms when the volume of water taken into the lake greatly exceeds 2,000 ac-ft.

**CCP&R Water Rights.** The CCP&R water rights primarily provide for increased evaporation from the Wetlands Park area. The amount and timing of evaporation losses from wetlands created for the Wetlands Park and the SNWA grade control structures would not be significantly affected by onsite stormwater retention in the upstream watershed.

**CRC Water Right for Return Flow Accounting.** The existing CRC water right assures that wastewater return flows will not be diverted prior to entering Lake Mead, thus assuring that the return flows for which SNWA receives credit (currently about 210,000 AFY) actually return to the Colorado River system. Onsite stormwater retention would not affect wastewater return flows in the wash, and thus would not directly impact exercising the CRC water rights. Methods used by SNWA to compute return flow credits could include small amounts of stormwater runoff in return flow estimates, however, it is not expected that onsite stormwater retention would adversely impact return flow credit calculations.

Figure 2 - USGS Data for Three Kids Wash and Estimate of Annual Average Base Flow

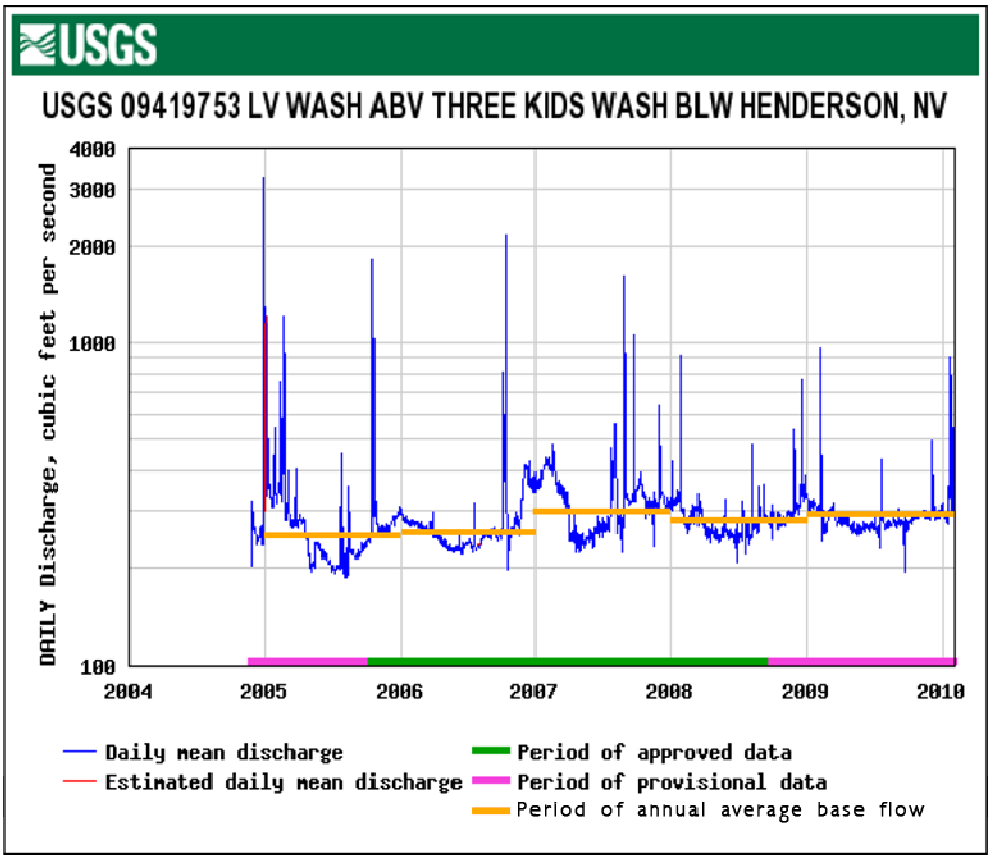



**Table 2. Annual Lake Las Vegas Inflow from Las Vegas Wash**

| Year | Lake Las Vegas Inflow from Las Vegas Wash (ac-ft) |
|---|---|
| 1992 | 3,935 |
| 1993 | 149 |
| 1994 | 70 |
| 1995 | 2,046 |
| 1996 | 305 |
| 1997 | 166 |
| 1998 | 8,262 |
| 1999 | 4,949 |
| 2000 | 2,731 |
| 2001 | 253 |
| 2002 | 0 |
| 2003 | 2,399 |
| 2004 | 12,489 |
| 2005 | 13,794 |

**State Engineer Policy.** The State Engineer does not currently have a formal policy for addressing water rights issues associated with urban stormwater retention. Strictly speaking, the State Engineer would have to issue a water right (surface water permit) for any stormwater retention facility that would capture runoff and put that runoff to beneficial use. All retention facilities that would measurably reduce flow rates and volumes in lower Las Vegas Wash would have to be reviewed to demonstrate that they do not injure existing water rights holders. In practice, the State Engineer would probably develop a policy whereby retention facilities below a certain size would not require a permit, and others would be reviewed on a case-by-case basis. Responsibility for obtaining State Engineer approvals would likely fall to the developer, although homeowners associations and property owners/managers would be responsible for complying with the terms of any permits. This situation may not be acceptable to the State Engineer. In addition, issuing hundreds or thousands of individual permits would create a substantial administrative burden for the State Engineer's Office.

**SNWA Policy.** SNWA would generally not object to onsite stormwater retention, unless it would have adverse impacts on downstream water quality through infiltration and subsequent resurfacing of poorer quality water. SNWA would not object to onsite retention that results in beneficial use of stormwater and a resulting decrease in use of Colorado River water.

**CRC Policy.** CRC would object to stormwater retention that resulted in infiltration or evaporation losses rather than onsite beneficial use, but would support stormwater retention that allows for a reduction in Lake Mead withdrawals in a like amount. If the CRC water right application for "all remaining stormwater in Las Vegas Valley" is approved, then CRC would have the right to all unallocated stormwater runoff in Las Vegas Wash and onsite stormwater retention would be in violation of that right. This would essentially prohibit stormwater retention facilities that dispose of water through infiltration or evaporation, but would allow retention facilities that are designed to use stored water for beneficial uses such as outdoor landscape irrigation.

**Groundwater Use.** As discussed previously, Nevada issues permits for development of groundwater resources on a first-in-time, first-in-right basis. Capture and infiltration of stormwater cannot adversely affect existing groundwater right holders. All potable groundwater in Las Vegas Valley is produced from deep aquifers that are recharged from runoff along the mountain fronts (i.e., at the upper edges of the alluvial fans surrounding the valley). Retention of stormwater in the current or future urban area will not significantly affect the quantity or quality of recharge to this deep aquifer system. Onsite stormwater infiltration could recharge the shallow aquifer system, which is generally poor in quality and contributes to high selenium and TDS concentrations in lower Las Vegas Wash and tributary drainages. Capture and infiltration of urban stormwater could adversely affect surface water quality in lower drainages of Las Vegas Valley that are currently impaired for selenium and TDS.

# 7 Analysis of Stormwater Capture and Subsurface Injection

Infiltration of stormwater is a BMP that is being used with some success in many parts of the country to manage stormwater. Dry wells and underground injection wells are common infiltration practices in portions of the arid Southwest, such as Maricopa County, Arizona. A dry well is defined by Nevada statute in the following manner: a well, other than an improved sinkhole or a subsurface fluid distribution system that is completed above the water table so that the bottom and sides of the well are typically dry except when receiving fluids. These practices not only assist in the management of stormwater, but can provide the additional benefit of groundwater recharge. There are a number of issues that the Las Vegas Valley MS4 co-permittees will have to consider prior to deciding whether to adopt infiltration practices using dry wells or underground injection wells as a BMP. The main issues will be regulatory in nature, as well as economic as the cost benefit of these systems may not justify their adoption as a BMP in the Las Vegas Valley.

The regulation of stormwater, or non-point source pollution, is established by Section 319 the federal Clean Water Act (CWA). This section of the CWA has been delegated to the state of Nevada and the authority to implement the program is found in NRS Chapter 445A. The specific provisions of Nevada's non-point source program, which is administered by NDEP can be found under Nevada Administrative Code (NAC) 445A.305 through 445A.340. In the NRS, the term diffuse source is used instead of non-point source.

Once stormwater is captured and directed to the subsurface, it is no longer regulated as a diffuse source but is regulated as a point source. NRS 445A.395 defines point source in the following way: any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. The term does not include return flows from irrigated agriculture. The presumption is that stormwater is carrying pollutants, which is the whole basis for the regulation of stormwater under the CWA. That being said, the implementation of a stormwater capture and infiltration program would be subject to NRS 445A.465, meaning that it would be necessary to obtain a permit from NDEP to legally implement infiltration as a BMP. NRS 445A.465 states the following:

- NRS 445A.465 Injection of fluids through well or discharge of pollutant without permit prohibited; regulations.

  1. Except as authorized by a permit issued by the Department pursuant to the provisions of NRS 445A.300 to 445A.730, inclusive, and regulations adopted by the Commission, it is unlawful for any person to:
     (a) Discharge from any point source any pollutant into any waters of the State or any treatment works.
     (b) Inject fluids through a well into any waters of the State.
     (c) Discharge from a point source a pollutant or inject fluids through a well that could be carried into the waters of the State by any means.

(d) Allow a pollutant discharged from a point source or fluids injected through a well to remain in a place where the pollutant or fluids could be carried into the waters of the State by any means.

NRS 445A.415 defines "waters of the state" as "all waters situated wholly or partly within or bordering upon Nevada, including: all streams, lakes ponds, impounding reservoirs, marshes, water courses, waterways, wells, springs, irrigation and drainage systems, all bodies or accumulations of water, surface and underground, natural or artificial."

There are five classes of injection wells defined in NAC 445A.845 through 445A.849. Class I and IV wells are prohibited and there have been no Class III applications submitted to NDEP. The five categories of wells are listed below:

- Class I - an injection well for the disposal of industrial, municipal and radioactive waste.
- Class II - an injection well for the production and storage of oil and gas.
- Class III - involves a special process which injects fluids for the extraction of minerals or energy, except geothermal energy.
- Class IV - an injection well which injects hazardous wastes into or above a formation containing, within one-quarter mile of the well bore, an underground source of drinking water or an aquifer which has been exempted pursuant to NAC 445A.850 to 445A.855.
- Class V - any injection well not included in Classes I, II, III and IV. Class V wells are broken down into subclasses which include drainage wells (drywells), which is the classification for stormwater drainage wells.

Oversight of a stormwater capture and infiltration program would fall under NDEP's Underground Injection Control (UIC) Program which is authorized by the Safe Drinking Water Act (SDWA) and delegated to Nevada. The mission of the UIC program, which is housed within the Bureau of Water Pollution Control, is to prevent degradation of underground sources of drinking water due to underground injection practices. Permits issued by NDEP's UIC Program would establish requirements for monitoring and reporting in order to ensure that the water being injected into the subsurface does not degrade the existing subsurface water quality. According to NDEP (Pers. comm., 2010), the level of monitoring would be developed on a case-by-case basis and would generally be more stringent in the more urbanized part of the valley versus areas receiving stormwater from undeveloped areas.

Due to the regulatory requirements, it would not be feasible for a developer to install numerous dry wells throughout a development. The reasons include the fact that each well would need to be separately permitted, which would place a resource and economic burden on the permittee since this would necessitate periodic monitoring and reporting for the life of the facility to NDEP. Additionally, NDEP will not issue these types of permits to homeowner associations meaning that individual homeowners would have to be the permittee. NDEP will issue permits to municipalities, however under this scenario, the private lot would be encumbered with an easement allowing the municipality access for

inspection and maintenance purposes. Additionally, the permit would impose on the municipality the burden of having to track, maintain, monitor, and report on every individual dry well in its jurisdiction. It may be possible for NDEP to develop a general UIC permit that would cover all wells of this type, but it would not eliminate the tracking, maintenance, monitoring and reporting requirements of the responsible municipality.

Another option available to the municipalities is the development of large-scale stormwater collection and injection systems similar to those in use in Maricopa County. Due to the subsurface geology in the Las Vegas Valley, shallow dry wells would not be an option in many locations. Due to the high levels of minerals and caliche in the subsurface, water injected just below the ground surface tends to pick up metals and salts and often does not penetrate the underlying caliche resulting in low-quality shallow perched aquifers. Since this is a scenario that should be avoided in this area, the only remaining option would be to drill the injection wells deep enough that the stormwater would be injected directly into the deeper drinking water aquifers. As a result, treatment prior to injection would be necessary to prevent water quality degradation in the aquifer due to stormwater injection and the monitoring requirements established by NDEP would be stringent in order to safeguard the valley's drinking water source. This is not considered to be a viable stormwater management option.

# 8 Water Quality Regulations

NDEP Bureau of Water Quality Protection is responsible for managing the state's water quality, including issuing waste discharge permits and setting water quality standards. A separate technical memorandum prepared for the MS4 program (MWH, 2010a) provides a review of Las Vegas Valley waterbodies that are currently impaired due to poor water quality. **Table 3** summarizes these impairments based on the current 303(d) List of impaired waters.

**Table 3. 2006 303(d) List of Impaired Waters in the Las Vegas Valley**

| Waterbody | Location | Parameter | Added in 2006 303(d) List |
|---|---|---|---|
| Las Vegas Creek | From its origin to Las Vegas Wash | pH | Yes |
| | | Selenium | Yes |
| Flamingo Wash | Above Las Vegas Wash | Selenium | Yes |
| | | Total Dissolved Solids | Yes |
| Duck Creek | From its origin to Las Vegas Wash | Selenium | Yes |
| | | Total Dissolved Solids | Yes |
| Las Vegas Wash | Above all wastewater treatment facilities | Iron | Yes |
| | | Selenium | Yes |
| | | Total Dissolved Solids | Yes |
| Las Vegas Wash | Telephone Line Rd to the confluence of Las Vegas Wash with Lake Mead; below all wastewater treatment facilities | Iron | No |
| | | Molybdenum | Yes |

Selenium and total dissolved solids (TDS) originate primarily in shallow groundwater aquifers that discharge to surface streams in the southeast part of Las Vegas Valley. Concentrations of these pollutants has increased as development has occurred, due to increased infiltration of surface runoff, landscaping water, vehicle wash water, and other urban water uses. Regional water quality management strategies by agencies such as SNWA, Clean Water Coalition and Las Vegas Valley Watershed Advisory Committee include minimizing infiltration of surface water to the poor quality shallow aquifer system. Disposal of stormwater using onsite retention basins would contradict that approach, and could cause or contribute to further water quality impairments in local waterbodies.

The Colorado River Basin Salinity Control Act gave the U.S Bureau of Reclamation and other federal agencies, including the Environmental Protection Agency, the authority to set standards and implement projects to control salinity in the Colorado River Basin (MWH, 2010b). The objective is to minimize impacts of high salinity water on agricultural, municipal and industrial water users in the United States and Mexico. A TDS standard of 723 mg/l was established for the Colorado River downstream of Hoover Dam. Hundreds of millions of dollars have been spent on salinity control projects in the Lower Colorado River Basin, including the Pittman Bypass Pipeline in Las Vegas Valley. Reclamation determined that the most cost-effective salinity control strategy in the Las Vegas Wash watershed is to prevent additional infiltration of surface water into high-saline shallow aquifers that subsequently discharge to downstream drainages. Disposal of stormwater using onsite retention basins would contradict that approach, and could cause or contribute to future water quality impairments in the Colorado River downstream of Lake Mead.

# 9 Summary

Current State water law and public agency policies generally discourage but do not necessarily prohibit onsite stormwater retention. At present, new developments that desire to implement onsite stormwater retention would be required to contact the State Engineer to determine if a surface water permit would be required. The State Engineer would have to determine whether the proposed project would injure Lake Las Vegas or other downstream water right holders. Stormwater retention accompanied by onsite beneficial use would not conflict with State water law or agency policies during small storms when Las Vegas Wash flows do not exceed 1,160 cfs, and during large storms when Las Vegas Wash flows contribute well over 2,000 ac-ft to Lake Las Vegas.

Stormwater retention combined with beneficial use onsite would have the support of CRC and SNWA. Retention without beneficial use would be opposed by CRC. Retention that induced infiltration that would have adverse impacts on water quality would be opposed by both CRC and SNWA. If CRC is successful in acquiring a surface water permit for all remaining runoff in Las Vegas Valley, it would have enhanced legal standing to oppose non-beneficial use stormwater retention.

Stormwater retention would not affect potable water supplies derived from local deep aquifers, but could increase recharge to shallow aquifers. These aquifers contribute to poor water quality in surface drainages in the lower portion of Las Vegas Valley that are currently impaired for selenium and TDS, and in the Colorado River downstream of Lake Mead which is the focus of the Colorado River Basin Salinity Control Program.

# 10 Conclusion

Stormwater retention without onsite beneficial use (infiltration and evaporation losses only) would contradict local agency policies and potentially exacerbate existing water quality problems, and is not recommended. Shallow dry wells would not be an option in many locations since water injected just below the ground surface tends to pick up metals and salts and often does not penetrate the underlying caliche resulting in low-quality shallow perched aquifers. Deep injection wells drilled so that the stormwater would be injected directly into the deeper drinking water aquifers is not an option. Treatment prior to injection would be necessary to prevent water quality degradation in the aquifer. This is not considered to be a viable stormwater management option.

Proposed stormwater retention with onsite beneficial use would have agency support but would have to be submitted to the State Engineer for approval; approval is not certain due to potential impacts on Lake Las Vegas and other water rights.

Stormwater retention with infiltration could cause or contribute to violations of water quality standards for selenium and TDS in Las Vegas Wash, its tributaries, and the Colorado River. Therefore, stormwater retention cannot be relied on for the MS4 program, and should not be part of mandatory programs developed by the permittees.

# 11 References

MWH. Technical Memorandum II.1 – Stormwater Contributions to Impaired Waters and TMDLs in Las Vegas Valley. 2010a.

MWH. Technical Memorandum IV. Limitations on Use of Infiltration-Based BMPs for New Development and Significant Redevelopment in Las Vegas Valley. 2010b.

Personal communication, Mr. Russ Land, Nevada Division of Environmental Protection, with Ms. Brenda Pohlmann, City of Henderson, 2010.

# Section 8

MWH

TECHNICAL MEMORANDUM

# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

## STORMWATER MANAGEMENT PLAN DOCUMENTATION

## Technical Memorandum IV.8

## Pollutants of Concern for Las Vegas Valley MS4 NDSR Program

May 26, 2010

*Prepared for*

**Stormwater Quality Management Committee**

*Prepared by*

MWH

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## Executive Summary

Pollutants of concern for the Las Vegas Valley New Development and Significant Development program were determined based on review of local stormwater monitoring data, state-determined water quality impairments, pollutants addressed by programs in other communities, and research by Environmental Protection Agency. The following pollutants were identified as pollutants of concern.

- Nutrients (phosphorus, nitrogen)
- Pathogens
- Hydrocarbons (oil and grease)
- Organic Compounds (solvents)
- Pesticides and Herbicides
- Sediment
- Metals (copper, lead, zinc)
- Litter/Floatables
- Selenium
- Total dissolved solids
- Other (pH, surfactants)
- Hydromodification (storm flows, low flows)

Based on the most acute water quality concerns, the following priority pollutants of concern were identified: hydromodification, phosphorus and sediment.

# 1 Introduction

This document describes the adopted approach for rationally determining the potential pollutants of concern that should be considered when developing the New Development and Significant Redevelopment (NDSR) Program for the Las Vegas Valley Municipal Separate Storm Sewer System (MS4). It then presents the recommended list of pollutants of concern, and identifies proposed priority pollutants that deserve special consideration with developing NDSR program elements.

# 2 Potential Approaches for Determining Pollutants of Concern

Four approaches were considered for determining NDSR pollutants of concern.

- **Approach #1 – Research Based**

  Under this approach pollutants of concern are those which, based on nationwide research on stormwater pollution, are commonly found in typical urban runoff. **Table 1** summarizes this research as it relates to common urban stormwater pollutants. **Table 2** relates these categories of pollutants to typical urban land uses.

- **Approach #2 – Local Water Quality Based**

  Under this approach pollutants of concern are those which, based on water quality data from the Las Vegas Valley MS4 stormwater monitoring program and other sources, are regularly found at concentrations exceeding natural background levels. Concentrations and loads of these pollutants are clearly affected by urban development in Las Vegas Valley. Note that these are not necessarily the only pollutants contributed to local watercourses by the urban area; they are the pollutants that the MS4 monitoring program has detected. **Table 3** lists the constituents found in Las Vegas Valley wet and dry weather flows that frequently exceed background levels from undeveloped areas.

- **Approach #3 – Water Quality Standards Based**

  Under this approach pollutants of concern are those which, based on Nevada Division of Environmental Protection's (NDEP) list of impaired waters (303(d) List), frequently have concentrations that exceed adopted water quality standards for the State of Nevada. The 2006 303(d) List and previous 303(d) Lists were used to determine critical constituents. These are listed in **Table 3**. Concentrations and/or loads of each of these constituents may be affected by urbanization, although in some cases those effects are expected to be peripheral or secondary. For example, lower Las Vegas Wash is impaired for iron; urban runoff does not contain high concentrations of iron, but increased erosion due to higher runoff rates and volumes associated with urbanization causes iron to be released from the local geology.

- **Approach #4 – EPA Model Program Based**

  Under this approach pollutants of concern are those that are normally addressed in EPA model programs for NDSR stormwater management. These are the pollutants of concern that are addressed by most major metropolitan areas in the United States. EPA's program goals were developed based on nationwide stormwater quality research, so the pollutants of concern under this approach are the same as those given in **Table 1**.

## Table 1. Pollutants Commonly Found in Nationwide Urban Runoff

| Pollutant | Major Urban Non-Point Sources | Potential Effects |
|---|---|---|
| • Nutrients<br>• Nitrogen (Nitrate, Total Nitrogen))<br>• Phosphorus (Total Phosphorus, Orthophosphate) | • Fertilizers<br>• Animal waste<br>• Detergents<br>• Atmospheric deposition<br>• Leaking sewer pipes | • Lowers oxygen levels<br>• Destroys habitat<br>• Promotes algal blooms<br>• Limits recreation<br>• Interferes with navigation |
| • Pathogens<br>• Bacteria<br>• Viruses | • Animal Waste<br>• Illicit connections between sewer lines and storm sewers<br>• Leaking sewer pipes | • Poses human health risks<br>• Closes beaches and recreation areas<br>• Closes shellfish harvesting areas |
| • Hydrocarbons<br>• Oil<br>• Grease<br>• Petroleum-based products<br>• Polycyclic Aromatic Hydrocarbons (PAHs) | • Parking lots<br>• Roads<br>• Automobile emissions<br>• Improper disposal of used motor oil<br>• Illicit connections to drain systems | • Lowers level of dissolved oxygen<br>• Causes toxic impacts<br>• Damages habitat |
| • Organic Compounds<br>• Pesticides<br>• Herbicides<br>• Polychlorinated biphenyls (PCBs) | • Lawn care<br>• Agricultural lands<br>• Industrial uses<br>• Illicit connections to storm drain systems | • Causes toxic impacts<br>• Leads to human and animal reproductive abnormalities<br>• Increases animal mortality rates |
| • Sediments | • Construction sites<br>• Agricultural lands<br>• Logged forest land<br>• Eroded streambanks | • Increases water turbidity (cloudiness)<br>• Alters water flows<br>• Destroys benthic habitat<br>• Blocks sunlight<br>• Attracts particulate forms of metals and nutrients |
| • Metals<br>• Lead<br>• Copper<br>• Cadmium<br>• Zinc<br>• Mercury<br>• Chromium<br>• Selenium<br>• Nickel | • Illicit storm drain connections<br>• Automobile usage – emissions, brake pad residues<br>• Atmospheric deposition<br>• Industrial activities<br>• Commercial activities | • Increases toxicity of sediment and water column<br>• Adds toxics to food chain<br>• Causes genetic defects, reproductive abnormalities and increased mortality rates<br>• Increases risk of cancer, neurological disorders and birth defects in humans |
| • Litter/Floatables | • Human activities | • Aesthetics<br>• Impairs recreational uses<br>• Threatens aquatic life |
| • Chlorides | • Outdoor storage and use of salts on roads, driveways and sidewalks in cold areas | • Toxic to freshwater organisms |

| Pollutant | Major Urban Non-Point Sources | Potential Effects |
|---|---|---|
| • Elevated Temperature | • Industrial sources<br>• Removal of trees in riparian area<br>• Impervious surfaces and conveyances | • Threat to insects, fish and other temperature sensitive aquatic species |
| • Oxygen Demanding Substances<br>• BOD<br>• COD | • Food product waste<br>• Decaying vegetative matter<br>• Trash | • Lowers levels of dissolved oxygen<br>• Damages aquatic habitat |
| Source: Adapted from EPA, 1995 | | |

## Table 2. Relationship Between Pollutant Categories and Land Use Types

| Development Type | General Pollutant Categories | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Pathogens | Heavy Metals | Nutrients | Pesticides and Herbicides | Organic Compounds | Sediment | Litter and Floatables | Oxygen Demanding Substances | Hydrocarbons |
| Detached residential | A | | A | A | | A | A | A | A |
| Attached Residential | P | | A | A | | A | A | P (1) | P (2) |
| Commercial/Industrial >100,000 sq ft | P (3) | | P (1) | P (5) | P (2) | P (1) | A | P (5) | A |
| Automotive Repair Shops | | A | | | A (4,5) | | A | | A |
| Restaurants | A | | | | | | A | A | A |
| Hillside Development >5,000 sq ft | | | A | A | | A | A | A | A |
| Parking Lots | | A | P (1) | P (2) | | P (1) | A | P (5) | A |
| Streets, Highways, Freeways | | A | P (1) | | A (4) | A | A | P (5) | A |

A = Anticipated
P = Potential

(1) Potential pollutant if landscaping exists onsite
(2) Potential pollutant if the site includes uncovered parking areas
(3) Potential pollutant if land use involves food or animal waste products
(4) Including petroleum hydrocarbons
(5) Including solvents

Source: Adapted from CASQA, 2003

**Table 3. Pollutants Exceeding Natural Background Levels in Las Vegas Valley Watercourses and Pollutants Exceeding Nevada Water Quality Standards**

| Pollutant (From Table 1) | Pollutant Species Found in Las Vegas Valley Stormwater System at Concentrations Greater Than Natural Background Levels | Pollutant Species Exceeding NV Water Quality Standards (1) |
|---|---|---|
| • Nutrients<br>• Nitrogen (Nitrate, Total Nitrogen))<br>• Phosphorus (Total Phosphorus, Orthophosphate) | • Nitrate (WW, DW)<br>• Total Phosphorus (WW, DW)<br>• Orthophosphate (WW, DW) | • Total phosphorus (Lower Las Vegas Wash; delisted for 2006; TMDL applies during dry weather conditions) |
| • Pathogens<br>• Bacteria<br>• Viruses | • Fecal coliform (WW, DW)<br>• Fecal streptococcus (WW, DW)<br>• E. coli (WW, DW) | |
| • Hydrocarbons<br>• Oil<br>• Grease<br>• Petroleum-based products<br>• Polycyclic Aromatic Hydrocarbons (PAHs) | • Oil and Grease (WW, DW) | |
| • Organic Compounds<br>• Pesticides<br>• Herbicides<br>• Polychlorinated biphenyls (PCBs) | • Pesticides (WW, DW)<br>• Herbicides (WW, DW) | |
| • Sediments | • TSS (WW)<br>• Sediment (WW) | • Sediment (Lower Las Vegas Wash; delisted for 2006) |
| • Metals<br>• Lead<br>• Copper<br>• Cadmium<br>• Zinc<br>• Mercury<br>• Chromium<br>• Selenium<br>• Nickel | • Lead (WW)<br>• Copper (WW)<br>• Zinc (WW)<br>• Selenium (DW) | • Selenium (Upper and Lower Las Vegas Wash, Duck Creek, Flamingo Wash, Sloan Channel, Las Vegas Creek, Monson Channel)<br>• Iron (Lower Las Vegas Wash)<br>• Molybdenum (Lower Las Vegas Wash) |
| • Litter/Floatables | • Trash (2) (WW, DW)<br>• Debris (2) (WW, DW) | |
| • Chlorides | • TDS (DW) | • TDS (Flamingo Wash, Monson Channel, Duck Creek, Upper Las Vegas Wash) |
| • Elevated Temperature | • None | |

| Pollutant (From Table 1) | Pollutant Species Found in Las Vegas Valley Stormwater System at Concentrations Greater Than Natural Background Levels | Pollutant Species Exceeding NV Water Quality Standards (1) |
|---|---|---|
| • Oxygen Demanding Substances<br>• BOD<br>• COD | • None | |
| • Other | • pH (DW)<br>• Surfactants (WW) | • pH (Sloan Channel, Las Vegas Creek) |

WW = Primary problem is with wet weather flows
DW = Primary problem is with dry weather flows

(1) From 2006 NDEP 303(d) List; includes previously listed constituents that have since been removed due to water quality improvement, since the washes remain sensitive to these constituents.
(2) Based on general observations, not water quality monitoring

# 3 Recommended Approach for Determining Pollutants of Concern

The NDSR Program should be designed to address the particular stormwater pollutants that are of concern in Las Vegas Valley. The list of pollutants of concern for the NDSR Program was therefore based on the following principles.

1. Pollutants identified by EPA as being commonly found in urban runoff (**Table 1**) that are also known to be present in Las Vegas Valley stormwater based on local monitoring data (**Table 2**) were selected as pollutants of concern.
2. Pollutants on current and recent 303(d) Lists for Las Vegas Valley (**Table 2**) that can be traced to urban sources were selected as pollutants of concern.

Adopting this strategy: (a) satisfies EPA and NDEP requirements for the NDSR Program; (b) assures that the program is tailored to local environmental and water quality conditions; and (3) meets the maximum extent practicable (MEP) standard for stormwater quality management. Applying these principles results in the pollutants of concern listed in **Table 4**.

In addition to water quality parameters, **Table 4** lists "hydromodification" as a pollutant of concern. Hydromodification refers to a change in flow conditions (peak flow or volume; wet weather or dry weather conditions) due to urbanization or other watershed changes. EPA considers hydromodification to be a process that should be considered by MS4 agencies in preparation of post-construction programs. It cites the effect that urban development can have on increasing storm runoff peak flows and volumes, and the consequence of increased erosion and sedimentation in downstream channels. Increased volumes of storm runoff and dry weather flow can increase pollutant loads delivered to downstream receiving waters. In addition, changes in flow rates, physical properties (e.g., temperature) and water chemistry can adversely impact aquatic habitat. As a result, EPA encourages MS4 communities to treat hydromodification as a "pollutant" similar to other more traditional water quality constituents.

The process for determining whether hydromodification should be considered a pollutant of concern for the Post-Construction Program was based on the answers to two key questions.

- **Question 1 –** Is there evidence of hydromodification in Las Vegas Valley?
- **Question 2 –** Does hydromodification have significant adverse consequences in Las Vegas Valley?

## Table 4. Recommended Pollutants of Concern

| Pollutant Category | Specific Pollutants of Concern | Typical Urban Sources in Las Vegas Valley |
|---|---|---|
| • Nutrients | • Nitrate<br>• Total Phosphorus<br>• Orthophosphate | • Residential development<br>• Landscaped portions of commercial and industrial sites<br>• Parks and golf courses<br>• Streets and parking lots |
| • Pathogens | • Bacteria | • Residential development<br>• Restaurants |
| • Hydrocarbons | • Oil and Grease | • All |
| • Organic Compounds | • Pesticides<br>• Herbicides | • Residential areas<br>• Landscaped portions of commercial and industrial sites<br>• Parks and golf courses |
| • Sediment | • TSS<br>• Sediment | • Residential development<br>• Hillside development<br>• Streets and highways |
| • Metals | • Copper<br>• Lead<br>• Zinc<br>• Selenium | • For copper, lead and zinc:<br>• Automotive repair shops<br>• Streets and parking lots<br>• For selenium:<br>• Urban irrigation return flows via shallow aquifer in areas with marine shales |
| • Litter/Floatables | • Trash and Debris | • All |
| • Chlorides | • TDS | • Urban irrigation return flows via shallow aquifer in areas with marine shales |
| • Other | • pH<br>• Surfactants | • For pH:<br>• Urban irrigation return flows via shallow aquifer in areas with alkaline soils<br>• For Surfactants:<br>• Residential development<br>• Commercial/Industrial development involving vehicle washing<br>• Mobile cleaning operations |
| • Hydromodification | • Increased storm flow rates and volumes<br>• Increased dry weather flow rates and volumes | • All |

- **Question 1 –** Is there evidence of hydromodification in Las Vegas Valley?

  ➤ YES

  Gage data for Las Vegas Wash and its major tributaries shows that storm runoff volume and dry weather discharges have increased over the past 25 years (MWH, 2010). These increases are attributed to urbanization in the watershed. Urbanization has increased storm runoff due to:

  a) Increased impervious areas, which increase the volume and rate of runoff
  b) Construction of a storm drain network and concrete lined regional flood control channels, which has reduced infiltration compared to the natural drainage system and increased the rate at which stormwater is delivered to downstream receiving waters

  Regional detention basins are effective in reducing peak discharges from high return period floods (e.g., 10-year and greater) but have less effect on smaller flood peaks and essentially no effect on reducing runoff volumes.

  Urbanization has increased dry weather discharges due to:

  a) Wastewater treatment plant effluent (Las Vegas Wash only)
  b) Landscape irrigation return flows
  c) Miscellaneous urban runoff (e.g., vehicle washing, swimming pool draining)
  d) Dewatering activities
  e) Increased resurfacing shallow groundwater due to infiltration of applied landscape irrigation water

  These factors have generally increased the magnitude and extent (i.e., length of channel with perennial flow) of dry weather discharges in Las Vegas Wash and its tributaries over time.

- **Question 2 –** Does hydromodification have significant adverse consequences in Las Vegas Valley?

  ➤ YES

  Based on research by Southern Nevada Water Authority (SNWA), Clark County Regional Flood Control District, United State Geological Survey, NDEP and others, increases in storm runoff and dry weather discharges have contributed to significant adverse consequences in Las Vegas Valley watercourses, Las Vegas Bay and Lake Mead. Some of these consequences include:

  f) Significant channel erosion in lower Las Vegas Wash, resulting in loss of historical wetland habitat in the Wash, threats to infrastructure (pipelines and roadways), adverse impacts on razorback sucker habitat in Las Vegas Bay, and transport of sediment-related pollutants (e.g., phosphorus, metals, iron) to Lake Mead.

g) Increased selenium concentrations in lower Las Vegas Wash and the downstream portions of tributaries in the southeast part of the Valley, due to increases in resurfacing groundwater volumes.
h) Increased loads of a variety of urban pollutants to Lake Mead (e.g., solids, nutrients, metals, organics, bacteria), potentially affecting water quality at the SNWA drinking water intake and recreation uses.

As a result of these findings, hydromodification is listed as a pollutant of concern for the Las Vegas Valley Post-Construction Program.

# 4 Priority Pollutants of Concern

High priority pollutant were identified that would justify incorporating new best management practices such as low impact development measures into the NDSR program. High priority pollutants would fall into one of three categories:

- Pollutant on current 303(d) list for impaired waters that could be generated in areas of new development
- Pollutant for which a TMDL has been developed that could be generated in areas of new development
- Pollutant with higher concentrations or loads in Las Vegas Valley than in other urban areas, suggesting it is a unique problem in Las Vegas Valley

**Table 5** lists pollutants of concern identified for the NDSR program, and presents information that justifies selection of the following priority pollutants of concern: hydromodification, phosphorus and sediment.

## Table 5. Priority Pollutants of Concern

| Pollutant of Concern | Major Flow Regime Source | Land Use Sources | On 303(d) List or Current TMDL | Other Issues | Significant Sources in New Development | Priority Pollutant of Concern for NDSR Program |
|---|---|---|---|---|---|---|
| Heavy Metals (copper, lead, zinc, mercury) | Wet | • Illicit storm drain connections<br>• Automobile usage – emissions, brake pad residues<br>• Atmospheric deposition<br>• Industrial activities<br>• Commercial activities | Yes – Iron, Molybdenum (naturally occurring) | | Yes – roads, parking lots | |
| Hydrocarbons (oil and grease) | Wet | • Parking lots<br>• Roads<br>• Automobile emissions<br>• Improper disposal of used motor oil<br>• Illicit connections to drain systems | | | Yes – roads, parking lots, used motor oil | |
| Hydromodification | Wet and Dry | • Directly connected impervious area<br>• Urban nuisance flows (watering, car washing, pool draining) | | • Evidence in stream gage data<br>• Key focus of EPA | Yes – roofs, driveways, roads, parking lots, over-watering, car washing | Yes |
| Litter and Floatables | Wet | • Human activities | | Significant accumulation in channels; includes other pollutants | Yes – general human activity | |
| Nutrients (nitrogen and phosphorus) | Wet | • Fertilizers<br>• Animal waste<br>• Detergents<br>• Atmospheric deposition<br>• Leaking sewer pipes | Yes – Total Phosphorus | | Yes – fertilizer, animal waste | Yes - phosphorus |
| Organic Compounds (SVOCs, VOCs) | Wet and Dry | • Lawn care<br>• Agricultural lands<br>• Industrial uses<br>• Household chemicals<br>• Illicit connections to storm drain systems | | Perchlorate problems in lower LVW groundwater | Yes – lawn care, household chemicals, industrial sites | |

| Pollutant of Concern | Major Flow Regime Source | Land Use Sources | On 303(d) List or Current TMDL | Other Issues | Significant Sources in New Development | Priority Pollutant of Concern for NDSR Program |
|---|---|---|---|---|---|---|
| Oxygen Demanding Substances (BOD) | Wet | • Food product waste<br>• Decaying vegetative matter<br>• Trash | | | Yes – restaurants, waste transfer stations, trash | |
| Pathogens (bacteria, viruses) | Wet and Dry | • Animal Waste<br>• Illicit connections between sewer lines and storm sewers<br>• Leaking sewer pipes | | Coliforms are consistently high | Yes – animal waste | |
| Pesticides & Herbicides | Wet | • Landscape care<br>• Parks and golf courses<br>• Agricultural areas | | | Yes – landscape care, parks, golf courses | |
| pH | Wet | • Industrial areas<br>• Storm drain dumping | Yes | | Yes – industrial areas, dumping | |
| Sediment (and turbidity) | Wet | • Construction sites<br>• Agricultural lands<br>• Natural desert land<br>• Eroded streambanks | Yes | Key focus of EPA | Yes – unlined drainages | Yes |
| Selenium | Dry | • Resurfacing shallow groundwater | Yes | Selenium Management Plan being developed | No | |
| Surfactants (detergents) | Wet | • Vehicle washing<br>• Paved areas<br>• Sanitary sewer overflows | | | Yes – vehicle washing, roads, parking lots | |
| TDS | Dry | • Resurfacing shallow groundwater | Yes | Correlated to selenium | No | |

# 5 References

California Stormwater Quality Association (CASQA), 2003. Stormwater Best Management Practice Handbook – New Development and Significant Redevelopment

MWH, 2010. Unique Factors Influencing the Las Vegas Valley MS4 Permit Program. Prepared for Las Vegas Valley Stormwater Quality Management Committee.

USEPA, 1995. Stormwater Discharges Addressed by Phase II of the National Pollutant Discharge Elimination System Storm Water Program; Report to Congress.

# Section 9

MWH

TECHNICAL MEMORANDUM

# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

## STORMWATER MANAGEMENT PLAN DOCUMENTATION

## TECHNICAL MEMORANDUM IV.9

## Description of Existing BMPs and Need for New BMPs for the New Development and Significant Redevelopment Program

September 21, 2010

*Prepared for*

**Stormwater Quality Management Committee**

*Prepared by*

MWH®

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# Executive Summary

The new Municipal Separate Storm Sewer System (MS4) Permit for Las Vegas Valley requires preparation of a program for areas of New Development and Significant Redevelopment. Existing best management practices (BMPs) already being implemented by the Permittees were described and reviewed, and potential BMPs that could be feasible in Las Vegas Valley based on a previous analysis were considered. Thirty-six existing BMPs were identified as already being part of the NDSR program. Existing and potential BMPs were organized into the three categories identified in the MS4 permit: Source Control Measures, Site Design Measures, and Treatment Control Measures.

A gap analysis was performed to determine whether new or expanded programs were required to comply with the MS4 permit. Existing and potential BMPs were linked to specific pollutants of concern and pollutant sources. A gap is defined as a situation in which the existing BMPs would clearly not meet the MEP standard, there are other BMPs feasible for Las Vegas Valley that could be implemented, and the pollutant/land use combination is linked to a proven local water quality problem such that it deserves considering additional BMPs.

BMP effectiveness was assessed based on the "maximum extent practicable" test. BMPs not currently being implemented to the MEP were recommended for expansion or upgrade. BMPs identified in a separate assessment of measures required to address impaired waterbodies and TMDLs were incorporated into the assessment. The new permit contains requirements for particular types of BMPs for the NDSR program.

Based on permit requirements, the gap analysis, and MEP expansions of existing programs, new or expanded BMPs are needed for the NDSR program in the following areas:

1. Regional detention basin retrofit investigation (permit requirement)
2. Additional BMPs for parking lots (result of gap analysis)
3. Storm drain inlet markers for new development (in progress)
4. Upgraded existing BMPs for public education and outreach (MEP requirement)
5. Upgraded existing BMPs for interagency coordination (MEP requirement)
6. Modifications to standard drainage design criteria to facilitate implementation of LID measures (MEP requirement)

Details of these upgraded existing programs will be developed and described in a separate technical memorandum.

# 1 Introduction

The Las Vegas Valley MS4 permittees proposed a comprehensive list of best management practices for their New Development and Significant Redevelopment (Post-Construction) Program in a letter of December 2008. BMPs were proposed with respect to the pollutants of concern they address and the associated land use types to which they could be applied. Subsequent BMP identification and MS4 program development work by the permittees resulted in many additions to the original list of existing BMPs. In addition, a number of other BMPs used by other communities and listed in BMP guidance manuals were considered.

This technical memorandum provides an updated description of each BMP, by category, and an evaluation of the effectiveness of each element in either a quantitative or qualitative manner. Based on this evaluation, the need for new BMPs was assessed.

Existing and potential BMPs are listed below and are organized within the BMP categories listed in the MS4 permit.

1. **Source Control Measures:**

*Existing Measures*

1.1. Street Sweeping Programs
1.2. Local Storm Drain System Maintenance
1.3. Regional Flood Infrastructure Maintenance
1.4. Water Conservation (Drought) Ordinance
1.5. Commercial/Industrial Housekeeping Practices
1.6. Household Hazardous Waste Collection
1.7. Ordinances Prohibiting Non-Stormwater Discharges and Littering
1.8. Desert Dumping Controls
1.9. Grease Interceptor Program
1.10. Dust Control Measures
1.11. Fertilizer, Pesticide and Herbicide Management Program
1.12. Public Education
1.13. Storm Drain Marking Program
1.14. Indoor Workshops
1.15. Spill Control Prevention Plans
1.16. Industrial Pretreatment Programs
1.17. Trash Receptacle Enclosures
1.18. Southern Nevada Health District Inspections
1.19. Turf Conversion Program
1.20. Regional Water Quality Planning
1.21. Pet Waste Stations

*Potential Measures*

1.22. Developer Education – Green Building LID Measures

**2. Site Design Measures:**

*Existing Measures*

2.1. Open Space and Landscaping Objectives
2.2. Rural Land Overlay
2.3. Hillside Development Ordinances
2.4. Preserve Natural Washes
2.5. Sustainability and Green Building Initiatives
2.6. Covered Fuel Areas
2.7. Raised Fuel Areas
2.8. Emergency Shut-off Switch and Shear Valves
2.9. Standard Drainage Design Criteria

*Potential Measures*

2.10. Minimize Directly Connected Impervious Area
2.11. Parking Lot Design
2.12. Street Design
2.13. Pervious Pavement
2.14. Site Design

**3. Treatment Control Measures:**

*Existing Measures*

3.1. Regional Detention Basins
3.2. Regional Channel Lining
3.3. Las Vegas Wash Stabilization Structures
3.4. Sand/Oil Separators
3.5. Sand Filter

*Potential Measures*

3.6. Hydrodynamic Separator
3.7. Infiltration Basin/Trench
3.8. Bioretention
3.9. Extended Detention Basin

Two existing BMPs listed in the December 2008 submittal to NDEP have been dropped from the current list of BMPs applicable to the NDSR program. The Cooperative Programs measure "SCOP Project" was dropped because the SCOP project has been put on hold due to financial and other factors. Similarly, the "Selenium Management Plan" was dependent on the SCOP project and has been shelved based on the fate of the SCOP Project.

Several potential BMPs are not listed above because previous evaluations by the Development Guidelines Working Group determined that they are not practical or desirable for Las Vegas Valley (see **Attachment B**). These are:

- Catch Basin Inserts
- Cisterns
- Green Roofs
- Porous Asphalt or Concrete
- Unpaved Parking Areas
- Dry Wells

# 2 Description of Existing and Potential BMPs for NDSR Program

Each existing and potential measure that could be proposed for the NDSR program is described in this section.

## 2.1 Category 1: Source Control Measures (Existing)

### Measure: 1.1 Street Sweeping Program

The current MS4 SWMP has an objective of sweeping curbed-and-paved public streets in all urban areas once every 30 days. This objective was met or exceeded by each entity in the 2008-2009 permit year. Clark County sweeps most urban public streets on a 7- to 10-day schedule. CLV and CNLV sweep most urban public streets on a 14-day schedule. In 2008-09 COH swept paved public streets on average once every 23 days. As new developments are completed, the new paved public streets will be added to the areas to be swept by municipalities under their current street sweeping programs. The current street sweeping objective will be applied to all areas of new development and redevelopment, so the same practices will be implemented Valley-wide.

Street sweeping in arid communities such as LVV can be particularly effective at preventing pollutants deposited on city streets from entering the stormwater system. Because of the long period between infrequent storms (often as much as several months in Las Vegas Valley), streets are often swept multiple times between storms. Permittees report the volume of material removed annually by street sweeping activities. Data for the past three years is presented in **Table 1**. This BMP has prevented this volume of material from being conveyed to downstream receiving waters such as Las Vegas Wash, Las Vegas Bay and Lake Mead.

**Table 1. Street Sweeping Accomplishments 2006-2009**

| | Clark County | Las Vegas | North Las Vegas | Henderson |
|---|---|---|---|---|
| **Streets Swept (miles)** | | | | |
| 2006-07 | 64,444 | 220,500 | 87,168 | 37,070 |
| 2007-08 | 82,030 | 220,244 | 100,255 | 39,673 |
| 2008-09 | 81,934 | 199,000 | 86,145 | 44,127 |
| **Material Removed (cu yd)** | | | | |
| 2006-07 | 25,594 | 48,500 (1) | 19,309 | 2,814 (1) |
| 2007-08 | 30,544 | 46,356 (1) | 23,233 | 2,682 (1) |
| 2008-09 | 22,248 | 23,000 | 20,581 | 3,424 (1) |
| Material volume is total volume removed by street sweeping and drain inlet maintenance. | | | | |

Sweeping of parking lots is less frequent. Parking lots for public facilities are swept by the entities on a regular basis according to their maintenance standards, but not as frequently as public streets. There are no standards or requirements for private parking lot owners to sweep their facilities. However, business owners recognize the value of keeping their premises clean and attractive for customers, so commercial and industrial parking lots are cleaned as needed for aesthetic purposes.

### Measure: 1.2 Local Storm Drain System Maintenance

The MS4 SWMP has an objective of inspecting 20 percent of drain inlets once per year, and cleaning them out as needed. This objective was met or exceeded by each entity except Henderson in the 2008-2009 permit year; Henderson inspected 18 percent of its drain inlets. Entities perform visual inspections of all open channels and detention basins two times per year (Spring and Fall) as part of their "Wash Walk" activity for the MS4 Illegal/Illicit Connection Detection and Elimination Program. In addition, entities regularly inspect and remove accumulated material from storm drains, open channels, and detention basins after significant runoff events. Large volumes of sediment, vegetative debris and trash are removed annually. As new developments are completed, the new public drainage infrastructure (storm drains, catch basins, inlets, detention basins) will be added to the inventory of drainage facilities inspected and maintained by municipalities under their current storm drain system maintenance program. The current objective will be applied to new facilities in all areas of new development and redevelopment, so the same practices will be implemented Valley-wide.

Storm drain system maintenance in LVV has been very effective at removing sediment, debris and trash. Permittees report the volume of material removed annually by storm drain system maintenance activities. Data for the past three years is presented in **Table 2**. This BMP has prevented this material from being conveyed to downstream receiving waters such as Las Vegas Wash, Las Vegas Bay and Lake Mead.

**Table 2. Storm Drain System Maintenance Accomplishments 2006-2009**

| | Clark County | Las Vegas | North Las Vegas | Henderson |
|---|---|---|---|---|
| **Number of Inlets/Detention Basins Cleaned** | | | | |
| 2006-07 | 14,617/14 | 57,000/18 | 228/9 | 814/8 |
| 2007-08 | 9,409/16 | NA/16 | 194/8 | 330/NA |
| 2008-09 | 6,600/17 | 54,000/22 | 239/5 | 659/5 |
| **Material Removed from Inlets/Detention Basin (cu yd)** | | | | |
| 2006-07 | NA/152 | 48,500 (1) | 1,970/1,471 | 2,814 (1) |
| 2007-08 | NA/914 | 1,500/46,356 (1) | 149/472 | 2,682 (1)/84 |
| 2008-09 | NA/1,593 | 5,000 cy/305 tons | 7,762/661 | 3,424 (1)/1,528 |
| Material volume is total volume removed by street sweeping and drain inlet maintenance. | | | | |

### Measure: 1.3 Regional Flood Infrastructure Maintenance

Clark County Regional Flood Control District (CCRFCD) is responsible for planning, designing, constructing and maintaining the regional flood control infrastructure in Las Vegas Valley. Maintenance activities include funding normal inspection and rehabilitation of regional channels, storm drains and detention basins to assure they are operating as

designed; and funding removal of accumulated sediment and debris from regional facilities. Maintenance funds are derived from the District's ¼-cent sales tax revenue, and are distributed to the individual entities based on annual requests. In FY2008-09, the District's maintenance budget was $10.6 million. Sediment, debris and associated pollutants removed from regional facilities by the entities under CCRFCD's maintenance program are included in the data reported in **Table 2**.

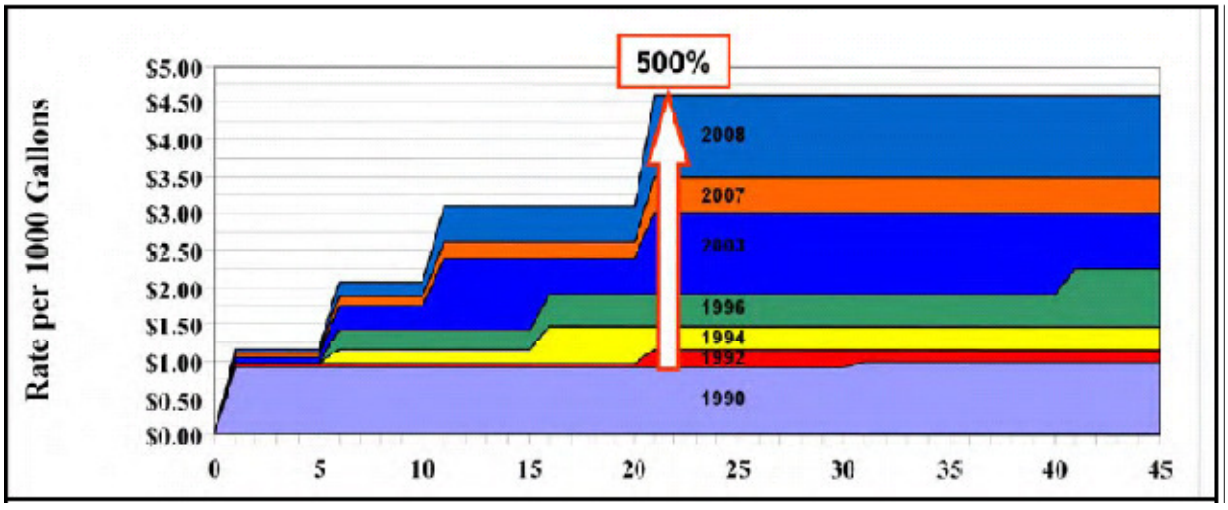
### Measure: 1.4 Water Conservation (Drought) Ordinance

SNWA has one of the most dynamic and comprehensive water conservation programs in the nation. In response to SNWA leadership in drought planning for Las Vegas Valley, and in conjunction with its Five-Year Conservation Plan (2004-2009), all local governments have adopted conservation or drought ordinances that promote reduced water use, particularly during times of drought. These ordinances are Clark County Code, Chapter 24.34, Water Use Restrictions; City of Henderson Municipal Code, Chapter 14.14, Conservation; City of Las Vegas Municipal Code, Chapter 14.11, Drought Plan; and City of North Las Vegas, Chapter 13.08, Water Conservation and Drought. Examples of activities affected by these ordinances include: penalties for outdoor water waste (e.g., over-watering of landscaping, vehicle washing); adoption of water budgets and conservation-encouraging water rates; repair of water leaks; and turf restrictions and buy-back programs. Turf limitations imposed by each entity are summarized in **Table 3**. Inclining block water rates that provide conservation incentives are shown in **Figure 1**, which documents a 500 percent increase in rates for high-volume users between 1990 and 2008. These practices have primarily been adopted in response to water supply shortages and are meant to permanently reduce water demand for outdoor and indoor uses. However, they have the added benefit of reducing non-storm flows and pollutant loads generated from residential and commercial/industrial lots. In fact, the EPA publication *Water-Efficient Landscaping: Preventing Pollution & Using Resources Wisely* EPA832-F-02-002, highlights the xeriscaping efforts in the Las Vegas Valley; see http://www.epa.gov/npdes/pubs/waterefficiency.pdf.

## Table 3. Turf Limitations in Las Vegas Valley Communities

| Land Use Type | Clark County (1) | Las Vegas (1) | North Las Vegas | Henderson |
|---|---|---|---|---|
| Single Family Residential | 50 percent of a front yard can be grass. This does not include a driveway or parking area. | 50 percent of a front yard, including a driveway or parking area, can be grass. | Prohibited in residential front yards and restricted to 50 percent of side and back yards. A maximum of 5,000 square feet of turf is allowed. | No new turf is allowed in front yards. Turf in side and rear yards may not exceed 50 percent, or 100 square feet, whichever is greater. Turf area dimension may not be less than 10 feet. |
| Multi-Family Residential (apartments, condos) | 30 percent of an area set aside for landscaping can be grass. This does not include parking lots or driveways | 30 percent of an area set aside for landscaping can be grass. This does not include parking lots or driveways. | Turf is prohibited in common areas of residential neighborhoods. This does not apply to parks, including required open space in multifamily developments. | New turf is prohibited in common areas, except for public and privately-owned parks as long as turf area is not less than 10 feet. |
| Non-Residential | 30 percent of an area set aside for landscaping can be grass. This does not include parking lots or driveways. | 25 percent of an area set aside for landscaping can be grass. This does not include parking lots or driveways. | Prohibited unless specifically permitted by a land use application that is approved by the city. | New turf installation is prohibited, unless specifically permitted by approval of land use application. |
| Golf Courses | Limited to a maximum of 90 acres for 18 holes and 10 acres for driving ranges. | Limited to 5 acres average per hole, with a maximum 10 additional acres for driving ranges. | Not specified | Not specified |
| Stricter limitations are imposed during Drought Watch and Drought Alert periods. | | | | |

## Figure 1. Las Vegas Valley Water District Water Rates




Source: SNWA Conservation Plan 2009-2013

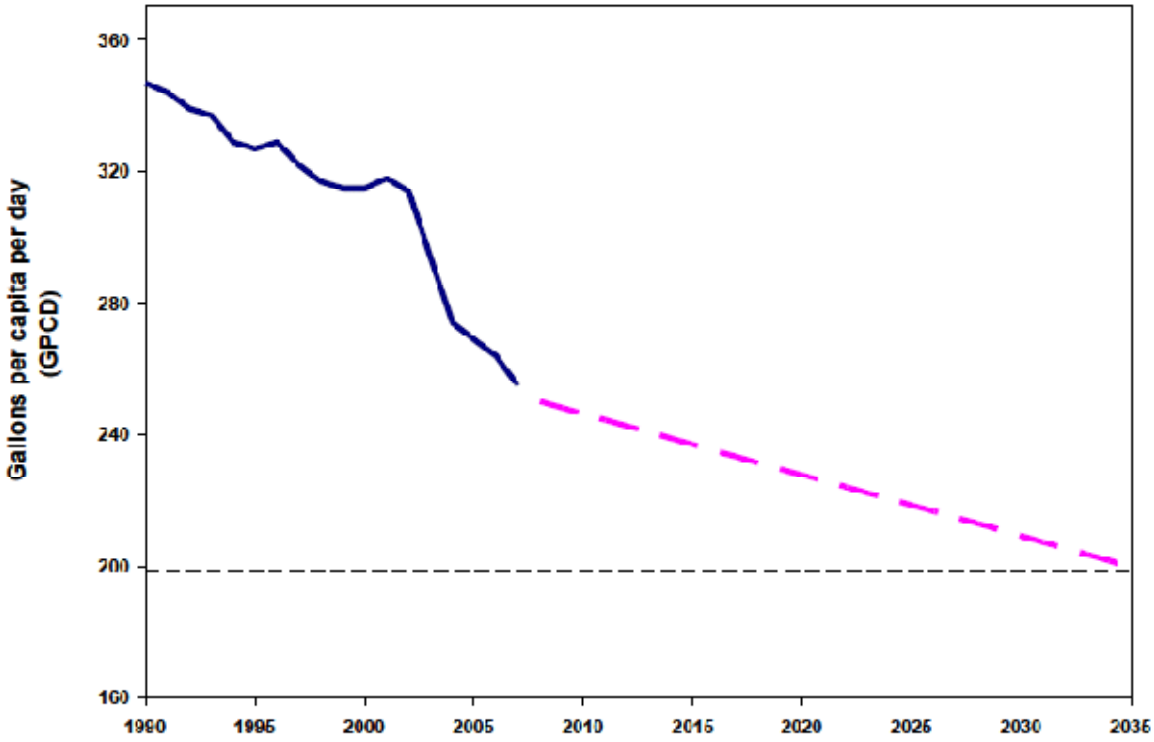
SNWA has documented reductions in water use over the past two decades. Per capita water use data is summarized in **Figure 2**. This shows a dramatic reduction in per capita water use since 1990, reflecting the effectiveness of water conservation measures in the LVV community. The majority of these water savings are due to reduction in outdoor water use from turf restrictions, watering restrictions, and public education.

Anecdotal evidence suggests that dry weather nuisance flows in street gutters and minor drainages in Las Vegas Valley have reduced considerably in areas where landscaping patterns have changed to include less turf and more xeriscape. In addition, reducing outdoor water use has resulted in less return flow from new and existing development to the major tributaries in the MS4 system. This can be seen by reviewing dry weather streamflow data at selected Las Vegas Valley stream gages near the confluences of major tributaries with lower Las Vegas Wash. The report *Unique Factors Influencing the Las Vegas Valley Municipal Separate Storm Sewer System Permit Program*, prepared by the LVV MS4 permittees, documents this trend. A sample plot of the 30-day moving average of dry weather flow (i.e., gaged flows with storm water contributions removed) for Flamingo Wash is shown in **Figure 3.** Data demonstrates that despite the significant population increase in Las Vegas Valley over the past 10-20 years, dry weather flows have not increased proportionally. This validates the effectiveness of turf reduction, outdoor watering restrictions and other conservation measures in reducing urban nuisance flows in the MS4.

The existing water conservation and drought ordinances apply to new as well as existing development, and can be more effective in new developments where landscaping, irrigation systems, and other on-lot features can be designed to minimize outdoor water use. The ordinances are considered to be permanent (i.e., not specifically tied to the recent drought or any future droughts); SNWA is relying on the permanent water use reduction generated by the ordinances in its future water supply planning for the region.

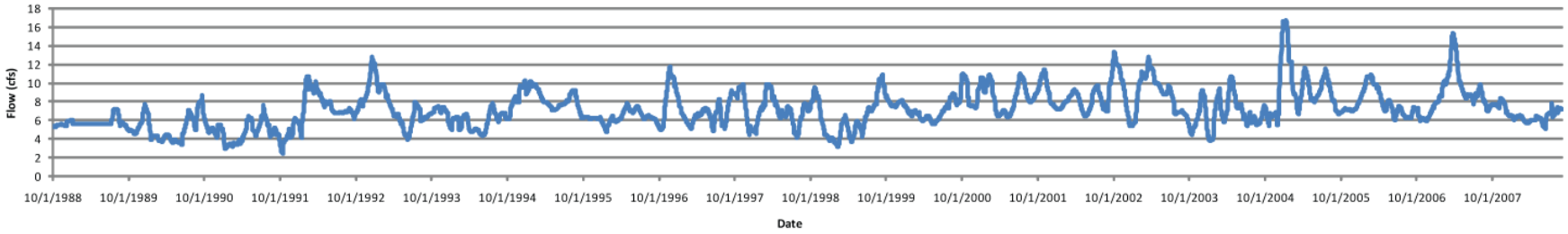
Reducing the volume of dry weather runoff can potentially be one of the most effective programs for reducing pollutant loads to Las Vegas Wash and Lake Mead because roughly 50 percent of the annual water volume conveyed by the MS4 facilities upstream of the regional wastewater treatment plants is from dry weather sources. Reducing dry weather flow also reduces the load of pollutants contributed to downstream receiving waters. SNWA has estimated that its turf buy-back program has permanently eliminated 130 million sq ft of turf from LVV landscaping. Drought ordinances have avoided installation of about 180,000 sq ft of turf over the past 5 years. Based on typical concentrations of nutrients found in Las Vegas Valley runoff, the SNWA turf buy-back program and turf limitations in development ordinances are responsible for reducing contributions of about 37,000 lb/year of nitrogen and 4,000 lb/yr of phosphorus to the MS4. Pesticide and herbicide loads have also been reduced, but data is not available to make numerical estimates for those pollutants.

**Figure 2. Per Capita Water Use Reduction in Las Vegas Valley – Historical and Projected**




Source: SNWA Conservation Plan 2009-2013

## Figure 3. Flamingo Wash Dry Weather Flow 30-Day Moving Average



## Measure: 1.5 Commercial/Industrial Housekeeping Practices

The MS4 Permittees have industrial site inspection programs that assure that industrial sites corresponding to certain criteria have adequate BMPs in place, including application of good housekeeping practices, to address potential stormwater pollution sources. Criteria for inspections are those listed in the MS4 Permit annual report for Las Vegas Valley. These inspection programs have been developed to enforce existing ordinances prohibiting discharge of non-storm waters to the storm drainage system, as well as to enforce existing sanitary sewer system pretreatment ordinances. Industrial site inspections will be extended to new industrial sites that meet the criteria for qualifying types of industrial activity. [Note that the Industrial Site Management and Control Program is developed to specifically address industrial site issues.]

Existing local industrial site inspection programs are briefly described as follows.

- The previous MS4 permit specifically identifies four classes of industrial facilities for which a program to monitor and control pollutants must be developed. These classes of industrial facilities are:
  - Industrial facilities that are subject to Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). Las Vegas Valley contained 64 such facilities in 2009.
  - Municipal landfills. No municipal landfills are covered under the MS4 industrial program requirements since there are no active municipal landfills in the Las Vegas Wash drainage area.
  - Hazardous waste treatment, disposal and recovery facilities. Seven such facilities are in the MS4 entities in the Las Vegas Valley.
  - Industrial facilities that the municipal permit applicant determines are contributing a substantial pollutant loading to the municipal storm sewer system. The MS4 Co-Permittees have not identified any facilities other than those already identified in the above categories that are contributing a substantial pollutant loading to the municipal storm sewer system. However, many industrial facilities in addition to those listed above are being inspected.
- Each city is using its industrial pretreatment program staff to conduct stormwater inspections during their regular site visits. Clark County has an inter-local agreement with CCWRD to allow designated staff to perform industrial stormwater inspections in unincorporated Clark County. The Cities of Las Vegas, North Las Vegas, and COH are inspecting all applicable industrial sites visited by their pretreatment inspectors.

In addition to the local programs, NDEP has an industrial site permit program that requires industries in selected categories of industrial activity to adopt a Storm Water Pollution Prevention Plan. Together these two parallel programs encourage industrial sites with the

highest potential to pollute to apply BMPs and minimize their impact on stormwater quality. These two programs will be automatically extended to new or redeveloped industrial sites that meet the MS4 Permit criteria.

### Measure: 1.6 Household Hazardous Waste Collection

All entities support collection of household hazardous wastes by Republic Services. Household hazardous wastes may be dropped off at two specific transfer stations in Henderson and North Las Vegas between Wednesday and Saturday. Providing household hazardous waste collection opportunities reduces the risk of toxic chemicals being illegally dumped into the MS4 system or running residential lots. This service is automatically extended to all areas of new development. Past outreach efforts of the CCRFCD and the MS4 permittees have addressed the importance of proper household hazardous waste disposal; these efforts will be continued.

### Measure: 1.7 Ordinance Prohibiting Non-Stormwater Discharges and Littering

All entities have ordinances prohibiting discharges of non-stormwater (except as expressly permitted) to the MS4. These ordinances have recently been reviewed and enhanced ordinances were adopted in 2009 to better address stormwater pollution. Ordinances are based on EPA's model stormwater ordinance. The LVV entities coordinated ordinance development with each other to make them as uniform as possible across all jurisdictions. Ordinances give the entities the authority to take enforcement action against illegal and illicit discharges, illegal dumping, littering, and other practices that may adversely affect the quality of water in the MS4 system. They also include the authority to enforce for BMPs with respect to the "potential to pollute," in addition to those in place for actual pollution violations. Violations may be reported by code enforcement officers, public agency staffs, or by general citizens through hotlines and websites. Technical Memorandum No. III.2 *Review of Present Legal Authority to Implement Las Vegas Valley MS4 Program* provides further description and documentation of current stormwater ordinances.

### Measure: 1.8 Desert Dumping Controls

Desert dumping has long been a problem in Las Vegas Valley communities. As a result, entities have existing ordinances prohibiting dumping of materials in the desert surrounding the developed areas of Las Vegas Valley. In addition to being unsightly and posing threats to the local ecology and human health, illegally dumped materials could be sources of water pollution if they come into contact with stormwater (e.g., old vehicles, household waste, commercial and industrial waste, construction waste, landscaping refuse). Depending on the type and location of the observation, reports of illegal dumping are referred to either the Bureau of Land Management, the Southern Nevada Health District, or the Clark County Public Response Office for investigation and enforcement. Technical Memorandum No. III.2 *Review of Present Legal Authority to Implement Las Vegas Valley MS4 Program* provides further description and documentation of current desert dumping ordinances.

### Measure: 1.9 Grease Interceptor Program

Entities have existing ordinances requiring proper removal and disposal of grease from grease traps in restaurants and industrial facilities. Clogged grease traps could allow wastewater to be directed to the MS4. Las Vegas Valley experiences about 100,000 visitors per day, and combined with 1.8 million residents, there are hundreds of thousands of potential diners each day. Public wastewater treatment service providers inspect over 2,000 restaurants and industrial facilities each year. Best practices are employed consistently among each of the entities in Las Vegas Valley.

### Measure: 1.10 Dust Control Measures

To meet regulations associated with the Clean Air Act, Las Vegas Valley entities enforce dust control measures at construction sites and stationary industrial sites that may generate significant dust (e.g., cement plants, rock crushing facilities). Deposition of airborne dust on watershed surfaces can be a source of pollutants in stormwater runoff. EPA has identified dust transport control as an effective mitigation measure for stormwater pollution, particularly in arid areas. This unique source of stormwater pollution in Las Vegas Valley has been addressed through a comprehensive air quality management program.

In Las Vegas Valley, Clark County Department of Air Quality and Environmental Management (DAQEM) has primary responsibility for assuring that air quality regulations are met. In Las Vegas Valley, the primary air quality concern is over PM10s, or small particulate matter (e.g, dust) with a diameter of 10 microns or less. In response to EPA requirements, Clark County adopted the current *PM10 State Implementation Plan for Clark County* in 2001. Based on the management plan, dust control plans for construction sites and areas of existing development are adopted and enforced in accordance with EPA regulations and guidelines. Control measures include stabilizing disturbed surfaces, using dust palliatives or water to control dust, and street sweeping to reduce sediment track-out.

Implementation of the PM10 management plan has brought Clark County into compliance with air quality regulations. Since 2001 it is estimated by DAQEM that the local dust control programs have reduced construction-related PM10 dust by about 100,000 tons and industry-related PM10 dust by over 100,000 tons. Although all of this dust would not have found its way to MS4 waterways, this significant reduction in airborne particulates is expected to have resulted in a reduction in fine particulates contributing to TSS concentrations during wet weather events.

At EPA Region 9's 10th Annual Environmental Awards Ceremony in San Francisco, Clark County was recognized in the Particulate Matter Program, which included adoption of fugitive dust rules and the implementation of a compliance program that directly resulted in a significant reduction in PM10 emissions in Clark County. EPA complimented the outreach campaign and the research conducted in PM10 paved road and vacant land emissions, stating that the Clark County dust control program served as a national model.

The primary effects of dust control regulations on new development and significant redevelopment will be to: (1) minimize dust generated during construction; (2) require

virtually all roadways and parking areas to be paved; and (3) require stabilization of all disturbed areas with appropriate landscaping, hard-scaping, or other stabilization treatments.

### Measure: 1.11 Fertilizer, Pesticide and Herbicide Management Program

Permittees have various existing programs to minimize the impacts of fertilizer, pesticide and herbicide use on water quality. These products are applied to areas of turf and landscaping. Water quality data for Las Vegas Valley indicates that the vast majority of loadings for pollutants associated with these products occur during storm runoff periods, not during dry weather periods. For example, common fertilizers contain significant amounts of phosphorus, and the typical phosphorus concentration in wet weather flows is about 1.0 mg/l as compared to <0.05 mg/l in dry weather flows.

Elements of local fertilizer, pesticide and herbicide management programs are described below.

- Minimize turf – The water conservation ordinances adopted by the entities include restrictions on new turfed areas, particularly in front yards, and incentives for removal of existing turf (see Measure 1.4 and Measure 1.19). Turf areas are the largest recipients of fertilizers. Significant reductions in existing turf areas and avoidance of new turf installations have substantially reduced the areas where fertilizers would potentially be used.
- Xeriscaping requirements – Associated with turf restrictions is the requirement to use xeriscaping for new landscaped areas whenever possible. Use of native and drought tolerant plants, combined with extensive use of rock and non-vegetative landscaping treatments, reduces the need for use of pesticides and herbicides to management plant growth.
- Public employee certification – Permittees require personnel who commonly use fertilizers, pesticides and herbicides to be certified through the state certification program. This primarily includes Parks and Recreation Department personnel responsible for landscaping maintenance.
- Use of alternate products – All Permittees are experimenting with or transitioning to use of "green" products to replace traditional fertilizers, pesticides and herbicides. For example, CLV is encouraging use of more organic pesticides and herbicides. COH is using pelletized corn meal as a herbicide to control pre-emergent vegetation.
- Public education – The Permittees, through CCRFCD, prepared and aired a public service announcement on proper use and disposal of fertilizers, pesticides, herbicides and other household chemicals.

At this time there is no requirement for private landscaping companies to use personnel certified in handling and application of fertilizers, pesticides and herbicides.

## Measure: 1.12 Public Education – General Stormwater Awareness

The MS4 Permittees have adopted a public education and outreach program to improve general awareness of stormwater quality issues. The main objectives of the program are to increase the general public's awareness of the relationship between stormwater runoff and water quality in Las Vegas Wash and Lake Mead, and to encourage behaviors that reduce the public's adverse impact on runoff quality. The program uses several different media, including television, the *lvstormwater.com* website, billboards, printed materials, presentations to elementary school classes, grade school poster contests, and attendance at environmental fairs and other events.

CCRFCD staff members coordinate public education and outreach programs for the entities. Subjects of past media campaigns have included the connection between stormwater and Lake Mead water quality, dumping in storm drains, proper disposal of household hazardous wastes, importance of proper vehicle maintenance, proper use of pesticides and herbicides, and plugged storm drains. CCRFCD has won awards from media organizations for its creative television public service announcements on stormwater and flood control. CCRFCD conducts an annual survey of residents to determine the effectiveness of its public education programs. Surveys continue to show improved understanding of stormwater quality issues among Las Vegas Valley residents.

A 24-hour hotline is available for residents to report conditions that pose threats to drainage and stormwater quality. Past media campaigns have stressed use of the hotline to report problems to local officials. A recent emphasis on identifying drain inlets plugged with sediment and debris resulted in numerous hotline calls.

As new development occurs, new residents will be automatically included in the audience for general stormwater awareness outreach activities. It is important that new residents are aware of the connection between stormwater quality and their drinking water source in Lake Mead, and understand how their behavior can affect stormwater quality in an arid environment.

## Measure: 1.13 Storm Drain Marking Program

Storm drain inlet markers are plaques or signs placed on storm drain inlets or fences around open channels to discourage the public from dumping pollutants in the MS4. An inlet marker program was started by Las Vegas Valley MS4 permittees and the Conservation District of Southern Nevada (CDSN) in 1999 using Section 319 grant funds. 10,000 metal signs were purchased with the message "Don't Pollute – Drains to Lake Mead." Approximately 5,100 plaques were installed by the entities and volunteers in areas of existing development. The program was discontinued after the grant money was spent and concerns were raised over the safety for volunteers working in or near channels and busy streets. In 2007 the CDSN, in partnership with CCRFCD, CLV and COH, won a second Section 319 grant for inlet marker installation. 6,600 plastic plaques, about 25 percent with a bi-lingual message, were purchased for installing at drain inlets. By June 2010 this program will install all of these inlet markers in areas of existing development, plus the remaining metal signs from the first inlet marker program.

Past inlet marker programs have targeted areas of existing development. The permittees are currently working with the Clark County Regional Transportation Commission (RTC) to develop design standards at the regional level specifying standards for marking drain inlets in all new developments in each of the entities. Concrete stamps that would imprint the "Don't Pollute – Drains to Lake Mead" message in curbs or inlet boxes are currently being investigated as a means for marking new inlets. For redevelopment areas, standards are being developed to require application of plastic plaques identical to those used in the current inlet marker program. These new standards will require developers to install inlet markers in all areas of new development and significant redevelopment in Las Vegas Valley.

### Measure: 1.14 Indoor Workshop

Municipal codes for each of the entities require that all activities and operations at industrial sites and commercial sites where hazardous materials and chemicals are used be conducted in enclosed structures. This includes gas stations (with the exception of fueling areas), vehicle repair shops, and manufacturing facilities. Code requirements will apply to these types of facilities in all new developments.

### Measure: 1.15 Spill Control Prevention Plan

Certain types of commercial and industrial sites are required by EPA to have spill control prevention plans. The EPA Spill Prevention, Control, and Countermeasure (SPCC) rule establishes requirements for oil spill prevention, preparedness, and response to prevent oil discharges to navigable waters and adjoining shorelines. The rule requires specific facilities to prepare, amend, and implement SPCC Plans. A facility is subject to the SPCC Rule if it meets three criteria: 1) it must be non-transportation-related; 2) it must have an aggregate aboveground storage capacity greater than 1,320 gallons or a completely buried storage capacity greater than 42,000 gallons; and 3) there must be a reasonable expectation of a discharge into or upon navigable waters of the United States or adjoining shorelines. All qualifying sites businesses must prepare a Facility Response Plan, which is a plan for responding to the maximum extent practicable to a worst-case discharge or threat of discharge of oil. This rule will apply to all new qualifying commercial/industrial sites.

In addition, the Permittees have developed a spill response strategy that applies to all hazardous chemicals. It was prepared in response to a requirement in the previous MS4 permit. Key components of the spill response strategy are described below.

- The State and County each have hazardous material emergency response plans that are compliant with EPA requirements and that outline field procedures, roles and responsibilities, training requirements, and notifications. Each local entity also has standard operating procedures for dealing with illegal dumping or accidental spills.
- The Clark County Local Emergency Planning Committee (LEPC) meets regularly to coordinate the activities of all emergency response agencies in Las Vegas Valley. The LEPC encourages use of common policies and procedures and passes on information related to regulations and spill response techniques.

Las Vegas Valley Water District staff participate the LEPC and act as a liaison to the SQMC, assuring that stormwater system concerns are adequately reflected in LEPC planning and coordination.

- H2O Environmental is a private contractor that is used by all entities in Las Vegas Valley to respond to and clean up hazardous material spills over 25 gallons. Standing contracts with H2O Environmental allow the firm to respond to spills quickly (within 45 minutes anywhere in Las Vegas Valley).
- The hazardous material emergency response plans contain extensive notification lists, of individuals and agencies that should be contacted in the event of a hazardous material spill. The CCRFCD is on the standard notification lists to assure that the MS4 representatives are aware of any hazardous material spills that could affect the stormwater systems in their jurisdictions.

Spill response measures will apply to all new developments.

### Measure: 1.16 Industrial Pretreatment Program

Each of the Permittees has an industrial pretreatment program associated with its wastewater system. The pretreatment program includes regulations on the types of materials that can be discharged to the wastewater collection system, as well as regular facility inspections to assure compliance with the program. Pretreatment program inspectors are trained to look for potential stormwater quality threats such as exposed chemical storage areas, spills, illicit connections to the MS4, and lack of hazardous material containment. Potential issues are reported to entity staff members for follow-up as part of the MS4 Industrial Program. All new qualifying industrial sites would have to comply with the industrial pretreatment project and would be subject to regular pretreatment inspections.

### Measure: 1.17 Trash Receptacle Enclosure

Municipal codes for each of the entities require that trash receptacles for commercial sites, industrial sites, and multi-family developments be enclosed but not necessarily covered. In the case of Las Vegas and North Las Vegas, the codes state that trash receptacles must be enclosed and covered with a roof or trellis; in the case of Clark County and Henderson, the codes state only that trash receptacles must be enclosed. For all entities, trash bins must have a lid. These code requirements reduce the potential for stormwater to contact sources of BOD, organics, bacteria, etc., and minimize the potential for litter to be blown from the trash receptacle into the MS4. Code requirements will apply to all new development.

### Measure: 1.18 Southern Nevada Health District Inspections

Southern Nevada Health District (SNHD) performs inspections of commercial and industrial sites that are "conditionally exempt generators of hazardous waste." These are smaller facilities that do not fall under the State's hazardous materials regulations. Inspections assure that no illicit discharges have occurred or could potentially occur, and check for secondary containment for hazardous materials. SNHD will expand its inspection

program to any new industrial facilities that meet the definition of conditionally exempt generators of hazardous waste.

### Measure: 1.19 Turf Conversion Program

SNWA has a turf conversion program, sometimes called "cash for grass," that offers a rebate for removal of existing turf areas. The Water Smart Landscapes rebate helps property owners convert water-thirsty grass to desert landscaping. SNWA will rebate customers $1.50 per square foot of grass removed and replaced with desert landscaping up to the first 5,000 square feet converted per property, per year. Beyond the first 5,000 square feet, SNWA will provide a rebate of $1.00 per square foot. Every square foot of grass replaced with water-smart trees, shrubs and flowers saves an average of 55 gallons of water per year. It also reduces the potential for overwatering to contribute to dry weather hydromodification, and reduces the potential for lawn care chemicals to be washed into the MS4. Although the turf conversion program would have less effect in areas of new development where the turf restrictions described in Measure 1.4 apply, it is open to all development in which home and business owners want to convert existing turf to xeriscape. Recent water savings and avoided pollutant loads for the turf conversion program are included in the savings reported for Measure 1.4 Water Conservation Ordinance.

### Measure: 1.20 Regional Water Quality Planning

Regional water quality planning activities by a variety of agencies provide benefits to stormwater quality in existing and new development.

- SNWA is involved in several programs associated with water supply development and water quality protection that have secondary benefits for stormwater quality improvement. These include leadership in regional water conservation; water use restrictions during droughts; turf buy-back program; and general water use education. They also include the Las Vegas Wash erosion control program, and comprehensive water quality monitoring programs. CCRFCD, on behalf of the MS4 permittees, and SNWA have applied for and received two Section 319 nonpoint source grants to fund general stormwater and water resources public education and outreach activities. All of these programs address problems associated with runoff from new development and redevelopment. The four MS4 local governments participate on SNWA boards and committees, and water users within the MS4 permit area fund SNWA activities.
- The Las Vegas Valley Watershed Advisory Committee (LVVWAC) is a recently formed organization comprised of SNWA, CCRFCD, the Clean Water Coalition, the MS4 Permittees, and others. Its objective is to address regional water quality concerns in Las Vegas Valley and adopt cooperative solutions. One of the key issues to be addressed is non-point pollution such as that associated with stormwater runoff. A Regional Water Quality Plan has

been developed and adopted by all the participating agencies. This plan integrates stormwater BMPs into the broader watershed context.

- The Las Vegas Wash Coordination Committee is comprised of the Permittees and a host of other agencies and groups with the mission of protecting and enhancing environmental resources associated with Las Vegas Wash. The Committee sponsors annual Wash clean-up days and other volunteer events to improve the Wash environment and increase public awareness of the unique resources associated with the Wash.
- The Lake Mead Water Quality Forum is a group of local, state and federal agencies that advances the science and coordinates management activities associated with southern Nevada's contribution to Lake Mead. The Forum is sponsored by NDEP and includes participation from U.S. Geological Survey, Bureau of Reclamation, local agencies and the Permittees. Water quality issues addressed in the past include perchlorate, selenium, phosphorus, and algae.

### Measure: 1.21 Pet Waste Station

Although they may not be required by regulation or ordinance, it is common practice for the Permittees to install pet waste stations in all public parks and greenbelts to encourage residents to pick up after their pets. This measure can have substantial benefits in reducing the potential for stormwater to pick up pathogens from pet waste in public areas. All new parks and greenbelts will incorporate pet waste stations.

Increased establishment and use of dog parks throughout Las Vegas Valley provides the ability to reduce dog waste left in other public areas and concentrate it at sites where it can be better managed.

## 2.2 Category 1: Source Control Measures (Potential)

### Measure: 1.22 Developer Education - Green Building and Low Impact Design Principles

There is considerable interest within the Las Vegas Valley development community in green building, LEED and low impact design principles. This interest is most strongly associated with gaining LEED certification, but other motivators also are involved. MS4 Permittees could work with organizations already promoting green building and low impact design principles to provide educational materials on the linkage between these principles and improved stormwater quality. This would improve the understanding within the development community (engineers, landscape architects, developers, inspectors) of the important connection between environmentally sensitive site design and runoff quality.

## 2.3 Category 2: Site Design Measures (Existing)

### Measure: 2.1 Open Space and Landscaping Objectives

Entities currently have open space, landscaping and recreation requirements for certain types of development. Setting aside land for open space will prevent impacts of development from occurring on that land. Similarly, applying low-impact landscaping approaches will minimize hydrologic and water quality impacts of new development. Through this measure entities will promote use of open space set-asides and landscaping requirements for Major Projects and for all projects in environmentally sensitive areas. Major Projects have been defined by each entity; environmentally sensitive areas will be defined at a regional level.

Las Vegas Valley entities currently use developers agreements to define development standards in master-planned communities. Throughout Las Vegas Valley, master-planned communities comprise the majority of new residential development. Each master-planned community is required to create legally-binding development standards. Entities will continue to use these agreements to specify open space requirements, minimum road widths, and landscaping requirements that provide stormwater management benefits. For example, recent master-planned communities in Henderson have had development agreements requiring the following:

- **Inspirada (1,900 acres)**
  - 200 acres of open space (10% of gross acreage)
  - Reduction in residential street widths
  - Landscape design that incorporates xeriscape, depressed landscape areas, and buffer strips.
- **Landwell (2,200 acres)**
  - 400 acres of open space (nearly 20% of gross acreage).
  - 18 ft residential street widths (25% reduction from standard).
  - Landscape design that incorporates xeriscape, depressed landscape areas, and buffer strips.

Samples of selected portions of current open space ordinances are provided below.

Clark County Code:

> **30.40 Purpose of the O-S Open Space District.** The O-S Open Space District is intended to provide for permanent open space in the community, to prevent irreversible environmental damage to sensitive areas and to safeguard the general prosperity, health, safety and welfare of the public by limiting development in areas where police and fire protection, protection against flooding by storm water or other services cannot be provided without excessive cost to the community or to provide a buffer between incompatible uses. See Table 30.56-2 (Design Standards) for additional design standards.

30.56. 6. Encourage the conservation of these areas as visual resources, parks, open space, conservation areas, and other related land uses

City of Las Vegas Municipal Code:

**19.06.030 (G) Open Space and Landscape Area Requirements.** A minimum of 20 percent of the gross property area in the PC District shall consist of open space, recreation facilities, multi-purpose trails, pedestrian and bikeway facilities, other common community facilities and landscaped areas in public rights-of-way. Any private recreation facility which serves more than one individual lot may be counted as a part of the minimum requirement. Specific open space and landscaped area requirements shall be set forth in the Planned Community Program.

**19.06.040 (C) (2) a., b., (3) R-PD Residential Planned Development District.** Site Development Plans shall show open space and common areas and landscaping. Drainage and grading information shall consist of either a contour map or sufficient information indicating the general flow pattern or percentage of slope.

**19.06.040 (G), (H) Allocation of Open Space and Common Recreational Facilities.** Each residential planned development containing 12 or more dwelling units shall allocate and provide open space and common recreational facilities which, at a minimum, comply with the following formula:

*Density (units per acre, to the nearest tenth)* × *1.65* =
*percentage of gross land required for open space/recreational area*

Any area allocated for streetscape within a subdivision may be counted toward the required open space and common recreational facility requirement. Required common recreational facilities and open space must be functional. Bare soil is not permitted. Standard subdivision procedure conformance requires the Tentative Map to include open space areas and drainage information. The Final Map shall indicate the parking areas, recreational facilities, open spaces and landscaped areas.

### Measure: 2.2 Rural Land Overlay

Each entity's planning department has a Rural Land Overlay that allows for reduced development requirements in new rural residential areas. These reduced requirements include narrower street sections, no sidewalks, and on curb and gutter. Applying these alternate development standards results in less impervious area and less stormwater runoff per acre of development. As an example, the City of Henderson currently has four developments covered under this program.

## Measure: 2.3 Hillside Development Ordinance

Hillside development ordinances regulate development on steep slopes to minimize erosion and other environmental effects. As development in Las Vegas Valley continues to push outward from the valley center and toward the mountain fronts forming the Valley, encroachment in to steep hillside areas will be more common. Clark County, CLV and COH have existing hillside development ordinances; these ordinances will continue to be enforced. CNLV does not have areas with steep slopes and does not have an existing hillside development ordinance. It does not need to adopt a hillside development ordinance.

Samples of selected portions of current hillside development ordinances are provided below.

### Clark County Code:

> **30.56 Hillside Development.** 1. Ensure stable slopes; 2. Reduce water runoff and control erosion by maintaining the natural features of the land to reduce erosion and minimize storm-water runoff; 3. Minimize grading and site disturbance to maximize compatibility with the natural terrain; 4. Preserve sensitive environments on the hillside; 5. Minimize the need for public services where the ability to provide services is limited by the terrain; 6. Encourage the conservation of these areas as visual resources, parks, open space, conservation areas, and other related land uses; and 7. Establish a transition zone between hillside development and more intensive development.

### City of Henderson Municipal Code:

> **19.6.9 Hillside Overlay District.** Reduces the physical impact of hillside development by ensuring stable slopes during and after development; reducing runoff, soil erosion, and rock slides; and providing specific design criteria

### City of Las Vegas Municipal Code

> **19.06.170 Hillside Development Standards and Guidelines.** In general, all development in hillside areas shall be designed with the following considerations: (a) Protect and conserve significant natural and visual resources, including major boulder outcrops, major ridges and peaks, prime wildlife habitat, and unique vegetation specimens; (b) Protect people and property from potentially hazardous conditions that are particular to mountains and hillside areas, including rock falls, other unstable slopes, flooding, subsidence, erosion and sedimentation, range fires, soils with high shrink-swell capacity, foundation instability, and air pollution; (c) Protect water quality, air quality, and other resources, such as soil and natural vegetation, from incompatible land uses; (d) Minimize the public costs of providing public services and facilities such as streets, water, sewer, emergency services, sanitation services, parks and recreation; (e) Ensure that decisions regarding

development in hillside areas are based on complete and accurate information about the environmental conditions and probable development impacts; (f) Minimize the impacts of development by controlling the location, intensity, pattern, design, construction techniques, and materials of development and construction; (g) Maintain significant open spaces that provide view corridors and land-use buffers, and maintain the City's unique desert setting; (h) Protect landmarks, prime wash area habitats, and environmentally sensitive lands, while also recognizing the legitimate expectations of property owners and the City's overall economic goals; (i) Encourage innovative planning, design, and construction techniques for development in environmentally sensitive areas; and (j) Minimize grading and site disturbance to maximize compatibility with the natural terrain.

### Measure: 2.4 Preserve Natural Washes

Although downstream channels in the urban center are primarily concrete lined to prevent erosion and subsequent transport of sediment to lower Las Vegas Wash, preservation of natural washes in upland master planned areas and recreation areas allows for natural runoff attenuation and infiltration in unlined channels. If development can occur such that runoff to these natural upland channels is not increased, then leaving them unlined could provide water quality benefits.

Existing ordinances addressing land use and open space requirements give the entities the legal authority to promote preservation of natural washes in areas of new development. Entities have been successful in working with developers in master planned areas to preserve some natural washes and surrounding floodplains.

Samples of selected portions of current ordinances addressing preservation of natural drainage ways are provided below.

Clark County Code:

> **30.16 Land Use Application Processing.** Minimizing negative environmental impacts, including but not limited to water, noise, dust, odor, smoke, air quality, drainage, light, glare, wildlife, vegetation, wetlands, and the natural functioning of the environment.
>
> Flood Control Flood Control. Storm drainage systems can be developed that emphasize the use of natural and/or open drainage, they can be developed emphasizing enclosed or piped drainage, or by incorporating the use of retention and detention basins.

City of Henderson Municipal Code:

> **19.6.10 Sensitive Land Overlay.** Sites are developed to protect the environmental qualities of the natural terrain and landscape including

protection of native vegetation, wildlife habitat, and riparian areas, and that land disturbance is kept to a minimum to preserve and enhance the natural resources and visual quality of a site.

City of Las Vegas Municipal Code:

**19.06.110 (A) 2. e., (C) 2 through 3, (E) T-D Traditional Development District; Intent and Objectives.** Locate development to take maximum advantage of the natural environment. Providing for adequate, well designed and well located open space and community facilities. Provide for the preservation of natural terrain drainage ways (arroyos and desert washes), and or area vegetation

### Measure: 2.5 Sustainability and Green Building Initiatives

Local governments in Las Vegas Valley are adopting sustainability and green building initiatives. Clark County, Las Vegas and Henderson have done so to date, and North Las Vegas is considering proposed language to adopt. While these initiatives have many different objectives (e.g., smart site design, reduced energy consumption, reduced water consumption, efficient transportation, LEED certification), the site design components can have stormwater quality benefits through reduced irrigation runoff, better onsite stormwater management, and reduced use of pesticides and herbicides.

### Measure: 2.6 Covered Fueling Area

It is standard practice in the fuel service industry to cover fueling areas. Covered fueling areas prevent rainfall from contacting potential spilled hydrocarbons around gasoline pumps. Although it is not required by local ordinances, all fueling areas at recently constructed gas stations in Las Vegas Valley are covered with awnings based on this industry standard. All new gas stations will have covered fueling areas based on this standard.

### Measure: 2.7 Raised Fuel Area

It is standard practice in the fuel service industry to raise fueling areas on a small (e.g., 6-inch) concrete platform. Raised fueling areas prevent runoff on the gas station site from contacting potential spilled hydrocarbons around gasoline pumps. Although it is not required by local ordinances, all fueling areas at recently constructed gas stations in Las Vegas Valley are raised based on this industry standard. All new gas stations will have raised fueling areas based on this standard.

### Measure: 2.8 Emergency Shut-off Switch and Shear Valve

It is standard practice in the fuel service industry to incorporate emergency shut-off switches and shear valves into design of all fuel pumps to prevent spills in case the fuel pump is not operated properly or is damaged. All new gas stations will have fuel pumps with emergency shut-off switches and shear valves based on this standard.

### Measure: 2.9 Standard Drainage Design Criteria

Each entity has adopted standard drainage design criteria for new local drainage facilities. These criteria require stabilizing all drainage ways on site and downstream to prevent erosion and accumulation of sediment that could be deposited in downstream receiving waters. All new developments will be designed in accordance with these standard design criteria.

## 2.4 Category 2: Site Design Measures (Potential)

### Measure: 2.10 Minimize Directly Connected Impervious Area

Minimizing directly connected impervious area is a standard LID practice intended to reduce runoff from paved areas to the MS4. Runoff from roofs, sidewalks, driveways, and other paved areas is directed to landscaped areas rather than directly to a gutter or storm drain so it receives some passive treatment prior to reaching the MS4. Las Vegas Valley Permittees do not currently have requirements for minimizing directly connected impervious area in new development.

### Measure: 2.11 Parking Lot Design

Strategies are available for designing parking lots to minimize runoff quantity and provide passive stormwater treatment. Measures often cited in the stormwater literature include depressing parking islands and medians; providing buffer strips; using unpaved areas for overflow parking; minimize parking requirements; and using permeable pavement. Unpaved areas are not allowed in Las Vegas Valley due to air quality concerns. Permeable asphalt and concrete are not recommended by the Permittees due to problems in other communities, but use of modular pavers is approved. LID parking lot designs are currently not required and not generally utilized in Las Vegas Valley.

### Measure: 2.12 Street Design

Strategies are available for designing streets to minimize runoff quantity and provide passive stormwater treatment. Measures often cited in the stormwater literature include depressing medians; minimizing street widths; incorporating vegetated sumps in the middle of cul de sacs; providing vegetated buffer strips; and using permeable pavement for parking lanes and alleys. Permeable asphalt and concrete are not recommended by the Permittees due to problems in other communities, but use of modular pavers is approved. LID street designs are currently not required and not generally utilized in Las Vegas Valley.

### Measure: 2.13 Pervious Pavement

Pervious pavement measures include porous asphalt, porous concrete, and modular pavers. Pervious pavement can be used in streets and parking areas to reduce runoff volume and allow potentially contaminated runoff to infiltrate rather than running off. As described previously, Las Vegas Valley Permittees reviewed the feasibility of using pervious pavement in the MS4 area and determined that porous asphalt and porous concrete were not recommended due to problems with clogging and poor performance reported in other

communities. Modular pavers are permitted. Use of pervious pavement of any kind is currently not required and not generally utilized in Las Vegas Valley.

### Measure: 2.14 Site Design

This measure includes any site design measures not listed separated in the preceding measures. Potential LID site design measures determined by the Permittees to be feasible, if needed, for Las Vegas Valley are listed in **Attachment C.**

## 2.5 Category 3: Treatment Control Measures (Existing)

### Measure: 3.1 Regional Detention Basin

The stormwater and flood control management approach for Las Vegas Valley is established by the policies and procedures of CCRFCD. All entities in the Valley are member agencies in CCRFCD and have adopted its criteria for facility design and maintenance. CCRFCD has developed a Flood Control Master Plan for Las Vegas Valley that presents a program for addressing existing and future flood control needs. It is updated every 5 years. CCRFCD projects are funded by a ¼ cent sales tax.

CCRFCD member entities own and operate a system of regional detention basins for runoff management throughout Las Vegas Valley. Regional detention basins capture and control runoff from large watershed areas (several square miles and larger), and are designed to reduce discharges from the 100-year flood and other large flood events. All regional facilities are designed to control the runoff from the 100-year storm occurring under full build-out conditions in the upstream watershed, with no assumption of onsite peak or volume reductions in new development. Thus existing and proposed flood control facilities are sized to accommodate all new development and significant redevelopment without relying on possible flow reductions from onsite hydrologic controls.

The regional detention basin approach is considered more effective in Las Vegas Valley than having a highly distributed system of small neighborhood-scale facilities due to the infrequency, randomness and localized nature of most storm events. Regional detention basins capture and regulate more runoff events than local facilities would, and concentrate the need for maintenance in fewer facilities. Seventy-three existing detention basins control runoff from a majority of the watershed area draining to Las Vegas Wash. An additional 60 regional detention basins are planned by CCRFCD as development expands to more remote parts of Las Vegas Valley. The map in **Figure 4** shows the locations of existing and proposed regional detention basins and the watershed areas draining to these basins. Virtually all areas of new development, with the exception of infill areas near the valley center, will be upstream of existing or proposed detention basins. Most significant redevelopment (e.g., in the vicinity of the Las Vegas Strip) will not be upstream of detention basins.

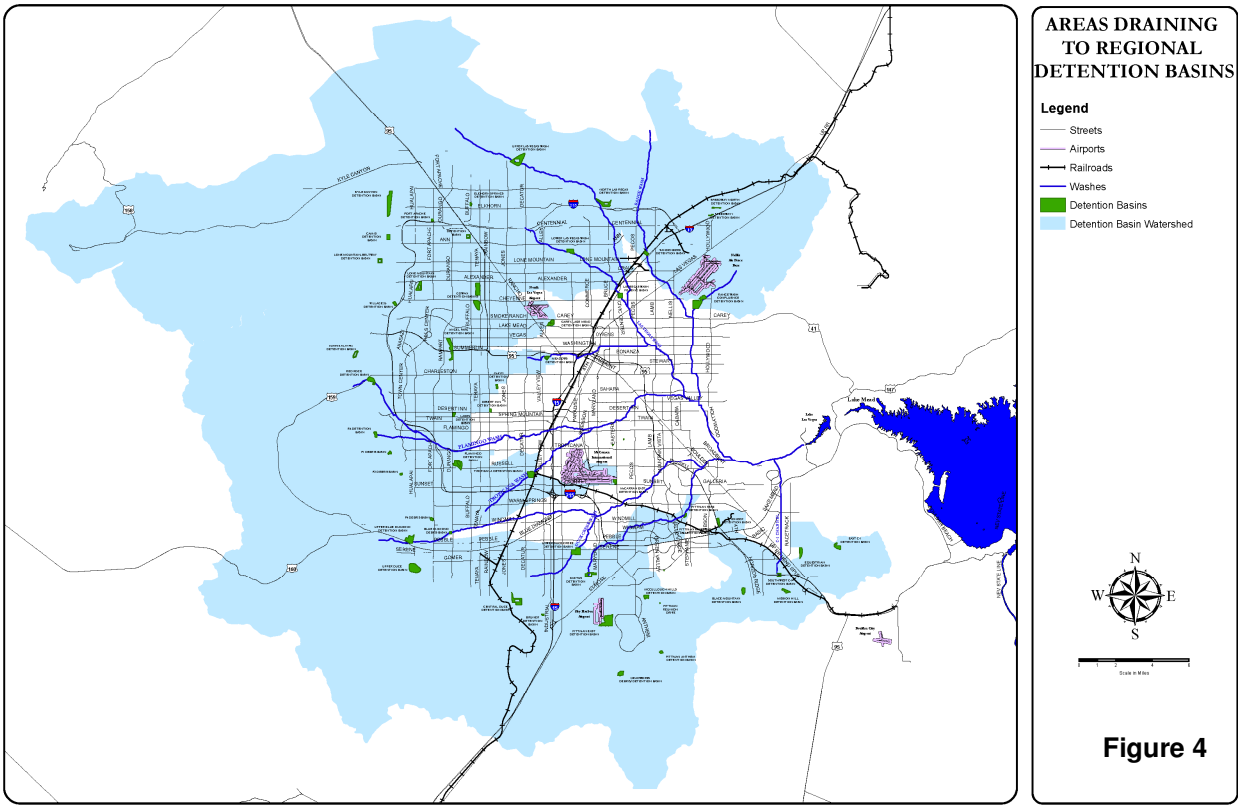



**Figure 4**

Regional detention basins in Las Vegas Valley have been monitored for stormwater pollutant reduction by the MS4 permittees. Basins have been shown to capture significant sediment volumes and reduce sediment delivered to downstream channels. All regional detention basins are designed with a sediment storage volume in addition to the flood control volume as an allowance for capturing sediment transported from upstream watershed areas. CCRFCD policy is to design sediment storage capacity equal to the computed inflow sediment volume of five 5-year storms plus one 100-year storm. This is more than sufficient to capture the sediment load associated with the typical frequent storms normally addressed by stormwater quality management programs (e.g., the 2-year event).

However, data shows that the regional detention basins are only marginally effective at reducing other pollutants. This data has been presented in previous Annual Reports for the Las Vegas Valley MS4 permit. Because the regional detention basins are designed to reduce peaks from large flood events, in most cases small runoff events of the kind normally addressed by stormwater quality programs pass through the regional detention basins with relatively little attenuation and little removal of constituents such as nitrogen, phosphorus and heavy metals.

The MS4 permittees conducted a preliminary assessment of a potential pilot project for retrofitting an existing detention basin to test improvements in water quality performance. Several sites and retrofit methods were investigated (e.g., modifying the outlet structure to add a water quality outlet and increase detention time for small events; creating and expanded sediment basin; lengthening the low flow path through the basin; adding wetland

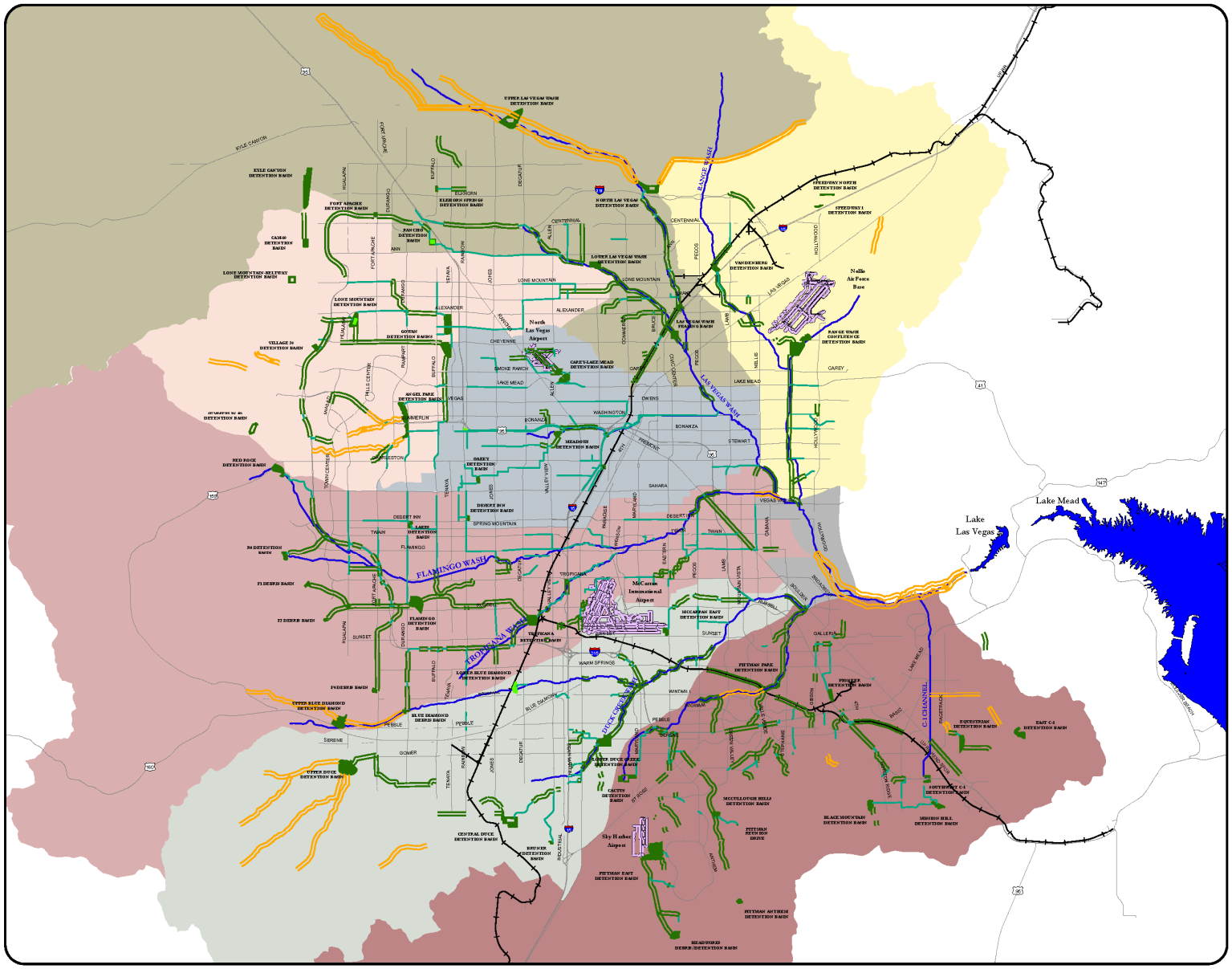
vegetation to the basin bottom). A viable site was found, but the permittees decided to wait on this project until the new MS4 permit was issued. This assessment will be revisited, including an estimate of the potential benefits of improving the water quality performance of selected existing regional detention basins through structural modifications. A decision will then be made on the viability of detention basin retrofitting in the Las Vegas Valley. If warranted, regional detention basin design standards will be modified for application all new detention basins.

### Measure: 3.2 Regional Channel Lining

The CCRFCD design manual requires all regional flood control channels to be stabilized in some manner. Because slopes in Las Vegas Valley are generally moderate to steep, velocities are high, and soils are erodible, most channels are stabilized using concrete lining. CCRFCD has a preference for providing concrete lining for regional flood control channels to minimize capital costs, right-of-way requirements (when taking of developed property is involved) and maintenance costs. Some channels are stabilized using riprap, gabions, grade control structures, or grass (most often in golf courses). Concrete or other channel lining eliminates production of sediment from the previously unlined or natural channels due to scour and erosion, thereby reducing sediment loads to Las Vegas Wash and Lake Mead.

As a result of the CCRFCD policy, very few channels within the existing developed area are unlined. **Figure 5** shows the extent of concrete lined channels, unlined stabilized channels, and natural channels in the Las Vegas Valley developed area. There are very few segments of large unlined channels remaining. The CCRFCD Master Plan calls for construction of new concrete lined channels as development expands into new areas. Approximately 450 miles of regional channels are currently stabilized, and another 400 miles of regional channel improvement projects are planned by CCRFCD.

Current CCRFCD policy and local development codes require new development to stabilize and prevent erosion from any waterways within the development area. If significant erosion hazards are created downstream, new development must mitigate those conditions as well. Thus as new development occurs, it is required to mitigate any impacts of onsite and offsite erosion through compliance with current development regulations.




# LAS VEGAS VALLEY STORMWATER SYSTEM MAP

**Legend**

- Washes

**Conveyance Facilities**

- Pipes
- Lined Channel
- Unlined Channel

**Detention Basins**

- Complete
- Under Construction

- Airports
- Railroads
- Range Wash Watershed
- Pittman / C-1 Watershed
- North Basin Watershed
- Lower Las Vegas Wash Watershed
- Gowan Watershed
- Flamingo / Tropicana Watershed
- Duck Creek Watershed
- Central Watershed

N W E S

Scale in Miles

**Figure 5**

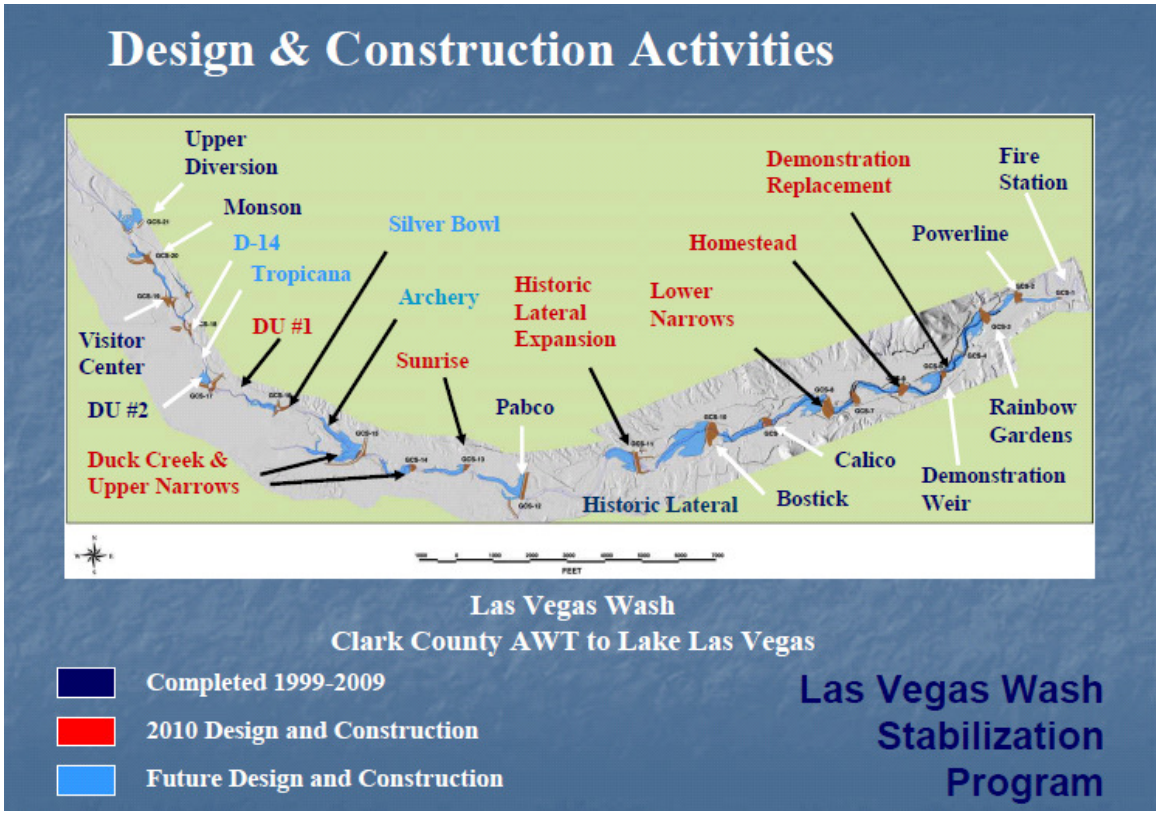
## Measure: 3.3 Las Vegas Wash Erosion Control Structures

Over the past 40 years erosion in the Las Vegas Wash due to wastewater discharges and urban stormwater runoff has resulted in dramatic channel erosion and reduction in wetland areas from approximately 2,000 acres to 200 acres. Erosion of the Lower Las Vegas Wash channel and floodplain is estimated to have deposited 11.2 million tons of sediment in Las Vegas Bay between 1934 and 2001, as well as contributing to water quality degradation and loss of critical habitat.

In order to address this issue, the Las Vegas Wash Coordination Committee was formed in 1998 to prepare and implement a management strategy for the Las Vegas Wash. A key element of the management strategy was to construct grade control structures in the eroding sections of the Wash to stabilize erosion and support new wetlands. SNWA, through the Las Vegas Wash Coordination Committee, was delegated responsibility for this effort and has a well-funded program for stabilizing lower Las Vegas Wash through construction of a series of erosion control structures. Eleven structures have been constructed, and 11 more are planned. In addition, another 6 erosion control structures are now proposed between Lake Las Vegas and Las Vegas Bay of Lake Mead. **Figure 6** shows the location of existing and proposed erosion control structures. These structures are downstream of essentially all possible new development and significant redevelopment in the Valley.

These structures provide water quality benefits by: (1) creating wetlands which can filter the water, and (2) reducing the velocity of water in the Las Vegas Wash to allow sediment to settle out upstream of the erosion control structures. Existing structures have significantly reduced the effects of scour and erosion, reducing sediment transport in the lower Wash by 60-80 percent. Lower Las Vegas Wash was on Nevada's 2002 303(d) list of impaired waters due to high TSS concentrations. By 2004 this segment was removed from the 303(d) list due to improvements in TSS associated with the erosion control structures. They have also re-established 165 acres of riparian wetlands between the Clark County Wetlands Park visitor's center and Lake Las Vegas. Both of these changes have resulted in water quality improvements in the lower Wash and Lake Mead. This program has received awards of recognition from EPA, the State of Nevada, and professional engineering and environmental associations. The program is featured on the EPA Non-Point Source website as an example of successful BMPs to address sediment (http://www.epa.gov/nps/success/state/nv.htm).

Figure 6. Existing and Proposed Erosion Control Structures for Las Vegas Wash (Source: SNWA)




### Measure: 3.4 Sand/Oil Separator

Sand/oil separators are small vaults with chambers that separate sand (and other heavy particulates) and oil (and other floatables) from the flow stream. They are often used at industrial sites and commercial locations where hydrocarbons are present.

### Measure: 3.5 Sand Filter

Sand filters are treatment devices that are designed to remove small particulates and some dissolved pollutants from stormwater. They are often used at commercial sites, industrial sites and parking areas to treat runoff prior to discharge to the MS4.

## 2.6 Category 3: Treatment Control Measures (Potential)

### Measure: 3.6 Hydrodynamic Separator

A hydrodynamic separator is a class of proprietary devices that use hydraulic dynamics to separate heavy materials and floatables in a compact swirling chamber. They are often used at commercial and industrial sites to treat runoff prior to discharge to the MS4. Permittees reviewed the feasibility of hydrodynamic separators for Las Vegas Valley. Limited experience in the Valley has shown that these measures have performance problems because of

extremely infrequent inflow, as well as odor and vector problems. Hydrodynamic separators are not currently required for new development in Las Vegas Valley.

### Measure: 3.7 Infiltration Basin/Trench

Infiltrations basins and trenches accept drainage and dispose of it through infiltration and evaporation. Permittees have reviewed the feasibility of stormwater infiltration in Las Vegas Valley and have concluded that it is problematic in most areas due to poor soils, shallow groundwater, and water quality concerns. There are no requirements for use of infiltration measures in new development in Las Vegas Valley. Developers wanting to use these devices must demonstrate through geotechnical studies that they will be effective and not contribute to high selenium or TDS concentrations in downstream drainages.

### Measure: 3.8 Bioretention

Bioretention facilities consist of retention basins with vegetation or filter media to treat stormwater. Water may be treated and disposed through infiltration and evaporation, or released slowly after biotreatment. The term "rain garden" is sometimes used for small lot-sized bioretention facilities. There is currently no requirement to use bioretention facilities in Las Vegas Valley.

### Measure: 3.9 Extended Detention Basin

Extended detention basins are stormwater storage basins with modified outlets to capture and store runoff from small frequent storms. After receiving treatment primarily through settling, water is slowly released to the downstream drainage system. Extended detention basins are generally used at the development scale. There is currently no requirement to use extended detention basins in Las Vegas Valley. However, Measure 3.1 consists of converting existing regional flood control detention basins into regional extended detention basins.

# 3 Pollutants of Concern Addressed by Existing NDSR BMPs

The Las Vegas Valley MS4 permittees previously identified the pollutants of concern for the NDSR program based on local monitoring data, nationwide research, and known water quality impairments. This analysis was included in documentation provided to NDEP in the MS4 permittees' letter of December 2008. The permittees further identified three high priority pollutants of concern – hydromodification, phosphorus and selenium. Justification for this selection is provided in **Attachment A**. **Table 4** identifies the pollutants of concern addressed by each of the existing NDSR BMPs. "Primary Pollutants" are those that the measure would address directly or would have the greatest potential for minimizing; "Secondary Pollutants" are those that would be addressed indirectly or marginally.

# 4 Evaluation of Need for Additional NDSR BMPs

A BMP gap analysis was prepared to relate existing BMPs to each pollutant of concern and the land uses from which they originate. This is shown in the table in **Attachment D**. The table shows which BMPs are currently required or recommended by individual Permittees or regional agencies. It provides a visual representation of the BMPs addressing all of the pollutants of concern in Las Vegas Valley.

The BMP gap analysis was used to determine the need for additional BMPs for the Las Vegas Valley NDSR program. Evaluation of the need for additional BMPs was based on three factors:

1. Are additional BMPs needed to address any of the high priority pollutants of concern based on TMDL or other regulatory requirements?
2. Should existing BMP programs be upgraded or are additional BMPs needed to address any of the pollutants of concern to the MEP?
3. Are any land use types not adequately addressed?

## 4.1 High Priority Pollutants

A separate technical memorandum (TM II.1 – Stormwater Contributions to Impaired Waters and TMDLs in Las Vegas Valley) was prepared to address pollutants contributing to impaired waterbodies in Las Vegas Valley and those for which a stormwater TMDL has been adopted. These pollutants are selenium, TDS, iron, molybdenum, and phosphorus. No new or upgraded BMPs are recommended in that evaluation, although the benefits of expanding existing public education and outreach programs are recognized.

## 4.2 Other Pollutants of Concern

Based on **Table 4** and Attachment D, all pollutants of concern for the Las Vegas Valley MS4 program are addressed by one or more existing BMP programs. Water quality data presented in past Annual Reports and in technical reviews performed for the new MS4 permit has demonstrated that pollutant concentrations have not increased over the past 18-year monitoring period despite an increase in population of over 200 percent. The most significant change over this period has been hydromodification, i.e., an increase in stormwater runoff peaks and volumes due to more impervious surfaces. The measures in **Table 5** adequately address the primary effects of hydromodification in Las Vegas Valley, which are primarily related to channel erosion.

The Permittees have previously committed to investigating the feasibility and potential benefits of retrofitting existing regional flood control detention basins to improve their pollutant reduction performance. This measure is being considered separately.

**Table 4. Pollutants of Concern Addressed by Existing NDSR BMPs**

| Existing and Potential BMPs | Description | Primary Pollutants of Concern Addressed by Measure | Secondary Pollutants of Concern Addressed by Measure |
|---|---|---|---|
| **1. SOURCE CONTROL MEASURES** | | | |
| 1.1. Street Sweeping Program | Remove pollutants from street surfaces and parking lots before they are introduced to the MS4. Municipalities have adequate programs for public streets. | • Heavy Metals<br>• Nutrients<br>• Organic Compounds Sediment<br>• Litter & Floatables Hydrocarbons<br>• Surfactants | |
| 1.2. Local Storm Drain System Maintenance | Remove pollutants from local drain inlets and storm drains before they are transported to receiving waters. Municipalities are responsible for cleaning public drains and channels. | • Hydrocarbons<br>• Sediment<br>• Heavy Metals<br>• Litter & Floatables<br>• Oxygen Demanding Substances | • Nutrients<br>• Pathogens<br>• Organic Compounds Pesticides & Herbicides<br>• Surfactants |
| 1.3. Regional Flood Infrastructure Maintenance | Remove pollutants from regional channels and detention basins before they are transported to receiving waters. Municipalities are responsible for cleaning public drains and channels. | • Hydrocarbons<br>• Sediment<br>• Heavy Metals<br>• Litter & Floatables<br>• Oxygen Demanding Substances | • Nutrients<br>• Pathogens<br>• Organic Compounds Pesticides & Herbicides<br>• Surfactants |
| 1.4. Water Conservation (Drought) Ordinance | Watering restrictions and turf limitations adopted by all LVV entities reduce urban dry weather flows and associated load and transport of landscaping pollutants | • Pathogens<br>• Nutrients<br>• Pesticides & Herbicides<br>• TDS<br>• Selenium<br>• Hydromodification | • pH<br>• Surfactants |
| 1.5.CCommercial/Industrial Site Housekeeping | Implement practices on commercial/industrial sites to prevent contact of rain water with potentially contaminated surfaces and materials and/or control site runoff. Required under NDEP general industrial permit. | • Hydrocarbons<br>• Organic Compounds | • Pathogens<br>• Nutrients<br>• Pesticides & Herbicides Litter & Floatables<br>• Surfactants |
| 1.6 Household Hazardous Waste Collection | Collection service to remove and properly dispose of hazardous materials prior to their introduction to trash collection areas and landfills. Existing program operates in LVV. | • Pesticides & Herbicides<br>• Organic Compounds<br>• Nutrients<br>• Hydrocarbons | |

| Existing and Potential BMPs | Description | Primary Pollutants of Concern Addressed by Measure | Secondary Pollutants of Concern Addressed by Measure |
|---|---|---|---|
| 1.7. Ordinances Prohibiting Non-Stormwater Discharges and Littering | Each entity has legal authority to prohibit discharge of non-stormwater (except as expressly permitted) to the MS4, including litter. | • Pesticides & Herbicides<br>• Organic Compounds<br>• Nutrients<br>• Hydrocarbons<br>• Trash & Floatables | • Heavy Metals<br>• Surfactants |
| 1.8. Desert Dumping Controls | All entities have ordinances prohibiting dumping in the desert. Enforcement of ordinances reduces incidents and impact of dumping of potentially hazardous materials in rural areas and vacant lands within the MS4. | • Trash & Floatables<br>• Oxygen Demanding Substances | • Pesticides & Herbicides Organic Compounds<br>• Nutrients<br>• Hydrocarbons<br>• Heavy Metals |
| 1.9. Grease Interceptor Program | Program prevents grease plugs causing overflows from sanitary system to stormwater system from restaurants and certain industrial facilities. All entities should adopt uniform sanitary sewer line and grease trap inspection programs. | • Hydrocarbons<br>• Oxygen Demanding Substances | |
| 1.10. Dust Control Measures | A variety of air quality management measures complying with federally imposed regulations reduce dust and airborne transport and eventual deposition of pollutants. | • Sediment | • Nutrients<br>• Heavy Metals |
| 1.11. Fertilizer, Pesticide and Herbicide Management Program | Measures to train and require certification from supervisors of public employees who handle these materials. | • Nutrients<br>• Pesticides and Herbicides | |
| 1.12. Public Education – General Stormwater Awareness | Attempt to modify potentially harmful behaviors by disseminating information and products; targeted activities and pollutants include pet waste, illegal dumping, household hazardous waste management, and over-watering. | • All except non-dust generated sediment | |
| 1.13. Storm Drain Marking Program | Install educational markers on drain inlets to discourage illegal dumping. Adopt local design standards for new inlets in all entities to require developers to install storm drain markers in all new development and redevelopment. | • Nutrients<br>• Organic Compounds<br>• Hydrocarbons<br>• Pathogens<br>• Pesticides & Herbicides<br>• Litter & Floatables | • Surfactants |
| 1.14. Indoor Workshop | Locate work areas indoors to prevent contact with rain or runoff | • Hydrocarbons<br>• Organic Compounds | |

| Existing and Potential BMPs | Description | Primary Pollutants of Concern Addressed by Measure | Secondary Pollutants of Concern Addressed by Measure |
|---|---|---|---|
| 1.15. Spill Control Prevention Plan | Secondary containment and cleanup procedures for potential hazardous material spills | • Hydrocarbons<br>• Organic Compounds | |
| 1.16. Industrial Pretreatment Program | Inspection of industrial sites by local wastewater pretreatment inspectors | • Organic Compounds<br>• Hydrocarbons | |
| 1.17 Trash Receptacle Enclosures | Enclose trash bins to minimize contact with stormwater and prevent migration of trash | • Trash & Floatables<br>• Oxygen Demanding Substances | |
| 1.18. Southern Nevada Health District Inspections | Inspections of commercial and industrial sites using small amounts of hazardous materials | • Organic Compounds<br>• Pesticides & Herbicides | |
| 1.19. Turf Conversion Program | SNWA program offering money to remove lawns to reduce water use and dry weather runoff | • Pathogens<br>• Nutrients<br>• Pesticides & Herbicides<br>• TDS<br>• Selenium<br>• Hydromodification | • pH<br>• Surfactants |
| 1.20. Regional Water Quality Planning | Cooperative regional efforts to address water quality issues | • All | |
| 1.21. Pet Waste Station | Stations in parks and open spaces to deposit pet waste | • Pathogens | |

| Existing and Potential BMPs | Description | Primary Pollutants of Concern Addressed by Measure | Secondary Pollutants of Concern Addressed by Measure |
|---|---|---|---|
| **2. SITE DESIGN MEASURES** | | | |
| 2.1. Open Space and Landscaping Objectives | Entities have open space, landscaping and recreation requirements. Setting aside land for open space will prevent impacts of development from occurring on that land. | • Sediment<br>• Hydromodification | • Hydrocarbons<br>• Organic Compounds<br>• Heavy Metals<br>• Surfactants |
| 2.2. Rural Land Overlay | Special land development criteria for rural areas allows use of LID measures | • Sediment<br>• Hydromodification | • Hydrocarbons<br>• Organic Compounds<br>• Heavy Metals<br>• Surfactants |
| 2.3. Hillside Development Ordinances | Specify design guidelines for development on steep slopes that minimize erosion. County, CLV and COH have existing ordinances; CNLV does not have areas with steep slopes. | • Sediment | |
| 2.4. Preserve Natural Washes | Preservation of natural washes in master planned areas and recreation areas allows for natural runoff attenuation and infiltration in unlined channels. | • Hydromodification | • Hydrocarbons<br>• Organic Compounds<br>• Pesticides & Herbicides<br>Surfactants |
| 2.5. Sustainability and Green Building Initiatives | Various sustainability and green building initiatives (e.g., LEED) adopted by local entities include minor components for onsite stormwater management that can reduce water quality effects. | • Nutrients<br>• Pesticides & Herbicides<br>• Hydromodification | • Pathogens<br>• Surfactants |
| 2.6. Covered Fuel Areas | Cover gas station and fueling area pump islands | • Hydrocarbons | |
| 2.7. Raised Fuel Areas | Raise gas station and fueling area pump islands | • Hydrocarbons | |
| 2.8. Emergency Shut-off Switch and Shear Valves | Emergency shut-off switch and valves to isolate fueling areas after spills | • Hydrocarbons | |
| 2.9 Standard Drainage Design Criteria | Regional and local criteria to stabilize onsite and downstream drainage ways | • Sediment | |

| Existing and Potential BMPs | Description | Primary Pollutants of Concern Addressed by Measure | Secondary Pollutants of Concern Addressed by Measure |
|---|---|---|---|
| **3. TREATMENT CONTROL MEASURES** | | | |
| 3.1 Regional Detention Basins | Regional detention basins capture runoff from developed areas, allowing sediment and associated pollutants to drop out. Conduct feasibility study for detention basin retrofits in selected areas (methods, costs, benefits, priorities), and modified design criteria for new detention basins. | • Sediment<br>• Litter & Floatables<br>• Hydromodification | • Heavy Metals<br>• Nutrients |
| 3.2. Regional Channel Lining | Concrete lining and other channel stabilization measures by CCRFCD reduce erosion and associated sediment transport to downstream receiving waters. | • Sediment<br>• Hydromodification | |
| 3.3. Las Vegas Wash Stabilization Structures | Wash stabilization measures (grade control structures, bank stabilization) by SNWA and LVWCC reduce erosion and encourage deposition of upstream sediment prior to reaching Las Vegas Bay and Lake Mead. | • Sediment<br>• Nutrients<br>• Hydromodification | • Heavy Metals |
| 3.4. Sand/Oil Separator | Device to separate solids and hydrocarbons at gas stations and similar industrial sites | • Sediment<br>• Litter & Floatables<br>• Hydrocarbons<br>• Surfactants | • Heavy Metals |
| 3.5. Sand Filter | Device to filter runoff from commercial or industrial sites | • Pesticides & Herbicides<br>• Organic Compounds<br>• Nutrients<br>• Hydrocarbons<br>• Surfactants<br>• Heavy Metals | |

## 4.3 Land Uses

The BMP gap analysis indicates that the only land use type responsible for generating important pollutants of concern that is not addressed by existing BMPs to the MEP is parking areas. LID measures feasible for Las Vegas Valley parking areas are not currently required, but could be implemented in future developments to upgrade the current NDSR program. Potential BMPs to be added to the NDSR program for parking lots will be investigated in a separate technical memorandum describing the proposed NDSR program.

## 4.4 Upgrade Miscellaneous Existing Measures to Meet MEP

In reviewing the existing BMP programs, certain miscellaneous opportunities for expanding or upgrading existing programs to meet the MEP standard for new development and significant redevelopment were considered. These opportunities are listed and evaluated in **Table 5**.

**Table 5. Possible Existing BMP Upgrades to Meet MEP Standard**

| Existing BMP | Potential Upgrade for MEP | Assessment |
|---|---|---|
| Street Sweeping | • Adopt requirements for street sweeping on private streets<br>• Adopt requirements for sweeping of public parking lots<br>• Adopt requirements for sweeping of private parking lots | • Private streets are not common and are not a significant contributor of pollutants to the MS4<br>• New public parking lots will be addressed through site design measures<br>• New private parking lots will be addressed through site design measures |
| Fertilizer, Pesticide and Herbicide Management Program | • Require certification of all public entity landscaping staff<br>• Require certification of private company landscape supervisors | • Public entity landscaping staff are already adequately trained, with strong incentive to not over-use chemicals<br>• Not practical for every little landscaping company; pesticides and herbicides are not commonly found in significant quantities in receiving waters |
| Public Education | • Expand public outreach programs to target issues important to areas of NDSR (e.g., new homeowners, new businesses) | • Beneficial and efficient to expand regional public outreach into other specific target areas to maximize benefits for NDSR |
| Storm Drain Marking Program | • Require installation of inlet markers by developers in all new development and significant redevelopment | • Currently being pursued by Permittees through RTC Standards Committee |
| Regional Water Quality Planning | • Improve coordination with LVVWAC and other regional planning agencies to gain additional synergies and avoid redundancies with existing water quality management programs | • Many opportunities to proactively coordinate MS4 program activities and objectives with other related programs, monitoring efforts, strategic plans, etc. |
| Raised Fuel Areas | • Add to local design standards as a requirement | • Not necessary – part of standard practice in gas station design |
| Covered Fuel Areas | • Add to local design standards as a requirement | • Not necessary – part of standard practice in gas station design |
| Emergency Shut-off Valves | • Add to local design standards as a requirement | Not necessary – part of standard practice in gas station design |

| Existing BMP | Potential Upgrade for MEP | Assessment |
|---|---|---|
| Standard Drainage Design Criteria | • Modify local and regional drainage design and development criteria to make LID measures easier to incorporate in standard designs | • Some criteria will have to be modified to accommodate parking lot LID designs, so other criteria could be changed at the same time |
| Sand/Oil Separator | • Modify development standards to require sand/oil separators for certain types of development | • Cost, performance issues, and maintenance issues do not justify use of these devices in the LVV arid climate |
| Sand Filter | • Modify development standards to require sand filters for certain types of development | • Cost, performance issues, and maintenance issues do not justify use of these devices in the LVV arid climate |

Based on this evaluation, the following existing BMP enhancements would be made to meet MEP:

- Expand storm drain inlet marking program to require developers to install storm drain inlet markers in new developments
- Expand public outreach programs to target issues important to areas of new development and significant redevelopment (e.g., new homeowners, new businesses)
- Improve coordination with LVVWAC and other regional planning agencies to gain additional synergies and avoid redundancies with existing water quality management programs
- Modify Standard Drainage Design Criteria and development standards to make LID measures easier to incorporate in standard designs

Details of these upgraded existing programs will be developed and described in a separate technical memorandum describing the NDSR program.

## 4.5 Summary of Need for New BMPs

Based on the permit requirements and above assessment of existing programs, new or expanded BMPs are needed for the NDSR program in the following areas:

1. Regional detention basin retrofit investigation
2. Additional BMPs for parking areas (LID measures and other BMPs)
3. Expanded storm drain inlet marking program to new development
4. Upgraded existing BMPs for public education and outreach
5. Upgraded existing BMPs for interagency regional water quality planning
6. Modifications to standard drainage design criteria to facilitate implementation of LID measures

# ATTACHMENT A

## Priority Pollutants for NDSR Program and Consequences for BMP Selection

Pollutants of concern for the New Development and Significant Redevelopment Program (Post-Construction Program) were identified in the "Proposed Post-Construction Runoff Management Program for New Development and Significant Redevelopment" (December 2008) submitted to NDEP.

The DGWG asked if certain pollutants were high priority, and thus would justify incorporating new BMPs such as LIDs into the NDSR program. High priority pollutants would fall into one of three categories:

- Pollutant on current 303(d) list for impaired waters that could be generated in areas of new development
- Pollutant for which a TMDL has been developed that could be generated in areas of new development
- Pollutant with higher concentrations or loads in Las Vegas Valley than in other urban areas, suggesting it is a unique problem in Las Vegas Valley

The following table lists pollutants of concern already identified for the NDSR program, and presents information that justifies selection of the following priority pollutants of concern: hydromodification, phosphorus and sediment.

| Pollutant of Concern | Major Flow Regime Source | Land Use Sources | On 303(d) List or Current TMDL | Other Issues | Significant Sources in New Development | Priority Pollutant of Concern for NDSR Program |
|---|---|---|---|---|---|---|
| Heavy Metals (copper, lead, zinc, mercury) | Wet | • Illicit storm drain connections<br>• Automobile usage – emissions, brake pad residues<br>• Atmospheric deposition<br>• Industrial activities<br>• Commercial activities | Yes – Iron, Molybden-um (naturally occurring) | | Yes – roads, parking lots | |
| Hydrocarbons (oil and grease) | Wet | • Parking lots<br>• Roads<br>• Automobile emissions<br>• Improper disposal of used motor oil<br>• Illicit connections to drain systems | | | Yes – roads, parking lots, used motor oil | |
| Hydromodification | Wet and Dry | • Directly connected impervious area<br>• Urban nuisance flows (watering, car washing, pool draining) | | • Evidence in stream gage data<br>• Key focus of EPA | Yes – roofs, driveways, roads, parking lots, over-watering, car washing | Yes |
| Litter and Floatables | Wet | • Human activities | | • Significant accumulation in channels; includes other pollutants | Yes – general human activity | |
| Nutrients (nitrogen and phosphorus) | Wet | • Fertilizers<br>• Animal waste<br>• Detergents<br>• Atmospheric deposition<br>• Leaking sewer pipes | Yes – Total Phosphorus | | Yes – fertilizer, animal waste | Yes - phosphorus |
| Organic Compounds (SVOCs, VOCs) | Wet and Dry | • Lawn care<br>• Agricultural lands<br>• Industrial uses<br>• Household chemicals<br>• Illicit connections to storm drain systems | | • Perchlorate problems in lower LVW groundwater | Yes – lawn care, household chemicals, industrial sites | |
| **Oxygen Demanding Substances (BOD)** | **Wet** | • **Food product waste**<br>• **Decaying vegetative matter**<br>• **Trash** | | | **Yes – restaurants, waste transfer stations, trash** | |

| Pollutant of Concern | Major Flow Regime Source | Land Use Sources | On 303(d) List or Current TMDL | Other Issues | Significant Sources in New Development | Priority Pollutant of Concern for NDSR Program |
|---|---|---|---|---|---|---|
| Pathogens (bacteria, viruses) | Wet and Dry | • Animal Waste<br>• Illicit connections between sewer lines and storm sewers<br>• Leaking sewer pipes | | • Coliforms are consistently high | Yes – animal waste | |
| Pesticides & Herbicides | Wet | • Landscape care<br>• Parks and golf courses<br>• Agricultural areas | | | Yes – landscape care, parks, golf courses | |
| pH | Wet | • Industrial areas<br>• Storm drain dumping | Yes | | Yes – industrial areas, dumping | |
| Sediment (and turbidity) | Wet | • Construction sites<br>• Agricultural lands<br>• Natural desert land<br>• Eroded streambanks | Yes | • Key focus of EPA | Yes – unlined drainages | Yes |
| Selenium | Dry | • Resurfacing shallow groundwater | Yes | • Selenium Management Plan being developed | No | |
| Surfactants (detergents) | Wet | • Vehicle washing<br>• Paved areas<br>• Sanitary sewer overflows | | | Yes – vehicle washing, roads, parking lots | |
| TDS | Dry | • Resurfacing shallow groundwater | Yes | • Correlated to selenium | No | |

# ATTACHMENT B

## Development Guidelines Working Group Assessment of Feasible BMPs for Las Vegas Valley

In 2007 and 2008 the Development Guidelines Working Group developed a list of potential BMPs for the Post-Construction Program, and evaluated those BMPs for feasibility in Las Vegas Valley. The following tables summarize the results of that evaluation.

**Accepted and Provisional BMPs for New Development and Redevelopment**

| BMP | Application | Justification for Selection |
|---|---|---|
| **Accepted BMPs – Watershed-Based Measures Implemented at Regional Level** | | |
| Water Quality Sensitive Areas | Areas adjacent to critical channels and washes where development could have higher impacts to water quality | Watershed based planning approach preferred by EPA |
| Enhanced Floodplain Ordinances | Areas adjacent to channels and washes where flood inundation or erosion could result in a higher risk to water quality | Watershed based planning approach preferred by EPA; integrates with existing floodplain management programs |
| Open Space and Conservation Plans | Areas of high habitat or open space value, particularly along channel and wash corridors | Watershed based planning approach preferred by EPA; integrates with land use planning initiatives of local entities |
| **Accepted BMPs – Applicable to All New Development and Significant Redevelopment throughout Las Vegas Valley** | | |
| Low Impact Development | Any new development | State of practice in sustainable site design; integrates with LEED and other green building initiatives in LVV |
| Enhanced Street Sweeping Practices | Municipal streets in high risk areas; large parking lots in new developments | Parking lots are key source of urban runoff pollutants as identified by EPA |
| Education and Outreach | Responsibility of MS4 permittees; target general public as well as specific business types | One of EPA Phase II minimum measures; benefits existing as well as new development |
| Extended Detention Basins | Applied at development level rather than parcel level | Effective pollutant removal when properly designed; design standards are readily available |
| Infiltration basins and trenches | Areas with adequate geologic conditions (no expansive or low permeability soils), adequate depth to ground water (minimum of 10 ft), and away from buildings | Effective for both runoff quality and quantity management. Part of common LID suite of practices. |
| Landscaped Swales | Areas where landscaping will generally be xeriscape, requiring little maintenance. | Part of common LID suite of practices. Easily integrated into side design. |
| Filter/Buffer Strips | Typically best for small applications adjacent to parking lots, streets, and other impervious areas. | Part of common LID suite of practices. Easily integrated into site design. |
| Bioretention/Landscape retention | Typically best for small applications adjacent to parking lots, streets, and other impervious areas. Differs from retention for purpose of infiltration by often having positive drainage outlet. | Part of common LID suite of practices. Easily integrated into site design. |
| Rain Gardens | Only acceptable in situations where supplemental water source to support vegetation is non-potable supply. Do not want to increase landscaping water requirements to support stormwater BMP. | If site and street runoff can be directed through proper grading to not leave the overall parcel, that would be effective. |

| BMP | Application | Justification for Selection |
|---|---|---|
| Good Housekeeping Practices | All commercial and industrial sites. Measures are difficult to enforce, and will be addressed primarily through an education and outreach program. | Low cost, non-structural measures that should be common practice on all commercial and industrial sites |
| Pollution Prevention | All commercial and industrial sites. Measures are difficult to enforce, and will be addressed primarily through an education and outreach program | Low cost, non-structural or minimal structural measures that should be common practice on all commercial and industrial sites |
| Porous Pavement | Locations where local soils are moderately to highly permeable, and where dependable maintenance organization is identified. Include concepts of open blocks and cellular materials in this category. | Addresses parking lot design, which is key focus of EPA. |
| **Provisional BMPs – Allowed for New Development and Significant Redevelopment Under Certain Conditions** | | |
| Wet Ponds | Allowed for large development-scale applications where permanent open water features are part of landscape design, and approval is obtained from SNWA for water conservation | Most effective structural treatment measure available when properly designed and maintained |
| Artificial Wetlands | Allowed only in areas where natural or sustainable water supply is available to support wetlands through extended dry periods. | Effective treatment removal where they are feasible. |
| Oil/Water Separators | Acceptable for commercial and industrial development only, where property owner has maintenance responsibility. Useful in highly urbanized areas with minimal space available for BMPs. | Effective when properly designed and maintained. Design criteria are available from other communities and vendors. |
| Wet Vaults | Acceptable for commercial and industrial development only, where property owner has maintenance responsibility. Useful in highly urbanized areas with minimal space available for BMPs. | Effective when properly designed and maintained. Design criteria are available from other communities and vendors. |
| Hydrodynamic Separators | Acceptable for commercial and industrial development only, where property owner has maintenance responsibility. Useful in highly urbanized areas with minimal space available for BMPs. | Effective when properly designed and maintained. Design criteria are available from other communities and vendors. |
| Sand Filters | Acceptable for commercial and industrial development only, where property owner has maintenance responsibility. Useful in highly urbanized areas with minimal space available for BMPs. | Effective when properly designed and maintained. Design criteria are available from other communities and vendors. |

**BMPs Not Recommended for Use in Las Vegas Valley**

| BMP | Justification for Rejection |
|---|---|
| Cisterns/Rainbarrels | Implemented only at the individual parcel level; impossible to guarantee long-term maintenance by property owner |
| Dry Wells | NDEP has restrictions on wells that would have the potential to contaminate groundwater resources. Surface water pollutants should not be transferred to the groundwater aquifer. Dry wells have had significant maintenance problems in other Southwest communities (e.g., Phoenix). |
| Drain Inlet and Catch Basin Inserts | Frequently creates drainage problems due to clogged inlets, causing street flooding. When installed in public rights-of-way (e.g., public streets), passes future maintenance responsibilities to municipalities. Other communities have reported significant performance and maintenance problems. |
| Rooftop Gardens (Green Roofs) | Infeasible to provide supplemental non-potable water for most of the year to support rooftop vegetation. Not a reasonable BMP in arid region. |
| Unpaved Parking | Unpaved parking lots are not currently permitted in Las Vegas Valley due to dust regulations. Alternate paving methods such as modular blocks are acceptable and are covered in the Porous Pavement category. |

# ATTACHMENT C

## Low Impact Development Measures Feasible for Las Vegas Valley

The LID measures determined to be feasible for use in the Las Vegas Valley NDSR program, if required, are listed below.

| LID Category | Specific Measure or Practice |
|---|---|
| Minimize directly connected impervious area | Minimize overall impervious area |
| | Direct runoff onto properly designed unpaved surfaces |
| | Disconnect rooftop drains |
| Parking Lot Design | Depressed medians |
| | Buffer strips |
| | Porous paving – modular pavers |
| | Minimize parking requirements |
| Street Design | Minimum street widths |
| | Cul de sac design |
| | Buffer strips |
| | Depressed medians |
| Site Design | Depressed landscaping |
| | Landscaped drainage swales |
| | Open space set-asides |
| | Density tradeoffs |
| Landscape Design | Xeriscaping |
| | Depressed landscape areas |
| | Buffer strips |

Source: Storm Water Management Plan Technical Memorandum IV.10 - Evaluation of Low Impact Development Measures for NDSR Program

# ATTACHMENT D

## Gap Analysis for Existing NDSR BMPs

## NEW DEVELOPMENT AND SIGNIFICANT REDEVELOPMENT PROGRAM - BMP GAP ANALYSIS

**Categories of BMP Adoption**

| | |
|---|---|
| Permittee has a mandatory program (ordinance, code, development standard) | |
| Permittee has an informal, voluntary or incentive-based program | |
| Industry standard or common practice | |
| Program is currently under development | D |
| Permittee benefits from a regional program | |

**BMP Type**

SC Source Control
SD Site Design
TC Treatment Control

| | | | | MS4 Permittees | | | | Regional Entities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pollutant of Concern** | **Land Use Source** | **Best Management Practice** | **BMP Type** | **COH** | **CLV** | **CNLV** | **CC** | **CCRFCD** | **SNWA** | **Other** | **Comments** |
| Hydrocarbons (oil and grease) | Parking Lots | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Street sweeping - Public parking lots | SC | | | | | | | | Swept per maintenance standards. |
| | | Street sweeping - Private parking lots | SC | | | | | | | | Swept for aesthetics, but not required. |
| | | Public education | SC | | | | | X | | | General, vehicle maintenance |
| | | Regional Flood Infrastructure Maintenance | TC | | | | | X | | | Regional channels and detention basins |
| | | Local Storm Drain Sustem Maintenance | TC | | | | | | | | Catch basins, inlets and storm drains |
| | | Minimize directly connected impervious area | SD | | | | | | | | Depressed islands; buffer strips; porous pavement; minimize parking requirements |
| | | Parking lot design | SD | | | | | | | | Depressed islands; buffer strips; porous pavement; minimize parking requirements |
| | | Porous pavement | SC | | | | | | | | Modular pavers |
| | | Sand filter | TC | | | | | | | | |
| | | Sand/Oil Separators | TC | | | | | | | | |
| | | Hydrodynamic separator | TC | | | | | | | | |
| | Automotive Repair/ Vehicle Maintenance | Indoor workshops | SC | | | | | | | X | SNHD inspection program |
| | | Hazardous Waste Storage and Collection | SC | | | | | | | | |
| | | Commercial/Industrial Housekeeping | SC | | | | | | | | |
| | | Spill Control Prevention Plans | SC | | | | | | | | |
| | | Pre-Treatment Programs | SC | | | | | | | | |
| | | Trash Receptacle Enclosures | SC | | | | | | | | CLV&CNLV: Enclosed with roof or trellis; COH&CC: Enclosed only; All: receptacles with lids |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Public education (vehicle maintenance) | SC | | | | | X | | | |
| | | Sand/Oil Separators | TC | | | | | | | | |

| | | | | MS4 Permittees | | | | Regional Entities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pollutant of Concern** | **Land Use Source** | **Best Management Practice** | **BMP Type** | **COH** | **CLV** | **CNLV** | **CC** | **CCRFCD** | **SNWA** | **Other** | **Comments** |
| Hydrocarbons (oil and grease) | Automotive Repair/ Vehicle Maintenance | Sand filter | TC | | | | | | | | |
| | | So. NV Health District inspections | SC | | | | | | | X | Inspections of "conditionally exempt generators of hazardous waste" |
| | Gas Stations | Covered Fuel Areas | SD | | | | | | | | Per IBC/IFC regulations |
| | | Raised Fuel Areas | SD | | | | | | | | |
| | | Emergency Shut-off Switch & Shear Valves | SC | | | | | | | | |
| | | Commercial/Industrial Housekeeping | SC | | | | | | | | |
| | | Spill Control Prevention Plans | SC | | | | | | | | Industry and State requirement |
| | | Pre-Treatment Programs | SC | | | | | | | | |
| | | Trash Receptacle Enclosures | SC | | | | | | | | CLV&CNLV: Enclosed with roof or trellis; COH&CC: Enclosed only; All: receptacles with lids |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Hazardous Waste Storage and Collection | SC | | | | | | | | |
| | | Sand filter | TC | | | | | | | | |
| | | Sand/Oil Separators | TC | | | | | | | | |
| | | So. NV Health District inspections | SC | | | | | | | X | Inspections of "conditionally exempt generators of hazardous waste" |
| | Streets | Street Sweeping | SC | | | | | | | | Only public streets are swept regularly |
| | | Regional Flood Infrastructure Maintenance | TC | | | | | X | | | Regional channels and detention basins |
| | | Local Storm Drain Sustem Maintenance | TC | | | | | | | | Catch basins, inlets and storm drains |
| | | Household Hazardous Waste Collection | SC | | | | | | | | |
| | | Commercial/Industrial Housekeeping | SC | | | | | | | | |
| | | Ordinances Prohibiting Non-Stormwater Discharges and Littering | SC | | | | | | | | |
| | | Desert Dumping Controls | SC | | | | | | | X | SNHD regulations |
| | | Grease Interceptor Inspection Program | SC | | | | | | | | |
| | | Drop Inlet Marking Program | SC | D | D | D | D | | | | Developing RTC standards for new dev't |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Public education | SC | | | | | X | | | General, vehicle maintenance |
| | | Rural Land Overlay | | | | | | | | | Narrow streets, no curb & gutter |
| | | Street design | SD | | | | | | | | Minimum street widths; cul de sac design; buffer strips; depressed medians |
| | | Porous pavement | SC | | | | | | | | Modular pavers; not porous asphalt or concrete; only in alleys, parking lanes, etc. |

| | | | | MS4 Permittees | | | | Regional Entities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pollutant of Concern** | **Land Use Source** | **Best Management Practice** | **BMP Type** | **COH** | **CLV** | **CNLV** | **CC** | **CCRFCD** | **SNWA** | **Other** | **Comments** |
| Hydromodification | All | Open Space and Landscaping Requirements | SD | | | | | | | | |
| | | Drought Ordinances | SC | | | | | | X | | Dry weather flow control - Efficient irrigation, Xeriscaping, Turf area restrictions |
| | | Turf Conversion Program | SC | | | | | | X | | |
| | | Preserve Natural Drainage Corridors | SD | | | | | | | | CCRFCD also designates land for preservation |
| | | Hillside Ordinance | SD | | | | | | | | Density restrictions, Preserve natural open space. Does not apply to CNLV - no steep slopes. |
| | | Sensitive Lands Overlay | SD | | | | | | | | Density restrictions, Preserve natural open and drainage paths, Set backs from sensitive lands, Rural development overlay |
| | | Rural Land Overlay | | | | | | | | | Narrow streets, no curb & gutter |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Las Vegas Wash Stabilization Structures | TC | | | | | | X | | |
| | | Floodplain Development Ordinances | SD | | | | | | | | |
| | | Public Education | SC | | | | | | X | | Dry weather control - Efficient water use, conservation |
| | | Regional Channel Lining | TC | | | | | X | | | |
| | | Sustainability and Green Building Initiatives | SD | | | D | | | | | Dry weather control - Efficient water use, conservation |
| | | Site design (misc measures not listed separately) | SD | | | | | | | | Depressed landscaping; landscaped swales; buffer strips for WQ |
| | | Infiltration basin/trench | TC | | | | | | | | Only if verified by site-specific geotech investigation; requires water right |
| | | Bioretention | TC | | | | | | | | Desert rain garden |
| | | Extended detention basin | TC | | | | | | | | At development scale |
| | | Regional Water Quality Planning | SC | | | | | | | X | LVVWAC, LVWCC, LMWQF, 208 Plan |
| | | Standard Drainage Design Criteria | SD | | | | | X | | | Also have CCRFCD regional criteria |
| Nutrients (Phosphorus, Nitrogen) | Residential Landscaping | Drought Ordinances | SC | | | | | | X | | Efficient irrigation, Xeriscaping, Turf area restrictions |
| | | Turf Conversion Program | SC | | | | | | X | | |
| | | Household Hazardous Waste Collection | SC | | | | | | | | |
| | | Fertilizer, Pesticide and Herbicide Management - Private contractors | SC | | | | | | | | |
| | | Public Education | SC | | | | | X | | | Fertilizer use |
| | | Drop Inlet Marking Program | SC | D | D | D | D | | | | Developing RTC standards for new dev't |

| | | | | MS4 Permittees | | | | Regional Entities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pollutant of Concern** | **Land Use Source** | **Best Management Practice** | **BMP Type** | **COH** | **CLV** | **CNLV** | **CC** | **CCRFCD** | **SNWA** | **Other** | **Comments** |
| Nutrients (Phosphorus, Nitrogen) | Residential Landscaping | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Las Vegas Wash Stabilization Structures | TC | | | | | | X | | |
| | | Floodplain Development Ordinances | SD | | | | | | | | |
| | | Site design (misc measures not listed separately) | SD | | | | | | | | Depressed landscaping; landscaped swales; buffer strips for WQ |
| | | Extended detention basin | TC | | | | | | | | At development scale |
| | Commercial/Industrial Landscaping | Drought Ordinances | SC | | | | | | X | | Efficient irrigation, Xeriscaping, Turf area restrictions |
| | | Turf Conversion Program | SC | | | | | | X | | |
| | | Fertilizer, Pesticide and Herbicide Management - Private contractors | SC | | | | | | | | |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Las Vegas Wash Stabilization Structures | TC | | | | | | X | | |
| | | Commercial/Industrial Housekeeping | SC | | | | | | | | |
| | | Site design (misc measures not listed separately) | SD | | | | | | | | Depressed landscaping; landscaped swales; buffer strips for WQ |
| | Parks and Golf Courses | Drought Ordinances | SC | | | | | | X | | Efficient irrigation, Xeriscaping, Turf area restrictions |
| | | Fertilizer, Pesticide and Herbicide Management - Public entities | SC | | | | | | | | |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Las Vegas Wash Stabilization Structures | TC | | | | | | X | | |
| | | Extended detention basin | TC | | | | | | | | At development scale |
| | Streets and Parking Lots | Street Sweeping - Streets | SC | | | | | | | | |
| | | Street sweeping - Public parking lots | SC | | | | | | | | Swept per maintenance standards. |
| | | Street sweeping - Private parking lots | SC | | | | | | | | Swept for aesthetics, but not required. |
| | | Sand filter | TC | | | | | | | | |
| | General | Ordinances Prohibiting Non-Stormwater Discharges and Littering | SC | | | | | | | | |
| | | Desert Dumping Controls | SC | | | | | | | X | SNHD regulations |
| | | Infiltration basin/trench | TC | | | | | | | | Only if verified by site-specific geotech investigation; requires water right |
| | | Bioretention | TC | | | | | | | | Desert rain garden |
| | | Regional Water Quality Planning | SC | | | | | | | X | LVVWAC, LVWCC, LMWQF, 208 Plan |
| | | Sustainability and Green Building Initiatives | SD | | | D | | | | | |

| | | | | MS4 Permittees | | | | Regional Entities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pollutant of Concern** | **Land Use Source** | **Best Management Practice** | **BMP Type** | **COH** | **CLV** | **CNLV** | **CC** | **CCRFCD** | **SNWA** | **Other** | **Comments** |
| Pathogens (Bacteria) | Residential Development | Drought Ordinances | SC | | | | | | X | | Efficient irrigation, Xeriscaping, Turf area restrictions |
| | | Public Education | SC | | | | | X | | | Pet waste cleanup |
| | | Drop Inlet Marking Program | SC | D | D | D | D | | | | Developing RTC standards for new dev't |
| | | Regional Water Quality Planning | SC | | | | | | | X | LVVWAC, LVWCC, LMWQF, 208 Plan |
| | | Site design (misc measures not listed separately) | SD | | | | | | | | Depressed landscaping; landscaped swales; buffer strips for WQ |
| | | Infiltration basin/trench | TC | | | | | | | | Only if verified by site-specific geotech investigation; requires water right |
| | | Bioretention | TC | | | | | | | | Desert rain garden |
| | | Pet waste stations in parks | SC | | | | | | | | |
| | | Ordinances Prohibiting Non-Stormwater Discharges and Littering | SC | | | | | | | | |
| | Restaurants | Grease Interceptor Inspection Program | SC | | | | | | | | |
| | | Pre-Treatment Programs | SC | | | | | | | | |
| | | Trash Receptacle Enclosures | SC | | | | | | | | CLV&CNLV: Enclosed with roof or trellis; COH&CC: Enclosed only; All: receptacles with lids |
| Organic Compounds (Solvents) | Residential Development | Public Education | SC | | | | | X | | | |
| | | Drop Inlet Marking Program | SC | D | D | D | D | | | | Developing RTC standards for new dev't |
| | | Desert Dumping Controls | SC | | | | | | | X | SNHD regulations |
| | | Household Hazardous Waste Collection | SC | | | | | | | | |
| | | Ordinances Prohibiting Non-Stormwater Discharges and Littering | SC | | | | | | | | |
| | | Site design (misc measures not listed separately) | SD | | | | | | | | Depressed landscaping; landscaped swales; buffer strips for WQ |
| | | Infiltration basin/trench | TC | | | | | | | | Only if verified by site-specific geotech investigation; requires water right |
| | | Bioretention | TC | | | | | | | | Desert rain garden |
| | Industrial Sites | Sand/Oil Separators | TC | | | | | | | X | SNHD Inspection program |
| | | Indoor workshops | SD | | | | | | | X | SNHD inspection program |
| | | Hazardous Waste Storage and Collection | SC | | | | | | | | |
| | | Commercial/Industrial Housekeeping | SC | | | | | | | | |
| | | Spill Control Prevention Plans | SC | | | | | | | | Industry and State requirement |
| | | Pre-Treatment Programs | SC | | | | | | | | |
| | | Trash Receptacle Enclosures | SC | | | | | | | | CLV&CNLV: Enclosed with roof or trellis; COH&CC: Enclosed only; All: receptacles with lids |

| | | | | MS4 Permittees | | | | Regional Entities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pollutant of Concern** | **Land Use Source** | **Best Management Practice** | **BMP Type** | **COH** | **CLV** | **CNLV** | **CC** | **CCRFCD** | **SNWA** | **Other** | **Comments** |
| Organic Compounds (Solvents) | Industrial Sites | Site design (misc measures not listed separately) | SD | | | | | | | | Depressed landscaping; landscaped swales; buffer strips for WQ |
| | | Sand filter | TC | | | | | | | | |
| | | So. NV Health District inspections | SC | | | | | | | X | Inspections of "conditionally exempt generators of hazardous waste" |
| Sediment (Sediment, TSS) | Res, Com and Ind Development | Regional Flood Infrastructure Maintenance | TC | | | | | X | | | Regional channels and detention basins |
| | | Local Storm Drain Sustem Maintenance | TC | | | | | | | | Catch basins, inlets and storm drains |
| | | Street Sweeping | SC | | | | | | | | |
| | | Dust Control Measures | SC | | | | | | | | Requires streets/parking to be stabilized |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Regional Channel Lining | TC | | | | | X | | | |
| | | Las Vegas Wash Stabilization Structures | TC | | | | | | X | | |
| | | Sensitive Lands Overlay | SD | | | | | | | | Density restrictions, Preserve natural open and drainage paths, Set backs from sensitive lands, Rural development overlay |
| | | Floodplain Development Ordinances | SD | | | | | | | | |
| | | Regional Water Quality Planning | SC | | | | | | | X | LVVWAC, LVWCC, LMWQF, 208 Plan |
| | | Standard Drainage Design Criteria | SD | | | | | X | | | Also have CCRFCD regional criteria |
| | | Sand/Oil Separators | TC | | | | | | | X | SNHD inspection program for industrial sites |
| | | Hydrodynamic separator | TC | | | | | | | | |
| | Hillside Development | Hillside Development Ordinance | SD | | | | | | | | Density restrictions, Preserve natural open space. Does not apply to CNLV - no steep slopes. |
| Heavy Metals (Copper, Lead, Zinc) | Streets and Parking Lots | Street Sweeping | SC | | | | | | | | |
| | | Street sweeping - Public parking lots | SC | | | | | | | | Swept per maintenance standards. |
| | | Street sweeping - Private parking lots | SC | | | | | | | | Swept for aesthetics, but not required. |
| | | Regional Flood Infrastructure Maintenance | TC | | | | | X | | | Regional channels and detention basins |
| | | Local Storm Drain Sustem Maintenance | TC | | | | | | | | Catch basins, inlets and storm drains |
| | | Ordinances Prohibiting Non-Stormwater Discharges and Littering | SC | | | | | | | | |
| | | Dust Control Measures | SC | | | | | | | | Requires streets/parking to be stabilized |
| | | Desert Dumping Controls | SC | | | | | | | X | SNHD regulations |
| | | Drop Inlet Marking Program | SC | D | D | D | D | | | | Developing RTC standards for new dev't |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Public education | SC | | | | | X | | | General, vehicle maintenance |
| | | Las Vegas Wash Stabilization Structures | TC | | | | | | X | | |

| | | | | MS4 Permittees | | | | Regional Entities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pollutant of Concern** | **Land Use Source** | **Best Management Practice** | **BMP Type** | **COH** | **CLV** | **CNLV** | **CC** | **CCRFCD** | **SNWA** | **Other** | **Comments** |
| Heavy Metals | Streets and Parking Lots | Rural Land Overlay | | | | | | | | | Narrow streets, no curb & gutter |
| (Copper, Lead, Zinc) | | Regional Water Quality Planning | SC | | | | | | | X | LVVWAC, LVWCC, LMWQF, 208 Plan |
| | | Minimize directly connected impervious area | SD | | | | | | | | Minimize overall imp area; disconnect downspouts; drain runoff to pervious areas |
| | | Parking lot design | SD | | | | | | | | Depressed islands; buffer strips; porous pavement; minimize parking requirements |
| | | Street design | SD | | | | | | | | Minimum street widths; cul de sac design; buffer strips; depressed medians |
| | | Porous pavement | SC | | | | | | | | Modular pavers; not porous asphalt or concrete |
| | | Sand filter | TC | | | | | | | | |
| | | Sand/Oil Separators | TC | | | | | | | | |
| | | Hydrodynamic separator | TC | | | | | | | | |
| | Automotive Repair Shops | Sand/Oil Separators | TC | | | | | | | X | SNHD inspection program |
| | | Indoor workshops | SD | | | | | | | X | SNHD inspection program |
| | | Hazardous Waste Storage and Collection | SC | | | | | | | | |
| | | Commercial/Industrial Housekeeping | SC | | | | | | | | |
| | | Spill Control Prevention Plans | SC | | | | | | | | Industry and State requirement |
| | | Pre-Treatment Programs | SC | | | | | | | | |
| | | Trash Receptacle Enclosures | SC | | | | | | | | CLV&CNLV: Enclosed with roof or trellis; COH&CC: Enclosed only; All: receptacles with lids |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | So. NV Health District inspections | SC | | | | | | | X | Inspections of "conditionally exempt generators of hazardous waste" |
| Litter/Floatables | All | Street Sweeping | SC | | | | | | | | |
| | | Regional Flood Infrastructure Maintenance | TC | | | | | X | | | Regional channels and detention basins |
| | | Local Storm Drain Sustem Maintenance | TC | | | | | | | | Catch basins, inlets and storm drains |
| | | Commercial/Industrial Housekeeping | SC | | | | | | | | |
| | | Desert Dumping Controls | SC | | | | | | | X | SNHD regulations |
| | | Drop Inlet Marking Program | SC | D | D | D | D | | | | Developing RTC standards for new dev't |
| | | Public education | SC | | | | | X | | | Littering campaigns (Don't Trash LV) |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Regional Water Quality Planning | SC | | | | | | | X | LVVWAC, LVWCC, LMWQF, 208 Plan |
| | | Infiltration basin/trench | TC | | | | | | | | Only if verified by site-specific geotech investigation; requires water right |

| | | | | MS4 Permittees | | | | Regional Entities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pollutant of Concern** | **Land Use Source** | **Best Management Practice** | **BMP Type** | **COH** | **CLV** | **CNLV** | **CC** | **CCRFCD** | **SNWA** | **Other** | **Comments** |
| Litter/Floatables | All | Extended detention basin | TC | | | | | | | | At development scale |
| | | Sand/Oil Separators | TC | | | | | | | | |
| | | Hydrodynamic separator | TC | | | | | | | | |
| Pesticides & Herbicides | Landscaped Areas | Fertilizer, Pesticide and Herbicide Management - Private contractors | SC | | | | | | | | |
| | | Fertilizer, Pesticide and Herbicide Management - Public entities | SC | | | | | | | | |
| | | Drought Ordinances | SC | | | | | | X | | Efficient irrigation, Xeriscaping, Turf area restrictions |
| | | Turf Conversion Program | SC | | | | | | X | | |
| | | Commercial/Industrial Housekeeping | SC | | | | | | | | |
| | | Hazardous Waste Storage and Collection | SC | | | | | | | | Required for municipal and industrial sites, not for residential |
| | | Ordinances Prohibiting Non-Stormwater Discharges and Littering | SC | | | | | | | | |
| | | Desert Dumping Controls | SC | | | | | | | X | SNHD regulations |
| | | Public education | SC | | | | | X | | | Proper use and disposal of fertilizers and garden chemicals |
| | | Drop Inlet Marking Program | SC | D | D | D | D | | | | Developing RTC standards for new dev't |
| | | Floodplain Development Ordinances | SD | | | | | | | | |
| | | Regional Water Quality Planning | SC | | | | | | | X | LVVWAC, LVWCC, LMWQF, 208 Plan |
| | | Site design (misc measures not listed separately) | SD | | | | | | | | Depressed landscaping; landscaped swales; buffer strips for WQ |
| | | Infiltration basin/trench | TC | | | | | | | | Only if verified by site-specific geotech investigation; requires water right |
| | | Bioretention | TC | | | | | | | | Desert rain garden |
| Selenium/TDS | Shallow Groundwater | Drought Ordinances | SC | | | | | | X | | Efficient irrigation, Xeriscaping, Turf area restrictions |
| | | Turf Conversion Program | SC | | | | | | X | | |
| | | Public education | SC | | | | | | X | | Water conservation |
| | | Ordinances Prohibiting Non-Stormwater Discharges and Littering | SC | | | | | | | | |
| | | Regional Water Quality Planning | SC | | | | | | | X | LVVWAC, LVWCC, LMWQF, 208 Plan |

**BMPs that were previously determined by DGWG to be infeasible or undesirable for LVV:**

| | |
|---|---|
| Catch basin insert | Porous asphalt or concrete |
| Cistern | Unpaved parking areas |
| Green roof | Dry wells |

# Section 10

MWH

TECHNICAL MEMORANDUM

# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

## STORMWATER MANAGEMENT PLAN DOCUMENTATION

## Technical Memorandum IV.10

## Evaluation of Low Impact Development Measures for NDSR Program

May 27, 2010

*Prepared for*

**Stormwater Quality Management Committee**

*Prepared by*

MWH

BUILDING A BETTER WORLD

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# Executive Summary

This document summarizes the Development Guidelines Working Group's review and recommendation of Low Impact Development (LID) measures considered for adoption as part of the Las Vegas Valley New Development and Significant Redevelopment (NDSR) Program. Low impact development consists of a variety of site planning and site design measures or practices to minimize the impact of individual urban developments on stormwater runoff quantity and quality.

LID measures were selected for the Las Vegas Valley LID "toolbox" using the following process.

1. Identify all known LID measures based on national manuals and guidelines.
2. Identify those LID measures that would be feasible in the context of the Las Vegas Valley climate, hydrology, hydrogeology, watershed conditions, and development styles.
3. Identify those locally feasible LID measures that meet the objective of LID for the NDSR Program, which is to fill gaps in existing measures or supplement existing programs on an "opportunistic" basis.

The LID measures determined to be feasible for use in the Las Vegas Valley NDSR program, if required, are listed below.

| LID Category | Specific Measure or Practice |
|---|---|
| Minimize directly connected impervious area | Minimize overall impervious area |
| | Direct runoff onto properly designed unpaved surfaces |
| | Disconnect rooftop drains |
| Parking Lot Design | Depressed medians |
| | Buffer strips |
| | Porous paving – modular pavers |
| | Minimize parking requirements |
| Street Design | Minimum street widths |
| | Cul de sac design |
| | Buffer strips |
| | Depressed medians |
| Site Design | Depressed landscaping |
| | Landscaped drainage swales |
| | Open space set-asides |
| | Density tradeoffs |
| Landscape Design | Xeriscaping |
| | Depressed landscape areas |
| | Buffer strips |

LID implementation could occur through mandatory, voluntary, or incentive-based programs, depending on the reason for including LID measures in the NDSR program. Implementation details will be worked out during preparation of the final proposed SWMP for the new MS4 permit.

# 1 Introduction

This document summarizes the Development Guidelines Working Group's (DGWG) review and recommendation of Low Impact Development (LID) measures considered for adoption as part of the Las Vegas Valley New Development and Significant Redevelopment (NDSR) Program. It is based on an earlier review of LID measures conducted by the DGWG and Las Vegas Valley Stormwater Stakeholders Working Group (SSWG) in 2008. This document updates and refines the original recommendations based on the requirements of the new Las Vegas Valley Municipal Separate Storm Sewer System (MS4) permit.

The MS4 permit contains the following requirement related to LID in the NDSR (or Post-Construction) Program.

> *IV.F.3.a* *Describe how the Permittees will review and enhance the SWMP post-construction program requirements in a manner appropriate for the unique hydrologic, hydrogeologic and regional conditions and needs of the Las Vegas Valley. The review shall address the following elements…*
>
> *IV.F.3.a.ii* *Describe how the Permittees will develop low-impact development ("LID") measures that will remain in effect after construction is complete and are effective and appropriate for the Las Vegas Valley and its environment. The program will outline the selected LID measures found effective and appropriate for the Las Vegas Valley along with a summary and schedule for implementation in the MS4…*

This memorandum documents the rationale for identifying certain LID measures as being appropriate for use in the Las Vegas Valley NDSR Program.

# 2 Definition

Low impact development consists of a variety of site planning and site design measures or practices to minimize the impact of individual urban developments on stormwater runoff quantity and quality. EPA offers the following definition of LID:

> *LID comprises a set of site design approaches and small-scale stormwater management practices that are designed to reduce runoff and associated pollutants from the site at which they are generated. By means of infiltration, evapotranspiration, and reuse of rainwater, LID techniques manage water and water pollutants at the source and thereby prevent or reduce the impact of development on rivers, streams, lakes, coastal waters, and ground water.*

# 3 Objective of LID for the Las Vegas Valley NDSR Program

The NDSR Program being developed in response to the MS4 permit requirements has the following key characteristics:

1. It is consistent with the unique climatic, hydrologic, hydrogeologic and water quality conditions in Las Vegas Valley, as described in the "Unique Factors" technical memorandum prepared in support of the SWMP (MWH 2010a).
2. It relies on regional and watershed-based structural and non-structural approaches for addressing impacts of new development and significant redevelopment on stormwater quality.
3. It focuses on addressing the specific pollutants of concern identified by the Stormwater Quality Management Committee (SQMC) and SSWG. These are listed in **Table 1**, and discussed more fully in a separate Pollutants of Concern technical memorandum (MWH, 2010c).
4. Practices that increase infiltration to the shallow groundwater system will not be adopted in order to avoid exacerbating problems with selenium concentrations that already exceed water quality standards. This is discussed more fully in a separate Infiltration Suitability technical memorandum (MWH, 2010b).

Given these program characteristics, the following objective for LID as a component of the NDSR Program is recommended:

> *The objective of LID within the Las Vegas Valley Post-Construction Program is to encourage use of site design principles on an opportunistic basis to reduce transport of pollutants to the MS4, without increasing infiltration to groundwater compared to pre-development conditions.*

The DGWG believes that existing and proposed regional and watershed-based measures will be successful in meeting the requirements of the NDSR Program. These programs should be mandatory, to assure that program goals are met. If gaps are found in existing and proposed watershed-based measures such that the maximum extent practicable (MEP) standard cannot be met, LID measures could be used to "fill the gap" to assure permit compliance. Even if proposed watershed-based measures are determined to be adequate to meet minimum MS4 permit requirements, additional benefits to stormwater quality could be achieved by encouraging developers to include appropriate LID measures in site designs. Because these measures would not be strictly required for compliance with the MS4 permit, they would be encouraged but not prescribed.

**Table 1. Pollutants of Concern for Las Vegas Valley NDSR Program**

| Pollutant Category | Specific Pollutants of Concern | Typical Urban Sources in Las Vegas Valley |
|---|---|---|
| Nutrients | • Nitrate<br>• Total Phosphorus<br>• Orthophosphate | • Residential development<br>• Landscaped portions of commercial and industrial sites<br>• Parks and golf courses<br>• Streets and parking lots |
| Pathogens | • Bacteria | • Residential development<br>• Restaurants |
| Hydrocarbons | • Oil and Grease | • All |
| Organic Compounds | • Solvents | • Commercial/industrial sites |
| Pesticides and Herbicides | • Pesticides<br>• Herbicides | • Residential areas<br>• Landscaped portions of commercial and industrial sites<br>• Parks and golf courses |
| Sediment | • Sediment<br>• Total Suspended Solids | • Residential development<br>• Hillside development<br>• Streets and highways |
| Metals | • Copper<br>• Lead<br>• Zinc | • Automotive repair shops<br>• Streets and parking lots |
| Selenium | • Selenium | • Urban irrigation return flows via shallow aquifer in areas with selenium-rich geology |
| Litter/Floatables | • Trash and Debris | • All |
| Hydromodification | • Storm flows<br>• Low flows | • All |
| Other | • TDS<br>• pH<br>• Surfactants | • For TDS:<br>• Urban irrigation return flows via shallow aquifer in areas with saline soils<br>• For pH:<br>• Urban irrigation return flows via shallow aquifer in areas with alkaline soils<br>• For Surfactants:<br>• Residential development<br>• Commercial/Industrial development involving vehicle washing<br>• Mobile cleaning operations |

The *Unique Factors* technical report (MWH, 2010a) describes the impact of past development in Las Vegas Valley on increasing storm runoff volume in Las Vegas Wash and tributaries. On the other hand, the MS4 permit indicates that one of the objectives of the NDSR Program is "to promote the reuse of stormwater for municipal water supply by developing BMPs to encourage beneficial use of stormwater." This is most efficiently achieved by delivering an acceptable quality of stormwater to Lake Mead, where it is blended with Colorado River water at a ratio of about 1:99 and delivered for potable and non-potable uses by the Southern Nevada Water Authority (SNWA) pumping and conveyance system. Therefore, the objective of the LID program is not primarily runoff volume reduction, but pollutant reduction. The *Unique Factors* report describes existing measures to control erosion from runoff from areas of new development and significant redevelopment. These include concrete lining of virtually all regional flood control channels; erosion stabilization structures in lower Las Vegas Wash; and requirements for developers to stabilize onsite and offsite channels in which erosion potential would be increased as a result of the development.

LID measures must not increase infiltration to the shallow groundwater system compared to existing conditions. This precludes use of infiltration-based LID practices in any area where the shallow aquifer is within 10 feet of the ground surface. Limitations on infiltration-based BMPs are described in the *Infiltration Suitability* technical memorandum (MWH, 2010b). In all areas it is assumed that typical landscaping and site design practices will not increase infiltration over pre-development conditions when applied on small scales at the site level.

# 4 Measures and Practices in the Low Impact Development 'Toolbox'

LID measures were selected for the Las Vegas Valley LID "toolbox" using the following process.

1. Identify all known LID measures based on national manuals and guidelines.
2. Identify those LID measures that would be feasible in the context of the Las Vegas Valley climate, hydrology, hydrogeology, watershed conditions, and development styles.
3. Identify those locally feasible LID measures that meet the above-stated objective of LID for the NDSR Program.

**All Potential LID Measures.** Numerous measures and practices are often discussed under the heading of LID. These include the following.

- **Minimize Directly Connected Impervious AreaJ:**
  - Minimize overall impervious area (streets, parking lots, sidewalks, driveways, rooftops) in a development
  - Direct runoff from paved surfaces onto unpaved surfaces before entering the storm drain system
  - Disconnect rooftop downspouts from driveways or storm drains and direct them to landscaped areas prior to entering the street or drainage system
- **Parking Lot Design:**
  - Depressed medians – depress parking lot medians so pavement drains into them; collected water is then infiltrated or evaporated
  - Buffer strips – landscaped areas between pavement and the drainage system; pavement runoff is directed as sheet flow into the buffer strips for infiltration or vegetative treatment
  - Porous pavement – permeable pavements or modular paving materials that allow for infiltration of stormwater
  - Minimize parking space requirements – reduce number of paved parking spaces required for different types of development
  - Unpaved overflow parking – allow use of unpaved areas for overflow or low-use parking

- **Street Design:**
  - Minimum street widths – reduce minimum street widths to reduce directly connected paved area
  - Cul de sac design – include depressed medians in the center of cul de sacs to minimize paved area and collect and infiltration runoff
  - Porous pavement – permeable pavements or modular paving materials that allow for infiltration of stormwater; used on shoulders and low-traffic areas
  - Buffer strips – landscaped areas between pavement and the drainage system; pavement runoff is directed as sheet flow into the buffer strips for infiltration or vegetative treatment
  - Depressed medians – depress street medians so pavement drains into them; collected water is then infiltrated or evaporated
- **Site Design – Parcel Level:**
  - Depressed landscaping – depressed yard areas that retain and infiltrate/evaporate runoff
  - Desert rain gardens – rain gardens are areas in yards, typically at the lot drainage outlet, designed to collect and retain runoff to support landscaping; in desert environment, rainfall cannot be expected to fully support vegetation so supplemental irrigation is required; positive drainage may be required; native or xeriscape vegetation is required
  - Cisterns – facilities to capture rooftop or other site runoff and store it for use onsite, e.g., for landscape watering or indoor non-potable use
- **Site Design – Subdivision Level:**
  - Detention/retention basins – storage basins, often combined with parks or other open space, to reduce runoff peak discharges
  - Landscaped drainage swales – landscaped areas to convey runoff and provide modest infiltration and treatment benefits
  - Open space set-asides – reserve areas in the development for open space to avoid impacts of development on that land, and/or to receive runoff from surrounding developed areas
  - Density tradeoffs – administrative measures to create lower overall density in a development by allowing higher densities in selected areas as a tradeoff for preserving more open space
- **Landscape Design:**
  - Xeriscaping – use drought-tolerant plants in landscaping to reduce over-irrigation runoff and fertilizer runoff
  - Desert rain gardens – rain gardens are areas in yards, typically at the lot drainage outlet, designed to collect and retain runoff to support landscaping; in desert environment, rainfall cannot be expected to fully

support vegetation so native vegetation or xeriscape landscaping is required; positive drainage may be required

- Depressed landscaped areas – depressed landscaped areas that retain and infiltrate/evaporate runoff
- Buffer strips – use landscaping strategically to create buffer strips alongside streets, parking lots and other areas with large amounts of paved area or significant pollutant potential

**LID Measures Feasible in Las Vegas Valley. Table 2** summarizes the results of the DGWG's review of these LID measures in the context of their potential applicability in the Las Vegas environment. It is noted that any LID measures that rely on infiltration as the primary stormwater disposal method could be problematic for two reasons:

1. The policy of the Nevada State Engineer is that capture of water onsite is only allowed if a water right has been granted based on a demonstrated beneficial use of the captured water. Infiltration is not a recognized beneficial use by the State Engineer. Therefore, capture of stormwater with the specific intent of infiltrating it would not be permittable.
2. Infiltration would not be allowed in areas that are not suitable for infiltration due to: shallow groundwater that is a potential source of selenium to lower Las Vegas Wash and its tributaries; expansive or collapsible soils; previous soil or groundwater contamination; heavy industrial activity; or other factors. The *Infiltration Suitability* technical memorandum contains an Infiltration Suitability Map that superimposes all infiltration constraints and indicates where stormwater infiltration can be accomplished safely.

As noted above, capture of water for a beneficial use would require a water right permit from the State Engineer. The State Engineer has indicated that capture and use of water using LID measures on individual lots (sometimes called "stormwater harvesting") would not be permittable under current policies.

Any landscaping-oriented LID measures are assumed to utilize xeriscape landscaping techniques in most applications due to conservation restrictions incorporated in ordinances for each MS4 permittee. These are described in MWH (2010a).

Use of porous concrete or asphalt for parking lot or street design was determined to be impractical for Las Vegas Valley due to serious concerns over maintenance and long-term performance. Clogging from fine particulates is a concern in the desert environment. Recent poor experience in the Denver area has led to a moratorium on use of porous concrete and asphalt until designs are improved and more long-term performance data is available. Until that time, it is recommended that porous concrete and asphalt not be used in Las Vegas Valley.

Use of unpaved areas for overflow parking is not feasible because it would violate air quality management practices. Las Vegas Valley was determined to be a non-attainment area for PM10 particulates (fine particles) under the Clean Air Act. As a result, air quality management programs were adopted by Clark County. These include a program to pave

unpaved roads and parking areas to prevent production of PM10s. Allowing more unpaved parking areas to address stormwater quality concerns would contradict the objectives of this program and threaten the ability of the region to comply with strict air quality standards.

Cisterns are a stormwater harvesting approach that would not be permittable by the State Engineer.

Roof gardens or green roofs are not practical in the Las Vegas Valley environment. Rainfall alone is not sufficient to support green roof vegetation, even when xeriscaping is used. Use of potable water to irrigate a green roof is not practical in the desert environment. Therefore, graywater (i.e., water from bathing, laundry and bathroom sinks) from the building would have to be used for irrigation. However, the boards and councils of Southern Nevada Water Authority, the Clean Water Coalition, Clark County, and the three cities have adopted a policy to "prohibit the use of treated or untreated graywater in the Las Vegas Valley and prohibit its use outside the valley where there is reasonable potential for return flow to the Colorado River system or other Water Recycling programs." The policy is part of an overall water recycling policy, and responds to health concerns over use of untreated graywater.

**Feasible LID Measures that Meet Post-Construction Program Objectives.** Of the feasible LID measures listed in **Table 2**, only Detention/Retention Basins do not meet the NDSR Program objectives. Storage basins have the potential to increase infiltration to the shallow groundwater system above pre-development conditions. Large retention basins could reduce the volume of flow delivered to Lake Mead, which would be contrary to the objective of maximizing beneficial use of stormwater by recovering it from Lake Mead. **Table 3** lists the LID measures considered acceptable for use in the Las Vegas Valley NDSR Program. It also indicates the limitations on their use in the valley, the level of compatibility with existing development standards in Las Vegas Valley communities, and the relative ease of modifying those standards to accommodate the LID practices.

## Table 2. Feasible LID Measures for Las Vegas Valley

| LID Category | Specific Measure or Practice | Feasible for LVV?[1] | Rationale |
|---|---|---|---|
| Minimize directly connected impervious area | Minimize overall impervious area | Yes | |
| | Direct runoff onto properly designed unpaved surfaces | Yes | |
| | Disconnect rooftop drains | Yes | |
| Parking Lot Design | Depressed medians | Yes | Only outside Selenium Management Area; Xeriscaping only |
| | Buffer strips | Yes | Xeriscaping only |
| | Porous paving – porous concrete or asphalt | No | Porous pavement may get clogged by fine particles in desert environment. Long-term performance is questionable. Moratorium on these materials in Denver adds to concerns. |
| | Porous paving – cobblestones, modular pavers | Yes | |
| | Minimize parking requirements | Yes | |
| | Unpaved overflow parking | No | Violates dust control regulations for LVV air quality management |
| Street Design | Minimum street widths | Yes | |
| | Cul de sac design | Yes | |
| | Porous pavement – porous concrete or asphalt | No | Porous pavement may get clogged by fine particles in desert environment. Long-term performance is questionable. Moratorium on these materials in Denver adds to concerns. |
| | Buffer strips | Yes | Xeriscaping only |
| | Depressed medians | Yes | Xeriscaping only |
| Site Design – Parcel Level | Depressed landscaping | Yes | Only outside Selenium Management Area; Xeriscaping only |
| | Desert rain gardens | Yes | Xeriscaping only |
| | Cisterns | No | Not enough rainfall to be a cost-effective source of water for typical on-site non-potable water uses. Violates state water law to capture and use rainwater onsite. |
| | Roof gardens/green roofs | No | Not enough rainfall to support vegetation, so only feasible when irrigated with graywater from building; this violates SNWA's policy on graywater use |
| Site Design – Subdivision Level | Detention/retention basins | Yes | |
| | Landscaped drainage swales | Yes | Xeriscaping only |
| | Open space set-asides | Yes | |
| | Density tradeoffs | Yes | |
| Landscape Design | Xeriscaping | Yes | |
| | Desert rain gardens | Yes | Xeriscaping only |
| | Depressed landscape areas | Yes | Only outside Selenium Management Area; Xeriscaping only |
| | Buffer strips | Yes | Xeriscaping only |

[1] While measures given a "No" rating may not be feasible in most cases, there may be certain circumstances when the measure may be uniquely viable (e.g., a roof garden in a large resort, for which air conditioner condensate could be plumbed to sustain the vegetation). Developers could choose to implement these measures in these cases, adopting appropriate design standards from other communities.

## Table 3. LID Measures Acceptable for Las Vegas Valley Post-Construction Program

| LID Category | Specific Measure or Practice | Limitations | Compatibility with Existing Development Standards | Ease of Incorporating into Development Standards |
|---|---|---|---|---|
| Minimize directly connected impervious area | Minimize overall impervious area | | No maximum % impervious specified; landscape buffers required on all lot lines | Easy |
| | Direct runoff onto properly designed unpaved surfaces | | No requirement; current practice most often uses concrete valley gutters or U-channels to convey runoff through landscape buffer to offsite point | Easy |
| | Disconnect rooftop drains | | Not required; most commercial roofs drain to concrete swale or pipe; residential roofs typically do not have gutters or downspouts due to lack of rainfall | Easy |
| Parking Lot Design | Depressed medians | Only outside Selenium Management Area; Xeriscaping only | Not required and not standard; typical design requires positive drainage and uses raised curbed median for ease of maintenance and public safety | Moderate; significant change in local design practices |
| | Buffer strips | Xeriscaping only | Required for landscaping but not drainage control; current practice most often uses concrete valley gutters or U-channels to convey runoff through landscape buffer to offsite point | Easy |
| | Porous paving – modular pavers | | Not required but allowed; used only infrequently | Easy |
| | Minimize parking requirements | | All entities have maximum parking allowance as a percentage of minimum requirement (e.g., 125% of minimum); all entities are invesitigating reducing the maximum parking allowance | Difficult; political issue |
| Street Design | Minimum street widths | | Minimum street widths are set based on public safety standards; LVV has very high ISO rating in part due to street design accommodating emergency vehicles | Difficult if would affect ISO rating |
| | Cul de sac design | | Cul de sac medians allowed but not required; all entities are seeking to reduce number of cul de sacs in new development | Moderate |
| | Buffer strips | Xeriscaping only | See above | Easy |
| | Depressed medians | Xeriscaping only | See above | Difficult; safety concerns |

| LID Category | Specific Measure or Practice | Limitations | Compatibility with Existing Development Standards | Ease of Incorporating into Development Standards |
|---|---|---|---|---|
| Site Design – Parcel Level | Depressed landscaping | Only outside Selenium Mgt Area; Xeriscaing only | Not required but allowed | Moderate |
| Site Design – Subdivision Level | Landscaped drainage swales | Xeriscaping only | Not required, but allowed as long as rip rap size is adequate for design storm | Easy |
| | Open space set-asides | | Required in form of setback requirements and open space requirements for master plan areas; requirements based on type and density of development | Moderate |
| | Density tradeoffs | | Allowed in master plan areas | Moderate |
| Landscape Design | Xeriscaping | | Required; ordinances prohibit use of turf in front yards and restrict use in back yards to | Easy |
| | Depressed landscape areas | Only outside Selenium Mgt Area; Xeriscaping only | Not required but allowed | Easy |
| | Buffer strips | Xeriscaping only | See above | Easy |

# 5 Implementation Options

Communities use a variety of methods of implementing LID practices. These are summarized below.

- **Mandatory –** require developers to implement LID practices as a condition of development approval; establish post-development runoff objectives; specify LID practices to be used under different design conditions. [Note: Certain aspects of this approach are already a part of local code and/or regulatory mechanisms]
- **Voluntary –** no LID requirements or incentives; LID practices used solely at discretion of developers; role of entities is limited to making LID design information available to the development community. Local jurisdictions may need to develop or modify current ordinances or regulatory mechanisms that may pose barriers to LID implementation or planning code that does not conflict with flood control (e.g., employing depressed landscaping areas prohibiting positive drainage of parking lots)
- **Incentive-Based –** entities promote LID by offering development incentives (density tradeoffs, accelerated approvals, reduced development fees, etc.) to developers who choose to incorporate LID principles in their design.

The LID objective adopted for the NDSR Program specifies that, unless specifically required for MS4 permit compliance, LID measures should be encouraged but not required. This is consistent with the recommendation of the SSWG, which recommended adopting an incentive-based approach to implementing LID measures in Las Vegas Valley if such incentives can be formalized. Communities were encouraged to develop various types of incentives to encourage developers to implement LID principles in their designs. These incentives could be coordinated with other sustainable development and "green building" initiatives already underway in the Valley. LID implementation details will be worked out during preparation of the final proposed SWMP for the new MS4 permit.

# 6 References

Environmental Protection Agency. 2009.

http://www.epa.gov/owow/nps/lid/costs07/documents/q-and-a-reducingstormwatercosts.pdf

MWH Americas, Inc. 2010a. Technical Memorandum IV.5 - Unique Factors Influencing the Las Vegas Valley Municipal Separate Storm Sewer Program.

MWH Americas, Inc. 2010b. Technical Memorandum IV.6 - Limitations on Use of Infiltration-Based BMPs for New Development and Significant Redevelopment in Las Vegas Valley.

MWH Americas, Inc. 2010c. Technical Memorandum IV.8 - Pollutants of Concern for Las Vegas Valley MS4 NDSR Program.

# Section 11

MWH

TECHNICAL MEMORANDUM

# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

## STORMWATER MANAGEMENT PLAN DOCUMENTATION

## Technical Memorandum IV.11

## Potential Water Quality Retrofits of Regional Detention Basins – Strategic Plan

January 28, 2011

*Prepared for*

**Stormwater Quality Management Committee**

*Prepared by*

MWH®

BUILDING A BETTER WORLD

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# Executive Summary

One of the requirements of the Municipal Separate Storm Sewer System (MS4) permit is to address water quality impacts from new development and significant redevelopment. An approach was developed to use existing Las Vegas Valley detention basins for water quality management as well as their current flood control purpose.

Methods for detention basin retrofit focus on implementing standard water quality design features for extended detention basins (EDBs) within the regional detention basins. These features could include dedicated water quality storage, water quality outlet, lengthened flow path, and wetland vegetation. EDBs would detain a water quality capture volume (WQCV) for a minimum of 24 hours up to 48 hours. The literature recommends calculation of a "maximized" WQCV that efficiently sizes water quality facilities to detain the runoff from the majority of storms.

The literature includes an empirical equation for estimating maximized WQCV using only basic watershed information. The empirical equation was compared to the runoff computed for CCRFCD 2008 Master Plan Update (MPU) HEC-1 models for the 85$^{th}$ percentile storm in Las Vegas Valley (0.32 inches). This depth was previously selected by the Development Guidelines Working Group as the recommended water quality design storm. The empirical equation resulted in acceptable estimates for smaller watersheds, but overestimated the WQCV for detention basins with larger tributary areas and with more land outside of the ultimate development boundary.

The empirical equation was used to estimate the WQCV for all of the land within the 10 major Las Vegas Valley watersheds with potential for new development. The total WQCV estimated for all potential new development is 1,438 acre-feet. This total WQCV could be implemented at detention basins downstream of both existing development and new development in a pollutant trading approach, which fulfills the MS4 permit requirement for new development.

The 52 Las Vegas Valley detention basins are connected by conveyance facilities in a dendritic manner. In the Las Vegas Valley there are 12 final detention basins, i.e., those located farthest downstream in a watershed and closest to the major receiving waters. Six final detention basins have tributary areas greater than 40 square miles each. Runoff from approximately 60 percent of the ultimate development boundary area flows through these six strategic detention basins. If the six strategic detention basins were retrofitted, a large amount of new and existing development could be addressed through a small number of projects. Unfortunately, in most cases, the WQCV for these detention basins is so large that the flood control operations of the basins would be compromised by the retrofit. Other than the Lower Duck Detention Basin and the Confluence Detention Basin, it does not appear feasible to only retrofit the strategic detention basins for water quality.

The recommended detention basin water quality retrofit approach is to develop a unique retrofit plan for each major watershed resulting in enough total WQCV to address the runoff

from new development and significant redevelopment. The approach has the following elements.

- Consider the most practical opportunities for retrofit in each watershed, rather than retrofitting every single detention basin.
- Consider opportunities for retrofit beginning with the most downstream detention basins in a watershed.
- Combine water quality retrofits with detention basin construction and upgrades when possible to keep total design and construction costs to a minimum.
- Use existing capacity opportunities including sediment storage and capacity that is not needed for 100-year flood storage.

The following table lists the required total WQCV associated with the developable area in each major watershed in Las Vegas Valley.

| Watershed | Required WQCV (AF) Based on Developable Area |
|---|---|
| C1 | 78 |
| Central Basin | 10 |
| Duck Creek Wash | 250 |
| Flamingo/Tropicana Washes | 168 |
| Gowan Basin | 122 |
| Lower Las Vegas Wash | 44 |
| Lower Northern | 144 |
| Pittman | 255 |
| Range Wash | 146 |
| Upper Northern | 222 |

An example water quality retrofit approach for the Gowan Watershed is presented. For the Gowan Watershed, four to five detention basins could be retrofitted to meet WQCV requirements for all of the potential new development in that watershed.

A pilot retrofit project is recommended before wide scale implementation of the detention basin retrofit program. A pilot project could show water quality effectiveness and could provide result in additional design guidelines for future projects.

# 1 Overview and Approach

This report discusses the feasibility of addressing stormwater quality concerns through retrofitting existing regional stormwater detention basins. One of the requirements of the Las Vegas Valley MS4 permit is to address water quality impacts from new development and significant redevelopment. Entities in the Las Vegas Valley have already invested greatly in

regional stormwater detention basins for managing floods. These regional detention basins are designed to control 100-year floods, and the smaller volumes of water from common runoff events that are the focus of stormwater quality programs generally pass right through the facilities. Previous water quality monitoring conducted by the MS4 Permittees at selected Las Vegas Valley detention basins has shown that they are only marginally effective at removing pollutants of concern for the MS4 program (Las Vegas Valley Stormwater Quality Management Committee 2008).

The approach to this study is as follows:

- Review the general approach to retrofitting regional detention basins for water quality.
- Determine the amount of water quality retrofit required to satisfy MS4 permit requirements in each watershed.
- Determine strategic opportunities to incorporate water quality capture volume in each watershed:
  - Minimize distance to Las Vegas Wash or a major tributary because the MS4 permit applies to the Las Vegas Wash and "major outfalls", which would include but not limited to Western Tributary, Range Wash (Sloan Channel), Las Vegas Creek, Flamingo Wash, Duck Creek and C-1 Channel.
  - If the 2008 MPU includes a recommendation to upgrade the detention basin to a larger volume, at some point a retrofit is required for flood control and the water quality retrofit could potentially be efficiently included at that time.
  - Determine if detention basin capacity is greater than the current 100-year storage volume (since construction, new detention basins may have been constructed upstream, reducing the 100-year storage requirement). In this case, existing flood capacity could be allocated to water quality volume.
  - Determine if detention basin capacity reserved for sediment storage could potentially be used for water quality capture volume. Although the design standards appear to vary, some of the detention basins have been designed with storage capacity for the 100-year sediment volume plus the annual sediment load. The annual sediment load volume could potentially be used for water quality capture volume, as long as water quality structures are adequately maintained.
  - Determine opportunities for pollutant trading by retrofitting a detention basin downstream of existing development rather than new development.
- Consider if there are other constraints that would preclude retrofit for water quality:
  - Detention basin is not downstream of any existing development or developable area and therefore, would not address water quality issues in runoff from development.

- Determine if there is a low-flow bypass around or under the facility and consider if there is any way to capture and treat that water.
- Are there design constraints that might make treating water difficult?
- Are there recreational or other multi-use facilities that would be affected?
- Would the retrofit compromise the level of flood protection provided by the detention basin?

The result is a plan for retrofitting existing regional detention basins and incorporating them into the MS4 Storm Water Management Plan (SWMP).

# 2 Options for Water Quality Retrofit

The water quality retrofit approach for Las Vegas Valley detention basins is based on best practices for stormwater quality, which are similar throughout stormwater literature. The challenge in retrofit situations is that designers are constrained by the existing flood control facility configuration and must maintain the required level of flood protection. The Las Vegas Valley represents a unique case that does not fit the mold of the typical stormwater quality program. In most communities with MS4 permits, structural water quality facilities are designed to capture runoff from individual developments, and therefore, treat the runoff from areas of a few acres to a few square miles. In the case of Las Vegas Valley, a watershed-scale approach is being developed. Retrofits of regional detention basins would capture the flow from substantially larger areas, ranging from less than 1 to more than 50 square miles. Therefore, water quality facilities sized using similar criteria as used in other communities, which are a function of tributary area, will result in large WQCVs relative to other communities.

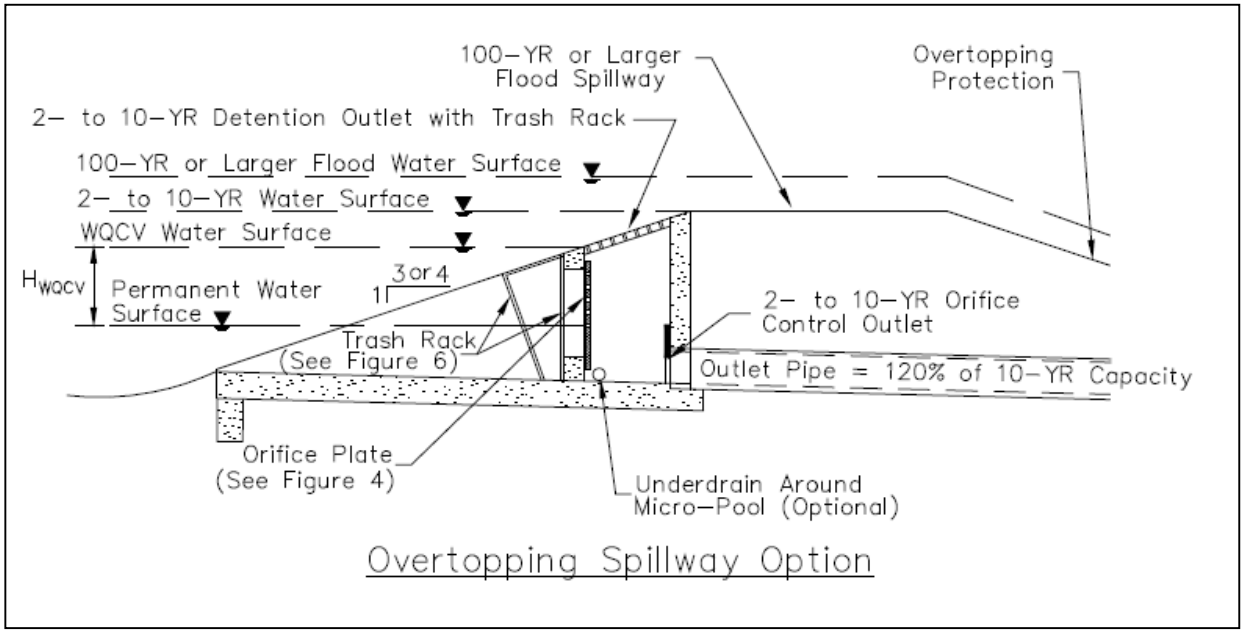
Most stormwater quality facilities function by capturing the runoff from frequently occurring events and releasing the volume slowly. This allows time for suspended pollutants to settle from the water. Settled pollutants are then removed by normal maintenance.

One of the most likely retrofits of the Las Vegas regional detention basins is to modify outlets to allow different release rates depending on the amount of inflow, such as:

- Water quality outlet – drains slowly, over 12 to 48 hours for minor storms
- Medium flow – for up to the 10-year event
- High flow – flow up to the 100-year event

**Figure 1** depicts an outlet design where a range of release flows are accommodated. Recommendations for water quality outlet perforation sizing and other design details are available from Urban Drainage (2008). The amount of water detained upstream of a water quality outlet is the WQCV. This amount of water would be stored in addition to the flood control storage of a regional detention basin. This additional volume is one major constraint for existing detention basin retrofit. If existing detention basins do not have enough capacity for the WQCV plus flood control storage, additional storage would have to be obtained through excavation, grading, or raising the spillway. In some cases, accommodating the additional WQCV may not be practical.

Figure 1. Typical Water Quality Outlet in Extended Detention Basins



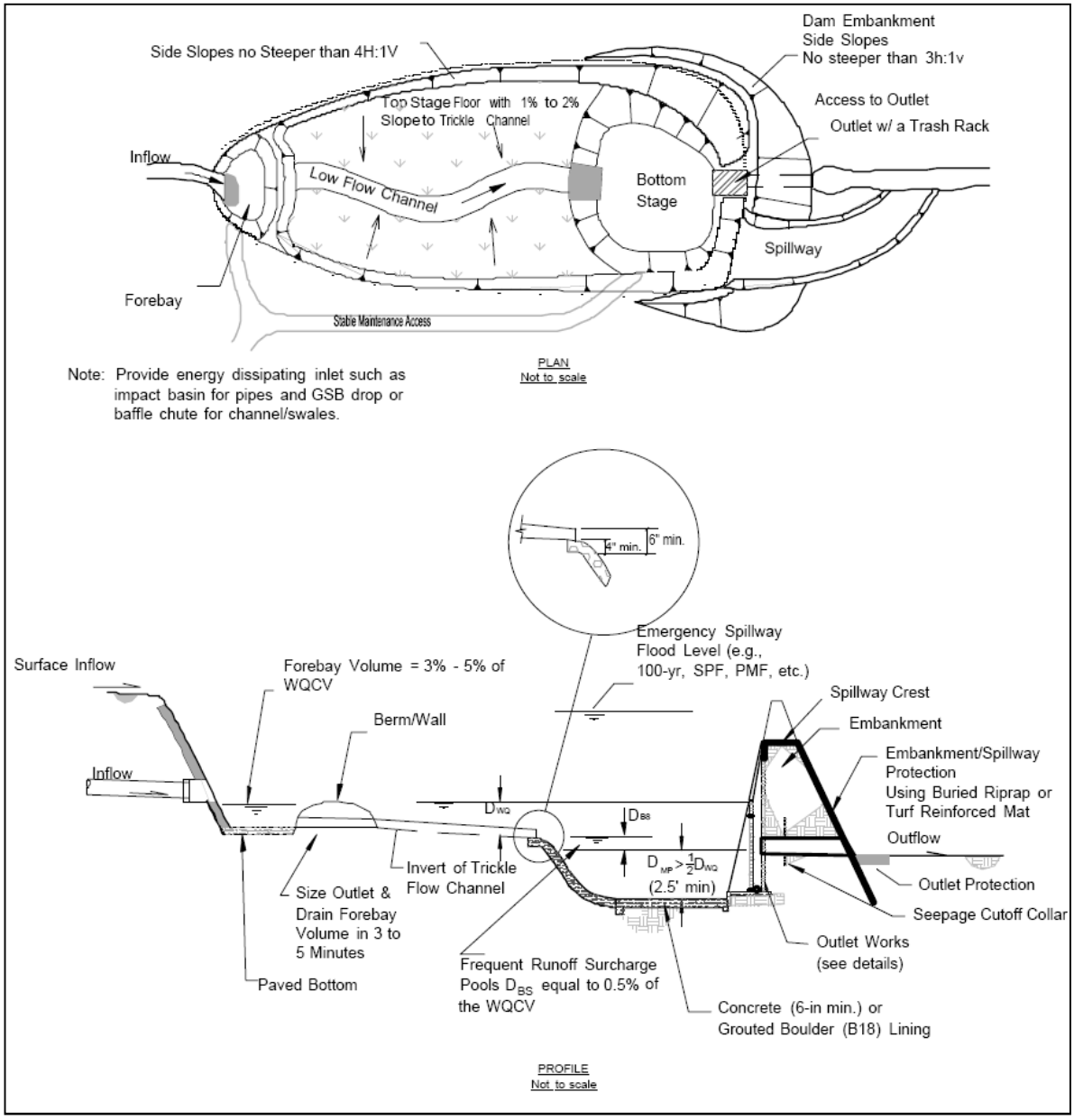

Source: Urban Drainage (2008)

Another retrofit consideration in Las Vegas Valley is the addition of sediment forebays near the detention basin inlets. This would provide an opportunity for larger particles to settle from the flow. Sediment forebays are typically hard surface-lined so that material can be removed by heavy equipment.

Of the array of structural water quality BMPs described in the literature, only a limited set can be effective as regional detention basin retrofits in Las Vegas Valley. Those BMPs that require vegetation or a constant water supply should only be considered in locations where there is a reliable flow of water during dry weather. Those locations with dry weather flows may have more design options and may have enhanced pollutant removal if dry weather flows are used to support vegetation or a permanent pool of water. Vegetated facilities may be more effective at removing dissolved pollutants than those that are not vegetated. However, in the arid Las Vegas Valley climate, the most likely detention basin retrofit is the addition of an extended detention basin (EDB) within a regional detention basin. EDBs and other BMPs that primarily promote settling are usually effective at removing suspended pollutants, but not necessarily dissolved pollutants.

An EDB is similar to a flood control detention basin with a water quality outlet to extend draining time. The long drain time provides quiescent conditions for fine sediment and pollutants associated with that sediment to settle to the basin floor. EDBs are commonly combined with flood control detention basins, as the lowest level of water storage. **Figure 2** is an example of how an EDB can be implemented below flood control storage in a detention basin. EDBs have been successfully implemented in smaller detention basin retrofit situations in other parts of the country, and are flexible enough to be implemented in a variety of configurations (Caltrans 2004).

**Figure 2. Extended Detention Basin within Flood Control Detention Basin**




Source: Urban Drainage (2008)

Urban Drainage recommends designing the EDB with a small, permanently wet area near the outlet, termed a micropool, to reduce outlet clogging. Vegetation that can grow in the micropool may reduce the concentration of soluble pollutants in stormwater (Urban Drainage 2008). Las Vegas Valley detention basins should be evaluated individually to determine if there is enough flow during dry weather to support a micropool.

# 3 Water Quality Capture Volume Estimates

Analyses to determine the appropriate methodology for sizing WQCVs for the regional detention basins in Las Vegas Valley are summarized in the following subsections. The analyses conducted include:

- Water Environment Federation's (WEF) Manual of Practice No. 23, Urban Runoff Quality Management (1998) empirical method for estimating maximized detention volume
- WQCV method described in City of Las Vegas White Paper
- HEC-1 Analyses
- Comparative analyses of results from empirical method and HEC-1 modeling
- Recommended method for use in Las Vegas Valley

## 3.1 Nationwide Empirical WQCV Estimate from Urban Runoff Quality Management (1998)

The WEF Manual of Practice No. 23, Urban Runoff Quality Management (1998) recommends sizing the WQCV to treat storms ranging in size from "mean" to "maximized", generally in the range of 70$^{th}$ to 90$^{th}$ percentile. This is where the efficiency of the facility is at its greatest and beyond which, increasing size results in rapidly diminishing returns. Denver Urban Drainage estimates that with WQCV sized to treat the 80$^{th}$ percentile runoff event, between 80 and 90 percent of the annual total suspended solids (TSS) load in the runoff will be removed. Increasing the size of the WQCV beyond the 80$^{th}$ percentile volume would only increase TSS removal by 1 to 2 percent (Urban Drainage 2008). In addition, larger water quality facilities may be less effective at pollutant removal for smaller storm events because flows would pass quickly through the facility.

The WEF Manual contains a method for estimating the maximized detention volume. The method begins with the calculation of a runoff coefficient using an empirical equation developed from analysis of rainfall and runoff data from over 60 urban watersheds nationwide for two years. The third-order equation (Equation 1) is a function of watershed imperviousness (i):

**Equation 1. Runoff Coefficient**

$$C = 0.858i^3 - 0.78\,i^2 + 0.774i + 0.04$$

An empirical relationship between the maximized detention volume ($P_o$, in watershed inches) and the event average rainfall depth ($P_6$, in watershed inches, 0.37 inches in Las Vegas) was developed through analysis of rainfall data and simulation of detention basins of different sizes for seven locations across the United States (WEF 1998, Guo and Urbonas 1994). The analysis included Phoenix, Arizona, which has a climate similar to Las Vegas Valley (Phoenix's event average rainfall depth is 0.42 inches). The regression analysis showed a strong correlation between event average rainfall depth and maximized detention volume (Equation 2).

**Equation 2. Maximized Detention Volume**

$$P_o = (a \times C) * P_6$$

$P_o$ = maximized detention volume in watershed inches
a = constant, for event maximization, drain times 12 hrs (1.109), 24 hours (1.299), 48 hours (1.545)
C = runoff coefficient
$P_6$ = event average rainfall depth, for Las Vegas = 0.37 inches

Equations were developed to maximize both the number of events captured as well as the volume of runoff captured. Guo and Urbonas (1994) recommend using the event capture equation because it is analogous to the procedure for combined sewer overflow control, where the number of overflow events is counted, and the analysis would not be skewed by a few extreme storm events.

The runoff coefficients and WQCVs for various BMP drain times (based on Equation 1 and Equation 2) are summarized in **Table 1**. The watershed inches are multiplied by the facility tributary area to result in a volume. Shorter drain times allow more cumulative volume to flow through the same size detention basin, and therefore, allow for smaller WQCVs for design. In general, if sediment characteristics are not explicitly known, a minimum 12-hour drain time is recommended for wet ponds and 24-hours is recommended for dry ponds (Guo and Urbonas 1994).

**Table 1. Estimated Water Quality Capture Volume in Las Vegas (watershed inches)**

| Impervious Ratio | Runoff Coefficient | Maximized Volume (watershed inches) by Storage Drain Time | | |
|---|---|---|---|---|
| | | 12 hr | 24 hr | 48 hr |
| 0.2 | 0.17 | 0.07 | 0.08 | 0.10 |
| 0.3 | 0.23 | 0.09 | 0.11 | 0.13 |
| 0.4 | 0.28 | 0.11 | 0.13 | 0.16 |
| 0.5 | 0.34 | 0.14 | 0.16 | 0.19 |
| 0.6 | 0.41 | 0.17 | 0.20 | 0.23 |
| 0.7 | 0.49 | 0.20 | 0.24 | 0.28 |
| 0.8 | 0.60 | 0.25 | 0.29 | 0.34 |
| 0.9 | 0.73 | 0.30 | 0.35 | 0.42 |
| 0.95 | 0.81 | 0.33 | 0.39 | 0.46 |
| 0.98 | 0.86 | 0.35 | 0.41 | 0.49 |
| a (Equation 2 constant) | | 1.109 | 1.299 | 1.545 |

Equation 1 and Equation 2 are supposedly applicable across the United States. However, watershed-specific runoff coefficients and analysis of Clark County rainfall data could provide more site-specific WQCV sizing for CCRFCD facilities. An analysis of historic daily rainfall data in Las Vegas showed that the 85$^{th}$ percentile storm is about 0.32 inches (MWH 2007). If the 85$^{th}$ percentile storm is considered the knee of the curve and is selected for the design of water quality facilities, the resulting runoff may be less than what is suggested in **Table 1**. This could be an important difference, because a tenth of an inch of runoff over a large watershed results in substantial storage differences (10 to 100 acre-feet).

## 3.2 WQCV Estimate from City of Las Vegas White Paper

Another empirical method used to estimating WQCVs is presented in the white paper, "Storm Water Quality Control Volume for Southwest Region of USA". This method is similar to the previously summarized method: the watershed area and corresponding percent impervious are used to estimate the WQCV. **Figure 3** (an excerpt from the CLV White Paper) is provided to show how WQCVs can be estimated. First, if the watershed percent impervious is known, Figure 3 can be used to determine the WQCV depth/Pm (referred to as Basin Volume/Pm) in Figure 3. Pm is the average rainfall event depth, which is 0.37 inches for Las Vegas Valley. The WQCV depth is then multiplied by the watershed area to determine the WQCV.

In comparison between the empirical method described previously and this method, this method yields slightly higher results.

Figure 3. WQCV with a Drain Time of 12 hours (Excerpt from CLV White Paper)

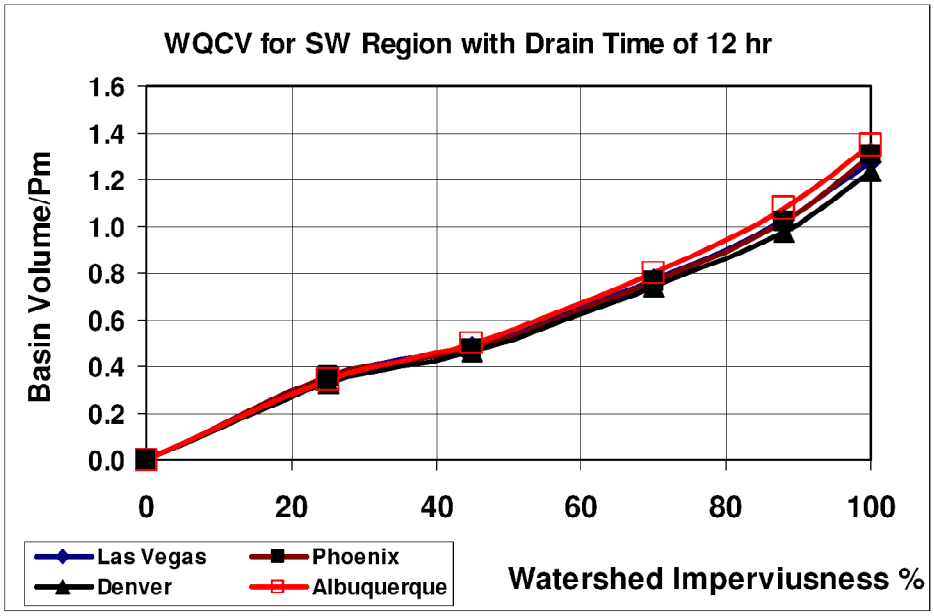



**Figure 4 WQCV for Southwest Region in the USA Continent ($T_0$=12-hour)**

## 3.3 HEC-1 Analysis of WQCV in Las Vegas Valley

For comparison to the results of Equation 1 and Equation 2, site-specific estimates of runoff generated from the Las Vegas 85th percentile storm were completed using the existing HEC-1 models for three detention basins:

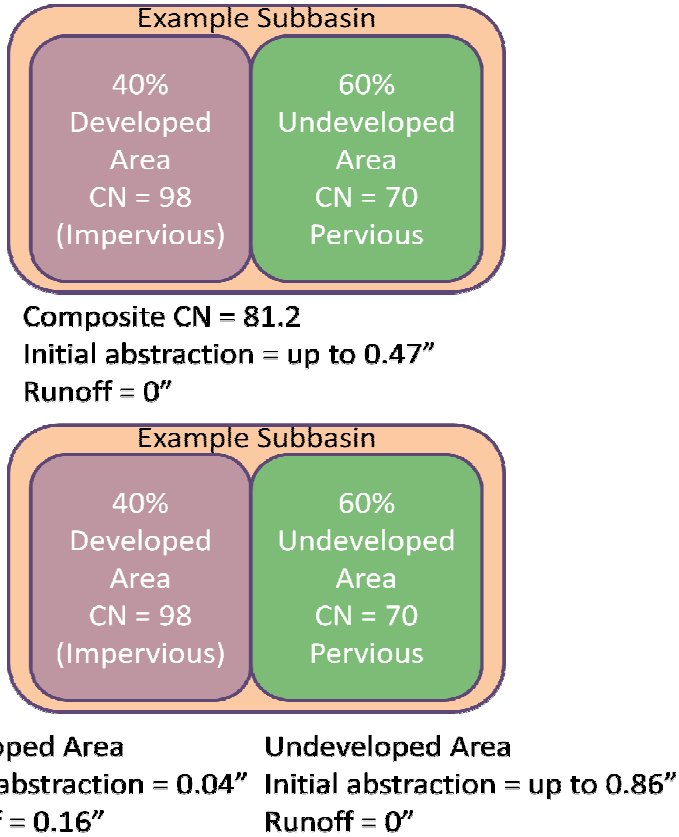
- Pioneer
- Angel Park
- Lower Duck

The 2008 MPU files contain several different HEC-1 models for each watershed using different storm distributions and depth-area reduction factors. The appropriate HEC-1 model for a detention basin depends on the tributary area and is noted in Volume 2 of the 2008 MPU.

MWH input a 6-hour 0.32 inch storm into the Pittman Wash HEC-1 model to determine the amount of runoff generated at the Pioneer Detention Basin. The Pioneer Detention Basin is currently the subject of an upgrade design project, which includes consideration of water quality treatment. The Pit3 model is the appropriate model for the Pioneer Detention Basin, which has a tributary area less than 8 square miles. The depth area-reduction factor matched the 2008 MPU, or 0.88 (corresponding to a 7.7 square mile tributary area). The model was also revised so that very minimal outflow from the detention basin was allowed and most of the water was collected in the detention basin.

The 2008 MPU version of the Pit3 model resulted in less than 1 acre-foot of runoff from the 0.32 inch storm. The low runoff amount was due to the standard method of assigning each subbasin a composite curve number, which is a weighted average of curve numbers for both impervious and pervious areas. For small storms, the model does not simulate any runoff from most subbasins because of the relatively low curve numbers. The composite curve numbers are appropriate for modeling the 100-year design storms that are the focus of the MPU. However, the simulations for small storms do not accurately reflect the amount of runoff from impervious surfaces. **Figure 4** is an example of the effect of using a composite curve number when estimating runoff from the water quality design storm of 0.32 inches. For this example, no runoff is generated when using the composite curve number approach, which considers that all precipitation up to 0.47 inches is lost to initial abstraction. When developed and undeveloped areas are considered separately, some runoff is generated from the developed area when precipitation exceeds 0.04 inches.

Figure 4. Composite Curve Number Compared to Pervious/Impervious Curve Number for 0.32 inch Storm




The Pit3 model was revised to assign curve numbers to the pervious areas only and include the percent impervious for each subbasin. The impervious areas are automatically assigned a curve number of 98. The result of the modified HEC-1 analysis was a maximum storage volume in the Pioneer Detention Basin of 57 acre-feet.

The HEC-1 model for the Angel Park Detention Basin within the Gowan Watershed, ALLGOW5, was modified to use percent impervious and pervious area curve numbers and to close the detention basin outlet works. The total runoff simulated for the 0.32 inch storm with a depth area-reduction factor of 0.76 (based on 22 square mile tributary area) was 126 acre-feet.

The HEC-1 model for Lower Duck Creek, within the Duck Creek Wash watershed, DUCK5B, was modified to use percent impervious and pervious area curve numbers and to close the detention basin outlet works. The total runoff simulated for the 0.32 inch storm with a depth area-reduction factor of 0.64 (based on 98 square mile tributary area) was 103 acre-feet. However, the sum of the subbasins from the HEC-1 model is 357 acre-feet.

**Table 2** compares the results of the HEC-1 modeling for the three detention basins to the runoff generated from Equation 1 (storm size of 0.32 inches) and the maximized WQCV from Equation 2.

**Table 2. Runoff Volumes for Regional Detention Basins Using Various Methods [a]**

| Detention Basin | Tributary Area (sq miles) | HEC-1 Depth Area Reduction Factor | HEC-1 0.32" Runoff Capture (acre-feet) | Equation 2 – Maximized WQCV with 24-hr Drain Time [c] | Approximate Regression Analyses Factor | Equation 2 – Maximized WQCV (24-hr) with Factor [c] |
|---|---|---|---|---|---|---|
| Pioneer | 7.7 | 0.88 | 57 | 68 (120%) | 0.85 | 58 (102%) |
| Angel Park | 22 | 0.76 | 126 | 172 (137%) | 0.75 | 129 (102%) |
| Lower Duck | 98 | 0.64 | 357 [b] | 595 (167%) | 0.60 | 357 (100%) |

[a] Unlike other estimates in this memo, these calculations include area outside of the development boundary because this area is included in the HEC-1 models.

[b] This value is the sum of the HEC-1 subbasins, output file showed HEC-1 volume was 103 acre-feet which appeared to be too low.

[c] Value in parentheses are the percent difference from HEC-1 results

The two empirical equations resulted in runoff amounts within 50 percent of the HEC-1 results for the smaller, more developed tributary areas of Pioneer and Angel Park. For Lower Duck Detention Basin, which has a larger tributary area with substantial undevelopable land, the empirical equations resulted in much larger estimated runoff/maximized WQCV, 103 acre-feet compared to 418/707 acre-feet.

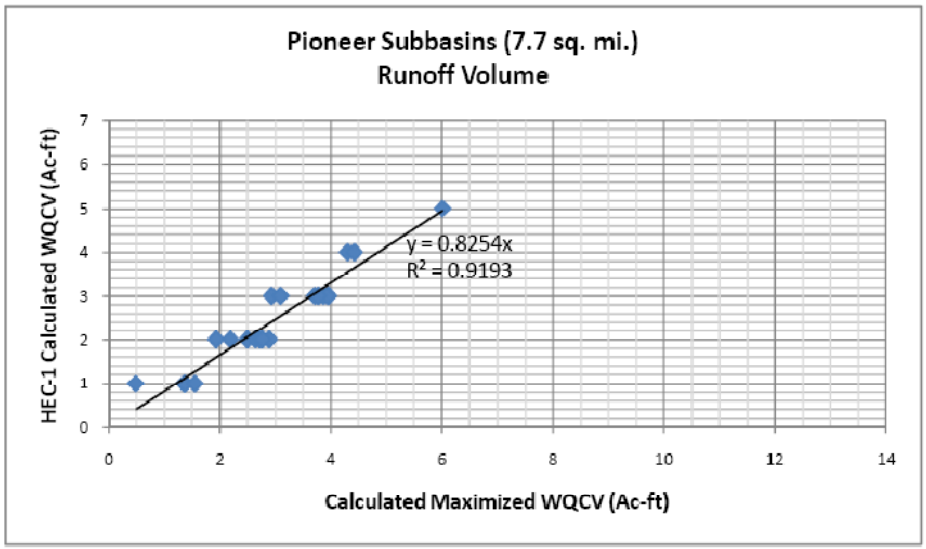
## 3.4 Comparative Analyses of Equation 2 Method and HEC-1

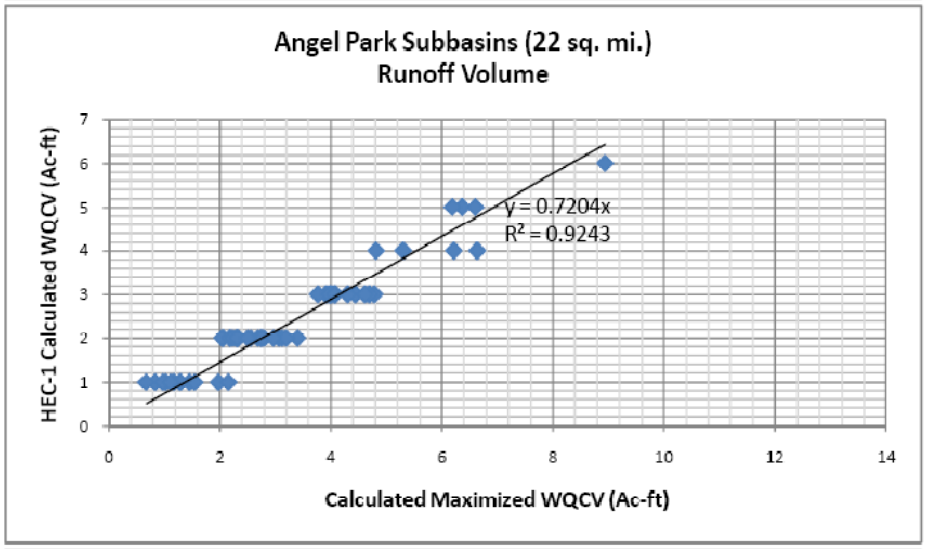
Comparative analyses are performed to determine the general difference between the empirical method and HEC-1 modeling. The subbasin WQCVs using the empirical method are compared to subbasin WQCVs generated from the HEC-1 model, as shown in **Figure 5**. A regression equation is developed to show the relationship between the two methods.

In addition to the regression equation for just the subbasins, it may be important to see a regression equation for the subbasins and a sampling of combined subbasins. A random sampling of combined subbasins is added to the plots in **Figure 5**, see **Figure 6**. Generally, the regression equation in **Figure 6** is similar to **Figure 5** (within 2 percent). This suggests good predictability in using the regression analyses results to estimate HEC-1 modeling output based on empirical method calculations. However, using the regression analyses factor with the maximized WQCV calculation may slightly underestimate or slightly overestimate HEC-1 output.

Another approach is to use factors similar to the depth area reduction factors (DARFs) included in the Clark County Regional Flood Control District's Hydrologic Criteria and Drainage Design Manual (CCRFCD Design Manual), which are shown in the third column of **Table 2**. These factors are higher than the regression analyses and are consistent with existing hydrologic modeling practices in Clark County. This approach will be discussed further in the next subsection.

Figure 5. Regression Analyses of Subbasin Results for Empirical Method vs HEC-1 Modeling



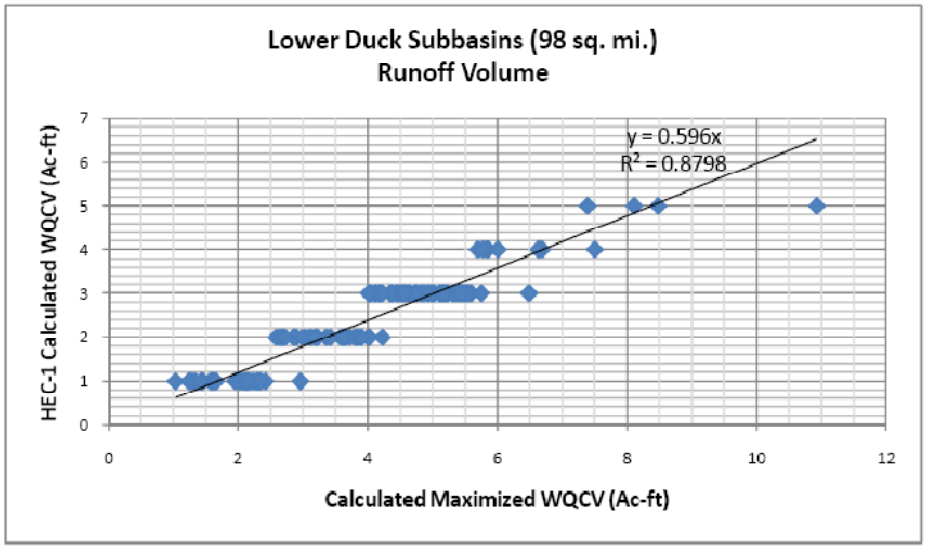
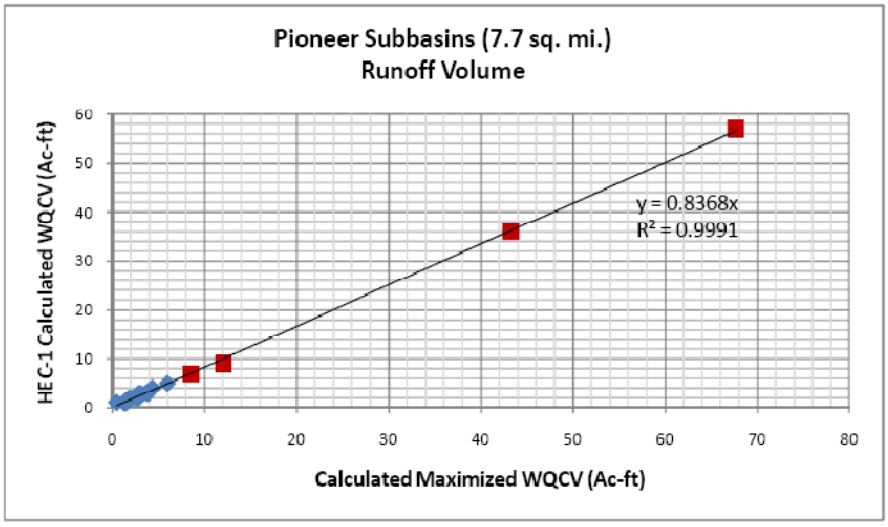
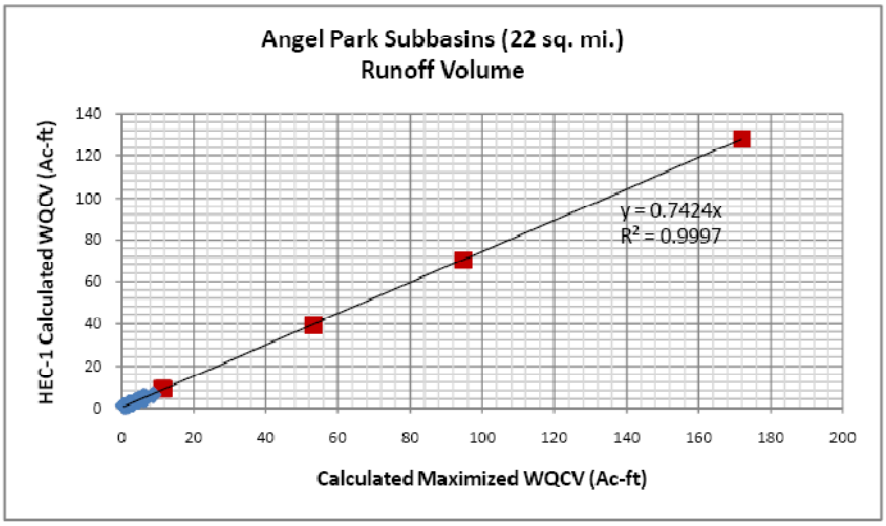
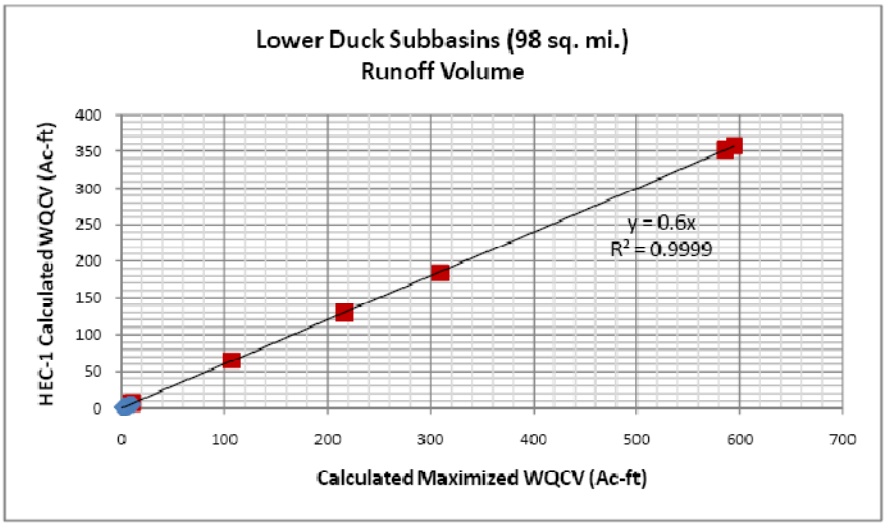



Figure 6. Regression Analyses of Subbasin and Combined Subbasin Results for Empirical Method vs HEC-1 Modeling



## 3.5 Recommended Method for Use in Las Vegas Valley

As previously described, the four methods analyzed to determine WQCV sizing include:

- Water Environment Federation's (WEF) Manual of Practice No. 23, Urban Runoff Quality Management (1998) method for estimating maximized detention volume
- HEC-1 Analyses
- WQCV described in City of Las Vegas White Paper
- Comparative analyses of results from empirical method and HEC-1 analyses

For a brief summary, the HEC-1 modeling yielded the lowest the result. The City of Las Vegas White Paper yielded the highest results, with maximized detention volume calculation (per WEF MOP No. 23) yielding the second highest results (slightly less than the City of Las Vegas White Paper). Results from the two highest yielding volumes were at least 120 percent greater than HEC-1 modeling results.

As discussion in Section 3.3 of this TM, another option is to apply an adjustment factor to the results from one of the empirical methods described herein. The volumes determined using the empirical methods are reasonable for smaller catchments but overestimate volumes from larger catchment areas. According to the Clark County Design Manual, DARFs are used in HEC-1 modeling for catchments (for example: 1 square mile drainage area has a DARF of 0.97). To simplify the DARF table, an adjustment factor can be used for a wider range in watershed area, as shown in **Table 3**.

**Table 3. Adjustment Factor Table**

| Tributary Area (sq miles) | Adjustment Factor |
|---|---|
| 0 - <1 | 1.00 |
| 1 - <10 | 0.85 |
| 10 - <40 | 0.75 |
| 40 and greater | 0.65 |

Because the CLV White Paper was based on a 12-hour drain time, it is recommended to use the maximized detention volume calculation (per WEF MOP No. 23) with a 24-hr drain time. The maximized detention volume calculation with the adjustment factor in **Table 3**, is shown to yield results in the range of approximately 2 to 8 percent greater than HEC-1.

The results from each of these methods are shown in **Table 4**.

**Table 4. Runoff Volumes for Regional Detention Basins Using Various Methods [a]**

| Detention Basin | Tributary Area (sq miles) | Weighted Avg % Impervious | HEC-1 Depth Area Reduction Factor | HEC-1 0.32" Runoff Capture (acre-feet) | Equation 1 – Runoff from 0.32" (% Diff from HEC-1) [c] | Equation 2 – Maximized WQCV with 24-hr Drain Time [c] | WQCV (Stormwater White Paper) [c] | Equation 2 – Maximized WQCV (24-hr) with Adjustment [c] |
|---|---|---|---|---|---|---|---|---|
| Pioneer | 7.7 | 49 | 0.88 | 57 | 43 (75%) | 68 (120%) | 79 (139%) | 58 (102%) |
| Angel Park | 22 | 44 | 0.76 | 126 | 116 (92%) | 172 (137%) | 208 (165%) | 129 (102%) |
| Lower Duck | 98 | 34 | 0.64 | 357 [b] | 418 (117%) | 595 (167%) | 793 (222%) | 387 (108%) |

[a] Unlike other estimates in this memo, these calculations include area outside of the development boundary because this area is included in the HEC-1 models.

[b] This value is the sum of the HEC-1 subbasins, output file showed HEC-1 volume was 103 acre-feet which appeared to be too low.

[c] Value in parentheses are the percent difference from HEC-1 results

It is recommended that calculations for sizing water quality capture volumes for detention basin retrofits use: (1) the maximized detention volume calculation (per WEF MOP No. 23) with a 24-hr drain time, combined with (2) the appropriate adjustment factor in **Table 4**.

## 3.6 Developable Area Estimates

The runoff volumes and WQCVs estimated above are based on the entire tributary area for the detention basins. The MS4 permit focuses on water quality impacts from new development and significant redevelopment. If sized for the entire tributary area, most regional detention basins will collect runoff from both existing and new development. To address MS4 permit requirements, the WQCV could be reduced to treat just the tributary area that is new development or significant redevelopment. For instance, aerial photos suggest that the tributary area to the Pioneer Detention Basin is already about 50 percent developed. In that case, the WQCV could be reduced from about 57 acre-feet for the entire tributary area to 28.5 acre-feet for just the area yet to be developed.

Runoff from existing development generates pollution in a similar manner to new development. However, in most communities, it is neither practical nor cost-effective to retrofit existing development for stormwater quality. Consequently, MS4 permits do not require controls on the runoff quality from existing development. In Las Vegas Valley the retrofit of regional detention basins is an opportunity for pollution trading by addressing runoff from existing development in some locations where it may be more practical than addressing runoff from new development or significant redevelopment.

The potential land area for new development in the Las Vegas Valley was evaluated by watershed and is summarized in **Table 5**. This estimate is based on two sources or information:

- The vacant land area for portions of the city of Las Vegas estimated on a parcel basis by MWH in 2009 for the Sewer Master Plan Update
- For the remaining area, review of the 2008 aerial photo for land within the ultimate development boundary that appears vacant[1].

This information was combined with ultimate development imperviousness to estimate the WQCV (using Equation 2) for the developable land only in each watershed. The WQCV summarized in **Table 5**, totaling 1,438 acre-feet, could be considered the water quality retrofit volume needed to address the MS4 permit requirements for new development. This estimated volume is likely conservative compared to what HEC-1 simulations of runoff from the 85th percentile storm would produce.

[1] Areas that appear vacant but are known to not be developable such as Nellis Air Force Base of golf courses were not considered vacant.

**Table 5. Estimated Developable Area and MS4 Permit Required WQCV Per Watershed**

| Watershed | Vacant Land Area (sq mi) | Total Watershed Area (sq mi) | Watershed Ultimate Condition Imperviousness* | Vacant Land WQCV Depth (in) | Vacant Land WQCV (AF) |
|---|---|---|---|---|---|
| | Within ultimate development boundary | | | | |
| C1 | 15 | 29 | 38% | 0.14 | 78 |
| Central Basin | 1 | 56 | 67% | 0.26 | 10 |
| Duck Creek Wash | 48 | 90 | 45% | 0.18 | 250 |
| Flamingo/Tropicana Washes | 28 | 91 | 46% | 0.18 | 168 |
| Gowan Basin | 19 | 69 | 49% | 0.18 | 122 |
| Lower Las Vegas Wash | 11 | 18 | 25% | 0.10 | 44 |
| Lower Northern | 24 | 54 | 45% | 0.18 | 144 |
| Pittman | 46 | 93 | 48% | 0.18 | 255 |
| Range Wash | 28 | 61 | 40% | 0.16 | 146 |
| Upper Northern | 64 | 86 | 25% | 0.10 | 222 |

*slightly underestimated because subbasins partially located outside of the ultimate development boundary are included in the weighted average (the portion of the subbasin outside of the ultimate development boundary has a percent impervious of 0)

In many communities, stormwater quality measures are implemented on a development scale as the developments are constructed. However, in the Las Vegas Valley, a watershed-scale program is being developed. The regional detention basins capture runoff from tributary areas larger than individual development, and the water quality retrofits will address development projects in various stages of planning and completion. Some of the vacant land in Las Vegas Valley may not develop for decades. The typical progression of development is from central Las Vegas Valley outward toward the ultimate development boundary. Therefore, the order of detention basin retrofit may logically proceed from central Las Vegas Valley outward.

# 4 Watershed Approach for Achieving Required WQCV

An inventory of regional detention basin information was reviewed to determine the most efficient way of achieving the WQCV requirements. The approach considers that it may not be necessary to retrofit every regional detention basin in order to meet MS4 permit requirements. The attributes of several 2008 CCRFCD MPU GIS layers were extracted to a spreadsheet for use as the basis of the inventory. Only detention basins with "completed" or "in construction" status were considered. Detention basins marked TN1 (scheduled in first five years of ten-year construction program), TN2 (scheduled in second five years), proposed, or awaiting funding were not considered. All debris basins and detention basins outside of the Las Vegas Valley were removed from the inventory. This left a total of 52 detention basins to be considered.

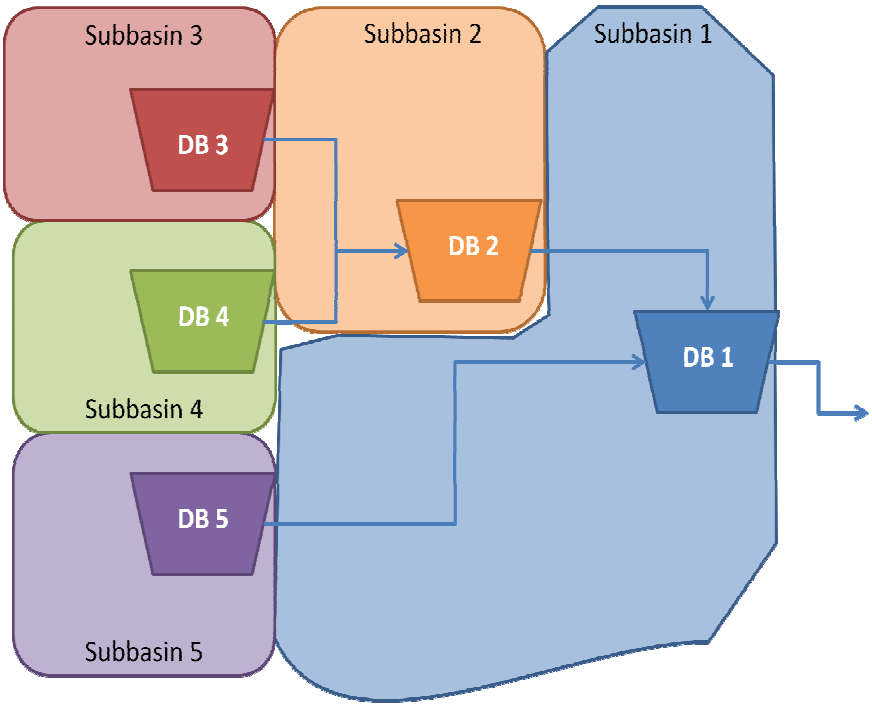
Notes related to the detention basin location relative to development and important design characteristics were compiled. These notes were based on review of the detention basin in

the context of the flood control system and aerial photos. Web links to aerial photos of each basin and the MPU map page were also recorded.

Those detention basins near the edge of the ultimate development boundary typically capture flow from undeveloped areas. For the inventory, those basins near the edge of the ultimate development boundary were only considered if they captured flow from at least 5 square miles of developable area. There are 6 basins located at or outside the development boundary and 9 with less than 5 square miles of developable tributary area. These 14 basins are listed in **Attachment A.** They are the lowest tier of the inventory and are not investigated any further in this report.

The Las Vegas Valley regional detention basins are connected by conveyance facilities in a dendritic manner, as shown in the schematic in **Figure 7**. In many watersheds, much of the runoff passes through one "final" downstream detention basins, the last facility upstream of the outfall, such as detention basin 1 in **Figure 7**. Retrofitting the final detention basin addresses more tributary area than a retrofit of any upstream detention basin. If a retrofit is completed at a final detention basin and another upstream basin, the water addressed in the upstream basin will also pass through the downstream basin. This is not the ideal configuration because the upstream water will basically be addressed in two locations. However, it would not be a fatal flaw if an upstream and downstream retrofit were required in a particular watershed because the extended detention time upstream would most likely keep the upstream water from interfering with the detained water in the downstream detention basin.

**Figure 7. Schematic Detention Basin Watershed**



In most cases it would be preferable to retrofit the final detention basin, rather than retrofitting each detention basin and potentially addressing the same water at more than one location. This approach could be the most cost effective (by minimizing the number of project locations) and would also address water quality as close to the Las Vegas Wash as possible. The challenge with this approach is to incorporate a large WQCV in the final detention basin. There are 12 final detention basins without a detention basin further downstream. Two of these basins are peaking basins, meaning that they are located off the main channel and require an overflow of the main channel for flow to enter the basin. The peaking basin inlets and storage configurations would need to be substantially modified in order to treat the low flows that are of interest for water quality.

**Table 6** lists the final detention basins and some important characteristics such as capacity, maximized tributary area, and distance upstream of major tributaries listed in the MS 4 permit. The maximized tributary area includes area that may be tributary to an upstream detention basin prior to discharge to the final detention basin.

**Table 6. Final Detention Basins (Furthest Downstream in Watershed)**

| Detention Basin | Capacity (AF) | Maximized Tributary Area (sq mi)[1] | Watershed | Major tributary [distance to major tributary] (distance to Las Vegas Wash) | Upgrade Planned?[2] |
|---|---|---|---|---|---|
| Cheyenne Peaking Basin | 456 | 122 | Lower Northern | on Western Tributary (0.5 miles) | yes |
| North Las Vegas | 1,435 | 83 | Lower Northern | NA, on Las Vegas Wash | yes |
| Pittman Park Peaking Basin | 75 | 66 | Pittman Wash | on Pittman Wash (5 miles) | no |
| Lower Duck Creek | 1,110 | 58 | Duck Creek | on Duck Creek Wash (5 miles) | no |
| Confluence | 1,025 | 47 | Range Wash | Range Wash [0.5 miles] (11 miles) | no |
| Tropicana | 825 | 46 | Flamingo / Tropicana | on Tropicana Wash (10 miles) | no |
| Meadows | 213 | 7 | Central | on Las Vegas Creek Wash (6 miles) | yes |
| Pioneer | 377 | 6 | Pittman Wash | None (4 miles) | yes |
| Equestrian | 409 | 3 | C1 Channel | C-1 Channel [1.5 miles] (6 miles) | yes |
| Offline Van Buskirk "C" | 16 | 3 | Flamingo / Tropicana | Flamingo Wash [2 miles] (5 miles) | no |
| McCarran | 100 | 1 | Duck Creek | Duck Creek Wash [5 miles] (9 miles) | no |
| Rainbow | 45 | 1 | Central | Las Vegas Creek Wash [4 miles] (9 miles) | yes |

[1] Area tributary to detention basin up to the ultimate development boundary, includes area that may be upstream of another detention basin
[2] 2008 MPU showed that additional storage capacity is needed at this basin and so it is on the list for upgrade.

Six detention basins have maximized tributary areas greater than 40 square miles each. Runoff from approximately 60 percent of the ultimate development boundary area flows through these six detention basins. If each could be retrofit to treat their entire tributary area, a large area could be treated for water quality through a small number of projects. The

strategic basins and tributary areas are shown in **Map 1**. **Table 7** summarizes key features of these strategic basins including their current capacity and the WQCV for the entire tributary from Equation 2 with the adjustment factor. The WQCVs range from greater than 30 percent of the basin current capacity to more than the current capacity. Implementing the large WQCV without disrupting flood control operations is not likely in most cases. **Attachment B** includes a more detailed discussion of the feasibility and challenges of retrofitting each identified strategic detention basin.

## Map 1. Tributary Area for Six Strategic Detention Basins

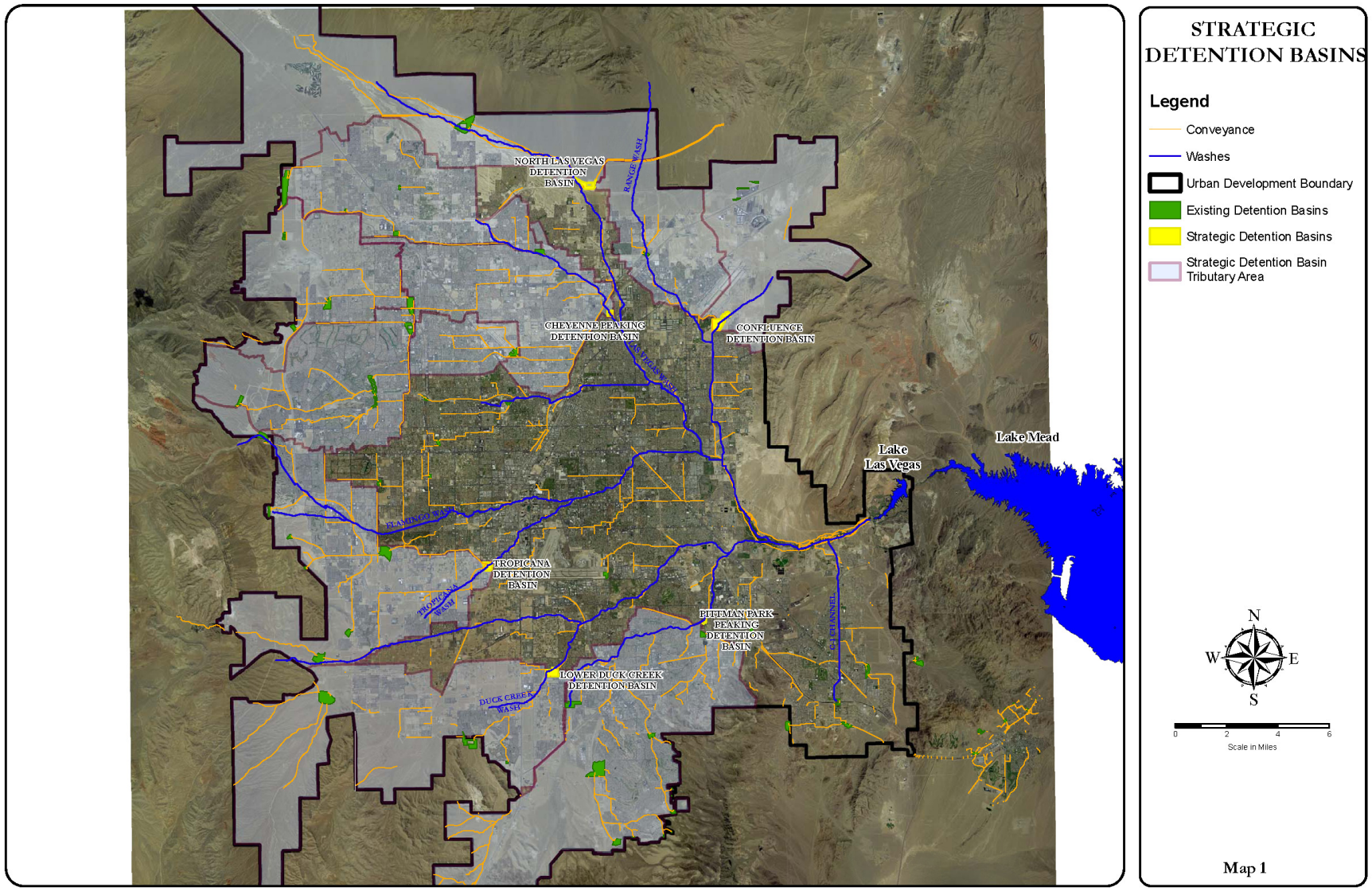


**Table 7. Summary of Strategic Detention Basins**

| Detention Basin | Maximized Tributary Area (square miles) | Basin Capacity (AF) | WQCV (AF) Estimated Using Equation 2 with Adjustment Factor | Comments |
|---|---|---|---|---|
| Cheyenne Peaking | 122 | 456 | 550 | Currently requires channel overflow to fill basin, upgrade planned. |
| North Las Vegas | 83 | 1,435 | 460 | Watershed is currently undeveloped, upgrade planned. |
| Pittman Park Peaking | 66 | 75 | 366 | Currently requires channel overflow to fill basin, includes recreation facilities |
| Lower Duck | 58 | 1,110 | 402 | Potential to use current bermed area for water quality storage |
| Confluence | 47 | 1,025 | 277 | The most developed part of the tributary area (about 18 square miles to the northwest of the basin) is conveyed in the Sloan Channel and only peak flows overflow a weir to the basin. The diversion weir could potentially be modified to convey low flows to the detention basin. |
| Tropicana | 46 | 825 | 312 | Design of basin includes berm, which increases the rate of drainage but presents a design challenge. |

Due to the design challenges of the strategic detention basins, it is necessary to expand the water quality retrofit approach to include additional detention basins. However, the total MS4 permit-required WQCV of 1,438 acre-feet can be accommodated by retrofitting a subset of the regional detention basins. A strategy for addressing the MS4 permit requirements on a watershed by watershed basis is discussed below.

# 5 Recommended Detention Basin Retrofit Approach

A watershed-based approach is recommended to efficiently implement water quality treatment at existing regional detention basins. The approach has the following characteristics.

- It is more efficient to consider the most practical opportunities for retrofit in each watershed, rather than retrofitting every detention basin in the Las Vegas Valley.
- Evaluate retrofit possibilities watershed by watershed, considering the possibilities of the most downstream detention basins first. Downstream basins have the largest tributary areas and may be able to provide more WQCV in one single project than upstream detention basins. The target total WQCV for each watershed is given in **Table 5**, based on the area subject to future development.
- When considering detention basins further upstream, avoid overlapping tributary areas so that the same water is not treated more than once. If tributary areas overlap, the resulting WQCV should only be counted toward the MS4 permit requirements once.
- Combine water quality retrofits with detention basin construction and upgrades when possible to keep total design and construction costs to a minimum.
- Use existing capacity that does not take away from flood storage where possible to avoid excavation cost. Existing capacity opportunities include sediment storage and existing capacity that is not used for 100-year flood storage. A list of detention basins with freeboard of more than 3 feet between the 100-year storage level and the emergency spillway[2] is included in **Attachment A** Sediment capacity included in detention basin design must be determined through review of design documents for each facility.

The result of this approach is an eventual retrofit plan for each major watershed. This watershed strategy was applied to the Gowan Watershed, as described in Section 5.1, to demonstrate how the process could be applied to any watershed in Las Vegas Valley.

[2] Freeboard information is included in the HEC-1 to HEC-HMS conversion folder on the 2008 MPU disk. Information on 100-year storage volumes was not readily available.

## 5.1 Gowan Watershed Example

The Gowan Watershed drains from west to east to the Western Tributary of the Las Vegas Wash, as shown in **Map 2**. About 70 percent of the Gowan Watershed, within the ultimate development boundary, is already developed, leaving about 19 square miles of developable land. The area within the ultimate development boundary has an average ultimate imperviousness of 49 percent. An estimated 122 acre-feet of WQCV is required to address the future development within the Gowan Watershed. This does not mean that exactly 122 acre-feet of WQCV need to be incorporated in the Gowan Watershed because pollutant trading could occur with other Las Vegas Valley watersheds.

The initial scan of retrofit opportunities in the Gowan Watershed revealed:

- There are no detention basins in the Gowan Watershed with excess capacity based on modeled 100 year water storage for the 2008 MPU (see Appendix A).
- There are several planned detention basins and several planned capacity upgrades, which could efficiently include WQCV addition.
- None of the design documents reviewed included information about sediment storage that could be used for WQCV.

Gowan Watershed regional detention basins were analyzed for retrofit candidacy from downstream to upstream. The entire watershed was assumed to have a uniform ultimate imperviousness of 49 percent. All Gowan Basin drainage eventually flows through the Cheyenne Peaking Basin, an off-channel facility that requires channel overflow to fill. As described in the strategic detention basin discussion, the Cheyenne Peaking Basin is not a good candidate for retrofit.

**Gowan North System**

The next upstream detention basin is the Gowan North Detention Basin. The Gowan North Detention Basin is designed to accept flows from the Gowan North system and the Gowan South system. It has a capacity of 921 acre-feet without any upgrade plans. The available design documents in the CCRFCD online library were reviewed but no sediment storage information was found. Therefore, the Gowan North Detention Basin has no excess capacity that could be dedicated to WQCV.

The Gowan North Detention Basin is divided into two basins connected by the outlet pipe under Gowan Road. The south half of the Gowan North Detention Basin is a multiuse facility, and any retrofit would likely affect those uses (see **Figure 8**). The north half of the Gowan North Detention Basin has less public use and could potentially be retrofit to treat the flow from the Gowan North system, a tributary area of about 23 miles. The Gowan North tributary area has a WQCV (from both developed and undeveloped area) of approximately 147 acre-feet. Assuming that an average of 1 foot of excavation over the north half of Gowan North is feasible, about 50 acre-feet of WQCV could be accommodated at Gowan North.

## Map 2. Gowan Watershed and Detention Basins

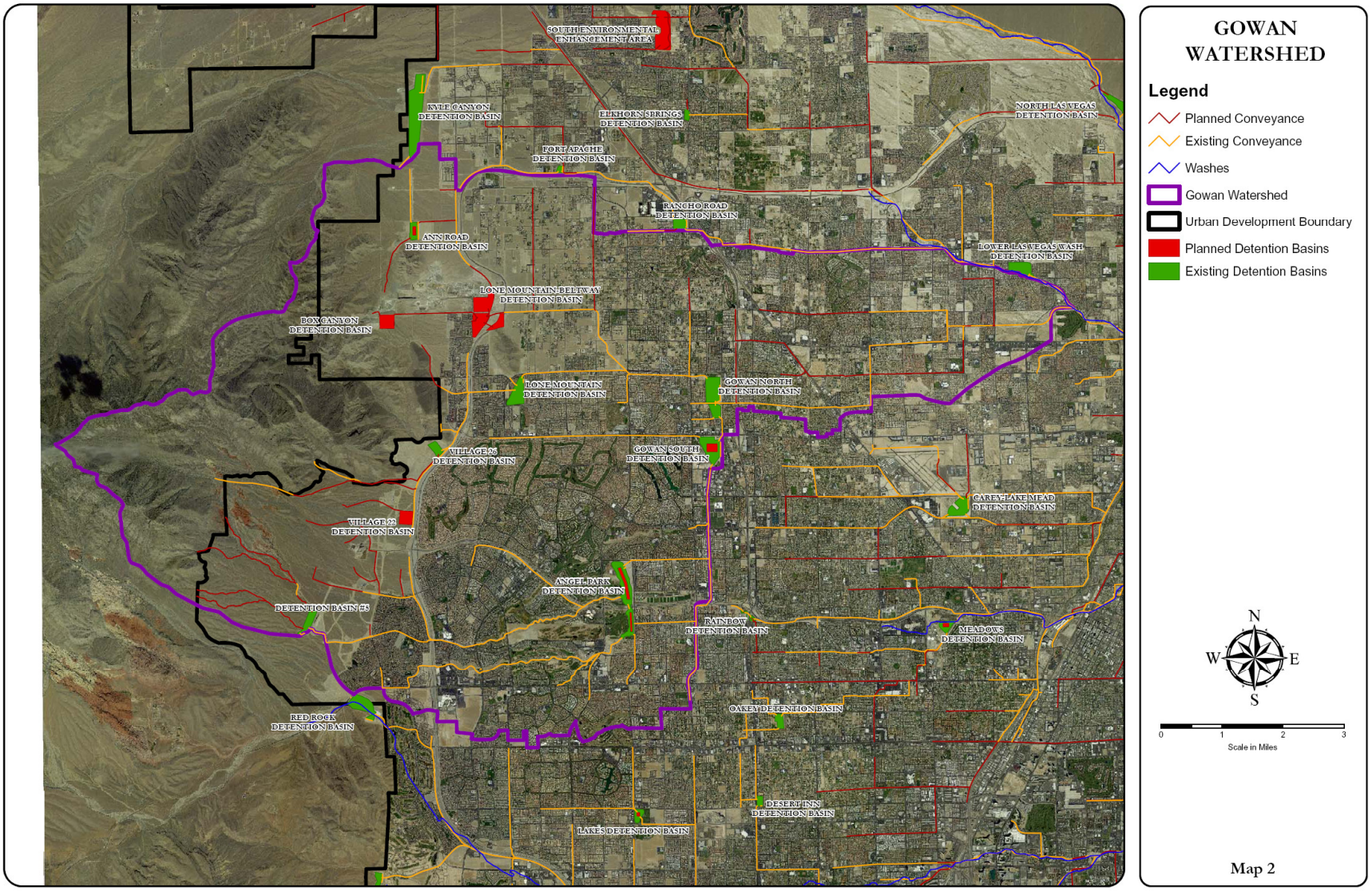


Figure 8. Gowan North Detention Basin




WQCV for some of the Gowan North system that cannot be addressed at the Gowan North Detention Basin could be efficiently addressed at the planned 589 acre-foot Lone Mountain-Beltway and 123 acre-foot Village 22 detention basins. Their status as "planned" facilities provides an opportunity for water quality to be incorporated in the design of the facilities minimizing cost:

- There is a large surface area planned for the Lone Mountain-Beltway Detention Basin suggesting there is adequate space for a large WQCV. The maximized tributary area (including area that would first flow through the Ann Road and planned Box Canyon detention basins) is about 6 square miles, corresponding to a WQCV of 49 acre-feet. Assuming that this WQCV can all be accommodated at the Lone Mountain-Beltway Detention Basin, there is no reason to consider retrofitting the upstream Ann Road and Box Canyon detention basins.
- The planned Village 22 Detention Basin has a relatively small maximized tributary are of 0.75 square miles. It is assumed that the entire 7 acre-feet of WQCV can be accommodated.

**Gowan South System**

The Gowan South Detention Basin is planned for a capacity upgrade from 624 acre-feet to 686 acre-feet. A water quality retrofit could potentially be combined with that project. The Gowan South Detention Basin captures the flow from a mostly developed tributary area of about 28 square miles. There is no information about sediment storage in the design documents and no excess freeboard. Retrofitting the detention basin for the entire 28 square mile maximized tributary area, a WQCV of 179 acre-feet, is probably not feasible. If the flow from only the north inlet is addressed (see **Figure 9**), then the tributary area would be reduced to about 7 square miles corresponding to a WQCV of about 51 acre-feet. With about 40 acres of open area at the Gowan South Detention Basin, an initial estimate is that 40 acre-feet of capacity could be dedicated to WQCV at the time of the planned capacity upgrade.

Figure 9. Gowan South Detention Basin




Much of the runoff from the Gowan South Detention Basin south inlet (about 21 square miles) first flows through the Angel Park Detention Basin. There is no information about sediments storage and there is no available freeboard at the Angel Park Detention Basin. It is currently planned for a capacity upgrade from 1,400 acre-feet to 1,512 acre-feet. With a surface area of 80 acres, it may be feasible to incorporate 80 acre-feet of WQCV with the Angel Park Detention Basin upgrade. There are no planned detention basins on the Gowan South system.

### Gowan Watershed Summary

**Table 8** summarizes the proposed approach for treating runoff from the Gowan Watershed. The feasible WQCVs for the existing detention basins are crude estimates based on open surface area and would be revised during conceptual design. Adding treatment to the five locations according to the volumes shown in **Table 8** would result in a total WQCV of 219 acre-feet. This would exceed the WQCV required for all future development in the Gowan Watershed, estimated at 122 acre-feet, thus exceeding the requirements of the MS4 permit.

**Table 8. Summary of Gowan Watershed Retrofit Approach**

| Detention Basin | Treatment Area / Approach | Tributary Area (square miles) | Estimated WQCV (Acre-Feet) |
|---|---|---|---|
| Gowan North Detention Basin | | 23 (maximized) | Up to 205 |
| Gowan North | North half, north inlet flows only. WQCV limited by facility constraints. | 16 (north inlet) | 50 (up to 147) |
| Lone Mountain-Beltway (planned) | Incorporate full WQCV of maximized tributary area | 6 | 49 |
| Village 22 (planned) | Incorporate full WQCV of maximized tributary area | 0.75 | 7 |
| Gowan South Detention Basin | | 28 (maximized) | Up to 174 |
| Gowan South | North inlet flows only, coordinate with planned flood control upgrade. WQCV limited by facility constraints. | 7 (north inlet) | 40 (up to 51) |
| Angel Park | All inflow, coordinate with planned flood control upgrade. WQCV limited by facility constraints. | 21 | 80 (up to 123) |

The following sequence is recommended for Gowan Watershed detention basin retrofits:

- Require the full 49 and 7 acre-feet of WQCV at the planned Lone Mountain-Beltway and Village 22 detention basins. Design and construction would occur as necessitated by development and flood control.
- Complete designs of Gowan South and Angel Park detention basin retrofits/capacity upgrades and determine reasonable WQCV amounts for each.
- Determine the total WQCV for the Gowan Watershed considering Lone Mountain-Beltway, Village 22, Gowan South, and Angel Park. It is possible that the full 122 acre-feet of WQCV for new development in the Gowan Watershed is accounted for at just these four basins. Retrofit of the Gowan North Detention Basin could proceed either to reach the full 122 acre-feet for the Gowan Watershed or to be used as pollutant trading for another watershed. Since there is not already a planned project at the Gowan North Detention Basin, it is recommended that any retrofit be completed here after the WQCVs for the other facilities have been determined.

## 5.2 Retrofit Pilot Projects

Because retrofitting large regional detention basins is a unique approach not widely used throughout the country, a pilot project is recommended before regional detention basin retrofits are completed throughout the system. A pilot project should be monitored to determine if it is operating according to design and if there are any maintenance issues. A pilot project was recommended in 2007 for the Vandenberg Detention Basin. This location was chosen for several reasons, including its location in a developing watershed, its design, which can accommodate retrofit, and that sampling could be conducted in a safe manner. Vandenberg Detention Basin is located on Range Wash, upstream of the diversion channel to the Confluence Detention Basin. Therefore, if a retrofit is conducted of the Confluence Detention Basin, it will not be necessary to retrofit the Vandenberg Detention Basin and another pilot location could be selected.

One of the detention basin capacity upgrade projects that are currently in development may be a good candidate as a combined water quality retrofit pilot project because construction is already required for flood control purposes.

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# Attachment A –Detention Basin Lists

**Lowest Tier Part A: detention basins outside of development boundary**

- 3,200 ac-ft Kyle Canyon Detention Basin
- 1,004 ac-ft Headworks Detention Basin
- 362 ac-ft R4 Detention Basin
- 880 ac-ft East C-1 Detention Basin
- 366 ac-ft Black Mountain Detention Basin
- 165 ac-ft Pittman Anthem Detention Basin

**Lowest Tier Part B: detention basins with less than 5 square miles within development boundary**

- 2,007 ac-ft Red Rock Detention Basin
- 480 ac-ft Mission Hills Detention Basin
- 384 ac-ft Detention Basin #5
- 333 ac-ft Village 26 Detention Basin
- 120 ac-ft Speedway # 3 Retention Basin
- 364 ac-ft Ann Road Detention Basin
- 9.5 ac-ft KB Detention Basin
- 109 ac-ft Bruner Detention Basin
- 353 ac-ft N. E. C-1 Detention Basin

**Detention Basins with at least 3 feet of freeboard from 2008 MPU**

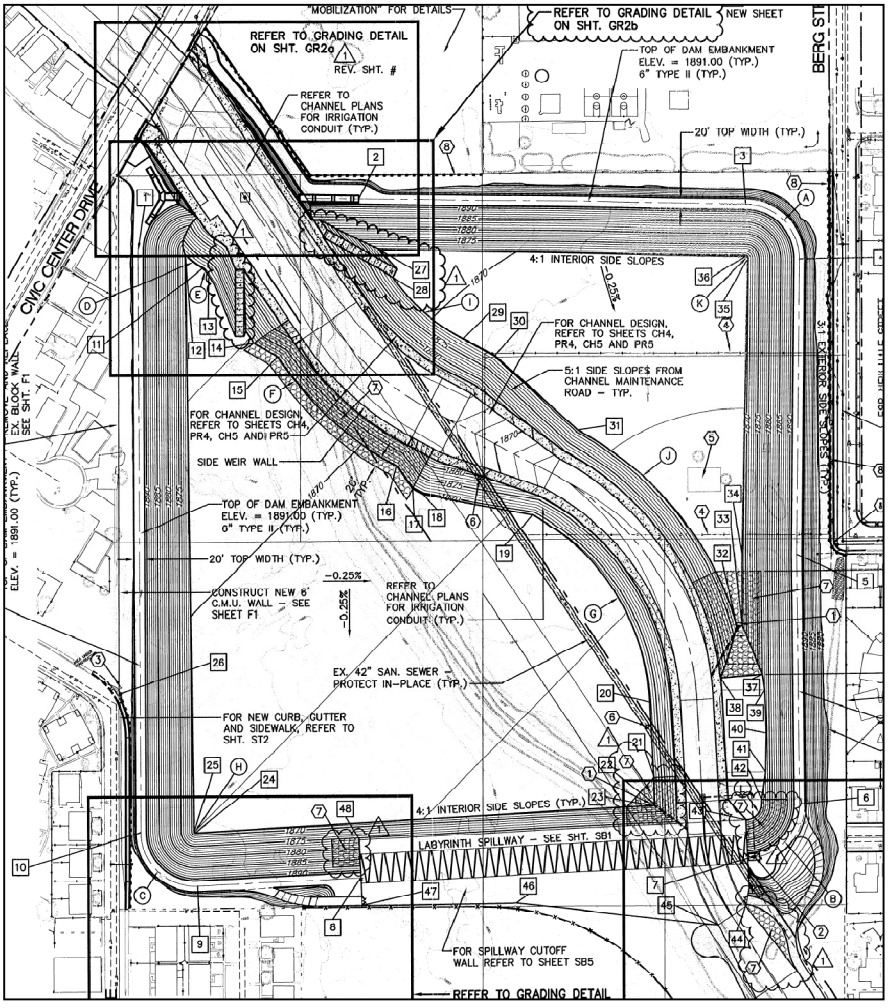
| Watershed | Detention Basin and 2008 MPU Capacity |
|---|---|
| C-1 | 366 ac-ft Black Mountain Detention Basin |
| CENTRAL | 45 ac-ft Rainbow Detention Basin |
| CENTRAL | 201 ac-ft Oakey Detention Basin |
| DUCK | 100 ac-ft McCarran Detention Basin |
| FLAM | 9.5 ac-ft KB Detention Basin |
| LOWER NORTHERN | 700 ac-ft Lower Las Vegas Wash Detention Basin |
| PITT | 1,718 ac-ft Pittman East Detention Basin |
| PITT | 600 ac-ft Cactus Detention Basin |
| RANGE | 349 ac-ft Vandenberg Detention Basin |
| UPPER NOTHERN | 450 ac-ft South Environmental Enhancement Area |

# Attachment B – Retrofit Feasibility for Strategic Detention Basins

### Cheyenne Peaking Basin

The Cheyenne Peaking Basin has a capacity of 456 AF with a required upgrade to 482 AF. As a peaking basin, it is designed to accept only those flows that are high enough that they overtop the Western Tributary channel weir and spill into the basin (see **Figure B-1**). As a rule, this type of design is not compatible with water quality treatment, which is targeted to low flows. Water quality retrofit would require rerouting low flows out of the large concrete-lined channel and into the peaking basin. Such a retrofit is likely to be complicated and potentially problematic. The Final Design Report (VTN 2000) does not note any current storage for sediment and the design does not include a sediment forebay.

**Figure B-1. Cheyenne Peaking Schematic**



Since the Cheyenne Peaking Basin has a maximized tributary area of over 100 square miles, and a WQCV greater than 500 AF, it is not possible for the entire WQCV to be accommodated in the detention basin, even if a method of getting low flows into the basin was designed.

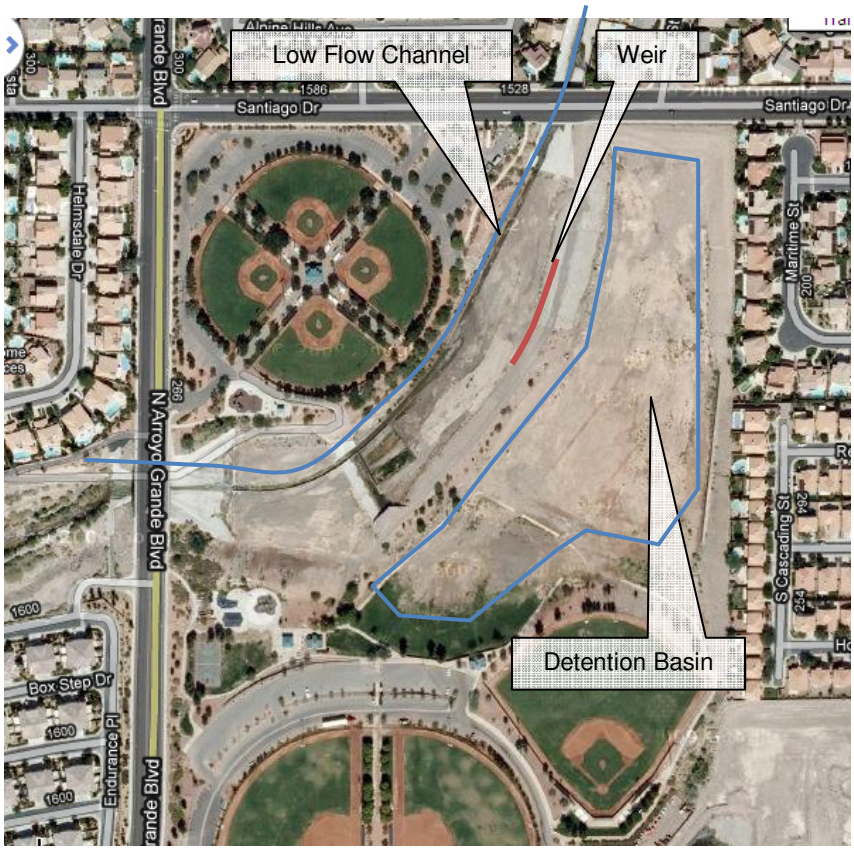
### North Las Vegas Detention Basin

Although the North Las Vegas Detention Basin has a large tributary area that is developable, the entire tributary area is currently undeveloped. Therefore, this detention basin is not a high priority candidate for water quality retrofit in the near term; if feasible, retrofitting could be delayed until development is planned within the tributary area.

### Pittman Park Peaking Basin

The Pittman Park Peaking Basin currently has a limited capacity of 75 AF. Since the Pittman Park Peaking Basin has a maximized tributary area of over 60 square miles, and a WQCV greater than 360 AF, it is not feasible to treat the entire WQCV at this location. The low flow channel for Pittman Wash runs down two drop structures and along the west side of the channel, on the opposite side from the weir where high flows overflow into the peaking basin (see **Figure B-2**). As with the Cheyenne Peaking Basin, low flows would need to be routed out of the channel and into the peaking basin for water quality treatment. High groundwater noted in the Design Memorandum could make additional excavation in the basin challenging. The Design Memorandum recommended 0.75 AF of sediment dead storage in the Pittman Park Peaking Basin (Montgomery Watson 1997).

Figure B-2. Pittman Park Peaking Basin Schematic




**Lower Duck Creek Detention Basin**

The Lower Duck Creek Detention Basin is designed to accept flows from three conveyance systems; Blue Diamond Channel 2, Duck Creek Gilespie Channel and Duck Creek Wash. The combined basin 100-year peak inflow is 5,844 cfs and the basin capacity is 1,100 acre-ft. The MPU indicates that the basin does not have adequate capacity for the 100-year ultimate condition outflow. The proposed improvement is to replace the current 54-inch orifice plate with a 66-inch orifice plate to increase the discharge flow rate. The detention basin does have enough capacity for the 100-year storage volume, with 1.6 feet of freeboard below the spillway (CCRFCD 2008). This suggests that there may be some, but not much additional capacity that can be allocated to water quality storage.

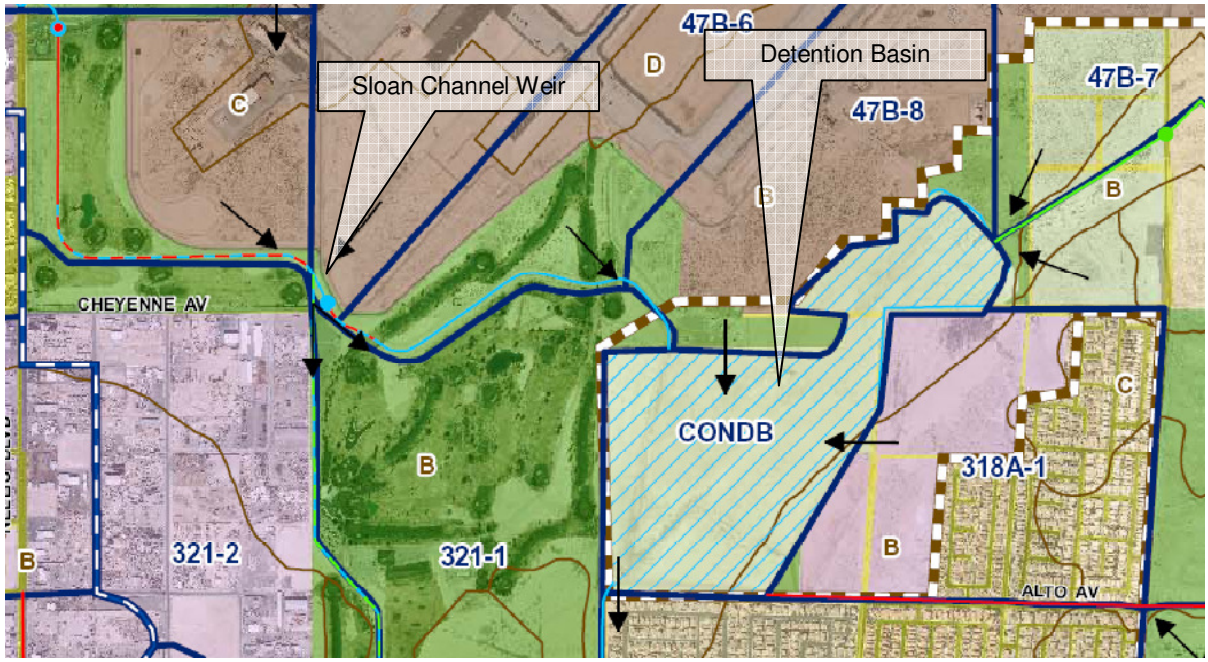
The Lower Duck Creek Detention is a good candidate for water quality retrofits due to its large size and location, which captures the flow from a tributary area (within the development boundary) of about 58 square miles. However, the WQCV of about 382 acre-feet is a large percentage of the total storage capacity. Modifications to the basin grading and/or utilizing some of the designed sediment capacity of 240 acre-ft could provide capacity to treat the water quality capture volume for this watershed. The basin was constructed with an interior berm bounding an area in the southwest portion of the basin to be used for a park. The berm directs the low flows entering the basin from the Blue Diamond Channel 2 around the park area. Since the basin construction, inlets for the two other conveyance systems entering the basin have been constructed in the southwest portion

of the basin. Flows from each of the systems enter the basin within the park area. The area designated for the park has not been developed and could be converted into a water quality treatment basin. This could involve directing the flow from the Blue Diamond Channel 2 into the treatment area. Additionally, the outlet orifices could be modified to accommodate the capacity required for the water quality treatment.

### Confluence Detention Basin

The Confluence Detention Basin is designed to accept peak flows from the Sloan Channel, flows from the north via the proposed Range Wash-East Tributary and flows from undeveloped area to the east via the proposed Alto Conveyance system. A diversion control structure on the Sloan Channel directs peak flows to the detention basin while containing smaller flows within the Sloan Channel that bypasses the basin (see **Figure B-3**). According to the 2008 MPU the diversion control structure routes 4,377 cfs of the peak flow to the Confluence detention basin via a grass lined channel through the Nellis Airforce Base golf course and allows 1,668 cfs to remain in the Sloan Channel. Other flows to the basin are 2,770 cfs from the Alto Conveyance system and 4,033 cfs from the Range Wash system. The MPU shows a combined peak flow into the basin of 6,081 cfs with a capacity of 1,025 acre ft.

Figure B-3. Confluence Detention Basin Schematic




Source: Modified from 2008 MPU.

The Confluence Detention Basin is a good candidate for water quality retrofits due to its large size and location, which captures the flow from a tributary area (within the development boundary) of about 50 square miles. The WQCV of about 250 acre-feet is a large percentage of the total capacity. Model results show that there is little excess capacity with a modeled freeboard of about 1.4 feet (CCRFCD 2008). Modifications to the basin grading or utilizing some of the designed sediment capacity of 160 acre-ft could provide capacity to treat at least a portion of the WQCV. A drawback here is that a large portion of the watershed to the east is undeveloped. The developed portion of the watershed is collected by the Sloan channel, which would be the highest priority for water quality treatment. The limitation to treating the Sloan Channel drainage is the diversion control structure on the Sloan Channel. Modifications to the structure could be made to allow low flows to pass the structure and enter the detention basin while maintaining the peak diversion flows as originally designed. Additional water quality benefits could potentially be gained by the existing grass lined channel as small flows are conveyed from the diversion structure to the Confluence Detention Basin.

### Tropicana Detention Basin

The Tropicana Detention Basin is designed to accept flows from both the Tropicana Wash and Flamingo Wash watersheds. According to the MPU the combined basin 100-year peak inflow is 6,700 cfs with a basin outlet flow of 495 cfs and 100-year capacity of 825 acre-ft.

The basin consists of a north and south bay separated by a center dike. Flows from the two channels enter into the north bay. The outlet from the basin is also in the north bay. The

dike dividing the two bays was designed to allow the water depth to increase more rapidly in the north bay maximizing the capacity of the outlet.

The Tropicana Detention Basin is a good candidate for water quality retrofits due to its large size and location, which captures the flow from a tributary area (within the development boundary) of about 48 square miles. The estimated WQCV is about 312 acre-feet, close to 50 percent of the total capacity. There is no available freeboard above the 100-year storage volume. The unusual configuration of the basin, where north and south bays are separated by a dike could make design of water quality retrofits challenging. Modifications to the basin grading or utilizing some of the designed sediment capacity of 72 acre-ft could provide capacity to treat a portion of the WQCV. The north bay does not have much available area whereas the south basin has a larger area in which to construct a water quality facility. To use the south bay for treatment, the basin configuration and operation would need to be modified to allow the inflow channels to flow into the south basin. For this reason water quality treatment beyond the current sediment storage is not recommended on this basin.

# Section 12

MWH

TECHNICAL MEMORANDUM

# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

# STORMWATER MANAGEMENT PLAN DOCUMENTATION

## Technical Memorandum IV.12

## Proposed New Development and Significant Redevelopment Program for Las Vegas Valley

January 13, 2011

*Prepared for*

**Stormwater Quality Management Committee**

*Prepared by*

MWH

BUILDING A BETTER WORLD

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# Executive Summary

The Las Vegas Valley Municipal Separate Storm Sewer System (MS4) Permittees have developed a proposed New Development and Significant Redevelopment (NDSR) Program (also known as a Post-Construction Program) in response to the requirements of the new permit dated February 9, 2010. The program is comprised of measures to mitigate the water quality impacts of stormwater runoff from areas of new development and significant redevelopment.

Proposed NDSR measures were selected by the Development Guidelines Working Group, a subcommittee of the Las Vegas Valley Stormwater Quality Management Committee made up of representatives from each Permittee and representatives of the development community. Measures were tailored to the unique climatic, hydrologic, geologic, watershed, land use, and legal conditions affecting stormwater runoff on Las Vegas Valley. They were selected to address pollutants of concern identified by the Permittees based on local water quality data and issues.

Special studies were conducted to support development of the NDSR Program. These included:

- unique local conditions affecting preparation of a feasible NDSR Program for Las Vegas Valley
- review and assessment of existing best management practices that already provide benefits for areas of NDSR
- assessment of the suitability of promoting stormwater infiltration in Las Vegas Valley
- review and assessment of the feasibility of commonly applied Low Impact Development (LID) measures for Las Vegas Valley
- review of local, state and federal legal and regulatory issues affecting stormwater capture and disposal

The proposed NDSR Program consists of existing practices and programs in the following categories:

- Source Control Measures
- Site Design Measures
- Treatment Control Measures

A "gap analysis" was performed to determine whether new or expanded programs are required to comply with the MS4 permit. Based on permit requirements, the gap analysis, and maximum extent practicable (MEP) expansions of existing programs, new or expanded BMPs are needed for the NDSR program in the following areas.

1. Regional detention basin retrofit investigation.
2. Additional BMPs for parking lots.
3. Upgraded public education and outreach program.

4. Upgraded interagency coordination.
5. Modified Standard Drainage Design Criteria and Development Standards.

The MS4 permit requires the Permittees to develop and implement an ordinance or other regulatory mechanism to address urban stormwater runoff from NDSR projects. Revised stormwater ordinances for each entity will be prepared by staff and reviewed by the Stormwater Stakeholders Working Group. Revised ordinances or development standards will be adopted by August 31, 2012.

In addition, the MS4 permit requires the Permittees to develop and implement an inventory and tracking system for post-construction structural stormwater BMPs. The Permittees propose to go beyond this requirement and track information related to both structural and non-structural BMPs.

The MS4 permit requires the Permittees to update MS4 maps to show areas of NDSR, including any new stormwater major infrastructure that was constructed to serve these areas. A single valley-wide GIS map depicting areas of new development and significant redevelopment in Las Vegas Valley will be prepared and provided in each MS4 Annual Report.

The MS4 Permit requires the Permittees to adopt BMPs for specific land uses and development types. Selected BMPs for Las Vegas Valley include a mix of site design, source control and treatment control BMPs. The MS4 Permit allows the Permittees to identify any other locally unique land use types that could cause or contribute to stormwater quality problems. The Permittees have identified hotel/casinos as locally unique development types that deserve consideration.

The Permittees will develop specific design criteria for structural BMPs that could be used in NDSR projects for the specific land uses and development types. Regional flood control facilities serving as BMPs are designed for the 100-yr flood. Local drainage facilities serving as BMPs are designed for the 10-yr flood. Special water quality structures will be designed for the runoff from the 85$^{th}$ percentile storm.

# 1 Introduction

This technical memorandum describes the proposed New Development and Significant Redevelopment (NDSR) Program required by the new Las Vegas Valley Municipal Separate Storm Sewer System (MS4) permit. This permit was issued by Nevada Division of Environmental Protection (NDEP) on February 9, 2010. The permit requires the MS4 Permittees (Clark County Regional Flood Control District, Clark County, City of Las Vegas, City of North Las Vegas and City of Henderson) to describe and adopt a program addressing new development and significant redevelopment within Las Vegas Valley (the permit area). The NDSR Program is also referred to as the Post-Construction Program, as it deals with stormwater management measures that will remain in place after construction of new development is completed.

The permit language related to the NDSR program is duplicated in **Attachment A.** Permit requirements are summarized as follows.

- Develop a NDSR program that is suited for the unique hydrologic, hydrogeologic and regional conditions of Las Vegas Valley
- Address post-construction runoff from projects that disturb 1.0 acre or more, or are part of a larger common plan of development or sale
- Describe low impact development measures for the NDSR program that are effective and appropriate for Las Vegas Valley
- Describe additional structural and non-structural best management practices (BMPs)
- Describe procedures to assure that future regional flood control projects are evaluated to determine if retrofitting the device to provide additional pollutant removal is feasible and appropriate
- Describe how the Permittees will implement an ordinance or other regulatory mechanism to address urban stormwater runoff from NDSR projects
- Describe how the Permittees will verify maintenance of NSDR BMPs on private property
- Describe how the Permittees will inventory and track post-construction BMPs
- Describe how the Permittees will inspect and enforce proper installation and maintenance of post-construction BMPs
- Describe how the Permittees will update MS4 maps to show areas of new development and significant redevelopment
- Develop special BMP requirements and design standards for the following development types:
  - Residential subdivisions five (5) acres or greater in size;
  - Single-family residences subject to local ordinances governing hillside development;
  - 100,000 square foot commercial and industrial developments;
  - Automotive repair shops (with Standard Industrial Classification ("SIC") codes 5013, 7532, 7533, 7534, 7537, 7538, and 7539);
  - Retail gasoline outlets disturbing greater than one (1) acre;
  - Restaurants disturbing greater than one (1) acre;
  - Parking lots greater than one (1) acre potentially exposed to urban runoff; and
  - Any other NDSR projects the Permittees deem necessary to be included in this part.

- Develop numerical design standards for site design, source control and treatment control BMPs as necessary

In addition to reducing the contribution of urban runoff to receiving water pollution to the maximum extent practicable (MEP), the Las Vegas Valley MS4 permit for Las Vegas Valley recognizes the following stormwater management goals:

1. To prevent stormwater discharges from post-construction projects from causing or contributing to downstream violations of water quality standards of selenium to the MEP;
2. To promote anti-degradation of ambient water quality by reducing the discharge of pollutants in stormwater causing or contributing to any degradation identified by NDEP's anti-degradation program; and
3. To develop best management practices (BMPs) to promote the reuse of stormwater for municipal supplies.

Permittees must provide a written evaluation of whether these goals are achieved by the proposed NDSR program.

The elements of the NDSR program were developed by the Development Guidelines Working Group (DGWG), a subcommittee of the Las Vegas Valley Stormwater Quality Management Committee (SQMC). The DGWG included representatives of the planning and public works departments of each Permittee, Clark County Regional Flood Control District (CCRFCD), local land development engineers, and local developers.

# 2 Background

## 2.1 Unique Local Conditions

The MS4 permit requires the Permittees to develop a NDSR that is tailored to the unique conditions in Las Vegas Valley. The Permittees prepared a comprehensive description of unique local factors that affect preparation and implementation of a feasible NDSR program. This is published separately as *Technical Memorandum No. IV.5 - Unique Factors Influencing the Las Vegas Valley MS4 Permit Program* (MWH 2010c). These factors and their influences on the NDSR program are summarized as follows.

- **Precipitation.** Las Vegas Valley is the driest MS4 in the U.S., with only 4.2 inches of annual precipitation and less than 10 runoff-producing storms per year. Traditional stormwater quality management approaches are not cost-effective in this environment. Traditional BMP techniques requiring vegetation, permanent pools, and flushing flows are not feasible in this region due to the climate.
- **Hydrology.** Storm runoff events generally last for only a few hours, and originate from storms of small areal extent. The main receiving water – Las Vegas Wash – is an effluent dominated stream in which 90 percent of mean annual flow is from wastewater discharges, only 4 percent is from storm runoff, and 6 percent is from

other urban sources (resurfacing groundwater and dry weather flows). Due to the minor contribution of stormwater to overall flow, watershed-based management approaches are more reasonable than parcel-level approaches. Streamflow data suggests that watershed changes including urbanization have resulted in an increase in storm runoff volume over the past 30 years.

- **Watershed Soils.** Undeveloped watersheds are comprised of desert soils with high erosion and sediment transport rates. Urban development generally stabilizes these surfaces. Thus addressing erosion and sediment control in developed areas is not as critical as in other regions. CCRFCD and SNWA have extensive programs for controlling erosion in channels downstream of development and in lower Las Vegas Wash.

- **Geology and Hydrogeology.** Infiltration, which is a common treatment and disposal process in many stormwater BMPs, is problematic in Las Vegas Valley due to soil conditions (caliche, expansive and collapsible soils) and potential impacts on selenium and TDS concentrations in the lower valley. Any BMPs that increase selenium discharges from groundwater to surface water would cause or contribute to exceedances of the water quality standard for selenium. BMPs that promote infiltration should generally be avoided.

- **Surface Water Quality.** Significant urbanization in the past 15 years has not increased pollutant concentrations for most constituents at most locations, but pollutant loads have increased due to increases in dry weather and wet weather flow volumes. Thus existing BMP programs have been effective and should be continued, and additional regional measures to address flow volumes should be considered.

- **Legal and Institutional.** State water law prohibits capturing stormwater and putting it to a beneficial use without a permit. Regional water resources agencies including SNWA and Colorado River Commission want to maximize delivery of good quality runoff from the Las Vegas Wash watershed to Lake Mead. These policies discourage use of onsite stormwater retention BMPs.

- **Flood Control Planning.** The current regional flood control approach consists of lining channels to prevent erosion and constructing large regional detention basins to manage flow rates. The resulting infrastructure is also effective for sediment management and other control of other pollutants associated with sediment. Existing regional infrastructure and flood management planning should be incorporated into the NDSR program to the maximum extent possible.

## 2.2 Pollutants of Concern

The Permittees determined pollutants of concern for the Las Vegas Valley NDSR program based on review of local stormwater monitoring data, state-determined water quality impairments, pollutants addressed by programs in other communities, and research by Environmental Protection Agency. Evaluation of pollutants of concern was described

separately in *Technical Memorandum No. IV.8 - Pollutants of Concern for Las Vegas Valley MS4 NDSR Program* (MWH 2010d). The following pollutants were identified as pollutants of concern.

- Nutrients (phosphorus, nitrogen)
- Pathogens
- Hydrocarbons (oil and grease)
- Organic Compounds (solvents)
- Pesticides and Herbicides
- Sediment
- Metals (copper, lead, zinc)
- Litter/Floatables
- Selenium
- Total dissolved solids
- Other (pH, surfactants)
- Hydromodification (storm flows, low flows)

These pollutants were selected primarily because of their general occurrence in stormwater based on nationwide research. While water quality monitoring in Las Vegas Valley has found these constituents to be present, nearly all are found at concentrations that are to be expected in the urban environment. Based on the most acute local water quality concerns, the following priority pollutants of concern were identified: hydromodification, phosphorus and sediment.

## 2.3 Infiltration Suitability

The Permittees reviewed the suitability of infiltrating stormwater in Las Vegas Valley based on soil conditions, slopes, shallow groundwater, water quality, contaminated soils, presence of industrial facilities, and regulatory factors. This is described in detail in *Technical Memorandum No. IV.6 - Limitations on Use of Infiltration-Based BMPs for New Development and Significant Redevelopment in Las Vegas Valley* (MWH 2010d). Widespread occurrence of caliche, steep slopes, and expandable and collapsible soils limits the areas where infiltration would be feasible. Infiltration of stormwater into poor quality shallow aquifers would cause exfiltration of degraded water in downstream channels. Infiltration in areas of known or potential soil contamination associated with industrial activity could lead to groundwater contamination.

Superimposing areas where infiltration could be infeasible due to one of these limiting factors led to the conclusion that stormwater infiltration is not a generally practical option for stormwater disposal in Las Vegas Valley and should be discouraged by the MS4 Permittees. Any BMPs relying on infiltration for stormwater disposal were considered infeasible for the NDSR program. If a land developer wishes to use stormwater retention and infiltration as a BMP, a site-specific geotechnical study will be required to demonstrate that infiltration is technically feasible and will not adversely affect ground or surface water quality.

## 2.4 Low Impact Development Evaluation

The MS4 permit requires the Permittees to consider low impact development (LID) measures for managing runoff from areas of new development and significant redevelopment. Low impact development consists of a variety of site planning and site design measures or practices to minimize the impact of individual urban developments on stormwater runoff quantity and quality. A detailed evaluation of potentially feasible LID measures for Las Vegas Valley is presented in *Technical Memorandum No. IV.10 - Evaluation of Low Impact Development Measures for NDSR Program* (MWH 2010h).

LID measures were selected for the Las Vegas Valley LID "toolbox" using the following process.

1. Identify all known LID measures based on national manuals and guidelines.
2. Identify those LID measures that would be feasible in the context of the Las Vegas Valley climate, hydrology, hydrogeology, watershed conditions, and development styles.
3. Identify those locally feasible LID measures that meet the objective of LID for the NDSR Program, which is to fill gaps in existing measures or supplement existing programs on an "opportunistic" basis.

The LID measures determined to be feasible for use in the Las Vegas Valley NDSR program, if required, are listed below.

| LID Category | Specific Measure or Practice |
|---|---|
| Minimize directly connected impervious area | Minimize overall impervious area |
| | Direct runoff onto properly designed unpaved surfaces |
| | Disconnect rooftop drains |
| Parking Lot Design | Depressed medians |
| | Buffer strips |
| | Porous paving – modular pavers |
| | Minimize parking requirements |
| Street Design | Minimum street widths |
| | Cul de sac design |
| | Buffer strips |
| | Depressed medians |
| Site Design | Depressed landscaping |
| | Landscaped drainage swales |
| | Open space set-asides |
| | Density tradeoffs |
| Landscape Design | Xeriscaping |
| | Depressed landscape areas |
| | Buffer strips |

## 2.5 Legal and Water Rights Evaluation

The new MS4 permit requires a review of low impact development measures, including onsite retention. Nevada water law was reviewed and the Nevada State Engineer's Office, SNWA, and the Colorado River Commission were contacted to determine potential legal and water rights issues that could affect use of stormwater retention facilities in Las Vegas Valley. The result of this evaluation is described in detail in *Technical Memorandum No. IV.7 - Potential Legal and Water Rights Issues Associated with Onsite Retention of Stormwater* (MWH, 2010e).

Stormwater retention without onsite beneficial use (infiltration and evaporation losses only) would contradict local agency policies and potentially exacerbate existing water quality problems, and is not recommended. Proposed stormwater retention with onsite beneficial use (e.g., for irrigation water) would have agency support but each individual retention project would have to be submitted to the State Engineer for approval; approval is not certain due to potential impacts on Lake Las Vegas and other water rights holders. Therefore, stormwater retention cannot be relied on for the MS4 program, and was rejected by the Permittees as a potential mandatory element of the NDSR program. However, it could still be pursued voluntarily by a new development if the proper approvals and water rights were obtained.

# 3 Overall Program Strategy

The proposed NDSR Program was developed based on the following strategic approach.

1. Develop a program that is tailored to unique local meteorologic, hydrologic, geologic, water quality, land use, legal, and flood control planning characteristics, as described in Section 2.
2. Adopt a regional, watershed-based approach. This approach is consistent with general environmental planning objectives of the Environmental Protection Agency, and the flood control planning strategy of CCRFCD. It is also well-suited to the unique local conditions.
3. Maximize incorporation of existing management measures already being implemented by the Permittees and other regional agencies, including those not specifically developed to address stormwater quality problems.
4. Identify new BMPs needed to meet the MEP requirement of the MS4 permit and address known, documented water quality problems in Las Vegas Valley surface waters.
5. Avoid BMPs that would likely have adverse effects such as degrading surface or ground water quality or creating legal problems.

# 4 Existing Best Management Practices

The Permittees and other regional agencies in Las Vegas Valley are currently engaged in many practices that benefit runoff quality from existing and future urban areas. Some of these are part of the existing NDSR Program, while others are associated with other regional environmental initiatives (e.g., air quality management, water conservation, Las Vegas Wash restoration). The Permittees completed a comprehensive review of existing BMPs that could be appropriate for inclusion in the proposed NDSR program. This review is described in *Technical Memorandum No. IV.9 - Description of Existing BMPs and Need for New BMPs for NDSR Program* (MWH, 2010g).

Existing practices already being implemented by the Permittees that could be included in the new NDSR program were described and reviewed, and potential BMPs that could be feasible in Las Vegas Valley based on a previous analysis were considered. Thirty-six existing practices were identified for inclusion in the NDSR program. Existing and potential BMPs were organized into the three categories identified in the MS4 permit: Source Control Measures, Site Design Measures, and Treatment Control Measures. Existing BMPs are listed below.

1. **Source Control Measures**
   - 1.1. Street Sweeping Programs
   - 1.2. Local Storm Drain System Maintenance
   - 1.3. Regional Flood Infrastructure Maintenance
   - 1.4. Water Conservation (Drought) Ordinance
   - 1.5. Commercial/Industrial Housekeeping Practices
   - 1.6. Household Hazardous Waste Collection
   - 1.7. Ordinances Prohibiting Non-Stormwater Discharges and Littering
   - 1.8. Desert Dumping Controls
   - 1.9. Grease Interceptor Program
   - 1.10. Dust Control Measures
   - 1.11. Fertilizer, Pesticide and Herbicide Management Program
   - 1.12. Public Education
   - 1.13. Storm Drain Marking Program
   - 1.14. Indoor Workshops
   - 1.15. Spill Control Prevention Plans
   - 1.16. Industrial Pretreatment Programs
   - 1.17. Trash Receptacle Enclosures
   - 1.18. Southern Nevada Health District Inspections
   - 1.19. Turf Conversion Program
   - 1.20. Regional Water Quality Planning
   - 1.21. Pet Waste Management
2. **Site Design Measures**
   - 2.1. Open Space and Landscaping Objectives
   - 2.2. Rural Land Overlay
   - 2.3. Hillside Development Ordinances
   - 2.4. Preserve Natural Washes
   - 2.5. Sustainability and Green Building Initiatives
   - 2.6. Covered Fuel Areas
   - 2.7. Raised Fuel Areas
   - 2.8. Emergency Shut-off Switch and Shear Valves

2.9. Standard Drainage Design Criteria

**3. Treatment Control Measures**

3.1. Regional Detention Basins

3.2. Regional Channel Lining

3.3. Las Vegas Wash Stabilization Structures

3.4. Sand/Oil Separators

3.5. Sand Filter

A "gap analysis" was performed to determine whether new or expanded programs are required to comply with the MS4 permit. The gap analysis is described in MWH, 2010e, and is summarized in the table in **Attachment B**. Existing and potential BMPs were linked to specific pollutants of concern and pollutant sources (land uses). A gap is defined as a situation in which the existing BMPs would clearly not meet the MEP standard, there are other BMPs feasible for Las Vegas Valley that could be implemented, and the pollutant/land use combination is important enough that it deserves considering additional BMPs.

BMP effectiveness was assessed based on the "maximum extent practicable" test. BMPs not currently being implemented to the MEP were recommended for expansion or upgrade. BMPs identified in a separate assessment of measures required to address impaired waterbodies and TMDLs were incorporated into the assessment (MWH 2010a). The new permit contains requirements for particular types of BMPs for the NDSR program.

# 5 Additional Requirements

Based on permit requirements, the gap analysis, and MEP expansions of existing programs, new or expanded BMPs are needed for the NDSR program in the following areas.

1. *Regional detention basin retrofit investigation.* This is required by the new permit (paragraph IV.F.3.a.iv), as is also a commitment the Permittees made to NDEP in their letter of December 2008. Stormwater sampling by the Permittees has shown that existing regional detention basins are only marginally effective at removing typical pollutants of concern in urban runoff. Because they are designed to manage the 100-year runoff event, small runoff events tend to pass through the regional detention basins with little or no attenuation and pollutant removal. The plan is to investigate the feasibility and benefits of retrofitting existing regional detention basins to improve their pollutant removal capabilities for small storms using one or more strategies (e.g., modified water quality outlet, in-basin sediment storage, wetland vegetation). A proposed strategy for investigating and implementing a regional detention basin retrofit program has been developed by the Permittees, and is described in a separate memorandum (*Technical Memorandum No. IV.11 0 Potential Water Quality Retrofits of Regional Detention Basins – Strategic Plan;* MWH 2010i). In summary the plan consists of the following:

- Target water quality capture volumes were established for each major watershed in Las Vegas Valley based on developable land area.
- A master plan for detention basin design and retrofitting will be prepared.
- Regional detention basins will be designed or retrofit to provide the target water quality capture volume based on the following priority:
  - New regional detention basins will be outfitted with water quality outlet structures;
  - Regional detention basins that must be upgraded due to flood control inadequacies will be provided with water quality outlet structures;
  - Other existing regional detention basins will be retrofit as needed to meet the target water quality capture volume for the major watershed.

2. *Additional BMPs for parking lots.* Although local water quality data does not show high concentrations of pollutants typically associated with parking lots (hydrocarbons, heavy metals), they are listed among the land uses requiring special attention in the MS4 permit (paragraph IV.F.3.b.vii). The BMP gap analysis shows there are few existing practices specifically targeting parking lot runoff. Based on review of potential parking lot BMPs, several site design measures were selected as being feasible for Las Vegas Valley. It was decided that treatment control measures (e.g., sand filters, oil/water separators, hydrodynamic separators) would not be mandated but could be used by the developer to address stormwater issues if other site design or source control measures are not feasible. Source control measures for parking lots generally involve site housekeeping and maintenance practices; this will be addressed through the upgraded public outreach program. The proposed Parking Lot BMP Program is described in **Attachment C**.

3. *Upgraded public education and outreach program.* An expanded public education and outreach program is needed to address issues of general public awareness for new residents, as well as concerns associated with new commercial and industrial site owners in targeted categories. The details of this program will be developed under the Public Education and Outreach Program for the new SWMP.

4. *Upgraded interagency coordination.* Many agencies and groups of agencies are involved with various aspects of water quality management in Las Vegas Valley. Improved coordination among these agencies would result in more efficient and effective water quality management programs and policies.

5. *Modified Standard Drainage Design Criteria and Development Standards.* In some cases, existing drainage design criteria and development standards either preclude or complicate implementation of LID site design measures. Examples include requirements for hard-lined drainage facilities connecting onsite drainage to off-site facilities; minimum street widths; and parking space requirements. Modifying these standards or making it easier to use pre-approved alternates would make it easier for developers and engineers to creatively implement LID site design principles in new

development. Each entity will review its design standards and development codes and adopt changes to facilitate implementation of LID measures.

These proposed practices are discussed further in Section 6, Technical Memorandum No. IV.9, and **Attachment D**.

# 6 NDSR Program Summary

This section summarizes the proposed NDSR program, and presents the specific program information required by the MS4 permit.

## 6.1 Applicability

The MS4 permit requires the Permittees to: develop, implement and enforce a program to address post-construction urban runoff from NDSR projects that disturb areas ≥ 1 acre (paragraph IV.F.3.a.i). All BMPs incorporated into the NDSR program will be applied as a minimum to new development and significant redevelopment projects with land disturbance of at least 1.0 acres. They will also apply to smaller areas that are part of a common plan of development or sale that disturbs at least 1.0 acres. The majority of proposed BMPs are implemented regionally or at the watershed scale, and will thus apply to all new development and redevelopment, as well as all existing development.

## 6.2 NDSR BMPs

**Table 1** lists the BMPs proposed for the Las Vegas Valley NDSR Program, and identifies the agencies responsible for their implementation, an implementation schedule, and proposed monitoring and tracking activities.

**Table 1. Proposed New Development and Significant Redevelopment Best Management Practices**

| Best Management Practice | Brief Description | Responsible Parties | Implementation Schedule | Monitoring and Tracking | Measurable Goals |
|---|---|---|---|---|---|
| **Source Control Measures** | | | | | |
| 1.1 Street Sweeping | Use street sweepers to remove sediment, debris, trash and associated pollutants from new public street surfaces | Clark County, CLV, CNLV, COH | Existing program | See Source Control Plan | See Source Control Plan |
| 1.2 Local Storm Drain System Maintenance | Remove sediment, debris, trash and associated pollutants from new local drain inlets and storm drains | Clark County, CLV, CNLV, COH | Existing program | See Source Control Plan | See Source Control Plan |
| 1.3 Regional Flood Infrastructure Maintenance | Remove sediment, debris, trash and associated pollutants from new regional channels and detention basins | Clark County, CLV, CNLV, COH; funding from CCRFCD | Existing program | See Source Control Plan | See Source Control Plan |
| 1.4 Water Conservation (Drought) Ordinance | Watering restrictions and turf limitations to reduce urban dry weather flows and associated load and transport of landscaping pollutants from new deveopments | Clark County, CLV, CNLV, COH; supported by SNWA | Existing Program | - | - |
| 1.5 Commercial/ Industrial Housekeeping Practices | Implement maintenance and housekeeping practices on new commercial/industrial sites to prevent contact of rain water with potentially contaminated surfaces and materials and/or control site runoff | Clark County, CLV, CNLV, COH | Existing Program | - | - |
| 1.6 Household Hazardous Waste Collection | Collection service to remove and properly dispose of hazardous materials prior to their introduction to trash collection areas and landfills | Clark County, CLV, CNLV, COH; collection by private contractor | Existing Program | See Source Control Plan | See Source Control Plan |
| 1.7 Ordinances Prohibiting Non-Stormwater Discharges and Littering | Legal authority to prohibit discharge of non-stormwater (except as expressly permitted) to the MS4, including litter, in all new development | Clark County, CLV, CNLV, COH; enforcement also by Southern Nevada Health District | Existing Program | - | - |

| Best Management Practice | Brief Description | Responsible Parties | Implementation Schedule | Monitoring and Tracking | Measurable Goals |
|---|---|---|---|---|---|
| 1.8 Desert Dumping Controls | Ordinances prohibiting dumping in the desert | Clark County, CLV, CNLV, COH; enforcement also by Southern Nevada Health District | Existing Program | - | - |
| 1.9 Grease Interceptor Program | Inspections to prevent grease plugs causing overflows from sanitary system to stormwater system from new restaurants and certain industrial facilities. | Clark County, CLV, CNLV, COH | Existing Program | Entities track inspections; will not report for MS4 permit | - |
| 1.10 Dust Control Measures | Air quality management measures complying with federally imposed regulations reduce dust and airborne transport and eventual deposition of pollutants from new construction and development | Clark County, CLV, CNLV, COH | Existing Program | Performed for Air Quality Management Program; will not report for MS4 permit | Per Air Quality Management Program |
| 1.11 Fertilizer, Pesticide and Herbicide Management Program | Measures to manage application and disposal of fertilizers, pesticides and herbicides | Clark County, CLV, CNLV, COH | Existing Program | See Source Control Plan | See Source Control Plan |
| 1.12 Public Education | Attempt to modify potentially harmful behaviors in new residents by disseminating information and products; targeted activities and pollutants include pet waste, illegal dumping, household hazardous waste management, and over-watering. | CCRFCD, Clark County, CLV, CNLV, COH | Enhanced Program – See Public Education and Outreach Program | See Public Education and Outreach Program | See Public Education and Outreach Program |

| Best Management Practice | Brief Description | Responsible Parties | Implementation Schedule | Monitoring and Tracking | Measurable Goals |
|---|---|---|---|---|---|
| 1.13 Storm Drain Marking Program | Install educational markers on drain inlets to discourage illegal dumping; adopt local design standards for new inlets to require developers to install storm drain markers in all new development and redevelopment. | Clark County, CLV, CNLV, COH, Regional Transportation Commission (for standards) | • Enhanced Program<br>• RTC adopt standards – 2/28/11<br>• Modify local design standards – 12/31/11 | Number of new storm drain inlet markers installed by developers | 90% of all new drain inlets and catch basins outfitted with drain inlet markers |
| 1.14 Indoor Workshop | Locate work areas indoors at new industrial sites to prevent contact with rain or runoff | Clark County, CLV, CNLV, COH | Existing Program | - | - |
| 1.15 Spill Control Prevention Plan | Secondary containment and cleanup procedures for potential hazardous material spills at new industrial sites | Clark County, CLV, CNLV, COH | Existing Program | - | - |
| 1.16 Industrial Pretreatment Program | Inspection of new industrial sites by local wastewater pretreatment inspectors | Clark County, CLV, CNLV, COH | Existing Program | See Industrial Site Program | See Industrial Site Program |
| 1.17 Trash Receptacle Enclosures | Enclose trash bins in areas of new development and redevelopment to minimize contact with stormwater and prevent migration of trash | Clark County, CLV, CNLV, COH | Existing Program | - | - |
| 1.18 Southern Nevada Health District Inspections | Inspections of new commercial and industrial sites using small amounts of hazardous materials | SNHD | Existing Program | SNHD sets policies and procedures; will not report for MS4 permit | Per SHND policies and procedures |
| 1.19 Turf Conversion Program | Program offering money to remove lawns to reduce water use and dry weather runoff | SNWA | Existing Program | SNWA sets policies and procedures; will not report for MS4 permit | Per SNWA policies and procedures |
| 1.20 Regional Water Quality Planning | Cooperative regional efforts to address water quality issues; improve coordination on stormwater-related issues | Clark County, CLV, CNLV, COH, CCRFCD, SNWA, LVVWAC, LMWQF, LVWCC, NDEP | Begin immediately to enhance existing programs | - | - |
| 1.21 Pet Waste Management | Stations in new parks and open spaces to deposit pet waste | Clark County, CLV, CNLV, COH | Existing Program | - | - |

| Best Management Practice | Brief Description | Responsible Parties | Implementation Schedule | Monitoring and Tracking | Measurable Goals |
|---|---|---|---|---|---|
| **Site Design Measures** | | | | | |
| 2.1 Open Space and Landscaping Objectives | Open space, landscaping and recreation requirements; prevents impacts of development from occurring on reserved land. | Clark County, CLV, CNLV, COH | Existing Program | - | - |
| 2.2 Rural Land Overlay | Special land development criteria for rural areas; allows use of LID measures | Clark County, CLV, CNLV, COH | Existing Program | - | - |
| 2.3 Hillside Development Ordinances | Design guidelines for new development on steep slopes that minimize erosion. | Clark County, CLV, COH (CNLV does not have hillside areas) | Existing Program | - | - |
| 2.4 Preserve Natural Washes | Preservation of natural washes in master planned areas and recreation areas allows for natural runoff attenuation and infiltration in unlined channels. | Clark County, CLV, CNLV, COH | Existing Program | - | - |
| 2.5 Sustainability and Green Building Initiatives | Various sustainability and green building initiatives (e.g., LEED) adopted by local entities include minor components for onsite stormwater management that can reduce water quality effects. | Clark County, CLV, CNLV, COH | Existing Program (under development for CNLV) | - | - |
| 2.6 Covered Fuel Areas | Cover new gas station and fueling area pump islands | Clark County, CLV, CNLV, COH | Existing Program | - | - |
| 2.7 Raised Fuel Areas | Raise new gas station and fueling area pump islands | Clark County, CLV, CNLV, COH | Existing Program | - | - |
| 2.8 Emergency Shut-off Switch and Shear Valve | Install emergency shut-off switch and valves at new gas stations to isolate fueling areas after spills | Clark County, CLV, CNLV, COH | Existing Program | - | - |

| Best Management Practice | Brief Description | Responsible Parties | Implementation Schedule | Monitoring and Tracking | Measurable Goals |
|---|---|---|---|---|---|
| 2.9 Standard Drainage Design Criteria | Regional and local criteria to stabilize onsite and downstream drainageways for new development | CCRFCD, Clark County, CLV, CNLV, COH | • Enhanced Program<br>• Modify local drainage criteria and development standards to more easily accommodate LID designs – 12/31/11 | - | Update all pertinent drainage criteria and development standards |
| 2.10 Parking Lot Low Impact Development | Implement new Parking Lot BMP Program for new and redeveloped parking lots | Clark County, CLV, CNLV, COH, CCRFCD (hydrologic design criteria) | • Develop design criteria and standard designs– 2/28/11<br>• Adopt codes, ordinances and/or development standards – 8/31/12 | • Number and size of new parking lots complying with LID program<br>• Number and size of new parking lots granted variances<br>• Inventory of structural BMPs on new public parking lots | 100% of all new parking lots comply with LID design standards |
| **Treatment Control Measures** | | | | | |
| 3.1 Regional Detention Basins | New regional detention basins downstream of areas of new development per the CCRFCD Master Plan. | CCRFCD, Clark County, CLV, CNLV, COH | Existing Program | Number of new detention basins constructed | Per CCRFCD Master Plan |
| 3.2 Regional Channel Lining | Concrete lining and other channel stabilization measures downstream of new development to reduce erosion and associated sediment transport to downstream receiving waters. | CCRFCD, Clark County, CLV, CNLV, COH | Existing Program | Miles of new stabilized channel constructed | Per CCRFCD Master Plan |

| Best Management Practice | Brief Description | Responsible Parties | Implementation Schedule | Monitoring and Tracking | Measurable Goals |
|---|---|---|---|---|---|
| 3.3 Las Vegas Wash Stabilization Structures | Wash stabilization measures (grade control structures, bank stabilization) downstream of new development and redevelopment to reduce erosion and encourage deposition of upstream sediment prior to reaching Las Vegas Bay and Lake Mead. | SNWA | Existing Program | Number of erosion control structures constructed | Per SNWA Master Plan |
| 3.4 Sand/Oil Separator | Device to separate solids and hydrocarbons at gas stations and similar industrial sites | Clark County, CLV, CNLV, COH | | - | - |
| 3.5 Sand Filter | Device to filter runoff from commercial or industrial sites | Clark County, CLV, CNLV, COH | | - | - |
| 3.6 Regional Detention Basin Retrofit | Conduct feasibility study for detention basin retrofits in selected areas (methods, costs, benefits, priorities), and modified design criteria for new detention basins | | • Strategic Plan for detention basin retrofits – 8/9/11<br>• Master Plan for detention basin retrofits – 8/9/12<br>• Water quality design criteria for new detention basins – 2/9/12<br>• Pilot retrofit projects – dependent on flood control design and construction schedules | • Inventory of detention basins with water quality design<br>• Volume or weight of material removed from water quality storage area | Per Detention Basin Retrofit Master Plan – to be developed |

## 6.3 LID Implementation

The MS4 permit requires the Permittees to: *develop low-impact development ("LID") measures that will remain in effect after construction is complete and are effective and appropriate for the Las Vegas Valley and its environment* (paragraph IV.F.3.a.ii). The proposed NDSR BMPs listed in **Table 1** include the following low impact development measures.

2.1 – Open Space and Landscaping Objectives

2.2 – Rural Land Overlay

2.3 – Hillside Development Ordinances

2.4 – Preserve Natural Washes

2.5 – Sustainability and Green Building Initiatives

2.9 – Standard Drainage Design Criteria

2.10 – Parking Lot BMP Program

## 6.4 Ordinances and Regulatory Measures

The MS4 permit requires the Permittees to: *develop and implement an ordinance or other regulatory mechanism to address urban stormwater runoff from NDSR projects* (paragraph IV.F.3.a.v). In 2008 the Permittees adopted new stormwater ordinances as part of implementing an enhanced Construction Site Runoff Management Program. The new ordinances were crafted based on EPA's model stormwater ordinance, with changes made based on local requirements and on input received from the local Stormwater Stakeholders Working Group. At that time, the Permittees committed to modifying their new stormwater ordinances as necessary to accommodate the requirements of the new NDSR program. The following NDSR BMPs will require changes to ordinances, codes or development standards.

1.13 – Storm Drain Inlet Marking Program

2.9 – Standard Drainage Design Criteria

2.10 – Parking Lot BMP Program

Revised stormwater ordinances for each entity will be prepared by staff and reviewed by the Stormwater Stakeholders Working Group. Revised ordinances or development standards will be adopted by August 31, 2012.

## 6.5 BMP Inventory and Tracking System

The MS4 permit requires the Permittees to: *develop and implement an inventory and tracking system for post-construction structural stormwater BMPs* (paragraph IV.F.3.a.vii). The Permittees propose to go beyond this requirement and track information related to both structural and non-structural BMPs. Proposed monitoring and tracking information is listed briefly in **Table 1**. Each item is described more fully below.

- Several non-structural measures (street sweeping, storm drain system maintenance, household hazardous waste collection, fertilizer/pesticide/herbicide management) will be tracked and reported as part of the Source Control and Maintenance Plan (see *Technical Memorandum No. IV.4 – Proposed Source Controls and Maintenance Program*, MWH 2010b).
- Inspections of new industrial sites that meet the industrial site inspection criteria established by the entities will be tracked as part of the Industrial Facility Program.
- Outreach activities for new residents and new commercial/industrial site owners will be tracked as part of the Public Education and Outreach Program.
- Certain non-structural measures are the primary responsibility of other agencies, which will be responsible for separate monitoring and tracking according to their adopted policies and procedures. These measures are: Grease Interceptor Program (wastewater agencies), Dust Control Measures (Clark County Department of Air Quality and Environmental Management), and Southern Nevada Health District inspections, Turf Conversion Program (SNWA). Tracking information on these measures will not be reported as part of the annual MS4 permit documentation.
- For the new Parking Lot LID Program, the following information will be tracked and reported:
  - Number and size of new parking lots complying with the LID design criteria
  - Number and size of new parking lots receiving a variance from the LID design criteria
  - Inventory of structural BMPs on new sites owned and operated by city or county public works or maintenance departments; inventory will include BMP type, size and maintenance history
- The number of new regional detention basins and the number of miles of new stabilized flood control channels (concrete, riprap, grade controls) is tracked by CCRFCD as part of its Master Plan implementation, and will be reported for the MS4 permit.
- The number of new Las Vegas Wash erosion control structures is tracked by SNWA as part of its Master Plan implementation, and will be reported for the MS4 permit.
- An inventory of regional detention basins with water quality features (new or retrofitted) will be maintained. The inventory will include facility location, type and size. The volume of material removed from water quality features in each regional detention basin will be tracked and reported.

## 6.6 BMP Maintenance Provisions

The MS4 permit requires the Permittees to: *provide verification of maintenance provisions for structural BMPs located on private property that are subject to post-construction structural BMP requirements* (paragraph IV.F.3.a.vi) and *inspect and enforce the proper installation and long-term maintenance of post-construction structural stormwater BMPs* (paragraph IV.F.3.a.viii). Maintenance of structural BMPs on private property is the responsibility of the private property owner. However, the Permittees understand that in some instances it may be necessary for private facilities to be inspected to assure adequate protection of the region's water quality. The proposed program for verifying and enforcing adequate maintenance of privately owned and operated structural BMPs is as follows.

1. Each individual entity will prepare a list of specific new development and redevelopment projects that pose a significant threat to water quality due to stormwater runoff or non-stormwater discharges. Each entity will develop its own criteria and process for identifying these projects. The following criteria will be considered:

   - Proximity to a major watercourse
   - Type of development/land use and activities expected to occur
   - Types of materials expected to be present onsite
   - Size of development
   - History of similar sites or site owner/operators in complying with stormwater regulations and management practices
   - Coverage by other environmental regulatory programs (e.g., hazardous materials)

   This list will be updated at least annually.

2. Each entity will establish priorities for inspecting new development and redevelopment sites on the list developed in Step 1. Priorities could be based on a number of factors, including perceived level of water quality threat, ability to integrate with other environmental inspection programs (e.g., industrial pretreatment program), and interest from business groups (e.g., hotel/casinos.)

3. Regardless of their priority or presence on the list developed in Step 1, inspections will be conducted for sites for which public complaints are received.

4. Inspections will consist of visual observations only, and may be performed by a variety of types of entity personnel, depending on the type of site involved (i.e., industrial, commercial or residential).

5. Entities currently have authority to inspect private facilities under existing stormwater ordinances, and can enforce existing ordinances related to nuisance conditions, littering, and prohibited non-stormwater discharges to the MS4.

6. When potential problems are observed, the entity will take one of the following responses, depending on the severity of the potential problem and consistent with existing ordinances.

   - Discuss the problem with the site owner/operator and request corrective action
   - Send a letter to the site owner/operator requesting corrective action
   - Cite the site owner/operator for violation of nuisance, litter, non-stormwater or other pertinent ordinances.

7. If required, enforcement actions will be taken against violators of the pertinent ordinances. However, the objective of the program is to work with site owners/operators to educate them on the importance of proper site maintenance and gain compliance with accepted practices, as opposed to punishment.

Post-construction structural BMPs on new sites owned and operated by the entities will be inspected and properly maintained by the entity's public works department or other staff under current maintenance policies. BMPs on sites owned by other public agencies and departments (for example, Clark County School District, Clark County Department of Aviation, state agencies, federal agencies) are considered to be the responsibility of those agencies. However, the Permittees will inform these agencies of any public complaints received on issues affecting stormwater quality, and may perform site inspections if considered necessary to prevent pollutants from entering the MS4 in accordance with their stormwater ordinances.

## 6.7 NDSR Maps

The MS4 permit requires the Permittees to update MS4 maps to: *show areas of NDSR, including any new stormwater major infrastructure that was constructed to serve these areas* (paragraph IV.F.3.a.ix). A single valley-wide GIS map depicting areas of new development and significant redevelopment in Las Vegas Valley will be prepared based on asset tracking software currently used by the entities, review of aerial photographs or similar resources. Data will be compiled only for development projects that have been completed (i.e., have received Certificates of Occupancy, Certificates of Completion, etc). The map may show boundaries of newly developed areas, or may simply indicate the approximate location of new development. **Figure 1** shows a template of the NDSR map, based on NDSR data from 2009-2010 permit year. A tabulation of the approximate acreage of new development and significant redevelopment occurring in Las Vegas Valley will be prepared. CCRFCD regularly updates GIS maps of regional flood control infrastructure based on construction projects it funds and 5-year updates of the Master Plan Update for Las Vegas Valley. An updated map showing new development and new flood control infrastructure completed during the previous permit year will be provided in each MS4 Annual Report.

# NEW DEVELOPMENT AND SIGNIFICANT REDEVELOPMENT AND LAS VEGAS VALLEY STORMWATER SYSTEM MAP

## Legend

New Development and Significant Redevelopment from July 1, 2009 to June 30, 2010

### Conveyance Facilities

- Concrete-Lined Channels
- Unlined Stabilized Channels
- Unlined Channels/Washes/Facilities
- Other

### Detention Basins

- Complete
- Under Construction
- Airports
- Railroads
- Streets
- Central Watershed
- Duck Creek Watershed
- Flamingo / Tropicana Watershed
- Gowan Watershed
- Lower Las Vegas Wash Watershed
- North Basin Watershed
- Pittman / C-1 Watershed
- Range Wash Watershed

### Jurisdictional Boundaries

- City of Henderson
- City of Las Vegas
- City of North Las Vegas

N W E S

0 2 4 6

Scale in Miles

**FIGURE 1**

## 6.8 Specific Land Uses

The MS4 Permit requires the Permittees to adopt BMPs for specific land uses and development types. Selected BMPs may be site design, source control or treatment control BMPs. Structural BMPs should be designed based on accepted and standard criteria to be developed by the Permittees (See Section 6.9).

Specific land uses and development types are listed in **Table 2**. NSDR BMPs from **Table 1** that specifically address these land uses and development types are also listed. However, as noted previously, the Las Vegas Valley NDSR program stresses regional, watershed-based measures that address runoff from all land use types and from both new and existing urban development. These regional watershed-based measures contribute significantly to managing runoff from the specific land uses identified in the permit. Although not listed in **Table 2**, the following watershed-based measures apply to one or more of the specific land use types:

1.1 Street Sweeping Programs

1.2 Local Storm Drain System Maintenance

1.3 Regional Flood Infrastructure Maintenance

1.4 Water Conservation (Drought) Ordinance

1.6 Household Hazardous Waste Collection

1.7 Ordinances Prohibiting Non-Stormwater Discharges and Littering

1.8 Desert Dumping Controls

1.10 Dust Control Measures

1.11 Fertilizer, Pesticide and Herbicide Management Program

1.12 Public Education

1.13 Storm Drain Marking Program

1.15 Spill Control Prevention Plans

1.18 Southern Nevada Health District Inspections

1.19 Turf Conversion Program

1.20 Regional Water Quality Planning

2.1 Open Space and Landscaping Objectives

2.2 Rural Land Overlay

2.4 Preserve Natural Washes

2.5 Sustainability and Green Building Initiatives

3.1 Regional Detention Basins

3.2 Regional Channel Lining

The MS4 Permit allows the Permittees to identify any other locally unique land use types that could cause or contribute to stormwater quality problems. The Permittees have identified hotel/casinos as locally unique development types that deserve consideration. BMPs already identified for new commercial/industrial sites, restaurants and parking lots will be effective for new hotel/casino sites. If requested, Permittees will conduct site audits with new hotel/casino managers to assure that all possible BMPs are used and implemented properly. Clark County has already conducted several of these audits.

**Table 2. NDSR BMPs for Specific Land Uses**

| Special Land Use | NDSR BMP |
|---|---|
| Residential subdivisions five (5) acres or greater in size | No specialized BMPs. All watershed-based measures apply. |
| Single-family residences subject to local ordinances governing hillside development | 2.3 Hillside Development Ordinances |
| 100,000 square foot commercial and industrial developments | 1.5 Commercial/Industrial Housekeeping Practices<br>1.14 Indoor Workshop<br>1.15 Spill Control Prevention Plan<br>1.16 Industrial Pretreatment Program<br>1.17 Trash Receptacle Enclosures<br>3.4 Sand/Oil Separator<br>3.5 Sand Filter |
| Automotive repair shops (with Standard Industrial Classification ("SIC") codes 5013, 7532, 7533, 7534, 7537, 7538, and 7539) | 1.5 Commercial/Industrial Housekeeping Practices<br>1.14 Indoor Workshop<br>1.15 Spill Control Prevention Plan<br>1.17 Trash Receptacle Enclosures |
| Retail gasoline outlets disturbing greater than one (1) acre | 1.5 Commercial/Industrial Housekeeping Practices<br>1.15 Spill Control Prevention Plan<br>1.17 Trash Receptacle Enclosures<br>2.6 Covered Fuel Areas<br>2.7 Raised Fuel Areas<br>2.8 Emergency Shut-off Switch and Shear Valve |
| Restaurants disturbing greater than one (1) acre | 1.9 Grease Interceptor Program<br>1.17 Trash Receptacle Enclosures |
| Parking lots greater than one (1) acre potentially exposed to urban runoff | 2.10 Parking Lot Low Impact Development |
| Any other NDSR projects the Permittees deem necessary to be included in this part. | Hotel/Casinos – same BMPs already identified for commercial/industrial sites, restaurants, and parking lots |

## 6.9 Design Criteria

This section describes the design criteria the Permittees will develop for NDSR projects such as those listed in Section 6.8. Specific design criteria for individual BMPs will be developed in the future, and will be incorporated into the CCRFCD Hydrologic Criteria and Drainage Design Manual.

### 6.9.1 Peak Urban Runoff Discharge Rates

*Describe how the Permittees will develop design standards for peak-urban runoff from NDSR projects that will provide protection against downstream erosion.*

Permittees currently have design standards for new development that require stabilization of onsite and offsite drainageways to protect against erosion. Regional facilities are designed for the 100-year discharge; local facilities are designed for the 10-year discharge. In each case hydrologic and hydraulic design criteria are applied from the CCRFCD Hydrologic Criteria and Drainage Design Manual (HCDDM). In addition, CCRFCD has policies for stabilizing all flood control channels (NDSR measure 3.2), and SNWA is implementing its Las Vegas Wash stabilization program (NDSR measure 3.3).

### 6.9.2 Site Design BMPs

*Describe how the Post-Construction Program will develop and implement site design BMPs in the site layout during the design and approval process to meet the goals of this program identified in Part IV.F.2.*

Site design BMPs proposed for the NDSR Program consist of measures 2.1 through 2.10 in **Table 1**. **Attachment D** provides a description of each measure. Each measure is applied during the site design and approval process. The ability of each measure to meet the goals of the NDSR program is described below.

- **2.1 – Open Space and Landscaping Objectives.** This measure allows entity planning departments to work with master plan communities to allow more open space and set landscaping requirements in large developments in trade for other considerations. These factors allow preservation of open space and permeable areas that will generate less runoff and pollutant load.
- **2.2 – Rural Land Overlay.** This measure lets entities set special development standards for rural areas that don't require curb-and-gutter and other improvements. This reduces runoff rates and volumes and allows more onsite infiltration.
- **2.3 – Hillside Development Ordinances.** This measure limits development or sets strict criteria for developing on steep slopes. This reduces high flow rates from areas that could be susceptible to erosion.
- **2.4 – Preserve Natural Washes.** This measure allows entities to limit development in and near natural wash floodplains. This preserves open space, preserves natural wash areas that may provide natural runoff treatment, and minimizes development immediately adjacent to active streamcourses.
- **2.5 – Sustainability and Green Building Initiatives.** Entities will promote green building practices including stormwater management designs for new developments that minimize runoff rates and volumes and provide onsite treatment. This approach will particularly be applied to new public projects, but incentives may also be provided to private developers.

- **2.6, 2.7 and 2.8 – Gas Station Measures.** Covered fuel areas, raised fuel areas, and emergency shut-off switches on gas pumps will reduce the potential for gas stations to contribute pollutants to the MS4 through stormwater runoff or fuel spills.
- **2.9 – Standard Drainage Design Criteria.** Entities will modify drainage design criteria and development standards to remove obstacles to implementing LID measures in new developments. This will make it easier for new projects to use LID design concepts that reduce runoff rates and volumes.
- **2.10 – Parking Lot Low Impact Design.** This measure will require application of LID measures to nearly all new parking lots. These measures will reduce runoff rates and volumes and pollutant loads generated from new parking lots.

### 6.9.3 Source Control BMPs

*The Post-Construction Program shall describe how source control BMPs will be implemented. The design standards program shall include the following source-control BMPs that are consistent with the goals of this program:*

- Slopes and channel design or protection to minimize erosion;
- Properly designed outdoor material storage areas; and
- Properly designed trash storage areas.

These requirements will be met by the following BMPs.

- Slopes and channel design or protection to minimize erosion: Measure 2.9 Standard Drainage Design Criteria requires new developments to stabilize onsite channels and offsite channels that could be affected by runoff from the new development.
- Properly designed outdoor material storage areas: Measure 1.5 Commercial/Industrial Housekeeping Practices and Measure 1.14 Indoor Workshop require new commercial and industrial developments to have material storage areas that are either indoors or, if outdoors, are covered to prevent contact with stormwater.
- Properly designed trash storage areas: Measure 1.17 Trash Receptacle Enclosures requires design of new trash receptacles in new residential, commercial and industrial developments that are enclosed, and preferably covered, to minimize contact of stormwater with stored trash and to minimize the potential or trash to be blown or washed into the MS4.

### 6.9.4 Treatment Control BMPs

*The post-construction program shall describe how treatment control BMPs will be developed and implemented.* This will include volumetric treatment controls and flow-based treatment controls.

Volume and flow-based design standards for treatment control measures are described as follows.

- **3.1 – Regional Detention Basins.** Flows and volumes are designed for the 100-year event with ultimate land use conditions, based on the CCRFCD Hydrologic Criteria and Drainage Design Manual (HCDDM).
- **3.2 – Regional Channel Lining.** Flows and volumes are designed for the 100-year event with ultimate land use conditions, based on the CCRFCD HCDDM.
- **3.3 – Las Vegas Wash Stabilization Structures.** Flows and volumes are designed for a minimum of the 100-year event with ultimate land use conditions, based on the CCRFCD HCDDM.
- **3.4 – Sand/Oil Separator.** Flows and volumes are designed based on either the 85th percentile storm selected by the Permittees for BMP design, or on the 10-year storm to be consistent with drainage system design.
- **3.5 – Sand Filter.** Flows and volumes are designed based on either the 85th percentile storm selected by the Permittees for BMP design, or on the 10-year storm to be consistent with drainage system design.
- **3.6 – Regional Detention Basin Retrofit.** Water quality capture volumes for detention basins will be based on the 85th percentile storm flow and volume, using methods to be developed by the DGWG and local engineers.

## 6.10 Other MS4 Permit Goals

The NDSR program described in the previous sections addresses the pollutants of concern in new development and significant development in Las Vegas Valley to the MEP. The Las Vegas Valley MS4 permit for Las Vegas Valley also recognizes three additional stormwater management goals. The ability of the NDSR Program to achieve these goals is described below.

1. *To prevent stormwater discharges from post-construction projects from causing or contributing to downstream violations of water quality standards of selenium to the MEP.* Selenium is contributed to the MS4 primarily by resurfacing groundwater. The NDSR program avoids these impacts from new development by adopting practices and policies to minimize additional infiltration of stormwater into the shallow aquifer system and reduce the amount of dry weather flow due to over-irrigation of landscaped areas. A key factor in meeting this objective is adopting BMPs that do not rely on onsite infiltration as a means of disposing of stormwater.
2. *To promote anti-degradation of ambient water quality by reducing the discharge of pollutants in stormwater causing or contributing to any degradation identified by NDEP's anti-degradation program.* Pollutants in Las Vegas Wash surface waters that have caused impairment to water quality conditions are described in MWH 2010a. These include selenium, phosphorus, TDS, iron, pH and molybdenum. With the exception of iron and molybdenum which are naturally occurring, the NDSR BMPs were selected to target

these and other pollutants of concern. In addition, BMPs were selected to avoid adverse impacts to these constituents (e.g., selenium, as described above). TDS is contributed by similar sources as selenium, so the factors described above that avoid selenium impacts also apply to TDS.

3. *To develop best management practices (BMPs) to promote the reuse of stormwater for municipal supplies.* In Las Vegas Valley, beneficial use of stormwater for municipal supply occurs through delivery of adequate quality stormwater to Lake Mead, from which is it pumped into the municipal water supply system. The proposed NDSR program maximizes delivery of stormwater to Lake Mead by minimizing reliance on stormwater infiltration devices. Infiltrating stormwater to the shallow aquifer system would not benefit the municipal water supply system because shallow groundwater quality is too poor for municipal use. Deep groundwater aquifers are tapped by municipal wells, but these aquifers are recharged by runoff at the mountain front, not by runoff from the valley floor and alluvial fans where urban development is occurring.

# 7 Conclusion

The MS4 Permit which took effect on February 9, 2010 includes requirements for a post-construction program to monitor and control pollutant discharges from NDSR. **Table 1** of this TM shows that the Permittees have identified numerous non-structural and structural measures to satisfy the permit requirements. Measurable goals and monitoring and tracking requirements are identified, as are the entities responsible for implementing each measure. The proposed NDSR program will be incorporated into the Las Vegas Valley Storm Water Management Plan.

# 8 References


MWH 2010a. Technical Memorandum No. II.1 - Stormwater Contributions to Impaired Waters and TMDLs in Las Vegas Valley. Prepared for Las Vegas Valley Stormwater Quality Management Committee.

MWH 2010b. Technical Memorandum No. IV.4 – Proposed Source Controls and Maintenance Program. Prepared for Las Vegas Valley Stormwater Quality Management Committee.

MWH, 2010c. Technical Memorandum No. IV.5 - Unique Factors Influencing the Las Vegas Valley MS4 Permit Program. Prepared for Las Vegas Valley Stormwater Quality Management Committee.

MWH, 2010d. Technical Memorandum No. IV.6 - Limitations on Use of Infiltration-Based BMPs for New Development and Significant Redevelopment in Las Vegas Valley. Prepared for Las Vegas Valley Stormwater Quality Management Committee.

MWH, 2010e. Technical Memorandum No. IV.7 - Potential Legal and Water Rights Issues Associated with Onsite Retention of Stormwater. Prepared for Las Vegas Valley Stormwater Quality Management Committee.

MWH, 2010f. Technical Memorandum No. IV.8 - Pollutants of Concern for Las Vegas Valley MS4 NDSR Program. Prepared for Las Vegas Valley Stormwater Quality Management Committee.

MWH, 2010g. Technical Memorandum No. IV.9 - Description of Existing BMPs and Need for New BMPs for NDSR Program. Prepared for Las Vegas Valley Stormwater Quality Management Committee.

MWH, 2010h. Technical Memorandum No. IV.10 - Evaluation of Low Impact Development Measures for NDSR Program. Prepared for Las Vegas Valley Stormwater Quality Management Committee.

MWH, 2010i. Technical Memorandum No. IV.11 - Potential Water Quality Retrofits of Regional Detention Basins – Strategic Plan. Prepared for Las Vegas Valley Stormwater Quality Management Committee.

# ATTACHMENT A

## MS4 Permit Language Requiring NDSR Program

**IV.F. Post-Construction Program For New Development and Significant Redevelopment Projects**

IV.F.1 The Permittees shall develop a Post-Construction BMP Program for new development and significant redevelopment ("NDSR") projects that is suited for the unique hydrologic, hydrogeologic and regional conditions of the Las Vegas Valley. The program shall focus on planning procedures consistent with the goals identified in Part IV.F.2.

IV.F.2 The Post-Construction Program shall have the following goals:

IV.F.2.a To prevent stormwater discharges from post-construction projects from causing or contributing to downstream violations of water quality standards of selenium to the MEP;

IV.F.2.b To promote anti-degradation of ambient water quality by reducing the discharge of pollutants in stormwater causing or contributing to any degradation identified by NDEP's anti-degradation program; and

IV.F.2.c To develop BMPs to promote the reuse of stormwater for municipal water supplies.

IV.F.3 The Post-Construction Program shall address at a minimum the following elements:

IV.F.3.a Describe how the Permittees will review and enhance the SWMP post-construction program requirements in a manner appropriate for the unique hydrologic, hydrogeologic and regional conditions and needs of the Las Vegas Valley. The review shall address the following elements:

IV.F.3.a.i Describe how the Permittees will develop, implement and enforce a program to address post-construction urban runoff from NDSR projects that disturb areas ≥1 acre, including projects <1 acre that are part of a

larger common plan of development or sale, that discharge into the MS4 by ensuring that NDSR projects are complying to the MEP with the requirements of this program;

IV.F.3.a.ii Describe how the Permittees will develop low-impact development ("LID") measures that will remain in effect after construction is complete and are effective and appropriate for the Las Vegas Valley and its environment. The program will outline the selected LID measures found effective and appropriate for the Las Vegas Valley along with a summary and schedule for implementation in the MS4;

IV.F.3.a.iii Describe how the Permittees will develop any additional structural and non-structural BMPs that will remain in effect after construction is complete and are effective and appropriate for Las Vegas Valley and its environment. The program will outline the selected BMP measures found effective and appropriate for the Las Vegas Valley along with a summary and schedule for implementation in the MS4;

IV.F.3.a.iv Describe procedures to assure that future regional flood management projects assess the impacts on the water quality of receiving water bodies and that existing structural flood control devices have been evaluated to determine if retrofitting the device to provide additional pollutant removal from stormwater is feasible and appropriate;

IV.F.3.a.v Describe how the Permittees will develop and implement an ordinance or other regulatory mechanism to address urban stormwater runoff from NDSR projects;

IV.F.3.a.vi Describe how the Permittees will provide verification of maintenance provisions for structural BMPs located on private property that are subject to post-construction structural BMP requirements;

IV.F.3.a.vii Describe how the Permittees will develop and implement an inventory and tracking system for post-construction structural stormwater BMPs. The inventory and tracking system shall use at a minimum the following items: project name, project location, project acreage, BMP type and description, inspection date and summary, and any corrective actions undertaken;

IV.F.3.a.viii Describe how the Permittees will inspect and enforce the proper installation and long-term maintenance of post-construction structural stormwater BMPs ; and

IV.F.3.a.ix Describe how the Permittees will update its MS4 maps to show areas of NDSR, including any new stormwater major infrastructure that was constructed to serve these areas.

IV.F.3.b All NDSR projects submitted to the permitting authority subsequent to program implementation as identified in IV.A.2 that fall into one of the following categories shall be subject to one or more of the SWMP design standards developed in accordance with Part IV.F.4:

IV.F.3.b.i Residential subdivisions five (5) acres or greater in size;

IV.F.3.b.ii Single-family residences subject to local ordinances governing hillside development;

IV.F.3.b.iii 100,000 square foot commercial and industrial developments;

IV.F.3.b.iv Automotive repair shops (with Standard Industrial Classification ("SIC") codes 5013, 7532, 7533, 7534, 7537, 7538, and 7539);

IV.F.3.b.v Retail gasoline outlets disturbing greater than one (1) acre;

IV.F.3.b.vi Restaurants disturbing greater than one (1) acre;

IV.F.3.b.vii Parking lots greater than one (1) acre potentially exposed to urban runoff; and

IV.F.3.b.viii Any other NDSR projects the Permittees deem necessary to be included in this part.

IV.F.4 **Design Standards.** The post-construction program shall describe how NDSR projects specified in the previous section will implement the design standards outlined in this section. Subject to Section IV.F.4.e, the design standards program shall address at minimum the following criteria:

IV.F.4.a **Peak-Urban Runoff Discharge Rates.** Describe how the Permittees will develop design standards for peak-urban runoff from NDSR projects that will provide protection against downstream erosion;

IV.F.4.b **Site Design BMPs.** Describe how the Post-Construction Program will develop and implement site design BMPs in the site

layout during the design and approval process to meet the goals of this program identified in Part IV.F.2;

IV.F.4.c **Source Control BMPs.** The Post-Construction Program shall describe how source control BMPs will be implemented. The design standards program shall include the following source-control BMPs that are consistent with the goals of this program:

IV.F.4.c.i Slopes and channel design or protection to minimize erosion;

IV.F.4.c.ii Properly designed outdoor material storage areas; and

IV.F.4.c.iii Properly designed trash storage areas.

IV.F.4.d **Treatment Control BMPs.** The post-construction program shall describe how treatment control BMPs will be developed and implemented. "Treatment control BMPs" and "treat" refer to any onsite or offsite process that provides for infiltration or detention of stormwater or that removes pollutants through any physical, chemical, or biological process. The design standards program shall describe in sufficient detail how the Permittees will size treatment control BMPs using accepted hydrologic engineering quantitative methods and the following design criteria:

IV.F.4.d.i **Volumetric Treatment Control** BMP design criteria. The post-construction program shall describe how the Permittees will design volume-based BMPs to treat stormwater discharges from projects listed in Part IV.F.3.b. The Permittees shall use one of the following conditions to develop the volumetric treatment control BMP design criteria :

IV.F.4.d.i.1 Historical rainfall records for the Las Vegas Valley to determine the maximized capture stormwater volume for the area for the 24-hour event using the formula recommended in Urban Runoff Quality Management, Water Environment Federation Manual of Practice No. 23/ASCE Manual of Practice No. 87, (1998); or

IV.F.4.d.i.2 The volume of annual runoff based on unit basin storage water quality volume, to achieve at least 80% of

volume treatment by the method recommended in hydrology manuals, textbooks or similar technical publications; or

IV.F.4.d.i.3 An alternative treatment design criteria, appropriate for the unique hydrologic, hydrogeologic and regional conditions of the Las Vegas Valley. Any alternative design criteria shall be submitted to NDEP with sufficient technical data to establish the appropriateness of the alternative treatment design criteria.

IV.F.4.d.ii **Flow-Based BMP Design Criteria.** The post-construction program shall describe how the Permittees will design flow-based BMPs to treat stormwater discharges from projects listed in Part V.F.3.b. The Permittees shall use one of the following conditions to develop flow-based BMP design criteria:

IV.F.4.d.ii.1 Historical rainfall data for the Las Vegas Valley to determine the maximum flow rate of runoff from rainfall per hour, for each hour of a storm event; or

IV.F.4.d.ii.2 The maximum flow rate of runoff produced by the 80th percentile hourly rainfall intensity (for each hour of the storm event), as determined from the local historical rainfall record; or

IV.F.4.d.ii.3 The maximum flow rate of runoff for each hour of a storm event, as determined from the local historical rainfall record that achieves approximately the same reduction in pollutant loads and flows as achieved by mitigation of the 80th percentile hourly rainfall intensity; or

IV.F.4.d.ii.4 An alternative treatment design criteria, appropriate for the unique hydrologic, hydrogeologic and regional

conditions of the Las Vegas Valley. Any alternative design criteria shall be submitted to NDEP with sufficient technical data to establish the appropriateness of the alternative treatment design criteria.

IV.F.4.d.iii If the Permittees will not use some or all of the design standards described in this section, the Permittees shall provide justification using documentation and engineering analyses, and propose reasonable alternatives that are appropriate for the unique hydrologic, hydrogeologic and regional conditions in Las Vegas Valley.

IV.F.5 Effect of the Post-Construction Program on Water Quality Standards and Drinking Water Supply

IV.F.5.a The Permittees shall provide a written evaluation whether the criteria developed as part of the post-construction program will tend to cause or contribute to elevated levels of selenium in surface waters within Las Vegas Valley, including an exceedance of the water quality standards for selenium in identified washes, and shall submit the evaluation to NDEP as part of the post-construction program; and

IV.F.5.b The Permittees shall provide a written evaluation whether the criteria developed as part of the post-construction program will tend to reduce or degrade the contribution of stormwater to the water supplies provided by the Colorado River.

IV.F.5.c If any criteria developed under the post-construction program in accordance with the provisions of this permit would have a reasonable potential of causing or contributing to any water quality or water quantity impairment, or violates Nevada law, they shall be rescinded, and the Permittees shall determine whether alternate criteria can be implemented without causing water quality or water quantity impairments or violating Nevada law.

# ATTACHMENT B

## Existing BMP Gap Analysis Table for NDSR Program

## NEW DEVELOPMENT AND SIGNIFICANT REDEVELOPMENT PROGRAM - BMP GAP ANALYSIS

**Categories of BMP Adoption**

| | |
|---|---|
| Permittee has a mandatory program (ordinance, code, development standard) | |
| Permittee has an informal, voluntary or incentive-based program | |
| Industry standard or common practice | |
| Program is currently under development | D |
| Permittee benefits from a regional program | |

**BMP Type**

SC Source Control
SD Site Design
TC Treatment Control

| | | | | MS4 Permittees | | | | Regional Entities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pollutant of Concern** | **Land Use Source** | **Best Management Practice** | **BMP Type** | **COH** | **CLV** | **CNLV** | **CC** | **CCRFCD** | **SNWA** | **Other** | **Comments** |
| Hydrocarbons (oil and grease) | Parking Lots | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Street sweeping - Public parking lots | SC | | | | | | | | Swept per maintenance standards. |
| | | Street sweeping - Private parking lots | SC | | | | | | | | Swept for aesthetics, but not required. |
| | | Public education | SC | | | | | X | | | General, vehicle maintenance |
| | | Regional Flood Infrastructure Maintenance | TC | | | | | X | | | Regional channels and detention basins |
| | | Local Storm Drain Sustem Maintenance | TC | | | | | | | | Catch basins, inlets and storm drains |
| | | Minimize directly connected impervious area | SD | | | | | | | | Depressed islands; buffer strips; porous pavement; minimize parking requirements |
| | | Parking lot design | SD | | | | | | | | Depressed islands; buffer strips; porous pavement; minimize parking requirements |
| | | Porous pavement | SC | | | | | | | | Modular pavers |
| | | Sand filter | TC | | | | | | | | |
| | | Sand/Oil Separators | TC | | | | | | | | |
| | | Hydrodynamic separator | TC | | | | | | | | |
| | Automotive Repair/ Vehicle Maintenance | Indoor workshops | SC | | | | | | | X | SNHD inspection program |
| | | Hazardous Waste Storage and Collection | SC | | | | | | | | |
| | | Commercial/Industrial Housekeeping | SC | | | | | | | | |
| | | Spill Control Prevention Plans | SC | | | | | | | | |
| | | Pre-Treatment Programs | SC | | | | | | | | |
| | | Trash Receptacle Enclosures | SC | | | | | | | | CLV&CNLV: Enclosed with roof or trellis; COH&CC: Enclosed only; All: receptacles with lids |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Public education (vehicle maintenance) | SC | | | | | X | | | |
| | | Sand/Oil Separators | TC | | | | | | | | |

| | | | | MS4 Permittees | | | | Regional Entities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pollutant of Concern** | **Land Use Source** | **Best Management Practice** | **BMP Type** | **COH** | **CLV** | **CNLV** | **CC** | **CCRFCD** | **SNWA** | **Other** | **Comments** |
| Hydrocarbons (oil and grease) | Automotive Repair/ Vehicle Maintenance | Sand filter | TC | | | | | | | | |
| | | So. NV Health District inspections | SC | | | | | | | X | Inspections of "conditionally exempt generators of hazardous waste" |
| | Gas Stations | Covered Fuel Areas | SD | | | | | | | | Per IBC/IFC regulations |
| | | Raised Fuel Areas | SD | | | | | | | | |
| | | Emergency Shut-off Switch & Shear Valves | SC | | | | | | | | |
| | | Commercial/Industrial Housekeeping | SC | | | | | | | | |
| | | Spill Control Prevention Plans | SC | | | | | | | | Industry and State requirement |
| | | Pre-Treatment Programs | SC | | | | | | | | |
| | | Trash Receptacle Enclosures | SC | | | | | | | | CLV&CNLV: Enclosed with roof or trellis; COH&CC: Enclosed only; All: receptacles with lids |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Hazardous Waste Storage and Collection | SC | | | | | | | | |
| | | Sand filter | TC | | | | | | | | |
| | | Sand/Oil Separators | TC | | | | | | | | |
| | | So. NV Health District inspections | SC | | | | | | | X | Inspections of "conditionally exempt generators of hazardous waste" |
| | Streets | Street Sweeping | SC | | | | | | | | Only public streets are swept regularly |
| | | Regional Flood Infrastructure Maintenance | TC | | | | | X | | | Regional channels and detention basins |
| | | Local Storm Drain Sustem Maintenance | TC | | | | | | | | Catch basins, inlets and storm drains |
| | | Household Hazardous Waste Collection | SC | | | | | | | | |
| | | Commercial/Industrial Housekeeping | SC | | | | | | | | |
| | | Ordinances Prohibiting Non-Stormwater Discharges and Littering | SC | | | | | | | | |
| | | Desert Dumping Controls | SC | | | | | | | X | SNHD regulations |
| | | Grease Interceptor Inspection Program | SC | | | | | | | | |
| | | Drop Inlet Marking Program | SC | D | D | D | D | | | | Developing RTC standards for new dev't |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Public education | SC | | | | | X | | | General, vehicle maintenance |
| | | Rural Land Overlay | | | | | | | | | Narrow streets, no curb & gutter |
| | | Street design | SD | | | | | | | | Minimum street widths; cul de sac design; buffer strips; depressed medians |
| | | Porous pavement | SC | | | | | | | | Modular pavers; not porous asphalt or concrete; only in alleys, parking lanes, etc. |

| | | | | MS4 Permittees | | | | Regional Entities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pollutant of Concern** | **Land Use Source** | **Best Management Practice** | **BMP Type** | **COH** | **CLV** | **CNLV** | **CC** | **CCRFCD** | **SNWA** | **Other** | **Comments** |
| Hydromodification | All | Open Space and Landscaping Requirements | SD | | | | | | | | |
| | | Drought Ordinances | SC | | | | | | X | | Dry weather flow control - Efficient irrigation, Xeriscaping, Turf area restrictions |
| | | Turf Conversion Program | SC | | | | | | X | | |
| | | Preserve Natural Drainage Corridors | SD | | | | | | | | CCRFCD also designates land for preservation |
| | | Hillside Ordinance | SD | | | | | | | | Density restrictions, Preserve natural open space. Does not apply to CNLV - no steep slopes. |
| | | Sensitive Lands Overlay | SD | | | | | | | | Density restrictions, Preserve natural open and drainage paths, Set backs from sensitive lands, Rural development overlay |
| | | Rural Land Overlay | | | | | | | | | Narrow streets, no curb & gutter |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Las Vegas Wash Stabilization Structures | TC | | | | | | X | | |
| | | Floodplain Development Ordinances | SD | | | | | | | | |
| | | Public Education | SC | | | | | | X | | Dry weather control - Efficient water use, conservation |
| | | Regional Channel Lining | TC | | | | | X | | | |
| | | Sustainability and Green Building Initiatives | SD | | | D | | | | | Dry weather control - Efficient water use, conservation |
| | | Site design (misc measures not listed separately) | SD | | | | | | | | Depressed landscaping; landscaped swales; buffer strips for WQ |
| | | Infiltration basin/trench | TC | | | | | | | | Only if verified by site-specific geotech investigation; requires water right |
| | | Bioretention | TC | | | | | | | | Desert rain garden |
| | | Extended detention basin | TC | | | | | | | | At development scale |
| | | Regional Water Quality Planning | SC | | | | | | | X | LVVWAC, LVWCC, LMWQF, 208 Plan |
| | | Standard Drainage Design Criteria | SD | | | | | X | | | Also have CCRFCD regional criteria |
| Nutrients (Phosphorus, Nitrogen) | Residential Landscaping | Drought Ordinances | SC | | | | | | X | | Efficient irrigation, Xeriscaping, Turf area restrictions |
| | | Turf Conversion Program | SC | | | | | | X | | |
| | | Household Hazardous Waste Collection | SC | | | | | | | | |
| | | Fertilizer, Pesticide and Herbicide Management - Private contractors | SC | | | | | | | | |
| | | Public Education | SC | | | | | X | | | Fertilizer use |
| | | Drop Inlet Marking Program | SC | D | D | D | D | | | | Developing RTC standards for new dev't |

| | | | | MS4 Permittees | | | | Regional Entities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pollutant of Concern** | **Land Use Source** | **Best Management Practice** | **BMP Type** | **COH** | **CLV** | **CNLV** | **CC** | **CCRFCD** | **SNWA** | **Other** | **Comments** |
| Nutrients (Phosphorus, Nitrogen) | Residential Landscaping | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Las Vegas Wash Stabilization Structures | TC | | | | | | X | | |
| | | Floodplain Development Ordinances | SD | | | | | | | | |
| | | Site design (misc measures not listed separately) | SD | | | | | | | | Depressed landscaping; landscaped swales; buffer strips for WQ |
| | | Extended detention basin | TC | | | | | | | | At development scale |
| | Commercial/Industrial Landscaping | Drought Ordinances | SC | | | | | | X | | Efficient irrigation, Xeriscaping, Turf area restrictions |
| | | Turf Conversion Program | SC | | | | | | X | | |
| | | Fertilizer, Pesticide and Herbicide Management - Private contractors | SC | | | | | | | | |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Las Vegas Wash Stabilization Structures | TC | | | | | | X | | |
| | | Commercial/Industrial Housekeeping | SC | | | | | | | | |
| | | Site design (misc measures not listed separately) | SD | | | | | | | | Depressed landscaping; landscaped swales; buffer strips for WQ |
| | Parks and Golf Courses | Drought Ordinances | SC | | | | | | X | | Efficient irrigation, Xeriscaping, Turf area restrictions |
| | | Fertilizer, Pesticide and Herbicide Management - Public entities | SC | | | | | | | | |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Las Vegas Wash Stabilization Structures | TC | | | | | | X | | |
| | | Extended detention basin | TC | | | | | | | | At development scale |
| | Streets and Parking Lots | Street Sweeping - Streets | SC | | | | | | | | |
| | | Street sweeping - Public parking lots | SC | | | | | | | | Swept per maintenance standards. |
| | | Street sweeping - Private parking lots | SC | | | | | | | | Swept for aesthetics, but not required. |
| | | Sand filter | TC | | | | | | | | |
| | General | Ordinances Prohibiting Non-Stormwater Discharges and Littering | SC | | | | | | | | |
| | | Desert Dumping Controls | SC | | | | | | | X | SNHD regulations |
| | | Infiltration basin/trench | TC | | | | | | | | Only if verified by site-specific geotech investigation; requires water right |
| | | Bioretention | TC | | | | | | | | Desert rain garden |
| | | Regional Water Quality Planning | SC | | | | | | | X | LVVWAC, LVWCC, LMWQF, 208 Plan |
| | | Sustainability and Green Building Initiatives | SD | | | D | | | | | |

| | | | | MS4 Permittees | | | | Regional Entities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pollutant of Concern** | **Land Use Source** | **Best Management Practice** | **BMP Type** | **COH** | **CLV** | **CNLV** | **CC** | **CCRFCD** | **SNWA** | **Other** | **Comments** |
| Pathogens (Bacteria) | Residential Development | Drought Ordinances | SC | | | | | | X | | Efficient irrigation, Xeriscaping, Turf area restrictions |
| | | Public Education | SC | | | | | X | | | Pet waste cleanup |
| | | Drop Inlet Marking Program | SC | D | D | D | D | | | | Developing RTC standards for new dev't |
| | | Regional Water Quality Planning | SC | | | | | | | X | LVVWAC, LVWCC, LMWQF, 208 Plan |
| | | Site design (misc measures not listed separately) | SD | | | | | | | | Depressed landscaping; landscaped swales; buffer strips for WQ |
| | | Infiltration basin/trench | TC | | | | | | | | Only if verified by site-specific geotech investigation; requires water right |
| | | Bioretention | TC | | | | | | | | Desert rain garden |
| | | Pet waste stations in parks | SC | | | | | | | | |
| | | Ordinances Prohibiting Non-Stormwater Discharges and Littering | SC | | | | | | | | |
| | Restaurants | Grease Interceptor Inspection Program | SC | | | | | | | | |
| | | Pre-Treatment Programs | SC | | | | | | | | |
| | | Trash Receptacle Enclosures | SC | | | | | | | | CLV&CNLV: Enclosed with roof or trellis; COH&CC: Enclosed only; All: receptacles with lids |
| Organic Compounds (Solvents) | Residential Development | Public Education | SC | | | | | X | | | |
| | | Drop Inlet Marking Program | SC | D | D | D | D | | | | Developing RTC standards for new dev't |
| | | Desert Dumping Controls | SC | | | | | | | X | SNHD regulations |
| | | Household Hazardous Waste Collection | SC | | | | | | | | |
| | | Ordinances Prohibiting Non-Stormwater Discharges and Littering | SC | | | | | | | | |
| | | Site design (misc measures not listed separately) | SD | | | | | | | | Depressed landscaping; landscaped swales; buffer strips for WQ |
| | | Infiltration basin/trench | TC | | | | | | | | Only if verified by site-specific geotech investigation; requires water right |
| | | Bioretention | TC | | | | | | | | Desert rain garden |
| | Industrial Sites | Sand/Oil Separators | TC | | | | | | | X | SNHD Inspection program |
| | | Indoor workshops | SD | | | | | | | X | SNHD inspection program |
| | | Hazardous Waste Storage and Collection | SC | | | | | | | | |
| | | Commercial/Industrial Housekeeping | SC | | | | | | | | |
| | | Spill Control Prevention Plans | SC | | | | | | | | Industry and State requirement |
| | | Pre-Treatment Programs | SC | | | | | | | | |
| | | Trash Receptacle Enclosures | SC | | | | | | | | CLV&CNLV: Enclosed with roof or trellis; COH&CC: Enclosed only; All: receptacles with lids |

| | | | | MS4 Permittees | | | | Regional Entities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pollutant of Concern** | **Land Use Source** | **Best Management Practice** | **BMP Type** | **COH** | **CLV** | **CNLV** | **CC** | **CCRFCD** | **SNWA** | **Other** | **Comments** |
| Organic Compounds (Solvents) | Industrial Sites | Site design (misc measures not listed separately) | SD | | | | | | | | Depressed landscaping; landscaped swales; buffer strips for WQ |
| | | Sand filter | TC | | | | | | | | |
| | | So. NV Health District inspections | SC | | | | | | | X | Inspections of "conditionally exempt generators of hazardous waste" |
| Sediment (Sediment, TSS) | Res, Com and Ind Development | Regional Flood Infrastructure Maintenance | TC | | | | | X | | | Regional channels and detention basins |
| | | Local Storm Drain Sustem Maintenance | TC | | | | | | | | Catch basins, inlets and storm drains |
| | | Street Sweeping | SC | | | | | | | | |
| | | Dust Control Measures | SC | | | | | | | | Requires streets/parking to be stabilized |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Regional Channel Lining | TC | | | | | X | | | |
| | | Las Vegas Wash Stabilization Structures | TC | | | | | | X | | |
| | | Sensitive Lands Overlay | SD | | | | | | | | Density restrictions, Preserve natural open and drainage paths, Set backs from sensitive lands, Rural development overlay |
| | | Floodplain Development Ordinances | SD | | | | | | | | |
| | | Regional Water Quality Planning | SC | | | | | | | X | LVVWAC, LVWCC, LMWQF, 208 Plan |
| | | Standard Drainage Design Criteria | SD | | | | | X | | | Also have CCRFCD regional criteria |
| | | Sand/Oil Separators | TC | | | | | | | X | SNHD inspection program for industrial sites |
| | | Hydrodynamic separator | TC | | | | | | | | |
| | Hillside Development | Hillside Development Ordinance | SD | | | | | | | | Density restrictions, Preserve natural open space. Does not apply to CNLV - no steep slopes. |
| Heavy Metals (Copper, Lead, Zinc) | Streets and Parking Lots | Street Sweeping | SC | | | | | | | | |
| | | Street sweeping - Public parking lots | SC | | | | | | | | Swept per maintenance standards. |
| | | Street sweeping - Private parking lots | SC | | | | | | | | Swept for aesthetics, but not required. |
| | | Regional Flood Infrastructure Maintenance | TC | | | | | X | | | Regional channels and detention basins |
| | | Local Storm Drain Sustem Maintenance | TC | | | | | | | | Catch basins, inlets and storm drains |
| | | Ordinances Prohibiting Non-Stormwater Discharges and Littering | SC | | | | | | | | |
| | | Dust Control Measures | SC | | | | | | | | Requires streets/parking to be stabilized |
| | | Desert Dumping Controls | SC | | | | | | | X | SNHD regulations |
| | | Drop Inlet Marking Program | SC | D | D | D | D | | | | Developing RTC standards for new dev't |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Public education | SC | | | | | X | | | General, vehicle maintenance |
| | | Las Vegas Wash Stabilization Structures | TC | | | | | | X | | |

| | | | | MS4 Permittees | | | | Regional Entities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pollutant of Concern** | **Land Use Source** | **Best Management Practice** | **BMP Type** | **COH** | **CLV** | **CNLV** | **CC** | **CCRFCD** | **SNWA** | **Other** | **Comments** |
| Heavy Metals | Streets and Parking Lots | Rural Land Overlay | | | | | | | | | Narrow streets, no curb & gutter |
| (Copper, Lead, Zinc) | | Regional Water Quality Planning | SC | | | | | | | X | LVVWAC, LVWCC, LMWQF, 208 Plan |
| | | Minimize directly connected impervious area | SD | | | | | | | | Minimize overall imp area; disconnect downspouts; drain runoff to pervious areas |
| | | Parking lot design | SD | | | | | | | | Depressed islands; buffer strips; porous pavement; minimize parking requirements |
| | | Street design | SD | | | | | | | | Minimum street widths; cul de sac design; buffer strips; depressed medians |
| | | Porous pavement | SC | | | | | | | | Modular pavers; not porous asphalt or concrete |
| | | Sand filter | TC | | | | | | | | |
| | | Sand/Oil Separators | TC | | | | | | | | |
| | | Hydrodynamic separator | TC | | | | | | | | |
| | Automotive Repair Shops | Sand/Oil Separators | TC | | | | | | | X | SNHD inspection program |
| | | Indoor workshops | SD | | | | | | | X | SNHD inspection program |
| | | Hazardous Waste Storage and Collection | SC | | | | | | | | |
| | | Commercial/Industrial Housekeeping | SC | | | | | | | | |
| | | Spill Control Prevention Plans | SC | | | | | | | | Industry and State requirement |
| | | Pre-Treatment Programs | SC | | | | | | | | |
| | | Trash Receptacle Enclosures | SC | | | | | | | | CLV&CNLV: Enclosed with roof or trellis; COH&CC: Enclosed only; All: receptacles with lids |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | So. NV Health District inspections | SC | | | | | | | X | Inspections of "conditionally exempt generators of hazardous waste" |
| Litter/Floatables | All | Street Sweeping | SC | | | | | | | | |
| | | Regional Flood Infrastructure Maintenance | TC | | | | | X | | | Regional channels and detention basins |
| | | Local Storm Drain Sustem Maintenance | TC | | | | | | | | Catch basins, inlets and storm drains |
| | | Commercial/Industrial Housekeeping | SC | | | | | | | | |
| | | Desert Dumping Controls | SC | | | | | | | X | SNHD regulations |
| | | Drop Inlet Marking Program | SC | D | D | D | D | | | | Developing RTC standards for new dev't |
| | | Public education | SC | | | | | X | | | Littering campaigns (Don't Trash LV) |
| | | Regional Detention Basin Retrofits | TC | D | D | D | D | X | | | Permittees committed to this. Strategy under development. |
| | | Regional Water Quality Planning | SC | | | | | | | X | LVVWAC, LVWCC, LMWQF, 208 Plan |
| | | Infiltration basin/trench | TC | | | | | | | | Only if verified by site-specific geotech investigation; requires water right |

| | | | | MS4 Permittees | | | | Regional Entities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pollutant of Concern** | **Land Use Source** | **Best Management Practice** | **BMP Type** | **COH** | **CLV** | **CNLV** | **CC** | **CCRFCD** | **SNWA** | **Other** | **Comments** |
| Litter/Floatables | All | Extended detention basin | TC | | | | | | | | At development scale |
| | | Sand/Oil Separators | TC | | | | | | | | |
| | | Hydrodynamic separator | TC | | | | | | | | |
| Pesticides & Herbicides | Landscaped Areas | Fertilizer, Pesticide and Herbicide Management - Private contractors | SC | | | | | | | | |
| | | Fertilizer, Pesticide and Herbicide Management - Public entities | SC | | | | | | | | |
| | | Drought Ordinances | SC | | | | | | X | | Efficient irrigation, Xeriscaping, Turf area restrictions |
| | | Turf Conversion Program | SC | | | | | | X | | |
| | | Commercial/Industrial Housekeeping | SC | | | | | | | | |
| | | Hazardous Waste Storage and Collection | SC | | | | | | | | Required for municipal and industrial sites, not for residential |
| | | Ordinances Prohibiting Non-Stormwater Discharges and Littering | SC | | | | | | | | |
| | | Desert Dumping Controls | SC | | | | | | | X | SNHD regulations |
| | | Public education | SC | | | | | X | | | Proper use and disposal of fertilizers and garden chemicals |
| | | Drop Inlet Marking Program | SC | D | D | D | D | | | | Developing RTC standards for new dev't |
| | | Floodplain Development Ordinances | SD | | | | | | | | |
| | | Regional Water Quality Planning | SC | | | | | | | X | LVVWAC, LVWCC, LMWQF, 208 Plan |
| | | Site design (misc measures not listed separately) | SD | | | | | | | | Depressed landscaping; landscaped swales; buffer strips for WQ |
| | | Infiltration basin/trench | TC | | | | | | | | Only if verified by site-specific geotech investigation; requires water right |
| | | Bioretention | TC | | | | | | | | Desert rain garden |
| Selenium/TDS | Shallow Groundwater | Drought Ordinances | SC | | | | | | X | | Efficient irrigation, Xeriscaping, Turf area restrictions |
| | | Turf Conversion Program | SC | | | | | | X | | |
| | | Public education | SC | | | | | | X | | Water conservation |
| | | Ordinances Prohibiting Non-Stormwater Discharges and Littering | SC | | | | | | | | |
| | | Regional Water Quality Planning | SC | | | | | | | X | LVVWAC, LVWCC, LMWQF, 208 Plan |

**BMPs that were previously determined by DGWG to be infeasible or undesirable for LVV:**

| | |
|---|---|
| Catch basin insert | Porous asphalt or concrete |
| Cistern | Unpaved parking areas |
| Green roof | Dry wells |

# ATTACHMENT C

## Las Vegas Valley Municipal Separate Storm Sewer System
## New Development and Significant Redevelopment Program
## Parking Lot Best Management Practices Program

**October 5, 2010**

### OBJECTIVE

The objective of the Parking Lot Best Management Practices (BMP) Program is to minimize the impact of pollutants generated from parking lot runoff on surface water quality in Las Vegas Valley. It is part of the New Development and Significant Redevelopment Program prepared by the Las Vegas Valley Municipal Separate Storm Sewer System (MS4) Permittees in compliance with the MS4 stormwater permit issued by the Nevada Division of Environmental Protection.

### COVERAGE

The Parking Lot BMP Program applies to all new residential, commercial and industrial site parking lots of 1 acre and larger in Las Vegas Valley.

The requirements in the Parking Lot BMP Program will apply to all new development and significant redevelopment projects requiring new site development permits. Any projects with active permits when the new NSDR program takes effect will not be subject to the new requirements. Projects that must reactivate an expired permit will be subject to the new requirements.

### REQUIREMENTS

*Developer Requirements* - Runoff must be treated from at least 75% of the parking lot area using one or more Site Design or Treatment Control BMPs approved by the local municipal entities, or other measures proposed by the developer. Approved Site Design and Treatment Control BMPs are listed in a following section. Use of site maintenance measures or adherence to local entity regulations as required to maintain acceptable site conditions does not relieve developers of the responsibility for implementing Site Design or Treatment Control BMPs for at least 75% of the parking lot area. The developer and site owner./operator are responsible for complying with all current local ordinances dealing with site design and maintenance.

*Permittee Requirements* – Permittees will incorporate appropriate education messages and activities into their Public Education and Outreach Program to encourage proper maintenance of parking areas. Permittees will enforce existing ordinances related to use of

parking areas and appurtenant facilities such as trash storage areas and loading docks, and will investigate the potential benefits and obstacles to modifying standards for minimum and maximum parking lot sizes. Permittees will respond to citizen complaints regarding parking lot maintenance and potential pollutant sources.

## SUBMITTAL AND APPROVAL PROCESS

Requirements for parking lot designs will be included in the CCRFCD Uniform Regulations and Hydrologic Criteria and Drainage Design Manual (HCDDM). Developers must submit parking lot designs to the appropriate local entity with the Technical Drainage Study required by CCRFCD. Verification of proper design will be conducted during review of final design plans as currently required for drainage improvements.

## HYDROLOGIC AND DRAINAGE DESIGN CRITERIA

Permittees will develop hydrologic and drainage design criteria for pre-approved structural BMPs. These criteria will be consistent with current standard practice for BMP design and local hydrologic conditions, and will be developed in cooperation with local flood control engineers.

Many stormater quality BMPs will also serve as onsite flood control facilities, In this case hydrologic design will be based on the 10-year or 100-year storm as currently specified in the HCDDM. Site Design and Treatment Control measures sized only for stormwater quality management will be designed to capture and treat the runoff from the 85$^{th}$ percentile storm (i.e, the storm that is equal to or greater than 85 percent of historical storms). This is a 6-hour storm with the 85$^{th}$ percentile depth of 0.32 inches in the McCarran Airport area and a distribution given in the CCRFCD Hydrologic Criteria and Drainage Design Manual. Comprehensive design criteria will be developed and distributed by the Permittees after the proposed NDSR program is approved by NDEP. The intent is to develop a simple approach to determining the design storm and runoff characteristics (peak flow and volume) using information already required for onsite drainage design.

## APPROVED BEST MANAGEMENT PRACTICES

This section lists parking lot BMPs that are pre-approved by the Las Vegas Valley Permittees. Other BMPs may be proposed by the developer and submitted to the local entity for consideration. BMP descriptions are provided in Appendix D. The Parking Lot BMP Program requires that one or more of the following Site Design and Treatment Control BMPs be used to capture and treat runoff from at least 75 percent of the new parking lot area. The Permittes prefer that developers select Site Design measures because of their low cost, ease of maintenance, and ease of inspection. However, developers should treat the following list of BMPs as a "toolbox" from which the most appropriate measures for each specific application can be selected.

This section also lists the maintenance measures and code requirements that are expected of all parking lot owners/operators. Permittees will be responsible for conducting outreach activities to commercial and industrial site owners to inform them of the need to implement these measures on an ongoing basis.

***Site Design Measures (Preferred)***

- *Measures:* Landscaped Drainage Swale, Depressed Median, Depressed Landscaping, Buffer Strip, Minimize Directly Connected Impervious Area, Pervious Overflow Parking
- *Usage:* Low impact development site design measures accept drainage from impervious parking areas to reduce stormwater volumes and velocities and trap pollutants prior to stormwater leaving the site
- *Benefits:* Low cost, easy construction, low maintenance, easy to incorporate into most site plans
- *Disadvantages:* May require additional site area to incorporate, may not be the most effective way to retain pollutants onsite

***Treatment Control Measures (Acceptable Alternates)***

- *Measures:* Sand Filter, Media Filter, Oil & Water Separator, Sump, Water Quality Inlet, Water Quality Basin (no infiltration)
- *Usage:* Treatment control measures accept site runoff and remove pollutants prior to stormwater leaving the site
- *Benefits:* Compact design allows for use in small areas, relatively efficient removal of many pollutants of concern
- *Disadvantages:* High cost, frequent maintenance required, may require onsite storm drain system for use

***Site Maintenance Measures (Required of all sites; Permittee education and outreach responsibility)***

- *Measures:* Building and Ground Maintenance, Non-Stormwater Discharges, Parking Cleaning, Plaza & Sidewalk Cleaning, Sorbents, Waste Handling and Disposal
- *Usage:* Site maintenance and pollution prevention measures to keep pollutants from contacting stormwater. Permittees will make information available to parking lot owners/operator on proper maintenance procedures and the importance of good site maintenance to regional water quality. Information will be distributed through brochures, websites, and other media as part of their Public Education and Outreach Program.
- *Benefits:* Already required, low cost to entities, easy to incorporate into site maintenance plans
- *Disadvantages:* No good way of verifying that practices are being implemented

***Code Measures (Require of all sites)***

- *Measures:* Trash Storage Areas, Vehicle & Equipment Washing Areas, Loading Dock Areas, Minimize Parking Requirements
- *Usage:* Pollution prevention measures associated with typical parking area appurtenances and activities, to keep potential pollutants from contacting stormwater. Permittees will review existing regulations to require these measures on all new parking lots.
- *Benefits:* Reduce pollutants from high potential sources, low implementation cost, close gaps in existing regulations
- *Disadvantages:* Process of revising codes and regulations must be completed by individual entities, requires coordination to assure consistency, difficult to verify continued compliance after design and construction are completed

# ATTACHMENT D

## BMP for New Development and Significant Development Program

Appendix material with single sheets for each BMP, including responsible agencies, measurable goals, schedules, etc. were not finalized at time this Technical Memorandum was finalized. BMP fact sheets are included in Appendix B Proposed Best Management Practices of the Storm Water Management Plan.

# Section 13

MWH

TECHNICAL MEMORANDUM

# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

## STORMWATER MANAGEMENT PLAN DOCUMENTATION

## Technical Memorandum IV.14

## Proposed Industrial Facility Program for Las Vegas Valley

November 15, 2010

*Prepared for*

**Stormwater Quality Management Committee**

*Prepared by*

MWH®

BUILDING A BETTER WORLD

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# 1 Introduction

On February 9, 2010 the Nevada Division of Environmental Protection (NDEP) issued the Las Vegas Valley Municipal Separate Storm Sewer System Permit Renewal (MS4 Permit) for a period of five years. The 2010-2015 MS4 Permit is a "permit for authorization to discharge from municipal separate storm sewer systems to waters of the United States under the National Pollutant Discharge Elimination System." The MS4 Permit requires an industrial facility monitoring and control program to monitor and control pollutants in stormwater discharges from various types of industrial facilities. This technical memorandum (TM) outlines the Permittees' proposed response to the permit requirements.

The purpose of this TM is to describe the measures proposed by the Permittees to comply with the MS4 Permit to monitor and control pollutant discharges in stormwater from industrial facilities. The Permittees include the City of Las Vegas, City of North Las Vegas, City of Henderson, Clark County, and the Clark County Regional Flood Control District. This TM includes the permit requirements in the MS4 Permit, describes the existing programs being implemented by the Permittees and discusses programs that will be implemented to address the new permit requirements.

# 2 2010-2015 MS4 Permit Requirement

The renewed MS4 Permit for Las Vegas Valley includes the following requirements for the industrial facility monitoring and control program:

> *"IV.H.I The updated SWMP shall include a description of a program to monitor and control pollutants in stormwater discharges to MS4s from municipal landfills, hazardous waste treatment, disposal and recovery facilities, industrial facilities that are subject to section 313 of title III of the Superfund Amendments and Reauthorization Act of 1986 ("SARA"), and industrial facilities that the municipal permit applicant determines are contributing a substantial pollutant loading to the MS4. The program shall include the following components:*
>
> > *IV.H.I.a Identify priorities and procedures for inspections and establishing and implementing control measures for such discharges;*
> >
> > *IV.H.1.b Each Permittee shall develop and maintain an inventory of the facilities identified in part IV.H.1. The inventory shall list the facilities by specific categories (e.g., restaurants, municipal maintenance yards, etc.) and list the minimum inspection frequency for each category of facilities;"*
> >
> > *IV.H.1.c Each Permittee shall provide a list of the inventoried facilities to NDEP by October 1, 2010. Each year thereafter for the life of this permit, each Permittee shall provide to NDEP by October 1 of that year, an updated list of the facilities inventoried during that year."*
> >
> > *IV.H.1.d Describe a monitoring program for stormwater discharges associated with the industrial facilities identified in this section, to be*

*implemented during the term of the permit in accordance with the monitoring programs defined in Part V.A.*

The following sections describe the existing and proposed practices to meet these requirements. The focus of this portion of the permit is pollution prevention, i.e., preventing pollutants from entering the MS4 system from industrial facilities.

# 3 Existing Industrial Facility Monitoring and Control Program

This section briefly describes the existing industrial facility program currently being implemented by the Permittees. More information can be found in the 2009-2010 Annual Report (MWH, 2010).

## 3.1 Industrial Facility Inspections

The Permittees have existing industrial facility inspection programs, as described below.

- Clark County staff inspect sites identified on the Superfund Amendments and Reauthorization Act of 1986 (SARA) Section 313 list, select industrial sites to determine if they have the potential to discharge a substantial pollutant load, and those identified with a potential to discharge a substantial pollutant load to the MS4 at least annually .
- CLV and CNLV use their pretreatment program staff to conduct stormwater inspections during their regular site visits. All industrial sites in the pretreatment program are inspected. If issues pertaining to stormwater are discovered during normal inspections for compliance with discharges to the sanitary sewer, these are noted and addressed accordingly.
- The COH Building and Fire Safety Department fire safety inspectors identify and inspect facilities identified by the COH as potential substantial contributors of pollutants to the MS4. The identification of facilities, inspection procedures, and enforcement of the industrial inspection program is based on the hazardous materials requirements in the 2006 International Fire Code.

Inspector training sessions are performed on an as-needed basis by each of the Permittees. Training materials for industrial facility inspectors were developed in the 2004-2005 permit year. The training presentation includes a description of the Las Vegas MS4 NPDES Permit and the Las Vegas Valley SWMP. The local ordinances and the Industrial Facility Monitoring and Control Plans for each jurisdiction are described. Contact information, such as names and phone numbers for Permittees and other interested parties were given for the inspectors' information. Training materials have been updated and customized to individual entities as needed.

The general procedures of the inspections are reported by each of the Permittees in the annual report. The items reported items include name and location of facility, date of the

inspection, results and/or violations that are inspected, any actions taken, and any follow-up actions taken.

## 3.2 Inventory of Industrial Facilities

The MS4 permit Section IV.H.1 specifically identifies four classes of industrial facilities for which a program to monitor and control pollutants must be developed. These classes of industrial facilities are:

- Industrial facilities that are subject to Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA)
- Municipal landfills
- Hazardous waste treatment, disposal and recovery facilities
- Industrial facilities that the municipal permit applicant determines are contributing a substantial pollutant loading to the municipal storm sewer system

The EPA regulates and keeps a list of industrial and other facilities that are subject to Section 313 that release certain amounts of regulated chemicals into the environment. The EPA's website (**www.epa.gov/enviro/html/tris/tris_query.html**) is used to search for and list all Toxic Release Inventory (TRI) facilities in Clark County. This list is compiled by the EPA based on reporting by regulated industries and is a reasonable source of information for this purpose. EPA classifies facilities by Standard Industrial Classification (SIC) codes.

The only landfill within the Las Vegas Valley is the Sunrise Landfill. This landfill has been closed since 1993. The Apex Regional Landfill is currently the only active local landfill, but is located outside of the Las Vegas Wash watershed. As a result, no municipal landfills are covered under the MS4 industrial program requirements since there are no active municipal landfills in the Las Vegas Wash drainage area.

The EPA keeps a list of hazardous waste treatment, disposal, and recovery facilities that are subject to the Resource Conservation and Recovery Act (RCRA). The EPA RCRA Info web site (**www.epa.gov/enviro/html/rcris/rcris_query.html**) is searched to find hazardous waste treatment and disposal facilities within Las Vegas Valley.

The MS4 Permittees have not identified any facilities that are contributing a substantial pollutant loading to the municipal storm sewer system. However, entities have identified facilities with the potential to pollute, and have plans in place to inspect those facilities. In addition, many industrial facilities, in addition to those listed above, are being inspected as parts of other regulatory programs (e.g., pretreatment program). Specific categories for other types of facilities that require inspections have not been identified; the additional industrial facilities are selected on a case-by-case basis.

### 3.3 List of Inventory of Industrial Facilities

In the Annual Report for each permit year, the Permittees have reported a list of the industrial facilities in the specific permit categories that were inspected during the permit year. Industrial pretreatment inspectors and fire inspectors cover many more facilities than required by the permit.

### 3.4 Monitoring Program for Industrial Facilities

To date the Permittees have not identified any industrial facilities that require stormwater monitoring.

# 4 Proposed Industrial Facility Monitoring and Control Program

This section describes the proposed industrial facility monitoring and control program to meet the requirements in the new MS4 Permit. Based on the permit language, the industrial facility program is focused on municipal landfills; hazardous waste treatment, disposal and recovery facilities; industrial facilities that are subject to Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 ("SARA"); and industrial facilities that the municipal permit applicant determines are contributing a substantial pollutant loading to the MS4.

**Table 1** lists the proposed program elements, responsible parties, measurable goals, and data to be monitored and tracked for each element. It is noted that all the program elements are non-structural.

## 4.1 Industrial Facility Inspections and Implementation of Control Measures

Section *IV.H.1.a* of the MS4 Permit requires the identification of the priorities and procedures for inspections of industrial facilities. In addition, this section of the MS4 permit requires implementation of control measures for the stormwater discharges from the industrial facilities.

### 4.1.1 Industrial Facility Inspection Program

The proposed Industrial Facility Inspection Program consists of the following measures.

#### Industrial Facility Inspection Checklist

The Permittees have developed a standard checklist to be used by inspectors to conduct industrial site inspections. This standard checklist is included in **Attachment A**. Each entity may modify the standard checklist slightly to meet its needs. However, the general information collected during inspections by each entity will be similar. The basic information on the inspection form includes:

- name, type of industry, location, jurisdiction and contact person of facility

- date of the inspection and name of inspector
- evidence of any non-stormwater discharges (e.g., process water, wastewater)
- evidence of any violations of local stormwater ordinances
- any actions taken or required in the future

#### Industrial Facility Inspections

The proposed industrial facility inspection process is similar to existing practices. The proposed inspection processes are described for each entity as follows.

- **City of Las Vegas –** Industrial pretreatment program staff will inspect the industrial facilities described in the following section using the standard industrial inspection checklist.
- **City of North Las Vegas –** Industrial pretreatment program staff will inspect the industrial facilities described in the following section using the standard industrial inspection checklist.
- **City of Henderson –** Building and Fire Safety Department fire safety inspectors will inspect the industrial facilities described in the following section using a checklist with similar information as included on the standard industrial inspection checklist.
- **Clark County –** Clark County Water Reclamation District staff will inspect industrial sites that fall in the four industrial categories specifically listed in the permit and they will conduct inspections to determine which industrial sites or categories of industrial activity have the potential to contribute a substantial pollutant loading to the MS4.

#### Stormwater-related Complaint Calls

The Permittees will respond to stormwater-related complaint calls associated with industrial activity when applicable. Each complaint call action will be documented using the Industrial Site Inspection Checklist. The Permittees will ensure industries execute any required corrective actions through follow up and/or referrals to other agencies or departments.

#### Recordkeeping and Reporting

The Permittees will file completed Industrial Site Inspection Checklists chronologically in a separate stormwater compliance file. For facilities that hold pretreatment permits, the Permittees may also file copies of the Industrial Site Inspection Checklists in the respective permit files.

### 4.1.2 Implementation of Control Measures

The Industrial Facility Program consists of control measures to reduce the potential for industrial sites to contribute significant pollutant loadings to the MS4. This program complements the State general industrial stormwater permit program.

**Measure: 1 – Commercial/Industrial Site Housekeeping**

Commercial and industrial site operators are required to apply good housekeeping practices in exterior areas such that stormwater runoff would not contact pollutant sources and contribute a substantial load of pollution to the MS4. Depending on the type of facility and material storage and handling, good housekeeping practices could include one or more of the following:

- promptly pick up trash and waste material
- promptly clean up chemical spills using proper methods
- store chemicals and hazardous materials in closed containers and in covered areas
- handle chemicals and hazardous materials in covered or enclosed areas where spills would not be contacted by stormwater runoff
- use dry cleaning methods for outside areas (e.g., sweeping rather than washing down)
- clean and maintain vehicles indoors or in covered areas

**Measure: 2 – Grease Interceptor Program**

Entities have existing ordinances requiring proper removal and disposal of grease from grease traps in restaurants and industrial facilities. Clogged grease traps could allow wastewater to be directed to the MS4. Las Vegas Valley experiences about 100,000 visitors per day, and combined with 1.8 million residents, there are hundreds of thousands of potential diners each day. Public wastewater treatment service providers inspect thousands of restaurants and industrial facilities each year. Best practices are employed consistently among each of the entities in Las Vegas Valley.

**Measure: 3 – Indoor Workshop**

Municipal codes for each of the entities require that all activities and operations at industrial sites and commercial sites where hazardous materials and chemicals are used be conducted in enclosed structures. This includes gas stations (with the exception of fueling areas), vehicle repair shops, and manufacturing facilities. Code requirements will apply to these types of facilities in all new developments.

**Measure: 4 – Spill Control Prevention Plan**

Certain types of commercial and industrial sites are required by EPA to have spill control prevention plans. The EPA Spill Prevention, Control, and Countermeasure (SPCC) rule establishes requirements for oil spill prevention, preparedness, and response to prevent oil discharges to navigable waters and adjoining shorelines. The rule requires specific facilities to prepare, amend, and implement SPCC Plans. A facility is subject to the SPCC Rule if it meets three criteria: 1) it must be non-transportation-related; 2) it must have an aggregate aboveground storage capacity greater than 1,320 gallons or a completely buried storage capacity greater than 42,000 gallons; and 3) there must be a reasonable expectation of a discharge into or upon navigable waters of the United States or adjoining shorelines. All qualifying sites businesses must prepare a Facility Response Plan, which is a plan for

responding to the maximum extent practicable to a worst-case discharge or threat of discharge of oil. This rule will apply to all new qualifying commercial/industrial sites.

In addition, the Permittees have developed a spill response strategy that applies to all hazardous chemicals. It was prepared in response to a requirement in the previous MS4 permit. Key components of the spill response strategy are described below.

- The State and County each have hazardous material emergency response plans that are compliant with EPA requirements and that outline field procedures, roles and responsibilities, training requirements, and notifications. Each local entity also has standard operating procedures for dealing with illegal dumping or accidental spills.
- The Clark County Local Emergency Planning Committee (LEPC) meets regularly to coordinate the activities of all emergency response agencies in Las Vegas Valley. The LEPC encourages use of common policies and procedures and passes on information related to regulations and spill response techniques. Las Vegas Valley Water District staff participate the LEPC and act as a liaison to the SQMC, assuring that stormwater system concerns are adequately reflected in LEPC planning and coordination.
- $H_2O$ Environmental is a private contractor that is used by all entities in Las Vegas Valley to respond to and clean up hazardous material spills over 25 gallons. Standing contracts with $H_2O$ Environmental allow the firm to respond to spills quickly (within 45 minutes anywhere in Las Vegas Valley).
- The hazardous material emergency response plans contain extensive notification lists, of individuals and agencies that should be contacted in the event of a hazardous material spill. The CCRFCD is on the standard notification lists to assure that the MS4 representatives are aware of any hazardous material spills that could affect the stormwater systems in their jurisdictions.

**Measure: 5 – Industrial Pretreatment Program**

Each of the Permittees has an industrial pretreatment program associated with its wastewater system. The pretreatment program includes regulations on the types of materials that can be discharged to the wastewater collection system, as well as regular facility inspections to assure compliance with the program. Pretreatment program inspectors are trained to look for potential stormwater quality threats such as exposed chemical storage areas, spills, illicit connections to the MS4, and lack of hazardous material containment. Potential issues are reported to entity staff members for follow-up as part of the MS4 Industrial Program. All new qualifying industrial sites would have to comply with the industrial pretreatment project and would be subject to regular pretreatment inspections.

**Measure: 6 – Trash Receptacle Enclosure**

Municipal codes for each of the entities require that trash receptacles for commercial sites, industrial sites, and multi-family developments be enclosed but not necessarily covered. In the case of Las Vegas and North Las Vegas, the codes state that trash receptacles must be

enclosed and covered with a roof or trellis; in the case of Clark County and Henderson, the codes state only that trash receptacles must be enclosed. For all entities, trash bins must have a lid. These code requirements reduce the potential for stormwater to contact sources of BOD, organics, bacteria, etc., and minimize the potential for litter to be blown from the trash receptacle into the MS4. Code requirements will apply to all new development.

**Measure: 7 – Southern Nevada Health District Inspections**

Southern Nevada Health District (SNHD) performs inspections of commercial and industrial sites that are "conditionally exempt generators of hazardous waste." These are smaller facilities that do not fall under the State's hazardous materials regulations. Inspections assure that no illicit discharges have occurred or could potentially occur, and check for secondary containment for hazardous materials. SNHD will expand its inspection program to any new industrial facilities that meet the definition of conditionally exempt generators of hazardous waste.

**Measure: 8 – Covered Fueling Area**

It is standard practice in the fuel service industry to cover fueling areas. Covered fueling areas prevent rainfall from contacting potential spilled hydrocarbons around gasoline pumps. Although it is not required by local ordinances, all fueling areas at recently constructed gas stations in Las Vegas Valley are covered with awnings based on this industry standard. All new gas stations will have covered fueling areas based on this standard; thus, additional codes will not be required for this measure in the stormwater program.

**Measure: 9 – Raised Fueling Area**

It is standard practice in the fuel service industry to raise fueling areas on a small (e.g., 6-inch) concrete platform. Raised fueling areas prevent runoff on the gas station site from contacting potential spilled hydrocarbons around gasoline pumps. Although it is not required by local ordinances, all fueling areas at recently constructed gas stations in Las Vegas Valley are raised based on this industry standard. All new gas stations will have covered fueling areas based on this standard; thus, additional codes will not be required for this measure in the stormwater program.

**Measure: 10 – Emergency Shut-off Switch and Shear Valve**

It is standard practice in the fuel service industry to incorporate emergency shut-off switches and shear valves into design of all fuel pumps to prevent spills in case the fuel pump is not operated properly or is damaged.

**Measure: 11 – Sand/Oil Separator**

Sand/oil separators are small vaults with chambers that separate sand (and other heavy particulates) and oil (and other flotables) from the flow stream. They are often used at industrial sites and commercial locations where hydrocarbons are present.

**Measure: 12 – Sand Filter**

Sand filters are treatment devices that are designed to remove small particulates and some dissolved pollutants from stormwater. They are often used at commercial sites, industrial sites and parking areas to treat runoff prior to discharge to the MS4.

**Measure: 13 – Education and Outreach**

This BMP will be implemented by the MS4 Permittees rather than by industrial site owners or operators. The Permittees will prepare and distribute information to:

- inform industrial owners/operators of sites where qualifying activities occur of the need to obtain a general industrial stormwater discharge permit from NDEP
- inform industrial owners/operators of the local ordinances and regulations that prohibit discharge of non-stormwater to the MS4
- inform industrial owners/operators of appropriate BMPs and control measures to implement on industrial sites

This may include preparation of an industrial site BMP guidance manual for Las Vegas Valley.

**Measure: 14 – Sewer Line Inspection and Replacement Program**

The Clark County Water Reclamation District Collection System Services currently performs closed circuit televising (CCTV) of sewer collection system assets utilizing the National Association of Sewer Service Companies – Pipeline Assessment Certification Program and Manhole Assessment Certification Program (NASSCO-PACP/MACP). This program focuses on assessing both maintenance and structural deficiencies as well as identifying areas of infiltration, which in some instances could lead to exfiltration. They inspect approximately 80 miles of sewer lines and manholes annually. This program helps ensure that sewage does not get into the storm drain system.

## 4.2 Inventory of Industrial Facilities

*Each Permittee shall develop and maintain an inventory of the facilities identified in part IV.H.1. The inventory shall list the facilities by specific categories (e.g., restaurants, municipal maintenance yards, etc.) and list the minimum inspection frequency for each category of facilities;"*

The MS4 permit Section *IV.H.1* specifically identifies four classes of industrial facilities for which a program to monitor and control pollutants must be developed. These classes of industrial facilities, along with the proposed method of developing an inventory of these facilities, are described below.

- *Industrial facilities that are subject to Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA).* The EPA regulates and keeps a list of industrial and other facilities that are subject to Section 313 that release certain amounts of regulated chemicals into the environment. The

EPA's website (www.epa.gov/enviro/html/tris/tris_query.html) will be used to search for and list all Toxic Release Inventory (TRI) facilities in Clark County. The Permittees will execute a geography search to identify all Section 313 facilities located within Clark County. The Permittees will then manually identify facilities location within their jurisdiction from the Clark County list. The EPA list has been found to be outdated in the past. Listings will be verified to assure the businesses are still active.

- *Municipal landfills.* There are no active municipal landfills in the Las Vegas Valley MS4 Permit area. Sunrise Landfill is a closed landfill within the Las Vegas Valley MS4 permit area. Entities are currently working with Republic Services, EPA and BLM on a closure process for the landfill. The closure plan design includes a complete cap, channels and retention basins to prevent downstream stormwater effects.
- *Hazardous waste treatment, disposal and recovery facilities.* The EPA keeps a list of hazardous waste treatment, disposal, and recovery facilities that are subject to the Resource Conservation and Recovery Act. The EPA RCRA Info web site (www.epa.gov/enviro/html/rcris/rcris_query.html) will be searched to find hazardous waste treatment and disposal facilities within Las Vegas Valley. The Permittees will execute a geography search to identify all facilities subject to RCRA located within Clark County. Similar to the Section 313 facilities search, the Permittees will then manually identify facilities location within their jurisdiction from the Clark County list. The EPA list has been found to be outdated in the past. Listings will be verified to assure the businesses are still active.
- *Industrial facilities that the municipal permit applicant determines are contributing a substantial pollutant loading to the municipal storm sewer system.* This category of facilities will be identified through Permittee inspections of facilities identified in illicit discharge and detection inspections, pretreatment inspections, stormwater complaints, and agency referrals. Note that CLV, CNLV and COH combine stormwater inspections with industrial pretreatment inspections and fire safety inspections. Clark County uses a combination of business license data, and water and sewer use data to identify facilities that should be inspected to determine if they are contributing a substantial pollutant loading to the municipal storm sewer system. As a result, a large number of sites are inspected that the Permittees have not determined to contribute a substantial pollutant loading to the MS4.

## 4.3 List of Inventory of Industrial Facilities

Section *IV.H.1.c* of the MS4 Permit requires that the Permittees provide to NDEP a list of industrial facilities to be inspected. This list will be provided in the MS4 Annual Report. Pertinent inventories of covered industrial sites will be updated at least annually by each Permittee.

Because industrial site inspectors are conducting other types of inspections for other regulatory programs (e.g., pretreatment inspections, stormwater complaints, illicit discharge and detection inspections), many industrial sites will be inspected that do not fit into one of the four categories for which inspections are required. Lists of sites that are inspected but do not fit one of the four covered categories will not be provided, but a total number of industrial site inspections performed will be included in the Annual Report.

## 4.4 Monitoring Program for Industrial Facilities

Section *IV.H.1.d* of the MS4 Permit requires that the Permittees develop a monitoring program for stormwater discharges associated with the industrial facilities. Monitoring of discharges from certain industrial sites is currently required by other NPDES point-source discharge permits. The Permittees propose to perform monitoring of stormwater discharges from industrial sites under the MS4 Permit authority only under the following conditions:

- Stormwater discharge monitoring is not already required under another permit; and
- Stormwater discharges are demonstrated to contributed a significant pollutant load to the MS4; and
- Inadequate stormwater BMPs are in place; and
- The site owner has demonstrated an unwillingness to comply with industrial BMP requirements and stormwater monitoring is required to support local enforcement actions.

No stormwater monitoring of industrial sites is currently required based on these conditions.

# 5 Conclusion

The MS4 Permit which took effect on February 9, 2010 includes requirements for a industrial facility monitoring and control program to monitor and control pollutant discharges in stormwater from industrial facilities. **Table 1** of this TM shows that the Permittees have identified numerous non-structural measures, most of which are current activities, to satisfy the permit requirements. Measurable goals and monitoring and tracking requirements are identified, as are the entities responsible for implementing each measure. The proposed industrial facility monitoring and control program will be incorporated into the Las Vegas Valley Storm Water Management Plan.

## Table 1. Industrial Facility Monitoring and Control Program for the Las Vegas Valley

| MS4 Permit Section | MS4 Permit Requirements | Proposed Measures | Responsible Parties | Monitoring and Tracking Information | Measurable Goals |
|---|---|---|---|---|---|
| IV.H.1.a | Identify priorities and procedures for inspections and establishing and implementing control measures for such discharges | • Develop industrial facility inspection checklist<br>• Conduct industrial facility inspections<br>• Implement industrial site control measures as appropriate for each site<br>• Prepare and distribute educational information for industrial site BMPs | • **Inspections –** CLV, CNLV, COH, CC<br>• **Control Measures –** Site Owners and Operators<br>• **Education –** CLV, CNLV, COH, CC, CCRFCD | • Complete checklist for each site inspected<br>• Track number of follow-up actions that were required annually | • **Develop Industrial Inspection Checklist** – 8/31/11<br>• **Conduct Inspections –** annually by 6/30/10 |
| IV.H.1.b | Develop and maintain an inventory of the facilities and list the minimum inspection frequency for each category of facilities | • The inventory of facilities include:<br>• Industrial facilities that are subject to Section 313 of Title III of SARA<br>• Municipal landfills<br>• Hazardous waste treatment, disposal and recovery facilities<br>• Industrial facilities that the Permittees determine are contributing a substantial pollutant loading to the MS4. | **Develop Inventory –**<br>• CLV<br>• CNLV<br>• COH<br>• CC | Number of inspections conducted by Permittees annually | Develop the inventory of facilities to be inspected Report on the number of inspections conducted by Permittees annually |
| IV.H.1.c | Each Permittee shall provide a list of the inventoried facilities to NDEP by October 1, 2010. Each year thereafter for the life of this permit, each Permittee shall provide to NDEP by October 1 of that year, an updated list of the facilities inventoried during that year | Provide list to NDEP by October 1, 2010 | **Develop Inventory –**<br>• CLV<br>• CNLV<br>• COH<br>• CC | Develop the inventory of facilities to be inspected | Develop the inventory of facilities to be inspected and submit to NDEP by October 1, 2010 |
| IV.H.1.d | Describe a monitoring program for stormwater discharges associated with the industrial facilities identified in this section. | Develop and implement a monitoring program | **Develop and Implement Program –**<br>• CLV<br>• CNLV<br>• COH<br>• CC | Documentation for monitoring conducted (site, date, location, results) | Update inventory of facilities to be monitored – Annual Report |

# 6 References

MWH, *Las Vegas Valley NPDES Municipal Stormwater Discharge Permit Annual Report 2009-2010*, September 2010.

Nevada Division of Environmental Protection, State of Nevada Department of Conservation and Natural Resources, *Clark County MS4 Permit No. NV0021911*, June 2003.

Nevada Division of Environmental Protection, State of Nevada Department of Conservation and Natural Resources, *Las Vegas Valley MS4 Permit No. NV0021911 Renewal*, February 2010.

# Attachment A

## Industrial Facility Inspection Checklist

*Las Vegas Valley Municipal Separate Storm Sewer System Permit*
*Industrial Facility Monitoring and Control Program*

# Industrial Site Inspection Checklist

| | |
|---|---|
| **Facility Name / Address:** | |
| **Type of Industry:** | |
| **Facility Contact Person:** | **Date / Time of Inspection:** |
| **Jurisdiction:** *(circle one)*<br>***CH CLV CNLV CC*** | **Inspector Name / Phone:** |

| **Inspection Criteria** | **Yes** | **No** |
|---|---|---|
| 1. Is there evidence of any process wastewater that has been or is being discharged from the site into the storm drain or public right-of-way? | | |
| 2. Were any violations of a local stormwater ordinance discovered during the inspection? | | |
| 3. Were any problems discovered on-site that require mitigation by the industry? | | |
| **Actions Taken** | **Yes** | **N/A** |
| Informed facility contact of need to correct problem | | |
| Observed facility contact correcting problem | | |
| **Actions Required** | **Yes** | **No** |
| 1. Notice of Violation | | |
| 2. Other | | |

**Comments:** *(include location/description of problems observed; continue on back)*

## Agency Industrial Site Inspection Programs

# Section 14

MWH

TECHNICAL MEMORANDUM

# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

# STORMWATER MANAGEMENT PLAN DOCUMENTATION

## Technical Memorandum IV.15

## Proposed Construction Site Management Program for Las Vegas Valley

September 8, 2010

*Prepared for*

**Stormwater Quality Management Committee**

*Prepared by*

MWH®

BUILDING A BETTER WORLD

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# 1 Introduction

On February 9, 2010 the Nevada Division of Environmental Protection (NDEP) issued the Las Vegas Valley Municipal Separate Storm Sewer System Permit (MS4 Permit) for a period of five years. The 2010-2015 MS4 Permit is a "permit for authorization to discharge from municipal separate storm sewer systems to waters of the United States under the National Pollutant Discharge Elimination System." The MS4 Permit requires a construction site best management practices (BMP) program to reduce pollutants in stormwater runoff from construction sites, inspection of construction sites for compliance with its local ordinances and permits, and implementation/enforcement of follow-up actions. This technical memorandum (TM) outlines the Permittees' proposed response to these permit requirements.

The purpose of this TM is to describe the measures proposed by the Permittees to comply the MS4 Permit Construction Site and Construction Site Inspection Programs to reduce pollutants in stormwater runoff from construction sites. The Permittees include the City of Las Vegas, City of North Las Vegas, City of Henderson, Clark County and the Clark County Regional Flood Control District. This TM includes the permit requirements in the MS4 Permit, describes the existing programs being implemented by the Permittees, identifies gaps between the MS4 Permit and the existing program, and discusses programs that will be implemented to address the new permit requirements.

# 2 MS4 Permit Requirement

The renewed MS4 Permit for Las Vegas Valley includes the following requirements relative to a Construction Site BMP Program to reduce pollutants in stormwater runoff from construction sites to the MS4.

> *IV.I.1 The updated SWMP shall include a description of a program to implement and maintain structural and non-structural BMPs to reduce pollutants in stormwater runoff from construction sites to the MS4, which shall include:*
>
> > *IV.I.1.a A description of procedures for notifying developers and operators of properties of one (1) acre or more (and less than one acre if part of a larger plan of development) of requirements applicable to stormwater runoff;*
> >
> > *IV.I.1.b A description of nonstructural and structural BMPs to be utilized for construction sites;*
> >
> > *IV.I.1.c A description of appropriate educational and training measures for construction site operators; and*
> >
> > *IV.I.1.d A description of a procedure to check for coverage under NDEP's General Construction Permit for Construction Activity prior to permit issuance.*

The 2010-2015 MS4 Permit for Las Vegas Valley includes the following requirements relative to Inspection of Construction Sites in order to verify compliance with local ordinances and permits, and implementation/enforcement of follow-up actions to necessary to comply with these renewal requirements.

*IV.J.1 Each permittee shall conduct construction site inspections for compliance with its local ordinances (grading, stormwater, etc.) and permits (construction, grading, etc.);*

*IV.J.2 Each permittee shall inspect at least monthly, all construction sites within its jurisdiction meeting the following criteria:*

*IV.J.2.a All sites disturbing 100 acres or more in size at one time;*

*IV.J.2.b All sites disturbing one (1) acre or more that are tributary to a CWA section 303(d) water body segment impaired for sediment or turbidity; and*

*IV.J.2.c Sites determined by the permittees as a significant threat to water quality. In evaluating threat to water quality, the following factors shall be considered:*

*IV.J.2.c.i Soil erosion potential;*

*IV.J.2.c.ii Site slope;*

*IV.J.2.c.iii Project size and type;*

*IV.J.2.c.iv Sensitivity of receiving water bodies;*

*IV.J.2.c.v Proximity to receiving water bodies;*

*IV.J.2.c.vi Proximity to water bodies 303(d) listed for turbidity and sediment;*

*IV.J.2.c.vii Non-storm water discharges;*

*IV.J.2.c.viii Past record of non-compliance by the construction site operators; and*

*IV.J.2.c.ix Any other relevant factors.*

*IV.J.2.d All other construction sites of > one (1) acre not listed in Part IV.J.2 shall be inspected at least two (2) times for the duration of ground disturbance activities;*

*IV.J.3 Based upon site inspection findings, each permittee shall implement all follow-up actions (i.e., re-inspection or enforcement) necessary to comply with this Permit;*

*IV.J.4 Inspections of construction sites shall include, but not be limited to:*

*IV.J.4.a Assessment of compliance with Permittee ordinances and permits related to urban runoff, including the implementation and maintenance of designated minimum BMPs;*

*IV.J.4.b Assessment of BMP effectiveness;*

*IV.J.4.c Visual observations for non-stormwater discharges and potential illicit connections;*

*IV.J.4.d Education and outreach on stormwater pollution prevention, as needed; and*

*IV.J.4.e Creation of a written or electronic inspection report.*

*IV.J.5 The permittees shall track the number of inspections for the inventoried construction sites throughout the reporting period to verify that the sites are inspected at the minimum frequencies required. This information shall be included in the Annual Report.*

The following sections describe existing and new BMPs to meet these requirements. The focus of this part of the permit is on pollution prevention, i.e. reducing the amount of pollutants from construction sites entering the MS4 system.

# 3 Existing Construction Site & Construction Site Inspection Programs

This section describes the existing Construction Site Program and Construction Site Inspection Program currently being implemented by the Permittees.

## 3.1 Existing Developer Notification Program

This subsection provides a description of the existing procedures used by the Permittees to notify developers, engineers, and contractors of the requirements of NDEP's construction site permit program and local stormwater regulations affecting construction sites.

Clark County and City of Las Vegas have a standard comment on their Grading Permit review letter notifying developers of the need for a NDEP Construction Permit. City of North Las Vegas and City of Henderson have a standard comment on their Drainage Study review letter notifying developers of the need for a NDEP Construction Permit. Also, all four Permittees have a standard general condition that is included on all construction plans or specifications assigning the owner or contractor the responsibility for obtaining the NDEP Construction Permit.

Each jurisdiction conditions issuance of grading and construction permits on proof of fee payment and coverage under the State's general permit for construction activity. In addition, submittal of a BMP checklist is required as a part of the permit application documents. The BMP checklist is included in the *Las Vegas Valley Construction Site BMP Guidance Manual*. Submittal of a Storm Water Pollution Prevention Plan (SWPPP) is not required with the development application. No formal BMP design review is performed at the time of permit application in favor of a more intense inspection program, as described in a following section.

## 3.2 Existing Construction Site Best Management Practices Manuals

In 2008, the Las Vegas Valley Stormwater Quality Management Committee (SQMC) formed the Construction Program Working Group (CPWG) made up of representatives of the Permittees and Stormwater Stakeholder Working Group (SSWG) members to develop

enhancements to the previous construction site runoff management program. One of the tasks of this group was to recommend improvements to BMP guidance currently available to contractors in the Las Vegas Valley area. The SSWG decided that a new Construction Site BMP Guidance Manual was warranted to describe the elements of the new construction site runoff management program and to provide BMP implementation guidance. The Permittees reviewed other existing BMP manuals that addressed construction practices and recommended modifications to them to be applicable to local conditions. As a result, the *Las Vegas Valley Construction Site BMP Guidance Manual* was developed to describe the elements of the new construction site runoff management program and to provide implementation guidance for nonstructural and structural BMPs. The manual is available on the Clark County Regional Flood Control District (CCRFCD) and lvstormwater.com websites.

The SQMC cooperated with the Truckee Meadows MS4 Permittees to prepare a *Nevada Contractors Field Guide for Construction Site BMPs* that could be used by contractors and construction site inspectors throughout the State. Preparation of the guide was managed by the Truckee Meadows MS4 Permittees and CCRFCD contributed $10,000 to the cost of printing. The *Nevada Contractors Field Guide for Construction Site BMPs* is available to contractors, engineers and other construction professionals. Copies are available at Permittees' permit counters, contractor training workshops, and other venues.

## 3.3 Existing Contractor Education and Training Program

As an example of recent practices, this subsection provides a description of the education and training programs that the permittees implemented in the 2008-2009 permit year. The entities conducted eight sessions of a contractor training workshop, with two sessions each held on November 18 and 20, 2008, and again on June 22 and 23, 2009. The November workshops were hosted by Clark County and conducted jointly by NDEP and CCRFCD. They covered aspects of local stormwater ordinances, NDEP construction permit requirements, and BMPs for construction sites. The June workshops were hosted by Clark County and conducted jointly by NDEP, CCRFCD, and COH. They covered aspects of the NDEP construction permit requirements, the newly adopted stormwater ordinances, the new local stormwater inspection program, and guidance on BMPs for construction sites. A total of over 400 construction industry personnel attended the contractor training workshops in the 2008-2009 permit year.

## 3.4 Existing Construction Site Inspection Program

This subsection summarizes the inspection component of the existing Construction Site Program for the Las Vegas Valley MS4 *SWMP*. A construction site inspection program is required by the MS4 permit to assure that local ordinances are effectively prohibiting discharge of pollutants to the drainage system and are not being violated.

Permittees currently have construction site inspection programs consistent with their ordinances. Each jurisdiction uses its own staff to conduct construction site inspections. Public Works and Building Department inspectors, aided with a Construction site Inspection Checklist, perform stormwater inspections within their respective jurisdiction as an added

component of routine site inspection. Each jurisdiction has developed its own process and schedule for site inspections to fit within its current building inspection program.

Supported by the ordinance language, construction sites are inspected not only for active discharges to the MS4 but also for the potential to discharge (i.e., absence of or poorly installed and maintained BMPs), effective waste management onsite, and effective erosion and sediment control practices. Every effort is made to resolve minor infractions through close coordination between the inspector and the site operator. Each Permittee has a progressive process for dealing with repeat offenders and failure to address violations.

# 4 Proposed Construction Site BMP Program Requirements from MS4 Permit

This section describes the proposed Construction Site Program and Construction Site Inspection Program to meet the requirements set forth in the MS4 Permit.

## 4.1 Developer Notification Program

Section *IV.I.1.a* of the MS4 Permit requires the Permittees to notify developers of properties of 1 acre or more, or smaller if part of a larger plan of development, of the requirements to comply with all State and local construction site stormwater permitting programs. **Table 1** summarizes the procedures the Permittees will use to notify developers of stormwater permitting requirements. Emphasis is on notifying developers of the need to obtain a general stormwater construction permit from NDEP.

**Table 1. Summary of Procedures for Developer Notification**

| Co-Permittee | Procedure |
|---|---|
| Clark County | Grading improvement plan submittals require a Construction Permit Submittal Checklist, including a copy of the NOI and a copy of the letter of authorization from NDEP. |
| | Standard comment on Grading Permit review letter notifying developer of need for NDEP construction permit |
| | Standard general condition for construction plans or specifications on Public Works projects assigning the owner or contractor the responsibility for obtaining the NDEP construction permit |
| | DAQEM includes statement on dust permit applications that developer needs to submit a Notice of Intent (NOI) to NDEP for construction permit |
| City of Las Vegas | Grading improvement plan submittals require a Construction Permit Submittal Checklist, including a copy of the NOI -or a copy of the letter of authorization from NDEP. |
| | Standard comment on Grading Permit review letter notifying developer of need for NDEP construction permit |
| | Standard general condition for construction plans or specifications on Public Works projects assigning the owner or contractor the responsibility for obtaining the NDEP construction permit |
| City of North Las Vegas | Grading improvement plan submittals require a Construction Permit Submittal Checklist, including a copy of the NOI and a copy of the letter of authorization from NDEP. |
| | Standard comment on Drainage Study review letter notifying developer of need for NDEP construction permit |
| | Standard general condition for construction plans or specifications assigning the owner or contractor the responsibility for obtaining the NDEP construction permit |
| City of Henderson | Grading improvement plan submittals require a Construction Permit Submittal Checklist, including a copy of the NOI and a copy of the letter of authorization from NDEP. |
| | Standard comment on Drainage Study review letter notifying developer of need for NDEP construction permit |
| | Standard general condition for construction plans or specifications assigning the owner or contractor the responsibility for obtaining the NDEP construction permit |

Permittees will condition issuance of grading and construction permits on proof of fee payment and coverage under the State's general permit for construction activity. Permittees will adhere to the developer notification program, consisting of:

- Standard comment on Grading Permit or Drainage Study review letter notifying developer of need for NDEP General Construction Permit.
- Standard general condition for construction plans or specifications requiring owner/contractor to obtain NDEP General Construction Permit.
- Grading plan submittals must include Construction Permit Submittal Checklist (included in the *Las Vegas Valley Construction Site Best Management Practices Guidance Manual*), Notice of Intent (NOI) for State General Construction Permit, -or letter of authorization from NDEP.

## 4.2 Nonstructural and Structural BMPs for Construction Sites

Section *IV.I.1.b* of the MS4 Permit requires the Permittees to describe nonstructural and structural BMPs to be utilized for construction sites. As described in Section 3.2, the existing

*Las Vegas Valley Construction Site Best Management Practices Guidance Manual* describes the construction site runoff management program and provides nonstructural and structural BMP implementation guidance. The manual provides guidance on selecting and designing construction site BMPs that are suitable to the unique environment and conditions in Las Vegas Valley.

**Table 2** shows a list of the various BMPs that are described in the *Construction Site BMP Guidance Manual*. The *Construction Site BMP Guidance Manual* is available to contractors, engineers, and other construction professionals on the CCRFCD website and on the www.lvstormwater.com website. The manual will be updated by CCRFCD as needed to incorporate new BMPs appropriate for the region and modify selection or design criteria for existing BMPs as more local experience is obtained.

The *Nevada Contractors Field Guide for Construction Site BMPs*, prepared by the Truckee Meadows MS4 group and funded in part by CCRFCD, is available in hardcopy form to contractors, engineers and other construction professionals. Copies are available at Permittees' permit counters, contractor training workshops, and other venues.

**Table 2. BMPs Described in Las Vegas Valley Construction Site BMP Guidance Manual**

| BMP Group | Construction Site BMPs | Structural Vs. Nonstructural |
|---|---|---|
| Planning | Site Design | Nonstructural |
| | Scheduling | Nonstructural |
| | Phased Construction | Nonstructural |
| | Topsoil Reuse | Nonstructural |
| | Employee Training | Nonstructural |
| Erosion Control | Erosion Control Mats | Structural |
| | Mulching | Structural |
| | Protection of Trees and Vegetation in Construction Areas | Structural |
| | Pipe Slope Drains | Structural |
| | Stabilized Construction Entrance | Structural |
| | Construction Road Stabilization | Structural |
| | Dust Control | Structural |
| | Temporary Access Waterway Crossing | Structural |
| | Diversion Dikes | Structural |
| | Drainage Swales | Structural |
| | Outlet Protection, Velocity Dissipation Devices | Structural |
| | Surface Roughening | Structural |
| Sediment And Pollution Control | Organic Filter Barrier | Structural |
| | Sand Bag Barrier | Structural |
| | Gravel Filter Berms | Structural |
| | Check Dams | Structural |
| | Silt Fence | Structural |
| | Revegetation and Landscape Buffers | Structural |
| | Storm Drain Inlet Protection | Structural |
| | Temporary Sediment Basins | Structural |
| | Temporary Sediment Traps | Structural |
| | Sediment Dewatering Operations | Structural |
| | Construction Entrance/Exit Tire Wash | Structural |
| General House Keeping | Chemical Management | Nonstructural |
| | Solid Waste Management | Nonstructural |
| | Equipment Maintenance Procedures | Nonstructural |
| | Designated Washdown Areas | Nonstructural |
| | Spill Containment Plan | Nonstructural |
| | Road Sweeping/Trackout Cleaning | Nonstructural |

## 4.3 Contractor Education and Training Measures

Section *IV.I.1.c* of the MS4 Permit requires the Permittees to provide a description of the appropriate educational and training measures for construction site operators.

Permittees will host Contractor Training Workshops a minimum of once per year. In the past up to four workshops have been held annually, but recently attendance has dwindled as local contractors become familiar with the stormwater program and appropriate BMP design and as construction activity has slowed dramatically. The number of annual workshops will be tailored to the current level of interest and need. Workshops will address State and local construction permitting requirements, BMP requirements, and inspection programs. As in the past, the workshops will be conducted jointly by the Permittees and NDEP.

## 4.4 Verification of Coverage Under NDEP Permit

Permittees will verify that new construction projects are covered under NDEP's general stormwater construction permit by requiring that all Grading Plan submittals include a copy of the NOI for the State General Construction Permit and the letter of authorization from NDEP. A grading permit will not be issued without this documentation. The need for this information is described in the *Construction Site BMP Guidance Manual.*

## 4.5 Construction Site Inspection Program

### 4.5.1 General Construction Site Inspection Program

Each municipal Permittee adopted a stormwater management ordinance in 2008 that includes regulatory authority to implement and enforce the provisions of their local construction site programs. These ordinances are based on EPA's model ordinance and apply to construction on sites with an area of one acre or greater.

Each municipal Permittee will conduct construction site inspections for compliance with its local ordinances and permits. Each Permittee will use existing inspection staff to perform all construction site inspections. This process and schedule for each entity is summarized as follows.

- **City of Las Vegas –** Off Site Inspection and Testing inspectors will inspect private development projects. CLV Construction Management personnel will inspect public construction projects. Stormwater inspections will occur during normal grading, offsite inspections.
- **City of North Las Vegas –** Offsite Department inspectors will perform inspection and enforcement activities. Stormwater inspections will occur during normal grading, offsite inspections.
- **City of Henderson –** Building Department, Public Works Department, and Quality Control Division inspectors will perform inspections. Stormwater inspections will occur during normal grading, offsite and building inspections.
- **Clark County –** Development Services personnel will perform inspection and enforcement activities. Stormwater inspections will occur during normal grading, offsite and building inspections. In addition, air quality inspectors have been trained in the past to perform stormwater inspections, and will report any apparent problems possible violations during their normal air quality inspections.

All construction sites not covered by Section 4.5.2 will be inspected at least two times during the period of ground disturbance activities, as long as this period is longer than four months.

In compliance with paragraph *IV.J.4* of the permit, construction site inspections will consist of the following activities.

- Assess compliance with Permittee stormwater ordinances.
- Verify proper implementation and maintenance of designated minimum BMPs as proposed by the contractor in the Construction Permit Submittal Checklist provided in the grading permit application.

- Assess potential BMP effectiveness.
- Conduct visual observations for non-stormwater discharges, potential illicit connections, and the potential to discharge pollutants to the MS4.
- Provide education and outreach materials to contractor personnel on stormwater pollution prevention and the MS4 and NDEP construction permit processes, as needed.
- Prepare a written or electronic inspection report.

These inspection items will be documented by using a Construction Site Inspection Checklist, which is included in the *Las Vegas Valley Construction Site Best Management Practices Guidance Manual.*

Supported by the ordinance language, construction sites will be inspected not only for active discharges to the MS4 but also for the potential to discharge (i.e., absence of or poorly installed and maintained BMPs), effective waste management onsite, and effective erosion and sediment control practices. Every effort will be made to resolve minor infractions through close coordination between the inspector and the site operator. The objective of the program will be education and compliance rather than punishment. Inspectors have the authority to review the Storm Water Pollution Prevention Plans (SWPPPs) required by NDEP's general construction permit if site conditions warrant; however, this is not a required aspect of every inspection.

### 4.5.2 Monthly Inspections

Each municipal Permittee will inspect, at least monthly, all construction sites within its jurisdiction that meet the criteria set forth on section *IV.J.2.a through IV.J.2.c* of the MS4 Permit.

a) All sites disturbing 100 acres or more at one time will be inspected at least monthly (par. *IV.J.2.a*).
b) All sites disturbing more than 1.0 acre that are tributary to a water body segment impaired for sediment or turbidity as determined through the State's Clean Water Act 303(d) listing process will be inspected at least monthly (par. *IV.J.2.b*). Currently, no water bodies or stream segments in Las Vegas Valley are listed as impaired for sediment or turbidity (see *Technical Memorandum II.1 Stormwater Contribution to Impaired Waters and TMDLs in Las Vegas Valley, MWH 2010).* In the future, if any stream segments become impaired for sediment or turbidity in the Las Vegas Valley, the proposed inspection procedures in this section will apply. The Permittees will interpret the permit language "*sites… that are tributary to a CWA section 303(d) water body segment*" to mean a construction site that is "directly tributary" (i.e., discharges directly to) the impaired water body segment. For example, if the segment of Las Vegas Wash upstream of the wastewater treatment plant discharges became impaired for sediment or turbidity, and a new construction site drains directly into that waterway, the construction site would be considered "*tributary to*" the impaired water body and would come under this permit requirement.

c) All sites determined by the Permittees as "*a significant threat to water quality*" will be inspected at least monthly (par. *IV.J.2.c*). The Permittees considered a number of factors in determining whether certain construction sites could present a significant threat to water quality. These included soil erosion potential, site slope, project size, project type, sensitivity of receiving waters, proximity of receiving waters, and current impairment of receiving waters for sediment and turbidity. It was determined that the infrequency and low volume of rainfall in Las Vegas Valley, combined with the high background erosion and sediment transport conditions in the desert environment, does not warrant special treatment for any construction sites beyond those already listed in the foregoing paragraphs.

### 4.5.3 Inspection Follow-Up Actions

Each municipal Permittee will implement follow-up actions, based upon site inspection findings, necessary to comply with their local stormwater ordinances and with the MS4 Permit. Resolution of infractions will be verified by repeat inspections at a frequency established by each Permittee. Failure to resolve minor infractions or observance of major violations (e.g. active discharges) will result in immediate and progressively increasing enforcement action including suspension of further inspections, stop work orders and fines. Failure to resolve issues and egregious neglect for compliance may result in notification of State representatives, whereby compliance pressure can be can be further asserted. Each Permittee has an established appeals process if a contractor feels enforcement actions are inappropriate. Appeals are first to the inspector's supervisor and could ultimately rest with each jurisdiction's governing board.

### 4.5.4 Construction Site Inspection Tracking

In compliance with paragraph *IV.J.5*, each municipal Permittee will track the number of inspections for construction sites throughout the reporting period (i.e., the MS4 permit year) to verify that the sites are inspected at the minimum frequencies required. The results will be included in the Annual Report. Records of inspections will be retained by the Permittees, and will be provided to NDEP upon request.

**Table 3** and **Table 4** list the proposed program elements, responsible parties, measurable goals, and data to be monitored and tracked for each element of the proposed Construction Site BMP Program.

## Table 3. Proposed Construction Site BMP Program

| MS4 Permit Section | MS4 Permit Requirements | Proposed Measures | Responsible Party | Monitoring and Tracking Information | Measurable Goals |
|---|---|---|---|---|---|
| IV.I.1.a | Procedures for notifying developers of properties on one acre or more of applicable requirements. | • Developer notification program, consisting of:<br>• Standard comment on Grading Permit or Drainage Study review letter notifying developer of need for NDEP general construction permit<br>• Standard general condition for construction plans or specifications requiring owner/contractor to obtain NDEP general construction permit<br>• Grading plan submittals must include Construction Permit Submittal Checklist (from Construction Site BMP Guidance Manual), NOI for state general construction permit, and letter of authorization from NDEP | CLV, CNLV, COH and CC | Grading plan approvals will include verification of receipt of NOI and letter of authorization | 100% of new developments will include developer and/or contractor notification |
| IV.I.1.b | Nonstructural and structural BMPs to be utilized for construction sites. | • Construction Site BMP Guidance Manual describing the construction site runoff management program and providing BMP implementation guidance. Update manual as needed. | CCRFCD | None | Review BMP Manual annually for need to update |
| IV.I.1.c | Appropriate educational and training measures for construction site operators. | • Annual Contractor Training Workshops | CCRFCD. CLV, CNLV, COH and CC, with NDEP assistance | Number of attendees at contractor training workshops | Conduct minimum of one contractor training workshop annually |
| IV.I.1.d | Procedure to check for coverage under NDEP's general Construction Permit for Construction Activity prior to permit issuance. | • Procedure to verify that grading plan submittals include NOI for state general construction permit and letter of authorization from NDEP | CLV, CNLV, COH and CC | Grading plan approvals will include verification of receipt of NOI and letter of authorization | 100% of new developments covered under State general permit at time of grading plan approval |

## Table 4. Proposed Construction Site Inspection Program

| MS4 Permit Section | MS4 Permit Requirements | Proposed Measures | Responsible Party | Monitoring and Tracking Information | Measurable Goals |
|---|---|---|---|---|---|
| IV.J.1 | Each permittee shall conduct construction site inspections for compliance with its local ordinances and permits. | Permittees will have construction site inspection programs consistent with their ordinances. Each jurisdiction will use its own staff to conduct construction site inspections | CLV, CNLV, COH and CC | Inspection Log | Inspect 100% of all covered construction sites per entity policies |
| IV.J.2. a through IV.J.2.c | Construction sites that meet the criteria set forth on section IV.J.2.a through IV.J.2.c shall be inspected on a monthly basis. | Construction sites over 100 acres, directly tributary to a water body impaired for sediment or turbidity, or presenting a significant threat to water quality will be inspected monthly | CLV, CNLV, COH and CC | Inspection Log | Inspect 100% of all covered construction sites per entity policies |
| IV.J.2.d | Construction sites that meet the criteria set forth on section IV.J.2.d shall be inspected at least 2 times during ground disturbance activities. | Construction sites over 1 acre will be inspected at least 2 times during ground disturbance activities | CLV, CNLV, COH and CC | Inspection Log | Inspect 100% of all covered construction sites per entity policies |
| IV.J.3 | Permittees shall implement necessary follow-up actions to comply with this Permit. | Permittees will conduct re-inspections, issue correction letters to potential violators and implement enforcement measures as needed to enforce local stormwater ordinances | CLV, CNLV, COH and CC | Enforcement Log | Follow-up on 100% of all potential violations per entity policies |
| IV.J.4 | Inspections of construction sites shall include, but be not limited to the information outlined in section IV.J.4. | The Permittees will make use their Construction Site Inspection Checklist to document required information collected during inspections | CLV, CNLV, COH and CC | Completed Construction Site Inspection Checklists | None |
| IV.J.5 | Inspections shall be tracked for the inventoried construction sites throughout the reporting period to verify the minimum frequencies required. This information shall be included in the Annual Report. | Permittees will document and track all inspections using Construction Site Inspection Checklists and a summary of inspections will be included in the Annual Report. | CLV, CNLV, COH and CC | Inspection Log Annual Report | Include construction inspection report in MS4 Annual Report |

# 5 Conclusion

All of the entities have taken the necessary proactive actions to fulfill the Construction Site BMP Program requirements set forth in the MS4 Permit. In recent year the entities developed and implemented a set of BMPs, conducted training sessions for contractors, developers, engineers and operators, conducted site inspections, and developed a series of checklists to streamline the implementation of the new requirements. These existing programs will be continued and where necessary enhanced or refined to comply with the new MS4 Permit.

**Table 3** and **Table 4** in **Section 4** of this TM show the proposed measures to satisfy the MS4 Permit requirements. The proposed Construction Site BMP Program will be incorporated into the Las Vegas Valley Storm Water Management Plan.

# 6 References


MWH. *2008-2009 Annual Report, Las Vegas Valley Municipal Separate Storm Sewer System.* September 2009.

Las Vegas Valley Stormwater Quality Management Committee and CCRFC. *Las Vegas Valley Construction Site Best Management Practices Guidance Manual.* January 2009.

Nevada Division of Environmental Protection. *2010 Las Vegas Valley MS4 Permit NV0021911.* February 2010.

MWH. *Technical Memorandum II.1 Stormwater Contributions to Impaired Waters and TMDLs in Las Vegas Valley*. Prepared for Las Vegas Valley Stormwater Quality Management Committee. May 2010.

TECHNICAL MEMORANDUM

# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

# STORMWATER MANAGEMENT PLAN DOCUMENTATION

## Technical Memorandum IV.16
## Strategic Plan for Use of Regional Detention Basins for Water Quality Management

February 7, 2013

*Prepared for*

**Stormwater Quality Management Committee**

*Prepared by*

MWH®

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Brian Sandoval, Governor
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Colleen Cripps, Ph.D., Administrator

RECD
2013 JUL 29 PM 2:21

July 23, 2013

Kevin Eubanks, P.E., CFM
Clark County Regional Flood Control District
600 S. Grand Central Parkway, Suite 300
Las Vegas, Nevada 89106-3870

**RE: Las Vegas Valley MS4 Technical Memorandum IV.16 – Strategic Plan to Use Regional Detention Basins for Water Quality Management - Permit No. NV0021911**

Dear Mr. Eubanks:

The Nevada Division of Environmental Protection (NDEP) finished its review of Las Vegas Valley MS4's Technical Memorandum (TM) IV.16 that discusses its proposed plan to use regional detention basins to address stormwater quality impacts from new development and significant redevelopment (NDSR). NDEP engineers studied the TM submittal and discussed the proposal in detail with Las Vegas Valley MS4's representatives and engineers. NDEP believes this approach makes sense for the Las Vegas Valley given its unique climate and topography. In addition, traditional on-site retention of stormwater may have detrimental effects on impaired waters in the Las Vegas Valley due to selenium and other naturally-occurring constituents. Thus, NDEP approves TM IV.16 for inclusion in Las Vegas Valley MS4's NDSR guidance manual.

If you have questions concerning this letter, please contact me at (775) 687-9429.

Sincerely,

Steve McGoff, P.E.
Staff Engineer III
Technical Services Branch
Bureau of Water Pollution Control

cc: Joe Maez, P.E., NDEP
John Tinger, EPA – Region IX, 75 Hawthorne St, San Francisco, CA 94105
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**Table 1. Acronyms**

| | |
|---|---|
| AF…….... | acre-feet |
| BMP……..... | best management practice |
| CCRFCD……..... | Clark County Regional Flood Control District |
| CIP……... | CCRFCD Ten-Year Construction Program |
| DARF……... | depth-area reduction factor |
| DB……..... | detention basin |
| EDB……..... | extended detention basin |
| GIS…… | geographic information system |
| MCV……..... | MS4 required water quality capture volume |
| MPU……..... | Master Plan Update |
| MS4……..... | Municipal Separate Storm Sewer System |
| NDEP……... | Nevada Department of Environmental Protection |
| NDSR……... | new development and significant redevelopment |
| O&M……..... | operation and maintenance |
| PCV……..... | prime water quality capture volume |
| RCV……..... | NDSR required water quality capture volume |
| SWMP……..... | Storm Water Management Plan |
| TM……..... | technical memorandum |
| UDB……..... | ultimate development boundary |
| WQCV…….. | water quality capture volume |

# 1 Executive Summary

The Las Vegas Valley Municipal Separate Storm Sewer System (MS4) permit addresses water quality impacts from new development and significant redevelopment (NDSR). The Las Vegas Valley Storm Water Management Plan (SWMP) Technical Memorandum (TM) IV.11, *Potential Water Quality Retrofits of Regional Detention Basins – Strategic Plan*, (MWH 2011) (TM IV.11), describes a process for using regional detention basins for this purpose. TM IV.11 suggests using existing and proposed detention basins for water quality management in each major watershed in the Las Vegas Valley. This is done primarily by incorporating extended detention basins (EDBs) within the regional detention basins. The volume of water treated by these EDBs is referred to as water quality capture volume (WQCV). Alternative methods such as using vegetation for water quality improvement are not incorporated here but will be evaluated in future permit years. An estimated 1,439 acre-feet (AF) of WQCV is needed to treat all the potential new development in the valley in order to meet the MS4 permit requirements. This total MS4 permit required WQCV (MCV) is broken down into the portion of MCV for each of the 10 major watersheds in an effort to address the MCV within its own watershed. When this is not possible, WQCV treated in one watershed beyond that watershed's MCV can be counted toward the MCV deficit in another watershed through a pollutant trade approach.

Due to physical, economical, and political restraints, not all detention basins will be able to be equipped with adequate water quality features to address the MCV within its tributary area. It is necessary to develop a prioritization and an implementation schedule in order to address the required WQCV (RCV) need as it increases based on NDSR in an economical and efficient manner. The prioritization looks first at new detention basin construction, then planned detention basin upgrades, and finally, if needed, at existing detention basin with no planned upgrades. Using the pollutant trade approach, 65 percent of the MCV could potentially be met using only proposed new detention basins. The remaining 35 percent could potentially be met using only the detention basins with proposed upgrades. The developed schedule is based on annual NDSR and the 2013 Capital Improvement Plan. The indicator that additional WQCV upgrades are needed will be when the RCV reaches 85 percent of the cumulative WQCV. The decision on what additional WQCV upgrades to initiate will then be determined based on the developed schedule and prioritization. Capital costs and the operations and maintenance costs will be funded by Clark County Regional Flood Control District (CCRFCD) from the Construction Program and under the regional flood control facility maintenance program.

# 2 Introduction

One of the requirements of the Las Vegas Valley MS4 permit is to address water quality impacts from NDSR. The Las Vegas Valley SWMP for the MS4 permit describes how the permittees will meet the permit requirements. TM IV.11 describes a process for using regional detention basins as a best management practice (BMP) for NDSR. In TM IV.11, an approach was developed to use existing and proposed Las Vegas Valley detention basins for water quality management as well as their flood control purpose. TM IV.11 further describes the strategy for using regional detention basins in each major watershed in Las Vegas Valley as a stormwater quality BMP for the NDSR program.

TM IV.11 described methods for regional detention basin designs and retrofits focusing on implementing standard water quality design features for EDBs within the regional detention basins. EDBs would detain a WQCV for a minimum of 24 hours and up to 48 hours. The literature recommends the calculation of a "maximized" WQCV that efficiently sizes water quality facilities to detain the runoff from the majority of storms.

In TM IV.11, an empirical equation was used to estimate the WQCV for the 10 major Las Vegas Valley watersheds shown in **Figure 1**. Because of the propensity of the empirical equation to overestimate the WQCV needed in larger watersheds, a reduction factor similar to the depth-area reduction factors (DARFs) used in calculating runoff was applied to the tributary area for each detention basin. The total WQCV estimated for all potential new development is 1,439 AF as shown in **Table 2**, which was taken from TM IV.11. This 1,439 AF of WQCV is the basis for the MS4 permit required WQCV referred to as the MCV.

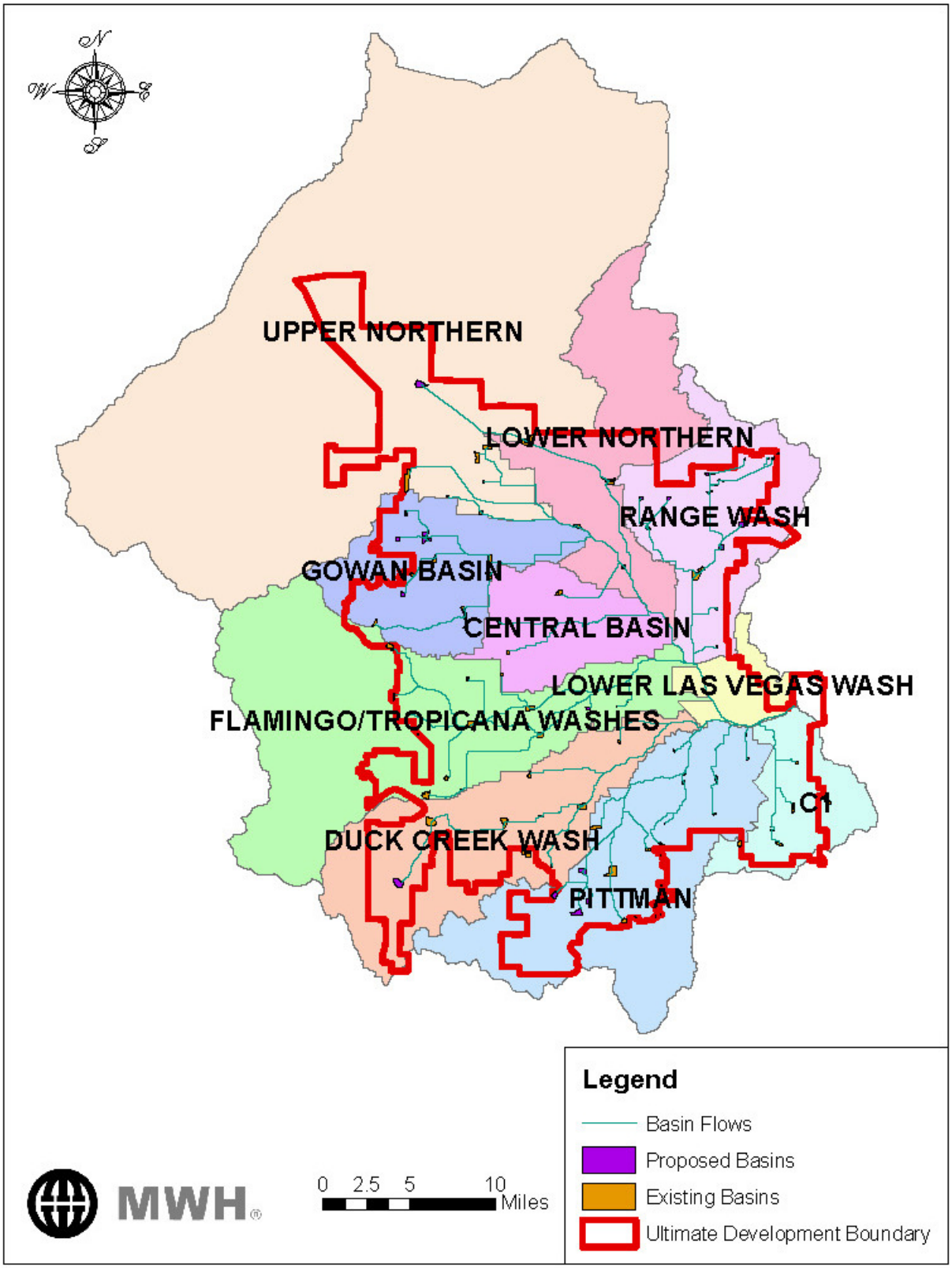



**Figure 1. Watershed Map**

**Table 2. Total Required WQCV in Major Watersheds**

| Watershed | Total Required WQCV (AF) Based on Developable Area |
|---|---|
| C1 | 78 |
| Central Basin | 10 |
| Duck Creek Wash | 250 |
| Flamingo/Tropicana Washes | 168 |
| Gowan Basin | 122 |
| Lower Las Vegas Wash | 44 |
| Lower Northern | 144 |
| Pittman | 255 |
| Range Wash | 146 |
| Upper Northern | 222 |
| **Total** | **1,439** |

*Total Required WQCVs are the MCVs.

TM IV.11 identified 52 existing or under-construction detention basins within the ultimate development boundary (UDB) in the Las Vegas Valley that are connected by conveyance facilities in a dendritic manner. Tree diagrams of the dendritic connections of the detention basins in each watershed are included in **Attachment A**. In the Las Vegas Valley, there are 12 final or strategic detention basins, i.e., those located farthest downstream in a watershed and closest to the major receiving waters. Six final detention basins were determined to have tributary areas greater than 40 square miles each. Runoff from approximately 60 percent of the UDB area flows through these six strategic detention basins. These six strategic detention basins were given special attention as retrofitting these basins could address a large amount of new and existing development with a small number of projects. Owing to the large WQCV that would need to be added to these six detention basins, it seemed impractical and uneconomical to try to address all the required WQCV in these detention basins alone.

The recommended detention basin water quality management approach in TM IV.11 was to develop a unique retrofit plan for each major watershed resulting in sufficient total WQCV to address the runoff from new development and significant redevelopment. The approach had the following elements.

- Consider the most practical opportunities for retrofit in each watershed, rather than retrofitting every single detention basin.
- Consider opportunities for retrofit beginning with the most downstream detention basins in a watershed.
- Combine water quality control measures with detention basin construction and upgrades when possible to keep total design and construction costs to a minimum.
- Use existing capacity opportunities including sediment storage and capacity that is not needed for 100-year flood storage.

**Table 2** lists the required total WQCV (MCV) associated with the developable area in each major watershed in Las Vegas Valley; this is the volume which must be provided to meet permit requirements.

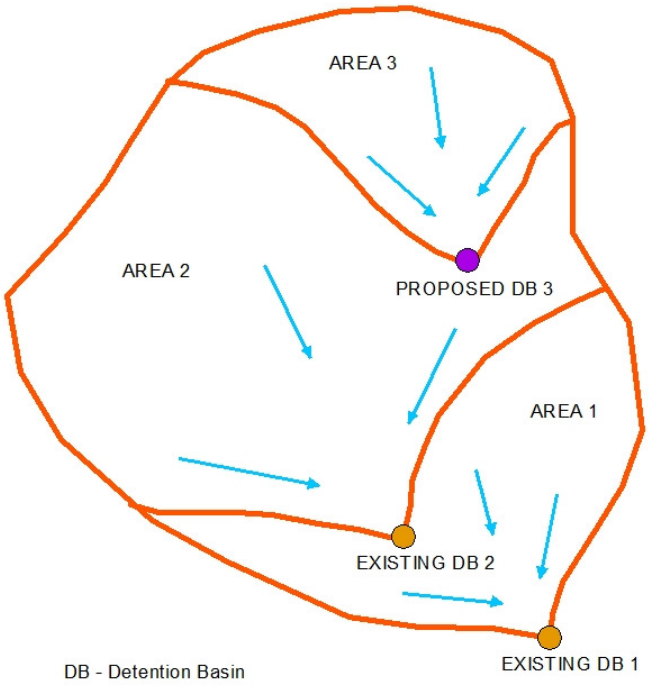
Based on the WQCV calculation method and the approach in TM IV.11, a broad look at the entire Las Vegas Valley was taken to determine a priority and schedule of construction of detention basins, upgrades to existing detention basins (together referred to as Proposed Basins), and retrofits that would be economical and provide RCV in pace with NDSR. It appears feasible that this can be accomplished with 3 pilot upgrade projects currently funded for construction coupled with new construction programmed on the CCRFCD's Ten Year Construction Program.

# 3 Finding the PCV

The MCV for each watershed is calculated in TM IV.11 based on only the developable portion of the tributary area. The detention basins will, however, receive runoff from the developed portion of the watershed as well. The SWMP proposes a pollutant trading approach. The pollutant trading approach allows runoff treated from currently developed areas to be counted as a credit towards the RCV from future developed areas.

The method recommended in TM IV.11 is used to determine the maximized WQCV generated by the fully developed (existing and future; developed and developable) area tributary to a given detention basin. This is referred to herein as the prime WQCV (PCV); it is the volume that could be provided in a given detention basin and above which no additional benefit in meeting permit requirements would be provided. The PCV establishes an upper limit target to be used at the onset of design. The Master Plan Update (MPU) for the Las Vegas Valley adopted on September 11, 2008 is used to determine the tributary area of each detention basin. If, according to the 2008 MPU, little to none of the tributary area is inside the UDB, then the PCV is not calculated. The PCV is not calculated for detention basins proposed after the 2008 MPU but is included in the PCV for the next existing detention basin downstream. The area and the percentage of imperviousness for the tributary area taken from the values calculated for TM IV.11 and are provided in **Attachment B**. These assumptions will be verified annually as development occurs and adjustments will be made as necessary to represent actual development densities.

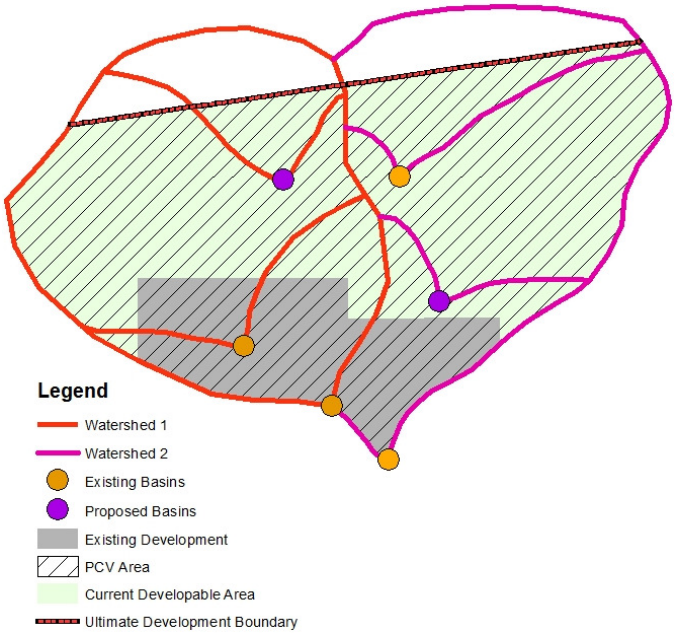
**Figure 2** is an example of how tributary area for WQCV calculations is determined and is described below. For each existing detention basin, the tributary area is the direct tributary area that flows directly into the detention basin, i.e., that does not pass through an upstream detention basin. Any tributary area that first flows through an upstream detention basin is part of the direct tributary area of that upstream detention basin. For proposed detention basins, the tributary area that will flow into the proposed detention basin may currently be part of the direct tributary area of an existing downstream detention basin. When the proposed detention basin is built, the direct tributary area of the new detention basin will need to be deducted from the direct tributary area of the existing detention basin. The total tributary area for each detention basin includes the direct tributary area of that detention basin plus the tributary area of any upstream detention basins.




- Total tributary area for Existing DB 1 is Area 1 plus Area 2 plus Area 3
- The direct tributary area for Existing DB 1 is Area 1 only
- The total tributary area for Existing DB 2 is the same as the direct tributary area which is Area 2 plus Area 3
- Once Proposed DB 3 is built, the direct tributary area for Existing DB 2 will be Area 2 only

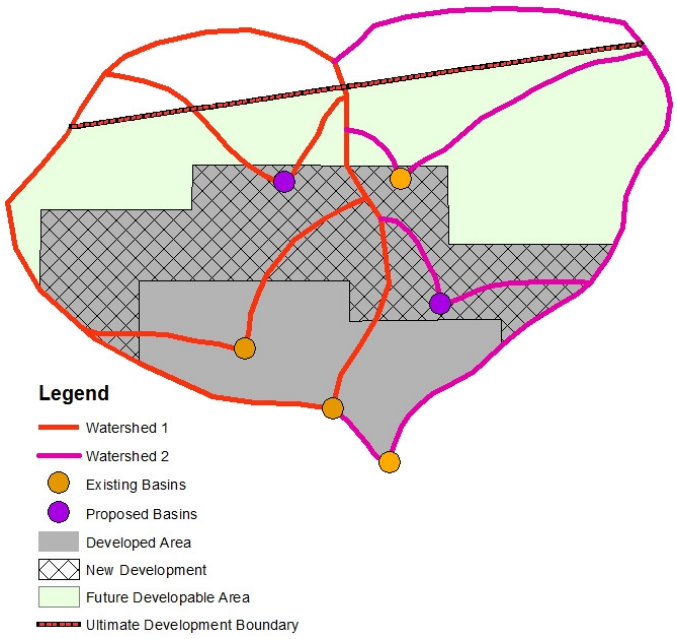
**Figure 2. Approach to Determining Tributary Area for WQCV Calculations**

**Figures 3a** through **3c** help to illustrate how the RCV and the PCV are calculated and the difference between the two values.



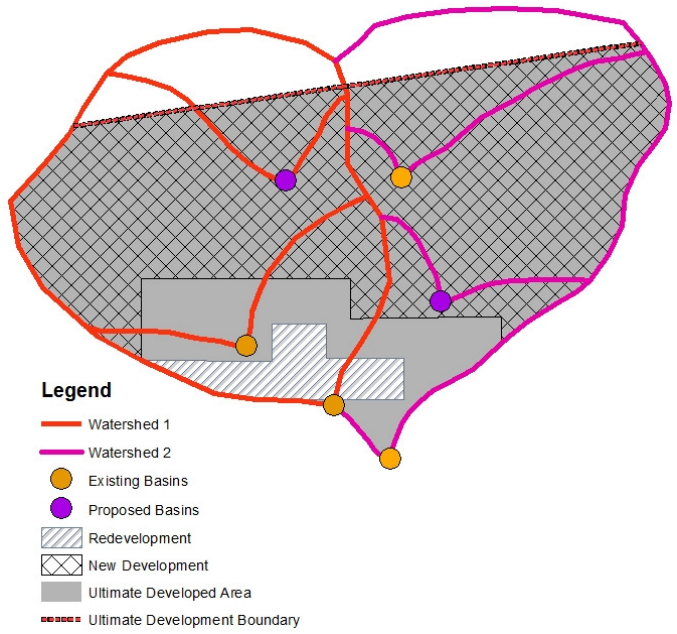

- The MCV is calculated based on the green area (Current Developable Area)
- The PCV is calculated based on the hatched area (PCV Area)
- The non-hatched Area outside the Ultimate Development Boundary has no effect on WQCV

**Figure 3a. Year 0 Development Condition**




- The RCV is calculated based on the Crosshatched Area (New Development)
- New Development represents any development not in place at Year 0

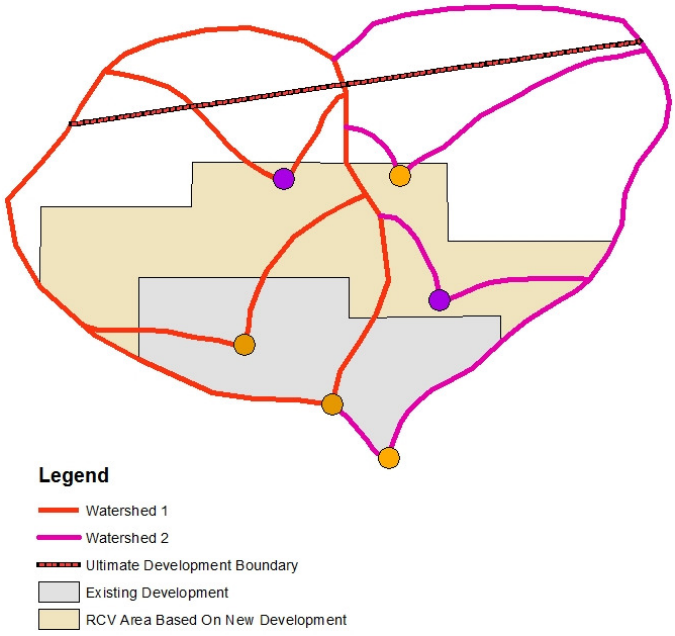
**Figure 3b. Interim Development Condition as Development Occurs**




- When the watersheds are fully developed, all the RCV will need to be in place
- The RCV may need to be adjusted based on the hatched area (Redevelopment)

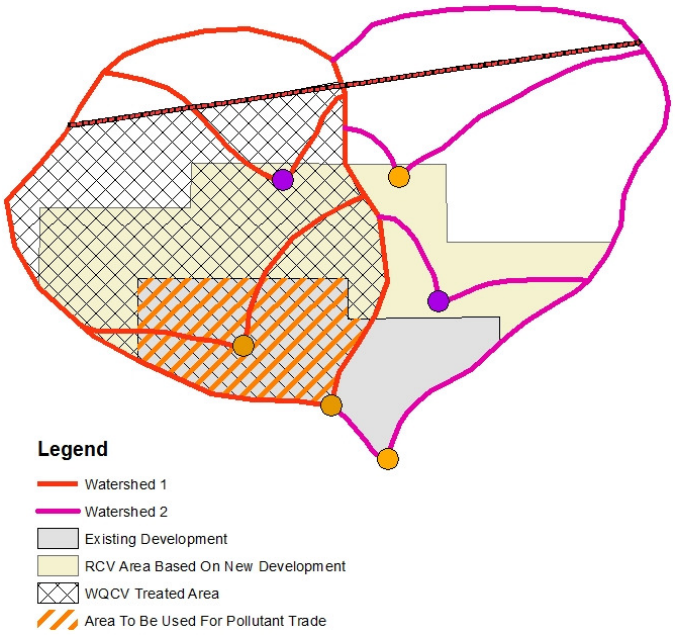
**Figure 3c. Ultimate Development Condition**

While the RCV for any area can be captured in any downstream detention basin for which it is part of the total tributary area, it is planned to be captured and treated once. If the RCV can be met for a watershed using less than the PCV, additional WQCV up to the PCV can be captured and counted toward the RCV in another watershed in a pollutant trading approach. **Figures 4a** and **4b** help to illustrate how the pollutant trade works.




- Interim RCV is based on the tan area (RCV Area Based On New Development)
- Existing Development is any development existing before Year 0

**Figure 4a. RCV Area Before Detention Basin (DB) Upgrade**




- **Figure 4b** assumes that the full PCV can be met in Watershed 1 and no WQCV can be captured in Watershed 2
- The WQCV from the orange hatched area (Area To Be Used For Pollutant Trade) can be used in a pollutant trade approach for the RCV deficit in Watershed 2

**Figure 4b. RCV Area After DB Upgrade**

# 4 Detention Basin Prioritization

Existing detention basins are prioritized in terms of their ability to provide WQCV for the NDSR program. The first step in the prioritization process is to prepare an inventory of existing regional detention basins. A list of attributes is compiled for 51 detention basins included in **Attachment C** based on the information gathered from the CCRFCD's website, which includes:

- CCRFCD 2008 MPU;
- final design memoranda;
- as-built drawings;
- predesign memoranda;
- FloodView Advanced (http://gustfront.ccrfcd.org/fvadvanced/fvadvanced.aspx); and
- aerial photographs.

Each detention basin is then given a normalized score to identify which detention basins would be the best candidates for water quality measures; see **Attachment D**. **Table 3** lists the scoring criteria used to prioritize the detention basins.

**Table 3. Scoring Criteria**

| Advantages | Disadvantages |
|---|---|
| Sediment storage allowance per CCRFCD design criteria: +1 | Low flow bypass: -4 |
| Dedicated sediment storage area with maintenance access (e.g., forebay): +1 | Recreation facilities in main flood pool: -2 |
| Final (most downstream) detention basin: +2 | Over 50% of tributary area outside ultimate development boundary: -1 |
| Developable Area:<br>< 2 $mi^2$ : +0<br>>2 $mi^2$ - 20 $mi^2$ : +1<br>> 20 $mi^2$ - 50 $mi^2$ : +2<br>> 50 $mi^2$ : +3 | Basin upgrade just completed, infeasible or never needed: -2 |
| Over 3ft of free board: +1 | Poor maintenance access: -1 |
| Side slopes flatter than 3:1: +1 | Multiple inlet structure: -1 |
| Wetland vegetation in basin floor: +2 | Multiple outlet structures: -1 |
| Basin upgrade planned for capacity improvements: +3 | Little Room for Expansion -2 |
| Positive bonus points: +2 | Negative bonus points: -2 |
| ***Maximum Score +16*** | ***Maximum Score -16*** |

The positive and the negative points are totaled on a detention basin by detention basin basis; 16 points are added to each detention basin score so that there are no negative scores. The resulting number is then divided by 32 (the range between the highest and the lowest possible scores,) to give each detention basin a normalized score within the range of 0 to 1, as shown in **Attachment D**. The positive and negative bonus points are assigned based on characteristics that may be unique to that detention basin and are not accounted for in the standard scoring system.

CCRFCD has a pilot program to install water quality outlets at three Las Vegas Valley detention basins as part of detention basin expansion projects. These detention basins are Pioneer Detention Basin, Equestrian Detention Basin, and Angel Park Detention Basin. The maximum feasible WQCV is added to each detention basin expansion based on the physical characteristics of the detention facility. In the case of the three pilot projects, the actual design WQCV is used in lieu of the PCV.

The CCRFCD Ten-Year Construction Program Fiscal Year 2013 through Fiscal Year 2022 (2013 CIP) was used to determine which detention basins are scheduled to be upgraded. While looking for detention basins scheduled for upgrades, it was determined that a significant portion of the required WQCV could be incorporated into proposed detention basins at a much lower cost than retrofitting existing detention basins. Proposed detention basins in the 2013 CIP are listed in **Table 4**.

## Table 4. Proposed Detention Basins

| DB Name | ID Mile | Design Storage in DB | Calculated P-WQCV | WQCV Compared to Design Storage | Sum of P-WQCVs | R-WQCV for the Watershed | Remaining WQCV Needed |
|---|---|---|---|---|---|---|---|
| | | Total (AF) | (AF) | % of Design Storage | Total (AF) | Total (AF) | R-WQCV - P-WQCV (AF) |
| Summerlin Village 22 | GOB20001 | 123 | 11.7 | 10% | 50 | 122 | 72 |
| Lone Mountain - Beltway | GOBW0052 | 589 | 38.3 | 7% | | | |
| Northwest | UPWE0436 | 3,385 | 304 | 9% | 304 | 222 | -82 |
| Dunes South | RWEA0165 | 1,112 | 80.2 | 7% | 168.1 | 146 | -22 |
| Dunes North | RWEA0355 | 1,108 | 39.1 | 4% | | | |
| Speedway North | RWHW0500 | 843 | 9.9 | 1% | | | |
| Beltway | RWRR0200 | 226 | 2.8 | 1% | | | |
| Vandenberg North DB | RWWE0407 | 290 | 34.3 | 12% | | | |
| Orchard | SLOR0146 | 142 | 0.8 | 1% | | | |
| Owens | SLWA0153 | 88 | 1 | 1% | | | |
| Tropicana Wash-McCarran Airport Offline | TRMC0033 | 120 | 46.6 | 39% | 46.6 | 168 | 121 |
| Silverado Ranch | BD020277 | 170 | 26.4 | 16% | 101 | 250 | 149 |
| Birdsprings | DCBS0323 | 1,820 | 74.6 | 4% | | | |
| Southeast Pittman | PTBE0064 | 751 | 22.9 | 3% | 261.1 | 255 | -6 |
| Pittman West | PTLA0219 | 2,521 | 100.4 | 4% | | | |
| Pabco North Peaking Basin | PTPA0032 | 49 | 21.3 | 43% | | | |
| Pabco South Peaking Basin | PTPA0163 | 60 | 25 | 42% | | | |
| Southwest Pittman | PTSD0234 | 737 | 43.7 | 6% | | | |
| Pittman North | PTNO0182 | 600 | 42.3 | 7% | | | |
| Pittman Horizon Ridge Debris Basin [a] | PTHR0205 | 66 | 5.5 | 8% | | | |

[a] 2012 Master Plan Amendment updated to change the Pittman Horizon Ridge Debris Basin to a detention basin with approximately 68 AF of capacity.

* Calculated WQCV represents the PCV and the Required WQCV represents the MCV.

If the PCV is incorporated into all of the proposed detention basins, the Upper Northern Las Vegas Wash, Range Wash, and Pittman Wash watersheds could meet their MCV without retrofitting any of the existing detention basins. The additional WQCV could be used for a pollutant trade with watersheds that cannot economically meet their RCV. An example of this kind of trade would be developing the Northwest Detention Basin to its PCV of 304 AF. Only 222 AF are needed for MCV in the Upper Northern Las Vegas Watershed. Forty-four of the 82 excess AF could be used in a pollution trade to meet the RCV for the Lower Las Vegas Wash watershed which has no existing detention basins and no proposed detention basins. If all the proposed detention basins were built with their PCV capabilities totaling 929 AF, they would account for approximately 65 percent of the total MCV for the Las Vegas Valley. The remaining 35 percent would need to be acquired by retrofitting existing detention basins.

A similar approach is taken with the existing detention basins that have proposed capacity increase. **Table 5** lists all the detention basins with proposed upgrades. Since there will be modifications to these detention basins, it may be more economical to incorporate WQCV retrofits during the modifications than it would be to retrofit existing detention basins that would not otherwise be modified. **Table 6** shows the WQCV that can be obtained if planned upgrades are used in conjunction with proposed detention basins.

**Table 5. Existing Detention Basins with Planned Upgrades**

| Watershed | Proposed Detention Basin Upgrades |
|---|---|
| C-1 Channel | Equestrian Detention Basin |
| Central Basin | Cheyenne Peaking Basin |
| | Meadows Detention Basin |
| Flamingo/Tropicana | Lakes Detention Basin |
| Gowan | Cheyenne Peaking Basin |
| | Gowan South Detention Basin |
| | Angel Park Detention Basin |
| | Ann Road Detention Basin |
| Pittman Wash | Pioneer Detention Basin |
| Range Wash | Speedway #2 Retention Basin |
| | Speedway #3 Retention Basin |
| Upper and Lower Northern | Cheyenne Peaking Detention Basin |
| | North Las Vegas Detention Basin |
| | Upper Las Vegas Detention Basin |

**Table 6. Summary of WQCV to be Developed in Each Watershed**

| Watershed | Total MCV (AF) for All Developable Area | PCV Generated in Watershed from Proposed DBs and Planned Upgrades (AF) | Excess WQCV - Available for Trade with other Watersheds (AF) | Deficit WQCV - Needed from other Sources (AF) | Comments |
|---|---|---|---|---|---|
| C-1 Basin | 78 | 17.0 | 0 | 61.0 | |
| Central Basin | 10 | 56.7 | 46.7 | 0 | Could develop more WQCV at Meadows DB |
| Duck Creek Basin | 250 | 148.5 | 0 | 101.5 | |
| Flamingo/Tropicana Basin | 168 | 72.7 | 0 | 95.3 | |
| Gowan | 122 | 336.9 | 214.9 | 0 | Could develop more WQCV |
| Lower Las Vegas Wash | 44 | 0 | 0 | 44.0 | |
| Lower Northern Basin | 144 | 194.0 | 50 | 0 | |
| Pittman Basin | 255 | 276.5 | 22 | 0 | |
| Range Wash | 146 | 192.4 | 46.4 | 0 | Could develop more WQCV |
| Upper Northern Basin | 222 | 434.9 | 212.9 | 0 | Could develop more WQCV at Upper LVW DB |
| **TOTALS** | 1,439 | 1,729.6 | 592.4 | 301.8 | |

In **Table 6**, it is assumed that the PCV can be added to all Proposed Basins. For a more detailed breakdown see **Attachment F**. Using this assumption, **Table 6** shows that the total Las Vegas Valley MCV could be achieved using only the Proposed Basins. If it is not feasible to develop the PCV at all the Proposed Basins, there will most likely be a need to retrofit existing detention basins that are not planned for upgrades. There is a presumed economic advantage in using Proposed Basins over retrofitting existing detention basins. Proposed Basins will be built and treat runoff from new development as it occurs. Because of this, the new detention basins are given the highest priority to include water quality measures. The next priority is given to the detention basins that have scheduled or proposed upgrades; and the lowest priority is given to the existing detention basins that have no proposed upgrades. Within the two groups of existing detention basins, those with proposed upgrades and those without, the priority is set based on the calculated normalized score. Although a pollutant swap between watersheds is allowed, the prioritization is set up on a watershed basis. **Tables 7** through **15** list the priority of detention basins for each watershed.

The PCV given in the tables is used as the target WQCV for each Proposed Basin. The target WQCVs for all these detention basins total 1,730 AF, which is 291 AF or 20 percent above the 1,439 AF needed in the Las Vegas Valley. In the case of the three pilot projects, the design WQCVs and not the PCVs were used as the target WQCVs. If economical, physical, or political restraints on the Proposed Basins do not allow for 1,439 AF of WQCV, then the remaining detention basins in each deficient watershed's table (**Tables 7** through **15**) can be evaluated in descending order. If a deficient watershed does not have sufficient suitable detention basins to implement all the RCV upgrades, the detention basins in the remaining watersheds should be evaluated in order of descending normalized scores on a pollutant trade basis. Progress in NDSR and provision of RCV will be tracked annually and adjustments made as necessary.

**Table 7. Water Quality Prioritization for C-1 Wash Watershed Detention Basins**

| MCV based on the developable area is 78 AF | | | |
|---|---|---|---|
| **Detention Basin (DB)** | **Status** | **Normalized Score** | **PCV (AF)** |
| Equestrian DB[a] | Pilot Water Quality Upgrade | 0.44 | 17 |
| Northeast C-1 DB | Existing | Insufficient Information | 10.4 |
| Mission Hills DB | Existing | Insufficient Information | 19.9 |
| Shaded DBs are included in the strategy to meet the RCV. | | | |

[a] 17 AF is what is being added as part of the pilot program.

**Table 8. Water Quality Prioritization for Central Watershed Detention Basins**

| MCV based on the developable area is 10 AF | | | |
|---|---|---|---|
| **Detention Basin (DB)** | **Status** | **Normalized Score** | **PCV (AF)** |
| Meadows DB | Planned Upgrade | 0.59 | 56.7 |
| Rainbow DB | Existing | 0.56 | 8.7 |
| Oakey DB | Existing | 0.53 | 12.8 |
| Carey Lake Mead DB | Existing | 0.44 | 79.2 |
| Shaded DBs are included in the strategy to meet the RCV. | | | |

**Table 9. Water Quality Prioritization for Duck Creek Watershed Detention Basins**

| MCV based on the developable area is 250 AF | | | |
|---|---|---|---|
| **Detention Basin (DB)** | **Status** | **Normalized Score** | **PCV (AF)** |
| Silverado Ranch DB | Proposed | N/A | 26.4 |
| Birdsprings DB | Proposed | N/A | 74.6 |
| Central Duck Creek DB | Planned Upgrade | 0.47 | 47.5 |
| Bruner DB | Existing | 0.53 | 90.4 |
| McCarran DB | Existing | 0.50 | 18.9 |
| Lower Duck Creek DB | Existing | 0.47 | 114.1 |
| Upper Duck Creek DB | Existing | 0.47 | 172.6 |
| Lower Blue Diamond DB | Existing | 0.34 | 39.0 |
| Duck Creek Railroad DB | Existing | Insufficient Information | 90.4 |
| Shaded DBs are included in the strategy to meet the RCV. | | | |

**Table 10. Water Quality Prioritization for Flamingo/Tropicana Wash Watersheds Detention Basins**

| MCV based on the developable area is 168 AF | | | |
|---|---|---|---|
| **Detention Basin (DB)** | **Status** | **Normalized Score** | **PCV (AF)** |
| Tropicana Wash-McCarran Airport Offline DB | Proposed | N/A | 46.6 |
| Lakes DB | Planned Upgrade | 0.53 | 26.1 |
| Tropicana DB and Outfall | Existing | 0.72 | 116.3 |
| R4 DB | Existing | 0.72 | 0.0 |
| Red Rock DB | Existing | 0.50 | 14.6 |
| Upper Blue Diamond DB | Existing | 0.41 | 60.0 |
| Flamingo DB | Existing | 0.38 | 142.7 |
| Desert Inn DB | Existing | 0.34 | 6.0 |
| Lower Flamingo DB | Existing | Insufficient Information | 78.2 |
| Shaded DBs are included in the strategy to meet the RCV. | | | |

**Table 11. Water Quality Prioritization for Gowan Watershed Detention Basins**

| MCV based on the developable area is 122 AF | | | |
|---|---|---|---|
| **Detention Basin (DB)** | **Status** | **Normalized Score** | **PCV (AF)** |
| Angel Park[a] DB | Pilot Water Quality Upgrade | 0.34 | 85.0 |
| Summerlin Village 22 DB | Proposed | N/A | 11.7 |
| Lone Mountain – Beltway DB | Proposed | N/A | 38.3 |
| Cheyenne Peaking Basin[b] | Planned Upgrade | 0.69 | 83.3 |
| Gowan South DB | Planned Upgrade | 0.66 | 88.9 |
| Ann Road CAM 10 DB | Planned Upgrade | 0.56 | 29.7 |
| Summerlin 5 DB | Existing | 0.53 | 15.9 |
| Lone Mountain DB | Existing | 0.47 | 38.3 |
| Gowan North DB | Existing | 0.44 | 85.8 |
| Village 26 DB | Existing | Insufficient Information | 12.5 |
| Shaded DBs are included in the strategy to meet the RCV. | | | |

[a] 85 AF is what is being added as part of the pilot program.

[b] The Cheyenne Peaking Basin is located in the Lower Northern DB but receives runoff from the Gowan Watershed. It can treat 83.3 AF from the Gowan Watershed.

**Table 12. Water Quality Prioritization for Lower Northern Las Vegas Wash Watershed Detention Basins**

| MCV based on the developable area is 144 AF | | | |
|---|---|---|---|
| **Detention Basin (DB)** | **Status** | **Normalized Score** | **PCV (AF)** |
| North Las Vegas DB | Planned Upgrade | 0.69 | 101.8 |
| Cheyenne Peaking Basin | Planned Upgrade | 0.69 | 92.9 |
| Lower Las Vegas Wash DB [a] | Existing | 0.47 | 21.9 |
| Shaded DBs are included in the strategy to meet the RCV. | | | |

[a] The Lower Las Vegas Wash DB has 21.9 AF of WQCV from the Lower Northern Las Vegas Watershed and another 98.5 AF from the Upper Northern Watershed.

**Table 13. Water Quality Prioritization for Pittman Wash Watershed Detention Basins**

| MCV based on the developable area is 255 AF | | | |
|---|---|---|---|
| **Detention Basin (DB)** | **Status** | **Normalized Score** | **PCV (AF)** |
| Pioneer DB[a] | Pilot Water Quality Upgrade | 0.53 | 12.0 |
| Pittman West DB | Proposed | N/A | 100.4 |
| Southwest Pittman DB | Proposed | N/A | 43.7 |
| Pittman North DB and Outfall | Proposed | N/A | 42.3 |
| Pabco South Peaking Basin | Proposed | N/A | 25.0 |
| Southeast Pittman DB | Proposed | N/A | 22.9 |
| Pabco North Peaking Basin | Proposed | N/A | 21.3 |
| Whitney Wash DB | Proposed | N/A | 8.9 |
| Pittman Horizon Ridge DB | Proposed | N/A | 5.5 |
| Pittman Park DB | Existing | 0.56 | 315.5 |
| Pittman East DB | Existing | 0.53 | 45.4 |
| McCullough Hills Park DB | Existing | 0.47 | 17.6 |
| Cactus DB | Private | Insufficient Information | 16.6 |
| Shaded DBs are included in the strategy to meet the RCV. | | | |

[a] 12 AF is what is being added as part of the pilot program.

**Table 14. Water Quality Prioritization for Range Wash Watershed Detention Basins**

| MCV based on the developable area is 146 AF | | | |
|---|---|---|---|
| **Detention Basin (DB)** | **Status** | **Normalized Score** | **PCV (AF)** |
| Dunes South DB | Proposed | N/A | 80.2 |
| Dunes North DB | Proposed | N/A | 39.1 |
| Vandenberg North DB | Proposed | N/A | 34.3 |
| Speedway North DB | Proposed | N/A | 9.9 |
| Beltway DB | Proposed | N/A | 2.8 |
| Orchard DB | Proposed | N/A | 0.8 |
| Owens DB | Proposed | N/A | 1.0 |
| Speedway #2 Retention Basin | Planned Upgrade | Insufficient Information | 4.5 |
| Speedway #3 Retention Basin | Planned Upgrade | Insufficient Information | 19.8 |
| Range Wash Confluence DB | Existing | 0.52 | 151.6 |
| Vandenberg DB | Existing | 0.26 | 79.3 |
| Speedway #1 DB | Existing | Insufficient Information | 17.4 |
| Shaded DBs are included in the strategy to meet the RCV. | | | |

**Table 15. Water Quality Prioritization for Upper Northern Las Vegas Wash Watershed Detention Basins**

| MCV based on the developable area is 222 AF | | | |
|---|---|---|---|
| **Detention Basin (DB)** | **Status** | **Normalized Score** | **PCV (AF)** |
| Northwest DB | Proposed | N/A | 304.2 |
| Upper Las Vegas Wash DB[b] | Planned Upgrade | 0.66 | 130.7 |
| SEEA DB @ Floyd Lamb Park | Existing | 0.28 | 18.3 |
| NEEA DB @ Floyd Lamb Park | Existing | 0.34 | 4.2 |
| Elkhorn Springs DB | Existing | Insufficient Information | 10.1 |
| Fort Apache DB | Existing | Insufficient Information | 22.8 |
| Rancho Road DB | Existing | Insufficient Information | 51.7 |
| Lower Las Vegas Wash DB [a] | Existing | 0.28 | 98.5 |
| Shaded DBs are included in the strategy to meet the RCV. | | | |

[a] The Lower Las Vegas Wash DB has 21.9 AF of WQCV from the Lower Northern Las Vegas Watershed and another 98.5 AF from the Upper Northern Watershed.

[b] The Upper Las Vegas Wash DB currently has a PCV of 434.9 AF but that will be reduced to 130.7 if the Northwest DB is built.

Special note should be taken of the Cheyenne Peaking Basin. While it is located in the Lower Northern watershed, it also receives flows from the Upper Northern, Gowan, and Central watersheds. The total PCV for the Cheyenne Peaking Basin's direct tributary area is 176.2 AF, (92.9 AF from the Lower Northern watershed and 83.3 AF from the Gowan watershed,) plus another 773.5 AF from the upstream detention basins. Based on evaluation criteria, it received one of the

highest normalized scores. Because of its configuration as a peaking basin, significant changes would need to be made in order for the basin to catch lower flows. Another concern is that there is little to no room for expansion laterally which will likely impede the ability to add significant WQCV to the basin without impacting the 100 year storm capacity. Additional evaluation will be necessary to determine if the Cheyenne Peaking Basin can be redeveloped for water quality upgrades.

# 5 Alternative Approaches

In addition to water quality improvements for regional detention basin, another option for water quality improvement that can be evaluated is the use of in-basin vegetation. Some of the detention basins in the Las Vegas Valley, such as the Lakes Detention Basin have grass covered bottoms. There are some water quality benefits in directing runoff through vegetation. Other areas such as the Springs Preserve (in the Meadows Detention Basin) and the wetland area in the Las Vegas Wash also provide water quality benefits associated with the wetland vegetation that uptakes nutrients, metals, and other constituents. Although these features of current detention basins could have water quality benefits, WQCV is the only metric used to develop this strategic plan for improving detention basin benefits on water quality. These special cases will be evaluated in future permit years to qualify water quality capture volume.

# 6 Implementation Schedule

Because the purpose of the detention basin water quality design program is to address potential impacts from NDSR, an implementation schedule is prepared based on the objective of having enough installed water quality features to treat all cumulative NDSR acreage starting in 2013, which will be the initial year of the program being effective. The detention basin program relies primarily on Water Quality BMPs from proposed and upgraded detention basins, supplemented when needed by existing detention basin Water Quality BMP retrofits. The 2013 CIP has planned construction dates for a few of the Proposed Basins in the MPU. Others will not be implemented until an undetermined number of years after the period of the 2013 CIP (i.e., after 2023). **Table 16** summarizes the current plan for constructing new detention basins and existing detention basin upgrades.

**Table 16. Timing of Construction for Proposed Basins**

| Watershed | Detention Basin | Status | Proposed Construction Year | PCV (AF) |
|---|---|---|---|---|
| C-1 Channel | Equestrian DB | Pilot Water Quality Upgrade | Current | 17 |
| Gowan | Angel Park | Pilot Water Quality Upgrade | Current | 85 |
| Pittman Wash | Pioneer DB | Pilot Water Quality Upgrade | Current | 12 |
| Range Wash | Orchard DB | New | 2013 | 0.8 |
| Range Wash | Vandenberg North DB | New | 2016 | 34.3 |
| Pittman Wash | Pittman North DB and Outfall | New | 2017 | 42.3 |

| Watershed | Detention Basin | Status | Proposed Construction Year | PCV (AF) |
|---|---|---|---|---|
| Range Wash | Beltway DB | New | 2017 | 2.8 |
| Pittman Wash | Pittman Horizon Ridge DB | New | 2013-2018 | 5.5 |
| Range Wash | Speedway North DB | New | 2018 | 9.9 |
| Range Wash | Owens DB | New | 2018 | 1 |
| Duck Creek/Blue Diamond | Silverado Ranch DB | New | 2018-2023 | 26.4 |
| Range Wash | Speedway #2 Retention Basin | Planned Upgrade | 2018-2023 | 4.5 |
| Central Basin | Meadows DB | Planned Upgrade | After 2023 | 56.7 |
| Duck Creek/Blue Diamond | Birdsprings DB | New | After 2023 | 76.4 |
| Duck Creek/Blue Diamond | Central Duck Creek DB | Planned Upgrade | After 2023 | 47.5 |
| Flamingo/Tropicana | Tropicana Wash-McCarran Airport Offline | New | After 2023 | 46.6 |
| Flamingo/Tropicana | Lakes DB | Planned Upgrade | After 2023 | 26.1 |
| Gowan | Summerlin Village 22 DB | New | After 2023 | 11.7 |
| Gowan | Lone Mountain - Beltway DB | New | After 2023 | 38.3 |
| Gowan | Cheyenne Peaking Basin | Planned Upgrade | After 2023 | 83.3 |
| Gowan | Gowan South DB | Planned Upgrade | After 2023 | 88.9 |
| Gowan | Ann Road CAM 10 DB | Planned Upgrade | After 2023 | 29.7 |
| Lower Northern Las Vegas Wash | North Las Vegas DB | Planned Upgrade | After 2023 | 101.8 |
| Lower Northern Las Vegas Wash | Cheyenne Peaking Basin | Planned Upgrade | After 2023 | 92.9 |
| Pittman Wash | Pittman West DB | New | After 2023 | 100.4 |
| Pittman Wash | Southwest Pittman DB | New | After 2023 | 43.7 |
| Pittman Wash | Pabco South Peaking Basin | New | After 2023 | 25 |
| Pittman Wash | Southeast Pittman DB | New | After 2023 | 22.9 |
| Pittman Wash | Pabco North Peaking Basin | New | After 2023 | 21.3 |
| Pittman Wash | Whitney Wash DB | New | After 2023 | 8.9 |
| Range Wash | Dunes South DB | New | After 2023 | 80.2 |
| Range Wash | Dunes North DB | New | After 2023 | 39.1 |
| Range Wash | Speedway #3 Retention Basin | Planned Upgrade | After 2023 | 19.8 |
| Upper Northern Las Vegas Wash | Northwest DB | New | After 2023 | 304.2 |
| Upper Northern Las Vegas Wash | Upper Las Vegas Wash DB | Planned Upgrade | After 2023 | 130.7 |

The plan is developed so that Proposed Basin construction keeps up with NDSR growth. This will be tracked on an annual basis to compare the accumulated RCV to the cumulative WQCV in the Las Vegas Valley. As the accumulated RCV need reaches 85 percent of the cumulative WQCV, this will trigger project review of the WQCV implementation schedule. This is similar to the approach required by Nevada Department of Environmental Protection Agency (NDEP) for wastewater treatment plant expansion found in section 5.2 of the Clark County Area-Wide Water Quality Management Plan (MWH 2008) and which is included in the NDEP discharge permits. **Figure 5** is an example of how this could work with a starting point of November 1, 2013, when the Detention Basin Retrofit strategy is fully implemented. For example, **Figure 5** has the NDSR in year one of the implementation resulting in 20 AF of RCV (sample calculation using 1,500 acres of NDSR per year with 50 percent impervious area.) The graph shows a comparison of the current RCV to 114 AF of WQCV, the total WQCV upgrades in the three detention basin pilot study retrofits. As the RCV reaches 85 percent of the accumulated WQCV, design of the next retrofit or detention basin will be initiated and constructed (as represented by the step increase in 2015).

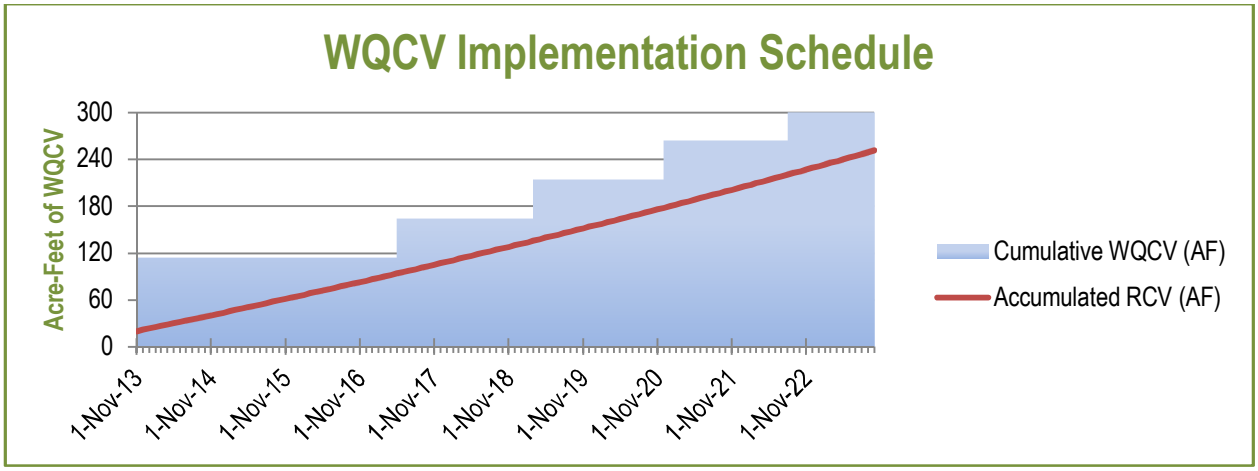



**Figure 5. Example WQCV Implementation Schedule**

The actual rate of growth of the RCV will vary from year to year based on actual NDSR. The actual RCV will be calculated and reported using development area data and locations in the Las Vegas Valley from the NDSR map and database. As new development occurs in currently undeveloped land, adjustment factors may be incorporated into the WQCV calculations for new development drainage areas greater than 1 square mile (640 acres); this will maintain consistency with development of water quality BMPs for detention basins. Some revisions of previous years' totals may be updated in future years; however, this will be fully documented and reported in annual evaluations. This is anticipated to include superimposing multiple years of NDSR on one map, to locate contiguous areas of new development greater than 1 square mile.

The step increase in the cumulative WQCV will be developed based on the size of each project. **Figure 5** is only a representation of one WQCV Implementation Schedule. The increase in the cumulative WQCV will have to be evaluated on an annual basis to compare it to the currently implemented water quality BMPs. If additional WQCV is needed, the permittees will then determine which projects to start based on the CIP, the location of the NDSR, and the prioritization of projects listed in **Tables 7** through **15**.

This type of flexible implementation schedule will allow the permittees to keep the cumulative WQCV capacity ahead of the accumulated RCV without a rigid time based schedule. A rigid time based schedule could result in falling behind the NDSR if growth exceeds expectation or it could result in the implementation of costly retrofits that are not needed if the growth rate is lower than expected.

# 7 Water Quality Improvement Funding

Financing for detention basin improvements for water quality BMPs includes funding for construction and operation and maintenance (O&M).

Construction of new detention basins in the CCRFCD 10-Year CIP will be funded by CCRFCD as part of its construction program. Construction of the three water quality BMP detention basin pilot projects is being funded by CCRFCD as part of the detention basin expansion projects. Installation of water quality outlet retrofits in existing detention basins will be funded by CCRFCD from the Construction Program. Entities will have to consider the need for water quality BMP retrofits at existing detention basins and expanded detention basins in their priorities for regional flood control funding.

O&M of water quality BMPs will be funded by CCRFCD under the regional flood control facility maintenance program.

# 8 Detention Basin Program Administration

## 8.1 Measurement of NDSR Area

The area of new urban development will be determined annually from geographic information system (GIS) information for new building permits available from Clark County. Maps of new development for areas greater than 1.0 acre will be prepared and acreages of new development will be computed based on the County GIS data. This information will be submitted as part of the MS4 Annual Report. The total accumulated NDSR area since the inception of the detention basin program (2013) will also be computed and reported annually for use in assessing the amount of RCV needed in Las Vegas Valley.

## 8.2 Measurement of Effectiveness

Effectiveness of the detention basin BMPs will be measured by tracking the amount of sediment and debris removed from the WQCV area. The Permittees do not propose to perform water quality monitoring to assess detention basin effectiveness. Previous studies reported by the Permittees have shown the difficulty of accurately determining water chemistry changes in regional detention basin inflows and outflows in the Las Vegas Valley. The weight or volume of sediment and debris removed from each water quality detention basin will be tracked as an indication of pollutants that were prevented from entering the downstream conveyance system and receiving waters.

## 8.3 Reporting

The NDSR section of future MS4 Annual Reports will include a sub-section on the regional detention basin design and retrofit program for water quality. Annual Reports will include data for areas of new urban development; accumulated new developed area since 2013; total required and total constructed WQCV; and amount (weight or volume) of material removed from regional detention basins with water quality features.

Any required modifications to the regional detention basin program will be noted in Annual Reports and incorporated into revisions of the Las Vegas Valley Storm Water Management Plan.

# 9 Conclusion

A key component of the NDSR program is incorporation of WQCV into regional detention basins. The WQCV needed to mitigate impacts of NDSR in each major watershed in Las Vegas Valley was computed. A strategy was prepared to create the target WQCV in each major watershed based on the following priorities:

1. Pilot water quality improvements in existing detention basins being upgraded
2. New detention basins scheduled for construction in the future
3. Detention basins scheduled for expansion or modification
4. Retrofits to existing detention basins solely for water quality purposes

For certain major watersheds it is not feasible or efficient to create the target WQCV using existing or proposed detention basins in that watershed. Excess WQCV can be created in other watersheds and a pollutant trading approach can be used to provide sufficient WQCV for NDSR in all of Las Vegas Valley.

The schedule for implementing WQCV projects will be determined on an annual basis to assure that the total volume of installed WQCV is equal to or more than the WQCV needed to treat the cumulative NDSR acreage developed starting in 2013.

Construction and maintenance of water quality outlets in regional detention basins will be funded by CCRFCD.

Accumulated NDSR will be measured annually based on County GIS maps. It will be used to calculate and compare the RCV to the cumulative WQCV. The effectiveness of the WQCV strategy will be evaluated based on the amount of sediment removed from the WQCV areas. The accumulated NDSR (RCV), the cumulative WQCV, and the amount of sediment removed from the WQCV areas will be included in the MS4 Annual Reports.

# 10 References

MWH 2008. Clark County Area-Wide Water Quality Management Pan, Preliminary Draft. Prepared for Clark County Nevada.

MWH 2011. Technical Memorandum IV.11, Potential Water Quality Retrofits of Regional Detention Basins – Strategic Plan. Prepared for Stormwater Quality Management Committee.

PBS&J. *2002 Las Vegas Valley Flood Control Master Plan Update.* Volume 1. September 2009.

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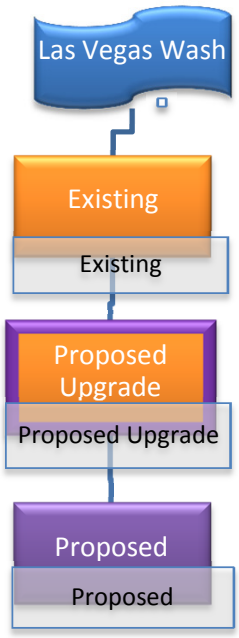
Regional Flood Control Distict. *FloodView Advanced.*

Online: http://gustfront.ccrfcd.org/fvadvanced/fvadvanced.aspx

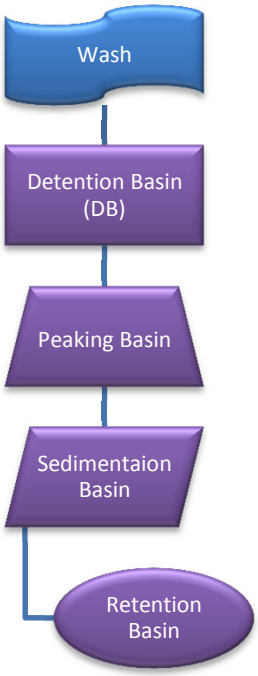
# Attachments

# Attachment A –
# Detention Basin Tree Diagrams

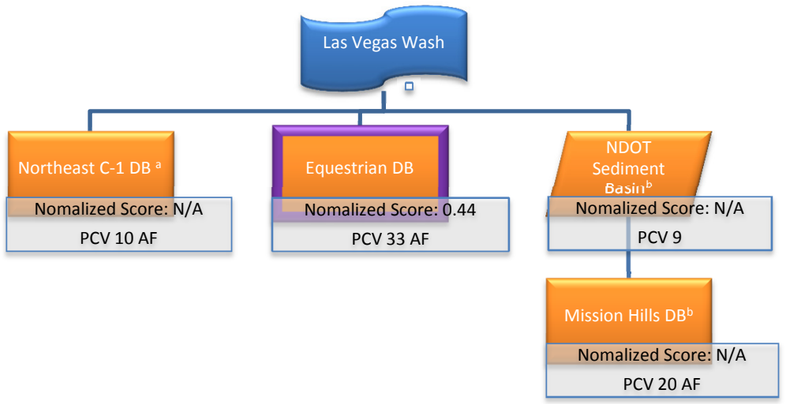
**Color Legend**




**Shape Legend**



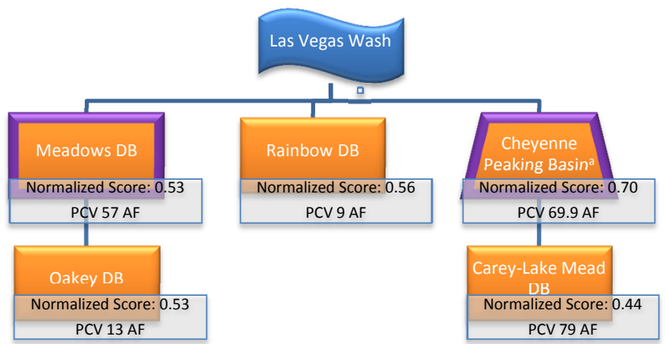
## C-1




[a] Insufficient information for scoring

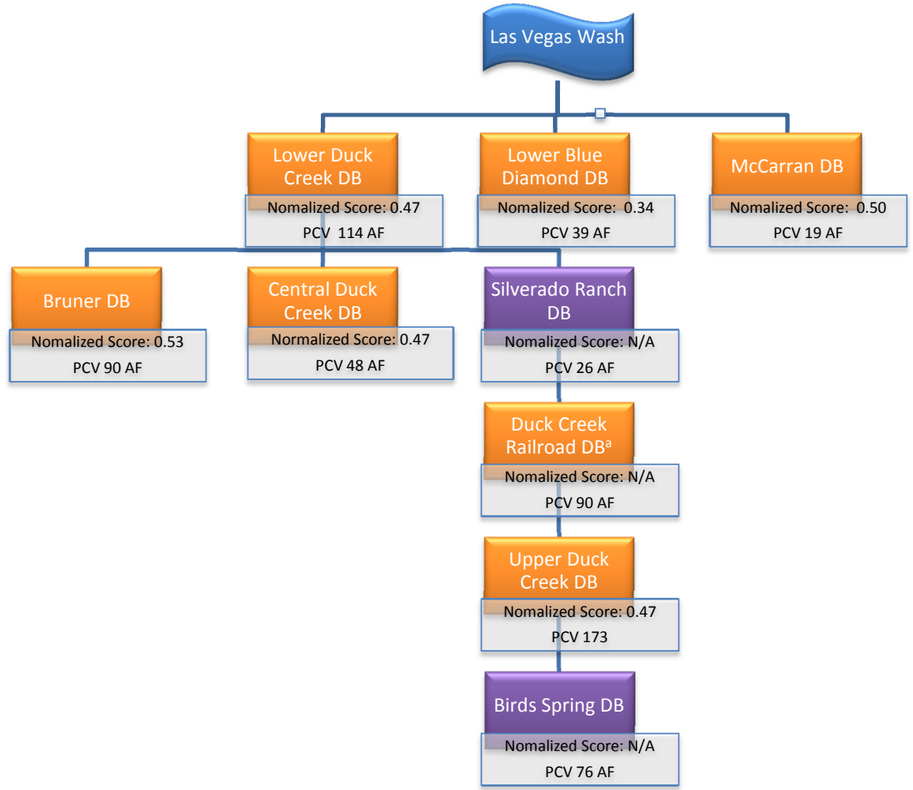
[b] Sediment Basins were not given a Normalized Score

## Central



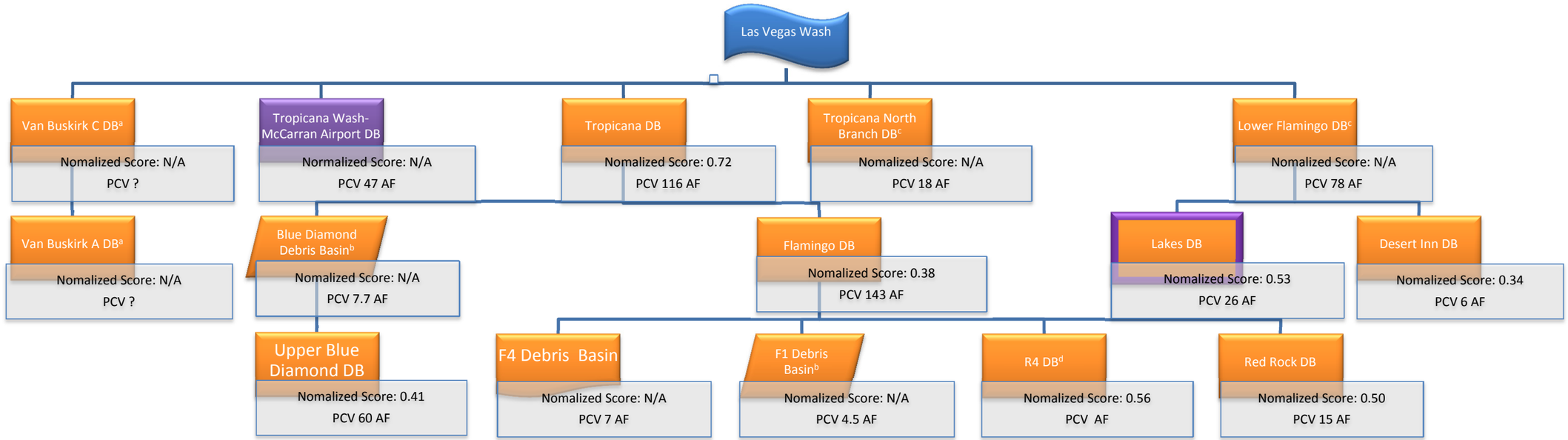

[a] Cheyenne Peaking Basin in in the Lower Northern watershed but receives additional flows from the Central, Gowan and Upper Northern Watersheds

## Duck Creek Wash




[a] Insufficient information for scoring

# Flamingo / Tropicana



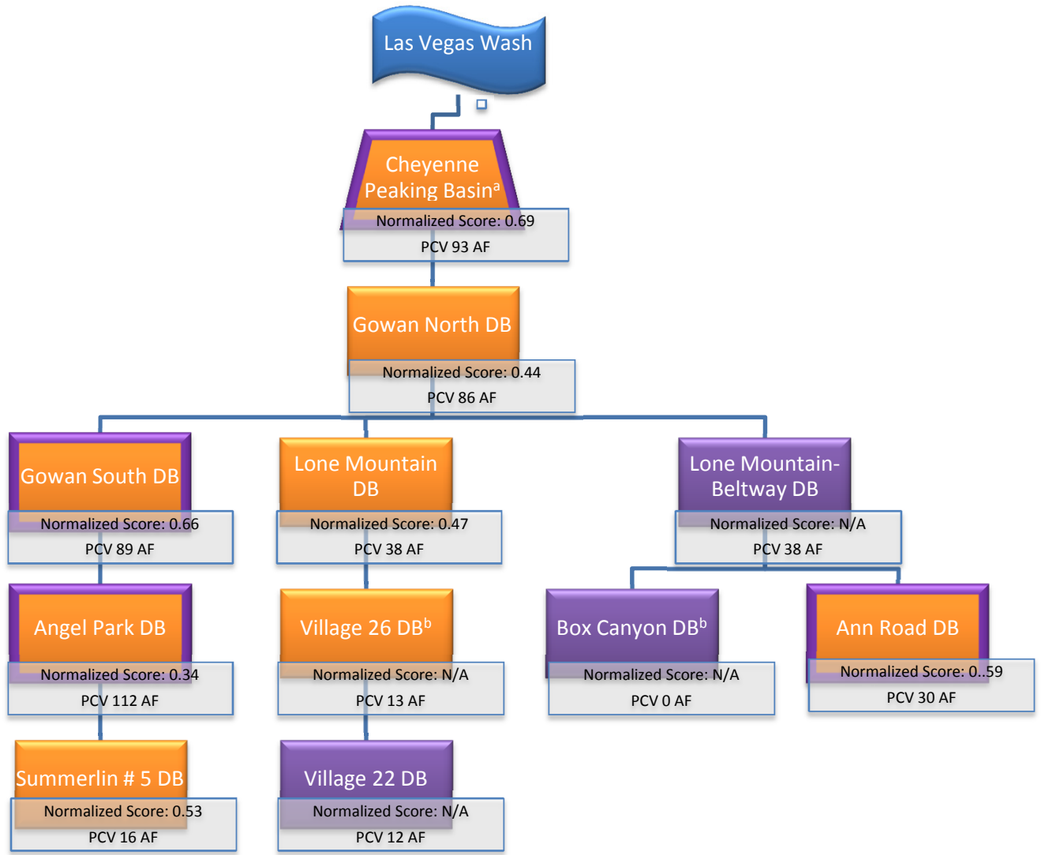

[a] Not included in 2008 MPU

[b] Debris Basins were not given a Normalized Score

[c] Insufficient information for scoring

[d] Tributary Area is outside the Ultimate Development Boundary

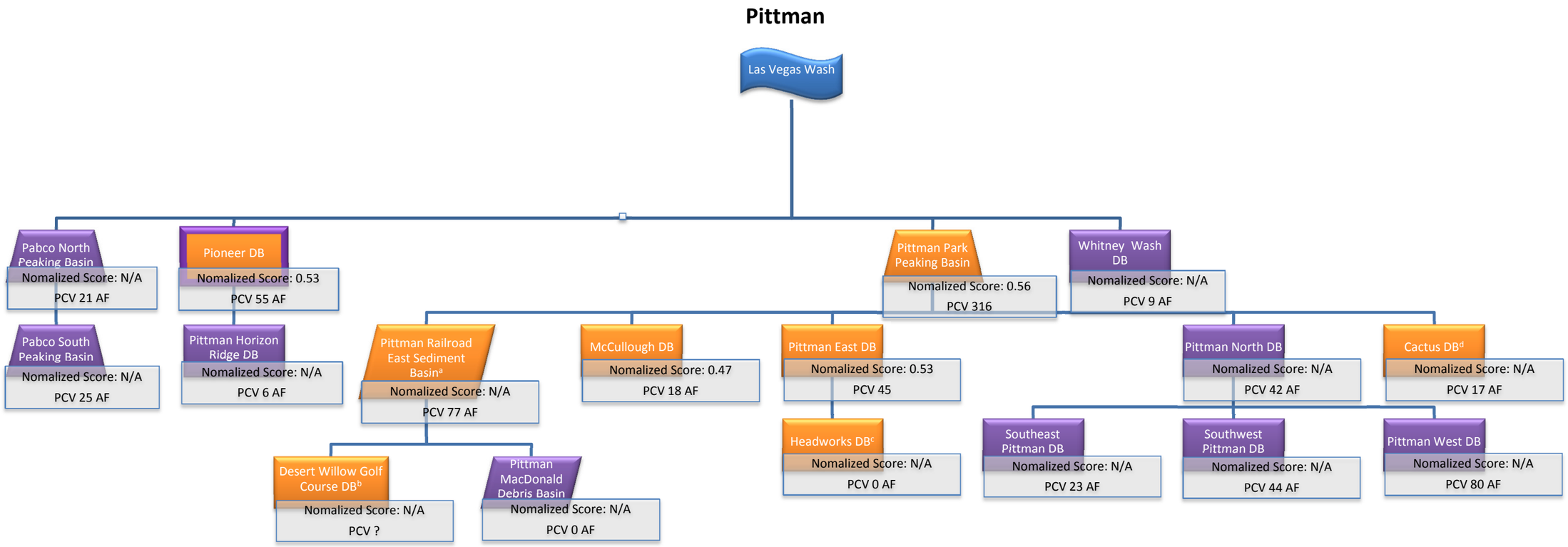
## Gowan Basin




[a] Cheyenne Peaking Basin in in the Lower Northern

[b] Tributary Area is outside the Ultimate Development Boundary

# Pittman



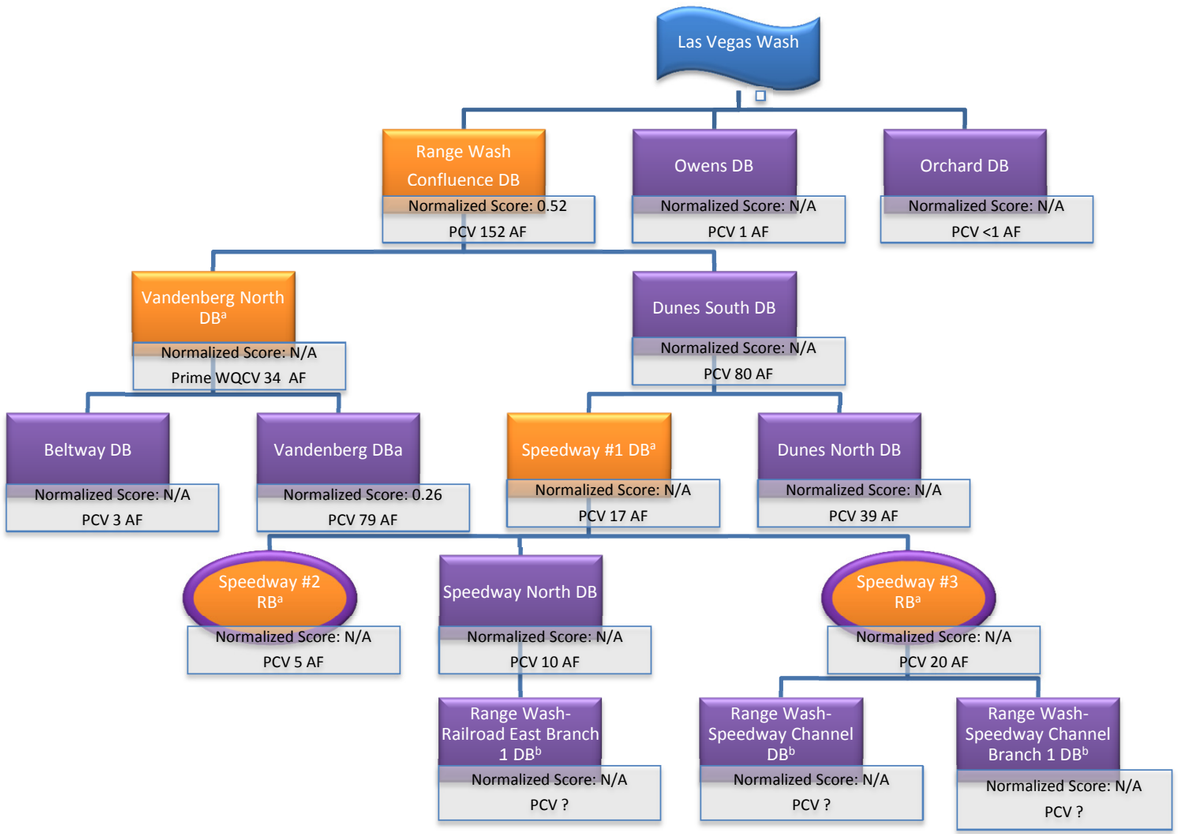

[a] Sediment Basins were not reviewed

[b] Not included in 2008 MPU

[c] Tributary Area is outside the Ultimate Development Boundary

[d] Insufficient information for scoring

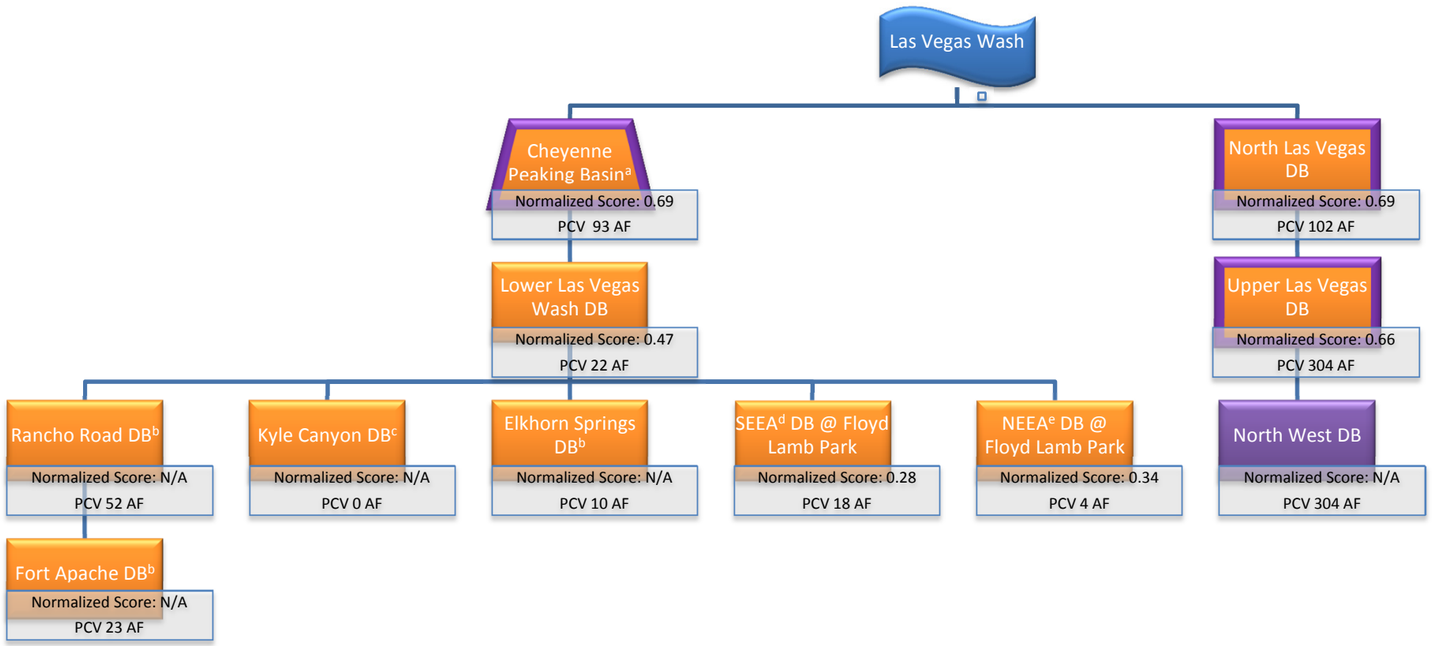
# Range Wash




[a] Insufficient information for scoring

[b] Not included in 2008 MPU

## Upper & Lower Northern




[a] Cheyenne Peaking Basin in in the Lower Northern watershed but receives additional flows from the Central, Gowan and Upper Northern Watersheds

[b] Insufficient information for scoring

[c] Tributary Area is outside the Ultimate Development Boundary

[d] Southern Environmental Enhancement Area

[e] Northern Environmental Enhancement Area

# Attachment B –
# Sub-Basin Calculations

# C-1

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| Northeast C-1 DB | East C-1 DB | | | | | | | | | | | | |
| | | | C1-66B | | 27.4% | | 59.5 | 16.287 | | | | | |
| | | | C1-65B | | 11.3% | | 61.7 | 6.950 | | | | | |
| | | | C1-55 | 967 | 61.4% | 1.51 | 37.4 | 22.945 | 46.18 | 0.85 | 0.3 | 0.2 | 10.4 |
| Equestrian DB | | | | | | | | | | | | | |
| | | | C1-47 | | 13.1% | | 54.2 | 7.105 | | | | | |
| | | | C1-46 | | 8.3% | | 71.2 | 5.901 | | | | | |
| | | | C1-44 | | 8.4% | | 34.1 | 2.877 | | | | | |
| | | | C1-34 | | 8.4% | | 72.5 | 6.067 | | | | | |
| | | | C1-47A | | 3.5% | | 59.2 | 2.042 | | | | | |
| | | | C1-33 | | 6.7% | | 69.5 | 4.639 | | | | | |
| | | | C1-32 | | 7.7% | | 35.0 | 2.700 | | | | | |
| | | | C1-31 | | 7.8% | | 35.6 | 2.772 | | | | | |
| | | | C1-41 | | 4.4% | | 53.5 | 2.354 | | | | | |
| | | | C1-40 | | 5.7% | | 52.6 | 3.001 | | | | | |
| | | | C1-30 | | 8.0% | | 70.2 | 5.626 | | | | | |
| | | | C1-38B | | 7.0% | | 61.9 | 4.350 | | | | | |
| | | | C1-37 | | 5.3% | | 62.0 | 3.308 | | | | | |
| | | | C1-36 | 2560 | 5.7% | 4.00 | 62.0 | 3.537 | 56.28 | 0.85 | 0.4 | 0.2 | 33.2 |
| NDOT Sediment Basin | | | | | | | | | | | | | |
| | Mission Hills DB | | C1-11 | | 22.5% | | 62.7 | 14.079 | | | | | |
| | | | C1-10 | | 40.0% | | 58.3 | 23.294 | | | | | |
| | | | C1-12 | 649 | 37.6% | 1.01 | 61.5 | 23.131 | 60.50 | 0.85 | 0.412796072 | 0.2 | 9.1 |
| Mission Hills DB | | | | | | | | | | | | | |
| | | | C1-2 | | 12.6% | | 29.1 | 3.681 | | | | | |
| | | | C1-3 | | 7.7% | | 30.9 | 2.363 | | | | | |
| | | | C1-4 | | 16.8% | | 25.4 | 4.258 | | | | | |
| | | | C1-5 | | 3.6% | | 40.5 | 1.451 | | | | | |
| | | | C1-6B | | 12.9% | | 32.1 | 4.125 | | | | | |
| | | | C1-7B | | 17.2% | | 25.6 | 4.387 | | | | | |
| | | | C1-8B | | 8.7% | | 65.4 | 5.708 | | | | | |
| | | | C1-9B | 2278 | 20.6% | 3.56 | 48.0 | 9.890 | 35.86 | 0.85 | 0.256831138 | 0.1 | 19.9 |

# Central

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious * \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.\ Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| Rainbow DB | | | | | | | | | | | | | |
| | | | AL00A-C | | 32.7% | | 73.8 | 24.142 | | | | | |
| | | | AL00A | 451 | 67.3% | 0.70 | 66.1 | 44.521 | 68.66 | 1.00 | 0.5 | 0.2 | 8.7 |
| Carey-Lake Mead DB | | | | | | | | | | | | | |
| | | | CY06B-C | | 6.1% | | 49.7 | 3.015 | | | | | |
| | | | CY04A-C | | 5.6% | | 54.2 | 3.017 | | | | | |
| | | | PD01-C | | 4.6% | | 72.0 | 3.305 | | | | | |
| | | | SR00A-C | | 4.5% | | 76.6 | 3.422 | | | | | |
| | | | LMO1-C | | 4.7% | | 64.4 | 3.006 | | | | | |
| | | | SR02E-C | | 3.7% | | 65.6 | 2.418 | | | | | |
| | | | PD05A-C | | 1.6% | | 78.6 | 1.296 | | | | | |
| | | | PD04B-C | | 5.7% | | 51.4 | 2.933 | | | | | |
| | | | SR05D-C | | 3.7% | | 58.9 | 2.173 | | | | | |
| | | | LM06B-C | | 4.3% | | 59.6 | 2.576 | | | | | |
| | | | A1-C1 | | 3.8% | | 64.5 | 2.446 | | | | | |
| | | | SR05B-C | | 4.4% | | 61.8 | 2.690 | | | | | |
| | | | FN2-C | | 2.6% | | 72.0 | 1.856 | | | | | |
| | | | B1-C | | 3.3% | | 77.0 | 2.568 | | | | | |
| | | | FN5-C | | 5.8% | | 64.0 | 3.722 | | | | | |
| | | | B3-2 | | 3.7% | | 70.0 | 2.611 | | | | | |
| | | | B3-1 | | 3.7% | | 69.9 | 2.609 | | | | | |
| | | | LM10-C | | 5.0% | | 49.4 | 2.462 | | | | | |
| | | | R-C | | 3.2% | | 68.6 | 2.222 | | | | | |
| | | | R2-CA | | 5.4% | | 70.1 | 3.817 | | | | | |
| | | | OG05-C | | 3.2% | | 76.5 | 2.480 | | | | | |
| | | | OG04-C | | 3.5% | | 70.1 | 2.461 | | | | | |
| | | | OG03-C | | 4.0% | | 62.3 | 2.465 | | | | | |
| | | | OG02-C | 5253 | 3.9% | 8.21 | 68.3 | 2.646 | 64.22 | 0.85 | 0.4 | 0.2 | 79.2 |
| Meadows DB | Oakey DB | | | | | | | | | | | | |
| | | | MEDB | | 4.2% | | 53.8 | 2.268 | | | | | |
| | | | AL05-C | | 4.3% | | 64.5 | 2.771 | | | | | |
| | | | AL01-A | | 2.3% | | 64.7 | 1.460 | | | | | |
| | | | AL04-C | | 3.3% | | 63.6 | 2.095 | | | | | |
| | | | CH09-C | | 6.9% | | 68.5 | 4.758 | | | | | |
| | | | OK03-C | | 6.7% | | 70.1 | 4.680 | | | | | |
| | | | OK06-C | | 3.2% | | 67.8 | 2.173 | | | | | |
| | | | SA01-C | | 4.8% | | 82.8 | 4.012 | | | | | |
| | | | US | | 0.5% | | 64.5 | 0.353 | | | | | |
| | | | AL14 | | 8.4% | | 77.5 | 6.516 | | | | | |
| | | | BR3 | | 1.4% | | 69.0 | 0.943 | | | | | |
| | | | AL09-3 | | 1.8% | | 63.5 | 1.137 | | | | | |
| | | | CH10 | | 5.1% | | 76.6 | 3.930 | | | | | |
| | | | OK08 | | 1.5% | | 67.0 | 1.019 | | | | | |
| | | | OK04-C | | 3.6% | | 49.5 | 1.801 | | | | | |
| | | | OK07 | | 4.4% | | 46.1 | 2.043 | | | | | |
| | | | SA05 | | 3.2% | | 73.8 | 2.390 | | | | | |
| | | | SA06 | | 1.5% | | 76.7 | 1.113 | | | | | |
| | | | AL16 | | 2.7% | | 72.5 | 1.974 | | | | | |
| | | | AL10-C | | 0.9% | | 69.4 | 0.611 | | | | | |
| | | | AL09 | | 1.8% | | 63.5 | 1.137 | | | | | |

# Central

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.\ Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | | CH14-A | | 2.7% | | 58.2 | 1.583 | | | | | |
| | | | OK12 | | 0.9% | | 88.0 | 0.803 | | | | | |
| | | | OK13 | | 1.8% | | 73.2 | 1.327 | | | | | |
| | | | CH14-B | | 4.0% | | 64.2 | 2.555 | | | | | |
| | | | AL13-3 | | 1.1% | | 64.4 | 0.696 | | | | | |
| | | | AL90-C | | 3.1% | | 71.3 | 2.242 | | | | | |
| | | | R3 | | 5.1% | | 68.1 | 3.446 | | | | | |
| | | | R1 | | 1.6% | | 64.9 | 1.028 | | | | | |
| | | | R2 | | 0.8% | | 65.6 | 0.548 | | | | | |
| | | | CH04-C | | 3.2% | | 74.9 | 2.407 | | | | | |
| | | | CH05-C | 3482 | 3.0% | 5.44 | 82.3 | 2.469 | 68.28 | 0.85 | 0.5 | 0.2 | 56.7 |
| Oakey DB | | | | | | | | | | | | | |
| | | | 1-GOLF | | 19.3% | | 43.5 | 8.375 | | | | | |
| | | | 2A-OAK-C | | 16.7% | | 42.5 | 7.105 | | | | | |
| | | | 3A-OAK-C | | 23.0% | | 32.1 | 7.373 | | | | | |
| | | | 3-ELP-C | | 11.1% | | 56.7 | 6.290 | | | | | |
| | | | 3-HOLM-C | | 17.6% | | 60.0 | 10.549 | | | | | |
| | | | 5-OAK-C | 1204 | 12.4% | 1.88 | 48.0 | 5.929 | 45.62 | 0.85 | 0.3 | 0.2 | 12.8 |
| Cheyenne Peaking Basin * | | | | | | | | | | | | | |
| | | | W1C2 | | 6.5% | | 73.3 | 4.747 | | | | | |
| | | | VG24-C | | 8.7% | | 71.5 | 6.202 | | | | | |
| | | | VG10-C | | 7.0% | | 70.3 | 4.918 | | | | | |
| | | | WA20-C | | 9.5% | | 74.0 | 7.029 | | | | | |
| | | | S1-C | | 8.5% | | 64.4 | 5.460 | | | | | |
| | | | S | | 10.3% | | 76.6 | 7.860 | | | | | |
| | | | R2-C | | 6.9% | | 82.5 | 5.650 | | | | | |
| | | | LM19 | | 4.6% | | 64.0 | 2.953 | | | | | |
| | | | LM20-C | | 6.9% | | 64.4 | 4.447 | | | | | |
| | | | LM14-C | | 6.2% | | 64.3 | 3.966 | | | | | |
| | | | LM16A-C | | 6.8% | | 70.9 | 4.840 | | | | | |
| | | | LM16B-C | | 6.8% | | 68.5 | 4.664 | | | | | |
| | | | VG07 | | 4.7% | | 48.8 | 2.295 | | | | | |
| | | | WA15A-C | 3551 | 6.7% | 5.55 | 58.1 | 3.912 | 68.94 | 0.85 | 0.5 | 0.2 | 58.5 |

* The Cheyenne Peaking Basin is in the Lower Northern watershed but receives additional flows from the Central, Gowan, and Upper Northern watersheds.

# Duck Creek/Blue Diamond

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| McCarran DB | | | DMC010 | | 26.6% | | 70.0 | 18.607 | | | | | |
| | | | DMC020 | | 29.3% | | 72.2 | 21.154 | | | | | |
| | | | DMC030 | | 28.9% | | 68.8 | 19.870 | | | | | |
| | | | DMC050 | 1140 | 15.2% | 1.78 | 63.5 | 9.689 | 69.32 | 0.85 | 0.5 | 0.2 | 18.9 |
| Lower Duck Creek DB | Central Duck Creek DB<br>Bruner DB<br>Duck Creek Railroad DB<br>Bruner DB | | | | | | | | | | | | |
| | | | DLD490 | | 2.6% | | 44.5 | 1.136 | | | | | |
| | | | DLD470 | | 2.4% | | 53.3 | 1.291 | | | | | |
| | | | DLD480 | | 3.2% | | 60.3 | 1.918 | | | | | |
| | | | DLD500 | | 1.8% | | 42.7 | 0.778 | | | | | |
| | | | DLD440 | | 2.5% | | 86.6 | 2.196 | | | | | |
| | | | DLD460 | | 1.6% | | 84.9 | 1.343 | | | | | |
| | | | DLD520 | | 1.7% | | 73.9 | 1.240 | | | | | |
| | | | DLD560 | | 1.8% | | 30.8 | 0.564 | | | | | |
| | | | DLD200 | | 1.8% | | 46.0 | 0.811 | | | | | |
| | | | DLD210 | | 5.1% | | 60.7 | 3.098 | | | | | |
| | | | DLD220 | | 1.3% | | 66.6 | 0.839 | | | | | |
| | | | DMD380E | | 1.5% | | 55.7 | 0.813 | | | | | |
| | | | DMD350 | | 2.3% | | 54.0 | 1.229 | | | | | |
| | | | DLD420 | | 1.8% | | 83.8 | 1.542 | | | | | |
| | | | DLD380 | | 1.1% | | 43.6 | 0.478 | | | | | |
| | | | DLD375 | | 2.5% | | 88.6 | 2.174 | | | | | |
| | | | DLD410 | | 2.0% | | 28.4 | 0.567 | | | | | |
| | | | DLD550 | | 3.1% | | 37.5 | 1.171 | | | | | |
| | | | DLD370 | | 2.6% | | 66.7 | 1.704 | | | | | |
| | | | DLD320 | | 1.7% | | 44.3 | 0.741 | | | | | |
| | | | DLD325 | | 1.9% | | 61.3 | 1.159 | | | | | |
| | | | DLD230 | | 3.5% | | 64.1 | 2.216 | | | | | |
| | | | DLD360 | | 3.1% | | 88.5 | 2.760 | | | | | |
| | | | DLD540 | | 3.3% | | 23.4 | 0.781 | | | | | |
| | | | DLD310 | | 1.4% | | 43.1 | 0.596 | | | | | |
| | | | DLD290 | | 4.4% | | 20.8 | 0.918 | | | | | |
| | | | DLD285 | | 1.7% | | 30.4 | 0.504 | | | | | |
| | | | DLD280 | | 1.8% | | 44.8 | 0.784 | | | | | |
| | | | DLD335 | | 2.5% | | 44.3 | 1.089 | | | | | |
| | | | DLD330 | | 2.0% | | 75.0 | 1.521 | | | | | |
| | | | DLD350 | | 2.4% | | 88.5 | 2.111 | | | | | |
| | | | DLD340 | | 2.2% | | 87.2 | 1.893 | | | | | |
| | | | DLD390 | | 2.6% | | 74.4 | 1.943 | | | | | |
| | | | DLD385 | | 1.2% | | 77.7 | 0.940 | | | | | |
| | | | DLD530 | | 2.3% | | 71.0 | 1.631 | | | | | |
| | | Silverado Ranch DB | DLD430 | | 3.4% | | 66.9 | 2.250 | | | | | |
| | | Silverado Ranch DB | DMD360 | | 1.4% | | 58.7 | 0.835 | | | | | |
| | | Silverado Ranch DB | DMD370 | | 2.8% | | 62.5 | 1.738 | | | | | |

# Duck Creek/Blue Diamond

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | Silverado Ranch DB | DMD320 | | 3.0% | | 58.6 | 1.757 | | | | | |
| | | Silverado Ranch DB | DMD340 | | 4.0% | | 63.2 | 2.518 | | | | | |
| | | Silverado Ranch DB | DMD380W | | 1.5% | | 56.2 | 0.820 | | | | | |
| | | Silverado Ranch DB | DMD330 | 9577 | 3.6% | 14.96 | 54.3 | 1.967 | 58.36 | 0.75 | 0.4 | 0.2 | 114.1 |
| Duck Creek Railroad DB | | | | | | | | | | | | | |
| | | | DWD100 | | 2.7% | | 61.3 | 1.624 | | | | | |
| | | | DWD110 | | 2.5% | | 62.0 | 1.534 | | | | | |
| | | | DWD120 | | 3.9% | | 61.9 | 2.435 | | | | | |
| | | | DWD130 | | 4.1% | | 56.9 | 2.332 | | | | | |
| | | | DWD140 | | 2.9% | | 20.1 | 0.591 | | | | | |
| | | | DWD150 | | 4.5% | | 44.7 | 2.018 | | | | | |
| | | | DWD160 | | 3.3% | | 62.4 | 2.039 | | | | | |
| | | | BUB030 | | 2.7% | | 62.6 | 1.664 | | | | | |
| | | | BUB040 | | 3.3% | | 68.6 | 2.280 | | | | | |
| | | | BUB080 | | 3.3% | | 50.0 | 1.657 | | | | | |
| | | | DWD170 | | 2.6% | | 70.8 | 1.826 | | | | | |
| | | | DWD180 | | 2.2% | | 48.5 | 1.060 | | | | | |
| | | | DWD190 | | 1.7% | | 30.1 | 0.507 | | | | | |
| | | | DMD100 | | 1.9% | | 54.3 | 1.052 | | | | | |
| | | | DMD110 | | 2.0% | | 60.1 | 1.182 | | | | | |
| | | | DMD120 | | 2.5% | | 57.1 | 1.414 | | | | | |
| | | | DMD130 | | 3.3% | | 27.2 | 0.909 | | | | | |
| | | | DMD150 | | 3.9% | | 60.2 | 2.353 | | | | | |
| | | | DMD160 | | 1.9% | | 61.8 | 1.205 | | | | | |
| | | | DMD170 | | 3.7% | | 7.9 | 0.290 | | | | | |
| | | | DMD180 | | 1.6% | | 61.5 | 0.970 | | | | | |
| | | | DMD200 | | 2.7% | | 62.0 | 1.699 | | | | | |
| | | | DMD210 | | 2.9% | | 62.0 | 1.806 | | | | | |
| | | | DMD220 | | 2.9% | | 62.0 | 1.811 | | | | | |
| | | | DMD250 | | 2.9% | | 62.0 | 1.797 | | | | | |
| | | | DMD260 | | 3.9% | | 62.0 | 2.414 | | | | | |
| | | | DMD270 | | 2.8% | | 62.0 | 1.717 | | | | | |
| | | | DMD280 | | 1.5% | | 62.0 | 0.903 | | | | | |
| | | | DMD290 | | 2.0% | | 62.0 | 1.221 | | | | | |
| | | | DMD295 | | 2.8% | | 62.0 | 1.750 | | | | | |
| | | | DMD300 | | 5.9% | | 56.8 | 3.341 | | | | | |
| | | | DMD310 | | 2.5% | | 40.4 | 1.014 | | | | | |
| | | | DCD220 | | 1.9% | | 62.0 | 1.208 | | | | | |
| | | | DCD230 | | 3.0% | | 62.0 | 1.836 | | | | | |
| | | | BUB130 | 8146 | 1.8% | 12.73 | 59.0 | 1.090 | 54.55 | 0.75 | 0.4 | 0.2 | 90.4 |
| Bruner DB | | | DLD270 | 280 | 100.0% | 0.44 | 85.6 | 85.577 | 85.58 | 1.00 | 0.7 | 0.3 | 7.5 |
| Upper Duck Creek DB | | | | | | | | | | | | | |
| | | | DUD260 | | 1.2% | | 11.3 | 0.135 | | | | | |
| | | | DUD160 | | 2.1% | | 62.0 | 1.310 | | | | | |
| | | | DUD150 | | 2.4% | | 62.0 | 1.459 | | | | | |

## Duck Creek/Blue Diamond

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor<br>Tributary Area / Adjustment Factor<br>0 - <1 : 1.00<br>1 - <10 : 0.85<br>10 - <40 : 0.75<br>40 and greater : 0.65 | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | DUD140 | | 1.6% | | 62.0 | 1.015 | | | | | |
| | | | DUD320 | | 1.9% | | 55.5 | 1.059 | | | | | |
| | | | DUD330 | | 1.8% | | 55.6 | 1.029 | | | | | |
| | | | DUD280 | | 1.9% | | 59.5 | 1.108 | | | | | |
| | | | DUD170 | | 2.2% | | 61.2 | 1.354 | | | | | |
| | | | DUD050 | | 2.3% | | 61.8 | 1.399 | | | | | |
| | | | DUD360 | | 2.1% | | 62.0 | 1.287 | | | | | |
| | | | DUD350 | | 1.8% | | 62.0 | 1.088 | | | | | |
| | | | DUD290 | | 1.6% | | 62.0 | 1.006 | | | | | |
| | | | DUD180 | | 1.8% | | 62.0 | 1.140 | | | | | |
| | | | DUD300 | | 2.0% | | 62.0 | 1.214 | | | | | |
| | | | DUD210 | | 1.8% | | 62.0 | 1.095 | | | | | |
| | | | DUD200 | | 2.0% | | 62.0 | 1.236 | | | | | |
| | | | DUD190 | | 2.1% | | 62.0 | 1.301 | | | | | |
| | | | DUD060 | | 2.2% | | 62.0 | 1.351 | | | | | |
| | | | DUD370 | | 2.0% | | 62.0 | 1.234 | | | | | |
| | | | DUD230 | | 1.7% | | 62.0 | 1.075 | | | | | |
| | | | DUD220 | | 2.0% | | 62.0 | 1.258 | | | | | |
| | | | DUD215 | | 2.3% | | 62.0 | 1.443 | | | | | |
| | | | DUD070 | | 2.1% | | 62.0 | 1.300 | | | | | |
| | | | DUD090 | | 2.3% | | 62.0 | 1.440 | | | | | |
| | | | DUD400 | | 0.9% | | 62.0 | 0.556 | | | | | |
| | | | DUD390 | | 1.8% | | 62.0 | 1.146 | | | | | |
| | | | DUD120 | | 2.3% | | 62.0 | 1.445 | | | | | |
| | | | DUD020 | | 2.4% | | 62.0 | 1.508 | | | | | |
| | | | DUD030 | | 2.0% | | 62.0 | 1.210 | | | | | |
| | | | DUD110 | | 2.2% | | 62.0 | 1.385 | | | | | |
| | | | DUD080 | | 1.9% | | 62.0 | 1.171 | | | | | |
| | | Birds Spring DB | DBS250 | | 1.9% | | 45.4 | 0.882 | | | | | |
| | | Birds Spring DB | DBS240 | | 2.4% | | 62.0 | 1.461 | | | | | |
| | | Birds Spring DB | DBS160 | | 2.0% | | 57.0 | 1.146 | | | | | |
| | | Birds Spring DB | DBS260 | | 1.4% | | 54.1 | 0.757 | | | | | |
| | | Birds Spring DB | DBS220 | | 2.3% | | 62.0 | 1.411 | | | | | |
| | | Birds Spring DB | DBS150 | | 1.6% | | 62.0 | 0.999 | | | | | |
| | | Birds Spring DB | DBS180 | | 2.1% | | 62.0 | 1.288 | | | | | |
| | | Birds Spring DB | DBS210 | | 2.3% | | 62.0 | 1.429 | | | | | |
| | | Birds Spring DB | DBS110 | | 2.5% | | 62.0 | 1.522 | | | | | |
| | | Birds Spring DB | DBS140 | | 1.9% | | 62.0 | 1.198 | | | | | |
| | | Birds Spring DB | DBS170 | | 1.8% | | 62.0 | 1.095 | | | | | |
| | | Birds Spring DB | DBS200 | | 2.2% | | 61.8 | 1.347 | | | | | |
| | | Birds Spring DB | DBS130 | | 1.7% | | 62.0 | 1.049 | | | | | |
| | | Birds Spring DB | DBS100 | | 2.4% | | 58.1 | 1.368 | | | | | |
| | | Birds Spring DB | DBS050 | | 2.2% | | 62.0 | 1.388 | | | | | |
| | | Birds Spring DB | DBS080 | | 1.5% | | 55.2 | 0.851 | | | | | |
| | | Birds Spring DB | DBS040 | | 2.4% | | 62.0 | 1.487 | | | | | |
| | | Birds Spring DB | DBS070 | | 1.1% | | 62.0 | 0.675 | | | | | |
| | | Birds Spring DB | DBS020 | | 2.2% | | 62.0 | 1.390 | | | | | |
| | | Birds Spring DB | DBS030 | 13969 | 1.4% | 21.83 | 59.3 | 0.814 | 60.31 | 0.75 | 0.4 | 0.2 | 172.6 |
| Central Duck Creek DB | | | | | | | | | | | | | |
| | | | DCD310 | | 6.4% | | 16.4 | 1.052 | | | | | |
| | | | DCD290 | | 5.5% | | 55.6 | 3.061 | | | | | |
| | | | DCD450 | | 8.0% | | 62.0 | 4.973 | | | | | |

# Duck Creek/Blue Diamond

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | | DCD260 | | 6.0% | | 62.0 | 3.740 | | | | | |
| | | | DCD270 | | 9.2% | | 62.0 | 5.694 | | | | | |
| | | | DCD240 | | 8.6% | | 62.0 | 5.354 | | | | | |
| | | | DCD430 | | 8.8% | | 62.0 | 5.450 | | | | | |
| | | | DCD420 | | 7.3% | | 62.0 | 4.552 | | | | | |
| | | | DCD210 | | 6.1% | | 62.0 | 3.768 | | | | | |
| | | | DCD330 | | 4.5% | | 62.0 | 2.804 | | | | | |
| | | | DCD340 | | 5.4% | | 62.0 | 3.355 | | | | | |
| | | | DCD370 | | 7.5% | | 62.0 | 4.653 | | | | | |
| | | | DCD390 | | 8.2% | | 62.0 | 5.080 | | | | | |
| | | | DCD360 | | 3.6% | | 61.8 | 2.206 | | | | | |
| | | | DCD410 | 3492 | 4.8% | 5.46 | 62.0 | 2.974 | 58.71 | 0.85 | 0.4 | 0.2 | 47.5 |
| Lower Blue Diamond DB | | | | | | | | | | | | | |
| | | | BLBDDB | | 2.2% | | 42.7 | 0.951 | | | | | |
| | | | BUB205 | | 5.2% | | 53.6 | 2.812 | | | | | |
| | | | BUB202 | | 9.4% | | 62.7 | 5.870 | | | | | |
| | | | BUB200 | | 6.5% | | 52.1 | 3.375 | | | | | |
| | | | BUB190 | | 6.8% | | 59.4 | 4.054 | | | | | |
| | | | BUB120 | | 7.3% | | 45.5 | 3.302 | | | | | |
| | | | BUB160 | | 6.6% | | 63.0 | 4.154 | | | | | |
| | | | BUB150 | | 5.4% | | 64.7 | 3.523 | | | | | |
| | | | BUB140 | | 6.4% | | 76.5 | 4.899 | | | | | |
| | | | BUB180 | | 5.2% | | 41.8 | 2.189 | | | | | |
| | | | BUB170 | | 8.5% | | 36.3 | 3.096 | | | | | |
| | | | BUB100 | | 9.2% | | 32.9 | 3.027 | | | | | |
| | | | BUB110 | | 7.0% | | 50.6 | 3.546 | | | | | |
| | | | BUB090 | | 9.6% | | 32.0 | 3.071 | | | | | |
| | | | BUB060 | 3400 | 4.6% | 5.31 | 37.5 | 1.722 | 49.59 | 0.85 | 0.3 | 0.2 | 39.0 |

# Flamingo/Tropicana

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor<br>Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Red Rock DB | | | | | | | | | | | | | |
| | | | RD1 | | 20.8% | | 48.4 | 10.059 | | | | | |
| | | | RD2 | | 28.1% | | 61.3 | 17.235 | | | | | |
| | | | RD3 | | 17.8% | | 63.8 | 11.342 | | | | | |
| | | | RD5 | | 19.9% | | 33.9 | 6.754 | | | | | |
| | | | RD6 | 1189 | 13.4% | 1.86 | 59.3 | 7.978 | 53.37 | 0.85 | 0.4 | 0.2 | 14.6 |
| Lakes DB | | | | | | | | | | | | | |
| | | | LF1 | | 13.9% | | 56.8 | 7.913 | | | | | |
| | | | LF2 | | 11.9% | | 64.0 | 7.617 | | | | | |
| | | | LF3 | | 9.9% | | 63.3 | 6.235 | | | | | |
| | | | LF4 | | 16.9% | | 60.0 | 10.163 | | | | | |
| | | | LF5 | | 18.7% | | 79.1 | 14.802 | | | | | |
| | | | LF6 | | 14.6% | | 65.7 | 9.588 | | | | | |
| | | | LF7 | 1676 | 14.1% | 2.62 | 68.0 | 9.561 | 65.88 | 0.85 | 0.5 | 0.2 | 26.1 |
| Desert Inn DB | | | | | | | | | | | | | |
| | | | LF23 | | 37.1% | | 43.0 | 15.959 | | | | | |
| | | | LF24 | | 36.9% | | 28.8 | 10.620 | | | | | |
| | | | LF25 | 661 | 25.9% | 1.03 | 41.8 | 10.842 | 37.42 | 0.85 | 0.3 | 0.1 | 6.0 |
| F1 Debris Basin | | | | | | | | | | | | | |
| | | | UFS3 | 279 | 100.0% | 0.44 | 58.9 | 58.855 | 58.86 | 1.00 | 0.4 | 0.2 | 4.5 |
| Flamingo DB | F1 Debris Basin<br>Red Rock DB | | | | | | | | | | | | |
| | | | UFR12 | | 2.3% | | 59.5 | 1.383 | | | | | |
| | | | UFR13 | | 2.6% | | 81.0 | 2.104 | | | | | |
| | | | UFR17 | | 1.3% | | 43.5 | 0.552 | | | | | |
| | | | UFR19A | | 0.9% | | 37.7 | 0.342 | | | | | |
| | | | UFR19B | | 1.1% | | 50.1 | 0.532 | | | | | |
| | | | UFR19C | | 1.7% | | 50.4 | 0.852 | | | | | |
| | | | UFR20 | | 2.1% | | 72.0 | 1.504 | | | | | |
| | | | UFR22 | | 1.4% | | 58.9 | 0.834 | | | | | |
| | | | UFR23 | | 1.7% | | 67.5 | 1.121 | | | | | |
| | | | UFR24 | | 1.6% | | 72.5 | 1.181 | | | | | |
| | | | UFR25 | | 1.8% | | 78.7 | 1.440 | | | | | |
| | | | UFR26 | | 0.9% | | 89.8 | 0.781 | | | | | |
| | | | UFS4 | | 1.8% | | 58.4 | 1.052 | | | | | |
| | | | UFS2 | | 1.3% | | 62.0 | 0.832 | | | | | |
| | | | UFS5B | | 1.5% | | 63.0 | 0.918 | | | | | |
| | | | UFS10 | | 1.8% | | 65.0 | 1.193 | | | | | |
| | | | UFS13 | | 2.1% | | 66.5 | 1.392 | | | | | |
| | | | UFS14 | | 2.3% | | 64.9 | 1.523 | | | | | |
| | | | UFS15 | | 3.1% | | 72.4 | 2.233 | | | | | |
| | | | UFS17 | | 1.9% | | 83.4 | 1.551 | | | | | |
| | | | UFS18 | | 1.4% | | 86.3 | 1.211 | | | | | |
| | | | UFS19 | | 1.9% | | 84.2 | 1.642 | | | | | |
| | | | UFS20 | | 1.9% | | 87.4 | 1.656 | | | | | |
| | | | UFS21 | | 2.0% | | 81.2 | 1.608 | | | | | |
| | | | UFS22 | | 1.4% | | 65.4 | 0.917 | | | | | |
| | | | UFS23 | | 1.1% | | 64.2 | 0.707 | | | | | |
| | | | UFS24 | | 2.8% | | 71.0 | 2.015 | | | | | |
| | | | UFS25 | | 2.5% | | 67.1 | 1.654 | | | | | |
| | | | UFS26 | | 1.2% | | 42.4 | 0.494 | | | | | |
| | | | UFS27 | | 2.1% | | 88.3 | 1.820 | | | | | |

# Flamingo/Tropicana

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | | UFS28 | | 2.7% | | 39.8 | 1.069 | | | | | |
| | | | UFS23-1 | | 1.7% | | 69.5 | 1.192 | | | | | |
| | | | UFR5 | | 2.4% | | 21.6 | 0.528 | | | | | |
| | | | UFR6 | | 2.6% | | 35.2 | 0.916 | | | | | |
| | | | UFR8 | | 1.5% | | 63.4 | 0.935 | | | | | |
| | | | UFR16 | | 2.2% | | 62.0 | 1.389 | | | | | |
| | | | UFR18 | | 2.0% | | 62.0 | 1.256 | | | | | |
| | | | UFR15 | | 2.5% | | 38.1 | 0.963 | | | | | |
| | | | UFR21 | | 2.8% | | 65.2 | 1.843 | | | | | |
| | | | UFR1 | | 2.8% | | 56.0 | 1.563 | | | | | |
| | | | UFR2 | | 1.9% | | 31.5 | 0.600 | | | | | |
| | | | UFR3 | | 2.1% | | 35.9 | 0.740 | | | | | |
| | | | UFR4 | | 1.6% | | 29.6 | 0.486 | | | | | |
| | | | UFR9 | | 2.1% | | 63.6 | 1.304 | | | | | |
| | | | UFR10 | | 2.5% | | 61.9 | 1.521 | | | | | |
| | | | UFR11 | | 1.5% | | 61.3 | 0.923 | | | | | |
| | | | UFR7 | | 2.9% | | 51.3 | 1.474 | | | | | |
| | | | UFS11 | | 2.8% | | 36.4 | 1.016 | | | | | |
| | | | UFS12 | | 1.5% | | 60.2 | 0.902 | | | | | |
| | | | UFS16 | | 2.4% | | 63.0 | 1.542 | | | | | |
| | | | UFS9 | 11633 | 2.0% | 18.18 | 35.8 | 0.722 | 59.93 | 0.75 | 0.4 | 0.2 | 142.7 |
| Tropicana DB | Flamingo DB<br>Upper Blue Diamond DB<br>Blue Diamond debris Basin | | | | | | | | | | | | |
| | | | TD8 | | 2.2% | | 83.9 | 1.843 | | | | | |
| | | | TD9 | | 3.8% | | 40.7 | 1.563 | | | | | |
| | | | TD10 | | 2.8% | | 33.3 | 0.942 | | | | | |
| | | | TD11 | | 2.2% | | 48.2 | 1.079 | | | | | |
| | | | TD12 | | 3.2% | | 44.4 | 1.439 | | | | | |
| | | | TD13 | | 2.8% | | 52.5 | 1.480 | | | | | |
| | | | TD14 | | 2.3% | | 69.1 | 1.619 | | | | | |
| | | | TD15 | | 1.9% | | 86.2 | 1.657 | | | | | |
| | | | TD16 | | 3.4% | | 64.8 | 2.173 | | | | | |
| | | | TD1 | | 3.3% | | 63.7 | 2.129 | | | | | |
| | | | TD2 | | 2.1% | | 64.4 | 1.376 | | | | | |
| | | | TD3 | | 2.2% | | 47.1 | 1.059 | | | | | |
| | | | TD4 | | 2.0% | | 85.2 | 1.705 | | | | | |
| | | | TD5 | | 3.9% | | 81.2 | 3.202 | | | | | |
| | | | TD6 | | 3.9% | | 63.9 | 2.492 | | | | | |
| | | | TD7 | | 2.3% | | 69.1 | 1.558 | | | | | |
| | | | TBD17 | | 3.8% | | 67.3 | 2.570 | | | | | |
| | | | TBD18 | | 2.7% | | 79.6 | 2.126 | | | | | |
| | | | TBD19 | | 2.9% | | 87.2 | 2.487 | | | | | |
| | | | TBD20 | | 3.1% | | 49.6 | 1.523 | | | | | |
| | | | TBD3 | | 3.0% | | 49.6 | 1.479 | | | | | |
| | | | TBD4 | | 4.2% | | 44.8 | 1.897 | | | | | |
| | | | TBD5 | | 3.7% | | 67.4 | 2.518 | | | | | |
| | | | TBD6 | | 2.8% | | 79.6 | 2.267 | | | | | |
| | | | TBD7 | | 2.0% | | 51.3 | 1.051 | | | | | |
| | | | TBD8 | | 3.9% | | 75.3 | 2.935 | | | | | |
| | | | TBD9 | | 3.9% | | 68.3 | 2.631 | | | | | |

# Flamingo/Tropicana

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | | TBD10 | | 3.0% | | 89.9 | 2.677 | | | | | |
| | | | TBD11 | | 2.9% | | 84.8 | 2.460 | | | | | |
| | | | TBD12 | | 3.9% | | 65.5 | 2.524 | | | | | |
| | | | TBD13 | | 3.8% | | 72.6 | 2.766 | | | | | |
| | | | TBD14 | | 2.9% | | 88.6 | 2.545 | | | | | |
| | | | TBD15 | 8403 | 3.0% | 13.13 | 86.0 | 2.559 | 66.33 | 0.75 | 0.5 | 0.2 | 116.3 |
| Blue Diamond Debris Basin | | | TBD1 | | 51.4% | | 56.8 | 29.212 | | | | | |
| | | | TBD2 | 531 | 48.6% | 0.83 | 49.6 | 24.113 | 53.32 | 1.00 | 0.4 | 0.2 | 7.7 |
| Upper Blue Diamond DB | | | | | | | | | | | | | |
| | | | BD1 | | 5.6% | | 61.9 | 3.442 | | | | | |
| | | | BD2 | | 6.1% | | 57.5 | 3.536 | | | | | |
| | | | BD3 | | 6.4% | | 60.5 | 3.899 | | | | | |
| | | | BD4 | | 5.9% | | 62.0 | 3.642 | | | | | |
| | | | BD5 | | 5.1% | | 62.0 | 3.132 | | | | | |
| | | | BD6 | | 6.3% | | 62.0 | 3.882 | | | | | |
| | | | BD12 | | 7.2% | | 60.2 | 4.339 | | | | | |
| | | | BD10 | | 7.6% | | 54.0 | 4.117 | | | | | |
| | | | BD14 | | 7.5% | | 62.0 | 4.654 | | | | | |
| | | | BD16 | | 7.0% | | 59.7 | 4.206 | | | | | |
| | | | BD17 | | 7.0% | | 61.3 | 4.289 | | | | | |
| | | | BD18 | | 6.8% | | 62.0 | 4.244 | | | | | |
| | | | BD19 | | 6.9% | | 62.0 | 4.275 | | | | | |
| | | | BD20 | | 4.2% | | 62.0 | 2.601 | | | | | |
| | | | BD21 | | 6.4% | | 27.9 | 1.775 | | | | | |
| | | | BD22 | 4437 | 4.0% | 6.93 | 60.4 | 2.397 | 58.43 | 0.85 | 0.4 | 0.2 | 60.0 |
| F4 Debris Basin | | | | | | | | | | | | | |
| | | | UFS7 | | 35.0% | | 13.7 | 4.801 | | | | | |
| | | | UFS8 | | 29.3% | | 5.3 | 1.558 | | | | | |
| | | | UFS6 | 982 | 35.7% | 1.53 | 55.7 | 19.884 | 26.24 | 0.85 | 0.2 | 0.1 | 6.8 |
| TropicanaNorth Branch DB | | | | | | | | | | | | | |
| | | | TW4 | | 27.0% | | 62.8 | 16.929 | | | | | |
| | | | TW5 | | 19.6% | | 73.6 | 14.431 | | | | | |
| | | | TW6 | | 28.6% | | 83.2 | 23.834 | | | | | |
| | | | TW7 | 963 | 24.8% | 1.50 | 83.3 | 20.631 | 75.83 | 0.85 | 0.6 | 0.3 | 18.1 |
| Lower Flamingo DB | | | | | | | | | | | | | |
| | | | LF8 | | 5.5% | | 60.4 | 3.347 | | | | | |
| | | | LF9 | | 4.7% | | 63.9 | 2.978 | | | | | |
| | | | LF10 | | 2.4% | | 41.9 | 1.000 | | | | | |
| | | | LF11 | | 5.5% | | 37.9 | 2.074 | | | | | |
| | | | LF12 | | 2.8% | | 43.0 | 1.193 | | | | | |
| | | | LF13 | | 5.6% | | 66.1 | 3.711 | | | | | |
| | | | LF14 | | 2.8% | | 34.6 | 0.969 | | | | | |
| | | | LF15 | | 2.9% | | 63.1 | 1.830 | | | | | |
| | | | LF16 | | 5.6% | | 40.1 | 2.254 | | | | | |
| | | | LF17 | | 2.9% | | 35.6 | 1.027 | | | | | |
| | | | LF18 | | 5.3% | | 62.3 | 3.316 | | | | | |
| | | | LF19 | | 3.3% | | 41.6 | 1.371 | | | | | |
| | | | LF20 | | 5.5% | | 65.6 | 3.574 | | | | | |

## Flamingo/Tropicana

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor<br>Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | LF21A | | 5.7% | | 66.7 | 3.814 | | | | | |
| | | | LF21 | | 5.7% | | 66.7 | 3.814 | | | | | |
| | | | LF22 | | 4.9% | | 70.1 | 3.464 | | | | | |
| | | | LF26 | | 2.7% | | 34.8 | 0.954 | | | | | |
| | | | LF27 | | 2.8% | | 75.5 | 2.087 | | | | | |
| | | | LF28 | | 5.6% | | 64.0 | 3.555 | | | | | |
| | | | LF29 | | 3.1% | | 70.3 | 2.164 | | | | | |
| | | | LF30 | | 5.8% | | 63.5 | 3.696 | | | | | |
| | | | LF31 | | 3.8% | | 58.5 | 2.246 | | | | | |
| | | | LF32 | | 2.5% | | 73.0 | 1.819 | | | | | |
| | | | LF33 | 5920 | 2.6% | 9.25 | 36.0 | 0.942 | 57.20 | 0.85 | 0.4 | 0.2 | 78.2 |

# Gowan

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\,Impervious * \%\,of\,Total\,Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\,Area * P_O * Adj.\,Factor}{12\,in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| Ann Raod DB | | | | | | | | | | | | | |
| | | | CAM-10A | | 33.6% | | 73.9 | 24.810 | | | | | |
| | | | CAM-10B | | 47.9% | | 45.1 | 21.613 | | | | | |
| | | | DETCAM10 | | 1.2% | | 0.9 | 0.010 | | | | | |
| | | | CAMDK2 | | 8.9% | | 48.2 | 4.303 | | | | | |
| | | | CAMDK3 | 2415 | 8.4% | 3.77 | 31.4 | 2.628 | 53.36 | 0.85 | 0.4 | 0.2 | 29.7 |
| Lone Mountain DB | Village 26 DB | | | | | | | | | | | | |
| | | | CRBW | | 7.1% | | 38.0 | 2.712 | | | | | |
| | | | LMDB | | 2.0% | | 0.0 | 0.001 | | | | | |
| | | | GABW | | 3.3% | | 53.9 | 1.794 | | | | | |
| | | | GRBW | | 4.9% | | 68.0 | 3.332 | | | | | |
| | | | GRBW2 | | 2.6% | | 47.6 | 1.228 | | | | | |
| | | | SV26-3 | | 6.2% | | 38.5 | 2.406 | | | | | |
| | | | SV22-3 | | 4.5% | | 77.0 | 3.472 | | | | | |
| | | | UVB2 | | 7.3% | | 65.0 | 4.774 | | | | | |
| | | | LMT1R | | 31.8% | | 8.2 | 2.614 | | | | | |
| | | | LMT2 | | 16.1% | | 82.3 | 13.226 | | | | | |
| | | | LMT3 | | 5.4% | | 36.5 | 1.959 | | | | | |
| | | | LMT5 | 3920 | 8.8% | 6.12 | 43.5 | 3.827 | 41.35 | 0.85 | 0.3 | 0.1 | 38.3 |
| Village 26 DB | | | | | | | | | | | | | |
| | | | SV26-2 | | 23.9% | | 60.6 | 14.499 | | | | | |
| | | Village 22 DB | SV22-2 | | 58.9% | | 66.9 | 39.396 | | | | | |
| | | Village 22 DB | SV22-1 | 764 | 17.2% | 1.19 | 85.4 | 14.690 | 68.58 | 0.85 | 0.5 | 0.2 | 12.5 |
| Gowan North DB | Lone Mountain DB | | | | | | | | | | | | |
| | | | GNDB | | 1.6% | | 21.1 | 0.348 | | | | | |
| | | | CPHW-C | | 2.1% | | 8.3 | 0.175 | | | | | |
| | | | ADHW-C | | 2.1% | | 24.2 | 0.516 | | | | | |
| | | | TRHW-C | | 2.2% | | 30.6 | 0.687 | | | | | |
| | | | EAHW-C | | 2.1% | | 30.6 | 0.646 | | | | | |
| | | | ARHW-C | | 2.6% | | 27.4 | 0.704 | | | | | |
| | | | WRHW-C | | 3.1% | | 28.7 | 0.895 | | | | | |
| | | | LMBW1 | | 1.0% | | 19.1 | 0.185 | | | | | |
| | | | LMBW2-C | | 2.8% | | 12.1 | 0.337 | | | | | |
| | | | BSFR-C | | 1.4% | | 56.9 | 0.823 | | | | | |
| | | | CPFR-C | | 1.8% | | 30.2 | 0.528 | | | | | |
| | | | ARFP-C | | 1.7% | | 29.7 | 0.511 | | | | | |
| | | | TRFR-C | | 1.8% | | 32.8 | 0.586 | | | | | |
| | | | EAFR-C | | 1.7% | | 32.4 | 0.563 | | | | | |
| | | | ARFR-C | | 1.7% | | 42.4 | 0.717 | | | | | |
| | | | HLFR-C | | 1.7% | | 33.0 | 0.556 | | | | | |
| | | | WRJS-C | | 1.8% | | 30.0 | 0.532 | | | | | |
| | | | LWFR-C | | 1.8% | | 31.3 | 0.556 | | | | | |
| | | | RSFR-C | | 1.9% | | 34.1 | 0.644 | | | | | |
| | | | HJS2-C | | 2.0% | | 54.2 | 1.074 | | | | | |
| | | | HAFR1-C | | 1.8% | | 29.2 | 0.524 | | | | | |
| | | | HAFR2-C | | 1.1% | | 27.6 | 0.309 | | | | | |
| | | | LV15-C | | 2.5% | | 63.0 | 1.562 | | | | | |
| | | | LV14-C | | 3.0% | | 64.4 | 1.949 | | | | | |
| | | | LV13-C | | 3.0% | | 62.2 | 1.848 | | | | | |

# Gowan

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB<br>$\sum \%\ Impervious * \%\ of\ Total\ Area$ | Adjustment Factor<br>Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | Runoff Coeffcient, C<br>$C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in)<br>$P_O = (a * C)P_6$<br>$a = 1.299$<br>$P_6 = 0.37in$ | WQCV (AF)<br>$\frac{Total\ Area * P_O * Adj.\ Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | GD24AA-C | | 2.5% | | 34.9 | 0.871 | | | | | |
| | | | GD20AA-C | | 2.8% | | 32.5 | 0.905 | | | | | |
| | | | GD20AB-C | | 2.8% | | 31.4 | 0.875 | | | | | |
| | | | GD17AB-C | | 2.6% | | 28.8 | 0.735 | | | | | |
| | | | GD17AA-C | | 2.7% | | 30.4 | 0.812 | | | | | |
| | | | GD14AA-C | | 2.8% | | 32.2 | 0.901 | | | | | |
| | | | GD14CB-C | | 1.6% | | 53.0 | 0.823 | | | | | |
| | | | LV36-C | | 1.5% | | 62.2 | 0.937 | | | | | |
| | | | LV32-C | | 2.1% | | 59.6 | 1.225 | | | | | |
| | | | LV43-C | | 1.2% | | 53.0 | 0.646 | | | | | |
| | | | BWHW1-C | | 2.0% | | 44.7 | 0.909 | | | | | |
| | | Lone Mountain-Beltway DB | CDMNA3 | | 2.5% | | 80.7 | 1.988 | | | | | |
| | | Lone Mountain-Beltway DB | CDMNA2 | | 0.9% | | 66.2 | 0.623 | | | | | |
| | | Lone Mountain-Beltway DB | EFPOA1 | | 1.6% | | 68.5 | 1.124 | | | | | |
| | | Lone Mountain-Beltway DB | EFPOA2 | | 2.1% | | 68.7 | 1.454 | | | | | |
| | | Lone Mountain-Beltway DB | EFPOB1 | | 2.7% | | 83.9 | 2.289 | | | | | |
| | | Lone Mountain-Beltway DB | HLBW1-C | | 2.9% | | 84.2 | 2.429 | | | | | |
| | | Lone Mountain-Beltway DB | WRWB1-C | | 1.8% | | 30.0 | 0.532 | | | | | |
| | | Lone Mountain-Beltway DB | WRBW1 | | 3.2% | | 82.5 | 2.604 | | | | | |
| | | Lone Mountain-Beltway DB | LWBW1 | | 3.4% | | 70.2 | 2.362 | | | | | |
| | | Lone Mountain-Beltway DB | UVB1-S | | 2.3% | | 68.4 | 1.598 | | | | | |
| | | Lone Mountain-Beltway DB | UVB1-1 | 9169 | 1.8% | 14.33 | 60.0 | 1.091 | 45.51 | 0.75 | 0.3 | 0.1 | 85.8 |
| Cheyenne Peaking Basin* | | | | | | | | | | | | | |
| | | | NW2A1-C | | 2.3% | | 48.7 | 1.115 | | | | | |
| | | | NW2A3-C | | 2.3% | | 48.7 | 1.115 | | | | | |
| | | | NW2B5-C | | 2.3% | | 48.7 | 1.115 | | | | | |
| | | | PT3AA1-C | | 1.3% | | 82.5 | 1.074 | | | | | |
| | | | NW2C1-C | | 2.3% | | 48.7 | 1.115 | | | | | |
| | | | NW2D1-C | | 2.3% | | 48.7 | 1.115 | | | | | |

# Gowan

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious * \%\ of\ Total\ Area$ | Adjustment Factor | | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.\ Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area | Adjustment Factor | | | |
| | | | | | | | | | | 0 - <1 | 1.00 | | | |
| | | | | | | | | | | 1 - <10 | 0.85 | | | |
| | | | | | | | | | | 10 - <40 | 0.75 | | | |
| | | | | | | | | | | 40 and greater | 0.65 | | | |
| | | | PT2AA4-C | | 5.1% | | 56.0 | 2.856 | | | | | | |
| | | | PT3AC1-C | | 3.4% | | 59.8 | 2.041 | | | | | | |
| | | | PT3AA2-C | | 1.3% | | 73.0 | 0.952 | | | | | | |
| | | | PD16A3-C | | 3.1% | | 78.8 | 2.465 | | | | | | |
| | | | PT2AC1 | | 0.8% | | 49.5 | 0.414 | | | | | | |
| | | | PT2AC2-C | | 2.5% | | 58.0 | 1.457 | | | | | | |
| | | | PT2AC3 | | 2.1% | | 49.9 | 1.052 | | | | | | |
| | | | PT2AC4 | | 0.4% | | 64.9 | 0.258 | | | | | | |
| | | | PT2AB1-C | | 2.0% | | 49.2 | 0.964 | | | | | | |
| | | | PT3DC1-C | | 3.2% | | 64.8 | 2.070 | | | | | | |
| | | | PT4B2-C | | 2.5% | | 46.6 | 1.143 | | | | | | |
| | | | PT4B3-C | | 2.5% | | 44.2 | 1.121 | | | | | | |
| | | | PT5B6-C | | 3.4% | | 48.4 | 1.669 | | | | | | |
| | | | PT4C-1 | | 2.2% | | 49.1 | 1.087 | | | | | | |
| | | | PT5C-1 | | 1.7% | | 57.9 | 0.970 | | | | | | |
| | | | PT3D-1 | | 2.0% | | 41.8 | 0.849 | | | | | | |
| | | | WTO4B-1 | | 1.7% | | 71.7 | 1.251 | | | | | | |
| | | | PT2AD-2 | | 4.1% | | 52.0 | 2.153 | | | | | | |
| | | | PT2AD-1 | | 2.8% | | 48.3 | 1.370 | | | | | | |
| | | | PT3D-2 | | 2.4% | | 57.3 | 1.353 | | | | | | |
| | | | PT4C-2 | | 2.2% | | 65.2 | 1.467 | | | | | | |
| | | | PT5C-2 | | 1.7% | | 25.5 | 0.446 | | | | | | |
| | | | PT3D-3 | | 2.4% | | 55.1 | 1.328 | | | | | | |
| | | | PT4C-3 | | 2.4% | | 66.4 | 1.582 | | | | | | |
| | | | PT5C-3 | | 2.0% | | 60.5 | 1.219 | | | | | | |
| | | | PT2AD-3 | | 1.1% | | 65.1 | 0.690 | | | | | | |
| | | | WTO4B-2 | | 2.3% | | 48.4 | 1.105 | | | | | | |
| | | | WTO4B-3 | | 2.5% | | 62.1 | 1.550 | | | | | | |
| | | | PT2AD-3 | | 1.1% | | 65.1 | 0.690 | | | | | | |
| | | | PT-2B-1 | | 3.5% | | 61.1 | 2.160 | | | | | | |
| | | | PT-2B-2 | | 2.8% | | 59.7 | 1.667 | | | | | | |
| | | | PT-2B-3 | | 2.4% | | 65.2 | 1.546 | | | | | | |
| | | | PT2C-1 | | 1.2% | | 79.1 | 0.916 | | | | | | |
| | | | PT2C-2 | | 2.3% | | 59.8 | 1.380 | | | | | | |
| | | | PT2C-3 | | 2.3% | | 67.2 | 1.531 | | | | | | |
| | | | PT4D-1 | | 3.5% | | 64.7 | 2.252 | | | | | | |
| | | | PT4D-2 | 7085 | 2.2% | 11.07 | 88.6 | 1.976 | 57.65 | 0.75 | | 0.4 | 0.2 | 83.3 |
| DB #5 | | | | | | | | | | | | | | |
| | | | DB55-2 | | 3.8% | | 48.7 | 1.861 | | | | | | |
| | | | DB55-4 | | 6.7% | | 29.2 | 1.955 | | | | | | |
| | | | DB55-5 | | 7.3% | | 38.0 | 2.771 | | | | | | |
| | | | DB55-6 | | 3.7% | | 65.4 | 2.435 | | | | | | |
| | | | DB55-7 | | 17.1% | | 52.0 | 8.900 | | | | | | |
| | | | DB55-8 | | 21.0% | | 50.9 | 10.697 | | | | | | |
| | | | DB54-4 | | 7.8% | | 30.3 | 2.375 | | | | | | |
| | | | DB54-6R | 1658 | 32.5% | 2.59 | 28.6 | 9.297 | 40.29 | 0.85 | | 0.3 | 0.1 | 15.9 |
| Gowan South DB | Angle Park DB | | | | | | | | | | | | | |
| | | | M-C | | 1.7% | | 48.9 | 0.833 | | | | | | |
| | | | X-C | | 2.5% | | 51.2 | 1.290 | | | | | | |
| | | | O-C | | 2.5% | | 49.7 | 1.252 | | | | | | |
| | | | J-C | | 1.9% | | 53.4 | 0.993 | | | | | | |

# Gowan

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\,Impervious * \%\,of\,Total\,Area$ | Adjustment Factor | | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\,Area * P_O * Adj.\,Factor}{12\,in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area | Adjustment Factor | | | |
| | | | | | | | | | | 0 - <1 | 1.00 | | | |
| | | | | | | | | | | 1 - <10 | 0.85 | | | |
| | | | | | | | | | | 10 - <40 | 0.75 | | | |
| | | | | | | | | | | 40 and greater | 0.65 | | | |
| | | | H-C | | 2.4% | | 54.2 | 1.320 | | | | | | |
| | | | AREAA1-C | | 3.1% | | 42.7 | 1.323 | | | | | | |
| | | | C-C | | 2.8% | | 57.8 | 1.642 | | | | | | |
| | | | B-C | | 3.9% | | 68.5 | 2.640 | | | | | | |
| | | | 1-C DSL | | 1.9% | | 68.6 | 1.317 | | | | | | |
| | | | 7-C | | 2.0% | | 67.7 | 1.353 | | | | | | |
| | | | 15 | | 1.1% | | 64.7 | 0.719 | | | | | | |
| | | | 17 | | 0.6% | | 67.3 | 0.413 | | | | | | |
| | | | 18 | | 0.5% | | 70.5 | 0.318 | | | | | | |
| | | | 16-C | | 4.4% | | 69.2 | 3.058 | | | | | | |
| | | | BUF01-C | | 3.1% | | 66.6 | 2.041 | | | | | | |
| | | | R37-C | | 3.3% | | 63.3 | 2.089 | | | | | | |
| | | | FU1-C | | 4.0% | | 57.6 | 2.317 | | | | | | |
| | | | A1-C | | 2.0% | | 65.8 | 1.343 | | | | | | |
| | | | FU6-C | | 4.1% | | 66.2 | 2.685 | | | | | | |
| | | | NFA-C | | 2.6% | | 57.6 | 1.484 | | | | | | |
| | | | K-C | | 1.8% | | 64.5 | 1.130 | | | | | | |
| | | | SF11-C | | 3.9% | | 45.3 | 1.774 | | | | | | |
| | | | GC1B-C | | 2.0% | | 23.4 | 0.475 | | | | | | |
| | | | VILL2-1 | | 1.9% | | 52.3 | 1.014 | | | | | | |
| | | | VILL2-2 | | 2.8% | | 60.5 | 1.690 | | | | | | |
| | | | VILL2-3 | | 4.0% | | 66.6 | 2.680 | | | | | | |
| | | | GB34AC | | 1.7% | | 53.9 | 0.942 | | | | | | |
| | | | GB34AA | | 1.7% | | 53.9 | 0.942 | | | | | | |
| | | | GB34AB | | 1.7% | | 53.9 | 0.942 | | | | | | |
| | | | W1BB-C | | 2.6% | | 72.9 | 1.891 | | | | | | |
| | | | 1-WEST-C | | 2.0% | | 64.5 | 1.305 | | | | | | |
| | | | A2-C | | 1.9% | | 53.8 | 1.034 | | | | | | |
| | | | Z-C | | 3.4% | | 55.8 | 1.886 | | | | | | |
| | | | R6-C | | 4.3% | | 52.1 | 2.222 | | | | | | |
| | | | 1-DUCH-C | | 2.4% | | 59.7 | 1.442 | | | | | | |
| | | | 1-ALTA-C | | 4.4% | | 72.5 | 3.189 | | | | | | |
| | | | 1-HOLM-C | | 3.8% | | 58.2 | 2.196 | | | | | | |
| | | | 2-GOLF-C | 7464 | 3.1% | 11.66 | 37.2 | 1.162 | 58.35 | 0.75 | | 0.4 | 0.2 | 88.9 |
| Angel Park DB | DB #5 | | | | | | | | | | | | | |
| | | | SF2-C | | 2.5% | | 36.0 | 0.917 | | | | | | |
| | | | 3C | | 1.0% | | 76.5 | 0.767 | | | | | | |
| | | | AP | | 4.4% | | 13.2 | 0.581 | | | | | | |
| | | | SWFH-1 | | 3.7% | | 47.2 | 1.733 | | | | | | |
| | | | SWFH-2 | | 3.5% | | 65.4 | 2.291 | | | | | | |
| | | | SWFH-3 | | 1.0% | | 79.1 | 0.798 | | | | | | |
| | | | SWFH-4 | | 0.8% | | 30.2 | 0.232 | | | | | | |
| | | | SWFH-5 | | 1.7% | | 61.2 | 1.039 | | | | | | |
| | | | SWFH-6 | | 1.7% | | 65.5 | 1.099 | | | | | | |
| | | | SWFH-7 | | 2.0% | | 71.5 | 1.434 | | | | | | |
| | | | SWFH-8 | | 1.9% | | 74.8 | 1.441 | | | | | | |
| | | | SWFH-9 | | 1.1% | | 77.6 | 0.871 | | | | | | |
| | | | SWAA-1 | | 1.6% | | 54.3 | 0.848 | | | | | | |
| | | | 57BA | | 2.1% | | 6.0 | 0.125 | | | | | | |
| | | | 3B-2B | | 1.8% | | 40.5 | 0.727 | | | | | | |
| | | | 3B-1 | | 1.7% | | 24.2 | 0.410 | | | | | | |

# Gowan

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious * \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.\ Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 3B-2A | | 1.6% | | 54.6 | 0.871 | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | | 8A | | 2.0% | | 50.6 | 1.016 | | | | | |
| | | | 8B-2 | | 2.8% | | 81.5 | 2.244 | | | | | |
| | | | 8B-1 | | 2.0% | | 60.3 | 1.201 | | | | | |
| | | | 11B-1 | | 2.6% | | 57.2 | 1.479 | | | | | |
| | | | 11B-2 | | 2.9% | | 49.1 | 1.422 | | | | | |
| | | | 11A-2 | | 1.9% | | 66.1 | 1.257 | | | | | |
| | | | 11A-1 | | 1.4% | | 57.2 | 0.779 | | | | | |
| | | | SWAA-3 | | 3.8% | | 64.3 | 2.452 | | | | | |
| | | | SWAA-2 | | 4.6% | | 70.4 | 3.236 | | | | | |
| | | | SW11 | | 3.9% | | 61.6 | 2.384 | | | | | |
| | | | SW17 | | 2.3% | | 63.7 | 1.489 | | | | | |
| | | | SW18 | | 2.7% | | 57.8 | 1.538 | | | | | |
| | | | 11A-3 | | 1.3% | | 67.4 | 0.860 | | | | | |
| | | | 12A | | 2.6% | | 68.2 | 1.752 | | | | | |
| | | | 19A | | 1.7% | | 63.0 | 1.046 | | | | | |
| | | | 13B-1 | | 1.6% | | 69.5 | 1.137 | | | | | |
| | | | 13A-1 | | 1.5% | | 68.4 | 1.005 | | | | | |
| | | | 3A | | 1.2% | | 30.3 | 0.353 | | | | | |
| | | | 12B | | 1.7% | | 66.2 | 1.132 | | | | | |
| | | | 13B-2 | | 1.4% | | 61.1 | 0.866 | | | | | |
| | | | 13A-2 | | 1.2% | | 62.1 | 0.766 | | | | | |
| | | | 57B-3 | | 2.0% | | 24.5 | 0.499 | | | | | |
| | | | 57B-2 | | 2.4% | | 31.4 | 0.746 | | | | | |
| | | | PIC-A | | 2.4% | | 67.2 | 1.582 | | | | | |
| | | | PIC-C | | 1.6% | | 64.1 | 1.021 | | | | | |
| | | | PIC-B | | 2.9% | | 67.3 | 1.949 | | | | | |
| | | | 57B-4 | | 1.3% | | 62.3 | 0.817 | | | | | |
| | | | 57B-1 | | 1.3% | | 41.6 | 0.539 | | | | | |
| | | | 38B | | 2.9% | | 75.8 | 2.186 | | | | | |
| | | | 38A | 9752 | 2.3% | 15.24 | 69.7 | 1.613 | 56.55 | 0.75 | 0.4 | 0.2 | 112.3 |

* The Cheyenne Peaking Basin is in the Lower Northern watershed but receives additional flows from the Central, Gowan, and Upper Northern watersheds.

# Lower Northwest Las Vegas Wash

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 : 1.00<br>1 - <10 : 0.85<br>10 - <40 : 0.75<br>40 and greater : 0.65 | | | |
| Cheyenne Peaking Basin * | Lower Las Vegas Wash DB | | | | | | | | | | | | |
| | | | LV1E-1 | | 5.2% | | 74.5 | 3.893 | | | | | |
| | | | LV1E-2 | | 2.9% | | 81.6 | 2.396 | | | | | |
| | | | LV1E-3 | | 2.2% | | 84.9 | 1.862 | | | | | |
| | | | LV1D-2 | | 2.3% | | 82.1 | 1.848 | | | | | |
| | | | LV1D-3 | | 2.5% | | 66.5 | 1.659 | | | | | |
| | | | LV1D-4 | | 4.2% | | 82.9 | 3.462 | | | | | |
| | | | LV1D-5 | | 4.1% | | 75.6 | 3.078 | | | | | |
| | | | LV99B-5 | | 6.9% | | 82.0 | 5.632 | | | | | |
| | | | NN104-C | | 4.2% | | 64.4 | 2.704 | | | | | |
| | | | LV99A-4 | | 4.9% | | 27.6 | 1.343 | | | | | |
| | | | LV99B-3 | | 2.5% | | 60.3 | 1.510 | | | | | |
| | | | LV99B-4 | | 6.1% | | 59.1 | 3.622 | | | | | |
| | | | LV99B-5 | | 6.9% | | 82.0 | 5.632 | | | | | |
| | | | LV99B-6 | | 3.0% | | 89.4 | 2.664 | | | | | |
| | | | LV99B-7 | | 4.9% | | 85.1 | 4.190 | | | | | |
| | | | NN118-C | | 4.6% | | 44.7 | 2.045 | | | | | |
| | | | NN134-C | | 3.4% | | 66.4 | 2.243 | | | | | |
| | | | NN070-C | | 4.4% | | 61.9 | 2.746 | | | | | |
| | | | NN086-C | | 2.1% | | 76.8 | 1.630 | | | | | |
| | | | LV99A-3 | | 6.5% | | 67.3 | 4.390 | | | | | |
| | | | LV99B-2 | | 2.2% | | 64.0 | 1.430 | | | | | |
| | | | LV99A-1 | | 4.1% | | 58.0 | 2.406 | | | | | |
| | | | LV99A-2 | | 4.4% | | 71.9 | 3.135 | | | | | |
| | | | LV99B-1 | | 2.7% | | 65.3 | 1.735 | | | | | |
| | | | LV1D-1 | 5558 | 2.9% | 8.6847426 | 83.3 | 2.409 | 69.66 | 0.85 | 0.5 | 0.2 | 92.9 |
| Lower Las Vegas Wash DB ** | Elkhorn Springs DB | | | | | | | | | | | | |
| | | | NN040-C | | 11.9% | | 63.7 | 7.575 | | | | | |
| | | | NN038-C | | 10.1% | | 59.1 | 5.976 | | | | | |
| | | | NN044-C | | 11.5% | | 71.5 | 8.213 | | | | | |
| | | | NN054-C | | 10.8% | | 63.6 | 6.859 | | | | | |
| | | | NN057-C | | 16.8% | | 63.5 | 10.682 | | | | | |
| | | | NN072 | | 5.9% | | 27.7 | 1.629 | | | | | |
| | | | NN071-C | | 10.2% | | 61.8 | 6.314 | | | | | |
| | | | NN052-C | 1543 | 22.8% | 2.4115174 | 60.8 | 13.863 | 61.11 | 0.85 | 0.4 | 0.2 | 21.9 |
| North Las Vegas DB | Upper Las Vegas Wash DB | | | | | | | | | | | | |
| | | | 306B | | 3.3% | | 45.8 | 1.509 | | | | | |
| | | | 306A | | 2.0% | | 62.1 | 1.214 | | | | | |
| | | | ELK06C | | 3.6% | | 19.6 | 0.710 | | | | | |
| | | | 101A | | 2.7% | | 43.1 | 1.154 | | | | | |
| | | | 101H | | 2.8% | | 63.4 | 1.794 | | | | | |
| | | | 306D | | 3.0% | | 61.6 | 1.827 | | | | | |
| | | | 306I | | 2.8% | | 63.5 | 1.762 | | | | | |
| | | | 306E | | 3.0% | | 62.0 | 1.840 | | | | | |
| | | | 306H | | 2.8% | | 63.5 | 1.752 | | | | | |
| | | | 306F | | 2.9% | | 62.6 | 1.827 | | | | | |
| | | | 306G | | 2.7% | | 62.6 | 1.684 | | | | | |
| | | | 213D | | 2.5% | | 62.8 | 1.596 | | | | | |
| | | | 213E | | 2.8% | | 62.5 | 1.779 | | | | | |

## Lower Northwest Las Vegas Wash

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | | 213C | | 2.5% | | 62.6 | 1.561 | | | | | |
| | | | 213F | | 2.9% | | 62.7 | 1.811 | | | | | |
| | | | 213B | | 2.7% | | 52.9 | 1.423 | | | | | |
| | | | 213G | | 3.1% | | 62.2 | 1.955 | | | | | |
| | | | 213A | | 2.5% | | 53.6 | 1.330 | | | | | |
| | | | 213H | | 3.0% | | 61.6 | 1.828 | | | | | |
| | | | NW166-C | | 2.0% | | 11.2 | 0.223 | | | | | |
| | | | NW186-C | | 2.9% | | 0.3 | 0.009 | | | | | |
| | | | NW174 | | 1.5% | | 0.2 | 0.002 | | | | | |
| | | | NW184-C | | 1.5% | | 31.9 | 0.475 | | | | | |
| | | | NW182-C | | 1.5% | | 31.4 | 0.474 | | | | | |
| | | | NW206-C | | 1.7% | | 20.9 | 0.351 | | | | | |
| | | | NW205-C | | 2.1% | | 38.2 | 0.813 | | | | | |
| | | | NW192-C | | 1.5% | | 38.2 | 0.577 | | | | | |
| | | | GT03B | | 3.1% | | 57.4 | 1.789 | | | | | |
| | | | GT03D | | 1.4% | | 1.0 | 0.013 | | | | | |
| | | | 115 | | 3.2% | | 15.4 | 0.486 | | | | | |
| | | | 109B | | 3.4% | | 13.8 | 0.474 | | | | | |
| | | | 109C | | 2.8% | | 33.3 | 0.929 | | | | | |
| | | | 109A | | 1.0% | | 0.0 | 0.000 | | | | | |
| | | | 101E | | 2.8% | | 33.0 | 0.917 | | | | | |
| | | | 101D | | 1.4% | | 0.6 | 0.008 | | | | | |
| | | | 101F | | 2.7% | | 63.0 | 1.731 | | | | | |
| | | | 101C | | 1.8% | | 37.3 | 0.676 | | | | | |
| | | | 101G | | 2.8% | | 63.2 | 1.762 | | | | | |
| | | | 101B | | 2.1% | | 43.2 | 0.911 | | | | | |
| | | | GT03A | 11321 | 3.3% | 17.689721 | 13.4 | 0.439 | 43.41 | 0.75 | 0.3 | 0.1 | 101.8 |

* The Cheyenne Peaking Basin is in the Lower Northern watershed but receives additional flows from the Central, Gowan, and Upper Northern watersheds.

** The Lower Las Vegas Wash DB is in the Lower Northern watershed but received additional flow from the Upper Northern watershed.

# Pittman

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB<br>$\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C<br>$C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in)<br>$P_O = (a * C)P_6$<br>$a = 1.299$<br>$P_6 = 0.37in$ | WQCV (AF)<br>$\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pittman Peaking Basin | Pittman Railroad East Sediment Basin<br>Cactus DB<br>Pittman East DB<br>McCullough DB | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 — 1.00<br>1 - <10 — 0.85<br>10 - <40 — 0.75<br>40 and greater — 0.65 | | | |
| | | | PWA290 | | 0.7% | | 50.2 | 0.343 | | | | | |
| | | | PWA300 | | 0.9% | | 58.2 | 0.529 | | | | | |
| | | | PWA250 | | 0.3% | | 62.8 | 0.169 | | | | | |
| | | | PWA245 | | 0.8% | | 36.3 | 0.292 | | | | | |
| | | | PWA240 | | 0.6% | | 62.7 | 0.364 | | | | | |
| | | | PWA280 | | 0.5% | | 61.2 | 0.326 | | | | | |
| | | | PWA310 | | 0.8% | | 49.6 | 0.411 | | | | | |
| | | | PWA010 | | 0.8% | | 63.5 | 0.485 | | | | | |
| | | | PWA020 | | 1.0% | | 71.8 | 0.715 | | | | | |
| | | | PWA030 | | 0.5% | | 60.9 | 0.329 | | | | | |
| | | | PWA040 | | 0.7% | | 60.9 | 0.400 | | | | | |
| | | | PWA050 | | 0.8% | | 70.2 | 0.529 | | | | | |
| | | | PWA060 | | 0.4% | | 69.0 | 0.293 | | | | | |
| | | | PWA070 | | 1.0% | | 56.1 | 0.568 | | | | | |
| | | | PWA080 | | 0.9% | | 71.7 | 0.622 | | | | | |
| | | | PWA090 | | 1.3% | | 54.4 | 0.689 | | | | | |
| | | | PWA095 | | 0.1% | | 81.2 | 0.091 | | | | | |
| | | | PWA100 | | 1.0% | | 59.2 | 0.590 | | | | | |
| | | | PWA110 | | 0.5% | | 72.9 | 0.383 | | | | | |
| | | | PWA120 | | 0.9% | | 65.5 | 0.601 | | | | | |
| | | | PWA130 | | 0.5% | | 69.1 | 0.364 | | | | | |
| | | | PWA140 | | 0.3% | | 69.8 | 0.208 | | | | | |
| | | | PWA150 | | 0.8% | | 56.4 | 0.471 | | | | | |
| | | | PWA190 | | 0.8% | | 80.2 | 0.612 | | | | | |
| | | | PWA195 | | 0.8% | | 80.2 | 0.612 | | | | | |
| | | | PWA200 | | 0.6% | | 65.7 | 0.370 | | | | | |
| | | | PWA210 | | 0.7% | | 63.6 | 0.416 | | | | | |
| | | | PWA220 | | 0.6% | | 48.8 | 0.269 | | | | | |
| | | | PWA225 | | 0.3% | | 50.4 | 0.139 | | | | | |
| | | | PWA230 | | 1.0% | | 67.4 | 0.671 | | | | | |
| | | | PWA160 | | 0.6% | | 68.7 | 0.390 | | | | | |
| | | | PWA170 | | 0.9% | | 62.9 | 0.571 | | | | | |
| | | | PWA180 | | 0.5% | | 66.8 | 0.338 | | | | | |
| | | | PPE010 | | 0.8% | | 38.6 | 0.326 | | | | | |
| | | | PPE015 | | 0.4% | | 43.1 | 0.162 | | | | | |
| | | | PPE020 | | 0.7% | | 55.8 | 0.366 | | | | | |
| | | | PPE030 | | 0.4% | | 60.1 | 0.250 | | | | | |
| | | | PPE040 | | 0.6% | | 57.7 | 0.324 | | | | | |
| | | | PPE050 | | 1.0% | | 33.2 | 0.318 | | | | | |
| | | | PPE060 | | 1.1% | | 66.3 | 0.744 | | | | | |
| | | | PPE070 | | 1.1% | | 36.2 | 0.384 | | | | | |
| | | | PPE080 | | 0.7% | | 58.2 | 0.385 | | | | | |
| | | | PPE090 | | 0.8% | | 63.8 | 0.514 | | | | | |
| | | | PPE100 | | 1.0% | | 65.7 | 0.663 | | | | | |
| | | | PPE110 | | 1.0% | | 65.7 | 0.663 | | | | | |
| | | | PPE130 | | 1.0% | | 72.7 | 0.746 | | | | | |
| | | | PPE140 | | 1.0% | | 72.7 | 0.746 | | | | | |

# Pittman

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | | PPE140A | | 0.2% | | 57.4 | 0.107 | | | | | |
| | | | PPE140B | | 0.8% | | 72.2 | 0.578 | | | | | |
| | | | PPE150 | | 0.7% | | 75.2 | 0.550 | | | | | |
| | | | PPE160 | | 0.3% | | 62.0 | 0.170 | | | | | |
| | | | PPE170 | | 0.9% | | 47.3 | 0.438 | | | | | |
| | | | PPE180 | | 0.6% | | 65.3 | 0.382 | | | | | |
| | | | PPE190 | | 1.1% | | 76.3 | 0.851 | | | | | |
| | | | PPE200 | | 0.5% | | 71.5 | 0.368 | | | | | |
| | | | PCD110 | | 0.7% | | 90.0 | 0.633 | | | | | |
| | | | PCD140 | | 1.1% | | 83.4 | 0.884 | | | | | |
| | | | PCD080 | | 0.9% | | 88.0 | 0.759 | | | | | |
| | | | PCD100 | | 1.4% | | 76.2 | 1.064 | | | | | |
| | | | PCD060B | | 0.4% | | 84.9 | 0.368 | | | | | |
| | | | PCD090X | | 0.7% | | 72.7 | 0.482 | | | | | |
| | | Pittman North | PND003X | | 0.9% | | 47.2 | 0.411 | | | | | |
| | | Pittman North | PND125C | | 0.4% | | 78.0 | 0.300 | | | | | |
| | | Pittman North | PCD060A | | 0.4% | | 64.2 | 0.273 | | | | | |
| | | Pittman North | PCD020X | | 0.4% | | 85.3 | 0.360 | | | | | |
| | | Pittman North | PND125B | | 0.4% | | 78.1 | 0.285 | | | | | |
| | | Pittman North | PND180X | | 0.6% | | 66.4 | 0.379 | | | | | |
| | | Pittman North | PND190X | | 0.7% | | 66.8 | 0.466 | | | | | |
| | | Pittman North | PND175X | | 0.3% | | 65.1 | 0.200 | | | | | |
| | | Pittman North | PND125A | | 0.7% | | 68.2 | 0.469 | | | | | |
| | | Pittman North | PND135X | | 0.3% | | 62.9 | 0.201 | | | | | |
| | | Pittman North | PND145X | | 0.3% | | 63.3 | 0.184 | | | | | |
| | | Pittman North | PND185X | | 0.4% | | 73.6 | 0.269 | | | | | |
| | | Pittman North | PND170X | | 0.6% | | 68.4 | 0.381 | | | | | |
| | | Pittman North | PND002X | | 0.8% | | 66.8 | 0.502 | | | | | |
| | | Pittman North | PND001X | | 0.6% | | 62.1 | 0.371 | | | | | |
| | | Pittman North | PND160X | | 0.6% | | 62.0 | 0.393 | | | | | |
| | | Pittman North | PND005X | | 0.4% | | 68.3 | 0.307 | | | | | |
| | | Pittman North | PND004X | | 0.4% | | 80.8 | 0.358 | | | | | |
| | | Pittman West | PWD260 | | 0.7% | | 27.6 | 0.187 | | | | | |
| | | Pittman West | PWD200 | | 1.0% | | 62.0 | 0.598 | | | | | |
| | | Pittman West | PWD210 | | 1.1% | | 61.8 | 0.671 | | | | | |
| | | Pittman West | PWD230 | | 0.6% | | 62.0 | 0.368 | | | | | |
| | | Pittman West | PWD240 | | 0.9% | | 62.0 | 0.573 | | | | | |
| | | Pittman West | PWD145 | | 0.6% | | 61.9 | 0.362 | | | | | |
| | | Pittman West | PWD150 | | 0.5% | | 62.0 | 0.321 | | | | | |
| | | Pittman West | PWD160 | | 0.6% | | 62.0 | 0.365 | | | | | |
| | | Pittman West | PWD170 | | 1.1% | | 62.0 | 0.674 | | | | | |
| | | Pittman West | PWD350C | | 0.4% | | 79.1 | 0.334 | | | | | |
| | | Pittman West | PWD350A | | 0.4% | | 73.4 | 0.312 | | | | | |
| | | Pittman West | PWD120 | | 1.0% | | 62.0 | 0.616 | | | | | |
| | | Pittman West | PWD330 | | 0.4% | | 81.2 | 0.306 | | | | | |
| | | Pittman West | PWD340 | | 0.4% | | 88.2 | 0.361 | | | | | |
| | | Pittman West | PWD345 | | 0.9% | | 66.5 | 0.629 | | | | | |
| | | Pittman West | PWD110 | | 0.8% | | 61.7 | 0.500 | | | | | |
| | | Pittman West | PWD090 | | 1.2% | | 62.0 | 0.743 | | | | | |
| | | Pittman West | PWD100 | | 0.8% | | 62.0 | 0.468 | | | | | |
| | | Pittman West | PWD310X | | 0.3% | | 83.3 | 0.245 | | | | | |
| | | Pittman West | PWD320 | | 0.6% | | 69.1 | 0.415 | | | | | |
| | | Pittman West | PWD325 | | 0.9% | | 62.0 | 0.563 | | | | | |

# Pittman

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | Pittman West | PWD070 | | 1.2% | | 62.0 | 0.726 | | | | | |
| | | Pittman West | PWD080 | | 0.8% | | 62.0 | 0.468 | | | | | |
| | | Pittman West | PWD295 | | 0.6% | | 73.2 | 0.437 | | | | | |
| | | Pittman West | PWD315 | | 0.6% | | 65.3 | 0.383 | | | | | |
| | | Pittman West | PWD300 | | 1.8% | | 65.6 | 1.154 | | | | | |
| | | Pittman West | PWD050 | | 0.8% | | 62.0 | 0.493 | | | | | |
| | | Pittman West | PWD290 | | 0.9% | | 65.8 | 0.568 | | | | | |
| | | Pittman West | PWD040 | | 1.1% | | 62.0 | 0.678 | | | | | |
| | | Pittman West | PWD280 | | 1.0% | | 71.0 | 0.702 | | | | | |
| | | Pittman West | PWD020 | | 0.8% | | 62.0 | 0.494 | | | | | |
| | | Pittman West | PWD270A | | 2.4% | | 41.2 | 0.995 | | | | | |
| | | Southeast | PSDSW8 | | 0.4% | | 70.4 | 0.263 | | | | | |
| | | Southeast | OFFD1 | | 0.8% | | 51.1 | 0.407 | | | | | |
| | | Southeast | PSDSW3 | | 0.5% | | 54.5 | 0.247 | | | | | |
| | | Southeast | G8 | | 0.4% | | 68.7 | 0.257 | | | | | |
| | | Southeast | PSDG7 | | 0.5% | | 39.1 | 0.202 | | | | | |
| | | Southeast | PSDSW7 | | 0.7% | | 57.5 | 0.414 | | | | | |
| | | Southeast | PSDSW6 | | 0.5% | | 39.6 | 0.210 | | | | | |
| | | Southeast | PSDSW5 | | 0.4% | | 32.8 | 0.117 | | | | | |
| | | Southeast | PSDSW4 | | 0.9% | | 44.4 | 0.399 | | | | | |
| | | Southeast | PSDSW2 | | 0.2% | | 41.3 | 0.087 | | | | | |
| | | Southeast | PSDSW1 | | 0.3% | | 36.0 | 0.113 | | | | | |
| | | Southeast | G5 | | 0.3% | | 58.7 | 0.163 | | | | | |
| | | Southeast | PSDG3 | | 0.8% | | 48.2 | 0.386 | | | | | |
| | | Southeast | PSDG4 | | 0.2% | | 50.6 | 0.127 | | | | | |
| | | Southwest | PSD000 | | 1.0% | | 62.1 | 0.643 | | | | | |
| | | Southwest | GC10 | | 0.5% | | 49.8 | 0.260 | | | | | |
| | | Southwest | PSD001 | | 0.9% | | 60.6 | 0.572 | | | | | |
| | | Southwest | PSD080X | | 0.5% | | 72.0 | 0.326 | | | | | |
| | | Southwest | PSD060 | | 0.7% | | 53.7 | 0.398 | | | | | |
| | | Southwest | PSD015 | | 1.2% | | 63.8 | 0.758 | | | | | |
| | | Southwest | PSD010 | 29231 | 7.7% | 45.67 | 45.9 | 3.525 | 60.74 | 0.65 | 0.4 | 0.2 | 315.5 |
| McCullough DB | | | | | | | | | | | | | |
| | | | PMD180 | | 9.5% | | 48.9 | 4.652 | | | | | |
| | | | PMD170 | | 14.1% | | 31.3 | 4.417 | | | | | |
| | | | PMD110 | | 10.4% | | 37.2 | 3.876 | | | | | |
| | | | PMD150 | | 12.8% | | 26.3 | 3.363 | | | | | |
| | | | PMD140 | | 7.0% | | 21.7 | 1.521 | | | | | |
| | | | PMD090 | | 8.3% | | 17.7 | 1.461 | | | | | |
| | | | PMD100 | | 6.1% | | 39.3 | 2.407 | | | | | |
| | | | PMD085 | | 8.0% | | 30.7 | 2.467 | | | | | |
| | | | PMD070 | | 2.9% | | 55.4 | 1.631 | | | | | |
| | | | PMD060 | | 12.7% | | 58.9 | 7.477 | | | | | |
| | | | PMD065 | 2005 | 8.1% | 3.13 | 34.4 | 2.778 | 36.05 | 0.85 | 0.3 | 0.1 | 17.6 |
| Pittman Railroad East Sediment Basin | | | | | | | | | | | | | |
| | | | PRE120 | | 3.6% | | 70.2 | 2.544 | | | | | |
| | | | PRE130 | | 2.9% | | 56.9 | 1.628 | | | | | |
| | | | PRE070 | | 2.5% | | 82.3 | 2.063 | | | | | |
| | | | PMR190 | | 2.0% | | 57.7 | 1.145 | | | | | |
| | | | PMR160 | | 3.8% | | 63.9 | 2.454 | | | | | |
| | | | PMR150 | | 2.9% | | 71.3 | 2.097 | | | | | |

# Pittman

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | | PRE110 | | 5.2% | | 70.7 | 3.690 | | | | | |
| | | | PRE060 | | 5.2% | | 65.5 | 3.394 | | | | | |
| | | | PRE050 | | 2.9% | | 63.0 | 1.804 | | | | | |
| | | | PMR170 | | 5.3% | | 73.3 | 3.909 | | | | | |
| | | | PMR180 | | 3.1% | | 65.4 | 2.052 | | | | | |
| | | | PMR200 | | 3.7% | | 62.3 | 2.300 | | | | | |
| | | | PMR140 | | 3.4% | | 48.6 | 1.641 | | | | | |
| | | | PMR165 | | 1.7% | | 65.0 | 1.125 | | | | | |
| | | | PRE040 | | 2.9% | | 50.5 | 1.481 | | | | | |
| | | | PMR130B | | 1.3% | | 51.6 | 0.661 | | | | | |
| | | | PMR130A | | 2.1% | | 33.1 | 0.708 | | | | | |
| | | | PMR120 | | 3.2% | | 27.4 | 0.875 | | | | | |
| | | | PRE100 | | 3.1% | | 25.8 | 0.791 | | | | | |
| | | | PRE090 | | 5.7% | | 36.8 | 2.089 | | | | | |
| | | | PRE030 | | 2.5% | | 61.9 | 1.552 | | | | | |
| | | | PMR095 | | 2.3% | | 62.0 | 1.432 | | | | | |
| | | | PMR090 | | 5.3% | | 55.9 | 2.964 | | | | | |
| | | | PMR110 | | 2.5% | | 46.5 | 1.182 | | | | | |
| | | | PMR060 | | 2.0% | | 54.0 | 1.058 | | | | | |
| | | | PMR080 | | 5.0% | | 61.9 | 3.083 | | | | | |
| | | | PMR070 | | 2.8% | | 47.6 | 1.342 | | | | | |
| | | | PMR040 | | 3.6% | | 64.7 | 2.336 | | | | | |
| | | | PMR050 | | 4.1% | | 62.4 | 2.546 | | | | | |
| | | | PMR030 | 6551 | 3.3% | 10.24 | 44.6 | 1.472 | 57.42 | 0.75 | 0.4 | 0.2 | 76.7 |
| Pioneer DB | | | | | | | | | | | | | |
| | | | PPD170 | | 3.4% | | 84.2 | 2.866 | | | | | |
| | | | PPD190 | | 3.9% | | 74.8 | 2.927 | | | | | |
| | | | PPD165 | | 0.8% | | 50.0 | 0.407 | | | | | |
| | | | PPD145 | | 2.0% | | 58.2 | 1.136 | | | | | |
| | | | PPD140 | | 4.0% | | 62.8 | 2.535 | | | | | |
| | | | PPD150 | | 6.9% | | 69.8 | 4.791 | | | | | |
| | | | PPD160 | | 4.5% | | 51.5 | 2.296 | | | | | |
| | | | PPD130 | | 5.8% | | 37.5 | 2.160 | | | | | |
| | | | PPD070 | | 2.9% | | 61.4 | 1.802 | | | | | |
| | | | PPD060 | | 7.2% | | 44.7 | 3.244 | | | | | |
| | | | PPD120 | | 4.2% | | 21.9 | 0.924 | | | | | |
| | | | PPD110 | | 5.9% | | 62.0 | 3.633 | | | | | |
| | | | PPD100 | | 5.1% | | 62.6 | 3.168 | | | | | |
| | | | PPD090 | | 7.8% | | 45.0 | 3.526 | | | | | |
| | | | PPD135 | | 2.4% | | 46.8 | 1.136 | | | | | |
| | | | PPD040 | | 4.9% | | 29.5 | 1.445 | | | | | |
| | | | PPD050 | | 5.6% | | 55.8 | 3.142 | | | | | |
| | | | PPD030 | | 4.8% | | 63.8 | 3.032 | | | | | |
| | | | PPD080 | | 3.8% | | 54.6 | 2.071 | | | | | |
| | | | PPD020 | | 5.1% | | 46.4 | 2.379 | | | | | |
| | | Pittman Horizon Ridge DB | PPD125 | | 4.0% | | 60.7 | 2.417 | | | | | |
| | | Pittman Horizon Ridge DB | PPD115 | 4445 | 5.0% | 6.95 | 42.8 | 2.151 | 53.19 | 0.85 | 0.4 | 0.2 | 54.5 |
| Cactus DB | | | | | | | | | | | | | |

# Pittman

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | | PCD120 | | 13.9% | | 64.4 | 8.940 | | | | | |
| | | | PCD130 | | 30.6% | | 55.3 | 16.938 | | | | | |
| | | | PCD150 | | 19.4% | | 80.5 | 15.586 | | | | | |
| | | | PCD070 | | 20.6% | | 81.2 | 16.713 | | | | | |
| | | | PCD040X | 1033 | 15.5% | 1.61 | 59.7 | 9.276 | 67.45 | 0.85 | 0.5 | 0.2 | 16.6 |
| Pittman East DB | | | | | | | | | | | | | |
| | | | PED270 | | 5.3% | | 10.9 | 0.579 | | | | | |
| | | | PTE001 | | 2.1% | | 64.1 | 1.331 | | | | | |
| | | | PTE002 | | 1.7% | | 33.8 | 0.560 | | | | | |
| | | | PTE003 | | 0.6% | | 46.5 | 0.301 | | | | | |
| | | | PTE004 | | 3.2% | | 41.0 | 1.328 | | | | | |
| | | | PTE005 | | 3.7% | | 49.2 | 1.824 | | | | | |
| | | | PTE006 | | 2.3% | | 55.8 | 1.261 | | | | | |
| | | | PTE007 | | 3.9% | | 53.4 | 2.080 | | | | | |
| | | | PTE008 | | 2.7% | | 67.3 | 1.791 | | | | | |
| | | | PTE009 | | 1.8% | | 57.1 | 1.001 | | | | | |
| | | | PTE010 | | 0.6% | | 62.0 | 0.353 | | | | | |
| | | | PTE013 | | 2.0% | | 52.7 | 1.076 | | | | | |
| | | | PTE014 | | 4.7% | | 41.7 | 1.964 | | | | | |
| | | | PTE015 | | 9.0% | | 36.8 | 3.310 | | | | | |
| | | | PTE016 | | 2.7% | | 61.9 | 1.676 | | | | | |
| | | | PTE017 | | 4.0% | | 51.6 | 2.080 | | | | | |
| | | | PTE018 | | 5.7% | | 48.1 | 2.734 | | | | | |
| | | | PTE019 | | 3.7% | | 41.8 | 1.550 | | | | | |
| | | | PTE020 | | 2.9% | | 39.6 | 1.169 | | | | | |
| | | | PTE028 | | 3.6% | | 44.3 | 1.583 | | | | | |
| | | | PTE030 | | 4.9% | | 43.7 | 2.159 | | | | | |
| | | | PTE043 | | 2.6% | | 49.0 | 1.269 | | | | | |
| | | | PTE044 | | 5.2% | | 56.6 | 2.949 | | | | | |
| | | | PTE045 | | 6.1% | | 40.2 | 2.443 | | | | | |
| | | | PTE046 | | 2.2% | | 42.6 | 0.918 | | | | | |
| | | | PTE047 | | 4.6% | | 36.7 | 1.704 | | | | | |
| | | | PTE058 | | 1.0% | | 62.0 | 0.643 | | | | | |
| | | | PTE059 | | 1.6% | | 61.9 | 0.967 | | | | | |
| | | | PTE060 | 4251 | 5.6% | 6.64 | 58.0 | 3.250 | 45.85 | 0.85 | 0.3 | 0.2 | 45.4 |

## Range

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious * \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| Speedway #1 DB | | Speedway North DB | 312B-1 | | 4.1% | | 19.7 | 0.811 | | | | | |
| | | Speedway North DB | 45-7 | | 17.2% | | 61.7 | 10.597 | | | | | |
| | | Speedway North DB | 45-6 | | 12.0% | | 62.0 | 7.436 | | | | | |
| | | Speedway North DB | 45-5 | | 10.1% | | 48.4 | 4.865 | | | | | |
| | | | 312B-2 | | 16.3% | | 8.5 | 1.384 | | | | | |
| | | | 312B-3 | | 8.6% | | 0.0 | 0.000 | | | | | |
| | | | 312B-4 | | 14.0% | | 5.5 | 0.765 | | | | | |
| | | | 312H | 1815 | 17.7% | 2.84 | 81.4 | 14.433 | 40.29 | 0.85 | 0.281 | 0.1352 | 17.4 |
| Speedway #2 Rtention Basin | Speedway #3 Rtention Basin | | 312C-1 | 227 | 100.0% | 0.35 | 69.9 | 69.911 | 69.91 | 1.00 | 0.493 | 0.2370 | 4.5 |
| Speedway #3 Rtention Basin | | | 312C-2 | | 11.1% | | 70.0 | 7.742 | | | | | |
| | | | 312C-3 | | 18.2% | | 66.0 | 12.031 | | | | | |
| | | | 312C-4 | | 17.9% | | 65.8 | 11.800 | | | | | |
| | | | 45-10 | | 18.5% | | 67.7 | 12.541 | | | | | |
| | | | 45-9 | | 19.4% | | 65.7 | 12.722 | | | | | |
| | | | 45-8 | 1267 | 14.9% | 1.98 | 62.9 | 9.377 | 66.21 | 0.85 | 0.460 | 0.2209 | 19.8 |
| Vandenberg DB | | | 307B-1 | | 2.7% | | 70.2 | 1.876 | | | | | |
| | | | NN202-C | | 3.1% | | 61.7 | 1.924 | | | | | |
| | | | NN217-C | | 3.0% | | 63.6 | 1.939 | | | | | |
| | | | NN183-C | | 3.3% | | 61.8 | 2.011 | | | | | |
| | | | NN214-C | | 2.4% | | 73.0 | 1.715 | | | | | |
| | | | NN213-C | | 4.8% | | 65.3 | 3.158 | | | | | |
| | | | NN181-C | | 5.6% | | 68.1 | 3.780 | | | | | |
| | | | NN197-C | | 3.4% | | 69.0 | 2.320 | | | | | |
| | | | NN209-C | | 2.5% | | 87.5 | 2.202 | | | | | |
| | | | NN226-C | | 3.2% | | 74.0 | 2.333 | | | | | |
| | | | NN161-C | | 4.9% | | 57.5 | 2.841 | | | | | |
| | | | NN178-C | | 4.9% | | 67.8 | 3.323 | | | | | |
| | | | NN209-C | | 2.5% | | 87.5 | 2.202 | | | | | |
| | | | NN225-C | | 3.5% | | 89.7 | 3.148 | | | | | |
| | | Beltway DB | NN230-C | | 2.3% | | 76.4 | 1.782 | | | | | |
| | | Beltway DB | 309-1 | | 3.4% | | 0.0 | 0.000 | | | | | |
| | | Vandenberg North DB | 306A1 | | 2.5% | | 75.5 | 1.856 | | | | | |
| | | Vandenberg North DB | 306A2 | | 4.2% | | 62.2 | 2.594 | | | | | |
| | | Vandenberg North DB | 306A3 | | 3.4% | | 62.3 | 2.139 | | | | | |
| | | Vandenberg North DB | 306B1 | | 4.0% | | 62.0 | 2.457 | | | | | |
| | | Vandenberg North DB | 306B2 | | 4.2% | | 50.3 | 2.095 | | | | | |
| | | Vandenberg North DB | 306B3 | | 4.3% | | 50.9 | 2.206 | | | | | |

## Range

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious * \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | Vandenberg North DB | 306B4 | | 3.6% | | 62.8 | 2.245 | | | | | |
| | | Vandenberg North DB | 306B5 | | 3.7% | | 53.6 | 1.981 | | | | | |
| | | Vandenberg North DB | 306B6 | | 3.4% | | 52.0 | 1.756 | | | | | |
| | | Vandenberg North DB | NN194-C | | 5.5% | | 68.8 | 3.776 | | | | | |
| | | Vandenberg North DB | NN207-C | | 3.8% | | 86.4 | 3.273 | | | | | |
| | | Vandenberg North DB | NN224-C | 5219 | 2.1% | 8.15 | 83.8 | 1.728 | 64.66 | 0.85 | 0.446 | 0.2145 | 79.3 |
| Confluence DB | Vandenberg DB | | 47B-6 | | 2.0% | | 56.1 | 1.111 | | | | | |
| | | | 47B-7 | | 1.4% | | 51.5 | 0.713 | | | | | |
| | | | 47B-8 | | 1.3% | | 57.2 | 0.771 | | | | | |
| | | | 318A-1 | | 1.3% | | 75.0 | 1.003 | | | | | |
| | | | 318A-2 | | 2.3% | | 24.9 | 0.583 | | | | | |
| | | | 317-1 | | 2.8% | | 2.1 | 0.059 | | | | | |
| | | | 317-2 | | 1.4% | | 58.0 | 0.793 | | | | | |
| | | | 317-3 | | 1.3% | | 62.0 | 0.828 | | | | | |
| | | | 317-4 | | 2.5% | | 61.8 | 1.526 | | | | | |
| | | | 317-5 | | 1.5% | | 18.3 | 0.271 | | | | | |
| | | | 312-D | | 1.6% | | 65.8 | 1.067 | | | | | |
| | | | 47A-5 | | 2.6% | | 49.7 | 1.298 | | | | | |
| | | | 47A-6 | | 1.5% | | 56.1 | 0.822 | | | | | |
| | | | 47B-1 | | 2.1% | | 70.1 | 1.490 | | | | | |
| | | | 47B-3 | | 3.0% | | 69.6 | 2.086 | | | | | |
| | | | 47B-4 | | 0.8% | | 70.0 | 0.533 | | | | | |
| | | | 47B-5 | | 2.0% | | 68.5 | 1.355 | | | | | |
| | | Dunes South DB | 312D-1 | | 1.2% | | 81.5 | 0.993 | | | | | |
| | | Dunes South DB | 312D-2 | | 2.1% | | 85.0 | 1.807 | | | | | |
| | | Dunes South DB | 312D-3 | | 1.7% | | 85.0 | 1.421 | | | | | |
| | | Dunes South DB | 312F-1 | | 1.5% | | 85.0 | 1.305 | | | | | |
| | | Dunes South DB | 312F-2 | | 2.0% | | 85.0 | 1.683 | | | | | |
| | | Dunes South DB | 312E-3 | | 1.7% | | 85.0 | 1.421 | | | | | |
| | | Dunes South DB | 312E-4 | | 1.7% | | 85.0 | 1.421 | | | | | |
| | | Dunes South DB | 312G-3 | | 2.1% | | 84.8 | 1.814 | | | | | |
| | | Dunes South DB | 312G-6 | | 2.0% | | 85.0 | 1.661 | | | | | |
| | | Dunes South DB | 47A-1 | | 1.9% | | 20.0 | 0.382 | | | | | |
| | | Dunes South DB | 47A-2 | | 2.2% | | 25.7 | 0.570 | | | | | |

## Range

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious * \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Dunes South DB | 47A-3 | | 1.6% | | 22.8 | 0.366 | | | | | |
| | | Dunes South DB | 47A-4 | | 1.1% | | 25.9 | 0.275 | | | | | |
| | | Dunes South DB | 317-18 | | 1.1% | | 20.0 | 0.221 | | | | | |
| | | Dunes South DB | 317-17 | | 1.1% | | 20.0 | 0.224 | | | | | |
| | | Dunes South DB | 317-16 | | 1.7% | | 20.0 | 0.336 | | | | | |
| | | Dunes South DB | 317-20 | | 1.3% | | 44.8 | 0.573 | | | | | |
| | | Dunes South DB | 317-19 | | 1.7% | | 40.0 | 0.663 | | | | | |
| | | Dunes South DB | 317-11 | | 1.4% | | 9.2 | 0.127 | | | | | |
| | | Dunes South DB | 317-12 | | 1.5% | | 12.8 | 0.195 | | | | | |
| | | Dunes South DB | 317-7 | | 1.0% | | 60.6 | 0.592 | | | | | |
| | | Dunes South DB | 317-8 | | 1.5% | | 38.2 | 0.565 | | | | | |
| | | Dunes South DB | 46B-11 | | 2.7% | | 19.7 | 0.540 | | | | | |
| | | Dunes South DB | 312G-5 | | 1.0% | | 83.2 | 0.795 | | | | | |
| | | Dunes South DB | 312G-4 | | 1.6% | | 84.4 | 1.356 | | | | | |
| | | Dunes South DB | 312G-2 | | 2.8% | | 84.8 | 2.362 | | | | | |
| | | Dunes South DB | 312G-1 | | 1.3% | | 84.0 | 1.129 | | | | | |
| | | Dunes North DB | 48-2 | | 2.1% | | 77.6 | 1.626 | | | | | |
| | | Dunes North DB | 48-3 | | 2.9% | | 49.4 | 1.444 | | | | | |
| | | Dunes North DB | 48-4 | | 0.9% | | 64.0 | 0.599 | | | | | |
| | | Dunes North DB | 48-5 | | 2.0% | | 25.1 | 0.513 | | | | | |
| | | Dunes North DB | 46B-10 | | 2.8% | | 17.4 | 0.480 | | | | | |
| | | Dunes North DB | 46B-7 | | 1.1% | | 11.7 | 0.125 | | | | | |
| | | Dunes North DB | 46B-8 | | 2.2% | | 13.6 | 0.305 | | | | | |
| | | Dunes North DB | 46B-9 | | 2.3% | | 18.4 | 0.420 | | | | | |
| | | Dunes North DB | 48-1 | | 1.1% | | 83.8 | 0.896 | | | | | |
| | | Dunes North DB | 45-12 | | 2.1% | | 84.1 | 1.755 | | | | | |
| | | Dunes North DB | 45-13 | | 3.2% | | 84.3 | 2.667 | | | | | |

| Adjustment Factor | |
|---|---|
| Tributary Area | Adjustment Factor |
| 0 - <1 | 1.00 |
| 1 - <10 | 0.85 |
| 10 - <40 | 0.75 |
| 40 and greater | 0.65 |

## Range

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB<br>$\sum \%\ Impervious * \%\ of\ Total\ Area$ | Adjustment Factor<br>Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | Runoff Coeffcient, C<br>$C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in)<br>$P_O = (a * C)P_6$<br>$a = 1.299$<br>$P_6 = 0.37in$ | WQCV (AF)<br>$\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Dunes North DB | 45-11 | 14012 | 1.6% | 21.89 | 80.5 | 1.255 | 53.19 | 0.75 | 0.360 | 0.1731 | 151.6 |

# Upper Northwest Las Vegas Wash

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB<br>$\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor<br>Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | Runoff Coeffcient, C<br>$C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in)<br>$P_O = (a * C)P_6$<br>$a = 1.299$<br>$P_6 = 0.37in$ | WQCV (AF)<br>$\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lower Las Vegas Wash DB * | Elkhorn Springs DB<br>Sothern Environmental Enhancement Area<br>Northern Envirionmental Enhancement Area | | NW3D3-C | | 1.7% | | 55.4 | 0.961 | | | | | |
| | | | NW2C2-C | | 1.6% | | 41.4 | 0.680 | | | | | |
| | | | NW2D2-C | | 1.6% | | 36.4 | 0.598 | | | | | |
| | | | NW3A1-C | | 1.7% | | 69.4 | 1.209 | | | | | |
| | | | NW3A3-C | | 1.8% | | 66.5 | 1.211 | | | | | |
| | | | NW3B1-C | | 1.7% | | 56.4 | 0.987 | | | | | |
| | | | NW3B2-C | | 1.8% | | 57.8 | 1.018 | | | | | |
| | | | NN011-C | | 1.8% | | 74.9 | 1.368 | | | | | |
| | | | NN043-C | | 2.8% | | 71.3 | 1.995 | | | | | |
| | | | NW172-C | | 1.8% | | 33.7 | 0.617 | | | | | |
| | | | NW170-C | | 1.7% | | 30.9 | 0.530 | | | | | |
| | | | NW168-C | | 1.7% | | 30.1 | 0.515 | | | | | |
| | | | NW3A2-C | | 1.7% | | 28.2 | 0.479 | | | | | |
| | | | NW3B3-C | | 1.6% | | 28.8 | 0.473 | | | | | |
| | | | NW180-C | | 2.0% | | 32.8 | 0.665 | | | | | |
| | | | NW178-C | | 1.4% | | 27.9 | 0.382 | | | | | |
| | | | NW3A4-C | | 1.7% | | 30.0 | 0.517 | | | | | |
| | | | NW3B4-C | | 1.7% | | 30.6 | 0.519 | | | | | |
| | | | NW190-C | | 1.5% | | 47.6 | 0.700 | | | | | |
| | | | NW-188-C | | 1.7% | | 47.4 | 0.788 | | | | | |
| | | | NW3C2-C | | 3.3% | | 44.2 | 1.477 | | | | | |
| | | | NW200-C | | 1.5% | | 59.7 | 0.911 | | | | | |
| | | | NW189-C | | 1.7% | | 47.4 | 0.788 | | | | | |
| | | | NW3D4-C | | 1.7% | | 61.9 | 1.070 | | | | | |
| | | | NW109-C | | 2.9% | | 69.0 | 2.000 | | | | | |
| | | | NW139-C | | 3.4% | | 60.4 | 2.033 | | | | | |
| | | | NW138-C | | 1.6% | | 65.7 | 1.034 | | | | | |
| | | | NW2A2-C | | 1.2% | | 59.3 | 0.737 | | | | | |
| | | | NW2A4-C | | 1.2% | | 51.6 | 0.604 | | | | | |
| | | | NW2B2-C | | 1.6% | | 83.4 | 1.349 | | | | | |
| | | | NW165 | | 1.9% | | 0.8 | 0.016 | | | | | |
| | | | NW164 | | 2.0% | | 31.0 | 0.630 | | | | | |
| | | | NW155 | | 1.6% | | 27.0 | 0.444 | | | | | |
| | | | NW144E | | 0.7% | | 38.5 | 0.269 | | | | | |
| | | | NW163-C | | 2.4% | | 37.1 | 0.905 | | | | | |
| | | | NW162-C | | 1.7% | | 34.3 | 0.576 | | | | | |
| | | | NW150-C | | 1.6% | | 27.0 | 0.444 | | | | | |
| | | | NW161-C | | 2.2% | | 39.7 | 0.880 | | | | | |
| | | | NW159-C | | 1.7% | | 28.0 | 0.470 | | | | | |
| | | | NW2C3-C | | 1.5% | | 36.0 | 0.558 | | | | | |
| | | | NW2C4-C | | 1.7% | | 29.2 | 0.493 | | | | | |
| | | | NW-2D3-C | | 1.6% | | 45.0 | 0.700 | | | | | |
| | | | NW2D4-C | | 1.7% | | 30.9 | 0.512 | | | | | |

# Upper Northwest Las Vegas Wash

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | | NW45-S | | 1.8% | | 85.0 | 1.562 | | | | | |
| | | | NW62-S | | 1.4% | | 84.5 | 1.184 | | | | | |
| | | | NW74-C | | 1.7% | | 79.9 | 1.330 | | | | | |
| | | | NW72-C | | 3.0% | | 79.5 | 2.370 | | | | | |
| | | | NW71-W | | 0.7% | | 74.7 | 0.525 | | | | | |
| | | | NW71-E | | 1.6% | | 69.9 | 1.121 | | | | | |
| | | | NW55-C | | 2.2% | | 54.8 | 1.203 | | | | | |
| | | | NW89-C | | 2.3% | | 74.8 | 1.703 | | | | | |
| | | | NW103-C | | 2.6% | | 79.3 | 2.083 | | | | | |
| | | | NWBB1-C | | 0.9% | | 55.2 | 0.502 | | | | | |
| | | | NWBB3-C | | 1.2% | | 87.9 | 1.012 | | | | | |
| | | | NWBD2-N | | 0.7% | | 69.4 | 0.464 | | | | | |
| | | | NWBD2-S | | 1.0% | | 73.7 | 0.708 | | | | | |
| | | | NW147-E | 9480 | 1.2% | 14.81 | 11.4 | 0.140 | 51.02 | 0.75 | 0.3 | 0.2 | 98.5 |
| Southern Environmental Enhancement Area | | | | | | | | | | | | | |
| | | | NW144W | | 13.5% | | 7.7 | 1.040 | | | | | |
| | | | NW147W | | 4.6% | | 1.5 | 0.069 | | | | | |
| | | | NW111N | | 9.1% | | 45.1 | 4.085 | | | | | |
| | | | NW111S | | 4.7% | | 55.6 | 2.609 | | | | | |
| | | | NW114-C | | 7.4% | | 29.3 | 2.165 | | | | | |
| | | | NW96-C | | 12.2% | | 63.9 | 7.780 | | | | | |
| | | | NW75-C | | 19.3% | | 68.8 | 13.304 | | | | | |
| | | | NW78-C | | 5.0% | | 85.0 | 4.212 | | | | | |
| | | | NW62-N | | 5.5% | | 79.3 | 4.399 | | | | | |
| | | | NW115-C | | 9.2% | | 68.3 | 6.265 | | | | | |
| | | | NW100-W | 1468 | 9.5% | 2.29 | 84.9 | 8.103 | 54.03 | 0.85 | 0.4 | 0.2 | 18.3 |
| Elkhorn Springs DB | | | | | | | | | | | | | |
| | | | NW134-C | | 55.2% | | 68.4 | 37.742 | | | | | |
| | | | NW133-C | 538 | 44.8% | 0.84 | 65.3 | 29.271 | 67.01 | 1.00 | 0.5 | 0.2 | 10.1 |
| Northern Envirionmental Enhancement Area | | | | | | | | | | | | | |
| | | | NW116-C | | 9.2% | | 32.5 | 3.008 | | | | | |
| | | | NW129-C | | 10.7% | | 29.6 | 3.164 | | | | | |
| | | | NW128-C | | 33.3% | | 2.6 | 0.874 | | | | | |
| | | | NW157 | | 18.8% | | 18.1 | 3.397 | | | | | |
| | | | NW130-E | | 18.2% | | 26.8 | 4.878 | | | | | |
| | | | NW148-C | 867 | 9.9% | 1.35 | 0.6 | 0.063 | 15.38 | 0.85 | 0.1 | 0.1 | 4.2 |
| Upper Las Vegas Wash DB | | | | | | | | | | | | | |
| | | | 116-1 | | 0.8% | | 28.1 | 0.234 | | | | | |
| | | | 116-2 | | 1.6% | | 20.0 | 0.310 | | | | | |
| | | | 116-3 | | 0.6% | | 20.0 | 0.117 | | | | | |
| | | | 116-4 | | 0.7% | | 20.0 | 0.149 | | | | | |
| | | | 116-5 | | 1.0% | | 20.0 | 0.197 | | | | | |
| | | | 116-6 | | 0.9% | | 23.1 | 0.206 | | | | | |
| | | | 116-7 | | 2.3% | | 27.9 | 0.633 | | | | | |
| | | | 116-13 | | 0.5% | | 13.4 | 0.067 | | | | | |
| | | | 116-14 | | 1.0% | | 10.8 | 0.111 | | | | | |
| | | | 125A-2 | | 0.8% | | 78.6 | 0.619 | | | | | |
| | | | 125A-3 | | 0.5% | | 79.5 | 0.370 | | | | | |

# Upper Northwest Las Vegas Wash

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 : 1.00<br>1 - <10 : 0.85<br>10 - <40 : 0.75<br>40 and greater : 0.65 | | | |
| | | | 125A-4 | | 0.5% | | 81.2 | 0.368 | | | | | |
| | | | 125A-5 | | 0.8% | | 75.1 | 0.603 | | | | | |
| | | | 125A-6 | | 0.5% | | 85.0 | 0.406 | | | | | |
| | | | 125A-7 | | 0.5% | | 85.0 | 0.402 | | | | | |
| | | | 125A-8 | | 0.5% | | 58.3 | 0.284 | | | | | |
| | | | 125A-9 | | 0.5% | | 85.0 | 0.408 | | | | | |
| | | | 125A-10 | | 0.5% | | 85.0 | 0.411 | | | | | |
| | | | 125A-11 | | 0.5% | | 85.0 | 0.396 | | | | | |
| | | | 125A-12 | | 0.8% | | 52.1 | 0.434 | | | | | |
| | | | 125A-13 | | 0.4% | | 85.0 | 0.378 | | | | | |
| | | | 125A-14 | | 0.6% | | 33.4 | 0.190 | | | | | |
| | | | 125A-15 | | 0.9% | | 18.9 | 0.174 | | | | | |
| | | | 125B-1 | | 0.5% | | 77.8 | 0.364 | | | | | |
| | | | 125B-2 | | 0.5% | | 84.9 | 0.412 | | | | | |
| | | | 125B-3 | | 0.5% | | 85.0 | 0.401 | | | | | |
| | | | 125B-4 | | 0.4% | | 85.0 | 0.378 | | | | | |
| | | | 223C-3B | | 0.5% | | 57.5 | 0.287 | | | | | |
| | | | 223C-3A | | 0.5% | | 85.0 | 0.413 | | | | | |
| | | | 223C-2 | | 0.5% | | 85.0 | 0.400 | | | | | |
| | | | 223C-4 | | 0.8% | | 84.4 | 0.670 | | | | | |
| | | | 223C-5 | | 0.4% | | 85.0 | 0.370 | | | | | |
| | | | 223C-6 | | 0.6% | | 85.0 | 0.485 | | | | | |
| | | | 223C-7 | | 0.7% | | 67.7 | 0.469 | | | | | |
| | | | 223C-8 | | 0.5% | | 83.5 | 0.402 | | | | | |
| | | | 223C-9 | | 0.5% | | 85.0 | 0.410 | | | | | |
| | | | 223C-10 | | 0.6% | | 85.0 | 0.517 | | | | | |
| | | | 223C-11 | | 0.6% | | 85.0 | 0.509 | | | | | |
| | | | 223C-12 | | 0.7% | | 57.6 | 0.401 | | | | | |
| | | | 223C-13 | | 0.5% | | 83.7 | 0.418 | | | | | |
| | | | 223C-14 | | 0.6% | | 85.0 | 0.506 | | | | | |
| | | | 223C-15 | | 0.7% | | 85.0 | 0.583 | | | | | |
| | | | 223C-16 | | 0.5% | | 84.7 | 0.438 | | | | | |
| | | | 223C-17 | | 0.6% | | 84.2 | 0.533 | | | | | |
| | | | 223C-18 | | 0.8% | | 82.5 | 0.637 | | | | | |
| | | | 223C-19 | | 0.4% | | 81.3 | 0.361 | | | | | |
| | | | 223C-20 | | 0.4% | | 81.7 | 0.364 | | | | | |
| | | | 223C-21 | | 0.7% | | 29.2 | 0.211 | | | | | |
| | | | 223A-2 | | 0.7% | | 81.7 | 0.575 | | | | | |
| | | | 223A-3 | | 0.5% | | 83.2 | 0.382 | | | | | |
| | | | 223A-6 | | 0.5% | | 83.2 | 0.382 | | | | | |
| | | | 213A-7 | | 0.5% | | 83.2 | 0.383 | | | | | |
| | | | 213A-8 | | 0.5% | | 85.0 | 0.398 | | | | | |
| | | | 213A-9 | | 0.5% | | 83.9 | 0.387 | | | | | |
| | | | 213A-10 | | 0.5% | | 83.4 | 0.385 | | | | | |
| | | | 213A-11 | | 0.5% | | 85.0 | 0.398 | | | | | |
| | | | 213B-1 | | 0.5% | | 83.6 | 0.400 | | | | | |
| | | | 213B-2 | | 0.5% | | 85.0 | 0.407 | | | | | |
| | | | 213B-3 | | 0.5% | | 84.7 | 0.393 | | | | | |
| | | | 213B-4 | | 0.5% | | 84.9 | 0.397 | | | | | |
| | | | 213B-5 | | 0.4% | | 83.3 | 0.366 | | | | | |
| | | | 213B-6 | | 0.4% | | 85.0 | 0.380 | | | | | |
| | | | 213B-7 | | 0.5% | | 83.7 | 0.382 | | | | | |
| | | | NW5-C | | 0.5% | | 27.3 | 0.137 | | | | | |

# Upper Northwest Las Vegas Wash

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | | NW11-C | | 0.5% | | 32.5 | 0.161 | | | | | |
| | | | NW17-C | | 0.8% | | 59.0 | 0.464 | | | | | |
| | | | NW23-C | | 0.7% | | 62.3 | 0.429 | | | | | |
| | | | NW51-C | | 0.6% | | 64.0 | 0.359 | | | | | |
| | | | NW50-W | | 0.4% | | 65.2 | 0.262 | | | | | |
| | | | NW2-C | | 0.7% | | 38.7 | 0.279 | | | | | |
| | | | NW9-C | | 0.5% | | 62.4 | 0.311 | | | | | |
| | | | 213A-4 | | 0.5% | | 25.0 | 0.115 | | | | | |
| | | | OFF1A-4 | | 0.5% | | 22.8 | 0.114 | | | | | |
| | | | OFF1A-5 | | 0.8% | | 25.0 | 0.191 | | | | | |
| | | | OFF2A | | 0.6% | | 25.0 | 0.146 | | | | | |
| | | | OFF3 | | 0.4% | | 25.0 | 0.102 | | | | | |
| | | | OFF5-1 | | 0.5% | | 15.8 | 0.086 | | | | | |
| | | | OFF5-2 | | 0.7% | | 12.9 | 0.093 | | | | | |
| | | | NW1-C | | 0.5% | | 19.4 | 0.104 | | | | | |
| | | | NW2-C | | 0.7% | | 38.7 | 0.279 | | | | | |
| | | | NW7-C | | 0.9% | | 21.6 | 0.193 | | | | | |
| | | | NW9-C | | 0.5% | | 62.4 | 0.311 | | | | | |
| | | | NW33-C | | 0.4% | | 84.8 | 0.353 | | | | | |
| | | | NW45-N | | 0.7% | | 84.1 | 0.630 | | | | | |
| | | | NW35-C | | 0.5% | | 65.1 | 0.303 | | | | | |
| | | | 213A-2 | | 0.9% | | 24.2 | 0.222 | | | | | |
| | | | 213A-3 | | 0.7% | | 25.0 | 0.170 | | | | | |
| | | | OFF1A-2 | | 0.7% | | 24.2 | 0.171 | | | | | |
| | | | OFF4-1 | | 0.6% | | 18.3 | 0.101 | | | | | |
| | | | OFF1A-3 | | 0.6% | | 25.0 | 0.139 | | | | | |
| | | Northwest DB | 223B-2 | | 0.4% | | 84.8 | 0.327 | | | | | |
| | | Northwest DB | 223B-3 | | 0.5% | | 85.0 | 0.414 | | | | | |
| | | Northwest DB | 223B-4 | | 0.5% | | 85.0 | 0.409 | | | | | |
| | | Northwest DB | 223B-5 | | 0.6% | | 85.0 | 0.474 | | | | | |
| | | Northwest DB | 223B-6 | | 0.4% | | 17.4 | 0.065 | | | | | |
| | | Northwest DB | 223B-7 | | 0.4% | | 84.1 | 0.323 | | | | | |
| | | Northwest DB | 223C-1 | | 0.5% | | 85.0 | 0.391 | | | | | |
| | | Northwest DB | 125A-1 | | 0.6% | | 27.7 | 0.157 | | | | | |
| | | Northwest DB | 222-1 | | 0.5% | | 85.0 | 0.400 | | | | | |
| | | Northwest DB | 222-2 | | 0.5% | | 85.0 | 0.412 | | | | | |
| | | Northwest DB | 222-3 | | 0.5% | | 85.0 | 0.406 | | | | | |
| | | Northwest DB | 222-4 | | 0.8% | | 85.0 | 0.660 | | | | | |
| | | Northwest DB | 222-5 | | 0.5% | | 85.0 | 0.388 | | | | | |
| | | Northwest DB | 222-6 | | 0.5% | | 85.0 | 0.406 | | | | | |
| | | Northwest DB | 222-7 | | 0.6% | | 85.0 | 0.499 | | | | | |
| | | Northwest DB | 222-8 | | 0.5% | | 85.0 | 0.404 | | | | | |
| | | Northwest DB | 222-9 | | 0.5% | | 85.0 | 0.403 | | | | | |
| | | Northwest DB | 222-10 | | 0.5% | | 85.0 | 0.406 | | | | | |
| | | Northwest DB | 222-11 | | 0.8% | | 85.0 | 0.693 | | | | | |
| | | Northwest DB | 222-12 | | 0.5% | | 85.0 | 0.405 | | | | | |
| | | Northwest DB | 222-13 | | 0.5% | | 85.0 | 0.406 | | | | | |
| | | Northwest DB | 222-14 | | 0.5% | | 85.0 | 0.408 | | | | | |
| | | Northwest DB | 222-15 | | 0.6% | | 85.0 | 0.505 | | | | | |
| | | Northwest DB | 222-16 | | 0.5% | | 85.0 | 0.419 | | | | | |
| | | Northwest DB | 221-19 | | 0.6% | | 85.0 | 0.483 | | | | | |
| | | Northwest DB | 223B-1 | | 0.5% | | 85.0 | 0.419 | | | | | |
| | | Northwest DB | 223B-8 | | 0.5% | | 85.0 | 0.416 | | | | | |

# Upper Northwest Las Vegas Wash

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | Northwest DB | 223B-9 | | 0.5% | | 85.0 | 0.431 | | | | | |
| | | Northwest DB | 223B-10 | | 0.5% | | 85.0 | 0.404 | | | | | |
| | | Northwest DB | 223B-11 | | 0.5% | | 85.0 | 0.392 | | | | | |
| | | Northwest DB | 223B-12 | | 0.5% | | 85.0 | 0.401 | | | | | |
| | | Northwest DB | 223B-13 | | 0.5% | | 85.0 | 0.421 | | | | | |
| | | Northwest DB | 223B-14 | | 0.5% | | 85.0 | 0.451 | | | | | |
| | | Northwest DB | 223B-15 | | 0.5% | | 85.0 | 0.441 | | | | | |
| | | Northwest DB | 223B-16 | | 0.5% | | 85.0 | 0.444 | | | | | |
| | | Northwest DB | 223B-17 | | 0.7% | | 85.0 | 0.616 | | | | | |
| | | Northwest DB | 126A-1 | | 0.6% | | 84.9 | 0.507 | | | | | |
| | | Northwest DB | 126A-2 | | 0.8% | | 85.0 | 0.659 | | | | | |
| | | Northwest DB | 126A-3 | | 0.5% | | 85.0 | 0.394 | | | | | |
| | | Northwest DB | 126A-4 | | 0.5% | | 85.0 | 0.405 | | | | | |
| | | Northwest DB | 126A-5 | | 0.5% | | 85.0 | 0.407 | | | | | |
| | | Northwest DB | 126A-6 | | 0.5% | | 85.0 | 0.395 | | | | | |
| | | Northwest DB | 126A-7 | | 0.6% | | 85.0 | 0.530 | | | | | |
| | | Northwest DB | 126A-8 | | 0.5% | | 85.0 | 0.406 | | | | | |
| | | Northwest DB | 126A-9 | | 0.5% | | 85.0 | 0.388 | | | | | |
| | | Northwest DB | 126A-10 | | 0.5% | | 85.0 | 0.405 | | | | | |
| | | Northwest DB | 126A-11 | | 0.5% | | 85.0 | 0.405 | | | | | |
| | | Northwest DB | 126A-12 | | 0.5% | | 85.0 | 0.391 | | | | | |
| | | Northwest DB | 126A-13 | | 0.8% | | 85.0 | 0.721 | | | | | |
| | | Northwest DB | 126A-14 | | 0.5% | | 85.0 | 0.390 | | | | | |
| | | Northwest DB | 126A-15 | | 0.5% | | 85.0 | 0.412 | | | | | |
| | | Northwest DB | 126A-16 | | 0.5% | | 85.0 | 0.412 | | | | | |
| | | Northwest DB | 126A-17 | | 0.5% | | 85.0 | 0.399 | | | | | |
| | | Northwest DB | 126A-18 | | 0.5% | | 85.0 | 0.404 | | | | | |
| | | Northwest DB | 126A-19 | | 0.5% | | 85.0 | 0.391 | | | | | |
| | | Northwest DB | 126A-20 | | 0.5% | | 85.0 | 0.419 | | | | | |
| | | Northwest DB | 126A-21 | | 0.5% | | 85.0 | 0.415 | | | | | |
| | | Northwest DB | 126A-22 | | 0.5% | | 85.0 | 0.402 | | | | | |
| | | Northwest DB | 126A-23 | | 0.4% | | 85.0 | 0.355 | | | | | |
| | | Northwest DB | 126A-24 | | 0.5% | | 85.0 | 0.407 | | | | | |
| | | Northwest DB | 126A-25 | | 0.5% | | 85.0 | 0.400 | | | | | |
| | | Northwest DB | 126A-26 | | 0.9% | | 84.9 | 0.735 | | | | | |
| | | Northwest DB | 126B-1 | | 0.5% | | 85.0 | 0.387 | | | | | |
| | | Northwest DB | 126B-2 | | 0.5% | | 84.0 | 0.404 | | | | | |
| | | Northwest DB | 135-1 | | 0.8% | | 85.0 | 0.658 | | | | | |
| | | Northwest DB | 131-1 | | 0.5% | | 85.0 | 0.401 | | | | | |
| | | Northwest DB | 221-1 | | 0.5% | | 85.0 | 0.463 | | | | | |
| | | Northwest DB | 221-2 | | 0.7% | | 85.0 | 0.572 | | | | | |
| | | Northwest DB | 221-3 | | 0.7% | | 85.0 | 0.559 | | | | | |
| | | Northwest DB | 221-4 | | 0.9% | | 85.0 | 0.790 | | | | | |
| | | Northwest DB | 221-5 | | 0.5% | | 85.0 | 0.426 | | | | | |
| | | Northwest DB | 221-6 | | 0.6% | | 85.0 | 0.494 | | | | | |
| | | Northwest DB | 221-7 | | 0.6% | | 85.0 | 0.517 | | | | | |
| | | Northwest DB | 221-8 | | 0.5% | | 85.0 | 0.416 | | | | | |
| | | Northwest DB | 221-9 | | 0.5% | | 85.0 | 0.391 | | | | | |
| | | Northwest DB | 221-10 | | 0.4% | | 85.0 | 0.358 | | | | | |
| | | Northwest DB | 221-11 | | 0.4% | | 85.0 | 0.366 | | | | | |
| | | Northwest DB | 221-12 | | 0.5% | | 85.0 | 0.412 | | | | | |
| | | Northwest DB | 221-13 | | 0.4% | | 85.0 | 0.380 | | | | | |
| | | Northwest DB | 221-14 | | 0.7% | | 85.0 | 0.619 | | | | | |

## Upper Northwest Las Vegas Wash

| DB | Existing Tributary DB | Proposed Tributary DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious\ *\ \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.\ Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | Northwest DB | 221-15 | | 0.8% | | 85.0 | 0.662 | | | | | |
| | | Northwest DB | 221-16 | | 0.5% | | 85.0 | 0.402 | | | | | |
| | | Northwest DB | 221-17 | | 0.5% | | 85.0 | 0.416 | | | | | |
| | | Northwest DB | 221-18 | | 0.5% | | 85.0 | 0.410 | | | | | |
| | | Northwest DB | 221-19 | 34945 | 0.6% | 54.60 | 85.0 | 0.483 | 68.28 | 0.65 | 0.5 | 0.2 | 434.9 |
| Fort Apache DB | | | | | | | | | | | | | |
| | | | NWBA3-C | | 12.3% | | 68.3 | 8.376 | | | | | |
| | | | CDMNA1 | | 18.0% | | 68.4 | 12.337 | | | | | |
| | | | NW53-C | | 10.8% | | 39.5 | 4.275 | | | | | |
| | | | NW77-C | | 9.1% | | 44.1 | 4.001 | | | | | |
| | | | NWBA6-C | | 9.9% | | 43.5 | 4.293 | | | | | |
| | | | NWBC2-C | | 10.4% | | 43.4 | 4.529 | | | | | |
| | | | NW66-C | | 10.2% | | 62.0 | 6.303 | | | | | |
| | | | NW27-C | | 5.6% | | 68.5 | 3.805 | | | | | |
| | | | NW26-C | 1706 | 13.8% | 2.67 | 71.6 | 9.858 | 57.78 | 0.85 | 0.4 | 0.2 | 22.8 |
| Rancho Road DB | Fort Apache DB | | | | | | | | | | | | |
| | | | NW1C1-E | | 4.1% | | 63.1 | 2.616 | | | | | |
| | | | NW1A4-C | | 5.7% | | 42.7 | 2.446 | | | | | |
| | | | NW1C1-W | | 8.0% | | 83.1 | 6.652 | | | | | |
| | | | NWBE2-C | | 5.5% | | 71.3 | 3.917 | | | | | |
| | | | NWBC6-C | | 5.5% | | 82.4 | 4.497 | | | | | |
| | | | NWBC3 | | 8.9% | | 72.5 | 6.472 | | | | | |
| | | | NW62-S | | 4.6% | | 84.5 | 3.849 | | | | | |
| | | | NW74-C | | 5.4% | | 79.9 | 4.324 | | | | | |
| | | | NW72-C | | 9.7% | | 79.5 | 7.707 | | | | | |
| | | | NW71-W | | 2.3% | | 74.7 | 1.707 | | | | | |
| | | | NW71-E | | 5.2% | | 69.9 | 3.646 | | | | | |
| | | | NW55-C | | 7.1% | | 54.8 | 3.913 | | | | | |
| | | | NW89-C | | 7.4% | | 74.8 | 5.539 | | | | | |
| | | | NW103-C | | 8.5% | | 79.3 | 6.772 | | | | | |
| | | | NWBB1-C | | 3.0% | | 55.2 | 1.633 | | | | | |
| | | | NWBB3-C | | 3.7% | | 87.9 | 3.290 | | | | | |
| | | | NWBD2-N | | 2.2% | | 69.4 | 1.508 | | | | | |
| | | | NWBD2-S | 2915 | 3.1% | 4.56 | 73.7 | 2.303 | 72.79 | 0.85 | 0.5 | 0.3 | 51.7 |

* The Lower Las Vegas Wash DB is in the Lower Northern watershed but received additional flow from the Upper Northern watershed.

**Proposed DBs**

| Watershed | Proposed DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious * \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| **Gowan** | Village 22 DB | SV22-2 | | 77.4% | | 66.9 | 51.784 | | | | | |
| | | SV22-1 | 581 | 22.6% | 0.91 | 85.4 | 19.309 | 71.09 | 1.00 | 0.5 | 0.2 | 11.7 |
| | Lone Mountain-Beltway DB | CDMNA3 | | 7.8% | | 80.7 | 6.301 | | | | | |
| | | CDMNA2 | | 3.0% | | 66.2 | 1.975 | | | | | |
| | | EFPOA1 | | 5.2% | | 68.5 | 3.563 | | | | | |
| | | EFPOA2 | | 6.7% | | 68.7 | 4.607 | | | | | |
| | | EFPOB1 | | 8.6% | | 83.9 | 7.252 | | | | | |
| | | HLBW1-C | | 9.1% | | 84.2 | 7.699 | | | | | |
| | | WRWB1-C | | 5.6% | | 30.0 | 1.687 | | | | | |
| | | WRBW1 | | 10.0% | | 82.5 | 8.250 | | | | | |
| | | LWBW1 | | 10.7% | | 70.2 | 7.486 | | | | | |
| | | UVB1-S | | 7.4% | | 68.4 | 5.063 | | | | | |
| | | UVB1-1 | 2893 | 5.8% | 4.52 | 60.0 | 3.456 | 57.34 | 0.85 | 0.4 | 0.2 | 38.3 |
| **Upper Northwest Las Vegas Wash** | Northwest DB | 223B-2 | | 0.9% | | 84.8 | 0.727 | | | | | |
| | | 223B-3 | | 1.1% | | 85.0 | 0.921 | | | | | |
| | | 223B-4 | | 1.1% | | 85.0 | 0.910 | | | | | |
| | | 223B-5 | | 1.2% | | 85.0 | 1.054 | | | | | |
| | | 223B-6 | | 0.8% | | 17.4 | 0.143 | | | | | |
| | | 223B-7 | | 0.9% | | 84.1 | 0.718 | | | | | |
| | | 223C-1 | | 1.0% | | 85.0 | 0.868 | | | | | |
| | | 125A-1 | | 1.3% | | 27.7 | 0.349 | | | | | |
| | | 222-1 | | 1.0% | | 85.0 | 0.888 | | | | | |
| | | 222-2 | | 1.1% | | 85.0 | 0.916 | | | | | |
| | | 222-3 | | 1.1% | | 85.0 | 0.903 | | | | | |
| | | 222-4 | | 1.7% | | 85.0 | 1.467 | | | | | |
| | | 222-5 | | 1.0% | | 85.0 | 0.863 | | | | | |
| | | 222-6 | | 1.1% | | 85.0 | 0.903 | | | | | |
| | | 222-7 | | 1.3% | | 85.0 | 1.110 | | | | | |
| | | 222-8 | | 1.1% | | 85.0 | 0.899 | | | | | |
| | | 222-9 | | 1.1% | | 85.0 | 0.896 | | | | | |
| | | 222-10 | | 1.1% | | 85.0 | 0.902 | | | | | |
| | | 222-11 | | 1.8% | | 85.0 | 1.542 | | | | | |
| | | 222-12 | | 1.1% | | 85.0 | 0.900 | | | | | |
| | | 222-13 | | 1.1% | | 85.0 | 0.903 | | | | | |
| | | 222-14 | | 1.1% | | 85.0 | 0.908 | | | | | |
| | | 222-15 | | 1.3% | | 85.0 | 1.123 | | | | | |
| | | 222-16 | | 1.1% | | 85.0 | 0.932 | | | | | |
| | | 221-19 | | 1.3% | | 85.0 | 1.075 | | | | | |
| | | 223B-1 | | 1.1% | | 85.0 | 0.931 | | | | | |
| | | 223B-8 | | 1.1% | | 85.0 | 0.924 | | | | | |
| | | 223B-9 | | 1.1% | | 85.0 | 0.957 | | | | | |
| | | 223B-10 | | 1.1% | | 85.0 | 0.899 | | | | | |
| | | 223B-11 | | 1.0% | | 85.0 | 0.872 | | | | | |
| | | 223B-12 | | 1.0% | | 85.0 | 0.891 | | | | | |

**Proposed DBs**

| Watershed | Proposed DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious * \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Tributary Area / Adjustment Factor: 0 - <1: 1.00; 1 - <10: 0.85; 10 - <40: 0.75; 40 and greater: 0.65 | | | |
| | | 223B-13 | | 1.1% | | 85.0 | 0.936 | | | | | |
| | | 223B-14 | | 1.2% | | 85.0 | 1.002 | | | | | |
| | | 223B-15 | | 1.2% | | 85.0 | 0.981 | | | | | |
| | | 223B-16 | | 1.2% | | 85.0 | 0.987 | | | | | |
| | | 223B-17 | | 1.6% | | 85.0 | 1.370 | | | | | |
| | | 126A-1 | | 1.3% | | 84.9 | 1.127 | | | | | |
| | | 126A-2 | | 1.7% | | 85.0 | 1.466 | | | | | |
| | | 126A-3 | | 1.0% | | 85.0 | 0.876 | | | | | |
| | | 126A-4 | | 1.1% | | 85.0 | 0.902 | | | | | |
| | | 126A-5 | | 1.1% | | 85.0 | 0.906 | | | | | |
| | | 126A-6 | | 1.0% | | 85.0 | 0.878 | | | | | |
| | | 126A-7 | | 1.4% | | 85.0 | 1.179 | | | | | |
| | | 126A-8 | | 1.1% | | 85.0 | 0.902 | | | | | |
| | | 126A-9 | | 1.0% | | 85.0 | 0.863 | | | | | |
| | | 126A-10 | | 1.1% | | 85.0 | 0.900 | | | | | |
| | | 126A-11 | | 1.1% | | 85.0 | 0.901 | | | | | |
| | | 126A-12 | | 1.0% | | 85.0 | 0.869 | | | | | |
| | | 126A-13 | | 1.9% | | 85.0 | 1.603 | | | | | |
| | | 126A-14 | | 1.0% | | 85.0 | 0.867 | | | | | |
| | | 126A-15 | | 1.1% | | 85.0 | 0.916 | | | | | |
| | | 126A-16 | | 1.1% | | 85.0 | 0.915 | | | | | |
| | | 126A-17 | | 1.0% | | 85.0 | 0.886 | | | | | |
| | | 126A-18 | | 1.1% | | 85.0 | 0.899 | | | | | |
| | | 126A-19 | | 1.0% | | 85.0 | 0.870 | | | | | |
| | | 126A-20 | | 1.1% | | 85.0 | 0.932 | | | | | |
| | | 126A-21 | | 1.1% | | 85.0 | 0.923 | | | | | |
| | | 126A-22 | | 1.1% | | 85.0 | 0.894 | | | | | |
| | | 126A-23 | | 0.9% | | 85.0 | 0.790 | | | | | |
| | | 126A-24 | | 1.1% | | 85.0 | 0.905 | | | | | |
| | | 126A-25 | | 1.0% | | 85.0 | 0.890 | | | | | |
| | | 126A-26 | | 1.9% | | 84.9 | 1.635 | | | | | |
| | | 126B-1 | | 1.0% | | 85.0 | 0.860 | | | | | |
| | | 126B-2 | | 1.1% | | 84.0 | 0.899 | | | | | |
| | | 135-1 | | 1.7% | | 85.0 | 1.463 | | | | | |
| | | 131-1 | | 1.0% | | 85.0 | 0.891 | | | | | |
| | | 221-1 | | 1.2% | | 85.0 | 1.029 | | | | | |
| | | 221-2 | | 1.5% | | 85.0 | 1.271 | | | | | |
| | | 221-3 | | 1.5% | | 85.0 | 1.244 | | | | | |
| | | 221-4 | | 2.1% | | 85.0 | 1.757 | | | | | |
| | | 221-5 | | 1.1% | | 85.0 | 0.948 | | | | | |
| | | 221-6 | | 1.3% | | 85.0 | 1.098 | | | | | |
| | | 221-7 | | 1.4% | | 85.0 | 1.149 | | | | | |
| | | 221-8 | | 1.1% | | 85.0 | 0.925 | | | | | |
| | | 221-9 | | 1.0% | | 85.0 | 0.868 | | | | | |
| | | 221-10 | | 0.9% | | 85.0 | 0.797 | | | | | |
| | | 221-11 | | 1.0% | | 85.0 | 0.814 | | | | | |
| | | 221-12 | | 1.1% | | 85.0 | 0.916 | | | | | |

**Proposed DBs**

| Watershed | Proposed DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious * \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | 221-13 | | 1.0% | | 85.0 | 0.844 | | | | | |
| | | 221-14 | | 1.6% | | 85.0 | 1.377 | | | | | |
| | | 221-15 | | 1.7% | | 85.0 | 1.472 | | | | | |
| | | 221-16 | | 1.1% | | 85.0 | 0.894 | | | | | |
| | | 221-17 | | 1.1% | | 85.0 | 0.926 | | | | | |
| | | 221-18 | | 1.1% | | 85.0 | 0.912 | | | | | |
| | | 221-19 | 15715 | 1.3% | 24.55 | 85.0 | 1.075 | 83.70 | 0.75 | 0.6 | 0.3 | 304.2 |
| **Range** | Speedway North DB | 312B-1 | | 9.5% | | 19.7 | 1.872 | | | | | |
| | | 45-7 | | 39.6% | | 61.7 | 24.452 | | | | | |
| | | 45-6 | | 27.7% | | 62.0 | 17.157 | | | | | |
| | | 45-5 | 787 | 23.2% | 1.23 | 48.4 | 11.225 | 54.71 | 0.85 | 0.370 | 0.1781 | 9.9 |
| | Beltway DB | NN230-C | | 40.6% | | 76.4 | 30.988 | | | | | |
| | | 309-1 | 300 | 59.4% | 0.47 | 0.0 | 0.000 | 30.99 | 1.00 | 0.230 | 0.1108 | 2.8 |
| | Vandenberg North DB | 306A1 | | 5.5% | | 75.5 | 4.169 | | | | | |
| | | 306A2 | | 9.4% | | 62.2 | 5.826 | | | | | |
| | | 306A3 | | 7.7% | | 62.3 | 4.805 | | | | | |
| | | 306B1 | | 8.9% | | 62.0 | 5.519 | | | | | |
| | | 306B2 | | 9.4% | | 50.3 | 4.707 | | | | | |
| | | 306B3 | | 9.7% | | 50.9 | 4.955 | | | | | |
| | | 306B4 | | 8.0% | | 62.8 | 5.042 | | | | | |
| | | 306B5 | | 8.3% | | 53.6 | 4.449 | | | | | |
| | | 306B6 | | 7.6% | | 52.0 | 3.945 | | | | | |
| | | NN194-C | | 12.3% | | 68.8 | 8.481 | | | | | |
| | | NN207-C | | 8.5% | | 86.4 | 7.351 | | | | | |
| | | NN224-C | 2323 | 4.6% | 3.63 | 83.8 | 3.880 | 63.13 | 0.85 | 0.434 | 0.2084 | 34.3 |
| | Dunes South DB | 312D-1 | | 2.7% | | 81.5 | 2.238 | | | | | |
| | | 312D-2 | | 4.8% | | 85.0 | 4.072 | | | | | |
| | | 312D-3 | | 3.8% | | 85.0 | 3.202 | | | | | |
| | | 312F-1 | | 3.5% | | 85.0 | 2.939 | | | | | |
| | | 312F-2 | | 4.5% | | 85.0 | 3.791 | | | | | |
| | | 312E-3 | | 3.8% | | 85.0 | 3.202 | | | | | |
| | | 312E-4 | | 3.8% | | 85.0 | 3.202 | | | | | |
| | | 312G-3 | | 4.8% | | 84.8 | 4.087 | | | | | |
| | | 312G-6 | | 4.4% | | 85.0 | 3.741 | | | | | |
| | | 47A-1 | | 4.3% | | 20.0 | 0.860 | | | | | |
| | | 47A-2 | | 5.0% | | 25.7 | 1.285 | | | | | |
| | | 47A-3 | | 3.6% | | 22.8 | 0.825 | | | | | |
| | | 47A-4 | | 2.4% | | 25.9 | 0.620 | | | | | |
| | | 317-18 | | 2.5% | | 20.0 | 0.498 | | | | | |
| | | 317-17 | | 2.5% | | 20.0 | 0.505 | | | | | |
| | | 317-16 | | 3.8% | | 20.0 | 0.757 | | | | | |
| | | 317-20 | | 2.9% | | 44.8 | 1.292 | | | | | |
| | | 317-19 | | 3.7% | | 40.0 | 1.493 | | | | | |
| | | 317-11 | | 3.1% | | 9.2 | 0.286 | | | | | |

**Proposed DBs**

| Watershed | Proposed DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious * \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 : 1.00<br>1 - <10 : 0.85<br>10 - <40 : 0.75<br>40 and greater : 0.65 | | | |
| | | 317-12 | | 3.4% | | 12.8 | 0.438 | | | | | |
| | | 317-7 | | 2.2% | | 60.6 | 1.333 | | | | | |
| | | 317-8 | | 3.3% | | 38.2 | 1.272 | | | | | |
| | | 46B-11 | | 6.2% | | 19.7 | 1.216 | | | | | |
| | | 312G-5 | | 2.2% | | 83.2 | 1.790 | | | | | |
| | | 312G-4 | | 3.6% | | 84.4 | 3.054 | | | | | |
| | | 312G-2 | | 6.3% | | 84.8 | 5.320 | | | | | |
| | | 312G-1 | 6220 | 3.0% | 9.72 | 84.0 | 2.543 | 55.86 | 0.85 | 0.379 | 0.1819 | 80.2 |
| | Dunes North DB | 48-2 | | 8.6% | | 77.6 | 6.715 | | | | | |
| | | 48-3 | | 12.1% | | 49.4 | 5.962 | | | | | |
| | | 48-4 | | 3.9% | | 64.0 | 2.472 | | | | | |
| | | 48-5 | | 8.4% | | 25.1 | 2.116 | | | | | |
| | | 46B-10 | | 11.4% | | 17.4 | 1.983 | | | | | |
| | | 46B-7 | | 4.4% | | 11.7 | 0.518 | | | | | |
| | | 46B-8 | | 9.3% | | 13.6 | 1.258 | | | | | |
| | | 46B-9 | | 9.4% | | 18.4 | 1.733 | | | | | |
| | | 48-1 | | 4.4% | | 83.8 | 3.698 | | | | | |
| | | 45-12 | | 8.6% | | 84.1 | 7.246 | | | | | |
| | | 45-13 | | 13.1% | | 84.3 | 11.014 | | | | | |
| | | 45-11 | 3393 | 6.4% | 5.30 | 80.5 | 5.182 | 49.90 | 0.85 | 0.339 | 0.1627 | 39.1 |
| | Owens DB | OW2 | | 37.5% | | 34.2 | 12.825 | | | | | |
| | | OW3 | 122 | 62.5% | 0.19 | 20.1 | 12.542 | 25.37 | 1.00 | 0.200 | 0.0962 | 1.0 |
| | Orchard DB | 5OR | | 25.6% | | 0.0 | 0.000 | | | | | |
| | | 7OR | 468 | 74.4% | 0.73 | 0.8 | 0.628 | 0.63 | 1.00 | 0.045 | 0.0215 | 0.8 |
| **Flamingo/Tropicana** | Tropicana Wash-McCarran Airport DB | MC9 | | 12.1% | | 82.9 | 10.014 | | | | | |
| | | MC10 | | 12.0% | | 70.1 | 8.381 | | | | | |
| | | MC11 | | 13.0% | | 75.6 | 9.858 | | | | | |
| | | MC6A | | 7.7% | | 84.6 | 6.552 | | | | | |
| | | MC6B | | 4.3% | | 87.5 | 3.749 | | | | | |
| | | MC7A | | 4.3% | | 86.5 | 3.700 | | | | | |
| | | MC7B | | 6.3% | | 81.8 | 5.187 | | | | | |
| | | MC8 | | 11.8% | | 53.5 | 6.322 | | | | | |
| | | MC2 | | 4.6% | | 80.8 | 3.749 | | | | | |
| | | MC3 | | 4.4% | | 71.2 | 3.153 | | | | | |
| | | MC4 | | 6.5% | | 30.1 | 1.949 | | | | | |
| | | MC5 | | 4.2% | | 31.7 | 1.326 | | | | | |
| | | TBD20A | 2767 | 8.7% | 4.32 | 69.9 | 6.112 | 70.05 | 0.85 | 0.5 | 0.2 | 46.6 |
| **Duck Creek/Blue Diamond** | Silverado Ranch DB | DLD430 | | 17.1% | | 66.9 | 11.462 | | | | | |
| | | DMD360 | | 7.2% | | 58.7 | 4.255 | | | | | |
| | | DMD370 | | 14.2% | | 62.5 | 8.855 | | | | | |
| | | DMD320 | | 15.3% | | 58.6 | 8.948 | | | | | |
| | | DMD340 | | 20.3% | | 63.2 | 12.828 | | | | | |

**Proposed DBs**

| Watershed | Proposed DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious * \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 : 1.00<br>1 - <10 : 0.85<br>10 - <40 : 0.75<br>40 and greater : 0.65 | | | |
| | | DMD380W | | 7.4% | | 56.2 | 4.176 | | | | | |
| | | DMD330 | 1880 | 18.5% | 2.94 | 54.3 | 10.018 | 60.54 | 0.85 | 0.4 | 0.2 | 26.4 |
| | Birds Spring DB | DBS250 | | 4.9% | | 45.4 | 2.247 | | | | | |
| | | DBS240 | | 6.0% | | 62.0 | 3.724 | | | | | |
| | | DBS160 | | 5.1% | | 57.0 | 2.921 | | | | | |
| | | DBS260 | | 3.6% | | 54.1 | 1.930 | | | | | |
| | | DBS220 | | 5.8% | | 62.0 | 3.595 | | | | | |
| | | DBS150 | | 4.1% | | 62.0 | 2.546 | | | | | |
| | | DBS180 | | 5.3% | | 62.0 | 3.282 | | | | | |
| | | DBS210 | | 5.9% | | 62.0 | 3.641 | | | | | |
| | | DBS110 | | 6.3% | | 62.0 | 3.880 | | | | | |
| | | DBS140 | | 4.9% | | 62.0 | 3.054 | | | | | |
| | | DBS170 | | 4.5% | | 62.0 | 2.790 | | | | | |
| | | DBS200 | | 5.6% | | 61.8 | 3.432 | | | | | |
| | | DBS130 | | 4.3% | | 62.0 | 2.673 | | | | | |
| | | DBS100 | | 6.0% | | 58.1 | 3.487 | | | | | |
| | | DBS050 | | 5.7% | | 62.0 | 3.538 | | | | | |
| | | DBS080 | | 3.9% | | 55.2 | 2.169 | | | | | |
| | | DBS040 | | 6.1% | | 62.0 | 3.790 | | | | | |
| | | DBS070 | | 2.8% | | 62.0 | 1.721 | | | | | |
| | | DBS020 | | 5.7% | | 62.0 | 3.543 | | | | | |
| | | DBS030 | 5481 | 3.5% | 8.56 | 59.3 | 2.074 | 60.04 | 0.85 | 0.4 | 0.2 | 76.4 |
| **Pittman** | Pittman North DB | PND003X | | 9.5% | | 47.2 | 4.500 | | | | | |
| | | PND125C | | 4.2% | | 78.0 | 3.282 | | | | | |
| | | PCD060A | | 4.7% | | 64.2 | 2.989 | | | | | |
| | | PCD020X | | 4.6% | | 85.3 | 3.942 | | | | | |
| | | PND125B | | 4.0% | | 78.1 | 3.116 | | | | | |
| | | PND180X | | 6.2% | | 66.4 | 4.140 | | | | | |
| | | PND190X | | 7.6% | | 66.8 | 5.092 | | | | | |
| | | PND175X | | 3.4% | | 65.1 | 2.189 | | | | | |
| | | PND125A | | 7.5% | | 68.2 | 5.133 | | | | | |
| | | PND135X | | 3.5% | | 62.9 | 2.199 | | | | | |
| | | PND145X | | 3.2% | | 63.3 | 2.012 | | | | | |
| | | PND185X | | 4.0% | | 73.6 | 2.943 | | | | | |
| | | PND170X | | 6.1% | | 68.4 | 4.168 | | | | | |
| | | PND002X | | 8.2% | | 66.8 | 5.489 | | | | | |
| | | PND001X | | 6.5% | | 62.1 | 4.057 | | | | | |
| | | PND160X | | 6.9% | | 62.0 | 4.300 | | | | | |
| | | PND005X | | 4.9% | | 68.3 | 3.361 | | | | | |
| | | PND004X | 2672 | 4.9% | 4.18 | 80.8 | 3.917 | 66.83 | 0.85 | 0.5 | 0.2 | 42.3 |
| | Pittman West DB | PWD260 | | 2.5% | | 27.6 | 0.694 | | | | | |
| | | PWD200 | | 3.6% | | 62.0 | 2.217 | | | | | |
| | | PWD210 | | 4.0% | | 61.8 | 2.488 | | | | | |
| | | PWD230 | | 2.2% | | 62.0 | 1.364 | | | | | |
| | | PWD240 | | 3.4% | | 62.0 | 2.124 | | | | | |

**Proposed DBs**

| Watershed | Proposed DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious * \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 : 1.00<br>1 - <10 : 0.85<br>10 - <40 : 0.75<br>40 and greater : 0.65 | | | |
| | | PWD145 | | 2.2% | | 61.9 | 1.342 | | | | | |
| | | PWD150 | | 1.9% | | 62.0 | 1.189 | | | | | |
| | | PWD160 | | 2.2% | | 62.0 | 1.351 | | | | | |
| | | PWD170 | | 4.0% | | 62.0 | 2.498 | | | | | |
| | | PWD350C | | 1.6% | | 79.1 | 1.238 | | | | | |
| | | PWD350A | | 1.6% | | 73.4 | 1.155 | | | | | |
| | | PWD120 | | 3.7% | | 62.0 | 2.281 | | | | | |
| | | PWD330 | | 1.4% | | 81.2 | 1.134 | | | | | |
| | | PWD340 | | 1.5% | | 88.2 | 1.336 | | | | | |
| | | PWD345 | | 3.5% | | 66.5 | 2.330 | | | | | |
| | | PWD110 | | 3.0% | | 61.7 | 1.852 | | | | | |
| | | PWD090 | | 4.4% | | 62.0 | 2.753 | | | | | |
| | | PWD100 | | 2.8% | | 62.0 | 1.734 | | | | | |
| | | PWD310X | | 1.1% | | 83.3 | 0.908 | | | | | |
| | | PWD320 | | 2.2% | | 69.1 | 1.538 | | | | | |
| | | PWD325 | | 3.4% | | 62.0 | 2.085 | | | | | |
| | | PWD070 | | 4.3% | | 62.0 | 2.692 | | | | | |
| | | PWD080 | | 2.8% | | 62.0 | 1.735 | | | | | |
| | | PWD295 | | 2.2% | | 73.2 | 1.619 | | | | | |
| | | PWD315 | | 2.2% | | 65.3 | 1.421 | | | | | |
| | | PWD300 | | 6.5% | | 65.6 | 4.277 | | | | | |
| | | PWD050 | | 2.9% | | 62.0 | 1.827 | | | | | |
| | | PWD290 | | 3.2% | | 65.8 | 2.106 | | | | | |
| | | PWD040 | | 4.0% | | 62.0 | 2.511 | | | | | |
| | | PWD280 | | 3.7% | | 71.0 | 2.600 | | | | | |
| | | PWD020 | | 3.0% | | 62.0 | 1.832 | | | | | |
| | | PWD270A | 7888 | 8.9% | 12.33 | 41.2 | 3.687 | 61.92 | 0.75 | 0.4 | 0.2 | 100.4 |
| | Southeast Pittman DB | PSDSW8 | | 5.4% | | 70.4 | 3.832 | | | | | |
| | | OFFD1 | | 11.6% | | 51.1 | 5.918 | | | | | |
| | | PSDSW3 | | 6.6% | | 54.5 | 3.596 | | | | | |
| | | G8 | | 5.4% | | 68.7 | 3.740 | | | | | |
| | | PSDG7 | | 7.5% | | 39.1 | 2.937 | | | | | |
| | | PSDSW7 | | 10.5% | | 57.5 | 6.025 | | | | | |
| | | PSDSW6 | | 7.7% | | 39.6 | 3.057 | | | | | |
| | | PSDSW5 | | 5.2% | | 32.8 | 1.709 | | | | | |
| | | PSDSW4 | | 13.1% | | 44.4 | 5.802 | | | | | |
| | | PSDSW2 | | 3.1% | | 41.3 | 1.270 | | | | | |
| | | PSDSW1 | | 4.6% | | 36.0 | 1.641 | | | | | |
| | | G5 | | 4.0% | | 58.7 | 2.364 | | | | | |
| | | PSDG3 | | 11.7% | | 48.2 | 5.619 | | | | | |
| | | PSDG4 | 2010 | 3.6% | 3.14 | 50.6 | 1.841 | 49.35 | 0.85 | 0.3 | 0.2 | 22.9 |
| | Southwest Pittman DB | PSD000 | | 8.2% | | 62.1 | 5.120 | | | | | |
| | | GC10 | | 4.2% | | 49.8 | 2.070 | | | | | |
| | | PSD001 | | 7.5% | | 60.6 | 4.556 | | | | | |
| | | PSD080X | | 3.6% | | 72.0 | 2.594 | | | | | |

**Proposed DBs**

| Watershed | Proposed DB | Sub-Basins | Total Area (Acres) | % of Total Area | Total Area (SM) | % Impervious (i) | % Impervious * % of Total Area | % Impervious for DB $\sum \%\ Impervious * \%\ of\ Total\ Area$ | Adjustment Factor | Runoff Coeffcient, C $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ | Maximized Detention Volume, Po (Watershed in) $P_O = (a * C)P_6$ $a = 1.299$ $P_6 = 0.37in$ | WQCV (AF) $\frac{Total\ Area * P_O * Adj.Factor}{12\ in}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Tributary Area / Adjustment Factor<br>0 - <1 / 1.00<br>1 - <10 / 0.85<br>10 - <40 / 0.75<br>40 and greater / 0.65 | | | |
| | | PSD060 | | 5.9% | | 53.7 | 3.164 | | | | | |
| | | PSD015 | | 9.4% | | 63.8 | 6.031 | | | | | |
| | | PSD010 | 3672 | 61.1% | 5.74 | 45.9 | 28.064 | 51.60 | 0.85 | 0.3 | 0.2 | 43.7 |
| | Pittman Horizon Ridge DB | PPD125 | | 44.2% | | 60.7 | 26.848 | | | | | |
| | | PPD115 | 400 | 55.8% | 0.63 | 42.8 | 23.891 | 50.74 | 1.00 | 0.3 | 0.2 | 5.5 |
| | Whitney Wash DB | PDC075 | | 29.2% | | 72.8 | 21.274 | | | | | |
| | | PDC070 | 516 | 70.8% | 0.81 | 58.6 | 41.493 | 62.77 | 1.00 | 0.4 | 0.2 | 8.9 |
| | Pabco South Peaking Basin | PPA045 | | 14.9% | | 72.4 | 10.809 | | | | | |
| | | PPA040 | | 16.7% | | 72.4 | 12.054 | | | | | |
| | | PPA030 | | 20.9% | | 81.6 | 17.026 | | | | | |
| | | PPA020 | | 9.1% | | 63.4 | 5.756 | | | | | |
| | | PPA010 | | 24.4% | | 58.7 | 14.327 | | | | | |
| | | PPA050 | 1505 | 14.1% | 2.35 | 66.5 | 9.363 | 69.34 | 0.85 | 0.5 | 0.2 | 25.0 |
| | Pabco North Peaking Basin | PPA060 | | 21.3% | | 72.4 | 15.456 | | | | | |
| | | PPA100 | | 18.5% | | 77.2 | 14.262 | | | | | |
| | | PPA070 | | 14.4% | | 72.0 | 10.365 | | | | | |
| | | PPA080 | | 31.8% | | 72.0 | 22.882 | | | | | |
| | | PPA090 | 1196 | 14.0% | 1.87 | 72.1 | 10.091 | 73.06 | 0.85 | 0.5 | 0.3 | 21.3 |

# Attachment C –
# Detention Basin Log

| | Basin Info | | | | | | | | Basin Design | | | | | | | | | | | | Basin Operations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DB Name** | **ID-Mile** | **Watershed** | **System** | **Location** | **Facility Type** | **Tributary Area ($mile^2$)** | **Capacity (AF)** | **Required Expansion (AF)** | **Typical Length (ft)** | **Typical Width (ft)** | **Max. Design Depth (ft)** | **Freeboard (ft)** | **Basin Floor Cover** | **Typical Side Slope** | **Side Slope Cover** | **Outlet Type** | **Number of Outlets** | **Number of Inlets** | **Inlet Flow Bypass (Y/N)** | **Annual Sedimentation Storage (AF)** | **100 Y Flood Sedimentation Storage (AF)** | **100 Y Flood Capacity (AF)** | **100 Y Flood Inflow (CFS)** | **100 Y Flood Outflow (CFS)** | **Sedimentation Forebay or Basin (AF)** |
| **Carey Lake Mead DB** | LVLM0228 | Central | Las Vegas Wash Central | Simmons btwn Carey and Lake Mead | Off-Channel DB | 11.78 ◊ | 607 † | N/A † | N/A | N/A | N/A | 0.36 † | Compacted Earthfill * | 8:1 * | Compacted Earthfill * | 48" RCP Culvert * | 1 * | 2 * | Y * | 6.2 • | 87 • | 420 • | 5,184 † | 373 • | 118 • |
| **Rainbow DB **** | LCCH0513 | Central | Las Vegas Wash Central | Rainbow and Westcliff | On-Channel DB | 1.11 | 102 † | 57 † | N/A | N/A | N/A | 9.67 † | Soil Cement * | | N/A | Pipe Culvert * | 2 * | 1 * | Y * | | | | 970 † | 85 | |
| **Meadows DB **** | LCME0020 | Central | Las Vegas Wash Central | Valley View btwn Bonanza and Alta | Off-Channel DB | 7.76 * | 213 † | 22 † | N/A | N/A | 2,115.5 ◦ | 0.11 † | Wet Lands | 3:1 * | N/A | RCB Culvert * | 1 * | 1 * | Y * | | 14.89 | 228 ◦ | 4,713 † | 1,344 * | |
| **Oakey DB** | MECH0324 | Central | Las Vegas Wash Central | Torrey Pines btwn Oakey and O'Bannon | On-Channel DB | 1.84 ◦ | 201 † | N/A † | N/A | N/A | N/A | 3.74 † | Compacted Earthfill * | | N/A | RCB Culvert * | 1 * | 2 * | N * | | 50.26 | 147 | 1,652 † | 32 | |
| **Bruner DB** | DCW10251 | Duck Creek-Blue Diamond | Central | Bruner btwn Southern Highlands and Decatur | On-Channel DB | 1.23 ◊ | 109 † | N/A † | N/A | N/A | N/A | 1.27 † | Soil Cement * | 2:1 * | Rip Rap * | Arch Culvert * | 1 * | 1 * | N * | | | | 1,681 † | 257 | |
| **Central Duck Creek DB** | DCWA1658 | Duck Creek-Blue Diamond | Central | Starr btwn Jones and Decatur | On-Channel DB | 18.72 * | 1,046 † | 334 † | N/A | N/A | N/A | 1.61 † | Compacted Earthfill * | 3:1 * | Compacted Earthfill * | Pipe Culvert w/Orifice Plate * | 1 * | 1 * | Y * | | 0 | 1,046 * | 7,537 † | 326 * | |
| **Lower Blue Diamond DB** | BDWA0470 | Duck Creek-Blue Diamond | Blue Diamond Tributaries | Decatur btwn Robindale and Windmill | On-Channel DB | 5.54 ◊ | 380 † | N/A † | N/A | N/A | N/A | 1.03 † | Compacted Earthfill * | | N/A | Pipe Culvert * | 1 * | 2 * | Y * | | | | 3,701 † | 197 | |
| **Lower Duck Creek DB *** | DCWA1217 | Duck Creek-Blue Diamond | Lower Duck Creek/Blue Diamond | Richmar btwn Gillespie and Bermuda | On-Channel DB | 13.29 ◊ | 1,110 † | N/A † | N/A | N/A | N/A | 1.63 † | Compacted Earthfill * | 4:1 * | N/A | 8' x 8.15' Orifice * | 1 * | 3 * | Y * | | 185.7 ◦ | 1,110 † | 5,844 † | 400 ◦ | 205 ◦ |
| **Upper Duck Creek DB** | DCW40942 | Duck Creek-Blue Diamond | Upper Duck Creek/Blue Diamond | near Blue Diamond and Ft. Apache | On-Channel DB | 29.62 | 2,644 † | N/A † | N/A | N/A | N/A | 2.49 † | Compacted Earthfill * | | N/A | Pipe Culvert * | 1 * | 3 * | N * | | | | 13,098 † | 360 | |
| **McCarran DB **** | MCE20056 | Duck Creek/Blue Diamond | Lower Duck Creek/Blue Diamond | Sunset and Eastern | Off-Channel DB | 1.78 | 100 † | N/A † | N/A | N/A | N/A | 4.54 † | Soil Cement * | | N/A | Pipe Culvert | 1 * | 1 * | Y * | | | | 1,179 † | 74 | |
| **Upper Blue Diamond DB** | TRBD0930 | Flamingo-Tropicana | Tropicana-Flamingo Wash | Blue Diamond and Hualpai Way | On-Channel DB | 68.25 ◦ | 2,270 † | N/A † | 100 ◦ | 19.68 ◦ | N/A | 0 † | RCC and Rip Rap ◦ | 2.5:1 * | RCC ◦ | RCB Culvert ◦ | 1 * | 2 * | Y * | 15.9 ◦ | 238 ◦ | 2,370 ◦ | 13,800 † | 213 ◦ | 210 ◦ |
| **Desert Inn DB** | FLLA0308 | Flamingo-Tropicana | Flamingo-Decatur | Desert Inn and Rainbow | Off-Channel DB | 1.07 * | 62 † | N/A † | N/A | N/A | N/A | 0.27 † | Compacted Earthfill * | 3:1 * | N/A | RCP Culvert w/18" Orifice * | 1 * | 1 * | Y * | | 2 * | 62 * | 744 † | 30 * | 2 * |
| **F-4 Basin** | FLF40355 | Flamingo-Tropicana | Tropicana-Flamingo Wash | Fort Apache near Warm Springs | On-Channel Debris/Sediment Basin | 1.3 * | 21.85 * | N/A † | N/A | N/A | N/A | 5 * | Compacted Earthfill * | 3:1 * | Soil Cement ◦ | RCB Culvert * | 1 * | 1 * | Y * | 1.09 ◦ | 16.4 ◦ | 21.85 | 1,600 * | 2,100 | 21.9 ◦ |
| **Flamingo DB** | FLWA1443 | Flamingo-Tropicana | Tropicana-Flamingo Wash | Durango btwn Russell and Hacienda | On-Channel DB | 30.35 | 1,340 † | N/A † | N/A | N/A | N/A | 0 † | Compacted Earthfill ◦ | 6:1 * | N/A | Orifice w/Restrictor Plate ◦ | 1 * | 3 * | Y * | 24.1 ◦ | 138 ◦ | 1,911 ◦ | 11,800 † | 290 ◦ | 29.7 ◦ |
| **Lakes DB** | FLSM0087 | Flamingo-Tropicana | Flamingo-Decatur | Desert Breeze Park | On-Channel DB | 2.6 * | 143 † | 22 † | N/A | N/A | N/A | 0.31 † | Grass * | | N/A | 36" RCP | 1 * | 1 * | N * | | 0 | 143 * | 1,976 † | 85 * | |
| **R-4 DB** | RRR40160 | Flamingo-Tropicana | Tropicana-Flamingo Wash | btwn Desert Inn extended and Flamingo extended | On-Channel DB | 5.54 * | 362 † | N/A † | N/A | N/A | N/A | 0 † | Compacted Earthfill * | 3:1 * | RCC ◦ | RCP Culvert w/Orifice ◦ | 1 * | 1 * | N * | 3.9 ◦ | 58.2 ◦ | 391.2 * | 3,400 † | 370.8 * | 77.7 * |
| **Red Rock DB** | RRWA0716 | Flamingo-Tropicana | Tropicana-Flamingo Wash | Charleston west of the 215 Beltway | On-Channel DB | 55.2 * | 2,007 † | N/A † | N/A | N/A | N/A | 0 † | Compacted Earthfill * | 5:1 * | N/A | RCB Culvert w/Constrictor Plate ◦ | 1 * | 1 * | N * | 15 ◦ | 222 ◦ | 2000 * | 12,800 † | 182 * | 222 ◦ |

| Basin Features | | | | | Water Quality Planning Data | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DB Name | Water Quality Treatment (Y/N) | Construction Year | Planned Upgrade (Years) | In-Basin Recreation Facilities (Y/N) | Total Tributary Area ($mile^2$) | Intermediate Tributary Area ($mile^2$) | Developed Portion of Total Tributary Area ($mile^2$) | Developable Portion of Total Tributary Area ($mile^2$) | Final Downstream Basin (Y/N) | Strategic Basin (Y/N) | Number of Upstream Basins | Folder Location | Upgrade Prioritization | Comments | Developed Portion of Total Tributary Area (%) | Developable Portion of Total Tributary Area (%) |
| **Carey Lake Mead DB** | N | 1991 ⁺ | N | N | 11.78 | 11.78 | 7.068 | 4.712 | N | N | 0 † | Central | | Just S of NLV Airport, drains fully developed area, upstream of Cheyenne Peaking Basin, fairly close to LV Wash, several inlets and two outlets, outlet to Lake Meade Blvd drain captures low flows, according to predesign report. Probably best to treat near Lake Meade outlet since there are multiple inlets. MPU shows there are plans to revise upstream drains, need to check what this means to capacity and inflow locations | 60% | 40% |
| **Rainbow DB **** | N | | Y | N | 1.11 | 1.11 | 0.999 | 0.111 | Y | N | 0 † | Central | | Limited resources available. Fact Sheet in Central Folder. planned for upgrade, two connected basins, trib area fully developed, may be hard to modify based on irregular shape | 90% | 10% |
| **Meadows DB **** | Y | 1987 ◦ | Y | Y | 10.71 | 7.76 | 10.1745 | 0.5355 | Y | N | 2 † | Central | | Already has a low flow channel and some wetlands in place, will need to consider if water quality improvements are possible, it is fairly far downstream, drains a good size, fully developed area in the Las Vegas Creek Wash Watershed, planned for facility upgrade, part of the Springs Preserve trails, may be difficult to make modifications. However, could make good educational opportunity. | 95% | 5% |
| **Oakey DB** | N | 1992 ⁺ | N | N | 1.84 | 1.84 | 1.104 | 0.736 | N | N | 0 † | Central | | Limited resources available. Part of original study, fully developed drainage area, next to park, one inlet, one outlet, upstream of Meadows, so area could potentially be addressed at Meadows | 60% | 40% |
| **Bruner DB** | N | 2002 ⁺ | N | N | 1.23 | 1.23 | 0.0615 | 0.246 | N | N | 0 ⁺ | Duck Creek | | No design report. | 5% | 20% |
| **Central Duck Creek DB** | N | 2000 ⁺ | Y | N | 18.72 | 18.72 | 0 | 2.808 | N | N | 0 † | Duck Creek | | No design report. This area is either outside the ultimate development boundary or on a mountainous slope. captures some developed area, but is quite far out and doesn't include that much more developable area | 0% | 15% |
| **Lower Blue Diamond DB** | N | | N | N | 5.54 | 5.54 | 0.554 | 4.986 | N | N | 0 † | Duck Creek | | Limited resources available. | 10% | 90% |
| **Lower Duck Creek DB *** | N | 1999 | N | N | 38.78 | 13.29 | 1.939 | 23.268 | Y | Y | 3 † | Duck Creek | | Needs picture for fact sheet. Intermediate Tributary Area used, total also listed. on-channel, drains substantial developed area and has potential for new development, several inlets, one outlet | 5% | 60% |
| **Upper Duck Creek DB** | N | | N | N | 29.62 | 29.62 | 0 | 1.481 | N | N | 0 † | Duck Creek | | Limited resources available. This area is either outside the ultimate development boundary or on a mountainous slope. | 0% | 5% |
| **McCarran DB **** | N | | N | N | 1.78 | 1.78 | 1.78 | 0 | Y | N | 0 † | Duck Creek | | Limited resources available. Fact Sheet in Duck Creek/Blue Diamond Folder. | 100% | 0% |
| **Upper Blue Diamond DB** | N | 1998 ◦ | N | N | 68.25 | 68.25 | 0 | 0 | N | N | 0 ◦ | Duck Creek | | This area is either outside the ultimate development boundary or on a mountainous slope. | 0% | 0% |
| **Desert Inn DB** | N | 1999 ⁺ | N | N | 1.07 | 1.07 | 1.0165 | 0.0535 | N | N | 0 † | Flamingo-Tropicana | | included in original study, drainage area is developed with some vacant lots, two inlets at same location, one outlet | 95% | 5% |
| **F-4 Basin** | N | 1999 ◦ | N | N | 1.3 | 1.3 | 0 | 0.39 | N | N | 0 † | Flamingo-Tropicana | | This area is either outside the ultimate development boundary or on a mountainous slope. | 0% | 30% |
| **Flamingo DB** | N | 2009 ◦ | N | N | 98.36 | 30.35 | 4.918 | 29.508 | N | N | 5 † | Flamingo-Tropicana | | large surface area, good candidate in terms of both developed and undeveloped area, looked at previously, challenging with several inflow locations (for monitoring) | 5% | 30% |
| **Lakes DB** | Y | 2002 ⁺ | Proposed Only | Y | 2.6 | 2.6 | 2.47 | 0.13 | N | N | 0 † | Flamingo-Tropicana | | planned for capacity upgrade, part of Desert Breeze Park, detention area is covered with turf, fully developed drainage area | 95% | 5% |
| **R-4 DB** | N | 2002 ⁺ | N | N | 5.54 | 5.54 | 0 | 0 | N | N | 0 † | Flamingo-Tropicana | | This area is either outside the ultimate development boundary or on a mountainous slope. | 0% | 0% |
| **Red Rock DB** | N | 1995 ⁺ | N | N | 55.2 | 55.2 | 0 | 0 | N | N | 0 † | Flamingo-Tropicana | | This area is either outside the ultimate development boundary or on a mountainous slope. | 0% | 0% |

| | Basin Info | | | | | | | | Basin Design | | | | | | | | | | | Basin Operations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DB Name** | **ID-Mile** | **Watershed** | **System** | **Location** | **Facility Type** | **Tributary Area ($mile^2$)** | **Capacity (AF)** | **Required Expansion (AF)** | **Typical Length (ft)** | **Typical Width (ft)** | **Max. Design Depth (ft)** | **Freeboard (ft)** | **Basin Floor Cover** | **Typical Side Slope** | **Side Slope Cover** | **Outlet Type** | **Number of Outlets** | **Number of Inlets** | **Inlet Flow Bypass (Y/N)** | **Annual Sedimentation Storage (AF)** | **100 Y Flood Sedimentation Storage (AF)** | **100 Y Flood Capacity (AF)** | **100 Y Flood Inflow (CFS)** | **100 Y Flood Outflow (CFS)** | **Sedimentation Forebay or Basin (AF)** |
| **Tropicana DB and Outfall *** | TRWA0454 | Flamingo-Tropicana | Tropicana-Flamingo Wash | Decatur and Oquendo | On-Channel DB | 172.12 ◦ | 825 † | N/A † | 2779.92 ◦ | 19.69 ◦ | 38.66 ◦ | 0 † | Concrete ◦ | 3:1 * | Concrete ◦ | RCP Pipe Culvert * | 1 * | 2 * | N * | 15.4 ◦ | 71.42 ◦ | 1,669 ◦ | 6,700 † | 496.88 ◦ | 71.42 ◦ |
| **Upper Flamingo Wash DB** | FLWA1443 | Flamingo-Tropicana | | | | | | | | | | | | | | | | | | | | | | | |
| **Van Buskirk "C" DB **** | VBMC0161 | Flamingo-Tropicana | Lower Flamingo | Harmon btwn Paso El Rio and Bunker Ct | On-Channel DB | 2.95 | 16 † | N/A † | N/A | N/A | N/A | | Compacted Earthfill * | | N/A | Channel * | 1 * | 1 * | Y * | | | | 266 † | | |
| **Angel Park** | APNO0000 | Gowan | Gowan South | N Durango and Vegas Dr | On-Channel DB | 24 * | 1,400 † | 112 † | N/A | N/A | N/A | .31 † | Compacted Earthfill * | 3:1 * | Riprap * | Pipe Culvert * | 2 * | 3 * | Y * | | 0 | 1,400 | 9,199 † | 1,248 | |
| **Ann Road CAM 10 DB** | GOAN0061 | Gowan | North Gowan | Near Ann Rd and the 215 Beltway | On-Channel DB | 3.77 * | 364 † | 115 † | N/A | N/A | N/A | 1.07 † | Compacted Earthfill * | 4:1 * | N/A | RCP Culvert w/Orifice * | 1 * | 1 * | N * | | 40 * | 304 * | 6,028 † | 156 * | 40 * |
| **Cliff Shadow Park** | | Gowan | | | | | | | | | | | | | | | | | | | | | | | |
| **Gowan North DB** | GONO 0008 | Gowan | North Gowan | Gowan and Tenaya | On-Channel DB | 38 * | 921 † | N/A † | N/A | N/A | N/A | 0.26 † | Compacted Earthfill and Grass * | 4:1 * | N/A | Baffled Culvert * | 1 * | 2 * | Y * | | 80.74 | 840 * | 4,054 † | 560 * | |
| **Gowan South DB** | GOSO 0051 | Gowan | South Gowan | Cheyenne and Tenaya | On-Channel DB | 11.8 ◦ | 624 † | 62 † | N/A | N/A | N/A | 0.1 † | Soil Cement * | 4:1 * | N/A | Baffled Culvert * | 1 * | 2 * | N * | | 38.9 | 585 ◦ | 5,625 † | 370 * | |
| **Lone Mountain DB** | GOLM0146 | Gowan | Gowan North | N Hualapai and W Gowan | On-Channel DB | 11.71 * | 888 † | N/A † | N/A | N/A | N/A | 0 † | Compacted Earthfill * | 4:1 * | N/A | Pipe Culvert * | 1 * | 2 * | N * | | 144 | 744 * | 7,252 † | 497 * | |
| **Summerlin 5 DB** | APM50000 | Gowan | South Gowan | Sky Vista Dr near Alta | On-Channel DB | 6.77 * | 384 † | N/A † | N/A | N/A | N/A | 3.52 † | Compacted Earthfill * | 3:1 * | N/A | RCB Culvert * | 1 * | 1 * | N * | | 42 * | 335 * | 7,001 † | 2,227 * | 42 * |
| **Cheyenne Peaking Basin *** | LVMD1645 | Lower Northern | Cheyenne Lamb Nellis | btwn Gowan and Cheyenne | On-Channel DB | 76.6 ◦ | 456 † | 26 † | N/A | N/A | N/A | .24 † | Compacted Earthfill * | 4:1 UP 3:1 Down | N/A | RCB Culvert w/a 2' Pier Orifice | 1 | 1 | Y ◦ | | 15.76 | 440 ◦ | 11,998 † | 7,400 ◦ | |
| **North Las Vegas DB *** | LVUP0405 | Lower Northern | Las Vegas Wash Craig | near Beltway and Losee | On-Channel DB | 70.8 | 1,435 † | 780 † | N/A | N/A | N/A | 1.01 † | Compacted Earthfill * | | N/A | | 1 * | 2 * | | | | | 12,887 † | 11,740 | |
| **Lower Las Vegas Wash DB** | LVMD2050 | Lower Northern | Lower Western Tributary | Clayton St btwn Hammer Ln and W Washburn | On-Channel DB | 37.65 * | 700 † | N/A † | N/A | N/A | N/A | 11.69 † | Concrete & Compacted Earthfill * | 4:1 * | N/A | RCB Culvert * | 1 * | 1 * | Y * | | | | 6,729 † | 3,756 * | |
| **Lower Las Vegas Wash DU Wetlands 2 Weir** | LVMD0495 | Lower Las Vegas Wash | Lower Las Vegas Wash | | Weir and Bank Protection | | | | | | | | | | | | | | | | | | | | |
| **A Channel-Peaking Basin** | LVMD1645 | North Basin | | | | | | | | | | | | | | | | | | | | | | | |
| **Kyle Canyon DB ***** | LVMD3315 | Upper Northern | Upper Western Tributary | | Detention Basin | 57.73 | | | | | | | | | | | | | | | | 3200 | 13554 | | |
| **Upper Las Vegas Wash DB** | LVUP0910 | Upper Northern | Sheep Mountain | N Decatur near Iron Mountain | On-Channel DB | 144 * | 1,836 † | 1,411 † | N/A | N/A | N/A | 1.1 † | In-Situ Terrain | 3:1 * | N/A | RCB Culvert * | 1 * | 1 * | N * | | 74.9 | 1,760 * | 15,898 † | 4,240 * | |
| **North Environmental Enhancement DB @ Floyd Lamb Park** | TSDB0011 | Upper Northern | Upper Western Tributary | Iron Mtn and N Buffalo | On-Channel DB | 1.9 * | 117 † | N/A † | N/A | N/A | N/A | 1.37 † | Soil Cement * | 3:1 * | N/A | 36" Culvert w/22" Orifice * | 1 * | 2 * | N * | | 18.1 * | 97.7 * | 804 † | 30 * | 18.1 * |
| **South Environmental Enhancement DB @ Floyd Lamb Park** | BRDB0032 | Upper Northern | Upper Western Tributary | N Cimmaron and Racel St | On-Channel DB | 8.3 * | 450 † | N/A † | N/A | N/A | N/A | 5.99 † | Compacted Earthfill * | 3:1 * | N/A | 36" Culvert w/18" Orifice * | 2 * | 2 * | Y * | | 20.7 * | 440 * | 1,902 † | 43 * | 20.7 * |

| Basin Features | | | | | Water Quality Planning Data | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DB Name | Water Quality Treatment (Y/N) | Construction Year | Planned Upgrade (Years) | In-Basin Recreation Facilities (Y/N) | Total Tributary Area ($mile^2$) | Intermediate Tributary Area ($mile^2$) | Developed Portion of Total Tributary Area ($mile^2$) | Developable Portion of Total Tributary Area ($mile^2$) | Final Downstream Basin (Y/N) | Strategic Basin (Y/N) | Number of Upstream Basins | Folder Location | Upgrade Prioritization | Comments | Developed Portion of Total Tributary Area (%) | Developable Portion of Total Tributary Area (%) |
| **Tropicana DB and Outfall *** | N | 1997 ◦ | N | N | 338.7 | 172.12 | 33.87 | 135.48 | Y | Y | 7 † | Flamingo-Tropicana | | Drains area S of I-215 with room for development, also areas to the west including the Flamingo DB | 10% | 40% |
| **Upper Flamingo Wash DB** | | | N | | | | | | N | N | | Flamingo-Tropicana | | Same DB as Flamingo. | | |
| **Van Buskirk "C" DB **** | N | | N | N | 4.44 | 2.95 | 4.44 | 0 | Y | N | 1 † | | | Limited resources available. Fact Sheet in Flamingo/Tropicana Folder. captures small trib area of full development in center of LV, appears to have a low flow channel with one inlet and outlet that could potentially be improved for WQ | 100% | 0% |
| **Angel Park** | N | | Estimated Fund Schedule | N | 30.77 | 24 | 9.231 | 7.6925 | N | N | 1 † | Gowan | 85 | Limited resources available. Being retrofit as part of basin expansion project. | 30% | 25% |
| **Ann Road CAM 10 DB** | N | 2002 + | Proposed Only | N | 3.77 | 3.77 | 0 | 0 | N | N | 0 † | Gowan/Ann Road | | This area is either outside the ultimate development boundary or on a mountainous slope. | 0% | 0% |
| **Cliff Shadow Park** | | | N | | | | | | N | N | | Gowan/Cliff Shadow Park | | Drainage System, not a DB. | | |
| **Gowan North DB** | Y | 1992 + | N | Y | 96.71 | 38 | 29.013 | 19.342 | N | N | 5 † | Gowan | | Possible retrofit w/o affecting in-basin recreation. No report. furthest downstream DB in Gowan watershed, divided into two halves, may be best to have two WQCV basins, drains a lot of residential area | 30% | 20% |
| **Gowan South DB** | N | 1992 + | Proposed Only | Y | 42.57 | 11.8 | 40.4415 | 2.1285 | N | N | 2 † | Gowan | | Possible retrofit w/o affecting in-basin recreation near outlet. upgrade planned, downstream of Angel Park, upstream of Gowan North, trib area includes a lot of residential development, adjacent to a park and CLV offices, 2 inlets, 1 outlet, seems completely developed | 95% | 5% |
| **Lone Mountain DB** | N | 1995 + | N | Y | 16.14 | 11.71 | 0.807 | 0.807 | N | N | 1 † | Gowan/Loan Mountain DB | | In basin recreation at end of DB away from inlet/outlets. Could retrofit w/o affecting baseball fields. Need fact sheet pic. No design report. This area is either outside the ultimate development boundary or on a mountainous slope. upstream of Gowan North, drainage area is mostly developed residential, one inlet drains Lone Mountain Park, other drains developed area, one outlet, park facilities included | 5% | 5% |
| **Summerlin 5 DB** | N | 2001 + | N | N | 6.77 | 6.77 | 0 | 0 | N | N | 0 † | Gowan | | This area is either outside the ultimate development boundary or on a mountainous slope. | 0% | 0% |
| **Cheyenne Peaking Basin *** | N | | Proposed Only | N | 228.98 | 76.6 | 22.898 | 91.592 | Y | Y | 12 † | North Basin | | Downstream of Lower Las Vegas Wash DB, captures drainage from N Las Vegas along I-95, lots of already developed area, planned for upgrade to storage, furthest downstream along Western Trib to LV Wash. From aerial, channel can overflow into basin at high flows, probably not suitable for retrofit | 10% | 40% |
| **North Las Vegas DB *** | N | | Y | N | 214.8 | 70.8 | 0 | 42.96 | Y | Y | 1 † | | | Limited resources available. Fact Sheet in North Basin folder. Plan to upgrade to make much larger, downstream of undeveloped area, on the outskirts, but does have some planned development tributary area | 0% | 20% |
| **Lower Las Vegas Wash DB** | N | 1997 + | N | Y | 55.67 | 37.65 | 8.3505 | 33.402 | N | N | 5 † | Lower LVW | | No design report. Captures mainly upper Northern Watershed, lots of development in trib area, located along Western Tributary | 15% | 60% |
| **Lower Las Vegas Wash DU Wetlands 2 Weir** | | | N | | | | | | N | N | | Lower LVW | | Part of a channel... No need to evaluate. | | |
| **A Channel-Peaking Basin** | | | N | | | | | | N | N | | North Basin | | Same DB as Cheyenne Peaking Basin. | | |
| **Kyle Canyon DB ***** | | | N | | 57.73 | 57.73 | 0 | 0 | N | N | 0 † | North Basin | | No need to evaluate. This area is either outside the ultimate development boundary or on a mountainous slope. | 0% | 0% |
| **Upper Las Vegas Wash DB** | N | 1991 + | Proposed Only | N | 144 | 144 | 0 | 21.6 | N | N | 0 † | North Basin | | Drains undeveloped area, quite far out, but some of drainage area appears to be within development boundary | 0% | 15% |
| **North Environmental Enhancement DB @ Floyd Lamb Park** | N | 2010 + | N | Y | 1.9 | 1.9 | 0.095 | 0.76 | N | N | 0 † | Central | | | 5% | 40% |
| **South Environmental Enhancement DB @ Floyd Lamb Park** | N | 2010 + | N | Y | 8.3 | 8.3 | 2.49 | 2.49 | N | N | 0 † | Central | | | 30% | 30% |

| | Basin Info | | | | | | | | Basin Design | | | | | | | | | | | | Basin Operations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DB Name** | **ID-Mile** | **Watershed** | **System** | **Location** | **Facility Type** | **Tributary Area ($mile^2$)** | **Capacity (AF)** | **Required Expansion (AF)** | **Typical Length (ft)** | **Typical Width (ft)** | **Max. Design Depth (ft)** | **Freeboard (ft)** | **Basin Floor Cover** | **Typical Side Slope** | **Side Slope Cover** | **Outlet Type** | **Number of Outlets** | **Number of Inlets** | **Inlet Flow Bypass (Y/N)** | **Annual Sedimentation Storage (AF)** | **100 Y Flood Sedimentation Storage (AF)** | **100 Y Flood Capacity (AF)** | **100 Y Flood Inflow (CFS)** | **100 Y Flood Outflow (CFS)** | **Sedimentation Forebay or Basin (AF)** |
| **Desert Inn Trap Erosion Control Structure** | | Pittman/C-1 | | | | | | | | | | | | | | | | | | | | | | | |
| **Equestrian DB **** | C1EQ0159 | Pittman/C-1 | C-1 | Equestrian and Magic Way | On-Channel DB | 6.9 | 409 † | 135 † | N/A | N/A | N/A | .9 † | Compacted Earthfill * | | N/A | Pipe Culvert * | 2 * | 2 * | Y • | | | | 6,444 † | 5,880 | |
| **Northeast C1 DB and Outfall** | C1HV0140 | Pittman/C-1 | C-1 | Near Magic Way | On-Channel DB | 9.8 * | 353 † | N/A † | N/A | N/A | N/A | 1.11 † | Soil Cement * | 3:1 * | N/A | Pipe Culvert w/Orifice * | 1 * | 1 * | N * | | 32 * | 321 * | 2,520 † | 204 * | 32 * |
| **Pittman East DB** | PTEA0439 | Pittman/C-1 | Beltway | Volunteer Blvd and Sun City Anthem | On-Channel DB | 33 * | 1,718 † | N/A † | N/A | N/A | N/A | 8.12 † | Compacted Earthfill * | 3:1 * | N/A | RCP Culvert * | 1 * | 2 * | N * | 13.2 ◦ | 91 * | 1,718 * | 6,183 † | 1,221 * | 157 ◦ |
| **Pittman North DB and Outfall** | PTNO0182 | Pittman/C-1 | Upper Pittman | Gilespie and Volunteer Blvd | Off-Channel DB | 16.68 * | 600 † | N/A † | N/A | N/A | N/A | 0.98 † | | 4:1 * | N/A | Pipe Culvert w/Orifice * | 1 * | 1 * | Y * | | | 1,041.5 * | 5,476 † | 442 * | |
| **Pittman Park DB *** | PTWA0050 | Pittman/C-1 | Lower Pittman | Arroyo Grande and Santiago | Off-Channel DB | 32.8 ◦ | 75 † | N/A † | N/A | N/A | N/A | 2.48 † | Compacted Earthfill * | 3:1 * | Rip-Rap * | 24" RCP w/Flap Gate ◦ | 1 ◦ | 1 | Y ◦ | 4.11 ◦ | 41 ◦ | 62 ◦ | 889 † | 45 ◦ | 41 ◦ |
| **Railroad East DB** | | Pittman/C-1 | | | | | | | | | | | | | | | | | | | | | | | |
| **South Pittman DB** | PTCR0020 | Pittman/C-1 | Beltway | At the end of Crescent Heights Ave | Debris/Sediment Basin | 0.45 | | N/A † | N/A | N/A | N/A | | In-Situ Terrain | | N/A | | 0 * | 1 * | N * | | | | 536 † | N/A | |
| **Pioneer DB **** | PTVW0185 | Pittman/C-1 | Burns | Eastgate Btwn Boulder Highway and Sunset | Off-Channel DB | 7.66 ◦ | 377 † | 65 † | 1,840 | 190 (varies) | N/A | 1.15 † | Compacted Earthfill * | 3:1 * | Concrete * | RCP Pipe Culvert w/Orifice Plate * | 1 * | 1 * | Y * | 2 | 8.35 | 382 | 6,163 † | 421 ◦ | 18.4 |
| **Pittman Anthem** | PTAN0280 | Pittman/C-1 | Beltway | Bensley Street | On-Channel DB | 2.45 | 165 † | N/A † | N/A | N/A | N/A | 1.05 † | Compacted Earthfill | | N/A | Pipe Culvert | 0 | 1 | N * | | | | 1,737 † | | |
| **McCullough Hills Park** | PTPW0309 | Pittman/C-1 | Beltway | Reunion and McCullough Hills Pkwy | On-Channel DB | 5.29 | 355 † | N/A † | N/A | N/A | N/A | 2.67 † | Grass * | | N/A | Pipe Culvert | 2 | 1 | N * | | | | 4,136 † | | |
| **Range Wash Confluence DB *** | RWSL0501 | Lower Range | Range Wash | On/Near Nellis Air Force Base | On-Channel DB | 82.4 * | 1,025 † | N/A † | N/A | N/A | N/A | 1.39 † | Soil Cement * | 3:1 * | Soil Cement * | Pipe Culvert * | 1 * | 3 * | N * | 30 • | 160 • | 1,280 • | 6,081 † | 1,800 * | 130 • |
| **Vandenberg DB** | RWWE0170 | Range Wash | West Range | Donovan Way near N Lamb | On-Channel DB | 9.4 * | 349 † | N/A † | N/A | N/A | N/A | 4.90 † | Compacted Earthfill * | | N/A | Pipe Culvert * | 2 * | 2 * | Y * | | 4.1 | 340 * | 3,121 † | 283 * | |
| **West Range Wash DB** | | Range Wash | | | | | | | | | | | | | | | | | | | | | | | |
| **Mission Hills DB** | C1CH0854 | Pittman/C-1 | Beltway | Half Mile SW of Mission Hills Park | On-Channel DB ◊ | 9.3 ◊ | | N/A | N/A | N/A | N/A | | Compacted Earthfill ◊ | | | Pipe Culvert ◊ | 1 ◊ | 2 ◊ | N ◊ | | | 480 ◊ | 5371 ◊ | 309 ◊ | Y |

* Strategic Basins. These basins should be looked at first.
** Final detention basins that are not Strategic basins.
*** No need to Evaluate
† Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
◦ Value taken from a Final Design Memorandum
* Value taken from As-Builts
• Value taken from a Pre-Design Memorandum
◊ Value taken from CCRFCD website

| Basin Features | | | | | Water Quality Planning Data | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DB Name | Water Quality Treatment (Y/N) | Construction Year | Planned Upgrade (Years) | In-Basin Recreation Facilities (Y/N) | Total Tributary Area ($mile^2$) | Intermediate Tributary Area ($mile^2$) | Developed Portion of Total Tributary Area ($mile^2$) | Developable Portion of Total Tributary Area ($mile^2$) | Final Downstream Basin (Y/N) | Strategic Basin (Y/N) | Number of Upstream Basins | Folder Location | Upgrade Prioritization | Comments | Developed Portion of Total Tributary Area (%) | Developable Portion of Total Tributary Area (%) |
| **Desert Inn Trap Erosion Control Structure** | | | N | | | | | | N | N | | Pittman/C-1 | | Can't determine ID-Mile...? This area is either outside the ultimate development boundary or on a mountainous slope. | | |
| **Equestrian DB **** | N | | 2011-2012 | N | 21.43 | 6.9 | 2.143 | 0 | Y | N | 3 † | Pittman/C-1 | 90.5 | Retrofit completed as pilot project as part of expansion. drains some developed and some undeveloped area near edge of development boundary, last DB before C-1 Channel | 10% | 0% |
| **Northeast C1 DB and Outfall** | N | 2008 * | N | N | 24.33 | 9.8 | 0 | 0 | N | N | 3 † | Pittman/C-1 | | This area is either outside the ultimate development boundary or on a mountainous slope. | 0% | 0% |
| **Pittman East DB** | N | 2002 * | N | N | 56.47 | 33 | 0 | 0 | N | N | 1 † | Pittman/C-1 | | This area is either outside the ultimate development boundary or on a mountainous slope. | 0% | 0% |
| **Pittman North DB and Outfall** | N | N/A | N | N | | | | | N | N | N/A | Pittman/C-1 | 70 | Under construction. 10 year plan, second 5. Data taken from 90% design plans. | | |
| **Pittman Park DB *** | N | 1998 * | N | N | 116.75 | 32.8 | 93.4 | 0 | Y | Y | 6 † | Pittman/C-1 | | Needs picture for fact sheet. Double check if in basin recreation. This area is either outside the ultimate development boundary or on a mountainous slope. | 80% | 0% |
| **Railroad East DB** | | | N | | | | | | N | N | | Pittman/C-1 | | Conveyance System, not a DB. | | |
| **South Pittman DB** | N | 2004 * | N | N | 0.45 | 0.45 | 0 | 0 | N | N | 0 † | Pittman/C-1 | | Actually called Pittman Crescent Debris Basin. Limited resources available. This area is either outside the ultimate development boundary or on a mountainous slope. | 0% | 0% |
| **Pioneer DB **** | N | 1999 | Estimated Fund Schedule | N | 7.66 | 7.66 | 2.298 | 0.383 | Y | N | 0 † | Pittman/C-1 | 92.5 | evaluated in original study, pilot retrofit designed as part of upgrade, furthest downstream facility, captures lots of developed area but also some potential for new development in the hills to the south, one inlet location and one outlet | 30% | 5% |
| **Pittman Anthem** | N | | N | N | 7.74 | 2.45 | 0 | 0 | N | N | 1 † | | | Limited resources available. Fact Sheet in the Pittman/C-1 Folder. This area is either outside the ultimate development boundary or on a mountainous slope. | 0% | 0% |
| **McCullough Hills Park** | Y | | N | Y | 5.29 | 5.29 | 1.058 | 0.2645 | N | N | 0 † | | | Limited resources available. Fact Sheet in the Pittman/C-1 Folder. developed with ballfields in the storage area, drains a lot of developed neighborhood area, two inlets, one outlet | 20% | 5% |
| **Range Wash Confluence DB *** | N | 1995 * | N | N | 114.9 | 82.4 | 5.745 | 57.45 | Y | Y | 3 † | Range Wash | | This area is either outside the ultimate development boundary or on a mountainous slope. would capture some developed, but a lot of undeveloped area north of Nellis AFB, furthest downstream facility in Range Wash watershed, low flows from NW currently bypass DB and go down Sloan Channel, PD report states <600 cfs to Sloan channel, while capacity is much greater, may be potential for treatment of low flows with an in channel system. | 5% | 50% |
| **Vandenberg DB** | N | 2000 * | N | N | 9.44 | 9.44 | 0.472 | 1.888 | N | N | 0 † | Range Wash | 87 | evaluated in original study, on-channel facility (Range Wash), drains developed area with some potential for new development | 5% | 20% |
| **West Range Wash DB** | | | N | | | | | | N | N | | Range Wash | | Diversion dike, not a DB. | | |
| **Mission Hills DB** | N | | N | N ◊ | 13 | 9.33 | 0 | 0 | N | N | 1 ◊ | Pittman/C-1 | | | | |

* Strategic Basins. These ba
** Final detention basins tha
*** No need to Evaluate
† Value taken from the *Las V*
◦ Value taken from a Final De
* Value taken from As-Builts
• Value taken from a Pre-De
◊ Value taken from CCRFCD

# Attachment D –
# Watershed Comparisons

## C-1

| | Advantages | | | | | | | | | | | Disadvantages | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DB Name | Sediment storage allowance per CCRFCD design criteria: +1 | Dedicated sediment storage area with maintenance access (e.g., forebay): +1 | Final (most downstream) detention basin: +2 | Developable Area: <2mi$^2$ : 0 2-20mi$^2$ : 1 21-50mi$^2$ : 2 >50mi$^2$ : 3 | Over 3ft of free board: +1 | Side slopes flatter than 3:1: +1 | Wetland vegetation in basin floor: +2 | Basin upgrade planned for capacity improvements: +3 | Positive bonus points: +2 | Comments on Bonus Points | *Total* | Low flow bypass: -1 | Recreation facilities in main flood pool: -2 | Over 50% of tributary area outside ultimate development boundary: -1 | Basin upgrade recently completed, infeasible or never needed: -2 | Poor maintenance access: -1 | Multiple inlet structure: -1 | Multiple outlet structures: -1 | Little Room for Expansion -2 | Negative bonus points: -2 | Comments on Bonus Points | *Total* | *Normalized Score* | Developed Portion of Total Tributary Area (mile$^2$) | Developable Portion of Total Tributary Area (mile$^2$) | Developable + Developed (mile$^2$) | Maximum WQCV |
| Equestrian DB | 1 | | 2 | 1 | | | | | | | 7 | 4 | | 1 | | | 1 | 1 | | 2 | Already retrofitted as part of expansion project | 9 | 0.44 | 2.143 | 0 | 2.143 | 33.2 |
| Northeast C-1 DB | | | | | | | | | | | | | | | | | | | | | | | Insufficient Information | | | | 10.4 |
| Mission Hills DB | | | | | | | | | | | | | | | | | | | | | | | Insufficient Information | | | | 19.9 |

## Central Watershed

| | Advantages | | | | | | | | | | | Disadvantages | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DB Name | Sediment storage allowance per CCRFCD design criteria: +1 | Dedicated sediment storage area with maintenance access (e.g., forebay): +1 | Final (most downstream) detention basin: +2 | Developable Area: <2mi$^2$ : 0 2-20mi$^2$ : 1 21-50mi$^2$ : 2 >50mi$^2$ : 3 | Over 3ft of free board: +1 | Side slopes flatter than 3:1: +1 | Wetland vegetation in basin floor: +2 | Basin upgrade planned for capacity improvements: +3 | Positive bonus points: +2 | Comments on Bonus Points | *Total* | Low flow bypass: -4 | Recreation facilities in main flood pool: -2 | Over 50% of tributary area outside ultimate development boundary: -1 | Basin upgrade recently completed, infeasible or never needed: -2 | Poor maintenance access: -1 | Multiple inlet structure: -1 | Multiple outlet structures: -1 | Little Room for Expansion -2 | Negative bonus points: -2 | Comments on Bonus Points | *Total* | *Normalized Score* | Developed Portion of Total Tributary Area (mile$^2$) | Developable Portion of Total Tributary Area (mile$^2$) | Developable + Developed (mile$^2$) | Maximum WQCV |
| Meadows DB | 1 | | 2 | 1 | | | 2 | | 1 | Could be good demonstration project in Springs Preserve | 7 | 4 | 2 | | | | | | | | | 6 | 0.53 | 10.1745 | 0.5355 | 10.71 | 56.7 |
| Rainbow DB | 1 | | 2 | | 1 | | | 3 | | | 7 | 4 | | | | | | 1 | | | | 5 | 0.56 | 0.999 | 0.111 | 1.11 | 8.7 |
| Oakey DB | 1 | | | | 1 | | | | | | 2 | | | | | | 1 | | | | | 1 | 0.53 | 1.104 | 0.736 | 1.84 | 12.8 |
| Carey Lake Mead DB | 1 | 1 | | 1 | | | | | | | 3 | 4 | | | | | 1 | | | | | 5 | 0.44 | 7.068 | 4.712 | 11.78 | 79.2 |

## Duck Creek-Blue Diamond Watershed

| | Advantages | | | | | | | | | | | Disadvantages | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DB Name | Sediment storage allowance per CCRFCD design criteria: +1 | Dedicated sediment storage area with maintenance access (e.g., forebay): +1 | Final (most downstream) detention basin: +2 | Developable Area: <2mi$^2$ : 0 2-20mi$^2$ : 1 21-50mi$^2$ : 2 >50mi$^2$ : 3 | Over 3ft of free board: +1 | Side slopes flatter than 3:1: +1 | Wetland vegetation in basin floor: +2 | Basin upgrade planned for capacity improvements: +3 | Positive bonus points: +2 | Comments on Bonus Points | *Total* | Low flow bypass: -1 | Recreation facilities in main flood pool: -2 | Over 50% of tributary area outside ultimate development boundary: -1 | Basin upgrade recently completed, infeasible or never needed: -2 | Poor maintenance access: -1 | Multiple inlet structure: -1 | Multiple outlet structures: -1 | Little Room for Expansion -2 | Negative bonus points: -2 | Comments on Bonus Points | *Total* | *Normalized Score* | Developed Portion of Total Tributary Area (mile$^2$) | Developable Portion of Total Tributary Area (mile$^2$) | Developable + Developed (mile$^2$) | Maximum WQCV |
| Central Duck Creek DB | | | | 1 | | | | 3 | | | 4 | 4 | | 1 | | | | | | | | 5 | 0.47 | 0 | 2.808 | 2.808 | 47.5 |
| Bruner DB | 1 | | | | | 1 | | | | | 2 | | | 1 | | | | | | | | 1 | 0.53 | 0.0615 | 0.246 | 0.3075 | 90.4 |
| McCarran DB | 1 | | 2 | | 1 | | | | | | 4 | 4 | | | | | | | | | | 4 | 0.50 | 1.78 | 0 | 1.78 | 18.9 |
| Lower Duck Creek DB | 1 | 1 | 2 | 2 | | | | | | | 6 | 4 | | | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 7 | 0.47 | 1.939 | 23.268 | 25.207 | 114.1 |
| Upper Duck Creek DB | 1 | | | | | | | | | | 1 | | | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0.47 | 0 | 1.481 | 1.481 | 172.6 |
| Lower Blue Diamond | 1 | | | 1 | | | | | | | 2 | 4 | | | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 7 | 0.34 | 0.554 | 4.986 | 5.54 | 39.0 |
| Duck Creek Railroad | | | | | | | | | | | | | | | | | | | | | | | Insufficient Information | | | | 90.4 |

## Flamingo-Tropicana Watershed

| | Advantages | | | | | | | | | | | Disadvantages | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DB Name | Sediment storage allowance per CCRFCD design criteria: +1 | Dedicated sediment storage area with maintenance access (e.g., forebay): +1 | Final (most downstream) detention basin: +2 | Developable Area: <2mi$^2$ : 0 2-20mi$^2$ : 1 21-50mi$^2$ : 2 >50mi$^2$ : 3 | Over 3ft of free board: +1 | Side slopes flatter than 3:1: +1 | Wetland vegetation in basin floor: +2 | Basin upgrade planned for capacity improvements: +3 | Positive bonus points: +2 | Comments on Bonus Points | *Total* | Low flow bypass: -1 | Recreation facilities in main flood pool: -2 | Over 50% of tributary area outside ultimate development boundary: -1 | Basin upgrade recently completed, infeasible or never needed: -2 | Poor maintenance access: -1 | Multiple inlet structure: -1 | Multiple outlet structures: -1 | Little Room for Expansion -2 | Negative bonus points: -2 | Comments on Bonus Points | *Total* | *Normalized Score* | Developed Portion of Total Tributary Area (mile$^2$) | Developable Portion of Total Tributary Area (mile$^2$) | Developable + Developed (mile$^2$) | Maximum WQCV |
| Lakes DB | | | | 1 | | | 2 | 3 | | | 6 | | 2 | 1 | | | | | 2 | | | 5 | 0.53 | 2.47 | 0.13 | 2.6 | 26.1 |
| Tropicana DB and Outfall | 1 | | 2 | 3 | | | 2 | | | | 8 | | | | | | 1 | | | | | 1 | 0.72 | 33.87 | 135.48 | 169.35 | 116.3 |
| R4 DB | 1 | 1 | | | | | | | | | 2 | | | | | | | | | | | | 0.56 | 0 | 0 | 0 | |
| Red Rock DB | 1 | | | | | | | | | | 1 | | | 1 | | | | | | | | 1 | 0.50 | 0 | 0 | 0 | 14.6 |
| Upper Blue Diamond DB | 1 | 1 | | | | 1 | | | | | 3 | 4 | | 1 | | | 1 | | | | | 6 | 0.41 | 0 | 0 | 0 | 60.0 |
| Flamingo DB | 1 | 1 | | 2 | | | | | | | 4 | 4 | | 1 | | | 1 | | 2 | | | 8 | 0.38 | 4.918 | 29.508 | 34.426 | 142.7 |
| Desert Inn DB | 1 | | | | | | | | | | 1 | 4 | | | | | | | 2 | | | 6 | 0.34 | 1.0165 | 0.0535 | 1.07 | 6.0 |
| Lower Flamingo | | | | | | | | | | | | | | | | | | | | | | | Insufficient Information | | | | 78.2 |
| Tropicana Wash- North Branch | | | | | | | | | | | | | | | | | | | | | | | Insufficient Information | | | | 18.1 |

## Gowan Watershed

| | Advantages | | | | | | | | | | | Disadvantages | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DB Name | Sediment storage allowance per CCRFCD design criteria: +1 | Dedicated sediment storage area with maintenance access (e.g., forebay): +1 | Final (most downstream) detention basin: +2 | Developable Area: <2mi$^2$ : 0 2-20mi$^2$ : 1 21-50mi$^2$ : 2 >50mi$^2$ : 3 | Over 3ft of free board: +1 | Side slopes flatter than 3:1: +1 | Wetland vegetation in basin floor: +2 | Basin upgrade planned for capacity improvements: +3 | Positive bonus points: +2 | Comments on Bonus Points | *Total* | Low flow bypass: -1 | Recreation facilities in main flood pool: -2 | Over 50% of tributary area outside ultimate development boundary: -1 | Basin upgrade recently completed, infeasible or never needed: -2 | Poor maintenance access: -1 | Multiple inlet structure: -1 | Multiple outlet structures: -1 | Little Room for Expansion -2 | Negative bonus points: -2 | Comments on Bonus Points | *Total* | *Normalized Score* | Developed Portion of Total Tributary Area (mile$^2$) | Developable Portion of Total Tributary Area (mile$^2$) | Developable + Developed (mile$^2$) | Maximum WQCV |
| Angel Park | | | | 1 | | | | 3 | | | 4 | 4 | | 1 | | | 1 | 1 | | 2 | Already retrofitted as part of expansion project | 9 | 0.34 | 9.231 | 7.6925 | 16.9235 | 112.3 |
| Cheyenne Peaking Basin | 1 | | 2 | 3 | | | | 3 | 1 | Picks up multiple tributaries; more effective | 10 | 4 | | | | | | | | | | 4 | 0.69 | 22.898 | 91.592 | 114.49 | 83.3 |
| Gowan South DB | 1 | | | 2 | | | | 3 | 2 | Offsets rec score because can add WQ facilities in other areas | 8 | | 2 | | | | 1 | | | | | 3 | 0.66 | 40.4415 | 2.1285 | 42.57 | 88.9 |
| Ann Road CAM 10 DB | 1 | | | | | | | 3 | | | 4 | | | 1 | | | | | | | | 1 | 0.59 | | | | 29.7 |
| Summerlin 5 DB | 1 | | | | 1 | | | | | | 2 | | | 1 | | | | | | | | 1 | 0.53 | | | | 15.9 |
| Lone Mountain DB | 1 | | | | | | | | 2 | Offsets rec score because can add WQ facilities in other areas | 3 | | 2 | 1 | | | 1 | | | | | 4 | 0.47 | 0.807 | 0.807 | 1.614 | 38.3 |
| Gowan North DB | 1 | | | 2 | | | 2 | | 2 | Offsets rec score because can add WQ facilities in other areas | 7 | 4 | 2 | | | | 1 | | 2 | | | 9 | 0.44 | 29.013 | 19.342 | 48.355 | 85.8 |
| Village 26 DB | | | | | | | | | | | | | | | | | | | | | | | Insufficient Information | | | | 12.5 |

## Lower Northern Las Vegas Watershed

| | Advantages | | | | | | | | | | | Disadvantages | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DB Name | Sediment storage allowance per CCRFCD design criteria: +1 | Dedicated sediment storage area with maintenance access (e.g., forebay): +1 | Final (most downstream) detention basin: +2 | Developable Area: <2mi$^2$ : 0 2-20mi$^2$ : 1 21-50mi$^2$ : 2 >50mi$^2$ : 3 | Over 3ft of free board: +1 | Side slopes flatter than 3:1: +1 | Wetland vegetation in basin floor: +2 | Basin upgrade planned for capacity improvements: +3 | Positive bonus points: +2 | Comments on Bonus Points | *Total* | Low flow bypass: -1 | Recreation facilities in main flood pool: -2 | Over 50% of tributary area outside ultimate development boundary: -1 | Basin upgrade recently completed, infeasible or never needed: -2 | Poor maintenance access: -1 | Multiple inlet structure: -1 | Multiple outlet structures: -1 | Little Room for Expansion -2 | Negative bonus points: -2 | Comments on Bonus Points | *Total* | *Normalized Score* | Developed Portion of Total Tributary Area (mile$^2$) | Developable Portion of Total Tributary Area (mile$^2$) | Developable + Developed (mile$^2$) | Maximum WQCV |
| North Las Vegas DB | 1 | | 2 | 2 | | | | 3 | | | 8 | | | 1 | | | 1 | | | | | 2 | 0.69 | 0 | 42.96 | 42.96 | 101.8 |
| Cheyenne Peaking Basin | 1 | | 2 | 3 | | | | 3 | 1 | Picks up multiple tributaries; more effective | 10 | 4 | | | | | | | | | | 4 | 0.69 | 22.898 | 91.592 | 114.49 | 92.9 |
| Lower Las Vegas Wash DB | 1 | | | 2 | 1 | | 2 | | 1 | Considered previously as possible pilot project | 7 | 4 | 2 | | | | | | | 2 | | 8 | 0.47 | 8.3505 | 33.402 | 41.7525 | 21.9 |

## Pittman

| | Advantages | | | | | | | | | | | Disadvantages | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DB Name | Sediment storage allowance per CCRFCD design criteria: +1 | Dedicated sediment storage area with maintenance access (e.g., forebay): +1 | Final (most downstream) detention basin: +2 | Developable Area: <2mi$^2$ : 0 2-20mi$^2$ : 1 21-50mi$^2$ : 2 >50mi$^2$ : 3 | Over 3ft of free board: +1 | Side slopes flatter than 3:1: +1 | Wetland vegetation in basin floor: +2 | Basin upgrade planned for capacity improvements: +3 | Positive bonus points: +2 | Comments on Bonus Points | *Total* | Low flow bypass: -1 | Recreation facilities in main flood pool: -2 | Over 50% of tributary area outside ultimate development boundary: -1 | Basin upgrade recently completed, infeasible or never needed: -2 | Poor maintenance access: -1 | Multiple inlet structure: -1 | Multiple outlet structures: -1 | Little Room for Expansion -2 | Negative bonus points: -2 | Comments on Bonus Points | *Total* | *Normalized Score* | Developed Portion of Total Tributary Area (mile$^2$) | Developable Portion of Total Tributary Area (mile$^2$) | Developable + Developed (mile$^2$) | Maximum WQCV |
| Pioneer DB | 1 | 1 | 2 | 1 | | | | | | | 8 | 4 | | 1 | | | | | | 2 | Already retrofitted as part of expansion project | 7 | 0.53 | 2.298 | 0.383 | 2.681 | 54.5 |
| Pittman Park DB | 1 | | 2 | 3 | | | | | | | 6 | 4 | | | | | | | | | | 4 | 0.56 | 93.4 | 0 | 93.4 | 315.5 |
| Pittman East DB | 1 | 1 | | | 1 | | | | | | 3 | | | 1 | | | 1 | | | | | 2 | 0.53 | 0 | 0 | 0 | 45.4 |
| McCullough Hills Park | 1 | | | | | | 2 | | | | 3 | | 2 | 1 | | | | 1 | | | | 4 | 0.47 | 1.058 | 0.2645 | 1.3225 | 17.6 |
| Cactus DB | | | | | | | | | | | | | | | | | | | | | | | Insufficient Information | | | | 16.6 |

## Range Watershed

| | Advantages | | | | | | | | | | | Disadvantages | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DB Name | Sediment storage allowance per CCRFCD design criteria: +1 | Dedicated sediment storage area with maintenance access (e.g., forebay): +1 | Final (most downstream) detention basin: +2 | Developable Area: <2mi$^2$ : 0 2-20mi$^2$ : 1 21-50mi$^2$ : 2 >50mi$^2$ : 3 | Over 3ft of free board: +1 | Side slopes flatter than 3:1: +1 | Wetland vegetation in basin floor: +2 | Basin upgrade planned for capacity improvements: +3 | Positive bonus points: +2 | Comments on Bonus Points | *Total* | Low flow bypass: -4 | Recreation facilities in main flood pool: -2 | Over 50% of tributary area outside ultimate development boundary: -1 | Basin upgrade recently completed, infeasible or never needed: -2 | Poor maintenance access: -1 | Multiple inlet structure: -1 | Multiple outlet structures: -1 | Little Room for Expansion -2 | Negative bonus points: -2 | Comments on Bonus Points | *Total* | *Normalized Score* | Developed Portion of Total Tributary Area (mile$^2$) | Developable Portion of Total Tributary Area (mile$^2$) | Developable + Developed (mile$^2$) | Maximum WQCV (AF) |
| Speedway #2 Retention Basin | | | | | | | | | | | | | | | | | | | | | | | Insufficient Information | | | | 4.5 |
| Speedway #3 Retention Basin | | | | | | | | | | | | | | | | | | | | | | | Insufficient Information | | | | 19.8 |
| Range Wash Confluence DB | 1 | 1 | 2 | 3 | | | | | 1 | Large and easy to work in; picks up multiple tribs | 8 | 4 | | | | | 1 | | | | | 5 | 0.52 | 5.745 | 57.45 | 63.195 | 151.6 |
| Vandenberg DB | 1 | | | 1 | 1 | | | | | | 3 | 4 | | 1 | | | 1 | 1 | | | | 7 | 0.26 | 0.472 | 1.888 | 2.36 | 79.3 |
| Speedway #1 DB | | | | | | | | | | | | | | | | | | | | | | | Insufficient Information | | | | 17.4 |

## Upper Northern Las Vegas Watershed

| | Advantages | | | | | | | | | | | Disadvantages | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DB Name | Sediment storage allowance per CCRFCD design criteria: +1 | Dedicated sediment storage area with maintenance access (e.g., forebay): +1 | Final (most downstream) detention basin: +2 | Developable Area: <2mi$^2$ : 0 2-20mi$^2$ : 1 21-50mi$^2$ : 2 >50mi$^2$ : 3 | Over 3ft of free board: +1 | Side slopes flatter than 3:1: +1 | Wetland vegetation in basin floor: +2 | Basin upgrade planned for capacity improvements: +3 | Positive bonus points: +2 | Comments on Bonus Points | *Total* | Low flow bypass: -1 | Recreation facilities in main flood pool: -2 | Over 50% of tributary area outside ultimate development boundary: -1 | Basin upgrade recently completed, infeasible or never needed: -2 | Poor maintenance access: -1 | Multiple inlet structure: -1 | Multiple outlet structures: -1 | Little Room for Expansion -2 | Negative bonus points: -2 | Comments on Bonus Points | *Total* | *Normalized Score* | Developed Portion of Total Tributary Area (mile$^2$) | Developable Portion of Total Tributary Area (mile$^2$) | Developable + Developed (mile$^2$) | Maximum WQCV |
| Upper Las Vegas Wash DB | 1 | | | 2 | | | | 3 | | | 6 | | | 1 | | | | | | | | 1 | 0.66 | 0 | 21.6 | 21.6 | 434.9 |
| SEEA DB @ Floyd Lamb Park | 1 | | | 1 | 1 | | | | | | 3 | 4 | 2 | | 2 | | 1 | 1 | | | | 10 | 0.28 | 2.49 | 2.49 | 4.98 | 18.3 |
| NEEA DB @ Floyd Lamb Park | 1 | | | | | | | | | | 1 | | 2 | 1 | 2 | | 1 | | | | | 6 | 0.34 | 0.095 | 0.76 | 0.855 | 4.2 |
| Elkhorn Springs DB | | | | | | | | | | | | | | | | | | | | | | | Insufficient Information | | | | 10.1 |
| Fort Apache DB | | | | | | | | | | | | | | | | | | | | | | | Insufficient Information | | | | 22.8 |
| Rancho Road DB | | | | | | | | | | | | | | | | | | | | | | | Insufficient Information | | | | 51.7 |

# Attachment E –
# Detention Basin Fact Sheets

# C1 Fact Sheets

# Equestrian Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | C1EQ0159 |
| **Watershed** | Pittman/C-1 |
| **System** | C-1 |
| **Location** | Equestrian and Magic Way |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 6.9 |
| **Capacity (AF)** | 409 † |
| **Required Expansion (AF)** | 135 † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | .9 † |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Pipe Culvert + |
| **Number of Outlets** | 2 + |
| **Number of Inlets** | 2 + |
| **Inlet Flow Bypass (Y/N)** | Y • |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 6,444 † |
| **100 Year Flood Outflow (CFS)** | 5,880 |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | 2011-2012 |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 21.43 |
| **Intermediate Tributary Area (mile2)** | 6.9 |
| **Developed Portion of Tributary Area (mile2)** | 2.143 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 3 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Mission Hills Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Insufficient Information**

### Basin Info

| | |
|---|---|
| **ID-Mile** | C1CH0854 |
| **Watershed** | Pittman/C-1 |
| **System** | Beltway |
| **Location** | Half Mile SW of Mission Hills Park |
| **Facility Type** | On-Channel DB ◊ |
| **Tributary Area (mile$^2$)** | 9.3 ◊ |
| **Capacity (AF)** | |
| **Required Expansion (AF)** | N/A |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | |
| **Basin Floor Cover** | Compacted Earthfill ◊ |
| **Typical Side Slope** | |
| **Side Slope Cover** | |
| **Outlet Type** | Pipe Culvert ◊ |
| **Number of Outlets** | 1 ◊ |
| **Number of Inlets** | 2 ◊ |
| **Inlet Flow Bypass (Y/N)** | N ◊ |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Y Flood Sedimentation Storage (AF)** | #VALUE! |
| **100 Year Flood Capacity (AF)** | 480 ◊ |
| **100 Year Flood Inflow (CFS)** | 5371 ◊ |
| **100 Year Flood Outflow (CFS)** | 309 ◊ |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | Y |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N ◊ |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 13 |
| **Intermediate Tributary Area (mile2)** | 9.33 |
| **Developed Portion of Tributary Area (mile2)** | |
| **Developable Portion of Tributary Area (mile2)** | |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 1 ◊ |

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

### References

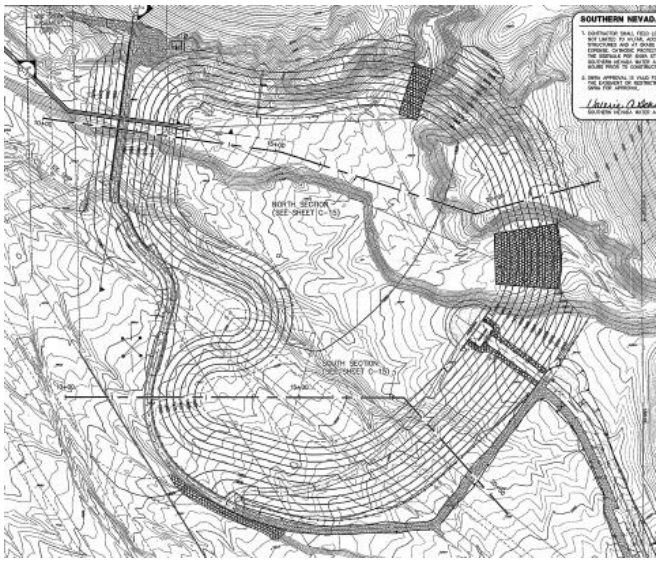

- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

# Northeast C1 Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | C1HV0140 |
| **Watershed** | Pittman/C-1 |
| **System** | C-1 |
| **Location** | Near Magic Way |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 9.8 + |
| **Capacity (AF)** | 353 † |
| **Required Expansion (AF)** | N/A † |



### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.11 † |
| **Basin Floor Cover** | Soil Cement + |
| **Typical Side Slope** | 3:1 + |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Pipe Culvert w/Orifice + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 32 + |
| **100 Year Flood Capacity (AF)** | 321 + |
| **100 Year Flood Inflow (CFS)** | 2,520 † |
| **100 Year Flood Outflow (CFS)** | 204 + |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 32 + |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2008 + |
| **Planed Upgrade (Years)** | N |

| | |
|---|---|
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 24.33 |
| **Intermediate Tributary Area (mile2)** | 9.8 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 3 † |

**References**

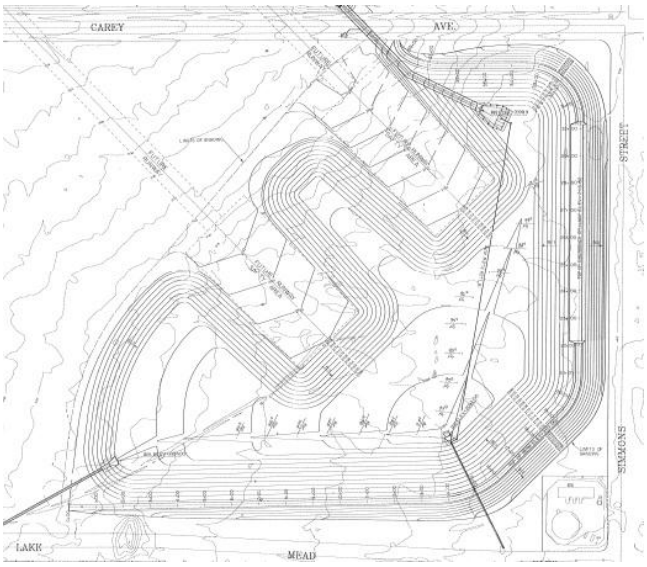

- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Central Basin Fact Sheets

# Carey Lake Mead Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**




### Basin Info

| | |
|---|---|
| **ID-Mile** | LVLM0228 |
| **Watershed** | Central |
| **System** | Las Vegas Wash Central |
| **Location** | Simmons btwn Carey and Lake Mead |
| **Facility Type** | Off-Channel DB |
| **Tributary Area (mile$^2$)** | 11.78 ◊ |
| **Capacity (AF)** | 607 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0.36 † |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | 8:1 + |
| **Side Slope Cover** | Compacted Earthfill + |
| **Outlet Type** | 48" RCP Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 2 + |
| **Inlet Flow Bypass (Y/N)** | Y + |
| **Annual Sedimentation Storage (AF)** | 6.2 • |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 87 • |
| **100 Year Flood Capacity (AF)** | 420 • |
| **100 Year Flood Inflow (CFS)** | 5,184 † |
| **100 Year Flood Outflow (CFS)** | 373 • |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 118 • |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1991 + |
| **Planed Upgrade (Years)** | N |

| | |
|---|---|
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 11.78 |
| **Intermediate Tributary Area (mile2)** | 11.78 |
| **Developed Portion of Tributary Area (mile2)** | 7.068 |
| **Developable Portion of Tributary Area (mile2)** | 4.712 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Meadows Detention Basin
## Water Quality Controls

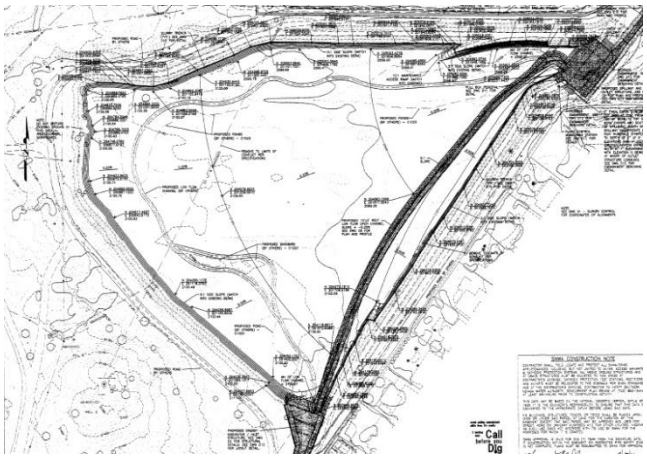
**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | LCME0020 |
| **Watershed** | Central |
| **System** | Las Vegas Wash Central |
| **Location** | Valley View btwn Bonanza and Alta |
| **Facility Type** | Off-Channel DB |
| **Tributary Area (mile$^2$)** | 7.76 ⁺ |
| **Capacity (AF)** | 213 † |
| **Required Expansion (AF)** | 22 † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | 2,115.5 ◦ |
| **Freeboard (ft)** | 0.11 † |
| **Basin Floor Cover** | Wet Lands |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCB Culvert ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 1 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |



### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 14.89 |
| **100 Year Flood Capacity (AF)** | 228 ◦ |
| **100 Year Flood Inflow (CFS)** | 4,713 † |
| **100 Year Flood Outflow (CFS)** | 1,344 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | Y |
| **Construction Year** | 1987 ◦ |
| **Planed Upgrade (Years)** | Y |
| **In-Basin Recreation Facilities (Y/N)** | Y |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 10.71 |
| **Intermediate Tributary Area (mile2)** | 7.76 |
| **Developed Portion of Tributary Area (mile2)** | 10.1745 |
| **Developable Portion of Tributary Area (mile2)** | 0.5355 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 2 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# NEEA Detention Basin at Floyd Lamb Park
## Water Quality Controls

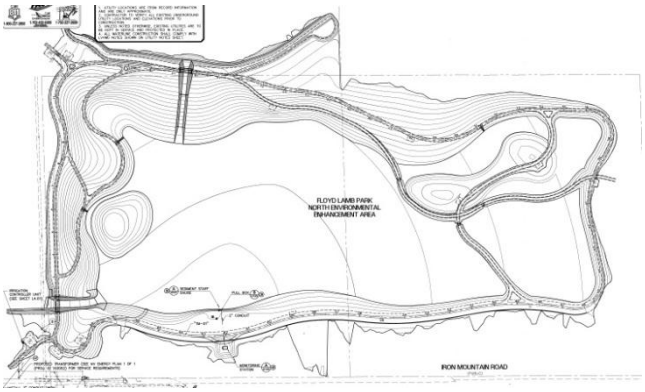
**Assessment of Water Quality Retrofit Potential: Poor**

### Basin Info

| | |
|---|---|
| **ID-Mile** | TSDB0011 |
| **Watershed** | Upper Northern |
| **System** | Upper Western Tributary |
| **Location** | Iron Mtn and N Buffalo |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 1.9 ⁺ |
| **Capacity (AF)** | 117 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.37 † |
| **Basin Floor Cover** | Soil Cement ⁺ |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | 36" Culvert w/22" Orifice ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 2 ⁺ |
| **Inlet Flow Bypass (Y/N)** | N ⁺ |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 18.1 ⁺ |
| **100 Year Flood Capacity (AF)** | 97.7 ⁺ |
| **100 Year Flood Inflow (CFS)** | 804 † |
| **100 Year Flood Outflow (CFS)** | 30 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 18.1 ⁺ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2010 ⁺ |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | Y |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 1.9 |
| **Intermediate Tributary Area (mile2)** | 1.9 |
| **Developed Portion of Tributary Area (mile2)** | 0.095 |
| **Developable Portion of Tributary Area (mile2)** | 0.76 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Oakey Detention Basin
## Water Quality Controls

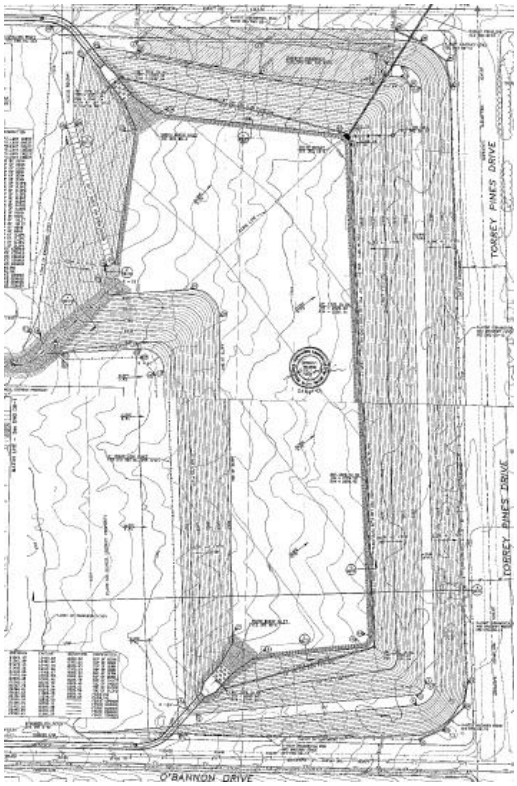
**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | MECH0324 |
| **Watershed** | Central |
| **System** | Las Vegas Wash Central |
| **Location** | Torrey Pines btwn Oakey and O'Bannon |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 1.84 ◦ |
| **Capacity (AF)** | 201 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 3.74 † |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCB Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 2 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 50.26 |
| **100 Year Flood Capacity (AF)** | 147 |
| **100 Year Flood Inflow (CFS)** | 1,652 † |
| **100 Year Flood Outflow (CFS)** | 32 |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1992 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 1.84 |
| **Intermediate Tributary Area (mile2)** | 1.84 |
| **Developed Portion of Tributary Area (mile2)** | 1.104 |
| **Developable Portion of Tributary Area (mile2)** | 0.736 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Rainbow Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | LCCH0513 |
| **Watershed** | Central |
| **System** | Las Vegas Wash Central |
| **Location** | Rainbow and Westcliff |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 1.11 |
| **Capacity (AF)** | 102 † |
| **Required Expansion (AF)** | 57 † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 9.67 † |
| **Basin Floor Cover** | Soil Cement ⁺ |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Pipe Culvert ⁺ |
| **Number of Outlets** | 2 ⁺ |
| **Number of Inlets** | 1 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 970 † |
| **100 Year Flood Outflow (CFS)** | 85 |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | Y |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 1.11 |
| **Intermediate Tributary Area (mile2)** | 1.11 |
| **Developed Portion of Tributary Area (mile2)** | |
| **Developable Portion of Tributary Area (mile2)** | |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

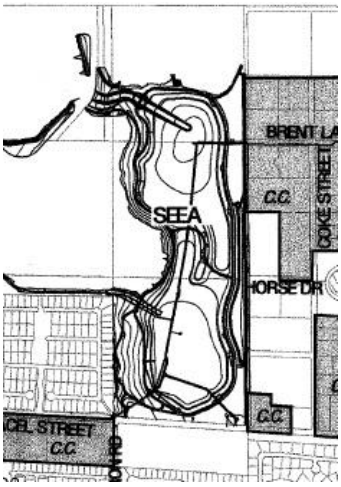

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# SEEA Detention Basin at Floyd Lamb Park
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Poor**

### Basin Info

| | |
|---|---|
| **ID-Mile** | BRDB0032 |
| **Watershed** | Upper Northern |
| **System** | Upper Western Tributary |
| **Location** | N Cimmaron and Racel St |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 8.3 ⁺ |
| **Capacity (AF)** | 450 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 5.99 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | 36" Culvert w/18" Orifice ⁺ |
| **Number of Outlets** | 2 ⁺ |
| **Number of Inlets** | 2 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 20.7 ⁺ |
| **100 Year Flood Capacity (AF)** | 440 ⁺ |
| **100 Year Flood Inflow (CFS)** | 1,902 † |
| **100 Year Flood Outflow (CFS)** | 43 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 20.7 ⁺ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2010 ⁺ |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | Y |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 8.3 |
| **Intermediate Tributary Area (mile2)** | 8.3 |
| **Developed Portion of Tributary Area (mile2)** | 2.49 |
| **Developable Portion of Tributary Area (mile2)** | 2.49 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Duck Creek Wash Fact Sheets

# Bruner Detention Basin
## Water Quality Controls

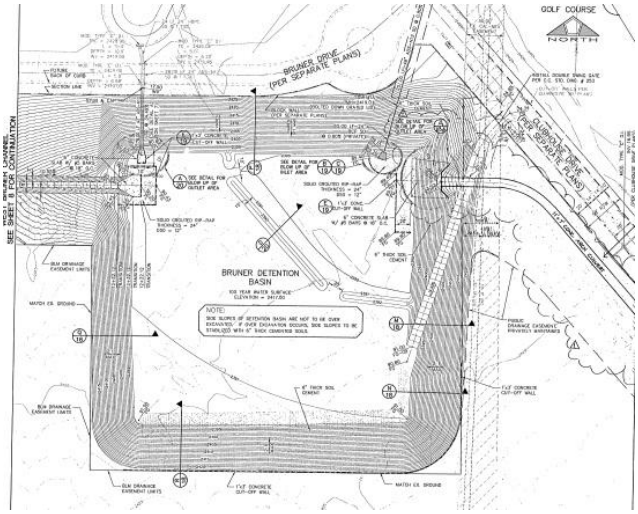
**Assessment of Water Quality Retrofit Potential:** Fair

### Basin Info

| | |
|---|---|
| **ID-Mile** | DCW10251 |
| **Watershed** | Duck Creek- Blue Diamond |
| **System** | Central |
| **Location** | Bruner btwn Southern Highlands and Decatur |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 1.23 ◊ |
| **Capacity (AF)** | 109 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.27 † |
| **Basin Floor Cover** | Soil Cement + |
| **Typical Side Slope** | 2:1 + |
| **Side Slope Cover** | Rip Rap + |
| **Outlet Type** | Arch Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 1,681 † |
| **100 Year Flood Outflow (CFS)** | 257 |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2002 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 1.23 |
| **Intermediate Tributary Area (mile2)** | 1.23 |
| **Developed Portion of Tributary Area (mile2)** | 0.0615 |
| **Developable Portion of Tributary Area (mile2)** | 0.246 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 + |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

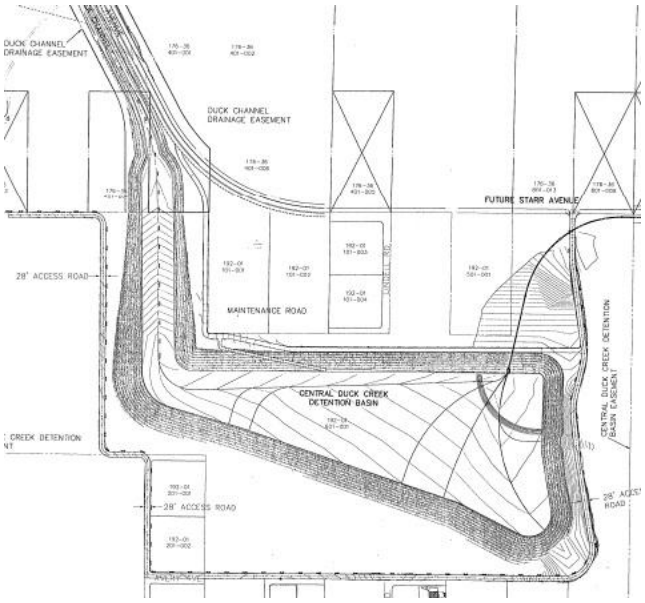

Note: The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Central Duck Creek Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | DCWA1658 |
| **Watershed** | Duck Creek- Blue Diamond |
| **System** | Central |
| **Location** | Starr btwn Jones and Decatur |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 18.72 ⁺ |
| **Capacity (AF)** | 1,046 † |
| **Required Expansion (AF)** | 334 † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.61 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | Compacted Earthfill ⁺ |
| **Outlet Type** | Pipe Culvert w/Orifice Plate ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 1 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | 1,046 ⁺ |
| **100 Year Flood Inflow (CFS)** | 7,537 † |
| **100 Year Flood Outflow (CFS)** | 326 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2000 ⁺ |
| **Planed Upgrade (Years)** | Y |

| | |
|---|---|
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 18.72 |
| **Intermediate Tributary Area (mile2)** | 18.72 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 2.808 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Lower Blue Diamond Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential:** Poor

### Basin Info

| | |
|---|---|
| **ID-Mile** | BDWA0470 |
| **Watershed** | Duck Creek- Blue Diamond |
| **System** | Blue Diamond Tributaries |
| **Location** | Decatur btwn Robindale and Windmill |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 5.54 ◊ |
| **Capacity (AF)** | 380 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.03 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Pipe Culvert ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 2 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 3,701 † |
| **100 Year Flood Outflow (CFS)** | 197 |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 5.54 |
| **Intermediate Tributary Area (mile2)** | 5.54 |
| **Developed Portion of Tributary Area (mile2)** | 0.554 |
| **Developable Portion of Tributary Area (mile2)** | 4.986 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Lower Duck Creek Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | DCWA1217 |
| **Watershed** | Duck Creek- Blue Diamond |
| **System** | Lower Duck Creek/Blue Diamond |
| **Location** | Richmar btwn Gillespie and Bermuda |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 13.29 ◊ |
| **Capacity (AF)** | 1,110 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.63 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 4:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | 8' x 8.15' Orifice ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 3 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 185.7 ◦ |
| **100 Year Flood Capacity (AF)** | 1,110 † |
| **100 Year Flood Inflow (CFS)** | 5,844 † |
| **100 Year Flood Outflow (CFS)** | 400 ◦ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 205 ◦ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1999 |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 38.78 |
| **Intermediate Tributary Area (mile2)** | 13.29 |
| **Developed Portion of Tributary Area (mile2)** | 1.939 |
| **Developable Portion of Tributary Area (mile2)** | 23.268 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | Y |
| **Number of Upstream Basins** | 3 † |

### References


- http://www.ccrfcd.org/


- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

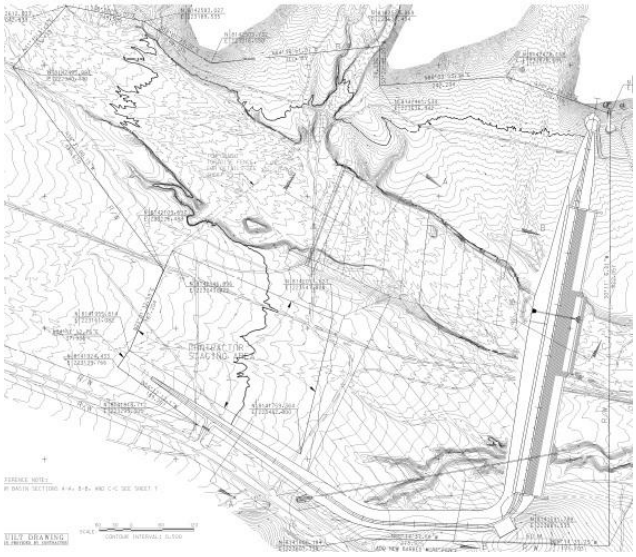
**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Upper Blue Diamond Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential:** Fair

### Basin Info

| | |
|---|---|
| **ID-Mile** | TRBD0930 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Tropicana- Flamingo Wash |
| **Location** | Blue Diamond and Hualpai Way |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 68.25 ◦ |
| **Capacity (AF)** | 2,270 † |
| **Required Expansion (AF)** | N/A † |



### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | 100 ◦ |
| **Typical Width (ft)** | 19.68 ◦ |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0 † |
| **Basin Floor Cover** | RCC and Rip Rap ◦ |
| **Typical Side Slope** | 2.5:1 + |
| **Side Slope Cover** | RCC ◦ |
| **Outlet Type** | RCB Culvert ◦ |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 2 + |
| **Inlet Flow Bypass (Y/N)** | Y + |
| **Annual Sedimentation Storage (AF)** | 15.9 ◦ |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 238 ◦ |
| **100 Year Flood Capacity (AF)** | 2,370 ◦ |
| **100 Year Flood Inflow (CFS)** | 13,800 † |
| **100 Year Flood Outflow (CFS)** | 213 ◦ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 210 ◦ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1998 ◦ |
| **Planed Upgrade (Years)** | N |

| | |
|---|---|
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 68.25 |
| **Intermediate Tributary Area (mile2)** | 68.25 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 ◦ |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


Note: The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

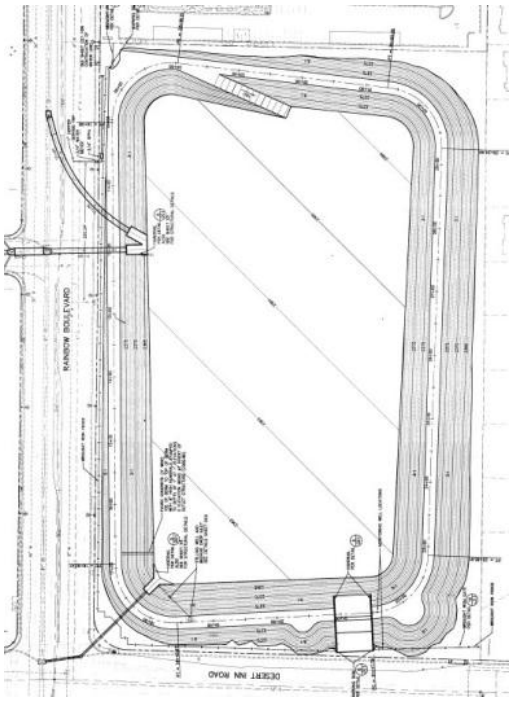
# Flamingo / Tropicana Washes Fact Sheets

# Desert Inn Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Poor**

### Basin Info

| | |
|---|---|
| **ID-Mile** | FLLA0308 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Flamingo- Decatur |
| **Location** | Desert Inn and Rainbow |
| **Facility Type** | Off-Channel DB |
| **Tributary Area (mile$^2$)** | 1.07 + |
| **Capacity (AF)** | 62 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0.27 † |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | 3:1 + |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCP Culvert w/18" Orifice + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | Y + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 2 + |
| **100 Year Flood Capacity (AF)** | 62 + |
| **100 Year Flood Inflow (CFS)** | 744 † |
| **100 Year Flood Outflow (CFS)** | 30 + |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 2 + |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1999 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 1.07 |
| **Intermediate Tributary Area (mile2)** | 1.07 |
| **Developed Portion of Tributary Area (mile2)** | 1.0165 |
| **Developable Portion of Tributary Area (mile2)** | 0.0535 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

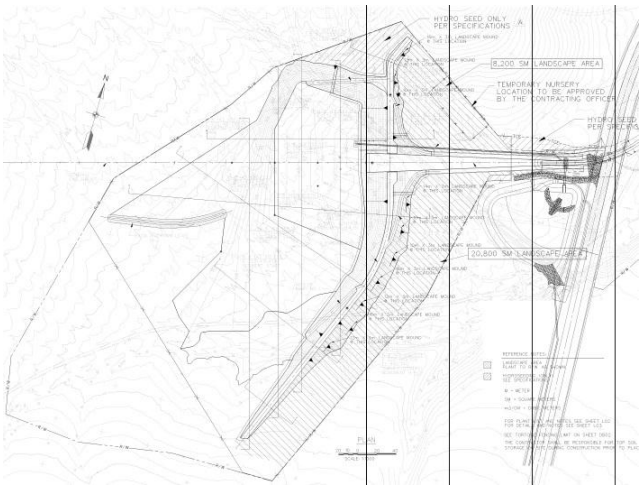

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# F-4 Debris Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential:** Fair

### Basin Info

| | |
|---|---|
| **ID-Mile** | FLF40355 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Tropicana- Flamingo Wash |
| **Location** | Fort Apache near Warm Springs |
| **Facility Type** | On-Channel Debris/Sediment Basin |
| **Tributary Area (mile$^2$)** | 1.3 + |
| **Capacity (AF)** | 21.85 + |
| **Required Expansion (AF)** | N/A † |



### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 5 + |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | 3:1 + |
| **Side Slope Cover** | Soil Cement ◦ |
| **Outlet Type** | RCB Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | Y + |
| **Annual Sedimentation Storage (AF)** | 1.09 ◦ |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 16.4 ◦ |
| **100 Year Flood Capacity (AF)** | 21.85 |
| **100 Year Flood Inflow (CFS)** | 1,600 + |
| **100 Year Flood Outflow (CFS)** | 2100 |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 21.9 ◦ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1999 ◦ |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 1.3 |
| **Intermediate Tributary Area (mile2)** | 1.3 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0.39 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Flamingo Detention Basin
## Water Quality Controls

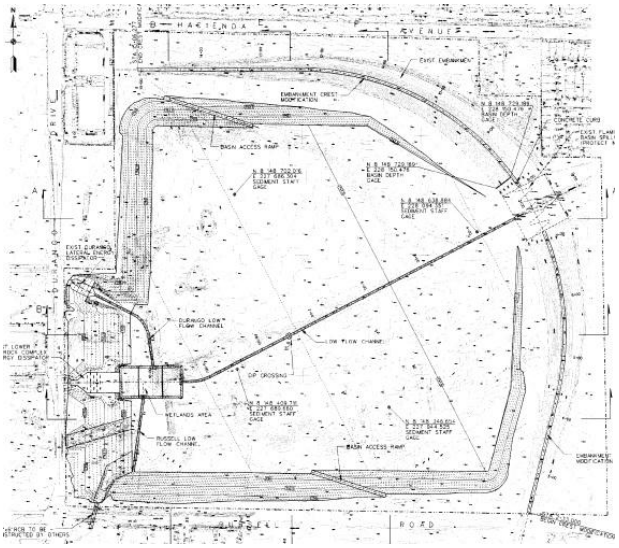
**Assessment of Water Quality Retrofit Potential: Poor**

### Basin Info

| | |
|---|---|
| **ID-Mile** | FLWA1443 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Tropicana- Flamingo Wash |
| **Location** | Durango btwn Russell and Hacienda |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 30.35 |
| **Capacity (AF)** | 1,340 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0 † |
| **Basin Floor Cover** | Compacted Earthfill ◦ |
| **Typical Side Slope** | 6:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Orifice w/Restrictor Plate ◦ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 3 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | 24.1 ◦ |



### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 138 ◦ |
| **100 Year Flood Capacity (AF)** | 1,911 ◦ |
| **100 Year Flood Inflow (CFS)** | 11,800 † |
| **100 Year Flood Outflow (CFS)** | 290 ◦ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 29.7 ◦ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2009 ◦ |
| **Planed Upgrade (Years)** | N |

| | |
|---|---|
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 98.36 |
| **Intermediate Tributary Area (mile2)** | 30.35 |
| **Developed Portion of Tributary Area (mile2)** | 4.918 |
| **Developable Portion of Tributary Area (mile2)** | 29.508 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 5 † |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

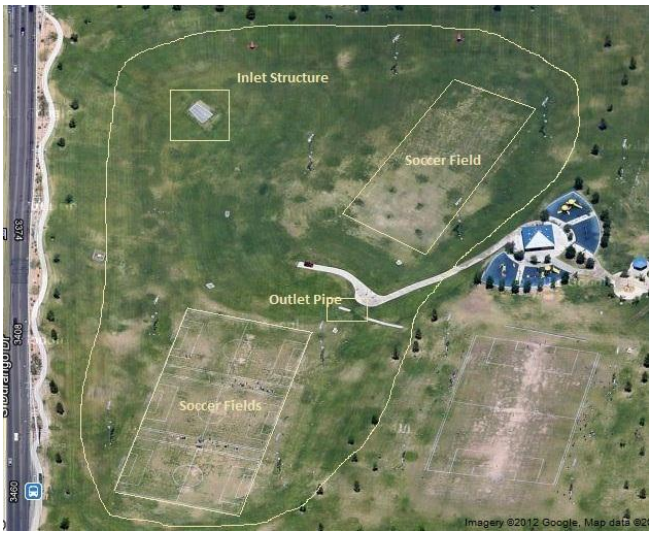

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Lakes Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | FLSM0087 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Flamingo- Decatur |
| **Location** | Desert Breeze Park |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 2.6 + |
| **Capacity (AF)** | 143 † |
| **Required Expansion (AF)** | 22 † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0.31 † |
| **Basin Floor Cover** | Grass + |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | 36" RCP |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | 143 + |
| **100 Year Flood Inflow (CFS)** | 1,976 † |
| **100 Year Flood Outflow (CFS)** | 85 + |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | Y |
| **Construction Year** | 2002 + |
| **Planed Upgrade (Years)** | Proposed Only |
| **In-Basin Recreation Facilities (Y/N)** | Y |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 2.6 |
| **Intermediate Tributary Area (mile2)** | 2.6 |
| **Developed Portion of Tributary Area (mile2)** | 2.47 |
| **Developable Portion of Tributary Area (mile2)** | 0.13 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

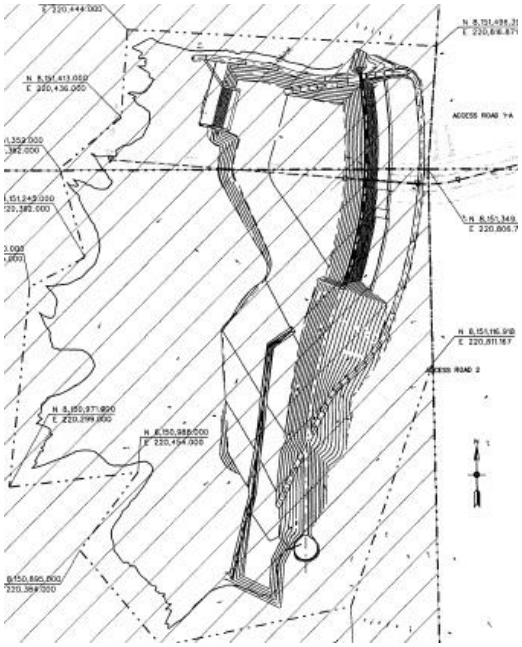

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# R-4 Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | RRR40160 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Tropicana- Flamingo Wash |
| **Location** | btwn Desert Inn extended and Flamingo extended |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 5.54 ⁺ |
| **Capacity (AF)** | 362 † |
| **Required Expansion (AF)** | N/A † |



### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | RCC ◦ |
| **Outlet Type** | RCP Culvert w/Orifice ◦ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 1 ⁺ |
| **Inlet Flow Bypass (Y/N)** | N ⁺ |
| **Annual Sedimentation Storage (AF)** | 3.9 ◦ |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 58.2 ◦ |
| **100 Year Flood Capacity (AF)** | 391.2 ⁺ |
| **100 Year Flood Inflow (CFS)** | 3,400 † |
| **100 Year Flood Outflow (CFS)** | 370.8 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 77.7 ⁺ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2002 ⁺ |

| | |
|---|---|
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 5.54 |
| **Intermediate Tributary Area (mile2)** | 5.54 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Red Rock Detention Basin
## Water Quality Controls

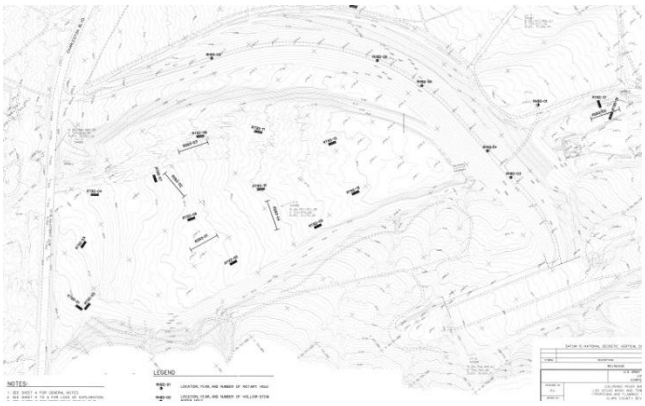
**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | RRWA0716 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Tropicana- Flamingo Wash |
| **Location** | Charleston west of the 215 Beltway |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 55.2 + |
| **Capacity (AF)** | 2,007 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0 † |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | 5:1 + |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCB Culvert w/Constrictor Plate ◦ |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | 15 ◦ |



### Basin Operations

| | |
|---|---|
| **100 Y Flood Sedimentation Storage (AF)** | 222 ◦ |
| **100 Year Flood Capacity (AF)** | 2000 + |
| **100 Year Flood Inflow (CFS)** | 12,800 † |
| **100 Year Flood Outflow (CFS)** | 182 + |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 222 ◦ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1995 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 55.2 |
| **Intermediate Tributary Area (mile2)** | 55.2 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

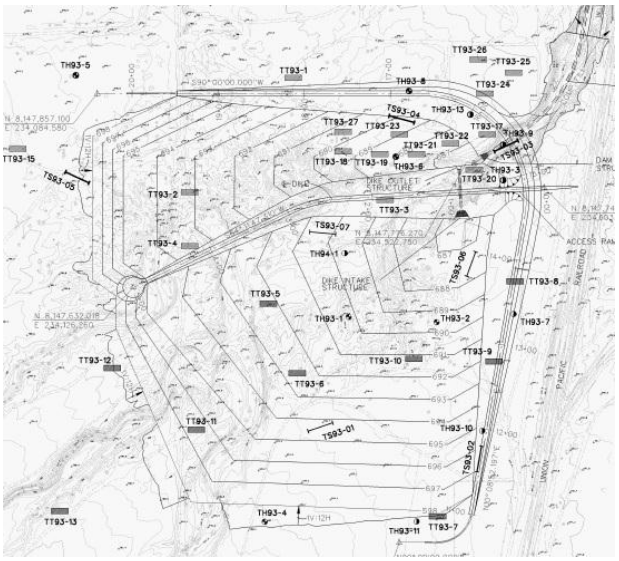

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Tropicana Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | TRWA0454 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Tropicana- Flamingo Wash |
| **Location** | Decatur and Oquendo |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 172.12 ◦ |
| **Capacity (AF)** | 825 † |
| **Required Expansion (AF)** | N/A † |



### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | 2779.92 ◦ |
| **Typical Width (ft)** | 19.69 ◦ |
| **Max. Design Depth (ft)** | 38.66 ◦ |
| **Freeboard (ft)** | 0 † |
| **Basin Floor Cover** | Concrete ◦ |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | Concrete ◦ |
| **Outlet Type** | RCP Pipe Culvert ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 2 ⁺ |
| **Inlet Flow Bypass (Y/N)** | N ⁺ |
| **Annual Sedimentation Storage (AF)** | 15.4 ◦ |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 71.42 ◦ |
| **100 Year Flood Capacity (AF)** | 1,669 ◦ |
| **100 Year Flood Inflow (CFS)** | 6,700 † |
| **100 Year Flood Outflow (CFS)** | 496.88 ◦ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 71.42 ◦ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1997 ◦ |
| **Planed Upgrade (Years)** | N |

| | |
|---|---|
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 338.7 |
| **Intermediate Tributary Area (mile2)** | 172.12 |
| **Developed Portion of Tributary Area (mile2)** | 33.87 |
| **Developable Portion of Tributary Area (mile2)** | 135.48 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | Y |
| **Number of Upstream Basins** | 7 † |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Van Buskirk "C" Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | VBMC0161 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Lower Flamingo |
| **Location** | Harmon btwn Paso El Rio and Bunker Ct |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 2.95 |
| **Capacity (AF)** | 16 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Channel + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | Y + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 266 † |
| **100 Year Flood Outflow (CFS)** | |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 4.44 |
| **Intermediate Tributary Area (mile2)** | 2.95 |
| **Developed Portion of Tributary Area (mile2)** | 4.44 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 1 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Gowan Basin Fact Sheets

# Angel Park Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Poor**

### Basin Info

| | |
|---|---|
| **ID-Mile** | APNO0000 |
| **Watershed** | Gowan |
| **System** | Gowan South |
| **Location** | N Durango and Vegas Dr |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 24 ⁺ |
| **Capacity (AF)** | 1,400 † |
| **Required Expansion (AF)** | 112 † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | .31 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | Riprap ⁺ |
| **Outlet Type** | Pipe Culvert ⁺ |
| **Number of Outlets** | 2 ⁺ |
| **Number of Inlets** | 3 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |



Angel Park North Angel Park South

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 0 |
| **100 Year Flood Capacity (AF)** | 1400 |
| **100 Year Flood Inflow (CFS)** | 9,199 † |
| **100 Year Flood Outflow (CFS)** | 1248 |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | Estimated Fund Schedule |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 30.77 |
| **Intermediate Tributary Area (mile2)** | 24 |
| **Developed Portion of Tributary Area (mile2)** | 9.231 |
| **Developable Portion of Tributary Area (mile2)** | 3.077 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 1 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Ann Road CAM 10 Detention Basin
## Water Quality Controls

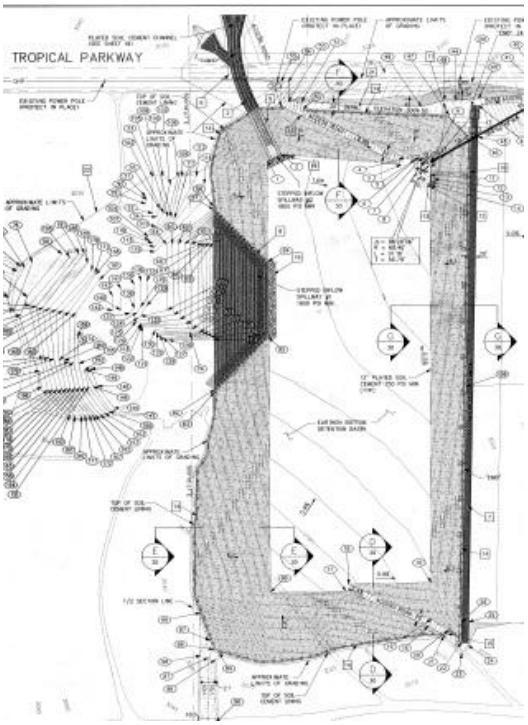
**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | GOAN0061 |
| **Watershed** | Gowan |
| **System** | North Gowan |
| **Location** | Near Ann Rd and the 215 Beltway |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 3.77 ⁺ |
| **Capacity (AF)** | 364 † |
| **Required Expansion (AF)** | 115 † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.07 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 4:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCP Culvert w/Orifice ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 1 ⁺ |
| **Inlet Flow Bypass (Y/N)** | N ⁺ |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 40 ⁺ |
| **100 Year Flood Capacity (AF)** | 304 ⁺ |
| **100 Year Flood Inflow (CFS)** | 6,028 † |
| **100 Year Flood Outflow (CFS)** | 156 ⁺ |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 40 + |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2002 + |
| **Planed Upgrade (Years)** | Proposed Only |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 3.77 |
| **Intermediate Tributary Area (mile2)** | 3.77 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Gowan North Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | GONO 0008 |
| **Watershed** | Gowan |
| **System** | North Gowan |
| **Location** | Gowan and Tenaya |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 38 + |
| **Capacity (AF)** | 921 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0.26 † |
| **Basin Floor Cover** | Compacted Earthfill and Grass + |
| **Typical Side Slope** | 4:1 + |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Baffled Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 2 + |
| **Inlet Flow Bypass (Y/N)** | Y + |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 80.74 |
| **100 Year Flood Capacity (AF)** | 840 + |
| **100 Year Flood Inflow (CFS)** | 4,054 † |
| **100 Year Flood Outflow (CFS)** | 560 + |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | Y |
| **Construction Year** | 1992 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | Y |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 96.71 |
| **Intermediate Tributary Area (mile2)** | 38 |
| **Developed Portion of Tributary Area (mile2)** | 29.013 |
| **Developable Portion of Tributary Area (mile2)** | 19.342 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 5 † |

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

# Gowan South Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | GOSO 0051 |
| **Watershed** | Gowan |
| **System** | South Gowan |
| **Location** | Cheyenne and Tenaya |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 11.8 ◦ |
| **Capacity (AF)** | 624 † |
| **Required Expansion (AF)** | 62 † |



### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0.1 † |
| **Basin Floor Cover** | Soil Cement + |
| **Typical Side Slope** | 4:1 + |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Baffled Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 2 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 38.9 |
| **100 Year Flood Capacity (AF)** | 585 ◦ |
| **100 Year Flood Inflow (CFS)** | 5,625 † |
| **100 Year Flood Outflow (CFS)** | 370 + |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1992 ⁺ |
| **Planed Upgrade (Years)** | Proposed Only |
| **In-Basin Recreation Facilities (Y/N)** | Y |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 42.57 |
| **Intermediate Tributary Area (mile2)** | 11.8 |
| **Developed Portion of Tributary Area (mile2)** | 40.4415 |
| **Developable Portion of Tributary Area (mile2)** | 2.1285 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 2 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

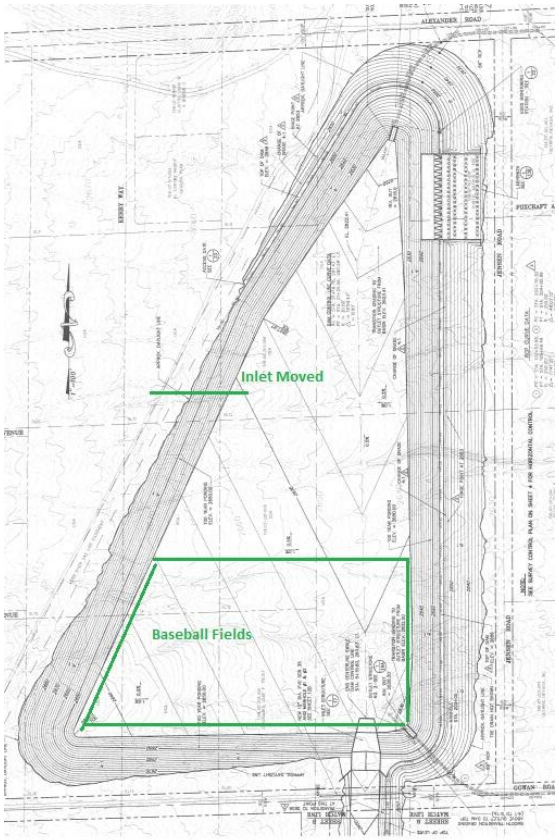

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Lone Mountain Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | APM50000 |
| **Watershed** | Gowan |
| **System** | South Gowan |
| **Location** | Sky Vista Dr near Alta |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 6.77 + |
| **Capacity (AF)** | 384 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 3.52 † |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | 4:1 + |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCB Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 42 + |
| **100 Year Flood Capacity (AF)** | 335 + |
| **100 Year Flood Inflow (CFS)** | 7,001 † |
| **100 Year Flood Outflow (CFS)** | 2,227 + |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 42 + |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2001 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 6.77 |
| **Intermediate Tributary Area (mile2)** | 6.77 |
| **Developed Portion of Tributary Area (mile2)** | 0.807 |
| **Developable Portion of Tributary Area (mile2)** | 0.807 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

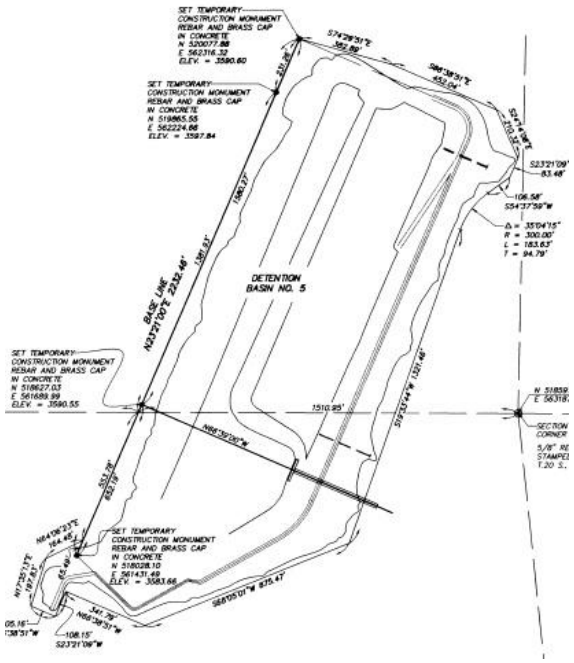

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Summerlin 5 Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | APM50000 |
| **Watershed** | Gowan |
| **System** | South Gowan |
| **Location** | Sky Vista Dr near Alta |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 6.77 + |
| **Capacity (AF)** | 384 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 3.52 † |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | 3:1 + |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCB Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 42 + |
| **100 Year Flood Capacity (AF)** | 335 + |
| **100 Year Flood Inflow (CFS)** | 7,001 † |
| **100 Year Flood Outflow (CFS)** | 2,227 + |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 42 + |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2001 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 6.77 |
| **Intermediate Tributary Area (mile2)** | 6.77 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Lower Las Vegas Wash Fact Sheets

# Lower Las Vegas Wash Detention Basin
## Water Quality Controls

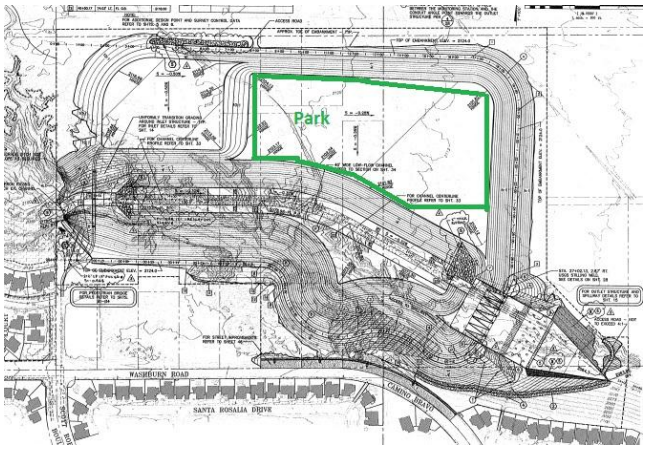
**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | LVMD2050 |
| **Watershed** | Lower Northern |
| **System** | Lower Western Tributary |
| **Location** | Clayton St btwn Hammer Ln and W Washburn |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 37.65 ⁺ |
| **Capacity (AF)** | 700 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 11.69 † |
| **Basin Floor Cover** | Concrete & Compacted Earthfill ⁺ |
| **Typical Side Slope** | 4:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCB Culvert ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 1 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 6,729 † |
| **100 Year Flood Outflow (CFS)** | 3,756 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1997 ⁺ |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | Y |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 55.67 |
| **Intermediate Tributary Area (mile2)** | 37.65 |
| **Developed Portion of Tributary Area (mile2)** | 8.3505 |
| **Developable Portion of Tributary Area (mile2)** | 33.402 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 5 † |

### References


- http://www.ccrfcd.org/


- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Pittman Fact Sheets

# McCullough Hills Park Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

## Basin Info

| | |
|---|---|
| **ID-Mile** | PTPW0309 |
| **Watershed** | Pittman/C-1 |
| **System** | Beltway |
| **Location** | Reunion and McCullough Hills Pkwy |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 5.29 |
| **Capacity (AF)** | 355 † |
| **Required Expansion (AF)** | N/A † |




## Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 2.67 † |
| **Basin Floor Cover** | Grass ⁺ |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Pipe Culvert |
| **Number of Outlets** | 2 |
| **Number of Inlets** | 1 |
| **Inlet Flow Bypass (Y/N)** | N ⁺ |
| **Annual Sedimentation Storage (AF)** | |

## Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | #VALUE! |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 4,136 † |
| **100 Year Flood Outflow (CFS)** | |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | Y |
| **Construction Year** | |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | Y |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 5.29 |
| **Intermediate Tributary Area (mile2)** | 5.29 |
| **Developed Portion of Tributary Area (mile2)** | 1.058 |
| **Developable Portion of Tributary Area (mile2)** | 0.2645 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

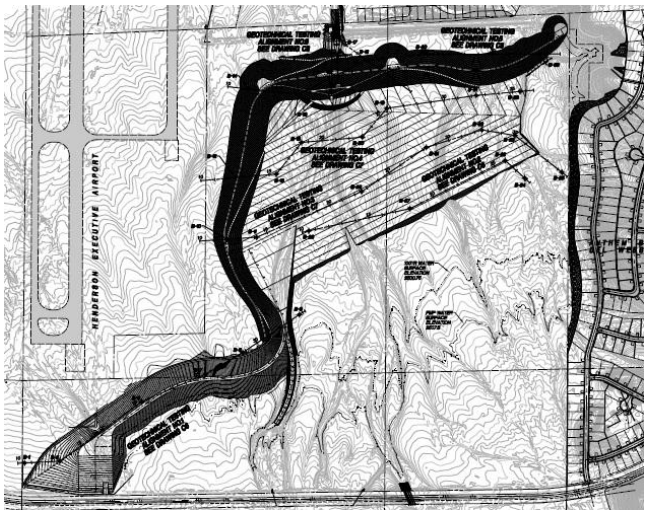

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Pittman East Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | PTEA0439 |
| **Watershed** | Pittman/C-1 |
| **System** | Beltway |
| **Location** | Volunteer Blvd and Sun City Anthem |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 33 ⁺ |
| **Capacity (AF)** | 1,718 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 8.12 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCP Culvert ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 2 ⁺ |
| **Inlet Flow Bypass (Y/N)** | N ⁺ |
| **Annual Sedimentation Storage (AF)** | 13.2 ◦ |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 91 ⁺ |
| **100 Year Flood Capacity (AF)** | 1,718 ⁺ |
| **100 Year Flood Inflow (CFS)** | 6,183 † |
| **100 Year Flood Outflow (CFS)** | 1,221 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 157 ◦ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2002 ⁺ |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 56.47 |
| **Intermediate Tributary Area (mile2)** | 33 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 1 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Pittman Anthem Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | PTAN0280 |
| **Watershed** | Pittman/C-1 |
| **System** | Beltway |
| **Location** | Bensley Street |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 2.45 |
| **Capacity (AF)** | 165 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.05 † |
| **Basin Floor Cover** | Compacted Earthfill |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Pipe Culvert |
| **Number of Outlets** | |
| **Number of Inlets** | 1 |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 1,737 † |
| **100 Year Flood Outflow (CFS)** | |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 7.74 |
| **Intermediate Tributary Area (mile2)** | 2.45 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 1 † |

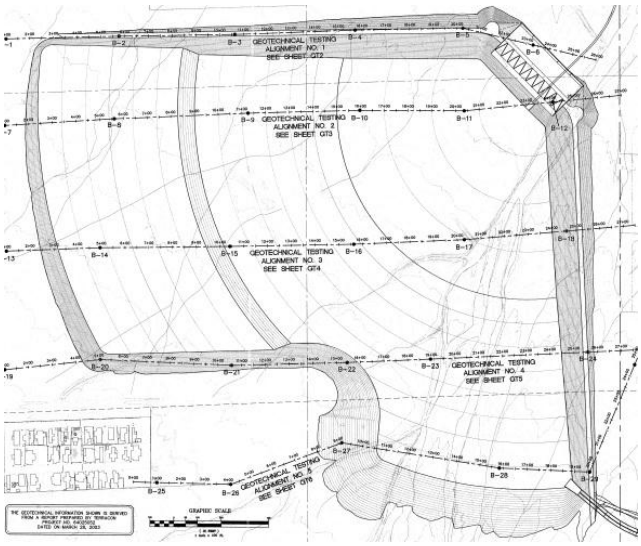
### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Pittman North Detention Basin and Outfall
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Poor**



### Basin Info

| | |
|---|---|
| **ID-Mile** | PTNO0182 |
| **Watershed** | Pittman/C-1 |
| **System** | Upper Pittman |
| **Location** | Gilespie and Volunteer Blvd |
| **Facility Type** | Off-Channel DB |
| **Tributary Area (mile$^2$)** | 16.68 ⁺ |
| **Capacity (AF)** | 600 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0.98 † |
| **Basin Floor Cover** | |
| **Typical Side Slope** | 4:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Pipe Culvert w/Orifice ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 1 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | 1,041.5 ⁺ |
| **100 Year Flood Inflow (CFS)** | 5,476 † |
| **100 Year Flood Outflow (CFS)** | 442 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | N/A |
| **Planed Upgrade (Years)** | N |

| | |
|---|---|
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | |
| **Intermediate Tributary Area (mile2)** | |
| **Developed Portion of Tributary Area (mile2)** | |
| **Developable Portion of Tributary Area (mile2)** | |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | N/A |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Pittman Park Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | PTWA0050 |
| **Watershed** | Pittman/C-1 |
| **System** | Lower Pittman |
| **Location** | Arroyo Grande and Santiago |
| **Facility Type** | Off-Channel DB |
| **Tributary Area (mile$^2$)** | 32.8 ◦ |
| **Capacity (AF)** | 75 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 2.48 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | Rip-Rap ⁺ |
| **Outlet Type** | 24" RCP w/Flap Gate ◦ |
| **Number of Outlets** | 1 ◦ |
| **Number of Inlets** | 1 |
| **Inlet Flow Bypass (Y/N)** | Y ◦ |
| **Annual Sedimentation Storage (AF)** | 4.11 ◦ |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 41 ◦ |
| **100 Year Flood Capacity (AF)** | 62 ◦ |
| **100 Year Flood Inflow (CFS)** | 889 † |
| **100 Year Flood Outflow (CFS)** | 45 ◦ |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 41 ◦ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1998 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 116.75 |
| **Intermediate Tributary Area (mile2)** | 32.8 |
| **Developed Portion of Tributary Area (mile2)** | 93.4 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | Y |
| **Number of Upstream Basins** | 6 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# South Pittman Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | PTCR0020 |
| **Watershed** | Pittman/C-1 |
| **System** | Beltway |
| **Location** | At the end of Crescent Heights Ave |
| **Facility Type** | Debris/Sediment Basin |
| **Tributary Area (mile$^2$)** | 0.45 |
| **Capacity (AF)** | |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | |
| **Basin Floor Cover** | In-Situ Terrain |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | |
| **Number of Outlets** | 0 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 536 † |
| **100 Year Flood Outflow (CFS)** | N/A |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2004 + |
| **Planed Upgrade (Years)** | N |

| | |
|---|---|
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 0.45 |
| **Intermediate Tributary Area (mile2)** | 0.45 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

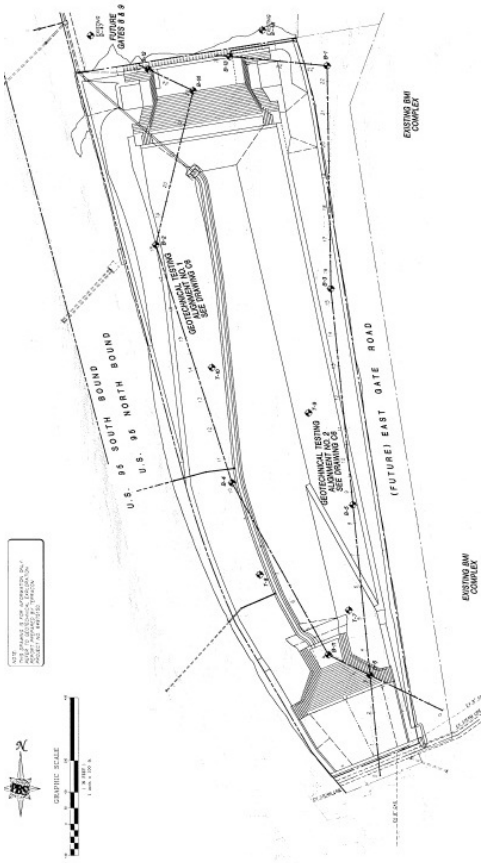

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Pioneer Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | PTVW0185 |
| **Watershed** | Pittman/C-1 |
| **System** | Burns |
| **Location** | Eastgate Btwn Boulder Highway and Sunset |
| **Facility Type** | Off-Channel DB |
| **Tributary Area (mile$^2$)** | 7.66 ◦ |
| **Capacity (AF)** | 377 † |
| **Required Expansion (AF)** | 65 † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | 1840 |
| **Typical Width (ft)** | 190 (varies) |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.15 † |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | 3:1 + |
| **Side Slope Cover** | Concrete + |
| **Outlet Type** | RCP Pipe Culvert w/Orifice Plate + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | Y + |
| **Annual Sedimentation Storage (AF)** | 2 |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 8.35 |
| **100 Year Flood Capacity (AF)** | 382 |
| **100 Year Flood Inflow (CFS)** | 6,163 † |
| **100 Year Flood Outflow (CFS)** | 421 ◦ |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 18.4 |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1999 |
| **Planed Upgrade (Years)** | Estimated Fund Schedule |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 7.66 |
| **Intermediate Tributary Area (mile2)** | 7.66 |
| **Developed Portion of Tributary Area (mile2)** | 2.298 |
| **Developable Portion of Tributary Area (mile2)** | 0.383 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

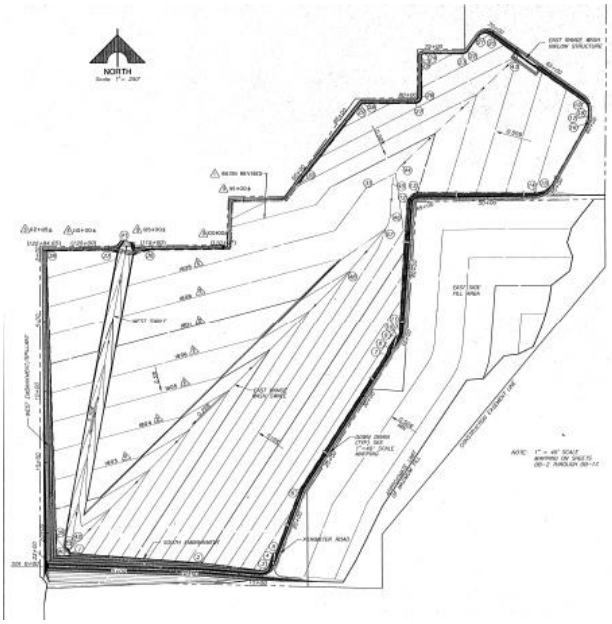
# Range Wash Basin

# Range Wash Confluence Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | RWSL0501 |
| **Watershed** | Lower Range |
| **System** | Range Wash |
| **Location** | On/Near Nellis Air Force Base |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 82.4 + |
| **Capacity (AF)** | 1,025 † |
| **Required Expansion (AF)** | N/A † |



### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.39 † |
| **Basin Floor Cover** | Soil Cement + |
| **Typical Side Slope** | 3:1 + |
| **Side Slope Cover** | Soil Cement + |
| **Outlet Type** | Pipe Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 3 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | 30 • |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 160 • |
| **100 Year Flood Capacity (AF)** | 1,280 • |
| **100 Year Flood Inflow (CFS)** | 6,081 † |
| **100 Year Flood Outflow (CFS)** | 1,800 + |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 130 • |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1995 ⁺ |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 114.9 |
| **Intermediate Tributary Area (mile2)** | 82.4 |
| **Developed Portion of Tributary Area (mile2)** | 5.745 |
| **Developable Portion of Tributary Area (mile2)** | 57.45 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | Y |
| **Number of Upstream Basins** | 3 † |

### References


- http://www.ccrfcd.org/


- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Vandenberg Detention Basin
## Water Quality Controls

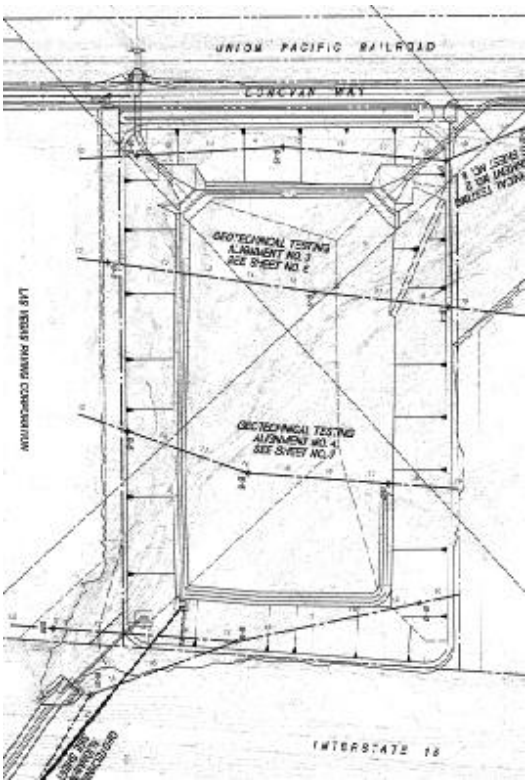
**Assessment of Water Quality Retrofit Potential: Poor**

### Basin Info

| | |
|---|---|
| **ID-Mile** | RWWE0170 |
| **Watershed** | Range Wash |
| **System** | West Range |
| **Location** | Donovan Way near N Lamb |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 9.4 ⁺ |
| **Capacity (AF)** | 349 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 4.90 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Pipe Culvert ⁺ |
| **Number of Outlets** | 2 ⁺ |
| **Number of Inlets** | 2 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 4.1 |
| **100 Year Flood Capacity (AF)** | 340 ⁺ |
| **100 Year Flood Inflow (CFS)** | 3,121 † |
| **100 Year Flood Outflow (CFS)** | 283 ⁺ |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2000 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 9.44 |
| **Intermediate Tributary Area (mile2)** | 9.44 |
| **Developed Portion of Tributary Area (mile2)** | 0.472 |
| **Developable Portion of Tributary Area (mile2)** | 1.888 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/


- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Lower Northern Basin Fact Sheets

# Cheyenne Peaking Basin
## Water Quality Controls

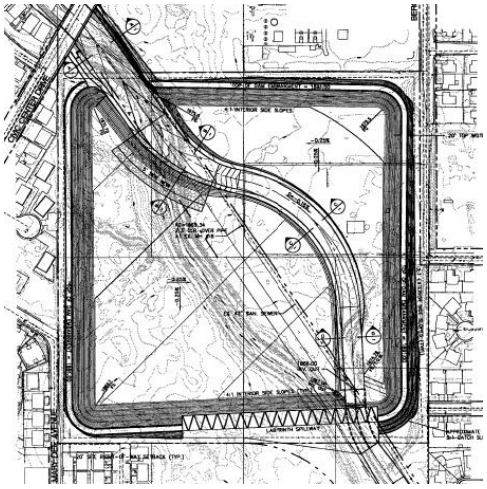
**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | LVMD1645 |
| **Watershed** | Lower Northern |
| **System** | Cheyenne Lamb Nellis |
| **Location** | btwn Gowan and Cheyenne |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 76.6 ◦ |
| **Capacity (AF)** | 456 † |
| **Required Expansion (AF)** | 26 † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | .24 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 4:1 UP 3:1 Down |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCB Culvert w/a 2' Pier Orifice |
| **Number of Outlets** | 1 |
| **Number of Inlets** | 1 |
| **Inlet Flow Bypass (Y/N)** | Y ◦ |
| **Annual Sedimentation Storage (AF)** | |



### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 15.76 |
| **100 Year Flood Capacity (AF)** | 440 ◦ |
| **100 Year Flood Inflow (CFS)** | 11,998 † |
| **100 Year Flood Outflow (CFS)** | 7,400 ◦ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | Proposed Only |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 228.98 |
| **Intermediate Tributary Area (mile2)** | 76.6 |
| **Developed Portion of Tributary Area (mile2)** | 22.898 |
| **Developable Portion of Tributary Area (mile2)** | 91.592 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | Y |
| **Number of Upstream Basins** | 12 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# North Las Vegas Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | LVUP0405 |
| **Watershed** | Lower Northern |
| **System** | Las Vegas Wash - Craig |
| **Location** | near Beltway and Losee |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 70.8 |
| **Capacity (AF)** | 1,435 † |
| **Required Expansion (AF)** | 780 † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.01 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | N/A |
| **Side Slope Cover** | N/A |
| **Outlet Type** | |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 2 ⁺ |
| **Inlet Flow Bypass (Y/N)** | |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 12,887 † |
| **100 Year Flood Outflow (CFS)** | 11,740 |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | Y |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 214.8 |
| **Intermediate Tributary Area (mile2)** | 70.8 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | Y |
| **Number of Upstream Basins** | 1 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

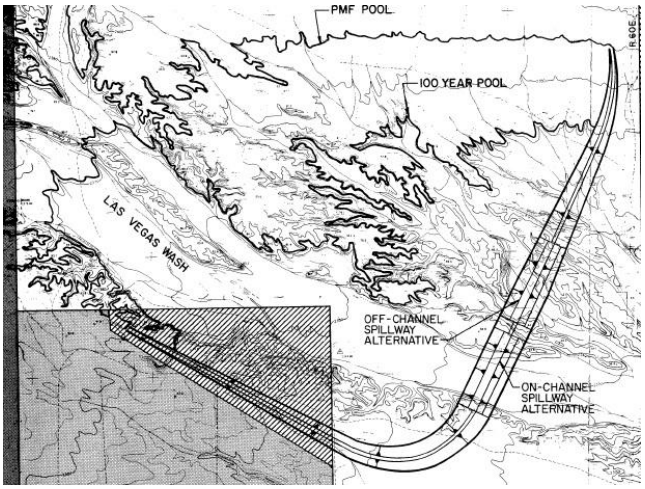

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Upper Las Vegas Wash Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | LVUP0910 |
| **Watershed** | Upper Northern |
| **System** | Sheep Mountain |
| **Location** | N Decatur near Iron Mountain |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 144 ⁺ |
| **Capacity (AF)** | 1,836 † |
| **Required Expansion (AF)** | 1,411 † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.1 † |
| **Basin Floor Cover** | In-Situ Terrain |
| **Typical Side Slope** | 0.125694444 |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCB Culvert ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 1 ⁺ |
| **Inlet Flow Bypass (Y/N)** | N ⁺ |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 74.9 |
| **100 Year Flood Capacity (AF)** | 1,760 ⁺ |
| **100 Year Flood Inflow (CFS)** | 15,898 † |
| **100 Year Flood Outflow (CFS)** | 4,240 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1991 ⁺ |
| **Planed Upgrade (Years)** | Proposed Only |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 144 |
| **Intermediate Tributary Area (mile2)** | 144 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 7.2 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# C1 Fact Sheets

# Equestrian Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | C1EQ0159 |
| **Watershed** | Pittman/C-1 |
| **System** | C-1 |
| **Location** | Equestrian and Magic Way |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 6.9 |
| **Capacity (AF)** | 409 † |
| **Required Expansion (AF)** | 135 † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | .9 † |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Pipe Culvert + |
| **Number of Outlets** | 2 + |
| **Number of Inlets** | 2 + |
| **Inlet Flow Bypass (Y/N)** | Y • |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 6,444 † |
| **100 Year Flood Outflow (CFS)** | 5,880 |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | 2011-2012 |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 21.43 |
| **Intermediate Tributary Area (mile2)** | 6.9 |
| **Developed Portion of Tributary Area (mile2)** | 2.143 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 3 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Mission Hills Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Insufficient Information**

### Basin Info

| | |
|---|---|
| **ID-Mile** | C1CH0854 |
| **Watershed** | Pittman/C-1 |
| **System** | Beltway |
| **Location** | Half Mile SW of Mission Hills Park |
| **Facility Type** | On-Channel DB ◊ |
| **Tributary Area (mile$^2$)** | 9.3 ◊ |
| **Capacity (AF)** | |
| **Required Expansion (AF)** | N/A |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | |
| **Basin Floor Cover** | Compacted Earthfill ◊ |
| **Typical Side Slope** | |
| **Side Slope Cover** | |
| **Outlet Type** | Pipe Culvert ◊ |
| **Number of Outlets** | 1 ◊ |
| **Number of Inlets** | 2 ◊ |
| **Inlet Flow Bypass (Y/N)** | N ◊ |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Y Flood Sedimentation Storage (AF)** | #VALUE! |
| **100 Year Flood Capacity (AF)** | 480 ◊ |
| **100 Year Flood Inflow (CFS)** | 5371 ◊ |
| **100 Year Flood Outflow (CFS)** | 309 ◊ |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | Y |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N ◊ |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 13 |
| **Intermediate Tributary Area (mile2)** | 9.33 |
| **Developed Portion of Tributary Area (mile2)** | |
| **Developable Portion of Tributary Area (mile2)** | |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 1 ◊ |

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

### References

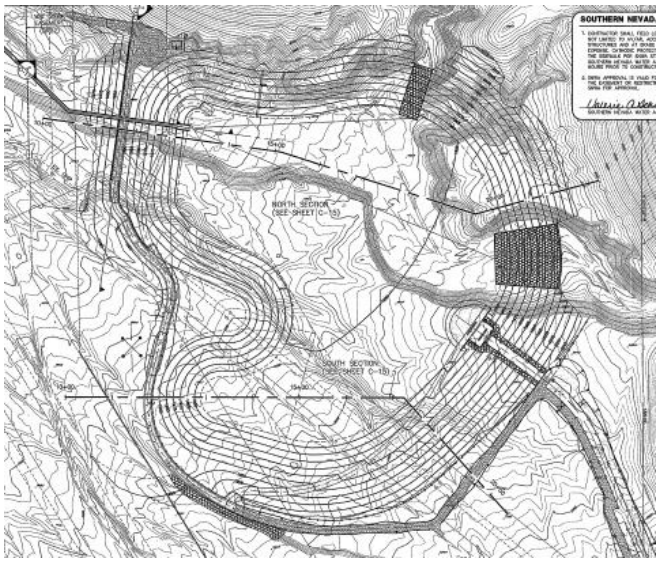

- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

# Northeast C1 Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | C1HV0140 |
| **Watershed** | Pittman/C-1 |
| **System** | C-1 |
| **Location** | Near Magic Way |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 9.8 + |
| **Capacity (AF)** | 353 † |
| **Required Expansion (AF)** | N/A † |



### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.11 † |
| **Basin Floor Cover** | Soil Cement + |
| **Typical Side Slope** | 3:1 + |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Pipe Culvert w/Orifice + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 32 + |
| **100 Year Flood Capacity (AF)** | 321 + |
| **100 Year Flood Inflow (CFS)** | 2,520 † |
| **100 Year Flood Outflow (CFS)** | 204 + |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 32 + |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2008 + |
| **Planed Upgrade (Years)** | N |

| | |
|---|---|
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 24.33 |
| **Intermediate Tributary Area (mile2)** | 9.8 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 3 † |

**References**

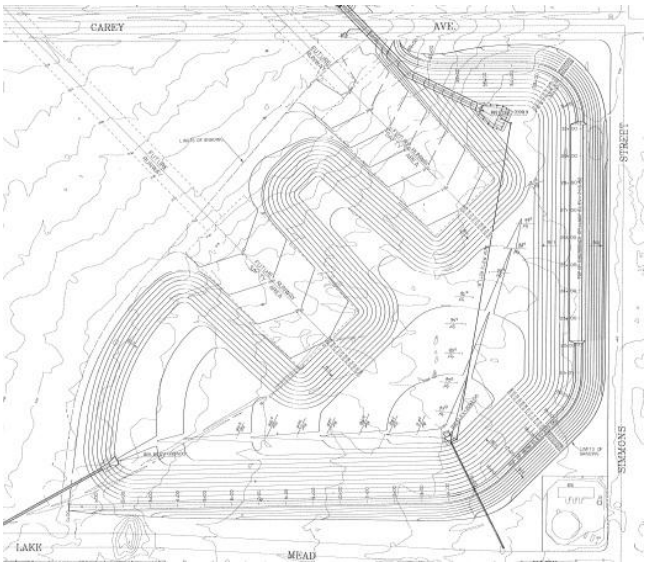

- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Central Basin Fact Sheets

# Carey Lake Mead Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**




### Basin Info

| | |
|---|---|
| **ID-Mile** | LVLM0228 |
| **Watershed** | Central |
| **System** | Las Vegas Wash Central |
| **Location** | Simmons btwn Carey and Lake Mead |
| **Facility Type** | Off-Channel DB |
| **Tributary Area (mile$^2$)** | 11.78 ◊ |
| **Capacity (AF)** | 607 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0.36 † |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | 8:1 + |
| **Side Slope Cover** | Compacted Earthfill + |
| **Outlet Type** | 48" RCP Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 2 + |
| **Inlet Flow Bypass (Y/N)** | Y + |
| **Annual Sedimentation Storage (AF)** | 6.2 • |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 87 • |
| **100 Year Flood Capacity (AF)** | 420 • |
| **100 Year Flood Inflow (CFS)** | 5,184 † |
| **100 Year Flood Outflow (CFS)** | 373 • |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 118 • |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1991 + |
| **Planed Upgrade (Years)** | N |

| | |
|---|---|
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 11.78 |
| **Intermediate Tributary Area (mile2)** | 11.78 |
| **Developed Portion of Tributary Area (mile2)** | 7.068 |
| **Developable Portion of Tributary Area (mile2)** | 4.712 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Meadows Detention Basin
## Water Quality Controls

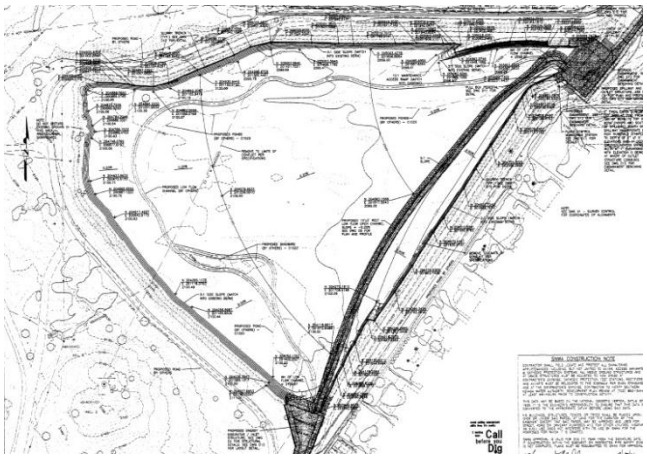
**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | LCME0020 |
| **Watershed** | Central |
| **System** | Las Vegas Wash Central |
| **Location** | Valley View btwn Bonanza and Alta |
| **Facility Type** | Off-Channel DB |
| **Tributary Area (mile$^2$)** | 7.76 ⁺ |
| **Capacity (AF)** | 213 † |
| **Required Expansion (AF)** | 22 † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | 2,115.5 ◦ |
| **Freeboard (ft)** | 0.11 † |
| **Basin Floor Cover** | Wet Lands |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCB Culvert ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 1 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |



### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 14.89 |
| **100 Year Flood Capacity (AF)** | 228 ◦ |
| **100 Year Flood Inflow (CFS)** | 4,713 † |
| **100 Year Flood Outflow (CFS)** | 1,344 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | Y |
| **Construction Year** | 1987 ◦ |
| **Planed Upgrade (Years)** | Y |
| **In-Basin Recreation Facilities (Y/N)** | Y |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 10.71 |
| **Intermediate Tributary Area (mile2)** | 7.76 |
| **Developed Portion of Tributary Area (mile2)** | 10.1745 |
| **Developable Portion of Tributary Area (mile2)** | 0.5355 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 2 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# NEEA Detention Basin at Floyd Lamb Park
## Water Quality Controls

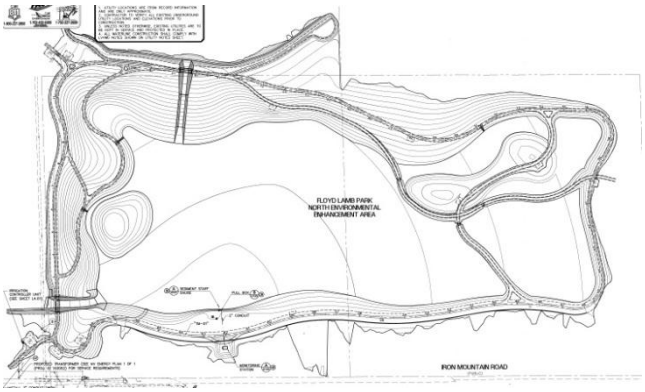
**Assessment of Water Quality Retrofit Potential: Poor**

### Basin Info

| | |
|---|---|
| **ID-Mile** | TSDB0011 |
| **Watershed** | Upper Northern |
| **System** | Upper Western Tributary |
| **Location** | Iron Mtn and N Buffalo |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 1.9 ⁺ |
| **Capacity (AF)** | 117 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.37 † |
| **Basin Floor Cover** | Soil Cement ⁺ |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | 36" Culvert w/22" Orifice ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 2 ⁺ |
| **Inlet Flow Bypass (Y/N)** | N ⁺ |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 18.1 ⁺ |
| **100 Year Flood Capacity (AF)** | 97.7 ⁺ |
| **100 Year Flood Inflow (CFS)** | 804 † |
| **100 Year Flood Outflow (CFS)** | 30 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 18.1 ⁺ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2010 ⁺ |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | Y |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 1.9 |
| **Intermediate Tributary Area (mile2)** | 1.9 |
| **Developed Portion of Tributary Area (mile2)** | 0.095 |
| **Developable Portion of Tributary Area (mile2)** | 0.76 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Oakey Detention Basin
## Water Quality Controls

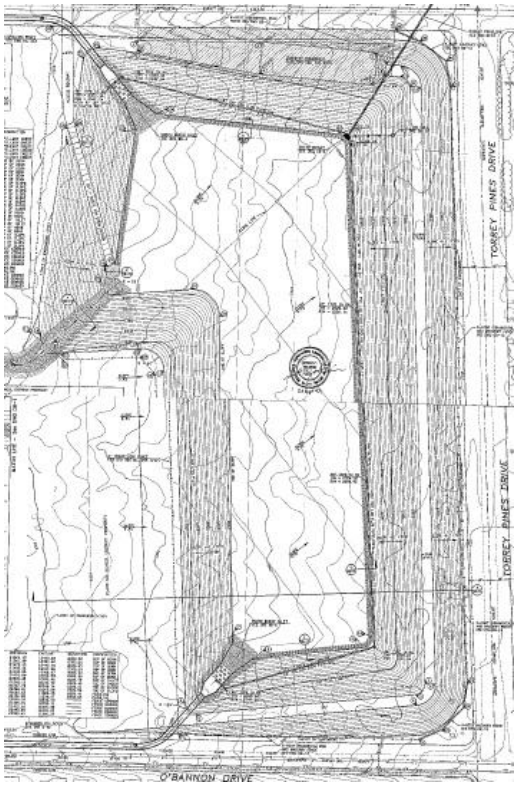
**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | MECH0324 |
| **Watershed** | Central |
| **System** | Las Vegas Wash Central |
| **Location** | Torrey Pines btwn Oakey and O'Bannon |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 1.84 ◦ |
| **Capacity (AF)** | 201 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 3.74 † |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCB Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 2 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 50.26 |
| **100 Year Flood Capacity (AF)** | 147 |
| **100 Year Flood Inflow (CFS)** | 1,652 † |
| **100 Year Flood Outflow (CFS)** | 32 |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1992 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 1.84 |
| **Intermediate Tributary Area (mile2)** | 1.84 |
| **Developed Portion of Tributary Area (mile2)** | 1.104 |
| **Developable Portion of Tributary Area (mile2)** | 0.736 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Rainbow Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | LCCH0513 |
| **Watershed** | Central |
| **System** | Las Vegas Wash Central |
| **Location** | Rainbow and Westcliff |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 1.11 |
| **Capacity (AF)** | 102 † |
| **Required Expansion (AF)** | 57 † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 9.67 † |
| **Basin Floor Cover** | Soil Cement ⁺ |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Pipe Culvert ⁺ |
| **Number of Outlets** | 2 ⁺ |
| **Number of Inlets** | 1 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 970 † |
| **100 Year Flood Outflow (CFS)** | 85 |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | Y |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 1.11 |
| **Intermediate Tributary Area (mile2)** | 1.11 |
| **Developed Portion of Tributary Area (mile2)** | |
| **Developable Portion of Tributary Area (mile2)** | |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

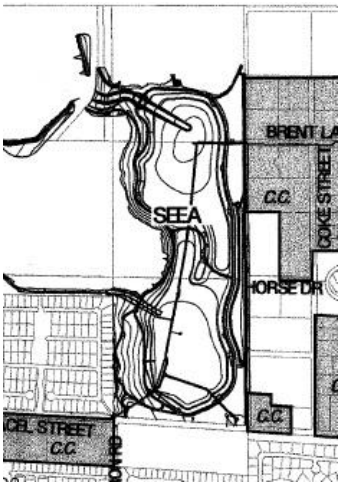

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# SEEA Detention Basin at Floyd Lamb Park
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Poor**

### Basin Info

| | |
|---|---|
| **ID-Mile** | BRDB0032 |
| **Watershed** | Upper Northern |
| **System** | Upper Western Tributary |
| **Location** | N Cimmaron and Racel St |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 8.3 ⁺ |
| **Capacity (AF)** | 450 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 5.99 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | 36" Culvert w/18" Orifice ⁺ |
| **Number of Outlets** | 2 ⁺ |
| **Number of Inlets** | 2 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 20.7 ⁺ |
| **100 Year Flood Capacity (AF)** | 440 ⁺ |
| **100 Year Flood Inflow (CFS)** | 1,902 † |
| **100 Year Flood Outflow (CFS)** | 43 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 20.7 ⁺ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2010 ⁺ |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | Y |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 8.3 |
| **Intermediate Tributary Area (mile2)** | 8.3 |
| **Developed Portion of Tributary Area (mile2)** | 2.49 |
| **Developable Portion of Tributary Area (mile2)** | 2.49 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Duck Creek Wash Fact Sheets

# Bruner Detention Basin
## Water Quality Controls

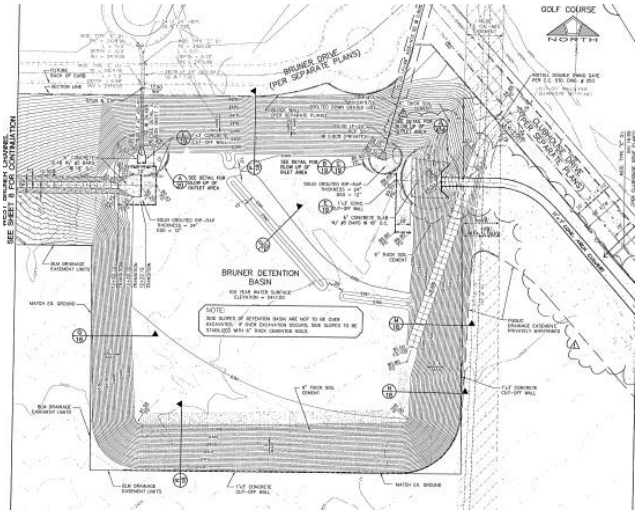
**Assessment of Water Quality Retrofit Potential:** Fair

### Basin Info

| | |
|---|---|
| **ID-Mile** | DCW10251 |
| **Watershed** | Duck Creek- Blue Diamond |
| **System** | Central |
| **Location** | Bruner btwn Southern Highlands and Decatur |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 1.23 ◊ |
| **Capacity (AF)** | 109 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.27 † |
| **Basin Floor Cover** | Soil Cement + |
| **Typical Side Slope** | 2:1 + |
| **Side Slope Cover** | Rip Rap + |
| **Outlet Type** | Arch Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 1,681 † |
| **100 Year Flood Outflow (CFS)** | 257 |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2002 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 1.23 |
| **Intermediate Tributary Area (mile2)** | 1.23 |
| **Developed Portion of Tributary Area (mile2)** | 0.0615 |
| **Developable Portion of Tributary Area (mile2)** | 0.246 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 + |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

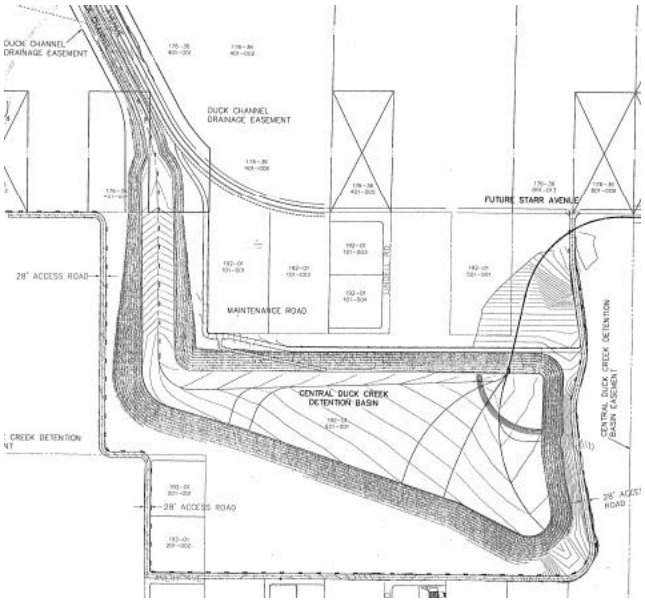

Note: The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Central Duck Creek Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | DCWA1658 |
| **Watershed** | Duck Creek- Blue Diamond |
| **System** | Central |
| **Location** | Starr btwn Jones and Decatur |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 18.72 ⁺ |
| **Capacity (AF)** | 1,046 † |
| **Required Expansion (AF)** | 334 † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.61 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | Compacted Earthfill ⁺ |
| **Outlet Type** | Pipe Culvert w/Orifice Plate ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 1 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | 1,046 ⁺ |
| **100 Year Flood Inflow (CFS)** | 7,537 † |
| **100 Year Flood Outflow (CFS)** | 326 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2000 ⁺ |
| **Planed Upgrade (Years)** | Y |

| | |
|---|---|
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 18.72 |
| **Intermediate Tributary Area (mile2)** | 18.72 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 2.808 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Lower Blue Diamond Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential:** Poor

### Basin Info

| | |
|---|---|
| **ID-Mile** | BDWA0470 |
| **Watershed** | Duck Creek- Blue Diamond |
| **System** | Blue Diamond Tributaries |
| **Location** | Decatur btwn Robindale and Windmill |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 5.54 ◊ |
| **Capacity (AF)** | 380 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.03 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Pipe Culvert ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 2 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 3,701 † |
| **100 Year Flood Outflow (CFS)** | 197 |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 5.54 |
| **Intermediate Tributary Area (mile2)** | 5.54 |
| **Developed Portion of Tributary Area (mile2)** | 0.554 |
| **Developable Portion of Tributary Area (mile2)** | 4.986 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Lower Duck Creek Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | DCWA1217 |
| **Watershed** | Duck Creek- Blue Diamond |
| **System** | Lower Duck Creek/Blue Diamond |
| **Location** | Richmar btwn Gillespie and Bermuda |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 13.29 ◊ |
| **Capacity (AF)** | 1,110 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.63 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 4:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | 8' x 8.15' Orifice ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 3 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 185.7 ◦ |
| **100 Year Flood Capacity (AF)** | 1,110 † |
| **100 Year Flood Inflow (CFS)** | 5,844 † |
| **100 Year Flood Outflow (CFS)** | 400 ◦ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 205 ◦ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1999 |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 38.78 |
| **Intermediate Tributary Area (mile2)** | 13.29 |
| **Developed Portion of Tributary Area (mile2)** | 1.939 |
| **Developable Portion of Tributary Area (mile2)** | 23.268 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | Y |
| **Number of Upstream Basins** | 3 † |

### References


- http://www.ccrfcd.org/


- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

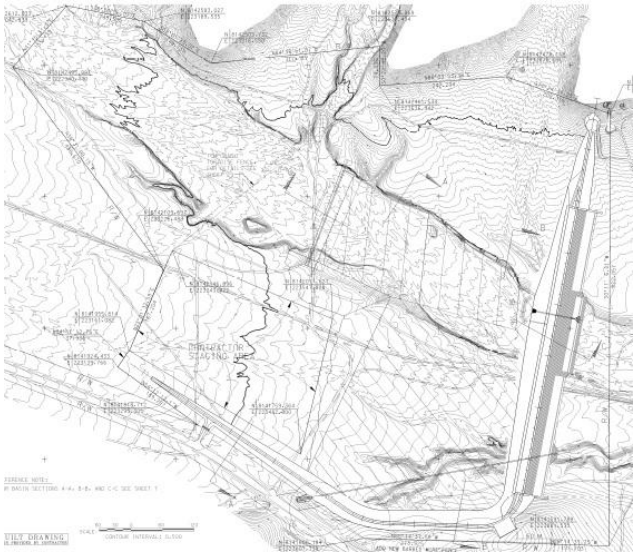
**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Upper Blue Diamond Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential:** Fair

### Basin Info

| | |
|---|---|
| **ID-Mile** | TRBD0930 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Tropicana- Flamingo Wash |
| **Location** | Blue Diamond and Hualpai Way |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 68.25 ◦ |
| **Capacity (AF)** | 2,270 † |
| **Required Expansion (AF)** | N/A † |



### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | 100 ◦ |
| **Typical Width (ft)** | 19.68 ◦ |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0 † |
| **Basin Floor Cover** | RCC and Rip Rap ◦ |
| **Typical Side Slope** | 2.5:1 + |
| **Side Slope Cover** | RCC ◦ |
| **Outlet Type** | RCB Culvert ◦ |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 2 + |
| **Inlet Flow Bypass (Y/N)** | Y + |
| **Annual Sedimentation Storage (AF)** | 15.9 ◦ |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 238 ◦ |
| **100 Year Flood Capacity (AF)** | 2,370 ◦ |
| **100 Year Flood Inflow (CFS)** | 13,800 † |
| **100 Year Flood Outflow (CFS)** | 213 ◦ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 210 ◦ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1998 ◦ |
| **Planed Upgrade (Years)** | N |

| | |
|---|---|
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 68.25 |
| **Intermediate Tributary Area (mile2)** | 68.25 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 ◦ |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


Note: The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

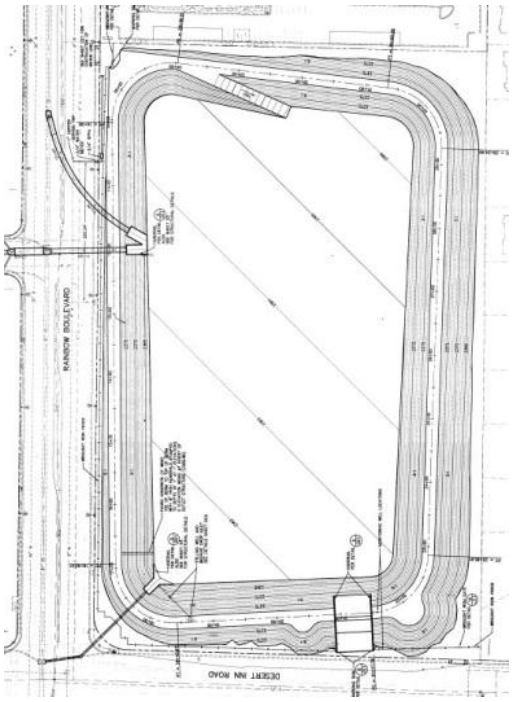
# Flamingo / Tropicana Washes Fact Sheets

# Desert Inn Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Poor**

### Basin Info

| | |
|---|---|
| **ID-Mile** | FLLA0308 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Flamingo- Decatur |
| **Location** | Desert Inn and Rainbow |
| **Facility Type** | Off-Channel DB |
| **Tributary Area (mile$^2$)** | 1.07 + |
| **Capacity (AF)** | 62 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0.27 † |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | 3:1 + |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCP Culvert w/18" Orifice + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | Y + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 2 + |
| **100 Year Flood Capacity (AF)** | 62 + |
| **100 Year Flood Inflow (CFS)** | 744 † |
| **100 Year Flood Outflow (CFS)** | 30 + |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 2 + |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1999 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 1.07 |
| **Intermediate Tributary Area (mile2)** | 1.07 |
| **Developed Portion of Tributary Area (mile2)** | 1.0165 |
| **Developable Portion of Tributary Area (mile2)** | 0.0535 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

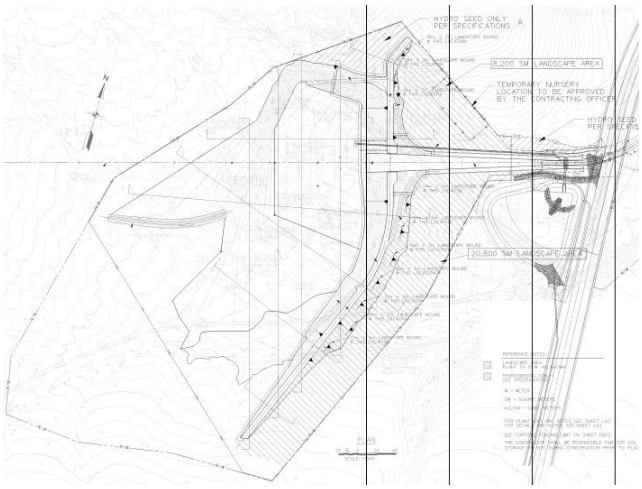

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# F-4 Debris Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential:** Fair

### Basin Info

| | |
|---|---|
| **ID-Mile** | FLF40355 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Tropicana- Flamingo Wash |
| **Location** | Fort Apache near Warm Springs |
| **Facility Type** | On-Channel Debris/Sediment Basin |
| **Tributary Area (mile$^2$)** | 1.3 + |
| **Capacity (AF)** | 21.85 + |
| **Required Expansion (AF)** | N/A † |



### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 5 + |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | 3:1 + |
| **Side Slope Cover** | Soil Cement ◦ |
| **Outlet Type** | RCB Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | Y + |
| **Annual Sedimentation Storage (AF)** | 1.09 ◦ |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 16.4 ◦ |
| **100 Year Flood Capacity (AF)** | 21.85 |
| **100 Year Flood Inflow (CFS)** | 1,600 + |
| **100 Year Flood Outflow (CFS)** | 2100 |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 21.9 ◦ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1999 ◦ |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 1.3 |
| **Intermediate Tributary Area (mile2)** | 1.3 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0.39 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Flamingo Detention Basin
## Water Quality Controls

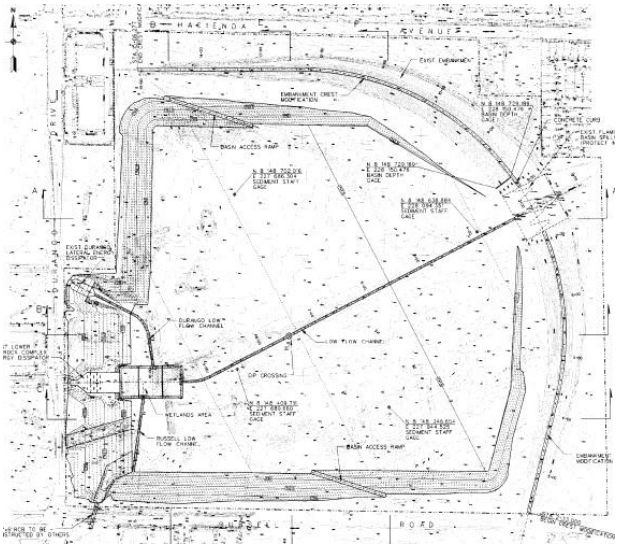
**Assessment of Water Quality Retrofit Potential: Poor**

### Basin Info

| | |
|---|---|
| **ID-Mile** | FLWA1443 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Tropicana- Flamingo Wash |
| **Location** | Durango btwn Russell and Hacienda |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 30.35 |
| **Capacity (AF)** | 1,340 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0 † |
| **Basin Floor Cover** | Compacted Earthfill ◦ |
| **Typical Side Slope** | 6:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Orifice w/Restrictor Plate ◦ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 3 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | 24.1 ◦ |



### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 138 ◦ |
| **100 Year Flood Capacity (AF)** | 1,911 ◦ |
| **100 Year Flood Inflow (CFS)** | 11,800 † |
| **100 Year Flood Outflow (CFS)** | 290 ◦ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 29.7 ◦ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2009 ◦ |
| **Planed Upgrade (Years)** | N |

| | |
|---|---|
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 98.36 |
| **Intermediate Tributary Area (mile2)** | 30.35 |
| **Developed Portion of Tributary Area (mile2)** | 4.918 |
| **Developable Portion of Tributary Area (mile2)** | 29.508 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 5 † |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

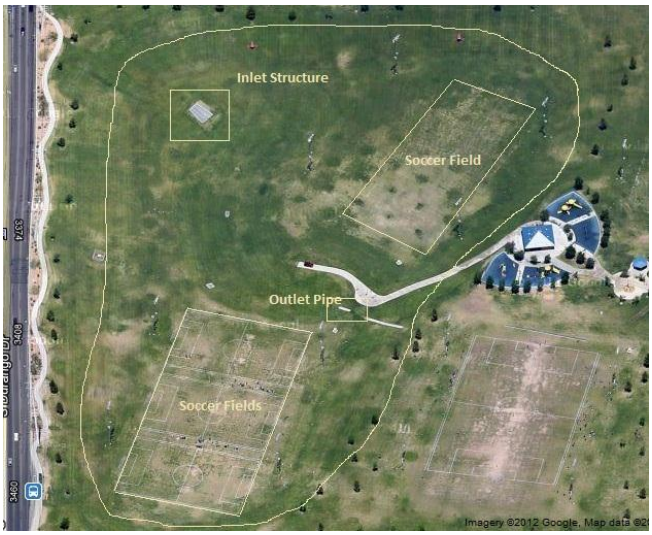

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Lakes Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | FLSM0087 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Flamingo- Decatur |
| **Location** | Desert Breeze Park |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 2.6 + |
| **Capacity (AF)** | 143 † |
| **Required Expansion (AF)** | 22 † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0.31 † |
| **Basin Floor Cover** | Grass + |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | 36" RCP |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | 143 + |
| **100 Year Flood Inflow (CFS)** | 1,976 † |
| **100 Year Flood Outflow (CFS)** | 85 + |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | Y |
| **Construction Year** | 2002 + |
| **Planed Upgrade (Years)** | Proposed Only |
| **In-Basin Recreation Facilities (Y/N)** | Y |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 2.6 |
| **Intermediate Tributary Area (mile2)** | 2.6 |
| **Developed Portion of Tributary Area (mile2)** | 2.47 |
| **Developable Portion of Tributary Area (mile2)** | 0.13 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

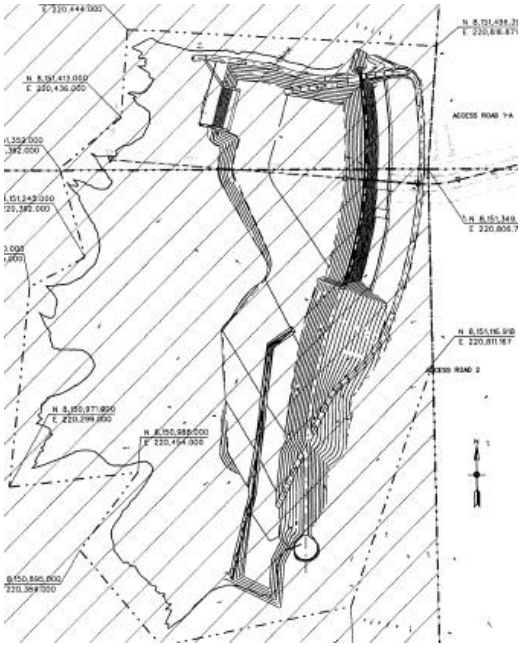

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# R-4 Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | RRR40160 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Tropicana- Flamingo Wash |
| **Location** | btwn Desert Inn extended and Flamingo extended |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 5.54 ⁺ |
| **Capacity (AF)** | 362 † |
| **Required Expansion (AF)** | N/A † |



### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | RCC ◦ |
| **Outlet Type** | RCP Culvert w/Orifice ◦ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 1 ⁺ |
| **Inlet Flow Bypass (Y/N)** | N ⁺ |
| **Annual Sedimentation Storage (AF)** | 3.9 ◦ |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 58.2 ◦ |
| **100 Year Flood Capacity (AF)** | 391.2 ⁺ |
| **100 Year Flood Inflow (CFS)** | 3,400 † |
| **100 Year Flood Outflow (CFS)** | 370.8 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 77.7 ⁺ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2002 ⁺ |

| | |
|---|---|
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 5.54 |
| **Intermediate Tributary Area (mile2)** | 5.54 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Red Rock Detention Basin
## Water Quality Controls

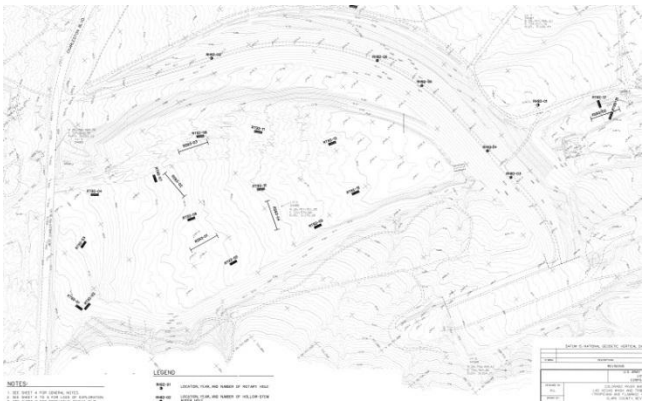
**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | RRWA0716 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Tropicana- Flamingo Wash |
| **Location** | Charleston west of the 215 Beltway |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 55.2 + |
| **Capacity (AF)** | 2,007 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0 † |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | 5:1 + |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCB Culvert w/Constrictor Plate ◦ |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | 15 ◦ |



### Basin Operations

| | |
|---|---|
| **100 Y Flood Sedimentation Storage (AF)** | 222 ◦ |
| **100 Year Flood Capacity (AF)** | 2000 + |
| **100 Year Flood Inflow (CFS)** | 12,800 † |
| **100 Year Flood Outflow (CFS)** | 182 + |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 222 ◦ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1995 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 55.2 |
| **Intermediate Tributary Area (mile2)** | 55.2 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

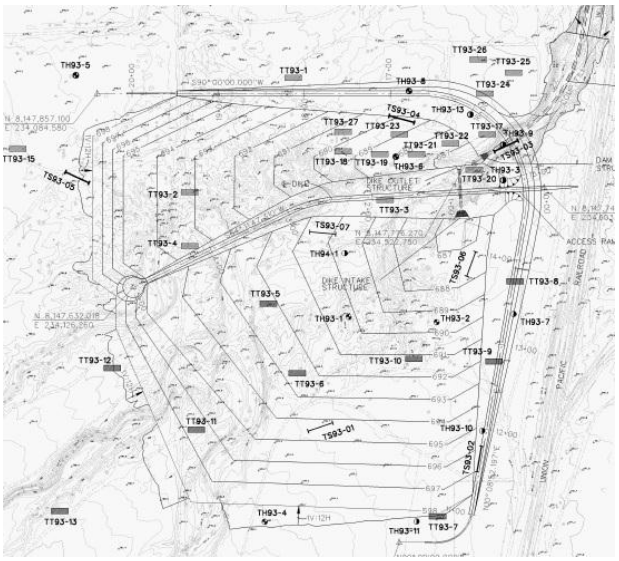

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Tropicana Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | TRWA0454 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Tropicana- Flamingo Wash |
| **Location** | Decatur and Oquendo |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 172.12 ◦ |
| **Capacity (AF)** | 825 † |
| **Required Expansion (AF)** | N/A † |



### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | 2779.92 ◦ |
| **Typical Width (ft)** | 19.69 ◦ |
| **Max. Design Depth (ft)** | 38.66 ◦ |
| **Freeboard (ft)** | 0 † |
| **Basin Floor Cover** | Concrete ◦ |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | Concrete ◦ |
| **Outlet Type** | RCP Pipe Culvert ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 2 ⁺ |
| **Inlet Flow Bypass (Y/N)** | N ⁺ |
| **Annual Sedimentation Storage (AF)** | 15.4 ◦ |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 71.42 ◦ |
| **100 Year Flood Capacity (AF)** | 1,669 ◦ |
| **100 Year Flood Inflow (CFS)** | 6,700 † |
| **100 Year Flood Outflow (CFS)** | 496.88 ◦ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 71.42 ◦ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1997 ◦ |
| **Planed Upgrade (Years)** | N |

| | |
|---|---|
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 338.7 |
| **Intermediate Tributary Area (mile2)** | 172.12 |
| **Developed Portion of Tributary Area (mile2)** | 33.87 |
| **Developable Portion of Tributary Area (mile2)** | 135.48 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | Y |
| **Number of Upstream Basins** | 7 † |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Van Buskirk "C" Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | VBMC0161 |
| **Watershed** | Flamingo-Tropicana |
| **System** | Lower Flamingo |
| **Location** | Harmon btwn Paso El Rio and Bunker Ct |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 2.95 |
| **Capacity (AF)** | 16 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Channel + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | Y + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 266 † |
| **100 Year Flood Outflow (CFS)** | |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 4.44 |
| **Intermediate Tributary Area (mile2)** | 2.95 |
| **Developed Portion of Tributary Area (mile2)** | 4.44 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 1 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Gowan Basin Fact Sheets

# Angel Park Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Poor**

### Basin Info

| | |
|---|---|
| **ID-Mile** | APNO0000 |
| **Watershed** | Gowan |
| **System** | Gowan South |
| **Location** | N Durango and Vegas Dr |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 24 ⁺ |
| **Capacity (AF)** | 1,400 † |
| **Required Expansion (AF)** | 112 † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | .31 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | Riprap ⁺ |
| **Outlet Type** | Pipe Culvert ⁺ |
| **Number of Outlets** | 2 ⁺ |
| **Number of Inlets** | 3 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |



Angel Park North Angel Park South

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 0 |
| **100 Year Flood Capacity (AF)** | 1400 |
| **100 Year Flood Inflow (CFS)** | 9,199 † |
| **100 Year Flood Outflow (CFS)** | 1248 |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | Estimated Fund Schedule |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 30.77 |
| **Intermediate Tributary Area (mile2)** | 24 |
| **Developed Portion of Tributary Area (mile2)** | 9.231 |
| **Developable Portion of Tributary Area (mile2)** | 3.077 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 1 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Ann Road CAM 10 Detention Basin
## Water Quality Controls

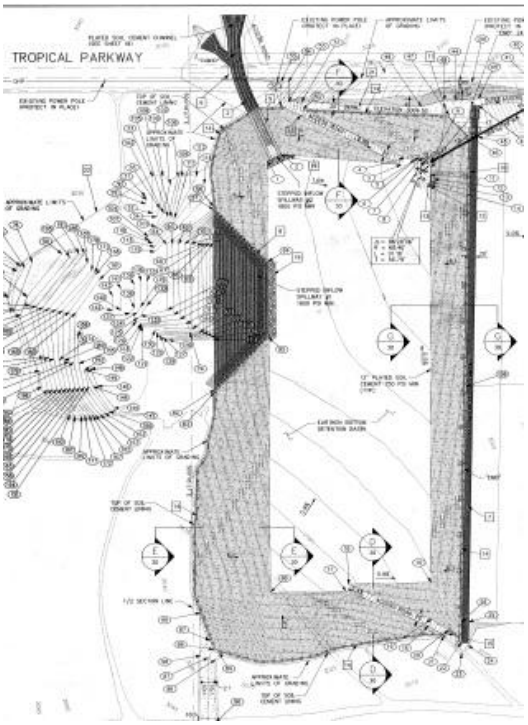
**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | GOAN0061 |
| **Watershed** | Gowan |
| **System** | North Gowan |
| **Location** | Near Ann Rd and the 215 Beltway |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 3.77 ⁺ |
| **Capacity (AF)** | 364 † |
| **Required Expansion (AF)** | 115 † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.07 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 4:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCP Culvert w/Orifice ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 1 ⁺ |
| **Inlet Flow Bypass (Y/N)** | N ⁺ |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 40 ⁺ |
| **100 Year Flood Capacity (AF)** | 304 ⁺ |
| **100 Year Flood Inflow (CFS)** | 6,028 † |
| **100 Year Flood Outflow (CFS)** | 156 ⁺ |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 40 + |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2002 + |
| **Planed Upgrade (Years)** | Proposed Only |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 3.77 |
| **Intermediate Tributary Area (mile2)** | 3.77 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Gowan North Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | GONO 0008 |
| **Watershed** | Gowan |
| **System** | North Gowan |
| **Location** | Gowan and Tenaya |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 38 + |
| **Capacity (AF)** | 921 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0.26 † |
| **Basin Floor Cover** | Compacted Earthfill and Grass + |
| **Typical Side Slope** | 4:1 + |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Baffled Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 2 + |
| **Inlet Flow Bypass (Y/N)** | Y + |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 80.74 |
| **100 Year Flood Capacity (AF)** | 840 + |
| **100 Year Flood Inflow (CFS)** | 4,054 † |
| **100 Year Flood Outflow (CFS)** | 560 + |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | Y |
| **Construction Year** | 1992 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | Y |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 96.71 |
| **Intermediate Tributary Area (mile2)** | 38 |
| **Developed Portion of Tributary Area (mile2)** | 29.013 |
| **Developable Portion of Tributary Area (mile2)** | 19.342 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 5 † |

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

# Gowan South Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | GOSO 0051 |
| **Watershed** | Gowan |
| **System** | South Gowan |
| **Location** | Cheyenne and Tenaya |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 11.8 ◦ |
| **Capacity (AF)** | 624 † |
| **Required Expansion (AF)** | 62 † |



### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0.1 † |
| **Basin Floor Cover** | Soil Cement + |
| **Typical Side Slope** | 4:1 + |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Baffled Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 2 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 38.9 |
| **100 Year Flood Capacity (AF)** | 585 ◦ |
| **100 Year Flood Inflow (CFS)** | 5,625 † |
| **100 Year Flood Outflow (CFS)** | 370 + |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1992 ⁺ |
| **Planed Upgrade (Years)** | Proposed Only |
| **In-Basin Recreation Facilities (Y/N)** | Y |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 42.57 |
| **Intermediate Tributary Area (mile2)** | 11.8 |
| **Developed Portion of Tributary Area (mile2)** | 40.4415 |
| **Developable Portion of Tributary Area (mile2)** | 2.1285 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 2 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

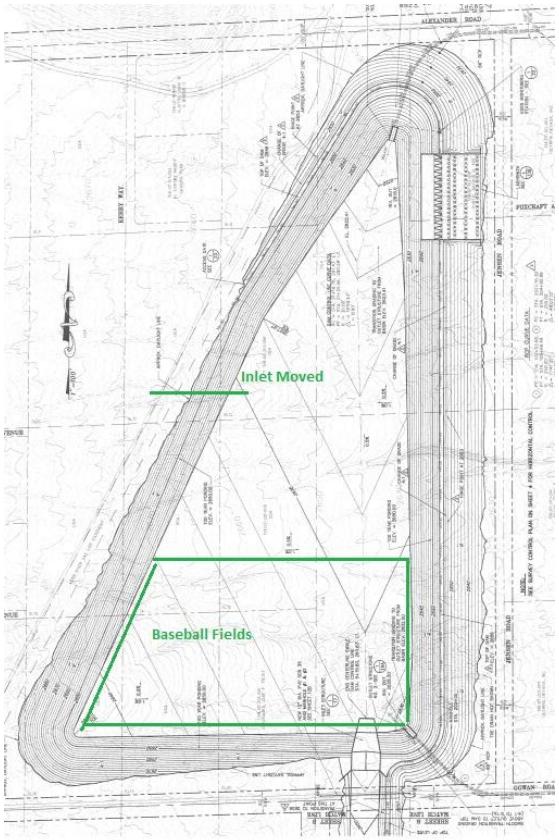

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Lone Mountain Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | APM50000 |
| **Watershed** | Gowan |
| **System** | South Gowan |
| **Location** | Sky Vista Dr near Alta |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 6.77 + |
| **Capacity (AF)** | 384 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 3.52 † |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | 4:1 + |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCB Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 42 + |
| **100 Year Flood Capacity (AF)** | 335 + |
| **100 Year Flood Inflow (CFS)** | 7,001 † |
| **100 Year Flood Outflow (CFS)** | 2,227 + |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 42 + |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2001 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 6.77 |
| **Intermediate Tributary Area (mile2)** | 6.77 |
| **Developed Portion of Tributary Area (mile2)** | 0.807 |
| **Developable Portion of Tributary Area (mile2)** | 0.807 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

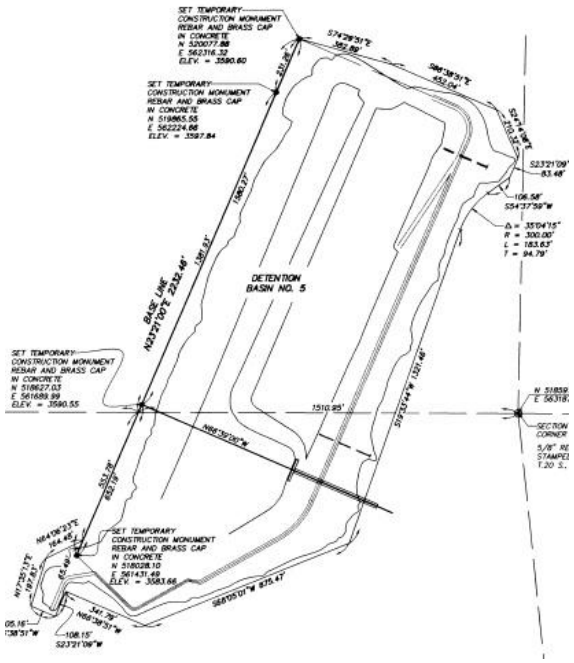

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Summerlin 5 Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | APM50000 |
| **Watershed** | Gowan |
| **System** | South Gowan |
| **Location** | Sky Vista Dr near Alta |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 6.77 + |
| **Capacity (AF)** | 384 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 3.52 † |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | 3:1 + |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCB Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 42 + |
| **100 Year Flood Capacity (AF)** | 335 + |
| **100 Year Flood Inflow (CFS)** | 7,001 † |
| **100 Year Flood Outflow (CFS)** | 2,227 + |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 42 + |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2001 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 6.77 |
| **Intermediate Tributary Area (mile2)** | 6.77 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Pittman Fact Sheets

# McCullough Hills Park Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

## Basin Info

| | |
|---|---|
| **ID-Mile** | PTPW0309 |
| **Watershed** | Pittman/C-1 |
| **System** | Beltway |
| **Location** | Reunion and McCullough Hills Pkwy |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 5.29 |
| **Capacity (AF)** | 355 † |
| **Required Expansion (AF)** | N/A † |




## Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 2.67 † |
| **Basin Floor Cover** | Grass ⁺ |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Pipe Culvert |
| **Number of Outlets** | 2 |
| **Number of Inlets** | 1 |
| **Inlet Flow Bypass (Y/N)** | N ⁺ |
| **Annual Sedimentation Storage (AF)** | |

## Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | #VALUE! |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 4,136 † |
| **100 Year Flood Outflow (CFS)** | |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | Y |
| **Construction Year** | |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | Y |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 5.29 |
| **Intermediate Tributary Area (mile2)** | 5.29 |
| **Developed Portion of Tributary Area (mile2)** | 1.058 |
| **Developable Portion of Tributary Area (mile2)** | 0.2645 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

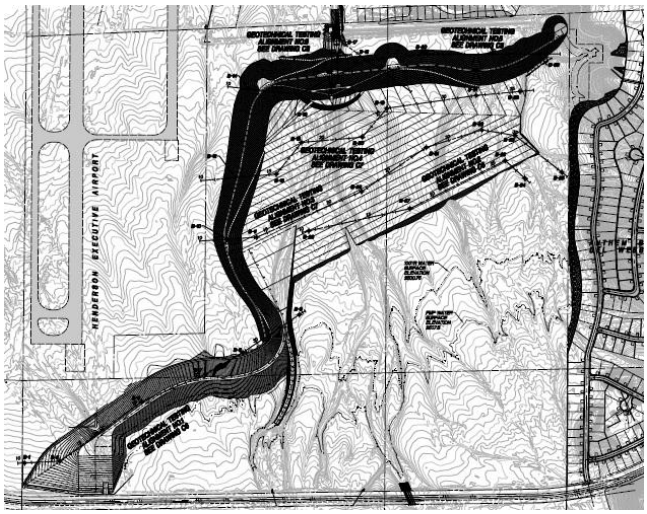

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Pittman East Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | PTEA0439 |
| **Watershed** | Pittman/C-1 |
| **System** | Beltway |
| **Location** | Volunteer Blvd and Sun City Anthem |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 33 ⁺ |
| **Capacity (AF)** | 1,718 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 8.12 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCP Culvert ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 2 ⁺ |
| **Inlet Flow Bypass (Y/N)** | N ⁺ |
| **Annual Sedimentation Storage (AF)** | 13.2 ◦ |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 91 ⁺ |
| **100 Year Flood Capacity (AF)** | 1,718 ⁺ |
| **100 Year Flood Inflow (CFS)** | 6,183 † |
| **100 Year Flood Outflow (CFS)** | 1,221 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 157 ◦ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2002 ⁺ |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 56.47 |
| **Intermediate Tributary Area (mile2)** | 33 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 1 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Pittman Anthem Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | PTAN0280 |
| **Watershed** | Pittman/C-1 |
| **System** | Beltway |
| **Location** | Bensley Street |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 2.45 |
| **Capacity (AF)** | 165 † |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.05 † |
| **Basin Floor Cover** | Compacted Earthfill |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Pipe Culvert |
| **Number of Outlets** | |
| **Number of Inlets** | 1 |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 1,737 † |
| **100 Year Flood Outflow (CFS)** | |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 7.74 |
| **Intermediate Tributary Area (mile2)** | 2.45 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 1 † |

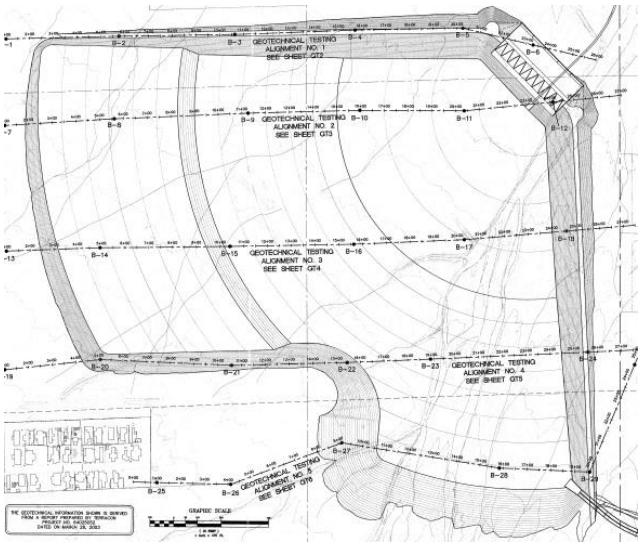
### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Pittman North Detention Basin and Outfall
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Poor**



### Basin Info

| | |
|---|---|
| **ID-Mile** | PTNO0182 |
| **Watershed** | Pittman/C-1 |
| **System** | Upper Pittman |
| **Location** | Gilespie and Volunteer Blvd |
| **Facility Type** | Off-Channel DB |
| **Tributary Area (mile$^2$)** | 16.68 ⁺ |
| **Capacity (AF)** | 600 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 0.98 † |
| **Basin Floor Cover** | |
| **Typical Side Slope** | 4:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Pipe Culvert w/Orifice ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 1 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | 1,041.5 ⁺ |
| **100 Year Flood Inflow (CFS)** | 5,476 † |
| **100 Year Flood Outflow (CFS)** | 442 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | N/A |
| **Planed Upgrade (Years)** | N |

| | |
|---|---|
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | |
| **Intermediate Tributary Area (mile2)** | |
| **Developed Portion of Tributary Area (mile2)** | |
| **Developable Portion of Tributary Area (mile2)** | |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | N/A |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Pittman Park Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | PTWA0050 |
| **Watershed** | Pittman/C-1 |
| **System** | Lower Pittman |
| **Location** | Arroyo Grande and Santiago |
| **Facility Type** | Off-Channel DB |
| **Tributary Area (mile$^2$)** | 32.8 ◦ |
| **Capacity (AF)** | 75 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 2.48 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 3:1 ⁺ |
| **Side Slope Cover** | Rip-Rap ⁺ |
| **Outlet Type** | 24" RCP w/Flap Gate ◦ |
| **Number of Outlets** | 1 ◦ |
| **Number of Inlets** | 1 |
| **Inlet Flow Bypass (Y/N)** | Y ◦ |
| **Annual Sedimentation Storage (AF)** | 4.11 ◦ |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 41 ◦ |
| **100 Year Flood Capacity (AF)** | 62 ◦ |
| **100 Year Flood Inflow (CFS)** | 889 † |
| **100 Year Flood Outflow (CFS)** | 45 ◦ |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 41 ◦ |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1998 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 116.75 |
| **Intermediate Tributary Area (mile2)** | 32.8 |
| **Developed Portion of Tributary Area (mile2)** | 93.4 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | Y |
| **Number of Upstream Basins** | 6 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# South Pittman Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | PTCR0020 |
| **Watershed** | Pittman/C-1 |
| **System** | Beltway |
| **Location** | At the end of Crescent Heights Ave |
| **Facility Type** | Debris/Sediment Basin |
| **Tributary Area (mile$^2$)** | 0.45 |
| **Capacity (AF)** | |
| **Required Expansion (AF)** | N/A † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | |
| **Basin Floor Cover** | In-Situ Terrain |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | |
| **Number of Outlets** | 0 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 536 † |
| **100 Year Flood Outflow (CFS)** | N/A |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2004 + |
| **Planed Upgrade (Years)** | N |

| | |
|---|---|
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 0.45 |
| **Intermediate Tributary Area (mile2)** | 0.45 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

**References**


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

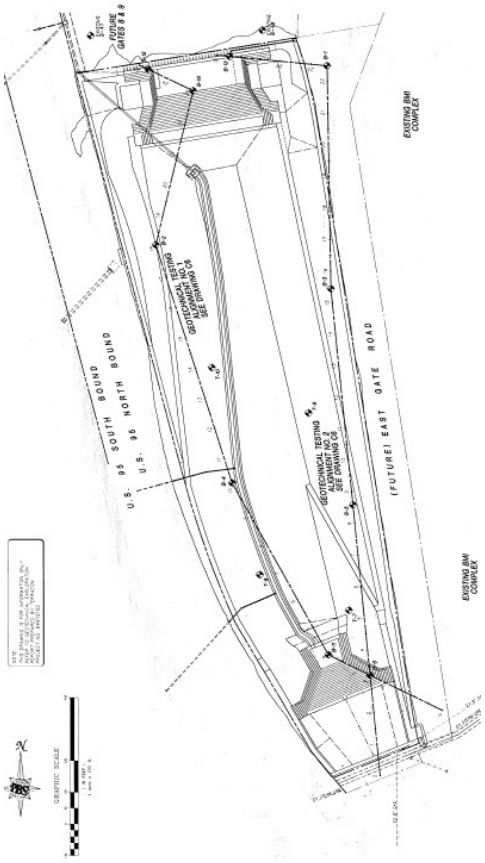

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Pioneer Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | PTVW0185 |
| **Watershed** | Pittman/C-1 |
| **System** | Burns |
| **Location** | Eastgate Btwn Boulder Highway and Sunset |
| **Facility Type** | Off-Channel DB |
| **Tributary Area (mile$^2$)** | 7.66 ◦ |
| **Capacity (AF)** | 377 † |
| **Required Expansion (AF)** | 65 † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | 1840 |
| **Typical Width (ft)** | 190 (varies) |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.15 † |
| **Basin Floor Cover** | Compacted Earthfill + |
| **Typical Side Slope** | 3:1 + |
| **Side Slope Cover** | Concrete + |
| **Outlet Type** | RCP Pipe Culvert w/Orifice Plate + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 1 + |
| **Inlet Flow Bypass (Y/N)** | Y + |
| **Annual Sedimentation Storage (AF)** | 2 |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 8.35 |
| **100 Year Flood Capacity (AF)** | 382 |
| **100 Year Flood Inflow (CFS)** | 6,163 † |
| **100 Year Flood Outflow (CFS)** | 421 ◦ |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 18.4 |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1999 |
| **Planed Upgrade (Years)** | Estimated Fund Schedule |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 7.66 |
| **Intermediate Tributary Area (mile2)** | 7.66 |
| **Developed Portion of Tributary Area (mile2)** | 2.298 |
| **Developable Portion of Tributary Area (mile2)** | 0.383 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

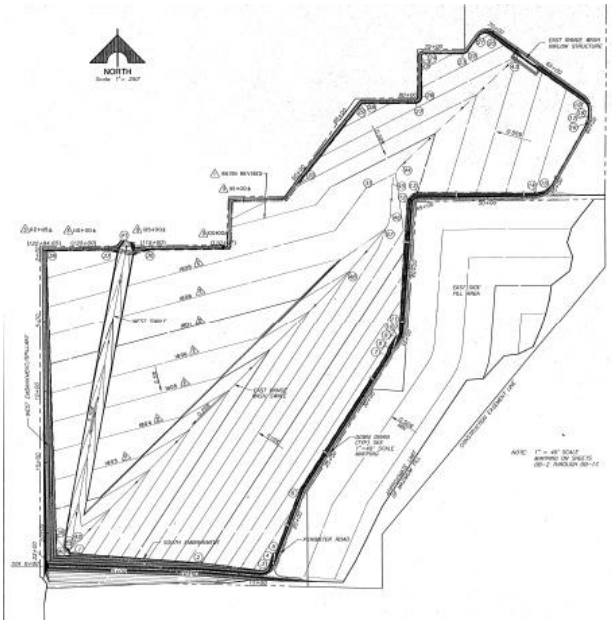
# Range Wash Basin

# Range Wash Confluence Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | RWSL0501 |
| **Watershed** | Lower Range |
| **System** | Range Wash |
| **Location** | On/Near Nellis Air Force Base |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 82.4 + |
| **Capacity (AF)** | 1,025 † |
| **Required Expansion (AF)** | N/A † |



### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.39 † |
| **Basin Floor Cover** | Soil Cement + |
| **Typical Side Slope** | 3:1 + |
| **Side Slope Cover** | Soil Cement + |
| **Outlet Type** | Pipe Culvert + |
| **Number of Outlets** | 1 + |
| **Number of Inlets** | 3 + |
| **Inlet Flow Bypass (Y/N)** | N + |
| **Annual Sedimentation Storage (AF)** | 30 • |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 160 • |
| **100 Year Flood Capacity (AF)** | 1,280 • |
| **100 Year Flood Inflow (CFS)** | 6,081 † |
| **100 Year Flood Outflow (CFS)** | 1,800 + |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | 130 • |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1995 ⁺ |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 114.9 |
| **Intermediate Tributary Area (mile2)** | 82.4 |
| **Developed Portion of Tributary Area (mile2)** | 5.745 |
| **Developable Portion of Tributary Area (mile2)** | 57.45 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | Y |
| **Number of Upstream Basins** | 3 † |

### References


- http://www.ccrfcd.org/


- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Vandenberg Detention Basin
## Water Quality Controls

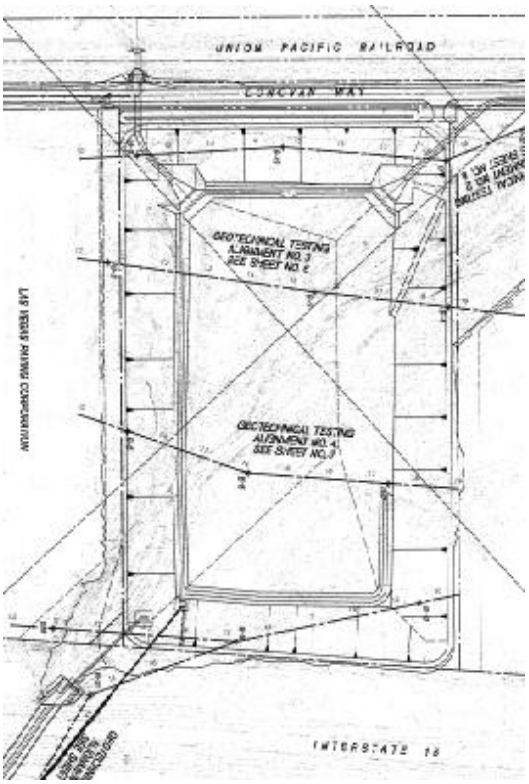
**Assessment of Water Quality Retrofit Potential: Poor**

### Basin Info

| | |
|---|---|
| **ID-Mile** | RWWE0170 |
| **Watershed** | Range Wash |
| **System** | West Range |
| **Location** | Donovan Way near N Lamb |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 9.4 ⁺ |
| **Capacity (AF)** | 349 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 4.90 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | |
| **Side Slope Cover** | N/A |
| **Outlet Type** | Pipe Culvert ⁺ |
| **Number of Outlets** | 2 ⁺ |
| **Number of Inlets** | 2 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 4.1 |
| **100 Year Flood Capacity (AF)** | 340 ⁺ |
| **100 Year Flood Inflow (CFS)** | 3,121 † |
| **100 Year Flood Outflow (CFS)** | 283 ⁺ |

## Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 2000 + |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 9.44 |
| **Intermediate Tributary Area (mile2)** | 9.44 |
| **Developed Portion of Tributary Area (mile2)** | 0.472 |
| **Developable Portion of Tributary Area (mile2)** | 1.888 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/


- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Lower Northern Basin Fact Sheets

# Cheyenne Peaking Basin
## Water Quality Controls

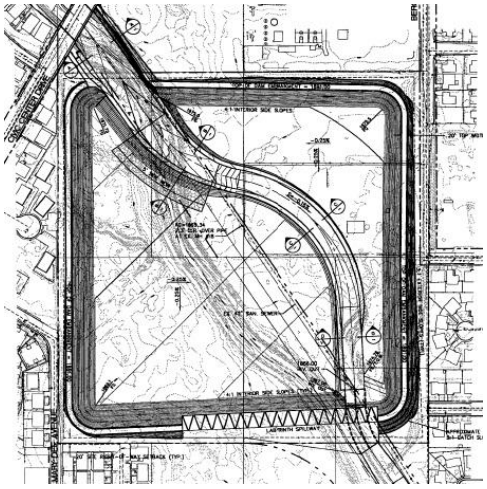
**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | LVMD1645 |
| **Watershed** | Lower Northern |
| **System** | Cheyenne Lamb Nellis |
| **Location** | btwn Gowan and Cheyenne |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 76.6 ◦ |
| **Capacity (AF)** | 456 † |
| **Required Expansion (AF)** | 26 † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | .24 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | 4:1 UP 3:1 Down |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCB Culvert w/a 2' Pier Orifice |
| **Number of Outlets** | 1 |
| **Number of Inlets** | 1 |
| **Inlet Flow Bypass (Y/N)** | Y ◦ |
| **Annual Sedimentation Storage (AF)** | |



### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 15.76 |
| **100 Year Flood Capacity (AF)** | 440 ◦ |
| **100 Year Flood Inflow (CFS)** | 11,998 † |
| **100 Year Flood Outflow (CFS)** | 7,400 ◦ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | Proposed Only |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 228.98 |
| **Intermediate Tributary Area (mile2)** | 76.6 |
| **Developed Portion of Tributary Area (mile2)** | 22.898 |
| **Developable Portion of Tributary Area (mile2)** | 91.592 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | Y |
| **Number of Upstream Basins** | 12 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# North Las Vegas Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | LVUP0405 |
| **Watershed** | Lower Northern |
| **System** | Las Vegas Wash - Craig |
| **Location** | near Beltway and Losee |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 70.8 |
| **Capacity (AF)** | 1,435 † |
| **Required Expansion (AF)** | 780 † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.01 † |
| **Basin Floor Cover** | Compacted Earthfill ⁺ |
| **Typical Side Slope** | N/A |
| **Side Slope Cover** | N/A |
| **Outlet Type** | |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 2 ⁺ |
| **Inlet Flow Bypass (Y/N)** | |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 12,887 † |
| **100 Year Flood Outflow (CFS)** | 11,740 |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | |
| **Planed Upgrade (Years)** | Y |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 214.8 |
| **Intermediate Tributary Area (mile2)** | 70.8 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 0 |
| **Final Downstream Basin (Y/N)** | Y |
| **Strategic Basin (Y/N)** | Y |
| **Number of Upstream Basins** | 1 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

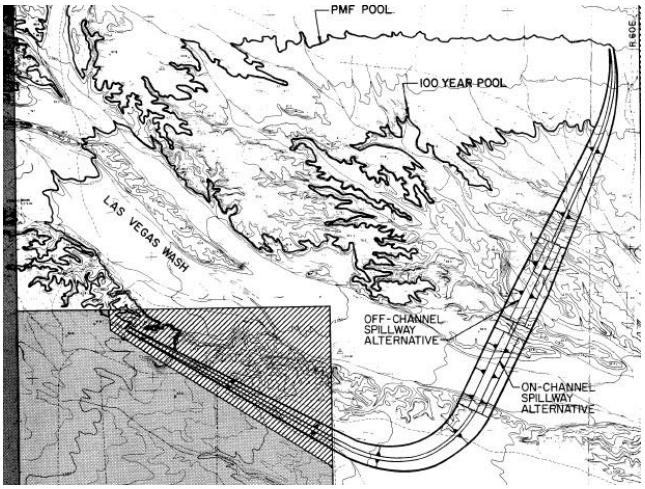

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Upper Las Vegas Wash Detention Basin
## Water Quality Controls

**Assessment of Water Quality Retrofit Potential: Good**

### Basin Info

| | |
|---|---|
| **ID-Mile** | LVUP0910 |
| **Watershed** | Upper Northern |
| **System** | Sheep Mountain |
| **Location** | N Decatur near Iron Mountain |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 144 ⁺ |
| **Capacity (AF)** | 1,836 † |
| **Required Expansion (AF)** | 1,411 † |




### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 1.1 † |
| **Basin Floor Cover** | In-Situ Terrain |
| **Typical Side Slope** | 0.125694444 |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCB Culvert ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 1 ⁺ |
| **Inlet Flow Bypass (Y/N)** | N ⁺ |
| **Annual Sedimentation Storage (AF)** | |

### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | 74.9 |
| **100 Year Flood Capacity (AF)** | 1,760 ⁺ |
| **100 Year Flood Inflow (CFS)** | 15,898 † |
| **100 Year Flood Outflow (CFS)** | 4,240 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1991 ⁺ |
| **Planed Upgrade (Years)** | Proposed Only |
| **In-Basin Recreation Facilities (Y/N)** | N |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 144 |
| **Intermediate Tributary Area (mile2)** | 144 |
| **Developed Portion of Tributary Area (mile2)** | 0 |
| **Developable Portion of Tributary Area (mile2)** | 7.2 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 0 † |

### References


- http://www.ccrfcd.org/
- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- + Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum


**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Lower Las Vegas Wash Detention Basin
## Water Quality Controls

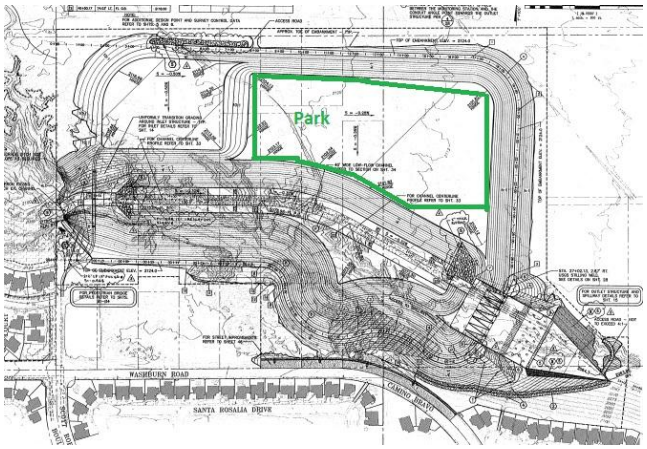
**Assessment of Water Quality Retrofit Potential: Fair**

### Basin Info

| | |
|---|---|
| **ID-Mile** | LVMD2050 |
| **Watershed** | Lower Northern |
| **System** | Lower Western Tributary |
| **Location** | Clayton St btwn Hammer Ln and W Washburn |
| **Facility Type** | On-Channel DB |
| **Tributary Area (mile$^2$)** | 37.65 ⁺ |
| **Capacity (AF)** | 700 † |
| **Required Expansion (AF)** | N/A † |

### Basin Design

| | |
|---|---|
| **Typical Length (ft)** | N/A |
| **Typical Width (ft)** | N/A |
| **Max. Design Depth (ft)** | N/A |
| **Freeboard (ft)** | 11.69 † |
| **Basin Floor Cover** | Concrete & Compacted Earthfill ⁺ |
| **Typical Side Slope** | 4:1 ⁺ |
| **Side Slope Cover** | N/A |
| **Outlet Type** | RCB Culvert ⁺ |
| **Number of Outlets** | 1 ⁺ |
| **Number of Inlets** | 1 ⁺ |
| **Inlet Flow Bypass (Y/N)** | Y ⁺ |
| **Annual Sedimentation Storage (AF)** | |




### Basin Operations

| | |
|---|---|
| **100 Year Flood Sedimentation Storage (AF)** | |
| **100 Year Flood Capacity (AF)** | |
| **100 Year Flood Inflow (CFS)** | 6,729 † |
| **100 Year Flood Outflow (CFS)** | 3,756 ⁺ |

### Basin Features

| | |
|---|---|
| **Sedimentation Forebay or Basin (AF)** | |
| **Water Quality Treatment (Y/N)** | N |
| **Construction Year** | 1997 ⁺ |
| **Planed Upgrade (Years)** | N |
| **In-Basin Recreation Facilities (Y/N)** | Y |

## Water Quality Planning Data

| | |
|---|---|
| **Total Tributary Area (mile2)** | 55.67 |
| **Intermediate Tributary Area (mile2)** | 37.65 |
| **Developed Portion of Tributary Area (mile2)** | 8.3505 |
| **Developable Portion of Tributary Area (mile2)** | 33.402 |
| **Final Downstream Basin (Y/N)** | N |
| **Strategic Basin (Y/N)** | N |
| **Number of Upstream Basins** | 5 † |

### References


- http://www.ccrfcd.org/


- † Value taken from the *Las Vegas Valley 2008 Master Plan Update - Volume I*
- ◦ Value taken from a Final Design Memorandum
- ⁺ Value taken from As-Built drawings
- • Value taken from a Pre-Design Memorandum

**Note:** The assessment of the water quality retrofit potential is based on the Normalized Score given in the report. Poor: ≤0.42. Fair: 0.43-0.55. Good: ≥0.56.

# Attachment F –
# Detention Basin WQCV Strategy for New Development and Significant Redesign

DETENTION BASIN WQCV STRATEGY FOR NEW DEVELOPMENT AND SIGNIFICANT REDEVELOPMENT

Target WQCV is the WQCV needed to manage runoff from all areas of potential new development in the watershed
For Current DB Retrofits, WQCV = designed WQCV
For Proposed DBs, WQCV = WQCV needed to manage all developed and developable area upstream unless otherwise noted
For Existing DBs, WQCV = WQCV needed to manage all developed and developable area upstream unless otherwise noted

| Watershed | Total PCV (AF) for All Developable Area | Detention Basin | Total Existing or Proposed DB Volume (AF) | WQCV (AF) | Comments |
|---|---|---|---|---|---|
| | | | | | |
| C-1 Basin | 78 | *Current DB Retrofit Pilots* | | | Target WQCV reduced from DB TM based on more detailed analysis of upstream area for Equestrian DB design |
| | | Equestrian | 409 | 17 | 135 AF expansion; WQCV is equal to sediment storage, which is larger than required WQCV for upstream developed area |
| | | *Subtotal* | | | |
| | | *Proposed DBs* | | 0 | |
| | | *Existing DB Retrofits* | | 0 | |
| | | Total Watershed | | 17 | An additional 41.1 AF will be needed from existing DBs that are not currently scheduled for an upgrade. With a maximum of 19.5 AF from the NDOT Sediment Basin and the Northeast C-1 DB, it is not possible to meet target WQCV for watershed using only in-watershed DBs. At least 21.6 AF of WQCV will need to come from another watershed. |
| | | | | | |
| Central Basin | 10 | *Current DB Retrofit Pilots* | | 0 | |
| | | *Proposed DBs* | | 0 | |
| | | *Existing DB Retrofits* | | | |
| | | Meadows | 213 | 56.7 | All that is needed to meet watershed objective. More could be treated here as compensation for other watersheds with a shortage of WQCV. 215.8 AF could be treated if all basins including the Cheyenne Peaking Basin were utilized. |
| | | *Total Watershed* | | 56.7 | |
| | | | | | |
| Duck Creek Basin | 250 | *Current DB Retrofit Pilots* | | 0 | |
| | | *Proposed DBs* | | | |
| | | Silverado Ranch | 170 | 26.4 | WQCV = 16% of total volume |
| | | Birdsprings | 1820 | 74.6 | WQCV = 4% of total volume |
| | | *Subtotal* | | 101 | |
| | | *Existing DB Retrofits* | | | None needed |
| | | Central Duck Creek | 1046 | 47.5 | |
| | | *Subtotal* | | 47.5 | |
| | | *Total Watershed* | | 148.5 | An additional 101.5 AF will be needed from existing DBs that are not currently scheduled for an upgrade. 489.9 AF is the maximum possible WQCV in this watershed. |
| | | | | | |
| Flamingo/Tropicana Basin | 168 | *Current DB Retrofit Pilots* | | 0 | |
| | | *Proposed DBs* | | | |
| | | Tropicana Wash-McCarran Airport Offline | 120 | 46.6 | WQCV = 39% of total volume. |
| | | *Subtotal* | | 46.6 | |
| | | *Existing DB Retrofits* | | | |
| | | Lakes DB | 143 | 26.1 | |
| | | *Subtotal* | | 26.1 | |
| | | *Total Watershed* | | 72.7 | An additional 95.3 AF will be needed from existing DBs that are not currently scheduled for an upgrade. 480.9 AF is the maximum possible WQCV in this watershed. |

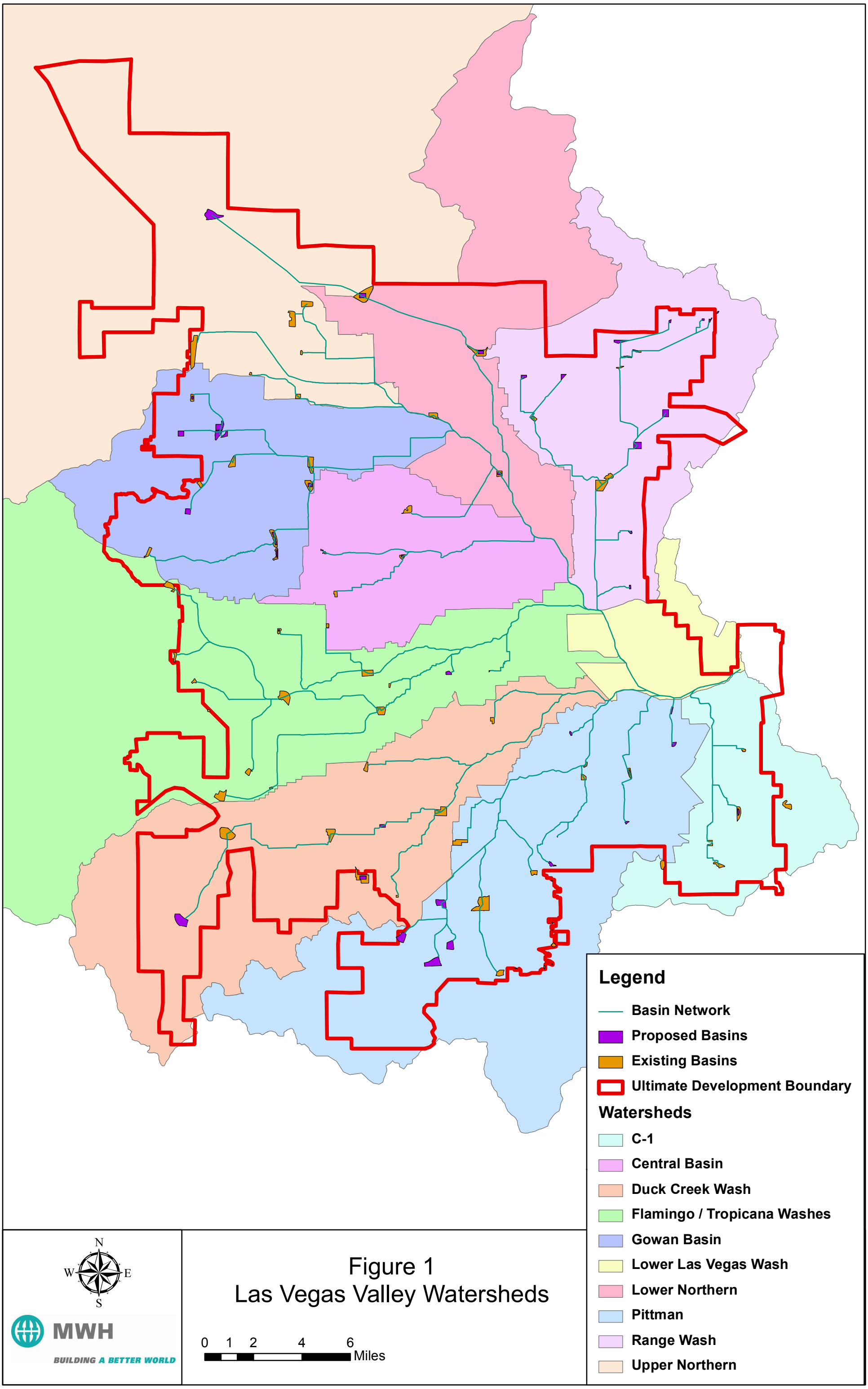
| Watershed | Total PCV (AF) for All Developable Area | Detention Basin | Total Existing or Proposed DB Volume (AF) | WQCV (AF) | Comments |
|---|---|---|---|---|---|
| | | | | | |
| Gowan | 122 | *Current DB Retrofit Pilots* | | | |
| | | Angel Park | | 85 | |
| | | *Subtotal* | | 85 | |
| | | *Proposed DBs* | | | |
| | | Cheyenne Peaking Basin | 456 | 83.3 | |
| | | Summerline Village 22 | 123 | 11.7 | WQCV = 10% of total volume |
| | | Lone Mountain - Beltway | 589 | 38.3 | WQCV = 7% of total volume |
| | | *Subtotal* | | 133.3 | |
| | | *Existing DB Retrofits* | | | |
| | | Ann Road DB | 479 | 29.7 | 115 AF expansion planned |
| | | Gowan South DB | 686 | 88.9 | 62 AF expansion planned |
| | | *Subtotal* | | 118.6 | |
| | | Total Watershed | | 336.9 | Proposed DBs in addition to the Angel Park DB upgrade provide all that is needed to meet watershed objective. More could be treated here as compensation for other watersheds with a shortage of WQCV. 466.8 AF is the maximum possible WQCV in this watershed. |
| | | | | | |
| Lower Las Vegas Wash | 44 | *Current DB Retrofit Pilots* | | 0 | |
| | | *Proposed DBs* | | 0 | |
| | | *Existing DB Retrofits* | | 0 | |
| | | *Total Watershed* | | 0 | Need 44 AF of compensatory WQCV from other watersheds |
| | | | | | |
| Lower Northern Basin | 144 | *Current DB Retrofit Pilots* | | 0 | |
| | | *Proposed DBs* | | 0 | |
| | | *Existing DB Retrofits* | | | |
| | | Cheyenne Peaking Basin | 456 | 92.2 | |
| | | North Las Vegas | 1435 | 101.8 | 780 AF expansion planned |
| | | *Subtotal* | | 194 | |
| | | *Total Watershed* | | 194 | An additional 42.2 AF will be needed from existing DBs that are not currently scheduled for an upgrade. 216.6 AF is the maximum possible WQCV in this watershed. |
| | | | | | |
| Pittman Basin | 255 | *Current DB Retrofit Pilots* | | | |
| | | Pioneer | 390 | 12 | |
| | | *Subtotal* | | 12 | |
| | | *Proposed DBs* | | | |
| | | *Pittman Horizon Ridge DB* | | | |
| | | Southeast Pittman | 751 | 22.9 | WQCV = 3% of total volume |
| | | Pittman West | 2521 | 100.4 | WQCV = 4% of total volume |
| | | Southwest Pittman | 737 | 43.7 | WQCV = 6% of total volume |
| | | Pabco South Peaking Basin | 60 | 25 | WQCV = 42% of total volume |
| | | Pabco North Peaking Basin | 49 | 21.3 | WQCV = 43% of total volume |
| | | Pittman North | 600 | 42.3 | WQCV = 7% of total volume; scheduled 2014-2020 |
| | | Whitney | 48 | 8.9 | WQCV = 19% of total volume |
| | | *Subtotal* | | 264.5 | |
| | | *Existing DB Retrofits* | | 0 | None needed |
| | | *Total Watershed* | | 276.5 | An additional 24.8 AF will be needed from existing DBs that are not currently scheduled for an upgrade. 526.2 AF is the maximum possible WQCV in this watershed. |

| Watershed | Total PCV (AF) for All Developable Area | Detention Basin | Total Existing or Proposed DB Volume (AF) | WQCV (AF) | Comments |
|---|---|---|---|---|---|
| | | | | | |
| Range Wash | 146 | *Current DB Retrofit Pilots* | | 0 | |
| | | *Proposed DBs* | | | |
| | | Dunes South | 1112 | 80.2 | WQCV = 7% of total volume |
| | | Dunes North | 1108 | 39.1 | WQCV = 4% of total volume |
| | | Speedway North | 843 | 9.9 | WQCV = 1% of total volume; scheduled for 2015-2019 |
| | | Beltway | 226 | 2.8 | WQCV = 1% of total volume |
| | | Vandenberg North DB | 290 | 34.3 | WQCV = 12% of total volume; scheduled 2013-2017 |
| | | Owens DB | 88 | 0.8 | WQCV = 1% of total volume |
| | | | 142 | 1 | WQCV = 1% of total volume |
| | | *Subtotal* | | 168.1 | |
| | | *Existing DB Retrofits* | | | None needed |
| | | Speedway #2 | 245 | 4.5 | 81 AF expansion planned |
| | | Speedway #3 | 229 | 19.8 | 109 AF expansion planned |
| | | *Subtotal* | | 24.3 | |
| | | *Total Watershed* | | 192.4 | Proposed DBs provide all that is needed to meet watershed objective. More could be treated here as compensation for other watersheds with a shortage of WQCV. 274.4 AF is the maximum possible WQCV in this watershed. |
| | | | | | |
| Upper Northern Basin | 222 | *Current DB Retrofit Pilots* | | 0 | |
| | | *Proposed DBs* | | | |
| | | Northwest | 3385 | 304.2 | WQCV = 9% of total volume |
| | | *Subtotal* | | 304.2 | |
| | | *Existing DB Retrofits* | | | |
| | | Upper Las Vegas Wash | 1836 | 130.7 | 1411 AF basin expansion planned; WQCV volume based on meeting target for this watershed; could possibly go larger if needed. This DB could treat any or all of the 304.2 AF included in the proposed Northwest DB if it is not built. |
| | | *Subtotal* | | 130.7 | |
| | | *Total Watershed* | | 434.9 | Proposed DBs provide all that is needed to meet watershed objective. More could be treated here as compensation for other watersheds with a shortage of WQCV. 640.4 AF is the maximum possible WQCV in this watershed. |

SUMMARY OF WQCV TO BE DEVELOPED IN EACH WATERSHED

| Watershed | Total MCV (AF) for All Developable Area | PCV Generated in Watershed from Proposed DBs and Planned Upgrades (AF) | Excess WQCV - Available for Trade with other Watersheds (AF) | Deficit WQCV - Needed from other Sources (AF) | Comments |
|---|---|---|---|---|---|
| C-1 Basin | 78 | 17.0 | 0 | 61.0 | |
| Central Basin | 10 | 56.7 | 46.7 | 0 | Could develop more WQCV at Meadows DB |
| Duck Creek Basin | 250 | 148.5 | 0 | 101.5 | |
| Flamingo/Tropicana Basin | 168 | 72.7 | 0 | 95.3 | |
| Gowan | 122 | 336.9 | 214.9 | 0 | Could develop more WQCV |
| Lower Las Vegas Wash | 44 | 0 | 0 | 44.0 | |
| Lower Northern Basin | 144 | 194.0 | 50 | 0 | |
| Pittman Basin | 255 | 276.5 | 22 | 0 | |
| Range Wash | 146 | 192.4 | 46.4 | 0 | Could develop more WQCV |
| Upper Northern Basin | 222 | 434.9 | 212.9 | 0 | Could develop more WQCV at Upper LVW DB |
| TOTALS | 1439 | 1729.6 | 592.4 | 301.8 | |

# Attachment G –
# Watershed Maps




# Figure 1
# Las Vegas Valley Watersheds

NORTHEAST C-1 DETENTION BASIN

EAST C-1 DETENTION BASIN

EQUESTRIAN DETENTION BASIN

NDOT SEDIMENT BASIN

BLACK MOUNTAIN DETENTION BASIN

MISSION HILLS DETENTION BASIN

N

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BUILDING A BETTER WORLD

Figure 2
C-1

0 0.5 1 2 3 Miles

## Legend

- Basin Network
- Proposed Basins
- Existing Basins
- Ultimate Development Boundary

### Watersheds

- C-1
- Flamingo / Tropicana Washes
- Lower Las vegas Wash
- Pittman

CHEYENNE PEAKING BASIN

CAREY-LAKE MEAD DETENTION BASIN

RAINBOW DETENTION BASIN UPGRADE

MEADOWS DETENTION BASIN

OAKEY DETENTION BASIN

DESERT INN DETENTION BASIN

N
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BUILDING A BETTER WORLD

0 0.5 1 2 3 Miles

Figure 3
Central Basin

**Legend**

- Basin Network
- Proposed Basins
- Existing Basins
- Ultimate Development Boundary

**Watersheds**

- Central Basin
- Flamingo / Tropicana Washes
- Gowan Basin
- Lower Northern
- Range Wash

MCCARRAN DETENTION BASIN

LOWER BLUE DIAMOND DETENTION BASIN

LOWER DUCK CREEK
DETENTION BASIN

SILVERADO RANCH
DETENTION BASIN

DUCK CREEK RAILROAD
DETENTION BASIN

UPPER DUCK CREEK DETENTION BASIN

CENTRAL DUCK CREEK DETENTION BASIN

BRUNER DETENTION BASIN

BIRDSPRING DETENTION BASIN

**Legend**

- Basin Network
- Proposed Basins
- Existing Basins
- Ultimate Development Boundary

**Watersheds**

- C-1
- Duck Creek Wash
- Flamingo / Tropicana Washes
- Lower Las Vegas Wash
- Pittman

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BUILDING A BETTER WORLD

0 0.5 1 2 3
Miles

Figure 4
Duck Creek Wash

RED ROCK DETENTION BASIN

LAKES DETENTION BASIN

R4 DETENTION BASIN

F1 DEBRIS BASIN

F2 DEBRIS BASIN

FLAMINGO DETENTION BASIN

LOWER FLAMINGO DETENTION BASIN

TROPICANA NORTH BRANCH DETENTION BASIN

TROPICANA WASH-MCCARRAN AIRPORT DETENTION BASIN

VAN BUSKIRK C DETENTION BASIN

VAN BUSKIRK A DETENTION BASIN

TROPICANA DETENTION BASIN

F4 DEBRIS BASIN

UPPER BLUE DIAMOND DETENTION BASIN

BLUE DIAMOND DEBRIS BASIN

N

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MWH

BUILDING A BETTER WORLD

0 0.5 1 2 3 Miles

Figure 5
Flamingo / Tropicana Washes

## Legend

- Basin Network
- Proposed Basins
- Existing Basins
- Ultimate Development Boundary

## Watersheds

- Range Wash
- Duck Creek Wash
- Lower Nothern
- Flamingo / Tropican Washes
- Lower Las Vegas Wash
- Pittman
- Central Basin
- Gowan Basin

ANN ROAD DETENTION BASIN

LONE MOUNTAIN-BELTWAY DETENTION BASIN

BOX CANYON DETENTION BASIN

LONE MOUNTAIN DETENTION BASIN

GOWAN NORTH DETENTION BASIN

VILLAGE 26 DETENTION BASIN

GOWAN SOUTH DETENTION BASIN

VILLAGE 22 DETENTION BASIN

ANGEL PARK DETENTION BASIN

DETENTION BASIN #5

RED ROCK DETENTION BASIN

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BUILDING A BETTER WORLD

0 0.5 1 2 3 Miles

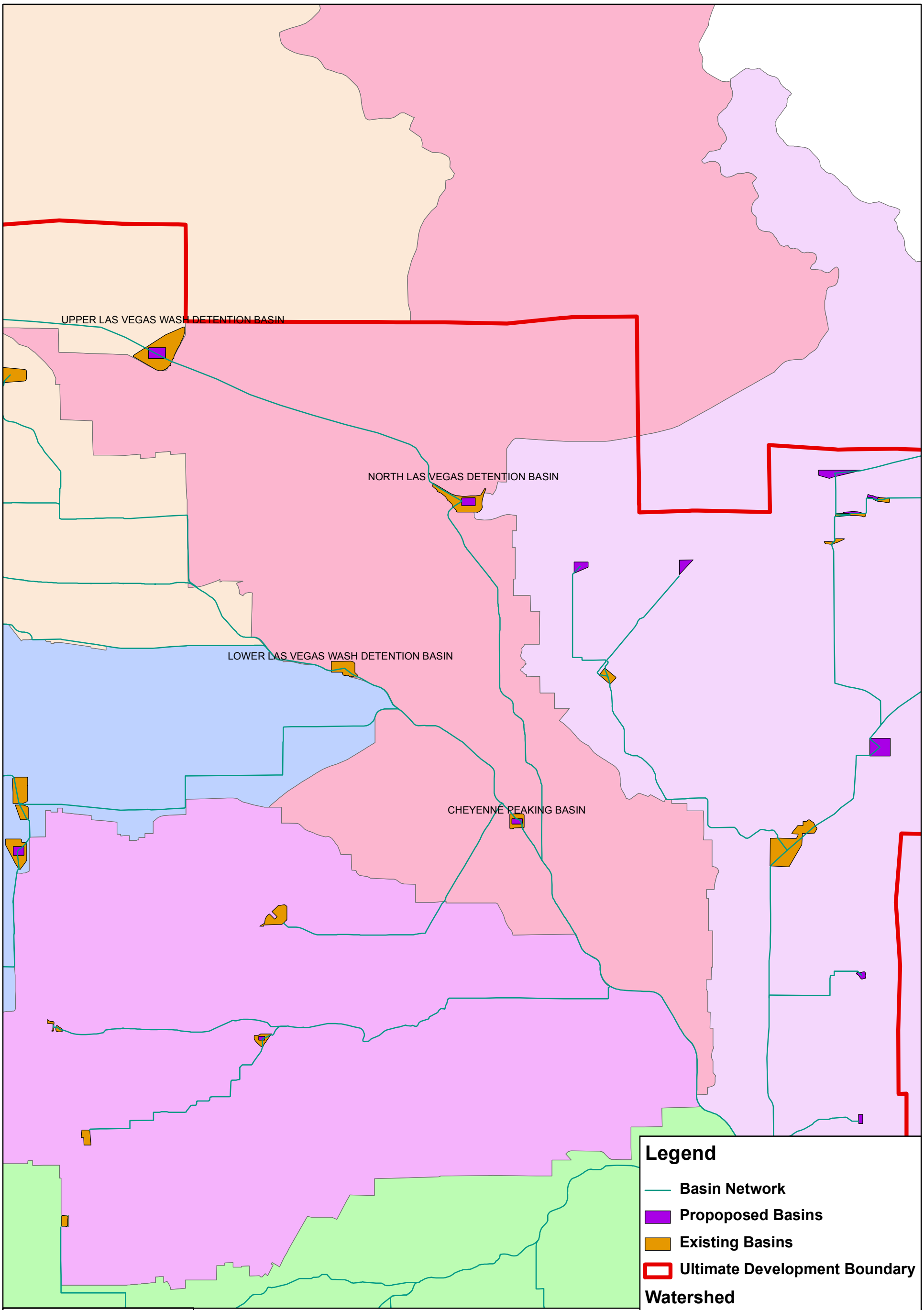
Figure 6
Gowan Basin

**Legend**

- Basin Network
- Proposed Basins
- Existing Basins
- Ultimate Development Boundary

**Watersheds**

- Central Basin
- Flamingo / Tropicana Washes
- Gowan Basin
- Lower Northern
- Pittman
- Upper Northern


UPPER LAS VEGAS WASH DETENTION BASIN
NORTH LAS VEGAS DETENTION BASIN
LOWER LAS VEGAS WASH DETENTION BASIN
CHEYENNE PEAKING BASIN
N
W
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MWH
BUILDING A BETTER WORLD
Figure 7
Lower Northern
0 0.5 1 2 3
Miles
Legend
Basin Network
Propoposed Basins
Existing Basins
Ultimate Development Boundary
Watershed
Central Basin
Flamingo / Tropicana Washes
Gowan Basin
Lower Northern
Range Wash
Upper Northern

PABCO NORTH PEAKING BASIN
WHITNEY WASH DETENTION BASIN
PABCO SOUTH PEAKING BASIN
PITTMAN PARK PEAKING BASIN
PIONEER DETENTION BASIN
PITTMAN RAILROAD EAST SEDIMENT BASIN
PITTMAN HORIZON RIDGE DETENTION BASIN
DESERT WILLOW GOLF COURSE DETENTION BASIN
CACTUS DETENTION BASIN
BLACK MOUNTAIN DETENTION BASIN
PITTMAN MACDONALD RANCH DEBRIS BASIN
MCCULLOUGH DETENTION BASIN
ANTHEM DEBRIS BASIN #1
PITTMAN EAST DETENTION BASIN
PITTMAN NORTH DETENTION BASIN
PITTMAN CRESCENT DEBRIS BASIN
PITTMAN OCEAN GROVE DEBRIS BASIN
PITTMAN WEST DETENTION BASIN
SOUTHEAST PITTMAN DETENTION BASIN
PITTMAN ANTHEM DETENTION BASIN
SOUTHWEST PITTMAN DETENTION BASIN
PITTMAN PONT NATIONAL DEBRIS BASIN
PITTMAN WASH SOUTHEAST DEBRIS BASIN
HEADWORKS DETENTION BASIN

## Legend

- Basin Network
- Proposed Basins
- Existing Basins
- Ultimate Development Boundary

### Watersheds

- C-1
- Duck Creek Wash
- Flamingo / Tropicana Washes
- Lower Las Vegas Wash
- Pittman

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BUILDING A BETTER WORLD

0 0.5 1 2 3 Miles

Figure 8
Pittman

APEX - RANGE
WATERSHED EAST

RANGE WASH -
RAILROAD EAST BRANCH 1

RANGE WASH - SPEEDWAY CHANNEL

SPEEDWAY NORTH DETENTION BASIN

NORTH LAS VEGAS
DETENTION BASIN UPGRADE

SPEEDWAY #3
DETENTION BASIN

SPEEDWAY #2
DETENTION BASIN

SPEEDWAY #1 DETENTION BASIN

VANDENBERG NORTH
DETENTION BASIN

BELTWAY DETENTION BASIN

VANDENBERG DETENTION BASIN

DUNES NORTH DETENTION BASIN

DUNES SOUTH DETENTION BASIN

CONFLUENCE DETENTION BASIN

OWENS DETENTION BASIN

ORCHARD DETENTION BASIN

## Legend

- Basin Network
- Proposed Basins
- Existing Basins
- Ultimate Development Boundary

### Watersheds

- Central Basin
- Flamingo / Tropicana Washes
- Lower Las Vegas Wash
- Lower Northern
- Range Wash
- Upper Northern

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# Figure 9
# Range Wash

0 0.5 1 2 3 Miles

NORTHWEST DETENTION BASIN

UPPER LAS VEGAS WASH
DETENTION BASIN

NORTH ENVIRONMENTAL ENHANCEMENT AREA

SOUTH ENVIRONMENTAL ENHANCEMENT AREA

KYLE CANYON DETENTION BASIN

ELKHORN SPRINGS DETENTION BASIN

FORT APACHE DETENTION BASIN

RANCHO ROAD
DETENTION BASIN

N
W E
S

MWH
BUILDING A BETTER WORLD

# Figure 10
# Upper Northern

0 0.5 1 2 3
Miles

## Legend

- Basin Nework
- Propoposed Basins
- Existing Basins
- Ultimate Development Boundary

## Watersheds

- Gowan Basin
- Lower Northern
- Upper Northern

TECHNICAL MEMORANDUM

# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

# STORMWATER MANAGEMENT PLAN DOCUMENTATION

## Technical Memorandum

## Proposed Parking Lot Low Impact Development Program for Las Vegas Valley

January 7, 2013

*Prepared for*

**Stormwater Quality Management Committee**

*Prepared by*

MWH®

BUILDING A BETTER WORLD

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# Appendices


Appendix A – Parking Lot Maintenance Requirements

Appendix B – Technical Memorandum

# 1 Introduction

On February 9, 2010 the Nevada Division of Environmental Protection (NDEP) issued the Las Vegas Valley Municipal Separate Storm Sewer System Permit Renewal (MS4 Permit) for a period of five years. The 2010-2015 MS4 Permit is a "permit for authorization to discharge from municipal separate storm sewer systems to waters of the United States under the National Pollutant Discharge Elimination System." The MS4 Permit requires a structural and source control measure program for existing and new development to mitigate the impacts of urbanization on stormwater quality. This technical memorandum (TM) outlines one of the Permittees' proposed responses to these permit requirements.

The purpose of this TM is to describe the measures proposed by the Permittees to comply with the MS4 Permit New Development and Significant Redevelopment (NDSR) program requirements for parking lots to mitigate urbanization effects on stormwater quality. The Permittees include the City of Las Vegas, City of North Las Vegas, City of Henderson, Clark County, and the Clark County Regional Flood Control District. This TM includes the permit requirements in the MS4 Permit, identifies gaps between the MS4 Permit and the existing program, and discusses parking lot best management practice (BMP) programs that will be implemented to address the new permit requirements.

# 2 MS4 Permit Requirement

The renewed 2010-2015 MS4 Permit for Las Vegas Valley includes the following requirements to reduce pollutants in stormwater runoff from parking lots.

*IV.F.3.b All NDSR projects submitted to the permitting authority subsequent to program implementation as identified in IV.A.2 that fall into one of the following categories shall be subject to one or more of the SWMP design standards developed in accordance with Part IV.F.4:*

*IV.F.3.b.vii Parking lots greater than one (1) acre potentially exposed to urban runoff;*

*IV.F.4 Design Standards. The post-construction program shall describe how NDSR projects specified in the previous section will implement the design standards outlined in this section. Subject to Section IV.F.4.e, the design standards program shall address at minimum the following criteria:*

*IV.F.4.a Peak-Urban Runoff Discharge Rates. Describe how the Permittees will develop design standards for peak-urban runoff from NDSR projects that will provide protection against downstream erosion;*

*IV.F.4.b Site Design BMPs. Describe how the Post-Construction Program will develop and implement site design BMPs in the site layout during the design and approval process to meet the goals of this program identified in Part IV.F.2;*

*IV.F.4.c Source Control BMPs. The Post-Construction Program shall describe how source control BMPs will be implemented. The design standards program shall include the following source-control BMPs that are consistent with the goals of this program:*

*IV.F.4.c.i Slopes and channel design or protection to minimize erosion;*

*IV.F.4.c.ii Properly designed outdoor material storage areas; and*

*IV.F.4.c.iii Properly designed trash storage areas.*

*IV.F.4.d Treatment Control BMPs. The post-construction program shall describe how treatment control BMPs will be developed and implemented. "Treatment control BMPs" and "treat" refer to any onsite or offsite process that provides for infiltration or detention of stormwater or that removes pollutants through any physical, chemical, or biological process. The design standards program shall describe in sufficient detail how the Permittees will size treatment control BMPs using accepted hydrologic engineering quantitative methods and the following design criteria:*

*IV.F.4.d.i Volumetric Treatment Control BMP design criteria. The post-construction program shall describe how the Permittees will design volume-based BMPs to treat stormwater discharges from projects listed in Part IV.F.3.b. The Permittees shall use one of the following conditions to develop the volumetric treatment control BMP design criteria:*

*IV.F.4.d.i.1 Historical rainfall records for the Las Vegas Valley to determine the maximized capture stormwater volume for the area for the 24-hour event using the formula recommended in Urban Runoff Quality Management, Water Environment Federation Manual of Practice No. 23/ASCE Manual of Practice No. 87, (1998); or*

*IV.F.4.d.i.2 The volume of annual runoff based on unit basin storage water quality volume, to achieve at least 80% of volume treatment by the method recommended in hydrology manuals, textbooks or similar technical publications; or*

*IV.F.4.d.i.3 An alternative treatment design criteria, appropriate for the unique hydrologic, hydrogeologic and regional conditions of the Las Vegas Valley. Any alternative design criteria shall be submitted to NDEP with sufficient technical data to establish the appropriateness of the alternative treatment design criteria.*

*IV.F.4.d.ii Flow-Based BMP Design Criteria. The post-construction program shall describe how the Permittees will design flow-based BMPs to treat stormwater discharges from projects listed in Part V.F.3.b. The Permittees shall use one of the following conditions to develop flow-based BMP design criteria:*

*IV.F.4.d.ii.1 Historical rainfall data for the Las Vegas Valley to determine the maximum flow rate of runoff from rainfall per hour, for each hour of a storm event; or*

*IV.F.4.d.ii.2 The maximum flow rate of runoff produced by the 80th percentile hourly rainfall intensity (for each hour of the storm event), as determined from the local historical rainfall record; or*

*IV.F.4.d.ii.3 The maximum flow rate of runoff for each hour of a storm event, as determined from the local historical rainfall record that achieves approximately the same reduction in pollutant*

*loads and flows as achieved by mitigation of the 80th percentile hourly rainfall intensity; or*

*IV.F.4.d.ii.4* *An alternative treatment design criteria, appropriate for the unique hydrologic, hydrogeologic and regional conditions of the Las Vegas Valley. Any alternative design criteria shall be submitted to NDEP with sufficient technical data to establish the appropriateness of the alternative treatment design criteria.*

*IV.F.4.e* *If the Permittees will not use some or all of the design standards described in this section, the Permittees shall provide justification using documentation and engineering analyses, and propose reasonable alternatives that are appropriate for the unique hydrologic, hydrogeologic and regional conditions in Las Vegas Valley.*

The following sections describe existing and new BMPs to meet these requirements on parking lots. The focus of this part of the permit is site design and the measures to accomplish this goal are structural. Measures included in the Source Control Program (i.e.. pollution prevention measures that are structural or non-structural) are proposed for areas of NDSR, as described in the New Development and Significant Redevelopment Program (MWH 2010b).

# 3 Proposed Parking Lot Low Impact Development Program

This section describes the proposed parking lot low impact development (LID) program to meet the requirements in the MS4 Permit.

## 3.1 Evaluation of Need for Additional NDSR BMPs

A BMP gap analysis was prepared to relate existing BMPs to each pollutant of concern and the land uses from which they originate. This analysis is fully described in the TM, "Description of Existing BMPs and Need for New BMPs for the SQMC NDSR Program." The BMP gap analysis table shows which BMPs are currently required or recommended by individual Permittees or regional agencies. It provides a visual representation of the BMPs addressing all of the pollutants of concern in Las Vegas Valley.

The BMP gap analysis was used to determine the need for additional BMPs for the Las Vegas Valley NDSR program. Evaluation of the need for additional BMPs was based on three factors:

1. Are additional BMPs needed to address any of the high priority pollutants of concern based on TMDL or other regulatory requirements?
2. Should existing BMP programs be upgraded or are additional BMPs needed to address any of the pollutants of concern to the MEP?
3. Are any land use types not adequately addressed?

The BMP gap analysis indicated that the only land use type responsible for generating important pollutants of concern that is not addressed by existing BMPs to the MEP is parking areas. LID measures feasible for Las Vegas Valley parking areas are not currently required, but could be implemented in future developments to upgrade the current NDSR program. Potential BMPs to be

added to the NDSR program for parking lots were investigated in a separate technical memorandum, entitled "Evaluation of Low Impact Development Measures for NDSR Program."

The Development Guidelines Working Group (DGWG) reviewed LID measures in the context of their potential applicability in the Las Vegas environment. **Table 1** summarizes the LID measures that could be feasible for parking lots in general, and **Table 2** summarizes the LID measures that were determined by the DGWG to be acceptable for the Las Vegas Valley NDSR Program.

**Table 1. Feasible LID Measures for Parking Lots**

| LID Category | Specific Measure or Practice | Feasible for LVV? | Rationale |
|---|---|---|---|
| Minimize directly connected impervious area | Minimize overall impervious area | Yes | - |
| | Direct runoff onto properly designed unpaved surfaces | Yes | - |
| | Disconnect rooftop drains | Yes | - |
| Parking Lot Design | Depressed medians | Yes | Only outside Selenium Management Area; Xeriscaping only |
| | Buffer strips | Yes | Xeriscaping only |
| | Porous paving – porous concrete or asphalt | No | Porous pavement may get clogged by fine particles in desert environment. Long-term performance is questionable. Moratorium on these materials in Denver adds to concerns. |
| | Porous paving – cobblestones, modular pavers | Yes | - |
| | Minimize parking requirements | Yes | - |
| | Unpaved overflow parking | No | Violates dust control regulations for LVV air quality management |

**Table 2. Parking Lot LID Measures Acceptable for Las Vegas Valley NDSR Program**

| LID Category | Specific Measure or Practice | Limitations | Compatibility with Existing Development Standards | Ease of Incorporating into Development Standards |
|---|---|---|---|---|
| Minimize directly connected impervious area | Minimize overall impervious area | - | No maximum % impervious specified; landscape buffers required on all lot lines | Easy |
| | Direct runoff onto properly designed unpaved surfaces | - | No requirement; current practice most often uses concrete valley gutters or U-channels to convey runoff through landscape buffer to offsite point | Easy |
| | Disconnect rooftop drains | - | Not required; most commercial roofs drain to concrete swale or pipe; residential roofs typically do not have gutters or downspouts due to lack of rainfall | Easy |
| Parking Lot Design | Depressed medians | Only outside Selenium Management Area; Xeriscaping only | Not required and not standard; typical design requires positive drainage and uses raised curbed median for ease of maintenance and public safety | Moderate; significant change in local design practices |
| | Buffer strips | Xeriscaping only | Required for landscaping but not drainage control; current practice most often uses concrete valley gutters or U-channels to convey runoff through landscape buffer to offsite point | Easy |
| | Porous paving – modular pavers | - | Not required but allowed; used only infrequently | Easy |
| | Minimize parking requirements | - | All entities have maximum parking allowance as a percentage of minimum requirement (e.g., 125% of minimum); all entities are investigating reducing the maximum parking allowance | Difficult; political issue |

## 3.2 Review of Existing Stormwater Quality Manuals

It was determined that BMP manuals already prepared by other entities would be relied upon for parking lot BMP design criteria, rather than creating original criteria for Las Vegas Valley. A literature search was conducted to identify urban drainage, stormwater quality, and LID manuals that could include information on BMPs that provide stormwater quality benefits from runoff from parking lots. **Table 3** summarizes the findings from the literature review. The manuals from other entities found to be most useful in providing BMP design criteria for parking lots in Las Vegas Valley are listed below:

1. County of San Diego SUSMP
2. City of San Diego Storm Water Standards
3. LA County Development Planning for Stormwater Management
4. LA County SUSMP Guidebook
5. Center for Watershed Protection
6. New York State Stormwater Management Design Manual
7. Urban Storm Drainage Criteria Volume 3 Denver, Colorado
8. City & County of Denver Water Quality Management Plan
9. Green Industry BMP for the Conservation & Protection of Water Resources in Colorado
10. Minnesota Urban Small Sites BMP Manual
11. Caltrans Treatment BMP Technology Report

Most manuals listed above suggested use of vegetated swales and grass filter strips. While these concepts could be modified for use in the Las Vegas Valley, vegetation would need to be limited and follow xeriscape requirements. Guidance is available that suggests curbing should be reduced and that slotted curbs can be used for conveying stormwater runoff to depressed areas or buffer zones. Pervious and porous pavements were mentioned in many of the manuals, but these are not allowed for stormwater treatment in Las Vegas Valley; however, guidance for installation of modular block pavers is available. Many of the manuals provide information on measures that can be incorporated for use in impervious areas, such as, disconnecting rooftops, having rooftops drain to planters, and reducing stall dimensions. However, based on a plan review of the stall dimension requirements in the Las Vegas Valley, reducing stall dimensions is not considered at this time. The reviewed materials included measures such as sand filters, swales, buffer / filter strips, curbing, impervious area and pavements for site design and treatment options. Engineered treatment measures, such as sand filters, are acceptable, if they do not rely on infiltration. Guidance for sizing and installation of structural measures are provided in multiple manuals. Section 3.4 provides brief descriptions of the parking lot BMPs and fact sheets for each BMP (documenting specific reference manuals) are included in **Appendix A**.

| | Las Vegas Valley SWMP | County of San Diego SUSMP<br>(Standard Urban Stormwater Mitigation Plan) | City of San Diego<br>Storm Water Standards | LA County<br>Development Planning for Storm Water Management | LA County SUSMP Guidebook | Center for Watershed Protection EPA |
|---|---|---|---|---|---|---|
| **Design & Site Information** | · Parking Lots greater than 1 acre | · Parking Lots 5,000 square feet or more or with 15 or more parking spaces<br><br>· 50% Rule: Projects on previously developed sites may need to retrofit drainage of impervious areas if project is creating or replacing 5,000 square feet of impervious area:<br>· If new project results in increase or replacement of 50% or more of the previously existing impervious surface, and the existing development was not subject to SUSMP requirements, then the entire project must be included in treatment measure design<br>· If less than 50% of the previously surface is affected, only that portion must be included in the treatment measure design<br><br>· LID treatment facilities designed to treat smaller storms & first flush of larger storms approximately 80% of average annual runoff<br>· Volume based facilities that infiltrate, filter or treat volume of runoff from 24-hr 85th percentile storm (rainfall depth varies form 0.55" - 1.5") | · Parking Lot with a minimum of 5,000 square feet or with 15 or more parking spaces<br><br>· 50% Rule: Projects on previously developed sites may need to retrofit drainage of impervious areas if project is creating or replacing 5,000 square feet of impervious area:<br>· If new project results in increase or replacement of 50% or more of the previously existing impervious surface, and the existing development was not subject to SUSMP requirements, then the entire project must be included in treatment measure design<br>· If less than 50% of the previously surface is affected, only that portion must be included in the treatment measure design<br><br>· Sized for volume of runoff produced by the 85 percentile storm event, or volume of annual runoff based on unit basin storage volume to achieve 90% or more volume treatment | · Parking Lot with a minimum of 5,000 square feet or more of surface area or with 25 or more parking spaces | · New parking lot with either 5,000 sq ft of impervious surface or 25 or more parking spaces<br><br>· Runoff from first 3/4" of rainfall (first flush), or continuous flow of runoff from 0.2" per hour storm | · Manual presents a single volumetric sizing requirement for each filter to capture and treat 90% of runoff producing rainfall event that occur each year.<br>· BMP sized to capture & treat the 3 month storm frequency storm (1.25" rainfall) will effectively treat 90% of the annual average rainfall<br>· Evaluation using 1" of rainfall at 4 sites found the average capture % to be 85%-91%<br>· Stormwater hotspot - land use or activity that generates higher concentrations of hydrocarbons, trace metals, toxicants than are found in typical stormwater runoff, based on a monitoring study. |
| **Sand Filter** | <u>Sand Filter</u><br>· No current requirement | <u>Sand Filter</u><br>· Calculate design flow using rational method with an intensity of 0.2"/hour & C Factors for treatment only from table 4-2<br>· Determine required surface area by dividing design flow by allowable design surface loading rate of 5"/hour<br>· Minimum 18" filter media. Washed sand with gradation similar to fine aggregate in ASTM C-33<br>· Should include gravel drain layer, perforated pipe underdrain, filter fabric between filter medial and gravel layer<br>· Consider the following instead of a pretreatment basin: provide screens at SD inlets, stabilize slopes to eliminate source of sediment in DMA, limit size and include only impervious area in drainage management area<br>· Should not include permanent pool or other standing water | <u>Sand Filter</u><br>· Uses information from County of San Diego SUSMP | <u>Sand Filter</u><br>· Volume calculate flow rate of stormwater to be mitigated volume based on 0.75" of rain<br>· Compute size of filter bed surface area based on Darcy's law | <u>Sand Filter</u> | <u>Surface Sand Filter</u><br>· Used to divert first flush to off-line sedimentation chamber<br>· 1st chamber may be wet or dry, used for pretreatment<br>· 2nd chamber consists of 18" deep sand filter bed & temp. runoff storage (3" topsoil) above bed<br><br><u>Underground Sand Filter</u><br>· 3 chamber underground vault accessible by manholes or grate openings<br>· Can be off-line or on-line<br>· 1st chamber relies on wet pool; & temporary runoff storage, used for pretreatment<br>· 2nd chamber consists of 11" pea gravel, filter cloth, 24" deep sand filter bed, 1" Debris Screen, underdrain<br>· 3rd Overflow chamber / outlet pipe<br>· Filtered runoff collected using perforated underdrains that extend into 3rd chamber<br><br><u>Perimeter Sand Filter</u><br>· 2 trench-like chambers installed along perimeter of parking lot<br>· 1st chamber for pretreatment<br>· 2nd chamber consists of 6" gravel, filter fabric, 18" deep sand filter bed & temp. temporary ponding (6" -12") above bed<br><br>· remaining runoff filtered through the sand & collected by underdrains delivered to outflow point<br><br><u>Organic Filter</u><br>· Same as surface sand filter except uses compost or pear / sand as filter media<br>· filter bed & subsoils separated by impermeable polyliner to prevent movement into groundwater<br>· Peat - 3" topsoil, 18" 50/50 peat / sand mix, 6" sand, filter fabric, 8" gravel<br>· Compost - 18" Compost, 8" gravel<br><br><u>Pocket Sand Filter</u><br>· bypass pipe sends excess runoff along storm drain system, flow diversion pipe routes water quality volume into system<br>· Pretreatment provided by concrete flow spreader, grass filter strip, plunge pill.<br>· 8" gravel, filter fabric, 18" sand filter bed 3" topsoil |

| | Las Vegas Valley SWMP | County of San Diego SUSMP<br>(Standard Urban Stormwater Mitigation Plan) | City of San Diego<br>Storm Water Standards | LA County<br>Development Planning for Storm Water Management | LA County SUSMP Guidebook | Center for Watershed Protection EPA |
|---|---|---|---|---|---|---|
| **Swales** | Rock or Xerscape Swale<br>· Size based on reducing slope of swale to minimize velocities<br>· Grass / Vegetated swales not allowed if vegetation is dense | Vegetated Swales<br>· See California Stormwater BMP Handbook<br>· Uses on-site soil, recommended 10 minute detention time<br>· Does not include underdrain system<br>· Calculate flow by multiplying weighted runoff factor times tributary times either (1) 0.2" per hour or (2) twice the 85th percentile hourly rainfall intensity<br>· Sizing the swale use value of 0.25 for Manning's "n"<br>· longitudinal slopes not to exceed 2.5%; flatter flows incorporate measures to avoid prolonged ponding<br>· Ensure flow enters near its highest point and no flow short-circuits treatment by entering swale along its length<br>· Consider bioretention area in place of conventional vegetated swale. | Vegetated Swales<br>·Uses information from County of San Diego SUSMP | Vegetated Swales<br>· Hydraulic residence time: optimal 9 min, ≥ 5 min<br>· Swale Length: optimal 200 ft, minimum 100 ft<br>· Average flow velocity: optimal ≤0.9 ft/s<br>· Swale Width: optimal 8 ft, minimum 2 ft<br>· Swale Slope: optimal -2 - 6%, minimum -1%<br>· Side Slope Ratio: optimal 4:1, minimum 2:1 | BioSwales (Grass)<br>· Grass 3-6" high, minimum 10 ft wide, surface area of 4% of tributary area<br>· No standing water within 72 hr of rainfall<br><br>Infiltration Swale<br>· Pre-filtration required - rock, no existing soil contamination<br><br>Vegetated Swales<br>· Use in lieu of underground piping or imperviously lined swales | Dry Swale<br>· Water quality retained by check dams, pea gravel window on downstream of each check dam to route water to underdrain<br>· Filter bed consists of 30" of sandy loam<br><br>Wet Swale<br>· Used when water table is close to surface<br>· Notched check dams set so that invert creates pool level when water table is high. Dimensions of notches set to provide desired detention time<br><br>· Also lists grass swales |
| **Buffer / Filter Strip** | Buffer Strips<br>· Xerscape only<br>· Grass / Vegetated strips not allowed if vegetation is dense | | | Vegetated Filter Strip<br>· Equipped with level spreading devices for even distribution of runoff<br>· Contains dense vegetation with mix of erosion resistant soil binding species<br>· 3-4 feet from edge of pavement<br>· Slopes should be not greater than 15%, preferably lower than 5% and be uniform throughout<br>· Hydraulic residence tine no less than 9 minutes<br>· Average velocity no greater than 0.9 feet/second<br>· Manning's friction factor (n) of 0.02 should be used in grass strips<br>· Average depth of flow no more than 0.5 inches | | Filter Strip<br>· On-line practice<br>· Requires sheet flow across entire strip<br>· Composed of 6" stone trench at edge of parking lot, grass strip for pretreatment, wooded strips<br>· Maintenance may include scraping sediment buildup to maintain flows, and mowing grass portion<br><br>Submerged Gravel Filter<br>· Cells filled with crushed rock or gravel. Standpipe from each cell set at an elevation to keep rocks / gravel submerged |
| **Medians / Curb** | Medians / Curb<br>· Depressed Medians, outside selenium management area, xeriscaping, not required or standard | | Medians / Curb<br>· Reduce / Eliminate curb & gutters from roadway sections | | Medians / Curb<br>· Weep hole in curb / slotted curb<br>· Parking Lot islands | Medians / Curb<br>· Divert runoff from curbed pavements using a curb opening with slotted deflector grooves in gutter pan. Utilize a 6" drop below curb, with a pea gravel diaphragm<br>· Utilize slotted curb with limited width and design parking area grades to diver the WQV into bioretention area. |
| **Impervious Areas** | Impervious Area<br>· Disconnect rooftop drains | Impervious Area<br>· Use flow-through planters to receive roof top runoff<br>· Subdivisions - agency may place conditional approvals to ensure SUSMP thresholds are not exceeded | Impervious Area<br>· Provide compact car spaces, minimize stall dimension, use pervious materials | Impervious Area<br>· Cistern<br>· Divert roof runoff to vegetated area | Impervious Area<br>· Hybrid parking - impervious and pervious areas<br>· Drain roof tops to adjacent landscape area<br>· Drain impervious sidewalks to adjacent landscape | Impervious Area<br>· Direct rooftop runoff through downspouts & over grassed areas<br>· Disconnect rooftop drains |
| **Pavements** | Pavements<br>· Modular pavers not required but allowed, used infrequently<br>·Pervious and porous pavements not allowed | Pavements<br>· Uses pervious pavements | Pavements<br>· Uses pervious pavements | Pavements<br>·Typical - Porous Pavement 65-100 mm, Filter Course 13 mm-diameter gravel 25-50 mm thick, stone reservoir 40-75 mm-diameter stone, Filter course 13-mm diameter gravel 50 mm thick, filter fabric, undisturbed soil (infiltration rate > 13 mm/h) | Pavements<br>· Uses pervious pavements<br>· Use permeable paving for overflow parking | |
| **Other Reference** | | Table 4-3 Structural BMP Treatment Control Selection | | | | Table 3-1 provide most appropriate filter option for different land uses<br>Table 3-2 provides comparison of stormwater filtering system options including space consumed and minimum head requirements<br>Table 3-3 provides estimate for pollutant removal capability of different filter systems<br>Table 3-4 provides comparative design criteria for filter systems<br>Chapter 5 provides details and key design elements for Sand Filters<br>Chapter 7 provides detail and key design elements for Filter strips |

| | New York State Stormwater Management Design Manual | Urban Storm Drainage Criteria Manual Volume 3 Denver, Colorado | City & County of Denver Water Quality Management Plan, Stormwater Quality BMP Implementation Guidelines | Green Industry BMP for the Conservation & Protection of Water Resources in Colorado | Minnesota Urban Small Sites BMP Manual | Caltrans |
|---|---|---|---|---|---|---|
| **Design & Site Information** | ·NPDES Phase 2 stormwater regulation - one or more acres of disturbance<br><br>Stormwater Management Practices<br>· Capture & treat full water quality Volume<br>· Capable of 80% TS and 40% TP removal<br>· Longevity in field<br>· Has pretreatment mechanism<br><br>· Green Infrastructure<br>· Water Quality Volume 90% Rule, capture and treat 90% of average annual stormwater runoff volume.<br>· runoff reduction infiltration, groundwater recharge, reuse, recycle evaporation/evapotranspiration of 100% of post-development WQV to replicate pre-development. Projects that cannot meet criteria must evaluate and identify reason based on physical constraints, hydrological conditions, soil testing, existing / proposed slopes, etc | · Water Quality Capture Volume runoff from 80th percentile storm (0.6" in UDFCD boundary) | · Criteria used in Urban Storm drainage Criteria Manual, Volume 3 Best Management Practices | · Water Quality capture volume 80th percentile storm | | · Mean influent concentrations must be below the 90th percentile of statewide characterization data |
| **Sand Filter** | Filtering System<br>· Maximum contributing area less than 10 acres<br><br>Surface Sand Filter<br>·Pretreatment sedimentation chamber, perforated standpipe detention structure, filter bed with underdrain collection system, overflow & outflow<br>· Underdrain - gravel, filter fabric, clean washed concrete sand filter bed, filter fabric, topsoil<br><br>Underground Sand Filter<br>· Wet pool chamber, filter bed with underdrain, overflow chamber<br>· underdrain - 11" gravel, 24" deep clean washed sand filter bed, 1" Debris Screen, temporary ponding area<br><br>Perimeter Sand Filter<br>· Curb stops, sedimentation chamber, sand filter bed with underdrain, outlet<br>· Underdrain - 6" gravel, filter fabric, 18" deep clean washed sand filter bed, temporary ponding area 6"-12"<br><br>Organic Filter<br>· Pretreatment sedimentation chamber, perforated standpipe, filter bed with underdrain collection system, overflow & outflow<br>· Peat - 3" topsoil, 18" 50/50 peat / sand mix, 6" sand, filter fabric, 8" gravel<br>· Compost - 18" - 24" leaf Compost, 6" gravel | Sand Filter<br>· Storage volume above sand bed equal to the WQCV based on a 24-hour drain time, although it will be designed to drain in 12 hours<br>· provide 18" layer of CDOT filter material<br>· No-infiltration - underdrain and impermeable linear required for<br>· Partial Infiltration - Underdrain System<br>· Full Infiltration - infiltration rate 2 time rate needed to drain WQCV over 12 hours | Sand Filter<br>· Uses sand filters | Sand Filter<br>· Sand Filter Extended Detention Basin | Surface Sand Filter<br>· Applicable in small drainage areas 1 - 10 acres<br>· Design based on Darcy's' law Q=KiA = VA (V=Ki)<br>· Length-to-width ration of pre-settling basin 3:1<br>· Sedimentation chamber, & 2nd chamber consisting of underdrain - minimum 8" of gravel, 1" filter fabric, 18" sand<br>· Off-line outlet sized for 15-minute peak flow of 2-year, 24-hour storm<br>· Clay liners minimum 12" thickness<br>· Drain rock 1.5-0.75" rock or gravel backfill washed free of clay<br><br>Underground Sand Filter<br>· 3 chamber pretreatment wet pool, sand filter chamber, overflow drains<br>· 2nd chamber consisting of underdrain - minimum 11" of gravel, 24" washed sand, 1" debris screen, temporary ponding area | Sand Filter<br>· DC filter designed to handle runoff from completely impervious drainage area of 1 acre or less<br>· Sedimentation Chamber & Open sand bed |

| | New York State Stormwater Management Design Manual | Urban Storm Drainage Criteria Manual Volume 3 Denver, Colorado | City & County of Denver Water Quality Management Plan, Stormwater Quality BMP Implementation Guidelines | Green Industry BMP for the Conservation & Protection of Water Resources in Colorado | Minnesota Urban Small Sites BMP Manual | Caltrans |
|---|---|---|---|---|---|---|
| **Swales** | Vegetated Swales<br>· Use of tree planting / tree box<br><br>Dry Swale (Open Channel)<br>· Runoff reduction capacity - 40% in HSG A & B; 20% HSG C & D<br>· Ponding time less than 48 hours, 2:1 slop absolute maximum side slope<br>· 6" gravel, filter fabric, 30" permeable soil, side slopes 2:1 or flatter, pea gravel diaphragm | Grass Swale<br>· Underdrain recommended for slopes under 2%<br>· Maximize length to increase residence time | Vegetated Swales<br>· Uses grass swales | Vegetated Street Swales<br>· Porous landscape detention and swale feature<br>· Narrow depressions, vegetated surfaces with rock trench and geotextile fabric | Dry (grass) Swale<br>· Typically designed for 2-year storm<br>· Grave; 2-6" soil / sand. WQ depth = 9" average, 2:1 slope or flatter. Checkdams should be installed when slopes are over 4% | Vegetated Swales<br>· Placed in areas of natural lows or cut section |
| **Buffer / Filter Strip** | Filter Strip<br>· Inflow approach length 35 ft -slope ≤2%, minimum filter strip length 10 ft<br>· Inflow approach length 75 ft -slope ≤2%, minimum filter strip length 20 ft<br>· Inflow approach length 35 ft -slope ≥2%, minimum filter strip length 15 ft<br>· Inflow approach length 75 ft -slope ≥2%, minimum filter strip length 25 ft | Grass Buffers<br>· Width same as the contributing basin, Length distance along sheet flow direction (minimum 14 feet)<br>· Flow should not exceed 10& in direction of flow. Minimum 2% | Buffers<br>· Uses grass buffers | Vegetated or Grass Buffers<br>· Uses grass buffers | Filter Strips<br>· Minimum 15 ft wide in the direction of flow, Length to stretch entire length of impervious surface, slope no less than 1 or 2% and no greater than 6%<br>· Install sand and gravel at toe of slope to enhance effectiveness<br>· Normally designed to handle flows from 1 to 2 year storm. Bypass should be incorporated for later storms | |
| **Medians / Curb** | Medians / Curb<br>· Landscape island at or below grade with curb cuts | Medians / Curb<br>· LID uses swales and open vegetated conveyances, opposed to curb and gutter systems<br>· Flush / slotted curbs when required | Medians / Curb<br>· Flush curbs along parking landscape medians to allow flow into swale<br>· Parking islands best located at 100 ft intervals<br>· Use of slotted curb with depressions between each parking space | Medians / Curb<br>· Replace roadside curb with grass ditches<br>· Use slotted curb along shoulders and swales | Medians / Curb<br>· Infiltration Islands | Medians / Curb |
| **Impervious Areas** | Impervious Area<br>· Reduce by eliminating unneeded spaces, provide compact car spaces, use porous pavement in overflow parking areas, use multi-storied parking desks<br>· Reduce building footprint by using taller buildings<br>· Disconnect rooftops to direct runoff flow to designated areas such as a stormwater planter | Impervious Area<br>· Reduce by minimizing sidewalks, parking lot aisles, etc.<br>· Planter boxes to collect roof drains | Impervious Area<br>· Drain roofs to porous landscape detention in planters adjacent to buildings<br>· Drain roofs to porous pavement detention or porous landscape detention in plazas and courtyards | Impervious Area<br>· Daylight roof downspouts to ground surface / planting beds | Impervious Area<br>· Minimize stall dimensions, in larger parking lots design 30% of the spaces for compact cars only | |
| **Pavements** | Pavements<br>· Uses pervious pavements | Pavements<br>· Estimation for storage volume based on a 12-hour drain time.<br>· Can be design to not infiltrate, partially infiltrate or full infiltration<br>· Recommended depth 6" minimum reservoir. If partial or no-infiltration underdrain is required and filter layer<br>· Interlocking pavement, concrete grid, pervious concrete, porous gravel, reinforced grass | Pavements<br>· Uses porous pavement and porous landscape detention in islands or medians | Pavements<br>· Uses permeable or porous pavement - modular block pavers, reinforced grass, poured porous concrete, porous asphalt | Pavements<br>· Modular paving block, cast-in-place concrete grids<br>· Cast-in-place concrete grids - 3-4" compacted aggregate / gravel for light/high used road. 8-10" for heavy vehicle use. | Pavements<br>· Porous Concrete<br>· Permeable Pavers<br>· Subsurface Drainage Structure |
| **Other Reference** | | | | | | |

## 3.3 Examples of Existing Parking Lot BMPs in the Las Vegas Valley

In the Las Vegas Valley, there are examples of parking lots that have incorporated BMP measures that have stormwater quality benefits into the site design. The BMP measures at the parking lots at the YMCA Centennial Hills and the Pepsi Bottling Group are described below.

### *3.3.1 YMCA Centennial Hills*

The YMCA site in Centennial Hills consists of LID elements that can be incorporated into other parking lot designs within the Las Vegas Valley, see **Figure 1**. Stormwater runoff is collected in a vegetated rock-lined swale, as shown in **Figure 2**. Stormwater runoff is conveyed from this swale to the stormwater drainage area shown in **Figure 3.**




**Figure 1. YMCA Centennial Hills in Las Vegas Valley (Clark County, Nevada)**




**Figure 2. YMCA Centennial Hills Vegetated Rock-Lined Swale**




**Figure 3. YMCA Centennial Hills Stormwater Drainage Area**

### *3.3.2 Pepsi Bottling Group*

The Pepsi Bottling Group site in Las Vegas Valley consists of elements that can be incorporated into other parking lot designs, see **Figure 4**. **Figure 5** shows a concrete channel BMP that can be used to direct flow from one portion of the parking lot to another. A rock-lined channel can be installed to treat stormwater runoff from the parking lot and route it offsite, as shown in **Figure 6**.

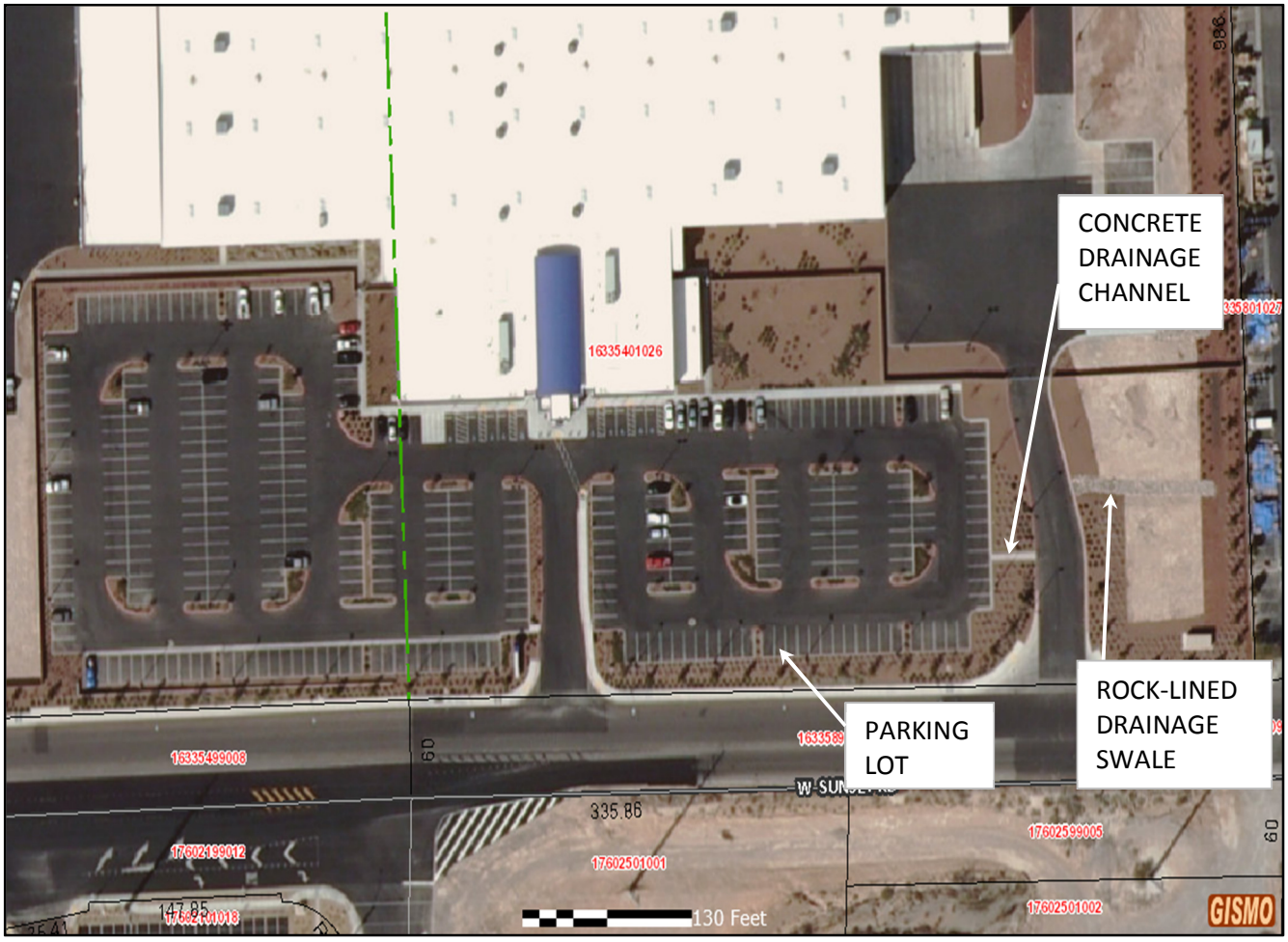



**Figure 4. Pepsi Bottling Group in Las Vegas Valley Parking Lot Design**




**Figure 5. Pepsi Bottling Group in Las Vegas Valley Concrete Channel**




**Figure 6. Pepsi Bottling Group in Las Vegas Valley Rock-Lined Drainage Swale**

## 3.4 Adopted Las Vegas Valley Parking Lot BMPs

Parking lot BMPs were adopted as part of the SWMP. BPMs fall into four categories: Site Design Measures, Treatment Control Measures, Source Control Measures and Site Maintenance Measures. Site design measures, such as a landscape drainage swale, can easily be incorporated into the site design of a parking lot. Treatment control measures, such as a sand filter, are infrastructure measures that are incorporated into a project. Source control measures, such as trash enclosures, help prevent stormwater pollutants from entering site design and treatment control measures, which would limit the effectiveness of the BMP. Maintenance measures, such as sweeping, help reduce pollutants from entering the storm drain system.

Parking lot designs must be submitted to local entities with the technical drainage study required by Municipal code. **Table 4** provides a list of accepted parking lot BMPs that can be used in the Las Vegas Valley. Parking lot BMPs adopted as part of the SWMP are briefly summarized in this subsection.

Various BMPs were included in the SWMP that can be used for the Parking Lot LID Program. These are briefly summarized below. The identification in front of the BMP name (e.g.,. SC-14) identifies the BMP number included in the SWMP. The definition for the letters in the ID are: Source Control (SC), Site Design (SD), and Treatment Control (TC). The additional BMPs that are developed for use in parking lots are described in **Appendix A**.

SC-14 Trash Receptacle Enclosures:

This requirement reduces the potential for stormwater to contact sources of BOD, organics, bacteria, etc., and minimize the potential for litter to enter the MS4. Trash receptacles for commercial, industrial, and multi-family developments must be enclosed and have a lid. Per Las Vegas and North Las Vegas development code, trash receptacles must be covered with a roof or trellis.

SD-9 Parking Lot Low Impact Development (LID) Measures:

Measures help to reduce runoff rates, volumes, and pollutant loads generated from residential, commercial, and industrial site parking lots. This BMP applies to all new development and significant redevelopment projects requiring new site development permits of certain sizes, as described in Section 3.6.1.

SD-10 Low Impact Development (LID) Measures:

Low impact development consists of a variety of site planning and site design measures or practices to minimize the impact of individual urban developments on stormwater runoff quantity and quality. **Table 4** lists the measures from SD-10 applicable to parking lot design. These measures are not required, but Developers are encouraged to implement these measures whenever feasible.

**Table 4. Accepted Parking Lot BMP's for Las Vegas Valley**

| | Site Design Measures | Treatment Control Measures | Source Control Measures | Site Maintenance Measures | Code Measures |
|---|---|---|---|---|---|
| Usage | • Site design measures accept drainage from impervious parking area to trap pollutants prior to stormwater leaving the site | • Infrastructure accepts site runoff and removes pollutants prior to stormwater leaving site | • Onsite control to reduce pollutants from reaching site design and treatment control measures | • Maintenance and pollution prevention measure to keep pollutants from the site design and treatment control measures. | • Pollution prevention associated with typical parking area appurtenances and activities, to keep potential pollutants from contacting stormwater |
| Measures | • Minimize Directly Connected Impervious Areas<br>• Landscape Drainage Swale<br>• Depressed Median<br>• Depressed Landscaping<br>• Buffer Strip<br>• Pervious Overflow Parking | • Sand / Media Filers<br>• Oil & Water Separator<br>• Onsite Water Quality Basin (no infiltration) | • Proposed use & disposal of Sorbents<br>• Proposed waste handling & Disposal | • Building and Ground Maintenance<br>• Parking Lot Sweeping<br>• Sidewalk cleaning | • Trash Storage Areas<br>• Vehicle & Equipment Washing Areas<br>• Loading Dock Areas<br>• Minimize Parking Requirements |
| Benefits | • Lower cost than treatment control<br>• Easier construction than treatment control<br>• Lower maintenance than treatment control<br>• Easy to incorporate in most site plans | • Compact design allows for installation in small areas<br>• Relatively efficient removal of many pollutants of concern | • Control measure to prevent pollutants from leaving site | • Aesthetics<br>• Prevention control for Site Design and Treatment Control | • Reduce pollutants from high potential sources<br>• Low implementation cost<br>• Close gaps in existing regulations |

TC-4 Sand / Oil Separator:

Sand / Oil Separators are treatment devices with chambers that separate sand and oil from the stormwater flow. These separators are often used at industrial sites and commercial locations where hydrocarbons are present, or at sites where land area is limited and BMPs that have larger footprints are not feasible. Application of this BMP is at the discretion of the site owner based on the potential of the site to contribute to pollutant discharges to the MS4.

TC-5 Sand Filter:

Sand Filters are treatment devices that remove small particles and some dissolved pollutants from stormwater. These filters are often used at commercial sites, industrial sites and parking areas to treat runoff prior to discharge to the MS4, or at sites where land area is limited and BMPs that have larger footprints are not feasible. Application of this BMP is at the discretion of the site owner based on the potential of the site to contribute to pollutant discharges to the MS4.

## 3.5 Development of Hydrologic Design Criteria

Peak discharges and runoff volumes for the Lase Vegas Valley BMP design storm ($85^{th}$ percentile storm) are needed to design structural parking lot BMPs. The DGWG formed an Engineering Subgroup consisting of representatives of various engineering consultants in the Las Vegas Valley to analyze various hydrologic methods that could be used to size water quality features and their related drainage facilities for parking lots. The objective was to find a simple approach to determining design discharges that would not involve substantially more effort than is already required by engineers to design parking lot drainage facilities. A technical memorandum describing the methods used and the outcome is in **Appendix B**.

## 3.6 Parking Lot BMP Design Requirements

The methods to determine the BMP requirements for various sizes of parking lots are detailed in this subsection. Parking Lot BMPs must be considered for all new commercial and industrial sites. BMPs are not required for multi-family residential sites (apartments, condominiums). BMP requirements shall adhere to the Clark County Regional Flood Control District's Hydrologic Criteria and Drainage Design Manual.

The first items that will be known to the developer are the total size of the site and the size of the parking lot. **Table 5** provides a stepped approach to determine whether a parking lot is categorized as small, medium, or large for the purpose of determining required BMPs. Any project site that is less than an acre in size is categorized as small; parking lot size is not a factor in determining required BMPs for small sites. For project sites that are greater than or equal to 1 acre, the parking lot size is used to determine if the category is medium or large. Sites having parking lots that are less than or equal to 1 acre are categorized as medium. Sites with parking lots greater than 1 acre are categorized as large.

**Table 5. Parking Lot Category Determination Based on Total Site and Parking Lot Size**

| Total Site Size | Parking Lot Size | Parking Lot Category |
|---|---|---|
| <1 acre | Not Applicable | Small |
| ≥1 acre | ≤1 acre | Medium |
| | >1 acre | Large |

Once the parking lot category is determined, the BMP requirements for parking lot design can determined. These are shown in **Table 6**. BMP requirements are more stringent as the parking lot size increases.

There are no specific BMP requirements for small parking lots; however, the developer has the option to install any of the BMPs that are listed for parking lots in the medium or large categories.

For the medium parking lot category, the design requirements consist of disconnecting impervious areas for at least 75 percent of the combined parking lot and contributing building area. This may be accomplished by directing runoff to pervious areas such as landscaping, depressed medians, parking strips, or stormwater retention basins. The design criteria are based on meeting the accepted minimum standards for the BMPs selected, e.g., as described in Appendix A. Similar to the policy for the small parking lot category, the developer may choose to install a treatment BMP listed in the large parking lot category.

For the large parking lot category, treatment BMPs are required to treat stormwater runoff from at least 75 percent of the parking lot. Because of typical site drainage layouts, treatment BMPs will need to be sized to accommodate runoff from the contributing building area as well. BMPs are to be sized for the 85$^{th}$ percentile storm, and hydrologic and hydraulic calculations are required to be submitted for the BMP design.

The requirement to treat 75 percent of the parking lot area, either through disconnecting impervious areas or installing treatment devices, recognizes that grading and other site conditions will prevent directing all site runoff to some type of BMP. However, developers are encouraged to exceed the minimum standard when this can be done cost effectively in order to maximize the potential water quality benefits of the BMP system.

**Table 6. Parking Lot BMP Design Requirements by Parking Lot Category**

| Parking Lot Category | BMP Requirements | Example BMPs |
|---|---|---|
| Small | None | None specifically required.<br>Developer has the option to install any BMPs listed in the Medium or Large Categories. |
| Medium, or minor potential impacts on MS4 | Disconnect at least 75% of parking lot and contributing building area.<br><br>Design based on accepted minimum standards | Depressed medians<br>Depressed planter areas<br>Modular pavers<br>Buffer strips<br>Disconnect roof drains<br>Developer has the option to install any BMPs listed in the Large Category. |
| Large, or major potential impacts on MS4 | Provide treatment BMPs for at least 75% of parking lot and contributing building area.<br><br>Design for 85th percentile storm. Provide supporting hydrologic and hydraulics calculations for BMP design. | Depressed medians<br>Depressed planter areas<br>Modular pavers<br>Buffer strips<br>Disconnect roof drains<br>Xeriscaped swales<br>Rock swales<br>Retention ponds (if no adverse impacts)<br>Settling basins<br>Sand filters<br>Sand/oil separators |

### *3.6.1* Site Design for Parking Lots

LID measures that are selected to be incorporated in the parking lot design should be planned during the site design process. Certain LID measures, including depressed medians, islands, and rock-lined swales, help to disconnect impervious areas and remove suspended particles in the stormwater runoff, prior to connection to the MS4. Parking Lot BMPs can be integrated into perimeter landscaped areas (e.g., buffers) and interior landscaped areas (e.g., medians) required by local development standards whenever possible. When incorporated into landscaping features, tributary areas to individual BMPs should be kept to less than 0.5 acres whenever possible, and should never exceed 1.0 acre.

Multiple manuals were reviewed and some included conceptual layouts to assist developers and engineers in parking lot design. Sample conceptual layouts, **Figures 7** through **Figure 9**, were developed to provide ideas on how parking lots can be designed to comply with the water quality regulations. The framework for these layouts came from examples such as the Toronto Urban City Planning Manual and the SUSMP Guidebook (www.jlha.net). The Developer is required to comply with the planning code for the municipality in which the site is located. The conceptual layouts incorporate planning requirements; however, planning measure requirements, such as for landscape buffers, are determined based in part on the adjacent property. The conceptual layouts are designed to represent a commercial property that is approximately 5 acres in size, with the total parking lot area of approximately 3.3 acres. **Table 7** displays data for each layout, including the size of the property, area of pervious cover, parking lot area, and amount of parking area to be treated (75% of total parking lot area). Calculations are rounded to 0.1 acres. During the parking lot design phase, the Developer should look at incorporating LID measures to address runoff from high traffic areas.

**Figure 7**, Conceptual Layout 1, represents a parking lot that can be designed so that the runoff can be directed towards the perimeter landscape buffer areas that are constructed with a landscaped

swale. These swales are designed as rock or xeriscaped swales to convey runoff to a low point, which discharges either directly to the MS4 or to a main drainage pipe and thence to the MS4.

**Table 7. Conceptual Parking Lot Layouts: Property and Parking Lot Data**

| Site Data | Area (acres) | | |
|---|---|---|---|
| | Conceptual Layout 1 – Perimeter Swales Only | Conceptual Layout 2 – Perimeter and Internal Swales | Conceptual Layout 3 – No Swales |
| Property Size | 5.0 | 5.0 | 5.0 |
| Building Size | 1.4 | 1.4 | 1.4 |
| Total Buffer Area | 0.2 | 0.2 | 0.2 |
| Depressed Medians | 0.0 | 0.1 | 0.0 |
| Tree Planters | 0.0 | 0.0 | 0.0 |
| Modular Pavers | 0.0 | 0.0 | 0.1 |
| Other | 0.0 | 0.0 | 0.0 |
| Other Pervious Area | 0.0 | 0.1 | 0.0 |
| Total Pervious Area | 0.2 | 0.3 | 0.3 |
| Parking Lot Area | 3.4 | 3.3 | 3.3 |
| Minimum Parking Lot Area to be Treated (75% of Parking Lot Area) | 2.6 | 2.5 | 2.5 |

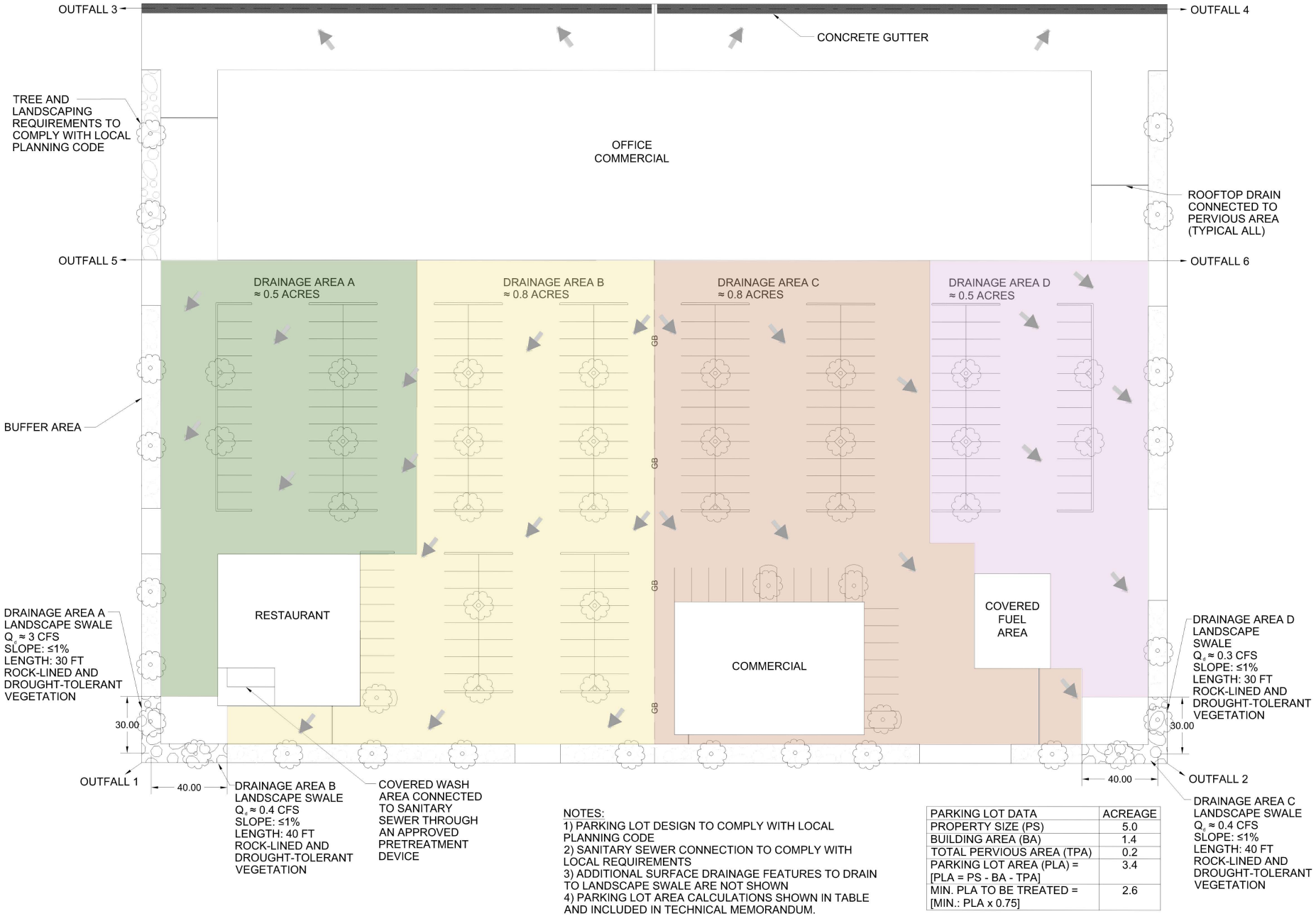
**Figure 8**, Conceptual Layout 2, represents a parking lot that is not designed to direct all runoff towards swales installed in the perimeter landscape buffer areas. One example could be that the adjacent right-of-way at this area is higher in elevation than the onsite grade. In order to still use the landscape swale BMP, the Developer could use swales in depressed medians within the site, combined with perimeter swales where feasible.

If the Developer elects to use treatment control devices rather than BMP swales, the amount of parking lot area required to be treated would need to be calculated. **Figure 9**, Conceptual Layout 3, shows a concept level layout for this scenario, which relies on a combination of modular pavers, sand/oil separators and underground detention to provide treatment for at least 75 percent of the parking lot area. To size the treatment control BMPs, the approaches described in Appendix B should be used. Note that for treatment devices, sizing should account for the contribution of runoff from building areas draining through the parking lot.

The Developer may choose how to meet the requirement to treat at least 75 percent of the parking lot area, depending on specific site characteristics. In order to maximize the water quality benefits of the parking lot BMPs, the Developer is encouraged to locate BMPs to capture runoff from portions of the site with the highest potential to generate pollutants. Examples of these areas include loading docks, material handling areas, waste storage areas and high traffic areas.

### *3.6.2* Sample Site Design BMPs and Treatment Control BMPs for Parking Lots

The medians, islands and swales shown in the conceptual layouts could be designed so that the parking lot concrete or asphalt is flush with the top of the BMP as shown in **Figure 2** and in



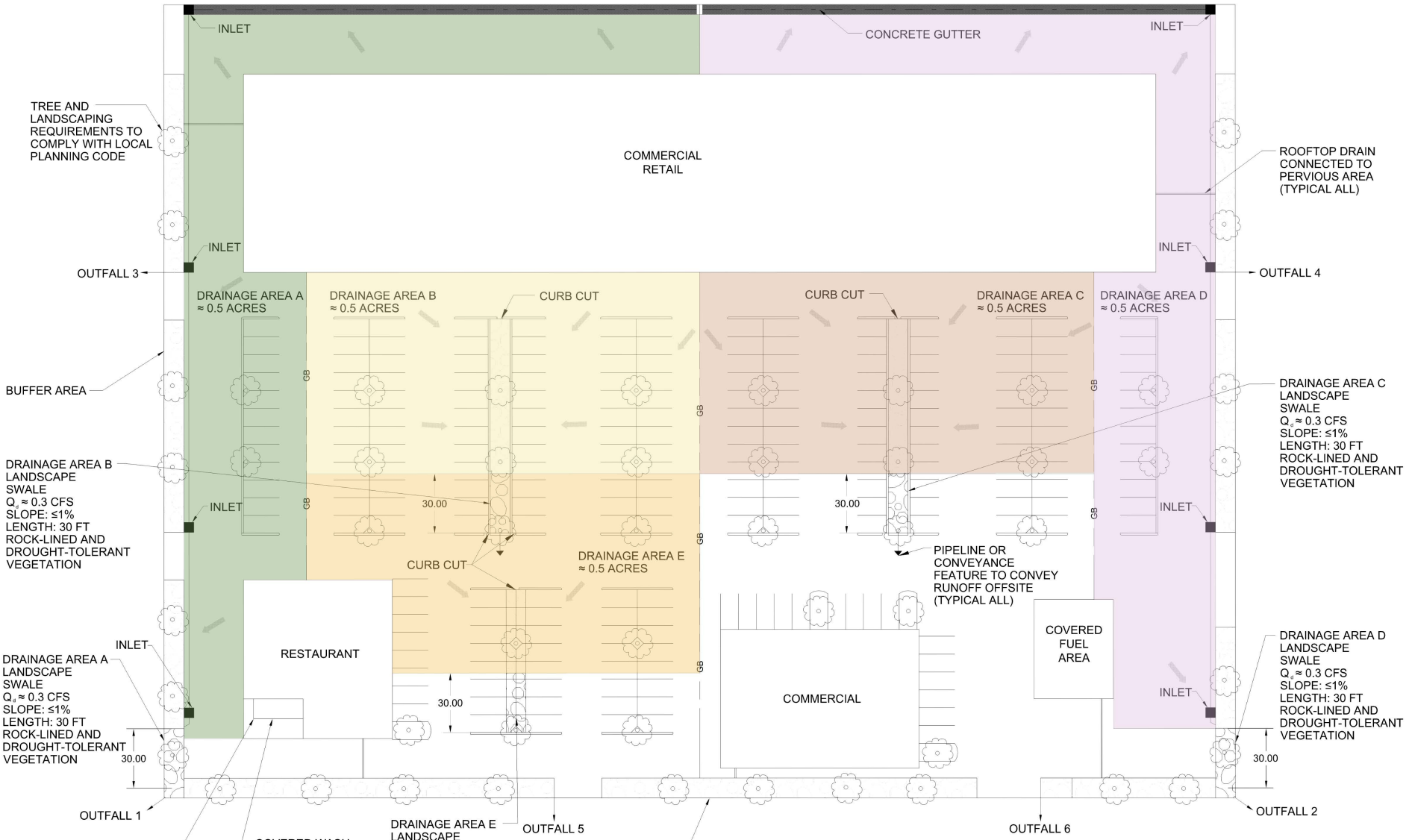

NOTES:
1) PARKING LOT DESIGN TO COMPLY WITH LOCAL PLANNING CODE
2) SANITARY SEWER CONNECTION TO COMPLY WITH LOCAL REQUIREMENTS
3) ADDITIONAL SURFACE DRAINAGE FEATURES TO DRAIN TO LANDSCAPE SWALE ARE NOT SHOWN
4) PARKING LOT AREA CALCULATIONS SHOWN IN TABLE AND INCLUDED IN TECHNICAL MEMORANDUM.

| PARKING LOT DATA | ACREAGE |
|---|---|
| PROPERTY SIZE (PS) | 5.0 |
| BUILDING AREA (BA) | 1.4 |
| TOTAL PERVIOUS AREA (TPA) | 0.2 |
| PARKING LOT AREA (PLA) = [PLA = PS - BA - TPA] | 3.4 |
| MIN. PLA TO BE TREATED = [MIN.: PLA x 0.75] | 2.6 |

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PARKING LOT LID PROGRAM
STORMWATER QUALITY MANAGEMENT COMMITTEE

CONCEPTUAL LAYOUT 1
PERIMETER SWALE ONLY
FIGURE 7




NOTES:

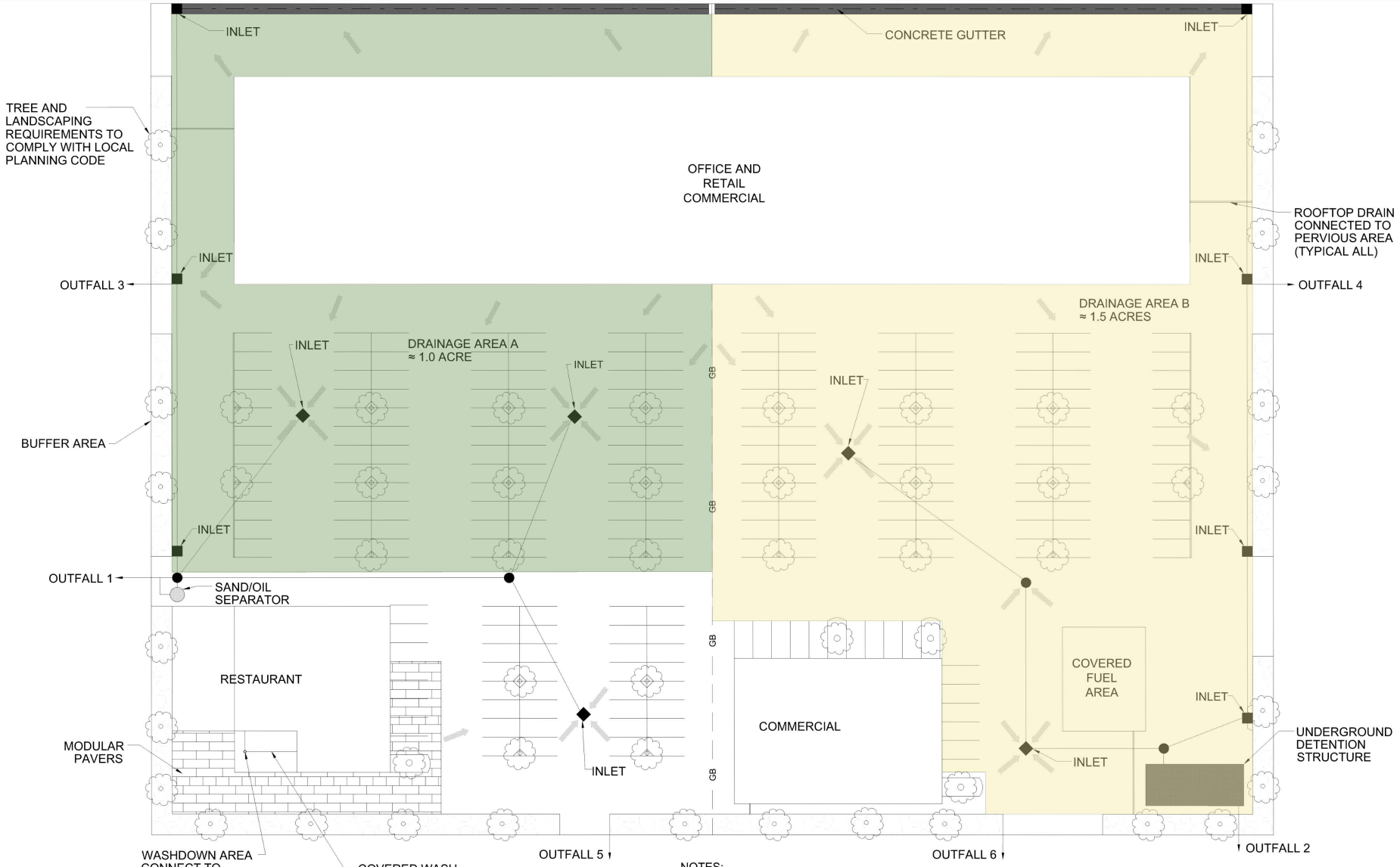
1) PARKING LOT DESIGN TO COMPLY WITH LOCAL PLANNING CODE
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| PARKING LOT DATA | ACREAGE |
|---|---|
| PROPERTY SIZE (PS) | 5.0 |
| BUILDING AREA (BA) | 1.4 |
| TOTAL PERVIOUS AREA (TPA) | 0.2 |
| PARKING LOT AREA (PLA) = [PLA = PS - BA - TPA] | 3.3 |
| MIN. PLA TO BE TREATED = [MIN.: PLA x 0.75] | 2.5 |

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PARKING LOT LID PROGRAM
STORMWATER QUALITY MANAGEMENT COMMITTEE

CONCEPTUAL LAYOUT 2
PERIMETER AND INTERNAL SWALES
FIGURE 8




NOTES:
1) PARKING LOT DESIGN TO COMPLY WITH LOCAL PLANNING CODE
2) SANITARY SEWER CONNECTION TO COMPLY WITH LOCAL REQUIREMENTS
3) ADDITIONAL SURFACE DRAINAGE FEATURES TO DRAIN TO LANDSCAPE SWALE ARE NOT SHOWN
4) PARKING LOT AREA CALCULATIONS SHOWN IN TABLE AND INCLUDED IN TECHNICAL MEMORANDUM.

| PARKING LOT DATA | ACREAGE |
|---|---|
| PROPERTY SIZE (PS) | 5.0 |
| BUILDING AREA (BA) | 1.4 |
| TOTAL PERVIOUS AREA (TPA) | 0.2 |
| PARKING LOT AREA (PLA) = [PLA = PS - BA - TPA] | 3.3 |
| MIN. PLA TO BE TREATED = [MIN.: PLA x 0.75] | 2.5 |

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PARKING LOT LID PROGRAM
STORMWATER QUALITY MANAGEMENT COMMITTEE

CONCEPTUAL LAYOUT 3 - NO SWALES
FIGURE 9

**Figure 10** from the Denver Stormwater Quality BMP Implementation Guideline manual, or with slotted concrete curbs as shown in **Figure 11** from the LA County SUSMP Guidebook.



**Figure 10. Depressed Median**




**Figure 11. Slotted Curb**

Disconnecting impervious areas should be included in the site design for parking lots. Measures for disconnecting impervious areas help slow stormwater flow and minimize pollutants conveyed directly to the MS4. Site design measures to disconnect impervious areas include directing drainage to landscape islands, swales, and buffer strips. A planter box, as shown in **Figure 12** from the County of San Diego SUSMP, can be utilized to receive runoff from rooftops.



**Figure 12. Flow through Planter**

The purpose of the xeriscaped or rock-lined swales as shown in the conceptual layouts is to settle out sediment, which in addition to being a pollutant itself has the potential to have urban pollutants

bound to the particulate matter. Sizing of these BMPs can follow the standard sizing requirements, as described in the fact sheet, or the developer may propose to use an alternative size swale, if supporting calculations are submitted. The required length of the swale to settle out particulate pollutants is dependent on multiple factors, including velocity, characteristics of the stormwater, characteristics of the swale, and length of the swale. The design philosophy is that the steeper the slope, the greater the length of swale that is required. The contributing drainage area for swale design is the total amount of impervious area draining to the swale, which includes but is not limited to, parking lots, roof tops, parking covers, etc. The swales can be installed either within the parking lot area or at the perimeter of the site.

Modular pavers, as shown in **Figure 13** from the Denver Urban Storm Drainage Criteria Manual, can also be used to disconnect impervious areas from the MS4. Parking areas with modular pavers are considered to be disconnected from the MS4 when calculating the area to be treated to meet the 75 percent minimum treatment criterion. Areas that use modular pavers should include an underdrain system, so stormwater runoff does not infiltrate into the ground.



**Figure 13. Modular Pavers**

Treatment BMPs, such as sand filters, sand / oil separators, retention basins and detention basins, retain stormwater for a short period of time and remove some particles and dissolved pollutants. An underground sand filter and sedimentation basin as shown in **Figure 14**, from the Center for Watershed Protection Design of Stormwater, can be used if space on the site is limited.

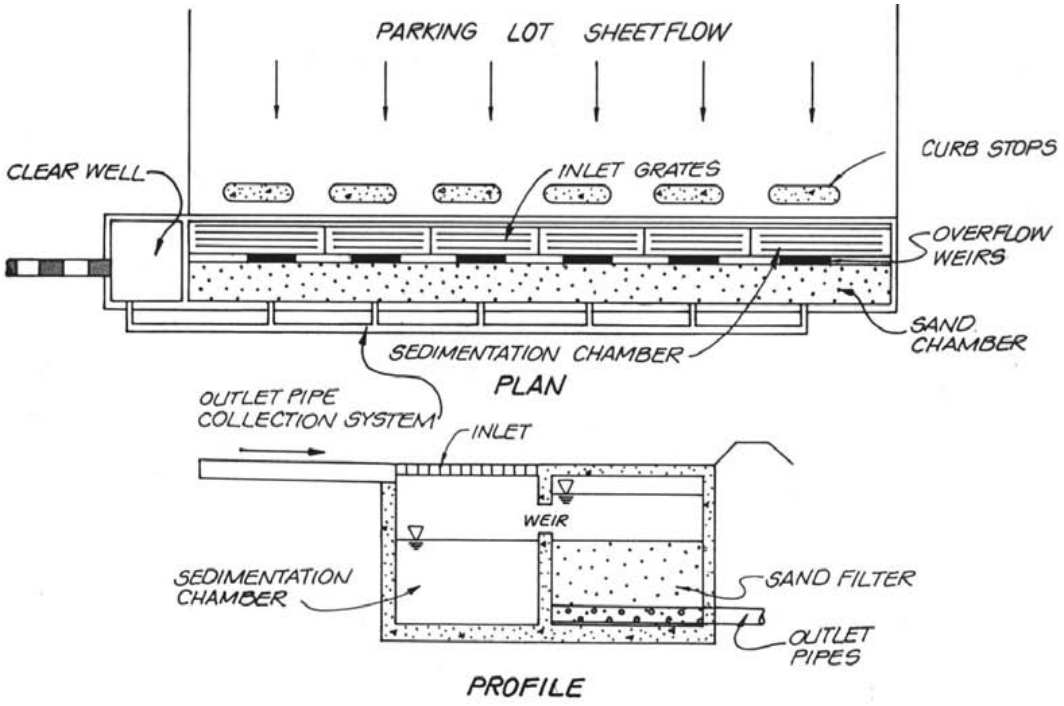



**Figure 14. Sedimentation Basin and Sand Filter**

Descriptions of BMPs that can be used for Parking Lots are included in the Fact Sheets, which include other pertinent data to assist the Developer in selecting an appropriate BMP.

## 3.7 Parking Lot Maintenance Requirements

Parking lots will require good housekeeping measures to help reduce the discharge of targeted constituents into the storm drain system. One important good housekeeping practice is regular cleaning. A parking lot sweeping frequency schedule should be established based on observation of waste accumulation. Before sweeping begins, any storm drains that may be affected should be protected and excess runoff water should be contained. Wash water shall be disposed of in the sanitary sewer through an approved pretreatment device or to a pervious surface. Debris accumulated from sweeping shall be disposed of properly in litter receptacles or at a landfill. Debris should be removed regularly from the parking lot. Litter receptacles should be cleaned out at regular intervals and should be covered to prevent spillage. Oily deposits should be cleaned with absorbent materials to prevent oil from entering the storm drain system. Rooftop drains should be cleaned out and arranged to prevent drainage directly on paved surfaces. Maintenance equipment should be inspected before cleanings. Maintenance logs should be kept to document materials removed and any improvements made.

If surface work will be conducted, work should be conducted during dry weather periods to prevent contamination of the storm drain system. Affected storm drains and manholes should be covered and protected. Limit water used to prevent runoff and contain excess runoff. Work materials should be mixed, heated or transferred away from storm drain inlets. Waste materials and absorbents should be properly disposed.

# 4 Summary of Policy for Implementation of Parking Lot BMPs

A summary of the policy for implementing parking lot BMPs is provided below.

1. Parking Lot BMPs are required on all new commercial and industrial sites that are over 1.0 acre. BMPs are not required for multi-family residential sites (apartments, condominiums).

2. Parking Lot BMPs can be integrated into perimeter landscaped areas (e.g., buffers) and interior landscaped areas (e.g., medians) required by local development standards whenever possible.

3. When incorporated into landscaping features, tributary areas to individual BMPs should be kept to less than 0.5 ac whenever possible, and should never exceed 1.0 ac.

4. A minimum of 75 percent of the parking lot area for medium and large sites must be disconnected from the municipal drainage system or drain through a Parking Lot BMP. For linear BMPs like swales, credit is given for all area from which runoff flows through the minimum BMP length (see 5a).

5. It is assumed that most BMPs will be xeriscaped swales. When using xeriscaped swales as BMPs in buffer strips or medians, the following criteria should be applied.
   a. BMP swales should be as long as practically feasible to provide as much treatment as possible. The minimum length is 30 feet for tributary areas up to 0.5 ac, and 40 feet for tributary areas up to 1.0 ac.
   b. BMP swales should have a minimum average topwidth of 6 feet, with a minimum topwidth at any point of 4 feet. When combined with a flood control facility, these dimensions should apply to the portion of the swale carrying low flows.
   c. BMP swales should have a maximum depth of 9 inches for water quality flows (approximately 2-year). When combined with a flood control facility, this dimension should apply to the portion of the swale carrying low flows.
   d. When lined with rock, BMPs should have a minimum rock size of 3-inch D50. When combined with a flood control facility, rock lining should be sized based on the anticipated flood velocities in the facility.

# 5 Conclusion

The MS4 Permit which took effect on February 9, 2010 includes requirements by the Permittees to develop a New Development and Significant Redevelopment (NDSR) program. One of the requirements adopted by the Permittees is BMPs for new parking lots to mitigate urbanization effects on stormwater quality. A tiered BMP program is proposed in which increasingly comprehensive BMP measures are required as the project site size and parking lot size increase. BMPs include a mixture of measures to disconnect impervious areas from the MS4, site design measures to make use of designed pervious areas to receive stormwater, and treatment devices with space is limited. Developers are given significant latitude in determining which measures they will

employ to assure that runoff from at least 75 percent of the parking lot area is directed to a BMP. The proposed parking lot LID measures within the NDSR Program are incorporated into the Las Vegas Valley SWMP.

# 6 References

MWH. *2008-2009 Annual Report, Las Vegas Valley Municipal Separate Storm Sewer System*. September 2009.

MWH. *Technical Memorandum No. IV.12 – Proposed New Development and Significant Development Program for Las Vegas Valley*. Prepared for Las Vegas Valley Stormwater Quality Management Committee. 2010b.

Nevada Division of Environmental Protection. *2010 Las Vegas Valley MS4 Permit NV0021911*. February 2010.

OC Watersheds Best Management Practices Industrial / Commercial / Business Activities. IC15 Parking and Storage Area Maintenance.
Online: http://www.ocwatersheds.com/Documents/IC15_ParkingLotandStorage.pdf

# Appendices

# Appendix A –
# Parking Lot Maintenance Requirements

# Source Control Measures
## Use & Disposal of Sorbents

### Description

There are two types of sorbent materials, absorbents and adsorbents, where each have specific physical and/or chemical properties that allow them to attract specific types of liquids and/or gases. Absorbent materials function by attracting compounds into their pore spaces, whereas, adsorbents attract materials to their surfaces but do not allow them to penetrate into their pore spaces. Both processes essentially capture materials to be removed by a media through sorption by concentrating or removing them from a solution.

Traditionally, sorbent materials have been used to clean up spills, such as for soaking up fuel spilled on a roadway. Since sorbent materials have the ability to remove oils and grease, the use of sorbent materials has recently been incorporated into storm water BMPs where it is placed in stormwater catch basins, sumps or other parts of the storm sewer system to capture hydrocarbons, other toxic chemicals and prevent them from being carried through the storm water system.

### Targeted Pollutants

- Oil and grease
- Litter

### Reference Manuals

- EPA Storm Water Technology Fact Sheet
- CalTrans Treatment BMP Technology Report

### Applications

The diversity of sorbent materials allows it to be utilized in several types of BMP applications, which include new and retrofit applications. Sorbent materials for most stormwater applications are placed near roadways, parking areas and service stations because much of the oil and grease in urban stormwater comes from motor vehicles via engine drippings, exhaust and maintenance activities.

### Limitations

Sorbent materials cannot capture emulsified oils; it can only capture free oil and grease within the water column. To ensure the sorbent material is not full or "spent", frequent inspection is required. There is a maximum sorbent capacity for each type of sorbent material based on its chemical composition and volume. The sorbent will cease to capture oil and grease when this capacity is reached and must be replaced.

Large litter and debris, such as leaves, clogs the drain inlet inserts with the sorbent materials, this decreases the system's hydraulics and reduces its sorbing capability.

Proper handling and disposal of used sorbent material is required at most local jurisdictions. The "spent" sorbent is either disposed at landfill or incinterated.

**Design Criteria**

Refer to manufacturer details for appropriate use and disposal of sorbents at a specific location. To provide a general idea of sorbents available, the StreamGuard™ is shown as an example of a sorbent. The product referenced and/or shown in schematics are not the only products available, nor should their presence in this manual be construed as an endorsement of these products. They are merely shown as manufactured sorbents that are known to be available from vendors.

This description of the StreamGuard™ has been adapted from the CalTrans Treatment BMP Technology report. The StreamGuard™ is placed at the inlet to a storm drain where stormwater flows through the insert, and the geotextile fabric absorbs oil and retains sediment and gross pollutants. When body of the unit fills with stormwater and sediment, the gross pollutants are collected at the bottom of the insert. Within the unit, the filter pack contained in a poly-net bag absorbs the floating oil and grease.

For the StreamGuard™ to perform most efficiently, a tight seal is necessary between the frame of the drain inlet and the insert. It should be installed into the inlet of the storm drain according to the manufacturer's recommendations. The insert should also have a high-flow bypass to prevent re-suspension and washout.

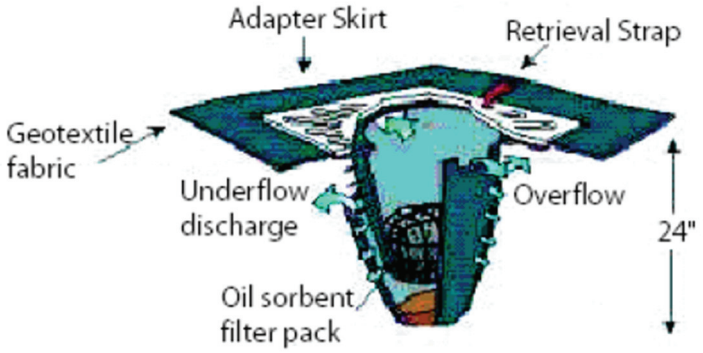



**Figure 1 StreamGuard™ Filter**
**(Courtesy of CalTrans Treatment BMP Technology Report)**

The Triton TT3 Filter™ Insert is designed to help eliminate hydrocarbons and other contaminates such as metals, sand, silt, and litter from stormwater runoff. Large particles are filtered out when storm water flows through the trench drain and passes through a primary sand/silt dam. Water then passes through a Trap Chamber where floatables are collected. The last of the sediment is removed via a secondary sand/silt filtration after the Trap Chamber. Hydrocarbons are retained by the ABSORB media in the Hydrocarbon Collection Cartridge. Clean water passes to the end of the trench and into the stormwater system.



**Figure 2 Triton TT3 Filter™installed in trench (Courtesy of CalTrans Treatment BMP Technology Report)**

For the Triton TT3 Filter™ to perform most efficiently, provision is to be provided for overflow or bypass to avoid flooding when the insert is clogged.

Some of the advantages of the Triton TT3 Filter™ are that it is constructed of over 40% recycled material, it has low maintenance and spent adsorbents can be recycled.

**Maintenance**

A requirement of basic operations and maintenance (O&M) for sorbent materials are periodic inspections of the sorbent material to ensure it has not reached its sorbing capacity or is clogged. Inspections depend on the individual unit and vary from monthly to quarterly. Depending on the type of BMP and the area in which the sorbent material is located determines the frequency of visits and cleaning of sediment and debris. Generally, a monthly inspection is recommended on all BMPs using oil sorbent materials. In locations where the sorbent material is placed in an area which is susceptible to a high loading rate, the BMP should be inspected and serviced more frequently. In the event of a spill, the BMP should be checked immediately.

# Source Control Measures
## Waste Handling & Disposal

### Description

To prevent contamination of stormwater runoff, eliminating trash and other materials is important. A major component of waste management is waste reduction which should be encouraged through training and public outreach. Reuse, recycling, or proper disposal are methods of managing waste once it is collected.

### Targeted Pollutants

The following lists pollutants which typically handle and dispose of waste. This list is from Idaho Department of Environmental Quality (IDEQ) Storm Water BMP Catalog.

- Sediment
- Nutrients
- Trash
- Bacteria
- Oil and Grease
- Organics
- Oxygen Demand

### Reference Manuals

The following manuals can be used for further information on waste handling and disposal:

- California Stormwater BMP Handbook – California Stormwater Quality Association
- Catalog of Stormwater Best Management Practices for Idaho Cities and Counties by the Idaho Department of Environmental Quality

### Applications

Maintaining a clean and orderly work environment is the first step in preventing pollution of stormwater runoff. Additionally, the possibility of accidental spills is reduced. Compliance with applicable regulations provides benefits in the protection of human health and the environment from hazardous waste generated by construction activities, liability reduction, and prevention of unnecessary interruptions to schedules (i.e., project shut down due to environmental investigations/enforcement actions).

The most inexpensive and simplest method to utilize is common sense. Improving the operation and maintenance of industrial machinery, material storage practices, material inventory controls, routine and regular clean-up, maintenance activities in work areas, and providing educational programs for employees regarding these practices will assist in reaching these goals.

### Limitations

Problems associated with the disposal of hazardous materials often result from carelessness and poor judgment. Stormwater contamination may occur if maintenance staff are not fully aware of all the hazards at the site which could increase the potential for mishandling of such wastes.

**Design Criteria**

The following are general protocols for handling and disposing of waste according to the IDEQ Stormwater BMP and the California Stormwater BMP Handbook. Other BMP manuals may be utilized for further information.

*Solid Waste Collection*

- Select a designated waste collection area on site. Implement procedures, where applicable, to collect, transport, and dispose of solid waste at appropriate disposal facilities in accordance with applicable federal, state, and local laws and regulations.
- Include properly designed trash storage areas. Secure solid waste containers; containers must be closed tightly when not in use.
- If feasible provide cover over trash storage areas. Secure an adequate number of containers with lids or covers. If possible, provide a covered area or spill containment pallets.
- Regularly inspect solid waste containers for structural damage. Repair or replace damaged containers as necessary.
- Arrange for waste collection before containers overflow (additional containers and more frequent pick-ups will be needed during a demolition phase).
- Do not fill waste containers with washout water or any other liquid. Provide immediate clean-up in case of a spill.
- A liner, concrete pad, berm, etc., should be utilized to keep waste separated and to contain accidental spills so that stormwater runoff is not polluted.
- Ensure that only appropriate solid wastes are added to the solid waste container. Certain wastes such as hazardous wastes, appliances, fluorescent lamps, pesticides, etc. may not be disposed of in solid waste containers
- Do not mix wastes; this can cause chemical reactions, make recycling impossible, and complicate disposal.
- Provide labels and signs for the area to educate contractors about proper storage and handling and to comply with regulatory requirements.

*Waste Reduction and Recycling*

- Whenever possible, waste is to be recycled. Recycling options for each waste type is limited however, many types of waste can be recycled. All gasoline, antifreeze, waste oil, and lead-acid batteries can be recycled. Latex and oil-based paint can be reused, as well as recycled. Materials that cannot be reused or recycled should either be incinerated or disposed of at a properly permitted landfill.
- Recycling is always preferable to disposal of unwanted materials.

*Controlling Litter*

- To enforce anti-litter laws, post "No Littering" signs.
- Provide litter receptacles in busy, high pedestrian traffic areas of the community, at recreational facilities, and at community events.
- Clean out and cover litter receptacles frequently to prevent spillage.

Illegal Dumping

Illegal dumping of substances into the storm drain system and creeks include paints, used oil and other automotive fluids, construction debris, chemicals, fresh concrete, leaves, grass clipping, and pet wastes.

- Post "No Dumping" signs with a phone number for reporting dumping and disposal. Signs indicating fines and penalties for illegal dumping should also be posted.
- Discouraging future dumping might be effective through beautification and landscaping efforts.

**Maintenance**

The following maintenance procedures have been adapted from the IDEQ Stormwater BMP Handbook. Other BMP manuals may be utilized for further information.

- Regularly pick up and dispose of all garbage and waste material.
- Ensure equipment is working properly.
- Routinely inspect for leaks or conditions that could lead to discharges of chemicals and contact with stormwater:
    - External corrosion and structural failure
    - Installation problems
    - Evidence of spills or overfills
- Locate storage areas away from direct traffic routes.
- Stack waste according to directions to avoid damage due to improper weight distribution.
- Sort out waste to store likes together and separate incompatible wastes.
- Assign hazardous material inventory to a limited number of people.
- Keep up-to-date inventory of all hazardous materials and wastes.
- Identify all chemical substances present at the work site.
- Label all containers with name, hazards, handling, and first-aid information.
- Mark those that require special instructions.
- Immediately clean up liquid or dry material spills.
- Provide initial and annual training for employees on the hazards and the proper handling procedures.
- Do not mix products together unless specifically recommended.
- Do not remove original product label from container.

# Site Design
## Disconnected Impervious Areas

### Description

Any surface in the landscape that cannot effectively absorb or infiltrate rainfall is an impervious area. This includes driveways, roads, parking lots, rooftops, and sidewalks. On natural landscapes, rainfall is absorbed into the soil and vegetation which naturally slow down, spread out, and soak up precipitation and runoff. A stable supply of groundwater is provided from water percolating into the soil, and the runoff is naturally filtered of impurities before it reaches creeks, streams, rivers, and bays.

The amount of impervious cover increases as areas become more developed. Natural filter systems are no longer in place to intercept the runoff which has serious implications for water quality and flood control. Typical pollutants in runoff from impervious areas include pesticides, oil, litter, fertilizers, sediment, salt, and bacteria.

### Targeted Pollutants

- N/A

### Reference Manuals

- IDEQ Storm Water BMP Practices Catalog

### Applications

Impervious areas are mostly found in urban areas. Although it causes damage to watershed, a beneficial way of mitigating stormwater runoff from impervious areas is to direct the runoff from parking lots and roads to pervious and vegetated soils.

### Limitations

Developed areas have a large amount of impervious surfaces which promotes sheet flow of polluted stormwater runoff to stormwater drainage and causes damage to watershed.

### Design Criteria

Ways to mitigate the stormwater runoff at impervious areas include:

- Breaking up flow directions from paved surfaces – where impervious surfaces are designed to allow stormwater to runoff in a dispersed manner in several directions. The drainage of impervious surfaces is pitched onto adjacent vegetated soil and not onto other pavements or into storm sewers.

- Minimize directly connected impervious areas - The impact of impervious surfaces is reduced by minimizing directly connected impervious areas, directing runoff from the impervious areas to pervious areas and/or small depressions, and in the process disconnecting hydrologic flow paths.

- Locating impervious surfaces to drain to natural systems - Existing zones of vegetation, from forested zones to scrub vegetation are used for management of stormwater runoff, often with some sort of landforming to achieve volume control. The scale of this technique can vary from microcontrol by redirecting sidewalk and driveway runoff to adjacent vegetation to conveyance of runoff from larger impervious surfaces to natural areas on the development site.

**Maintenance**

- Sweep impervious areas regularly to collect loose particles and litter. Wipe up spills with rags and other absorbent material immediately, but do not hose down the area to a storm drain.

# Site Design
## Landscape Swale

### Description

The purpose of the swale is to settle out sediment, which has the potential to have urban pollutants bound to the particulate matter. The required length of the swale to settle out particulate pollutants is dependent on multiple factors, including velocity, characteristics of the stormwater, characteristics of the swale, and length of the swale. For the Parking Lot LID program, sizing of swales will be based on minimizing the slope of the swale to minimize the swale length and flow velocities. The design philosophy is that the steeper the slope, the greater the length of swale that is required. Xeriscaped or rock swales can be sized using the standard sizing requirements, as shown in Table 1.

The impervious area of the site for which runoff should be directed toward the swale is the total amount of impervious area onsite, which includes but is not limited to, parking lots, roof tops, parking covers, etc. The swales can be installed either within the parking lot area or at the perimeter of the site.

### Targeted Pollutants

- Sediment
- Total phosphorus
- Trace metals
- Hydrocarbons

### Reference Manuals

The following manuals can be used for designing swales. Where vegetation and grass is used, Xeriscaped or rock shall be used for the Las Vegas Valley.

- County of San Diego SUSMP
- LA County Development Planning for Stormwater Management
- Center for Watershed Protection
- Truckee Meadows Structural Controls Design Manual
- New York State Stormwater Management Design Manual
- City & County of Denver Water Quality Management Plan

### Applications

Landscape swales are typically located in parks, parkways or private landscaped areas and can also be used as pre-treatment devices for other structural treatment controls. It is primarily used as stormwater conveyance systems; however it is limited in its ability to mitigate large storms. Landscape swales are best utilized in low to moderate sloped areas as an alternative to ditches and curb and gutter drainage.

## Limitations

The effectiveness of landscape swales is decreased by compacted soils, frozen ground conditions, short grass heights, steep slopes, large storm events, high discharge rates, high velocities, and a short runoff contact time. Landscape swales also require a sufficient amount of available land area and it may not be appropriate for industrial sites or locations where spills may occur. In areas where burrowing animals are abundant, landscape swales may not perform effectively. Additionally the infiltration rates of local soils can limit the application of landscape swales, unless underdrains are installed. Another possible issue is the formation of mosquito breeding habitat if water does not drain or infiltrate.

## Design Criteria

Table 1 provides minimum criteria for sizing landscaped swales using xeriscaped surface treatments. Sizing was based on maximum desirable flow velocities and sediment settling times.

**Table 1. Standard Sizes for Xeriscaped or Rock Swales**

| Tributary Area (ac) | Swale Slope | Minimum Swale Length (ft) | Size of Swale |
|---|---|---|---|
| ≤0.5 | ≤1% | 30 | 9" deep maximum, 6 ft wide at top average, 4ft wide at top minimum, 4:1 side slope |
| 0.5 - 1.0 | ≤1% | 40 | 9" deep maximum, 6 ft wide at top average, 4ft wide at top minimum, 4:1 side slope |

BMP swales should be as long as practically feasible to provide as much treatment as possible. The minimum length is 30 ft for tributary areas up to 0.5 acres, and 40 ft for tributary areas of up to 1.0 acre. When incorporating swales into landscaping features, tributary areas to individual BMPs should be kept to less than 0.5 acre whenever possible, and should never exceed 1.0 acre unless hydrologic and hydraulic calculations are provided. BMP swales should have a minimum average topwidth of 6 ft, with a minimum topwidth at any point of 4 ft. When combined with a larger flood control facility these dimensions should apply to the portion of the swale carrying low flows. BMP swales should have a maximum flow depth of 9 inches for water quality flows (approximately 2-yr storm). When combined with a larger flood control facility this dimension should apply to the portion of the swale carrying low flows. When lined with rock, landscaped swale BMPs should have a minimum rock size of 3-inch D50. When combined with a larger flood control facility, rock lining should be sized based on the anticipated flood velocities in the facility.

The Developer may propose to use an alternative size swale, if supporting calculations are submitted.

## Maintenance

Remove any sediment or debris build-up when the depths exceed 3 inches. Inspect for pools of standing water. At regular intervals, regrade to restore design grade and revegetate.

Use of heavy equipment for mowing and removing plants/debris should be avoided to minimize soil compaction. Disturbed areas should be stabilized with seed and mulch, or revetment, as necessary.

If a spill occurs and hazardous materials contaminate soils in the swales, the affected areas should be removed immediately and the appropriate soils and materials replaced as soon as possible.

# Site Design
## Depressed Medians

### Description

Medians physically separate traffic travelling in opposite directions on dual carriageway roads. Medians are most effective when it is designed with high visibility during day and night, and contrasts with the traffic lanes.

Medians are most beneficial on arterial roads with four or more traffic lanes. The medians come in the depressed or raised form, or are made flush with the surface of the carriageways. Only the depressed median will be further explored in this fact sheet.

Some safety benefits of medians are that they significantly reduce the risk of collisions by separating opposing traffic streams, provide a recovery area for out-of-control vehicles, provide a stopping area in case of emergencies, minimize the effects of headlight glare, accommodate safety barriers and glare screening and prevents indiscriminate u-turn movements.

For stormwater management purposes, depressed medians are beneficial in reducing stormwater runoff whereby it collects in the depressed median and is carried to a drainage system. They also provide an open green space in urban areas.

Median width is measured between the edges of opposing traffic lanes, including the adjacent offside (right hand) shoulders, if any. See Figure 1. Median widths range from a minimum of 1.2 m in urban areas to 25 m or more in rural areas.

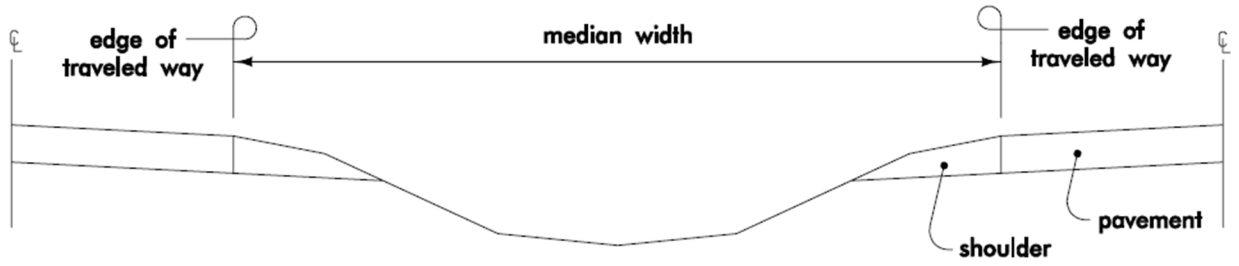



**Figure 1. Depressed Median**
**(Courtesy of Iowa Department of Transportation, Office of Design)**

### Targeted Pollutants

- Nutrients
- Sediment
- Metals
- Hydrocarbons

**Reference Manuals**

- Transit New Zealand – State Highway Geometric Design Manual, Section 6: Cross Section
- Iowa Department of Transportation, Office of Design

**Applications**

In stormwater management applications, depressed medians serve as a means of collecting stormwater run-off from the roads.

**Limitations**

The depressed medians is limited in providing nutrient removal from the stormwater runoff and may even add to the nutrient loading due to landscape material such as wood chips applied to the edges of the depressed medians.

**Design Criteria**

The depressed median configuration has more efficient drainage and is therefore normally used on rural roads. They should also have side slopes which are traversable.

The depressed median side slopes should be traversable and should preferably be ≤1:20; should not exceed 1:10, particularly when a median barrier is installed; and must not exceed 1:6.

Generally, depressed medians should be kept clear of obstructions within the clear zone requirements of the road and need to avoid the use of head walls, unprotected culvert openings, solid sign foundations, non-frangible sign posts and light poles. Where longitudinal culverts are required, eg. under cross overs, the ends facing traffic should be sloped at 1:20 (preferably), no steeper than 1:6, and provided with traversable safety grates. All other drainage inlets should be designed with their tops flush with the ground.

Depressed medians should be designed to ensure that they are as maintenance free as possible. The amount of time that maintenance personnel will be required to spend on the median will be reduced thereby minimizing their exposure to traffic hazards. Planting should consist of xeriscaped species suitable for the Las Vegas Valley. Landscaping design and species selection will depend on the specific circumstances and requires specialist input. Features in medians that limit horizontal sight distance on curves should normally be located such that adequate sight distance is achieved.

**Maintenance**

The depressed median should be inspected at regular intervals and remove and sediment or debris buildup when necessary. Inspect for pools of standing water, regrade to restore design grade and revegetate when necessary. After large storm events, the depressed landscape should be inspected.

# Site Design
## Depressed Landscaping

### Description

Depressed landscaping consists of a low-lying vegetated area underlain by a sand reservoir and an underdrain system. A combination of soils and plants is utilized to remove pollutants from storm water runoff through physical and biological processes for depressed landscaping. A typical depressed landscape design includes a depressed ponding area, topsoil or mulch layer, an engineered soil mix of peat or leaf compost and clean sand, and a gravel sub-base layer with an underdrain system consisting of a perforated HDPE or PVC pipe in a gravel layer. As an option for pre-treatment, a vegetated buffer strip can be added. Designing depressed landscapes with slotted curb or curb cuts slows the velocity of the storm water runoff from small events as it passes through and distributes it evenly along the length of the ponding area. Water ponded to approximately 6 inches gradually infiltrates into the underdrain system, underlying soils or is evapotranspired over a period of days. To divert excess runoff from large events away from the surrounding area, the depressed landscape area should be graded for the flows to move towards the conventional storm drain system.

### Targeted Pollutants

- Sediment
- Nutrients
- Trace metals
- Hydrocarbon

### Reference Manuals

- The Truckee Meadows Structural Controls Design Manual

### Applications

Depressed landscaping may be installed in commercial, residential, and industrial areas. In addition to providing benefits in water quality, the advantages of depressed landscaping are that it improves an area's aesthetics, reduce irrigation needs, and reduce or eliminate the need for an underground storm drain system.

### Limitations

Clogging may be a problem in depressed landscaping, especially in areas with high sediment loads in the runoff.

Sediment controls and fencing should be installed to prevent clogging and compaction of engineered and existing site soils from heavy equipment, if located in the vicinity of active construction sites.

**Design Criteria**

The following design criteria have been adapted from the Truckee Meadows Structural Controls Design Manual. Other BMP manuals may be utilized for further information.

For an efficient depressed landscape, using the appropriate plant species can stabilize banks and increase the infiltration capacity and storm water treatment effectiveness. Sand and gravel must be rinsed with potable water prior to installation and construction of the sand filter since locally available sand and gravel is typically washed with a high pH, recycled wastewater.

The size of the depressed landscape area is a function of the drainage area and the runoff generated from the area. The recommended minimum dimensions of the depressed landscape area are 15 ft wide by 40 ft long. For areas longer than 20 ft, the depressed landscape should be twice as long as they are wide.

To allow infiltration and prevent clogging, a liner such as a woven geotextile fabric layer should be used to mitigate infiltration and the underdrain system. An example of a geotextile fabric to utilize is the SI Corporation Geotex 117F or an approved equivalent should be installed.

Flows in excess of the WQV should drain out of the depressed landscape and flow to another treatment control or the conventional storm drain system.

The following equation is used to determine the ponding depth of the depressed landscape based on the available surface area (SA):

$$\boldsymbol{DWQV = \frac{WQV}{SA} \times 12}$$

Where:

DWQV = ponding depth of the temporary ponded water (ft)
WQV = Water Quality Volume using the method outlined in Section 3.2.2 (ft3)
SA = Surface area of ponding area based on the length and width at the toe of the sideslopes

The maximum recommended ponding depth is 12 inches and minimum ponding depth is 6 inches with water standing no longer than 7 days. This prevents problems with mosquito breeding and certain plants that can't tolerate standing water.

The recommended engineered soil mixture is 50-60 percent clean sand (ASTM 33), 20- 30 percent peat or certified compost with a low P-index, and 20-30 percent topsoil.

The pH of the soil should be between 5.5 and 6.5.

Approximately 3 inches of shredded hardwood mulch should be applied to the area.

A general rule is 1 tree or shrub for each 50 $ft^2$ of landscape detention area.

Plant selection and layout should consider aesthetics, maintenance, native versus non-native invasive species, and regional landscaping practices.

Some trees should be planted on the perimeter to provide shade and shelter.

**Maintenance**

Depressed landscaping should be inspected monthly and after large storm events upon installation. Once the depressed landscaping has proven to work efficiently and vegetation is established, inspections can be reduced to a semi-annual schedule. A health evaluation of the xeriscape and shrubs should be conducted biannually. Replacement of mulch is generally required every two to three years. If ponding is observed for seven (7) consecutive days or longer, cleaning of the underdrain system or replacement of engineered soils may be required. Key maintenance areas include inlet areas, under drain, and overflow structures.

If a spill occurs and hazardous materials contaminate soils in depressed landscaping areas, the affected materials should be removed immediately and the appropriate soils and materials replaced as soon as possible.

# Site Design
## Buffer Strip

### Description

A buffer strip, also known as the vegetative buffer strip is a gently sloping area of vegetative cover that runoff water flows through before entering a stream, storm sewer, or other conveyance. The buffer strip may be an undisturbed strip of natural vegetation or it can be a graded and planted area.

Buffer strips reduce the flow and velocity of surface runoff, promotes infiltration, and reduces pollutant discharge by capturing and holding sediments and other pollutants carried in the runoff water. It acts as a living sediment filter that intercepts and detains stormwater runoff. Buffer strips function much like vegetated or grassed swales, however, they are fairly level and treat sheet flow across them. Whereas grassed swales are indentations that treat concentrated flows running along them.

### Targeted Pollutants

- Sediment

### Reference Manuals

- IDEQ Storm Water BMP Catalog
- The Truckee Meadows Structural Controls Design Manual

### Applications

Buffer strips are usually used in conjunction with other sediment collection and slope protection practices for temporary or permanent control. Consider the use of buffer strips with level spreaders or diversion measures such as earth dikes and slope drains. Also, installing silt fences upgradient can prevent overloading of the buffer strip.

Buffer strips may be placed at in various locations between the source of sediment (road surface, side slopes) and a natural or constructed waterway. They are inexpensive and easily constructed, whereby it can be installed at any time if climatic conditions allow for planting.

Where a site can support vegetation, the buffer strip may be used, , but is best suited for areas where the soils are well drained or moderately well drained and where the bedrock and the water table are well below the surface. Buffer strips also provide low to moderate treatment of pollutants in stormwater while providing a natural look to a site and can provide habitat for wildlife. They can also screen noise and views if trees or high shrubs are planted on the filter strips.

**Limitations**

Buffer strips cannot treat high velocity flows, and do not provide enough storage or infiltration to effectively reduce peak discharges to predevelopment levels for design storms. This lack of quantity control dictates use in rural or low density development.

Buffer strips require a slope less than 5 percent and have a large land requirement. They also require low to fair permeability of natural subsoil and often concentrates water, which significantly reduces its effectiveness. Pollutant removal is unreliable in urban settings. The useful life of a buffer strip may be short due to clogging by sediments and oil and grease.

Buffer strips typically requires supplemental irrigation.

**Design Criteria**

The following design criteria have been adapted from the IDEQ Storm Water BMP Catalog and the Truckee Meadows Structural Controls Design Manual. Other BMP manuals may be utilized for further information.

Registered professional civil engineers and landscape architects should work together on the design vegetated buffer strips. It is recommended that slopes should not be greater than 4 percent (2 to 4 percent is preferred). Maximum drainage area is 5 acres.

Channelized flow across buffer strips should not be permitted; sheet flow is preferred to be maintained across buffer strips. This can be created by installing a level spreader at the top edge of the buffer strip along a contour.

The top of the vegetated buffer strip should be installed 2 – 5 inches lower than the impervious surface that is being drained. If supplemental irrigation is not available, use drought tolerant species in the buffer strip to minimize irrigation in dry climates.

In many cases, a vegetative buffer strip will not effectively control runoff and retain sediments unless employed in conjunction with other control measures. Where heavy runoff or large volumes of sediment are expected, provide diversion measures or other filtering measures above or below the buffer strip.

**Maintenance**

Regularly inspect the buffer strip to ensure it is functioning properly and remove sediments when necessary. Check for damage by equipment and vehicles. For areas which are newly planted, check progress of plant growth.

Ensure additional erosion is not caused by water flowing through the buffer strip and that it is not forming ponds from erosion of the buffer strip. Promptly repair any damage from equipment, vehicles, or erosion.

# Site Design
## Pervious Overflow Parking

### Description

Pervious overflow parking is designed to infiltrate stormwater runoff instead of shedding it off the surface. The advantage of pervious overflow parking is decreasing the effective imperviousness of an urbanizing or redevelopment site, thereby reducing runoff and pollutant loads leaving the site.

Pervious overflow parking can be designed with and without underdrains. Whenever underdrains are used, infiltrated water will behave similarly to interflow and will surface at much reduced rates over extended periods of time. All types of pervious pavement help to return stormwater runoff hydrology to more closely resemble pre-developed conditions. The designer needs to consult with a geotechnical engineer as to the suitability of each type of pervious pavement for the loads and traffic it will support and carry, and the geologic conditions the pavement will rest upon.



**Figure 2. Example of pervious overflow parking. (Courtesy of Urban Storm Drainage Criteria Manual, Urban Drainage and Flood Control District Denver, CO)**

The pervious overflow parking consists of concrete block units with open surface voids laid on a gravel sub-grade with open surface voids. These voids occupy at least 20 percent of the total surface area that are filled with sand (ASTM C-33 sand fine concrete aggregate or mortar sand) or sandy loam turf that has at least 50 percent sand.

The modular block pavement used in pervious overflow parking may be sloped or flat.

### Targeted Pollutants

- Sediment
- Nutrients
- Trace metals
- Hydrocarbons

### Reference Manuals

- The City of Aspen Urban Runoff Management Plan
- Urban Storm Drainage Criteria Manual – Urban Drainage and Flood Control District, Denver CO

- The Truckee Meadows Structural Controls Design Manual

**Applications**

The modular block pavements for pervious overflow parking are best suited for use in low vehicle movement zones, such as roadway shoulders, driveways, parking strips and parking lots. Vehicle movement (i.e., not parking) lanes that lead up to one of these types of porous pavement parking pads may be better served, but not always, by solid asphalt or concrete pavement. The following are potential applications for the pervious overflow parking: low vehicle movement zones, crossover/emergency stopping/parking lanes, residential street parking lanes, and private and public building driveways.

**Limitations**

Pervious overflow parking pavers are less effective and are prone to clogging when used to receive runoff from other areas.

Unless underlying soils are extremely permeable, larger storms will either sheet flow off the site, or if not graded properly, will pond on the site. To address these concerns, the following limitations are recommended from the Truckee Meadows Source Control Manual:

- Not to be applied in heavily trafficked areas or where speeds exceed 30 miles per hour.
- Care must be taken when applying in commercial or industrial areas.
- May become clogged if not properly installed and maintained.
- Maintenance costs can be relatively high if the blocks frequently become clogged with sediment from offsite sources. No additional area drains onto the paver area.
- Porous pavements may cause uneven driving surfaces and may be problematic for high heel shoes.
- May not be suitable for areas that require wheelchair access because of the pavement texture.

**Design Criteria**

Design criteria for pervious pavers are available in various reference manuals and should be designed by registered professional civil engineers. The following are conceptual level design criteria.

Sub-base layers should be capable of bearing an appropriate load without deforming. Block patterns should have a minimum surface area void space of 20 percent. Place the paver blocks tightly against each other on top of the compacted sand leveling course. Before compacting the pavers into place, cut and place paver units to tightly fill spaces between adjacent pavers and the restraining wall at the edges.

## Maintenance

| Maintenance Recommendations for Modular Block Pervious Pavement Required Action | Maintenance Objective and Action | Frequency of Action |
|---|---|---|
| Debris and litter removal | Accumulated material should be removed as a source control measure. | Routine – As needed. |
| Sod maintenance | If sandy loam turf is used, provide lawn care, irrigation system, and inlay depth maintenance as needed. | Routine – As dictated by inspection. |
| Inspection | Inspect representative areas of surface filter sand or sandy loam turf for accumulation of sediment or poor infiltration. | Routine and during a storm event to ensure that water is not bypassing these surfaces on frequent basis by not infiltrating into the pavement. |
| Rehabilitating sand infill surface | To remove fine sediment from the top of the sand and restore its infiltrating capacity. | Routine – Sweep the surface annually and, if need be, replace lost sand infill to bring its surface to be ¼ below the adjacent blocks. |
| Replacement of Surface Filter Layer | Remove, dispose, and replace surface filter media by pulling out turf plugs or vacuuming out sand media from the blocks. Replace with fresh ASTM C-33 sand or sandy loam turf plugs, as appropriate. | Non-routine – When it becomes evident that runoff does not rapidly infiltrate into the surface. May be as often as every two year or as little as every 5 to 10 years. |
| Replace modular block pavement | Restore the pavement surface. Remove and replace the modular pavement blocks, the sand leveling course under the blocks and the infill media when the pavement Surface shows significant deterioration. | Non-routine – When it becomes evident that the modular blocks have deteriorated significantly. Expect replacement every 10 to 15 years dependent on use and traffic. |

# Treatment Control
## Sand / Media Filters

### Description

Sand/media filters are used for filtering stormwater runoff through a sand layer into an underdrain system that conveys the treated runoff to the point of discharge or other stormwater system. The sand/media filters may be configured to be at the surface or if space is a constraint, then an underground sand/media filter is also an option.

A typical sand/media filter contains a two-stage treatment system which includes a pretreatment settling basin and a filter bed containing sand or other filter media. The filters are only designed to treat the water quality capture volume (WQCV) and not the entire storm volume. The WQCV represents the site runoff volume generated from the 85$^{th}$ percentile storm, which is 0.32 inches of rainfall in the McCarran Airport Rainfall Area.

There are a number of sand/media filter configurations but there are four basic components which most contain and is shown schematically in **Figure 1**.

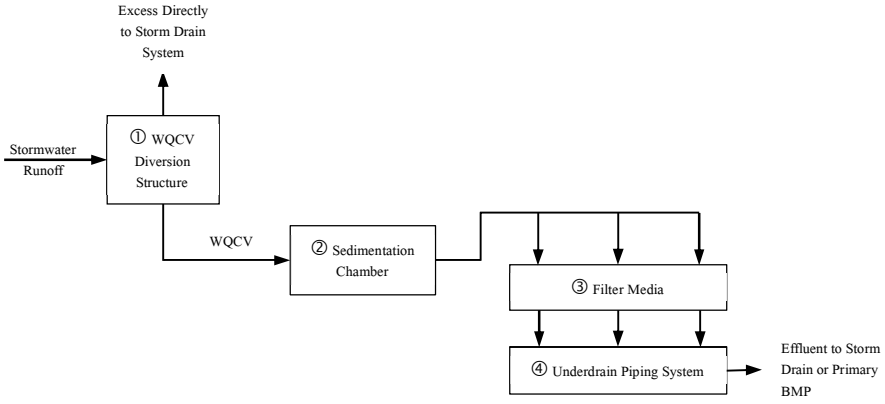
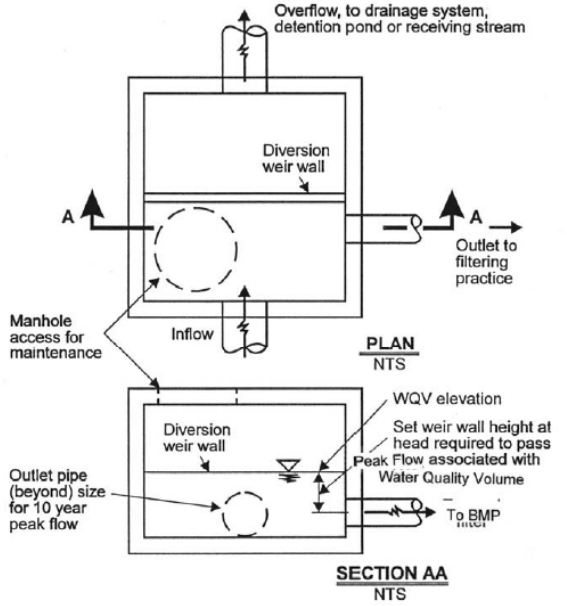



**Figure 1. Schematic of a typical sand filter.**
**(Courtesy of Los Angeles County Department of Public Works)**

- Diversion Structure – This directs the WQCV to the filter and bypasses the overflow directly to the point of discharge or other stormwater system. It is either incorporated into the filter itself or is a stand-alone device. Refer to **Figure 2**.
- Sedimentation Chamber – The removal of large grained sediments prior to exposure to the filter media is important to the long-term successful operation of any filtration system. The sedimentation chamber is typically integrated directly into the sand filter BMP but can also be a stand-alone unit if space permits.
- Filter Media – Typically consists of a 1-inch gravel layer over an 18 to 24 inch layer of washed sand. A layer of geotextile fabric can be placed between the gravel and sand layers.
- Underdrain System – Below the filter media is a gravel bed, separated from the sand by a layer of geotextile fabric, of which a series of perforated pipes is placed. The treated runoff is routed out of the BMP to the downstream stormwater facility.




**(Courtesy of Chesapeake Research Consortium)**

The sand/media filtering systems are generally applied to land uses with a high percentage of impervious surfaces which make these BMPs suitable for the parking lot LID program.

Common sand/media filter alternatives are the surface sand filter, underground sand filter, perimeter sand filter and the organic filter. These alternatives are illustrated in **Figures 3** through **6**. Each were developed and adapted by various governments and engineers to serve different water quality treatment goals or to accommodate different physical constraints. In addition to the filter alternatives described, there may be other alternative configurations which may also be useful for different land use applications or climatic conditions.

## Surface Sand Filter

The surface sand filter, shown in **Figure 3**, consists of a flow splitter used to divert the WQCV into an off-line sedimentation chamber. The chamber may be either wet or dry and is used for pretreatment; however, in the Las Vegas Valley, the chamber should be a dry chamber. Coarse sediments drop out as the runoff velocities are reduced. Runoff is then distributed into the second chamber, which consists of an 18 inch deep sand filter bed and temporary runoff storage above the bed. Pollutants are trapped or strained out at the surface of the filter bed. The filter bed surface may have sand or grass cover. An underdrain system consisting of a series of perforated pipes located in a gravel bed collects the runoff passing through the filter bed, and conveys it to the point of discharge or other stormwater system. If underlying soils are permeable and groundwater contamination unlikely, the bottom of the filter bed may have no lining, and the filtered runoff may be allowed to percolate into the ground. (Note: In Las Vegas Valley, special geotechnical studies are required if infiltration is used to dispose of stormwater.)

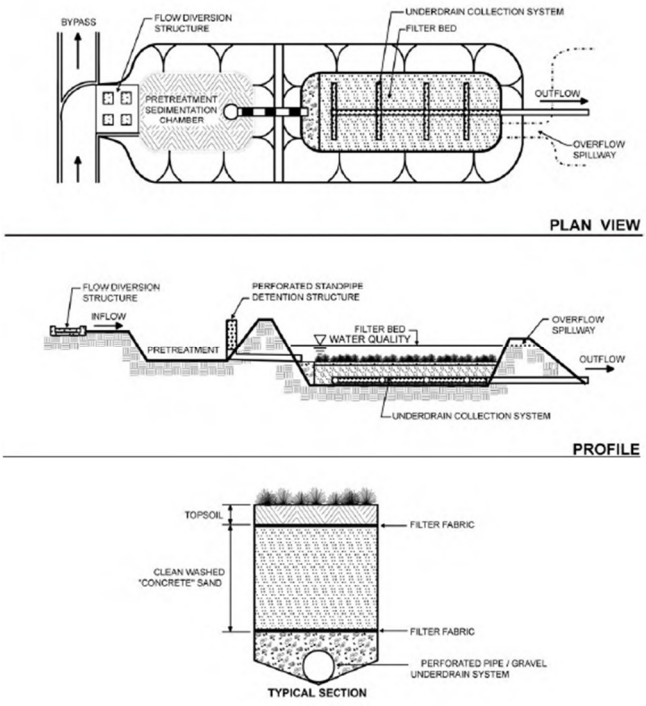



**Figure 3. Surface Sand Filter**
**(Courtesy of Chesapeake Research Consortium)**

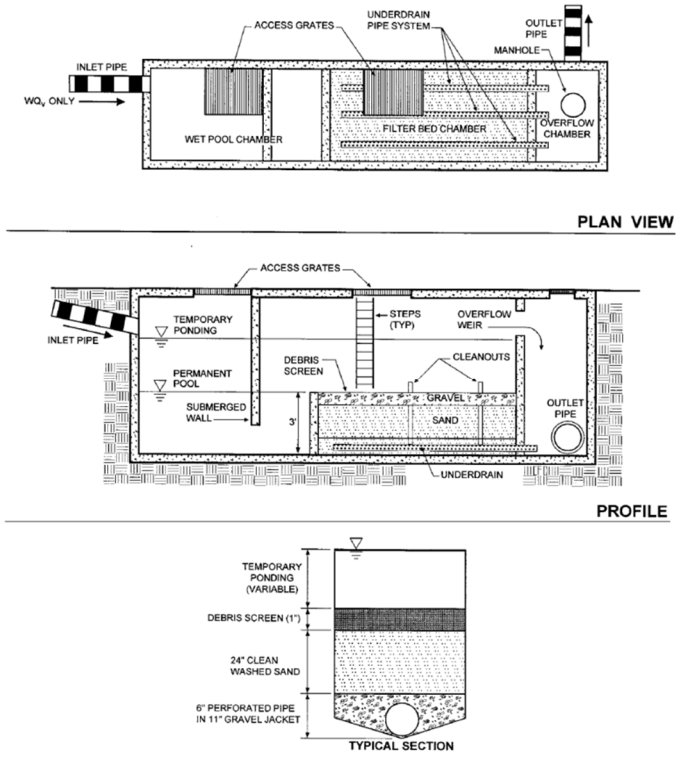



**Figure 4. Underground Sand Filter**
**(Courtesy of Chesapeake Research Consortium)**

## Underground Sand Filter

The underground sand filter was adapted for sites where space is at a premium. In this design, the sand filter is placed in a three chamber underground vault accessible by manholes or grate openings (**Figure 4**). The vault can be either on-line or off-line in the storm drain system. The first chamber is used for pretreatment and relies on a wet pool as well as temporary runoff storage. It is connected to the second sand filter chamber by an inverted elbow, which keeps the filter surface free from trash and oil. The filter bed is 18 inches in depth and may have a protective screen of gravel or permeable geotextile to limit clogging. During a storm, runoff is temporarily stored in both the first and second chambers. Flows in excess of the filter's capacity are diverted through an overflow weir. Filtered runoff is collected using perforated underdrains that extend into the third "overflow" chamber.

## Perimeter Sand Filter

The perimeter sand filter consists of two parallel trench-like chambers that are typically installed along the perimeter of a parking lot (**Figure 5**). Parking lot runoff enters the first chamber which has a shallow permanent pool of water. The first trench provides pretreatment before the runoff spills into the second trench, which consists of an 18 inch deep sand layer. During a storm event, runoff is temporarily ponded above the normal pool and sand layer, respectively. When both chambers fill up to capacity, excess parking lot runoff is routed to a bypass drop inlet. The remaining runoff is filtered through the sand, and collected by underdrains and delivered to the point of discharge or other stormwater system.

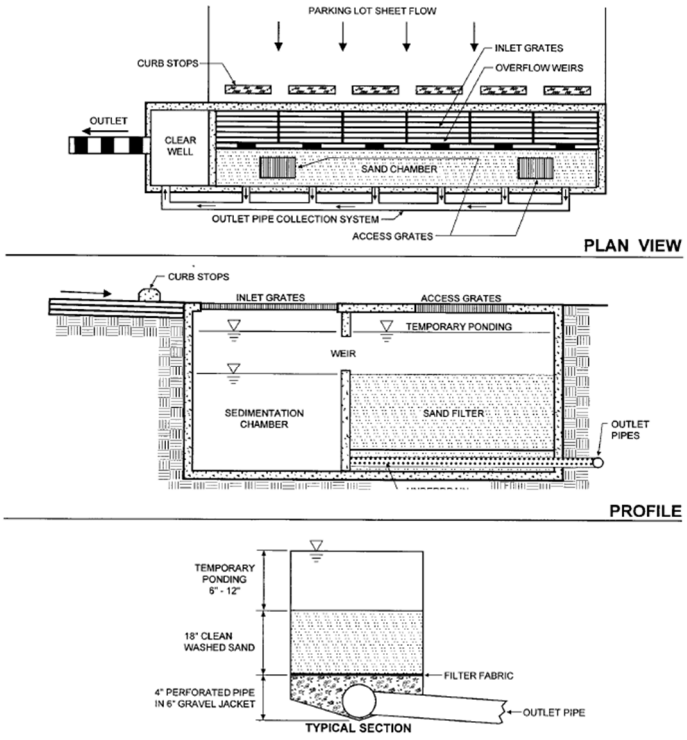



**Figure 5. Perimeter Sand Filter**
**(Courtesy of Chesapeake Research Consortium)**

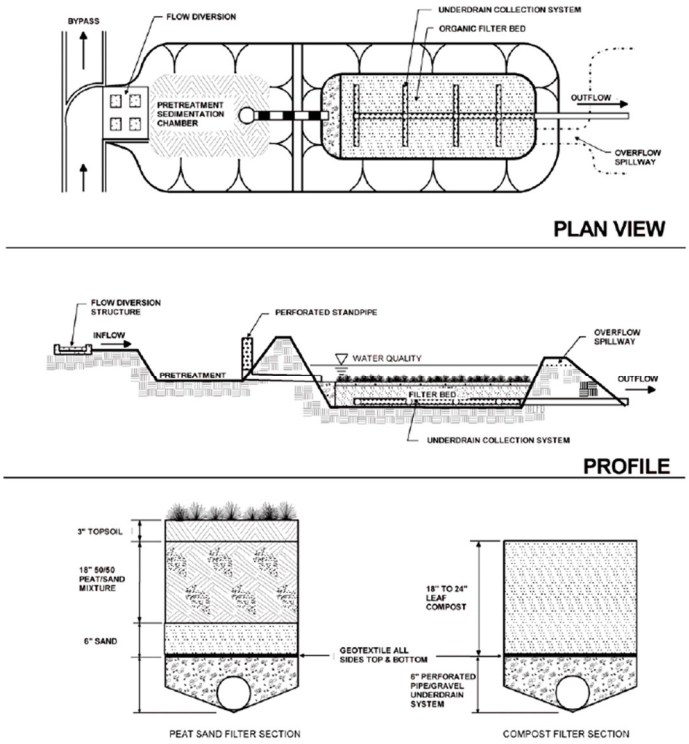



**Figure 6. Organic Filter**
**(Courtesy of Chesapeake Research Consortium)**

## Organic Filter

The organic filter functions the same as a surface sand filter design, with the exception that it uses compost or peat/sand as the filter media. The basic design of an organic filter is shown in **Figure 6**. A flow splitter diverts runoff into a pretreatment chamber, and then runoff passes into a series of filter cells. Each filter bed contains an 18 inch layer of compost or peat, underlain by a filter fabric, and six inches of perforated pipe and gravel. Runoff filters through the organic media and is then collected by a perforated pipe and directed toward the outlet. In most organic filters, the filter bed and subsoils are separated by impermeable polyliner to prevent movement into groundwater.

## Reference Manuals

The following manuals can be used for designing sand/media filters.

- LA County Development Planning for Stormwater Management
- New York State Stormwater Management Design Manual
- Design of Stormwater Filtering Systems for Chesapeake Research Consortium.
- County of San Diego SUSMP
- Catalog of Stormwater Best Management Practices for Idaho Cities and Communities, Idaho Department of Environmental QualityCalifornia Stormwater BMP Handbook by California Stormwater Quality Association (CASQA)

## Targeted Pollutants

The following pollutants are typically removed by the sand/media filters. This list is from the IDEQ Storm Water BMP Catalog.

- Sediment
- Phosphorus
- Trace metals
- Bacteria
- Hydrocarbons

## Applications

The following recommendation in the application of the sand/media filter is adapted from the IDEQ Storm Water BMP Catalog.

Sand filters generally take up little space and can be added to retrofit existing sites. They can also be used on highly developed sites and sites with steep slopes. It is not recommended where high sediment loads are expected, unless pre-treatment (e.g. sedimentation chamber) is provided since the fine sediment clogs sand filters, or where the runoff is likely to contain high concentrations of toxic pollutants (e.g. heavy industrial sites).

Where there is smaller drainage areas, sand/media filtration trenches are used rather than sand filtration basins. A trench is typically placed along the perimeter of a parking lot. Trenches have experienced fewer problems with clogging than basins, perhaps because their use in the field has been limited to high-impervious cover sites where less suspended solids are generated.

Sand/media filters are effective at removing total suspended solids with moderate removal effectiveness for total phosphorus. This is due to the physical straining, pollutant settling and pollutant adsorption to remove pollutants.

Basins should be located off-line from the primary conveyance/detention system where possible and should be preceded by a pre-treatment sedimentation chamber in order to improve the effectiveness of sand filtration basins and to protect the media from clogging. Additionally, disturbed areas that contribute to sediments accumulating in the drainage area should be identified and stabilized. Sand/media filters should never be used as sediment basins during construction because of the potential for clogging. Smaller filters, such as a sand filtrations trench in a parking lot, can be installed on-line.

In areas with high water table conditions and the possibility of groundwater contamination, liners are recommended for trenches and basins. Depending on agency approval, sand/media filtration may be a substitute for API and CPS-type oil/water separators (which are described in the Oil/Water Separators Fact Sheet) to remove oil from runoff.

## Limitations

The following limitations are adapted from the California Stormwater BMP Handbook.

Sand/media filters may be more expensive to construct than many other BMPs. It may also require more maintenance than some other BMPs depending upon the sizing of the filter bed. They generally require more hydraulic head to operate properly (minimum 4 feet). A high solids load will cause the filter to clog. Sand/media filters work best for relatively small, impervious watersheds. It can present aesthetic and safety problems if constructed with vertical concrete walls in residential areas. Some designs may maintain permanent sources of standing water where mosquito and midge breeding is likely to occur.

**Design Criteria**

The following is the design criteria for sand/media filters, according to the Truckee Meadows Structural Controls Design Manual. Other BMP Manuals may also be utilized to size the facility.

- Registered professional civil engineers should design the underground sand filters.
- The locally available sand and gravel is typically washed with a high pH, recycled wastewater. (Sand and gravel must be rinsed with potable water prior to installation and construction of the sand filter.)
- The structure to detain the WQCV is to be designed based on the method presented in the Hydrology TM.
- Flows in excess of the WQCV should be diverted around the underground sand filter with an upstream diversion structure.
- The maximum allowable depth of water in the underground sand filter ($h_{max}$) is determined by considering the difference between the inlet and outlet invert elevations.
- The sand filter layer should consist of a minimum 16-inch gravel bed ($d_g$) covered with a minimum 18-inch sand filter layer ($d_s$) and a minimum 2-inch gravel layer above the sand filter layer. Geotextile fabric liners should be placed between the sand and gravel layers (e.g. above and below the sand layer).
- A woven geotextile fabric layer such as SI Corporation Geotex 117F or equal should be installed between the sand filter and the gravel under drain.
- The top of the sand and gravel filter should not have any slope or grade.

In order to size a sand/media filter bed two major underground filter types can be considered, the D.C. and Delaware.

The required bed area for the D.C. type underground sand filter is calculated using the following equation:

$$\boldsymbol{A_f = \frac{(WQCV)\,(d_f)}{(k)(h_f + d_f)(t_f)}}$$

Where:
- $A_f$ = Surface area of filter bed ($ft^2$)
- WQCV = Water Quality Control Volume (cf)
- $d_f$ = Filter bed depth ($d_f=d_g+d_s$) (ft)
- k = Coefficient of permeability for the sand filter (typically 1.18 ft/hr for clean, well graded sand with $d_{10}$ = 0.1 mm (ft/hr)
- $h_f$ = Average height of water above filter bed or one half of the maximum allowable water depth ($2h_f$) over the filter bed ($2h_f=h_{max}-d_f$) (ft)
- $t_f$ = Design filter bed drain time or the time required for the WQCV to pass through the filter in hrs (Max: 48 hours) (hrs)

- Considering site constraints, assume a filter width ($W_f$) and calculate the filter length ($L_f$) using:

$$L_f = \frac{A_f}{W_f}$$

- Determine the volume of storage available above the filer bed using:

$$V_{tf} = A_f * 2h_f$$

- Compute the storage volume of the filter voids ($V_v$) by assuming a 40% void space and using:

$$V_v = 0.4A_f * d_f$$

- Compute the flow through the filter during filling assuming 1 hour to fill the voids using:

$$V_q = k * \frac{A_f(d_f+h_f)t_f}{d_f}$$ (assume k = 0.0833 ft/hr and $t_f$ = 1 hr)

- Compute net volume to be stored in the permanent pool awaiting filtration using:

$$V_{st} = WQCV - V_{tf} - V_v - V_q$$

- Compute the minimum length of the permanent pool using:

$$L_{pm} = \frac{V_{st}}{2h_f * W_f}$$

Furthermore, the following design criteria are applicable to the D.C. type underground sand filter:

| ***Parameter*** | ***Design Criteria*** |
|---|---|
| Maximum drainage area | 1.5 acres |
| Filter sand size | Concrete sand (Sec. 200.05.04 SSPWC*) |
| Typical sand coefficient of permeability (k) for sand with $D_{max}$=10 mm and Effective Size $D_{10}$=0.1 mm | 1.18 ft/hr** |
| Maximum diameter of gravel in upper gravel layer | 1 in, Class C backfill (Sec. 200.03.04 SSPWC*) |
| Diameter of gravel in under drain gravel layer | ½ to 1 in, Class B or C backfill (Sec. 200.03.03 & 200.03.04 SSPWC*) |
| Minimum size of under drain pipes | 6-in Schedule 40 PVC |
| Minimum size of perforations in under drain pipes | 3/8-in diameter |
| Minimum number of perforations per under drain pipe | 6 |
| Minimum spacing of perforations | 6 in |
| Maximum spacing of under drain pipes | 27 in center to center |
| Minimum volume of sediment chamber | 20% of the WQCV |
| Minimum length of the clearwell chamber | 3 ft |

*SSPWC: Standard Specifications for Public Works Construction
**USCOE, 2001 EM 1110-2-1100 Part VI

The required bed area for the Delaware type underground sand filter is calculated as follows:

- When the maximum ponding depth above the filter ($2h_f$) is less than 2.67 feet, the area of the sediment chamber ($A_s$) and the area of the filter chamber ($A_f$) can be found using the following equation:

$$\boldsymbol{A_s = A_f = \frac{WQCV}{4.1h_f + 0.9}}$$

- When the maximum ponding depth above the filter ($2h_f$) is 2.67 feet or greater, use the following equation:

$$\boldsymbol{A_s = A_f = \frac{WQCV * d_f}{k(h_f + d_f)}}$$

- Establish the dimensions of the facility assuming sediment chambers ($A_s$) and filter chambers ($A_f$) are typically 18 to 30 inches wide. Use of standard grates requires a chamber width of 26 inches.

The following table summarizes important design criteria that apply to the Delaware type underground sand filter:

| ***Parameter*** | ***Design Criteria*** |
|---|---|
| Maximum drainage area | 5 acres |
| Filter sand size | Concrete sand (Sec. 200.05.04 SSPWC*) |
| Typical sand coefficient of permeability (k) for sand with $D_{max}$=10 mm and Effective Size $D_{10}$=0.1 mm | 1.18 ft/hr** |
| Maximum diameter of gravel in upper gravel layer | 1 in, Class C backfill (Sec. 200.03.04 SSPWC*) |
| Diameter of gravel in under drain gravel layer | ½ to 1 in, Class B or C backfill (Sec. 200.03.03 & 200.03.04 SSPWC*) |
| Weir height between sedimentary chamber and sand filter | 2 in above filter bed |
| Minimum size of under drain pipes | 6-in Schedule 40 PVC |
| Minimum size of perforations in under drain pipes | 3/8-in diameter |
| Minimum number of perforations per under drain pipe | 6 |
| Minimum spacing of perforations | 6 in |
| Minimum weephole diameter | 3 in |
| Minimum spacing between weepholes | 9 in – center to center |
| Sedimentation chamber and sand filter trench width | 18 to 30 in |

*SSPWC: Standard Specifications for Public Works Construction
**USCOE, 2001 EM 1110-2-1100 Part VI

**Maintenance**

The following guidelines for inspection and maintenance of sand filters have been adapted from the IDEQ Storm Water BMP Catalog.

Inspection Schedule:

Inspect the sand filters at least annually. Additionally, the observation well in a filtration trench should be monitored for water quality periodically. For the first year after completion of construction, the well should be monitored after every large storm (greater than 1 inch in 24 hours). A logbook should be maintained by the responsible person designated by the owner indicating the rate at which the facility dewaters after large storms and the depth of the well for each observation. Once the performance characteristics of the structure have been verified, the monitoring schedule can be reduced to an annual basis unless the performance data indicate that a more frequent schedule is required.

Sediment and Debris Removal:

Sediment build-up in the top foot of stone aggregate or the surface inlet should be monitored on the same schedule as the observation well. A monitoring well in the top foot of stone aggregate should be required when the trench has a stone surface. Sediment deposits should not be allowed to build up to the point where they will reduce the rate of infiltration into the device. As a general rule, remove silt when accumulation exceeds 0.5 inch and remove accumulated paper, trash and debris every 6 months or as necessary.

Sand Media Rehabilitation and Replacement:

Over time, a layer of sediment will build up on top of the filtration media that can inhibit the percolation of runoff. Experience has shown that this sediment can be readily scraped off during dry periods with steel rakes or other devices. Once sediment is removed, the design permeability of the filtration media can typically be restored by then forming grooves on the surface layer of the media. Eventually, however, finer sediments that have penetrated deeper into the filtration media will reduce the permeability to unacceptable levels, thus necessitating replacement of some or all of the sand. The frequency in which the sand media should be replaced is not well established and will depend on the suspended solids levels entering the system. Drainage areas that have disturbed areas containing clay soils will likely necessitate more frequent replacement. Properly designed and maintained sand filtration BMPs in arid climates have been found to function effectively, without complete replacement of the sand media, for at least 5 years and should have design lives of 10 to 20 years.

# Treatment Control
## Oil / Water Separators

### Description

Oil/water separators remove oil and other water insoluble hydrocarbons and settleable solids from stormwater runoff. Variations of this device include the Spill Control (SC), American Petroleum Institute (API) and the Coalescing plate (CP).

For the purposes of the parking lot LID program, the SC device (shown in **Figure 1**) is likely to be sufficient and these types of separators are the least expensive and complex of the three. The SC device is a simple underground vault or manhole with a "T" outlet designed to trap small spills.

The owner of the site may elect to use an API or CP device; however, details of these devices are not included in this fact sheet.

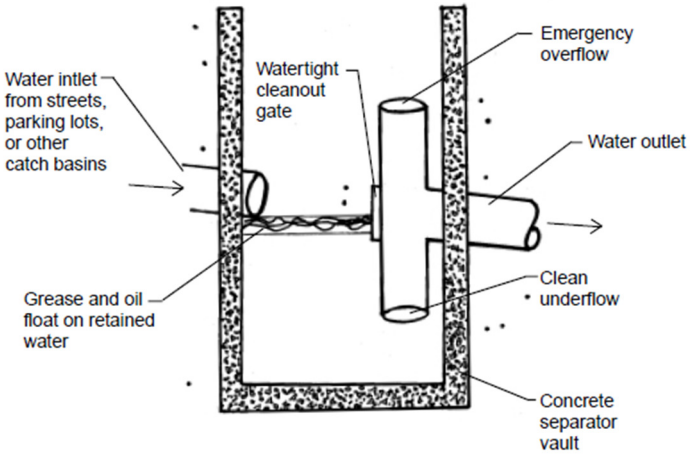



**Figure 7. Spill Control type oil/water separator (Courtesy of IDEQ Storm Water BMP Catalog)**

### Targeted Pollutants

- Sediment
- Phosphorus
- Trace metals
- Hydrocarbons
- Small floatables

### Reference Manuals

The following manuals can be used for designing oil/water separators:

- Catalog of Stormwater Best Management Practices for Idaho Cities and Counties by the Idaho Department of Environmental Quality
- City of Tacoma Stormwater Management Manual (SWMM), 2012 Edition

### Applications

Oil/water separators have limited application in stormwater treatment. These treatment mechanisms are generally not well suited for stormwater runoff with high discharge rates, turbulent flow regime, low oil concentration or high suspended solids concentration. The primary use of oil/water separators will be in cases where oil spills are a concern or areas where oil and grease can accumulate, such as high traffic areas and parking lots. Oil/water separators should be located offline from the primary stormwater system. The contributing drainage area should be completely impervious and as small as necessary to contain the sources of oil. Under no circumstances should any portion of the contributing drainage area contain disturbed pervious areas that can be sources of sediment.

## Limitations

The following limitations are adapted from the IDEQ Storm Water BMP Catalog.

- Drainage area- 1 ac.
- Minimum bedrock depth – 8 ft
- NRCS soil type – A, B, C
- Drainage/flood control – no
- Max site slope – 15%
- Minimum water table – 8 ft
- Freeze/thaw - fair

## Design Criteria

The oil/water separator inflow design flow rate should be calculated using the hydrologic design criteria for parking lot BMPs for Las Vegas Valley. Oil/water separators should be installed upstream of any pumps to prevent oils from emulsifying and also upstream of any other stormwater treatment facility. Stormwater from building rooftops and other impervious surfaces are not likely to be contaminated by oil and should not be discharged to the separator. Appropriate removal covers should be provided to allow access for observation and maintenance.

To size the oil water separator, consideration needs to be given on the wide distribution of sizes of the oil droplets in water. The oil/water separator is a propriety product which is sized to remove droplets of various sizes. Sizing of the oil/water separator is per the manufacturer's sizing requirements. Refer to manufacturer's guidelines to determine a suitable product for specific site.

## Maintenance

Oil/water separators should be cleaned frequently to keep accumulated oil from escaping during storms. As a general rule, they should be cleaned annually at a minimum to remove material that has accumulated, and again after any significant storm (i.e., 1 inch of rainfall within a 24 hour period).

General maintenance procedures should include the following:

- Weekly inspections of the facility by the owner.
- Replacement of the oil absorbent pads at least every 6 months, before both rainy seasons (July and December), or as needed.
- During cleaning operations, the effluent shutoff valve is to be closed.
- Dispose of waste oil and residuals in accordance with current local government health department requirements.
- Any standing water removed during the maintenance operation should be disposed to a sanitary sewer through an approved pretreatment device at a discharge location approved by the local government.
- Any standing water removed should be replaced with clean water to prevent oil carry-over through the outlet weir or orifice.

# Treatment Control
## Oil & Grit Separators

### Description

Oil/grit separators are underground storage tanks with three chambers designed to remove heavy particulates, floating debris and hydrocarbons from stormwater, see **Figure 8**. Stormwater enters the first chamber where heavy sediments and solids drop out. The flow moves into the second chamber where oils and greases are removed and further settling of suspended solids takes place. Oil and grease are stored in this second chamber for future removal. After moving into the third outlet chamber, the clarified stormwater runoff is then discharged to a pipe and onto a point of discharge or other stormwater system.

### Targeted Pollutants

- Sediment
- Nutrients
- Trace metals
- Phosphorus
- Hydrocarbons
- Small floatables

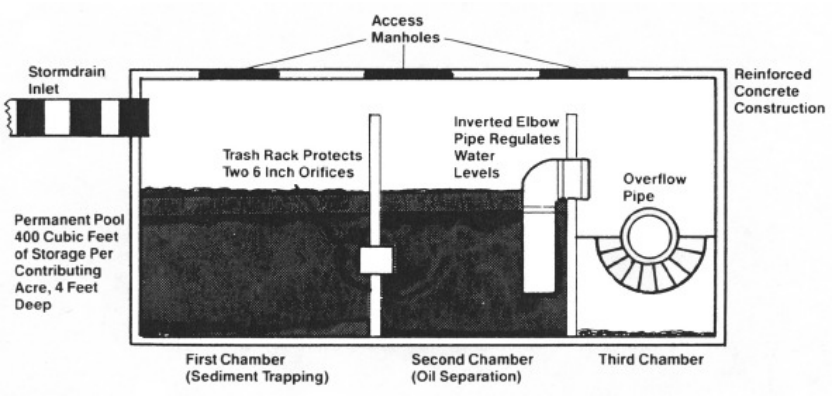



**Figure 8. Oil & grit separator**
**(Courtesy of Minnesota Urban Small Sites BMP Manual)**

### Reference Manuals

The following manuals can be used for designing oil/grit separators:

- Structural BMP Specifications for the Massachusetts Stormwater Handbook
- Georgia Stormwater Management Manual, Vol. 2 Technical Handbook
- Minnesota Urban Small Sites BMP Manual
- Knox County Tennessee Stormwater Management Manual

### Applications

Oil/grit separators are best used in commercial, industrial and transportation land uses and are intended primarily as a pretreatment measure for high-density or urban sites, or for use in hydrocarbon hotspots, such as parking lots, gas stations and areas with high vehicular traffic. However, gravity separators cannot be used for the removal of dissolved or emulsified oils and pollutants such as coolants, soluble lubricants, glycols and alcohols.

Since resuspension of accumulated sediments is possible during heavy storm events, gravity separator units are typically installed off-line. One of the most important selection criteria when considering an oil-grit separator is the long-term maintenance and operation costs, and the need for

regular inspections and cleanout. Inspection and maintenance needs for such systems can be considered high relative to other stormwater BMPs. Therefore, the oil-grit separator system should only be constructed if the property owner or tenant of the site has both the physical and fiscal ability to perform regular inspection and maintenance of the system on a long-term basis.

Oil/grit separators are available as prefabricated proprietary systems from a number of different commercial vendors. One example of a prefabricated system is the Stormceptor® system, see **Figure 9**. This product referenced is not the only product available, nor should its presence in this manual be construed as an endorsement of these products. It is merely shown as a manufactured oil/grit separator that is known to be available from vendors.

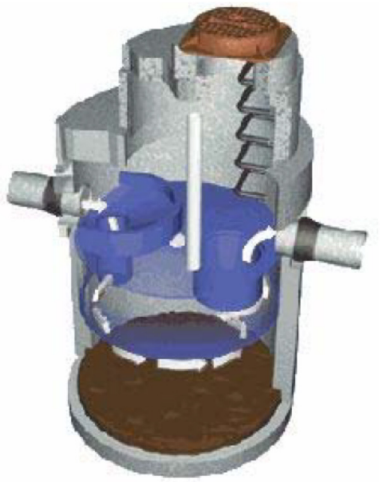


**Figure 9. Stormceptor® Oil/Grit Separator (Courtesy of CalTrans Treatment BMP Technology Report)**

The Stormceptor® is primarily installed for filtration and for small drainage areas. It is a precast concrete structure with a fibreglass insert which extends into the treatment chamber to provide dual wall containment of hydrocarbons. This system may be used in place of a traditional inlet structure upstream of a conventional treatment device in small drainage areas.

## Limitations

The oil/grit separator cannot effectively remove soluble pollutants, fine particles, or bacteria and can become a source of pollutants due to resuspension of sediment unless properly maintained. During large storms it is susceptible to flushing and is limited to being installed in relatively small contributing drainage areas of one acre or less of impervious cover. The oil/grit separator may be expensive to install and maintain compared to other BMPs. This is usually installed where the cost of land would be prohibitive or where resources are sensitive or valuable. Frequent maintenance is necessary and it requires proper disposal of trapped sediments and oils. It may also be an entrapment hazard for amphibians and other small animals

## Design Criteria

Sizing of the oil/grit separator is per the manufacturer's sizing requirements. Refer to manufacturer's guidelines to determine a suitable product for specific site.

The following is general outline of the design criteria to size a conventional oil/grit separator according to the Knox County Tennessee Stormwater Management Manual. Other BMP Manuals may be utilized to size the facility; however, guidance provided below should be used to determine the WQCV.

Step 1

Calculate the WQCV based on the methods described for hydrologic design of parking lot BMPs in Las Vegas Valley.

Step 2

Calculate the rise velocity of oil droplets using Stokes Law:

$$V_p = \frac{1.79\times10^{-8}(S_w - S_p)D_p^2}{N}$$

Where:

- $V_p$ = Upward rise velocity of petroleum droplet (ft/s)
- $S_w$ = Specific gravity of water (0.998 to 1.000)
- $S_p$ = Specific gravity of the petroleum droplet (typically 0.85 – 0.95)
- $D_p$ = Diameter of petroleum droplet to be removed (microns)
- N = Absolute viscosity of water (poises)

The expected temperature is generally chosen for cold winter months. Typical values for the specific gravity and absolute viscosity of water at various temperatures are shown in the following table:

| *Temperature* | $S_w$ | *N* |
|---|---|---|
| 32°F | 0.999 | 0.01794 |
| 40°F | 1.000 | 0.01546 |
| 50°F | 0.999 | 0.01310 |
| 60°F | 0.999 | 0.01129 |
| 70°F | 0.998 | 0.00982 |

Step 3

Calculate the size of the oil/grit separator:

$$D = \left(\frac{Q}{RV_H}\right)^{0.5}$$

$$W = RD$$

$$L = \frac{V_H D}{V_p}$$

$$V_H = \frac{V_p D}{L} = 15(V_p)$$

Where:

- D = Depth of unit (ft), generally between 3 and 8 ft
- W = Width of unit (ft), usually twice the depth
- L = Total Length of unit (ft), usually fifteen times the depth
- Q = Design flow rate (cfs), i.e., the WQCV
- R = Width to depth ratio, generally a value of 2 is recommended
- $V_H$ = Allowable horizontal velocity (ft/s), maximum 0.05 ft/s

$V_p$ = Upward rise velocity of petroleum droplet (ft/s)

- The total depth shall be adjusted by adding 1 foot of freeboard to the depth calculated using the equations above, or equations provided by a manufacturer.

- Top baffles should extend downward by 0.85D, and bottom baffles should extend upward by 0.15D, where D is the depth of the unit (in feet). The distribution baffle should be located at a distance of 0.10L from the inlet of the unit, where L is the length of the unit (in feet).

The following are general design criteria to consider when designing an oil/grit separator.

Location and Siting

- Any individual oil/grit separator shall have a contributing drainage area no greater than 1 acre.
- It is desirable to maintain reasonable dimensions by bypassing larger storm flows in excess of the design flow rates. It is preferred that oil-grit separators be located off-line where a separator can use an existing or proposed manhole with a baffle or other control.
- Oil/grit separator systems can be installed in almost any soil or terrain. Since these devices are underground, appearance is not an issue and public safety risks are low.
- The design loading rate for oil/grit separators is low; therefore, they can only be cost-effectively sized to detain and treat the WQCV. It is usually not economical or feasible to size an oil/grit separator to treat large design storms. Oil/grit separators require frequent maintenance for the life of the separator unit. Maintenance can be minimized (and performance can be increased) by careful planning and design, particularly upstream and downstream of the separator unit.

Physical Specifications/Geometry

- Design procedures for commercially available oil/grit separators are usually given by the manufacturer in simplified tables or graphs based on field testing and observed pollutant removal rates. Oil-grit separators must be constructed with watertight joints and seals.

- The separation chamber shall provide for three separate storage volumes, as follows:
  (1) A volume for separated oil storage at the top of the chamber;
  (2) A volume for settleable solids accumulation at the bottom of the chamber; and,
  (3) A volume required to give adequate flow-through detention time for separation of oil and sediment from the stormwater flow.
- Ideally, a gravity separator design will provide an oil draw-off mechanism to a separate chamber or storage area. This design is required where a gravity separator is utilized to treat oil, grease and/or petroleum hotspots.
- Oil/grit separators are typically designed to bypass runoff flows in excess of the WQCV peak flow. Some designs have built-in high flow bypass mechanisms, whereas others require

a diversion structure or flow splitter located upstream of the device in the drainage system. Bypass mechanisms must minimize potential for captured pollutants from being washed-out or resuspended by large flows.

- Regardless of the bypass mechanism, an adequate outfall/outlet must be provided for both the discharge from the separator itself, and the bypassed discharge. Runoff shall be discharged in a non-erosive manner.
- The device shall be designed such that the velocity through the separation chamber does not exceed the entrance velocity.
- A trash rack shall be included in the design to capture floating debris, preferably near the inlet chamber to prevent debris from becoming oil impregnated.
- The total wet storage of the gravity separator unit shall be no less than 400 cubic feet per contributing impervious acre.

Manufactured Oil/Grit Separators

Manufactured separators should be selected on the basis of good design, suitability for the desired pollution control goals, durabilty, ease of installation, ease of maintenance, and reliability. Manufacturers generally provide design methods, installation guidelines, and proof of effectiveness for each application where used. These structures tend to include innovative methods of providing high flow bypass. However, it is incumbent upon the landowner to carefully investigate the suitability and overall trustworthiness of each manufacturer and/or subcontractor.

**Maintenance**

Sediments and associated pollutants and trash are removed only when inlets or sumps are cleaned out, so regular maintenance is essential. Most studies have linked the failure of oil/grit separators to the lack of regular maintenance. The more frequent the cleaning, the less likely sediments will be resuspended and subsequently discharged. In addition, frequent cleaning also makes more volume available for future storms and enhances overall performance. Cleaning includes removal of accumulated oil and grease and sediment using a vacuum truck or other ordinary catch basin cleaning device. In areas of high sediment loading, inspect and clean inlets after every major storm. At a minimum, inspect oil/grit separators monthly, and clean them out at least twice per year. Polluted water or sediments removed from an oil grit separator should be disposed of in accordance with all applicable local, state and federal laws and regulations.

# Treatment Control
## On-Site Water Quality Basin

### Description

On-site water quality basins are depressed basins that can be utilized in the Las Vegas Valley to detain a portion of stormwater runoff following a storm event. See **Figure 10**. Water is controlled by means of a hydraulic control structure to restrict outlet discharge. General objectives of on-site water quality basins are to remove particulate pollutants and to reduce maximum runoff values associated with development to their pre-development levels. Water quality basins may be berm-encased areas, excavated basins, or tanks.

On-site water quality basins do not maintain a permanent pool between storm events. A micropool is not necessary and likely cannot be sustained in arid conditions of Las Vegas Valley.

Outlets are designed to detain the volume of a water quality design storm for a minimum of 24 hours and a maximum of 72 hours to allow for the settling of particles and associated pollutants. In addition, on-site water quality basins provide flood control by either including additional temporary storage for peak flows above the WQCV or providing provisions for peak flows to pass through the outlet structure. On-site water quality basins are designed to detain and treat runoff from the smaller more frequent runoff events.

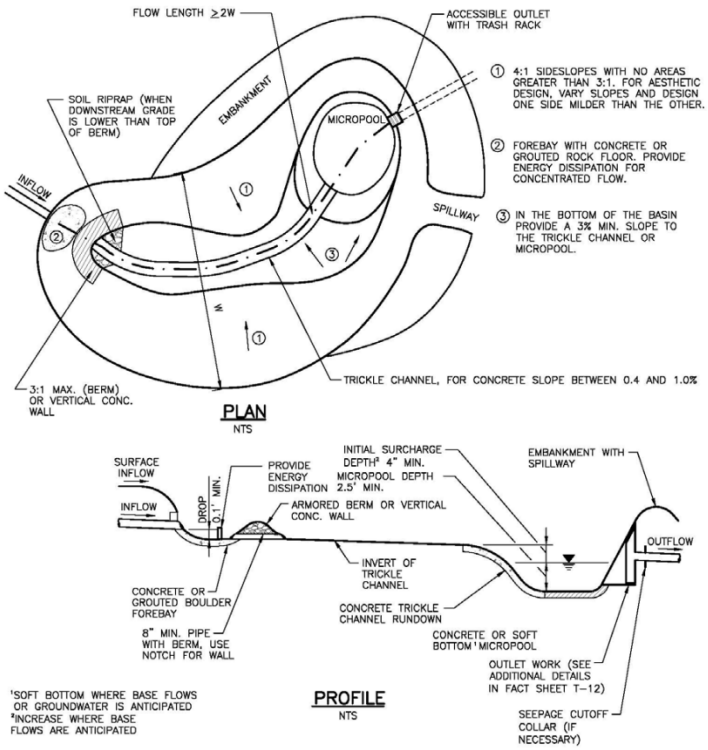



**Figure 10. On-site Water Quality Basin Plan and Profile**
**(Courtesy of Urban Storm Drainage Criteria Manual Vol. 3)**

**Targeted Pollutants**

The following targeted pollutants listed are adapted from the IDEQ Stormwater BMP Catalog:

- Sediment
- Phosphorus
- Trace metals
- Hydrocarbons

**Reference Manuals**

- Catalog of Stormwater Best Management Practices for Idaho Cities and Communities, Idaho Department of Environmental Quality
- Denver Urban Storm Drainage Criteria Manual, Volume 3, Best Management Practices
- Los Angeles County Development Planning for Stormwater Management
- New York State Stormwater Management Design Manual
- County of San Diego SUSMP

**Applications**

On-site water quality basins require careful planning in order to function correctly. Of critical importance is the prediction of flow volumes and the design of an outlet structure to drain slowly enough to provide some water quality benefits but rapidly enough to be empty for the next storm. Since the basin drains completely between storms, the first flush of the next storm tends to resuspend sediments deposited during the last.

On-site water quality basins often serve multiple purposes. In addition to flood control and water quality benefits, the basin may be used for recreation, such as a playground or picnic area, when dry. Thus, aesthetic considerations are important in siting basins. Use of good landscaping principles is encouraged. The planting and preservation of xeriscaped vegetation should be an integral part of the storage facility design.

In a localized situation, an individual property owner can help to attenuate peak flows in the storm system by detaining stormwater runoff. However, uncontrolled installation of localized water quality basins within a watershed can severely alter natural flow conditions, causing compounded flow peaks or increased flow duration that can contribute to downstream degradation or capacity concerns. In addition, upstream impacts due to future land use changes should be considered when designing the structure. Land use planning and regulation may be necessary to preserve the intended function of the impoundment.

**Limitations**

The following limitations have been adapted from the IDEQ Stormwater BMP Catalog:

- Drainage area – 10 to 50 ac.
- Minimum bedrock depth – 6 ft
- NRCS soil type – B, C, D

- Drainage/flood control – yes
- Max slope – 10%
- Minimum water table – 4 ft
- Freeze/thaw – good

Other limitations according to the California Stormwater BMP Handbook – Development are:

- Limitation of the diameter of the orifice may not allow use of extended detention in watersheds of less than 5 acres (would require an orifice with a diameter of less than 0.5 inches that would be prone to clogging).
- Dry extended detention ponds have only moderate pollutant removal when compared to some other structural stormwater practices, and they are relatively ineffective at removing soluble pollutants.

**Design Criteria**

Failure of water quality basins can cause significant property damage and even loss of life. Only professional engineers registered in the State of Nevada who are qualified and experienced in impoundment design should design such structures. Local safety standards for flood control design should be followed. Below grade on-site water quality basins are preferred to above grade basins.

The following design criteria to size an on-site water quality basin are from the California Stormwater BMP Handbook – Development. Other BMP Manuals may be utilized to size the basin; however, guidance provided below should be used to determine the WQCV.

1. Facility Sizing – Calculate the WQCV based on the hydrologic design criteria for parking lot BMPs developed for Las Vegas Valley.

   Basin Configuration – A high aspect ratio may improve the performance of detention basins; consequently, the outlets should be placed to maximize the length of the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet should be at least 1.5:1 (L:W). The flowpath length is defined as the distance from the inlet to the outlet as measured at the surface. The width is defined as the mean width of the basin. Basin depths optimally range from 2 to 5 feet. The basin may include a sediment forebay to provide the opportunity for larger particles to settle out.

   A micropool should not be incorporated in the design because of vector concerns. For online facilities, the principal and emergency spillways must be sized to provide 1.0 foot of freeboard during the 25-year event and to safely pass the flow from the 100-year storm.

2. Pond Side Slopes - Side slopes of the pond should be 3:1 (H:V) or flatter for grass stabilized slopes. Slopes steeper than 3:1 (H:V) must be stabilized with an appropriate slope stabilization practice.

3. Basin Lining – Basins must be constructed to prevent possible contamination of groundwater below the facility. If infiltration is planned as a means of disposing of

stormwater, a special geotechnical study is required to assure there will be no adverse impacts on soil stability or downstream surface water quality.

4. Basin Inlet – Energy dissipation is required at the basin inlet to reduce resuspension of accumulated sediment and to reduce the tendency for short-circuiting.

5. Outflow Structure - The facility's drawdown time should be regulated by a gate valve or orifice plate. In general, the outflow structure should have a trash rack or other acceptable means of preventing clogging at the entrance to the outflow pipes.

   The outflow structure should be sized to allow for complete drawdown of the water quality volume in 72 hours. No more than 50% of the water quality volume should drain from the facility within the first 24 hours. The outflow structure should be fitted with a valve so that discharge from the basin can be halted in case of an accidental spill in the watershed. This same valve also can be used to regulate the rate of discharge from the basin.

   The discharge through a control orifice is calculated from:

$$Q = CA(2gH - H_0)^{0.5}$$

   Where:

   Q = Discharge ($ft^3/s$)
   C = Orifice coefficient
   A = Area of the orifice ($ft^3$)
   g = Gravitational constant (32.2)
   H = Maximum water surface elevation (ft)
   $H_0$= Orifice elevation (ft)

   Recommended values for C are 0.66 for thin materials and 0.80 when the material is thicker than the orifice diameter. This equation can be implemented in spreadsheet form with the pond stage/volume relationship to calculate drain time. To do this, use the initial height of the water above the orifice for the water quality volume. Calculate the discharge and assume that it remains constant for approximately 10 minutes. Based on that discharge, estimate the total discharge during that interval and the new elevation based on the stage volume relationship. Continue to iterate until H is approximately equal to $H_0$. When using multiple orifices the discharge from each is summed.

6. Splitter Box - When the pond is designed as an offline facility, a splitter structure is used to isolate the water quality volume flowing from the parking lots to the basin.

7. Erosion Protection at the Outfall - For online facilities, special consideration should be given to the facility's outfall location. Flared pipe end sections that discharge at or near the stream invert are preferred. The channel immediately below the pond outfall should be modified to conform to natural dimensions, and lined with large stone riprap placed over filter cloth. Energy dissipation may be required to reduce flow velocities from the primary spillway to non-erosive velocities.

8. Safety Considerations - Safety is provided either by fencing of the facility or by managing the contours of the pond to eliminate dropoffs and other hazards. Earthen side slopes should not exceed 3:1 (H:V) and should terminate on a flat safety bench area. Landscaping can be used to impede access to the facility. The primary spillway opening must not permit access by small children. Outfall pipes above 48 inches in diameter should be fenced.

**Maintenance**

On-site water quality basin structures should be regularly inspected for signs of failure, such as seepage or cracks in the berm.

The on-site water quality basin will require regular maintenance between rain events such as removal of debris. Any exposed soil on steep slopes should be promptly re-stabilized.

Safety, Signage and Fencing

Ponds that are readily accessible to populated areas, which includes all ponds adjacent to parking lots, should incorporate all possible safety precautions. Steep side slopes (steeper than 3H:1V) at the perimeter should be avoided and dangerous outlet facilities should be protected by enclosure. Warning signs should be used wherever appropriate. Signs should be placed so that at least one is clearly visible and legible from all adjacent streets, sidewalks or paths.

Heavy Metal Contamination

Dry ponds are less likely to build up excessive levels of heavy metals from sediments washed off impervious areas than wet ponds. However, routine maintenance should remove any significant sediment deposits.

# Site Maintenance Measures
## Building & Grounds Maintenance

### Description

Contaminants such as toxic hydrocarbons in solvents, fertilizers and pesticides, suspended solids, heavy metals, and abnormal pH can be found in stormwater runoff from building and grounds maintenance activities.

Prevention and reduction of the discharge of pollutants to stormwater from building and grounds maintenance activities can be accomplished by washing and cleaning up with as little water as possible, following good landscape management practices, preventing and cleaning up spills immediately, keeping debris from entering the storm drains, and maintaining the stormwater collection system.

### Targeted Pollutants

The following lists pollutants which are typically prevented and reduced by following the protocols. This list is adapted from the California Stormwater BMP Handbook.

- Sediment
- Nutrients
- Trash
- Metals
- Bacteria
- Oil and Grease
- Organics
- Oxygen Demand

### Reference Manuals

- California Stormwater BMP Handbook
- EPA Storm Water Technology Fact Sheet

### Applications

Maintenance of building and grounds on a regular basis is important to ensure the prevention and reduction of pollutants and contaminants in the stormwater runoff. The implementation of a maintenance schedule for the building and grounds at time frames of weekly, monthly, quarterly and yearly is recommended.

The most inexpensive and simplest method to utilize is common sense. Improving the operation and maintenance of industrial machinery, material storage practices, material inventory controls, routine and regular clean-up, maintenance activities in work areas, and providing educational programs for employees regarding these practices will assist in reaching these goals.

### Limitations

Private properties may not keep to their maintenance schedules which may cause runoff of contaminated stormwater.

Carelessness and poor judgment often result in problems associated with the disposal of hazardous materials. Not being fully aware of all the hazards at the site could increase the potential for mishandling of such wastes, resulting in stormwater contamination.

**Design Criteria**

The following are suggested protocols adapted from the California Stormwater BMP Handbook.

*Pressure Washing of Buildings, Rooftops, and Other Large Objects*

- In situations where soaps or detergents are used and the surrounding area is paved, pressure washers must use a waste water collection device that enables collection of wash water and associated solids. A sump pump, wet vacuum or similarly effective device must be used to collect the runoff and loose materials. The collected runoff and solids must be disposed of properly.
- If soaps or detergents are not used, and the surrounding area is paved, wash water runoff does not have to be collected but must be screened. Pressure washers must use filter fabric or some other type of screen on the ground and/or in the catch basin to trap the particles in wash water runoff.
- If you are pressure washing on a grassed area (with or without soap), runoff must be dispersed as sheet flow as much as possible, rather than as a concentrated stream. The wash runoff must remain on the grass and not drain to pavement. Ensure that this practice does not kill grass.

*Landscaping Activities*

- Do not apply any chemicals (insecticide, herbicide, or fertilizer) directly to surface waters, unless the application is approved and permitted by the state.
- Dispose of grass clippings, leaves, sticks, or other collected vegetation as garbage, or by composting. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures on exposed soils.
- Check irrigation schedules so pesticides will not be washed away and to minimize non-stormwater discharge.

*Building Repair, Remodeling, and Construction*

- Do not dump any toxic substance or liquid waste on the pavement, the ground, or toward a storm drain.
- Use ground or drop cloths underneath outdoor painting, scraping, and sandblasting work, and properly dispose of collected material daily.
- Use a ground cloth or oversized tub for activities such as paint mixing and tool cleaning.

- Clean paint brushes and tools covered with water-based paints in sinks connected to sanitary sewers or in portable containers that can be dumped into a sanitary sewer drain. Brushes and tools covered with non-water-based paints, finishes, or other materials must be cleaned in a manner that enables collection of used solvents (e.g., paint thinner, turpentine, etc.) for recycling or proper disposal.
- Use a storm drain cover, filter fabric, or similarly effective runoff control mechanism if dust, grit, wash water, or other pollutants may escape the work area and enter a catch basin. The containment device(s) must be in place at the beginning of the work day, and accumulated dirty runoff and solids must be collected and disposed of before removing the containment device(s) at the end of the work day.
- If you need to de-water an excavation site, you may need to filter the water before discharging to a catch basin or off-site. In which case you should direct the water through hay bales and filter fabric or use other sediment filters or traps.
- Store toxic material under cover with secondary containment during precipitation events and when not in use. A cover would include tarps or other temporary cover material.

*Trimming, and Planting*

- Dispose of leaves, sticks, or other collected vegetation as garbage, by composting or at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures when soils are exposed.
- Place temporarily stockpiled material away from watercourses and drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.
- Consider an alternative approach when bailing out muddy water; do not put it in the storm drain, pour over landscaped areas.
- Use hand or mechanical weeding where practical.

*Fertilizer and Pesticide Management*

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.
- Follow manufacturers' recommendations and label directions. Pesticides must never be applied if precipitation is occurring or predicted. Do not apply insecticides within 100 feet of surface waters such as lakes, ponds, wetlands, and streams.
- Use less toxic pesticides that will do the job, whenever possible. Avoid use of copper-based pesticides if possible.
- Do not use pesticides if rain is expected.
- Do not mix or prepare pesticides for application near storm drains.
- Use the minimum amount needed for the job.

- Calibrate fertilizer distributors to avoid excessive application.
- Employ techniques to minimize off-target application (e.g. spray drift) of pesticides, including consideration of alternative application techniques.
- Apply pesticides only when wind speeds are low.
- Work fertilizers into the soil rather than dumping or broadcasting them onto the surface.
- Irrigate slowly to prevent runoff and then only as much as is needed.
- Clean pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- Dispose of empty pesticide containers according to the instructions on the container label.
- Use up the pesticides. Rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Implement storage requirements for pesticide products with guidance from the local fire department and County Agricultural Commissioner. Provide secondary containment for pesticides.

*Inspection*

- Periodically inspect the irrigation system to ensure that the right amount of water is being applied and that excessive runoff is not occurring. Minimize excess watering, and repair leaks in the irrigation system as soon as they are observed.

**Maintenance**

- Sweep paved areas regularly to collect loose particles, and wipe up spills with rags and other absorbent material immediately, but do not hose down the area to a storm drain.

# Site Maintenance Measures
## Parking Lot Sweeping

### Description

Substances such as trash, suspended solids, hydrocarbons, oil and grease, and heavy metals from parking lots can enter receiving waters through stormwater runoff or non-stormwater discharges. The following protocols are intended to prevent or reduce the discharge of pollutants from parking areas and to provide good housekeeping practices.

### Targeted Pollutants

- Sediment
- Nutrients
- Trash
- Metals
- Bacteria
- Oil and Grease
- Organics
- Oxygen Demand

### Reference Manuals

- California Stormwater BMP Handbook
- EPA Storm Water Technology Fact Sheet

### Applications

Maintenance of parking lots on a regular basis is important to ensure the prevention and reduction of pollutants and contaminants in the stormwater runoff. The implementation of a consistent maintenance schedule for the parking lots at time frames of weekly, monthly, quarterly and yearly is recommended.

The most inexpensive and simplest method to utilize is common sense. Improving the operation and maintenance of industrial machinery, material storage practices, material inventory controls, routine and regular clean-up, maintenance activities in work areas, and providing educational programs for employees regarding these practices will assist in reaching these goals.

### Limitations

Carelessness and poor judgment often result in problems associated with the disposal of hazardous materials. Not being fully aware of all the hazards at the site could increase the potential for mishandling of such wastes, resulting in stormwater contamination.

### Design Criteria

The following are suggested protocols adapted from the California Stormwater BMP Handbook.

*Street Sweeping and Cleaning*

- Maintain a consistent sweeping schedule. Provide minimum monthly sweeping of curbed streets.
- Perform street cleaning during dry weather if possible.
- Avoid wet cleaning or flushing of street, and utilize dry methods where possible.
- Consider increasing sweeping frequency based on factors such as traffic volume, land use, field observations of sediment and trash accumulation, proximity to water courses, etc. For example:
    - Increase the sweeping frequency for streets with high pollutant loadings, especially in high traffic and industrial areas.
    - Increase the sweeping frequency just before the wet season to remove sediments accumulated during the summer.
    - Increase the sweeping frequency for streets in special problem areas such as special events, high litter or erosion zones.
- Maintain cleaning equipment in good working condition and purchase replacement equipment as needed. Old sweepers should be replaced with new technologically advanced sweepers (preferably regenerative air sweepers) that maximize pollutant removal.
- Operate sweepers at manufacturer requested optimal speed levels to increase effectiveness.
- To increase sweeping effectiveness consider the following:
    - Institute a parking policy to restrict parking in problematic areas during periods of street sweeping.
    - Post permanent street sweeping signs in problematic areas; use temporary signs if installation of permanent signs is not possible.
    - Develop and distribute flyers notifying residents of street sweeping schedules.
- Regularly inspect vehicles and equipment for leaks, and repair immediately.
- If available use vacuum or regenerative air sweepers in the high sediment and trash areas (typically industrial/commercial).
- Keep accurate logs of the number of curb-miles swept and the amount of waste collected.
- Dispose of street sweeping debris and dirt at a landfill.
- Do not store swept material along the side of the street or near a storm drain inlet.
- Keep debris storage to a minimum during the wet season or make sure debris piles are contained (e.g. by berming the area) or covered (e.g. with tarps or permanent covers).

**Maintenance**

- Maintain parking lot sweeping schedule regularly to collect loose particles, and wipe up spills with rags and other absorbent material immediately, but do not hose down the area to a storm drain.

# Site Maintenance Measures
## Sidewalk Cleaning

### Description

Pollutants on sidewalks and other pedestrian traffic areas and plazas are typically due to littering and vehicle use. This fact sheet describes good housekeeping practices that can be incorporated into an existing cleaning and maintenance program.

### Targeted Pollutants

- Sediment
- Nutrient
- Trash
- Metals
- Bacteria
- Oil and Grease
- Organics

### Reference Manuals

- California Stormwater BMP Handbook
- EPA Storm Water Technology Fact Sheet

### Applications

Maintenance of sidewalks and other pedestrian traffic areas and plazas on a regular basis is important to ensure the prevention and reduction of pollutants and contaminants in the stormwater runoff. The implementation of a consistent maintenance schedule for the parking lots at time frames of weekly, monthly, quarterly and yearly is recommended.

### Limitations

Private properties may not keep to their maintenance schedules which may cause contaminated stormwater runoff to receiving waters or non-stormwater discharges.

### Design Criteria

The recommended approach in pollution prevention is to use dry cleaning methods whenever practical for surface cleaning activities and use the least toxic materials available (e.g. water based paints, gels or sprays for graffiti removal).

The following are suggested protocols adapted from the California Stormwater BMP Handbook.

*Surface Cleaning*

- Regularly broom (dry) sweep sidewalk, plaza and parking lot areas to minimize cleaning with water.

- Dry clean-up first (sweep, collect, and dispose of debris and trash) when cleaning sidewalks or plazas, then wash with or without soap.
- Block the storm drain or contain runoff when cleaning with water. Discharge wash water to landscaping or collect water and pump to a tank or discharge to sanitary sewer through an approved pretreatment device if allowed. (Permission may be required from local sanitation district.)
- Block the storm drain or contain runoff when washing parking areas, driveways or drive-throughs. Use absorbents to pick up oil; then dry sweep. Clean with or without soap. Collect water and pump to a tank or discharge to sanitary sewer through an approved pretreatment device if allowed.

*Street Repair and Maintenance.*

- Avoid graffiti abatement activities during rain events.
- Direct runoff from sand blasting and high pressure washing (with no cleaning agents) into a dirt or landscaped area after treating with an appropriate filtering device.
- Plug nearby storm drain inlets and vacuum/pump wash water to the sanitary sewer through an approved pretreatment device if authorized to do so if a graffiti abatement method generates wash water containing a cleaning compound (such as high pressure washing with a cleaning compound). Ensure that a non-hazardous cleaning compound is used or dispose as hazardous waste, as appropriate.

*Surface Removal and Repair*

- Schedule surface removal activities for dry weather if possible.
- Avoid creating excess dust when breaking asphalt or concrete.
- Take measures to protect nearby storm drain inlets prior to breaking up asphalt or concrete (e.g. place hay bales or sand bags around inlets). Clean afterwards by sweeping up as much material as possible.
- Designate an area for clean-up and proper disposal of excess materials.
- Remove and recycle as much of the broken pavement as possible to avoid contact with rainfall and stormwater runoff.
- When making saw cuts in pavement, use as little water as possible. Cover each storm drain inlet completely with filter fabric during the sawing operation and contain the slurry by placing straw bales, sandbags, or gravel dams around the inlets. After the liquid drains or evaporates, shovel or vacuum the slurry residue from the pavement or gutter and remove from site.
- Always dry sweep first to clean up tracked dirt. Use a street sweeper or vacuum truck. Do not dump vacuumed liquid in storm drains. Once dry sweeping is complete, the area may be hosed down if needed. Wash water should be directed to landscaping or collected and pumped to the sanitary sewer through an approved pretreatment device if allowed.

*Concrete Installation and Repair*

- Schedule asphalt and concrete activities for dry weather.
- Take measures to protect any nearby storm drain inlets and adjacent watercourses, prior to breaking up asphalt or concrete (e.g. place sand bags around inlets or work areas).
- Limit the amount of fresh concrete or cement mortar mixed, mix only what is needed for the job.
- Store concrete materials under cover, away from drainage areas. Secure bags of cement after they are open. Be sure to keep wind-blown cement powder away from streets, gutters, storm drains, rainfall, and runoff.
- Return leftover materials to the transit mixer. Dispose of small amounts of hardened excess concrete, grout, and mortar in the trash.
- Do not wash sweepings from exposed aggregate concrete into the street or storm drain.
- Collect and return sweepings to aggregate base stockpile, or dispose in the trash.
- Protect applications of fresh concrete from rainfall and runoff until the material has dried.
- Do not allow excess concrete to be dumped onsite, except in designated areas.
- Wash concrete trucks off site or in designated areas on site designed to preclude discharge of wash water to drainage system.

*Controlling Litter*

- Post "No Littering" signs and enforce anti-litter laws.
- Provide litter receptacles in busy, high pedestrian traffic areas of the community, at recreational facilities, and at community events.
- Cover litter receptacles and clean out frequently to prevent leaking/spillage or overflow.
- Clean parking lots on a regular basis with a street sweeper.

**Maintenance**

- Maintain cleaning schedule of sidewalks and other pedestrian traffic areas and plazas regularly to collect loose particles, and wipe up spills with rags and other absorbent material immediately, but do not hose down the area to a storm drain.

# Appendix B –
# Technical Memorandum

MWH

BUILDING A BETTER WORLD

# TECHNICAL MEMORANDUM

| | | | |
|---|---|---|---|
| TO: | Development Guidelines Working Group | DATE: | August 16, 2013 |
| FROM: | Chip Paulson, P.E.<br>Raul Valdez, P.E. | | |
| CC: | Angela MacKinnon, P.E. | | |
| PROJECT: | Las Vegas Valley MS4 NDEP Development Program | | |
| SUBJECT: | Derivation of Parking Lot BMP Hydrologic Design Criteria | | |

## 1 Introduction

This Technical Memorandum documents the calculations and analyses performed to create the parking lot BMP hydrologic sizing methodology for Permittees listed under the Las Vegas Valley Municipal Separate Storm System (MS4) National Pollution Discharge Elimination System (NPDES) permit. Portions of the Clark County Regional Flood Control District (CCRFCD) Hydrologic Design manual were referenced.

## 2 Background

Through the cooperation of the Engineering Committee of the Las Vegas Valley Stormwater Quality Management Committee Development Guidelines Working Group (DGWG), hydrologic sub-basin information was gathered for nine different project sites located throughout the Las Vegas Valley. The sites represent different land uses but all have significant parking areas. The hydrologic information was referenced from each project's respective technical hydrology and flood control study. Technical hydrology and flood control studies are typical requirements by city and county entities prior to site construction and development. Typical information referenced consisted of: sub-basin area, SCS Curve Number (CN), average percent impervious area, travel length, design 100-year rainfall depth and basin slope. In general, the hydrologic sub-basins varied in area from less than 0.5 acres to over 25 acres and encompassed mostly commercial or high density residential land use types. The average percent impervious area corresponding to each sub-basin varied from 65 to 90% since the boundaries encompassed portions of the project site that were pervious (i.e., landscape or open areas adjacent to the paved parking surface). A total of 56 hydrologic sub-basin areas were referenced from the nine different project sites. The hydrologic sub-basins are summarized in **Table 1**, while the project general locations are depicted in **Figure 1**. Sites "A" and "B" are conceptual projects located in the Summerlin and at the western edge of the ultimate development boundary respectively part of the Las Vegas Valley.

They have the same physical characteristics as Project Number 1, but they are assumed to be located at a location further from the McCarran Airport Rainfall Area so it has a higher design precipitation. The purpose for including Sites "A" and "B" is to increase the number of data points used in the regression analyses that relate peak runoff flows and volumes to site characteristics. The regression analyses are fully described in subsequent sections.

**Table 1: Hydrologic Sub-Basins Summary**

| Project Number | Project Name | Hydrologic Sub-Basin ID | Area (acres) | Average Percent Impervious Area |
|---|---|---|---|---|
| 1 | Clark County School District N.W. Transportation Center | ON5 | 7.06 | 90 |
| | | FUT1 | 3.34 | 90 |
| | | ON2 | 1.89 | 90 |
| | | ON7 | 9.98 | 97 |
| | | ON1 | 4.13 | 90 |
| | | ON6 | 1.34 | 90 |
| | | RO | 1.56 | 90 |
| | | R1 | 0.37 | 90 |
| | | R2 | 1.90 | 90 |
| | | ON3 | 3.26 | 80 |
| | | ON4 | 2.43 | 90 |
| | | R3 | 0.91 | 100 |
| | | R4 | 0.68 | 80 |
| | | R5 | 1.65 | 80 |
| 2 | Bledsoe Apartment Building | ON1 | 0.93 | 75 |
| 3 | Hope Baptist Church | ON1D | 10.00 | 75 |
| 4 | Yeshiva School Site | ON1D | 1.56 | 65 |
| 5 | VDG Commercial Site | ON1D | 0.60 | 70 |
| | | ON2D | 1.80 | 70 |
| 6 | American Pacific Apartments | ON1D | 2.60 | 90 |
| | | ON2D | 2.00 | 90 |
| | | ON3D | 0.20 | 90 |
| | | ON4D | 2.50 | 90 |
| 7 | Mountain's Edge Pod 111 Commercial & Residential Site | ON1D | 27.60 | 90 |
| | | ON2D | 9.00 | 90 |
| | | ON3D | 4.50 | 90 |
| | | ON4D | 2.20 | 90 |
| | | ON5D | 3.40 | 90 |
| 8 | Site A | ONA | 7.06 | 90 |
| | | ONB | 3.34 | 90 |
| | | ONC | 1.89 | 90 |
| | | OND | 9.98 | 97 |
| | | ONE | 4.13 | 90 |
| | | ONF | 1.34 | 90 |
| | | ONG | 1.56 | 90 |
| | | ONH | 0.37 | 90 |
| | | ONI | 1.90 | 90 |
| | | ONJ | 3.26 | 80 |
| | | ONK | 2.43 | 90 |
| | | ONL | 0.91 | 100 |

| Project Number | Project Name | Hydrologic Sub-Basin ID | Area (acres) | Average Percent Impervious Area |
|---|---|---|---|---|
| 8 | Site A | ONM | 0.68 | 80 |
| | | ONN | 1.65 | 80 |
| 9 | Site B | ONA | 7.06 | 90 |
| | | ONB | 3.34 | 90 |
| | | ONC | 1.89 | 90 |
| | | OND | 9.98 | 97 |
| | | ONE | 4.13 | 90 |
| | | ONF | 1.34 | 90 |
| | | ONG | 1.56 | 90 |
| | | ONH | 0.37 | 90 |
| | | ONI | 1.90 | 90 |
| | | ONJ | 3.26 | 80 |
| | | ONK | 2.43 | 90 |
| | | ONL | 0.91 | 100 |

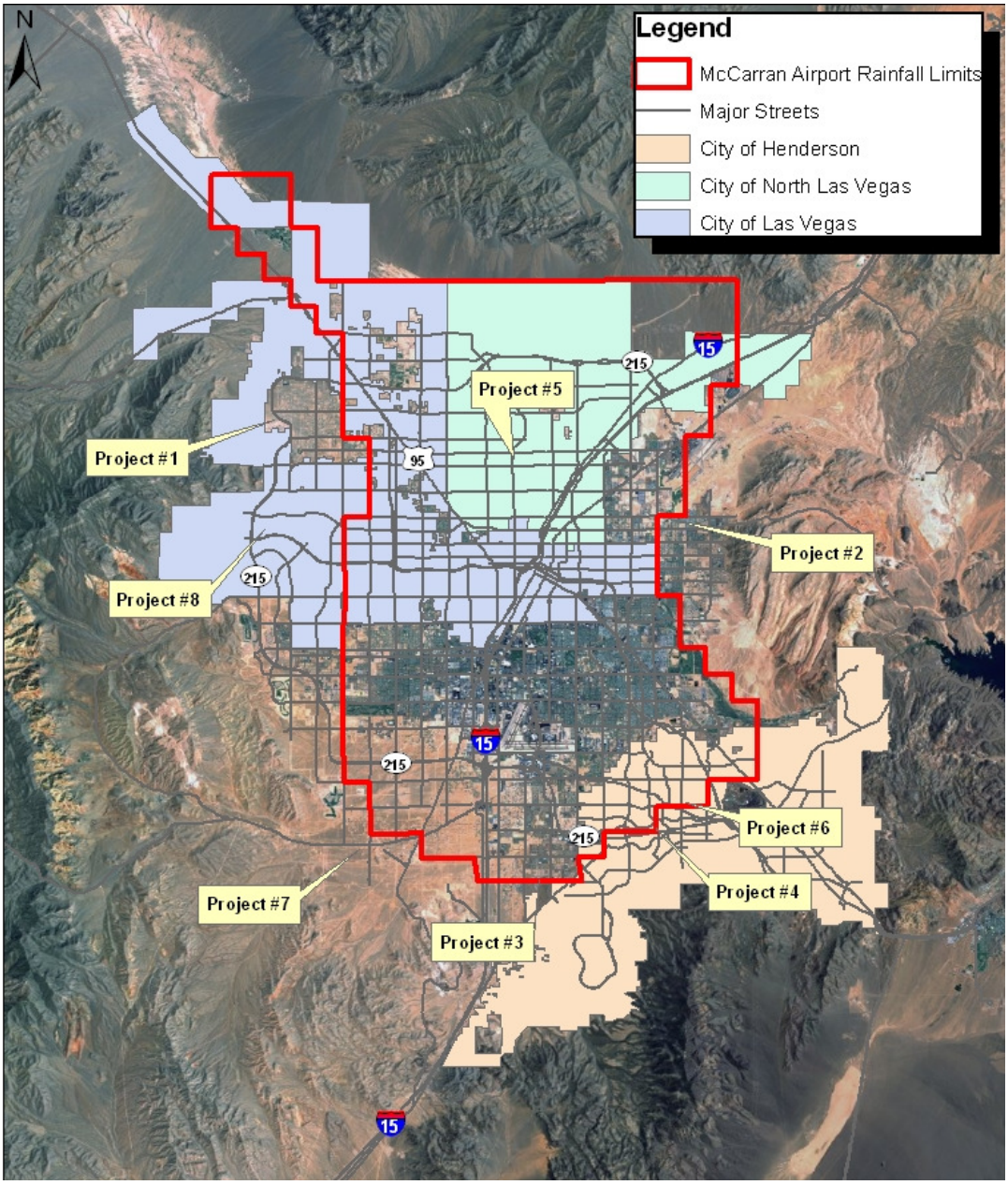



**Figure 1: Project Location Map**

A hydrologic analysis was performed to determine storm runoff peak flow rates and volumes by utilizing the BMP design storm selected previously by the DGWG. Two separate analyses were prepared for the 56 hydrologic sub-basins; one used the United States Environmental Protection Agency (USEPA) Storm Water Management Model (SWMM) version 5.0 and a second used the Modified Rational Method. Statistical computations were subsequently performed on the results of both analyses and a series of regression equations and graphs were derived in order to standardize the Las Vegas Valley parking lot BMP hydrologic sizing methodology. Specific details of both parallel analyses are documented in this memorandum.

# 3 EPA Storm Water Management Model (SWMM)

The USEPA SWMM software was utilized to determine the BMP design storm peak flow rates and runoff volumes. This model calculates infiltration into the unsaturated upper soil zone for pervious portions of the hydrologic sub-basins. Infiltration is not calculated by the model for impervious portions of the basins. The available options for computing infiltration within SWMM are: Horton, Green and Ampt, or the SCS CN method. For purposes of creating the parking lot BMP sizing standards, the SCS CN method was chosen for the infiltration computation. Physical sub-basin parameters used as input in the SWMM analysis included: acreage, CN, average percent impervious area, travel length, and slope.

## 3.1 Design Rainfall

The BMP design storm rainfall utilized in the SWMM analysis was the 85th percentile storm depth. A precipitation depth of 0.32 inches was quantified as the 85th percentile storm for the geographic area within the McCarran Airport Rainfall limits in *MWH 2009*. Since several of the referenced hydrologic sub-basins are located outside of the McCarran Airport Rainfall area, a proportion equation was solved to determine the corresponding 85th percentile storm depths at other locations. The proportion equation utilized in solving for the 85th percentile depth is listed as follows:

$$\frac{D^{85}}{0.32 - inches} = \frac{D_2}{0.72 - inches}$$

where:

- $D^{85}$ is the adjusted 85th percentile storm depth, in inches, for areas outside of the McCarran Airport Rainfall Area.

- $D_2$ is the 6-hour, 2-year storm depth, in inches, from the NOAA Atlas multiplied by the CCRFCD Hydrologic Design Manual adjustment factors (Table 501) for the referenced hydrologic sub-basin. The 0.72-inch denominator value is the 6-hour, 2-year McCarran Airport Rainfall Area precipitation depth.

## 3.2 Storm Distribution

A cumulative type storm distribution was utilized in the SWMM analysis to determine the BMP design peak flow rates and runoff volumes. The BMP design storm distribution was assumed to have a duration of approximately 1 hour and was divided into twelve 5-minute time increments. This duration was chosen based on the assumption that the highest pollutant concentration runoff will be produced within the first 60-minutes of a storm event, and because of the small area and short time of concentration of most parking lots. The cumulative precipitation percentage is linear. The linear storm distribution was found to yield results similar to those produced by the modified rational method. Generally, the modified rational method is an acceptable methodology for calculating peak flow rates from small drainage areas, therefore it was used as a base line comparison for the SWMM model. The modified rational method analysis is described in a subsequent section. The 1-hour first flush storm distribution cumulative percentage table and curve are depicted in **Table 2** and **Figure 2**.

**Table 2: BMP Design Storm Distribution Derivation**

| Time Increment | Storm Time (Minutes) | Percent of Total Storm Depth |
|---|---|---|
| 0 | 0 | 0.0% |
| 1 | 5 | 8.3% |
| 2 | 10 | 16.7% |
| 3 | 15 | 25.0% |
| 4 | 20 | 33.3% |
| 5 | 25 | 41.7% |
| 6 | 30 | 50.0% |
| 7 | 35 | 58.3% |
| 8 | 40 | 66.7% |
| 9 | 45 | 75.0% |
| 10 | 50 | 83.3% |
| 11 | 55 | 91.7% |
| 12 | 60 | 100.0% |

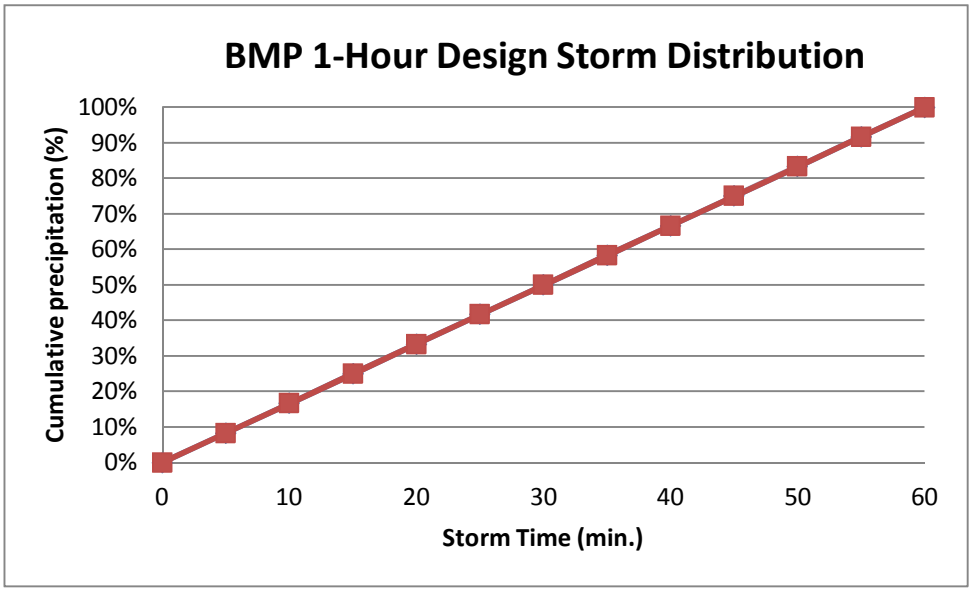



**Figure 2: BMP Design Storm Distribution**

## 3.3 SWMM Results

The results from the SWMM analysis for peak flow rate and volume were utilized to determine unit discharge ($Q_P/A$) and volume to area (Vol/A) ratios for each individual hydrologic sub-basin. A statistical analysis was subsequently performed on the $Q_P/A$ and Vol/A ratios. The statistical analysis and derivation of the BMP sizing regression equations and graphs are described in detail within Section 5of this memorandum.

# 4 Modified Rational Method Analysis

As mentioned in Section 2, a modified rational method analysis was also performed for all 56 referenced hydrologic sub-basins. The modified rational method is generally acceptable for small drainage areas and is characterized by the following equation:

$$Q = KCIA$$

where:

- K is the local Las Vegas adjustment factor used to modify the peak. According to the CCRFCD Hydrologic Design Manual, this adjustment factor is accepted as 0.5.
- C is the runoff coefficient
- I is the average intensity of rainfall (inches/hour) for a storm duration that is equal to the time of concentration over the duration of 1-hour.
- A is the hydrologic sub-basin area in acres.

The result of the modified rational method formula provides peak flow rate (Q) in cfs. A description of the intensity and runoff coefficient parameters used in the modified rational method calculation is provided in the following sections.

## 4.1 Design Rainfall Intensity

The 85$^{th}$ percentile storm depth for each sub-basin was converted into a BMP design rainfall intensity for use in the modified rational method formula. The following assumptions were made to determine the intensities:

- Average duration of the 85$^{th}$ percentile storm was approximately 1-hour.
- The time of concentration ($T_C$) was assumed to be 5-minutes for all parking lot sub basins; this is the minimum allowable per the CCRFCD Hydrologic Design Manual.

Table 504 of the Hydrologic Design Manual (Factors for Durations Less than 1-hour) was referenced for the 5-minute duration since this was the assumed $T_C$. The 5-minute duration factor (ratio to 1-hour) is 0.29. The 5-minute intensity was then calculated and converted to units of inches per hour using the following formula:

$$I = D^{85} \times 0.29 \times \frac{60 \text{ minutes}}{1 \text{ hour}} \times \frac{1}{5 \text{ minutes}}$$

where:

- $D^{85}$ is the design 85$^{th}$ percentile storm depth in inches. For areas within the McCarran Airport Rainfall Area $D^{85}$ is 0.32 inches; for areas outside of the McCarran Airport Rainfall

Area $D^{85}$ is computed using the proportion equation listed in Section 3-1 of this memorandum.

## 4.2 Runoff Coefficients

Table 601 from the CCRFCD Hydrologic Design Manual was referenced for runoff coefficients pertaining to the hydrologic sub-basins. The 10-year runoff coefficient "C" values for average percent impervious areas of 65% and above were plotted and a linear trend line was fit to the points (see **Table 3** and **Figure 3**). The 10-year runoff coefficients were chosen since they were the lowest return period values available in Table 601. Specific runoff coefficients were calculated using the linear equation and the average percent impervious area for each of the 56 sub-basins and are summarized in **Table 4**.

**Table 3: Average Percent Impervious Area - "C" Coefficient Correlation**

| Land Use Type | Average Percent Impervious Area | Runoff Coefficient (10-yr Desert) |
|---|---|---|
| Paved | 100 | 0.90 |
| Drives and Walks | 95 | 0.88 |
| Downtown Areas | 95 | 0.88 |
| Roofs | 90 | 0.85 |
| Industrial | 72 | 0.76 |
| Residential (1/8-ac. lots or less) | 65 | 0.73 |

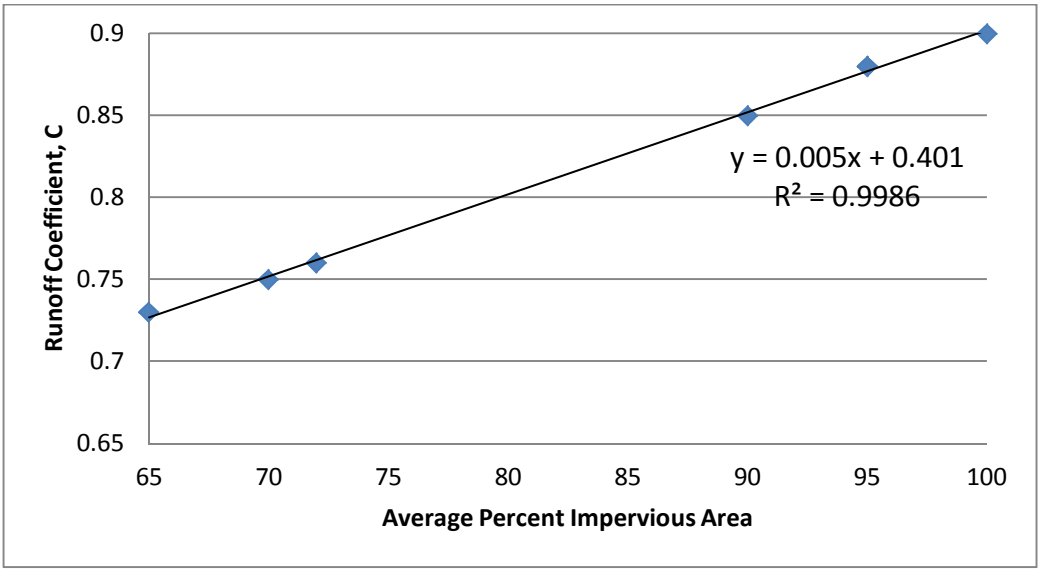



**Figure 3:"C" Coefficient Adjustment to Average Percent Impervious Regression Curve**

### 4.3 Modified Rational Method Results

The 85th percentile peak flow rate results from the modified rational method calculation were utilized to determine a $Q_P/A$ ratio for each hydrologic sub-basin. A statistical analysis was performed on the $Q_P/A$ ratios to derive the regression equations and graphs for BMP facility sizing. Details of the statistical analysis are covered in Section 5.

# 5 Statistical Analysis

The $Q_P/A$ and Vol/A ratios from the SWMM analysis and modified rational method calculations are summarized in **Table 4**. Comparison of the $Q_P/A$ ratios revealed that the modified rational method produces slightly higher peak flow rates than the SWMM method based on the 85th percentile storm depths. The higher unit flow rate results from the modified rational method calculation were utilized to determine BMP design criteria in order to be conservative. For the purpose of sizing first flush runoff volumes, Vol/A ratios from the SWMM analysis (with adjustments) were utilized for statistical analysis, since the rational method does not produce runoff volumes.

**Table 4: SWMM and Rational Method Results for Selected Parking Lots**

| | | | Sub-basin Data | | | EPA SWMM Results | | Mod. Rat.Method Results |
|---|---|---|---|---|---|---|---|---|
| Project Number | Project Name | Hydrologic Sub-Basin ID | $D_{85}$ (inches) | Average Percent Impervious Area (%) | Calculated Runoff Coefficient "C" | $Q_P/A$ (cfs/acre) | Vol/A (ac-ft /acre) | $Q_P/A$ (cfs/acre) |
| 1 | Clark County School District N.W. Transportation Center | ON5 | 0.36 | 90 | 0.85 | 0.36 | 0.030 | 0.53 |
| | | FUT1 | 0.36 | 90 | 0.85 | 0.35 | 0.028 | 0.53 |
| | | ON2 | 0.36 | 90 | 0.85 | 0.35 | 0.032 | 0.53 |
| | | ON7 | 0.36 | 97 | 0.89 | 0.36 | 0.031 | 0.55 |
| | | ON1 | 0.36 | 90 | 0.85 | 0.34 | 0.030 | 0.53 |
| | | ON6 | 0.36 | 90 | 0.85 | 0.35 | 0.023 | 0.53 |
| | | RO | 0.36 | 90 | 0.85 | 0.34 | 0.020 | 0.53 |
| | | R1 | 0.36 | 90 | 0.85 | 0.35 | 0.000 | 0.53 |
| | | R2 | 0.36 | 90 | 0.85 | 0.34 | 0.032 | 0.53 |
| | | ON3 | 0.36 | 80 | 0.80 | 0.30 | 0.028 | 0.50 |
| | | ON4 | 0.36 | 90 | 0.85 | 0.35 | 0.025 | 0.53 |
| | | R3 | 0.36 | 100 | 0.90 | 0.36 | 0.034 | 0.56 |
| | | R4 | 0.36 | 80 | 0.80 | 0.31 | 0.046 | 0.50 |
| | | R5 | 0.36 | 80 | 0.80 | 0.30 | 0.019 | 0.50 |
| 2 | Bledsoe Apartment Building | ON1 | 0.34 | 75 | 0.78 | 0.26 | 0.033 | 0.46 |
| 3 | Hope Baptist Church | ON1D | 0.32 | 75 | 0.78 | 0.25 | 0.018 | 0.43 |
| 4 | Yeshiva School Site | ON1D | 0.34 | 65 | 0.73 | 0.27 | 0.020 | 0.43 |
| 5 | VDG Commercial Site | ON1D | 0.32 | 70 | 0.75 | 0.25 | 0.000 | 0.42 |
| | | ON2D | 0.32 | 70 | 0.75 | 0.25 | 0.017 | 0.42 |

| | | | Sub-basin Data | | | EPA SWMM | | Sub-basin Data |
|---|---|---|---|---|---|---|---|---|
| Project Number | Project Name | Hydrologic Sub-Basin ID | D85 (inches) | Average Percent Impervious Area (%) | Calculated Runoff Coefficient "C" | QP/A (cfs/acre) | Vol/A (ac-ft /acre) | QP/A (cfs/acre) |
| 6 | American Pacific Apartments | ON1D | 0.32 | 90 | 0.85 | 0.30 | 0.023 | 0.47 |
| | | ON2D | 0.32 | 90 | 0.85 | 0.31 | 0.016 | 0.47 |
| | | ON3D | 0.32 | 90 | 0.85 | 0.30 | 0.000 | 0.47 |
| | | ON4D | 0.32 | 90 | 0.85 | 0.30 | 0.024 | 0.47 |
| 7 | Mountain's Edge Pod 111 Commercial & Residential Site | ON1D | 0.36 | 90 | 0.85 | 0.35 | 0.026 | 0.53 |
| | | ON2D | 0.36 | 90 | 0.85 | 0.35 | 0.024 | 0.53 |
| | | ON3D | 0.36 | 90 | 0.85 | 0.35 | 0.027 | 0.53 |
| | | ON4D | 0.36 | 90 | 0.85 | 0.35 | 0.028 | 0.53 |
| 8 | Site A | ONA | 0.40 | 90 | 0.85 | 0.40 | 0.215 | 0.57 |
| | | ONB | 0.40 | 90 | 0.85 | 0.39 | 0.092 | 0.57 |
| | | ONC | 0.40 | 90 | 0.85 | 0.39 | 0.061 | 0.56 |
| | | OND | 0.40 | 97 | 0.89 | 0.40 | 0.307 | 0.61 |
| | | ONE | 0.40 | 90 | 0.85 | 0.38 | 0.123 | 0.56 |
| | | ONF | 0.40 | 90 | 0.85 | 0.40 | 0.031 | 0.60 |
| | | ONG | 0.40 | 90 | 0.85 | 0.38 | 0.031 | 0.58 |
| | | ONH | 0.40 | 90 | 0.85 | 0.38 | 0.000 | 0.54 |
| | | ONI | 0.40 | 90 | 0.85 | 0.38 | 0.061 | 0.58 |
| | | ONJ | 0.40 | 80 | 0.80 | 0.34 | 0.092 | 0.49 |
| | | ONK | 0.40 | 90 | 0.85 | 0.39 | 0.061 | 0.58 |
| | | ONL | 0.40 | 100 | 0.90 | 0.40 | 0.031 | 0.55 |
| | | ONM | 0.40 | 80 | 0.80 | 0.37 | 0.031 | 0.44 |
| | | ONN | 0.40 | 80 | 0.80 | 0.35 | 0.061 | 0.48 |
| 9 | Site B | ONA | 0.49 | 90 | 0.85 | 0.50 | 0.245 | 0.73 |
| | | ONB | 0.49 | 90 | 0.85 | 0.50 | 0.122 | 0.73 |
| | | ONC | 0.49 | 90 | 0.85 | 0.50 | 0.061 | 0.73 |
| | | OND | 0.49 | 97 | 0.89 | 0.50 | 0.368 | 0.76 |
| | | ONE | 0.49 | 90 | 0.85 | 0.49 | 0.153 | 0.73 |
| | | ONF | 0.49 | 90 | 0.85 | 0.49 | 0.061 | 0.73 |
| | | ONG | 0.49 | 90 | 0.85 | 0.50 | 0.061 | 0.73 |
| | | ONH | 0.49 | 90 | 0.85 | 0.49 | 0.000 | 0.73 |
| | | ONI | 0.49 | 90 | 0.85 | 0.87 | 0.061 | 0.73 |
| | | ONJ | 0.49 | 80 | 0.80 | 0.49 | 0.122 | 0.68 |
| | | ONK | 0.49 | 90 | 0.85 | 0.50 | 0.092 | 0.73 |
| | | ONL | 0.49 | 100 | 0.90 | 0.49 | 0.030 | 0.77 |
| | | ONM | 0.49 | 80 | 0.80 | 0.50 | 0.030 | 0.68 |
| | | ONN | 0.49 | 80 | 0.80 | 0.50 | 0.061 | 0.68 |

Using the results of the hydrologic analyses of the actual proposed parking lots, a simple generalized method was developed to allow parking lot BMP hydrologic design values (peak flow rate and volumes) to be computed without modeling. The objective was to provide design engineers with a series of charts or equations that could be used to quickly determine hydrologic design parameters for parking lot BMPs.

## 5.1 Average Unit Discharge Regression Equation

The following calculations were performed to produce a simple method for estimating Qp/A given the 85th percentile precipitation depth:

- Separate mean values for $Q_P/A$ ratios were computed on hydrologic sub-basins with 85th percentile storm depths of 0.32, 0.36, 0.40, and 0.49-inches respectively, with an average impervious area of 90%.

- The mean values of the $Q_P/A$ ratios were plotted as ordinate values against the corresponding $D^{85}$ abscissa values.

- A linear trend line was fit to the data points. **Figure 4** depicts this graph, as well as the regression equation.

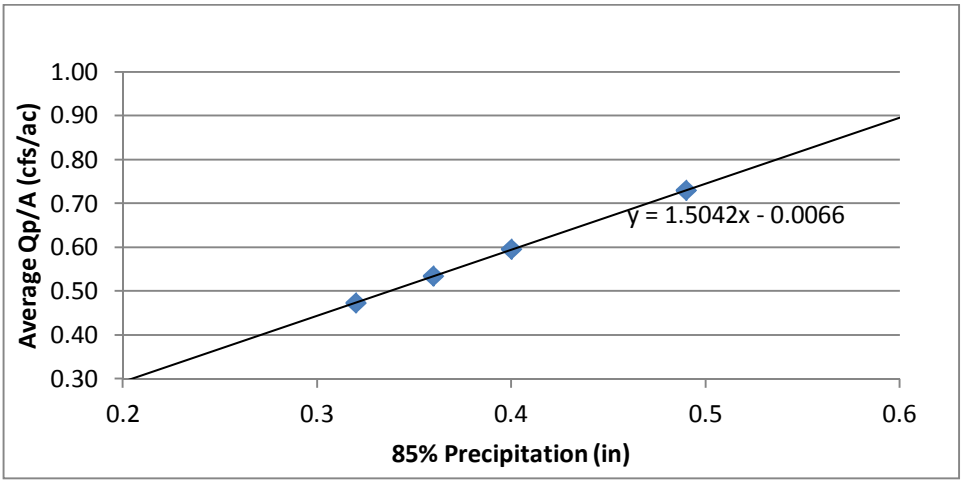



**Figure 4 Average Unit Discharge vs 85% Precipitation for 90% Average Percent Imperviousness**

## 5.2 Adjustment For Average Percent Impervious Area To Average Unit Discharge

The statistical analysis performed in Section 5-1 only considered hydrologic sub-basins that contained 90% imperviousness. In practice, not all hydrologic sub-basins will encompass areas with 90% average impervious area due to inclusion of landscape or open areas. An adjustment graph was plotted with data that accounts for hydrologic sub-basins with areas containing less or more than 90% imperviousness for this reason. The following statistical calculations were performed to construct this graph.

- Separate mean values for $Q_P/A$ ratios were computed on hydrologic sub-basins with an 85th percentile storm depth of 0.32-inches and impervious area percentages of 90, 75, and 70 respectively. The mean values were normalized with respect to the 90% $Q_P/A$ mean value. For example, the 90% mean $Q_P/A$ ratio (0.47) was divided into both the 75% and

70% mean $Q_P/A$ ratios (0.43 and 0.42) which results in adjustment factors of 0.91 and 0.88 respectively.

- Separate mean values for $Q_P/A$ ratios were computed on hydrologic sub-basins with an 85th percentile storm depth of 0.49 inches and impervious area percentages of 97, 90, and 80 respectively. The mean values were normalized with respect to the 90% $Q_P/A$ mean value in the same manner as described above.

- A separate linear trend line was fit to each set of data points. **Figure 5** depicts the graph along with corresponding regression equations and should be used to find the adjustment multiplier to the average $Q_P/A$ ratio obtained from **Figure 4** when sizing a parking lot BMP for a site with imperviousness different than 90 percent.

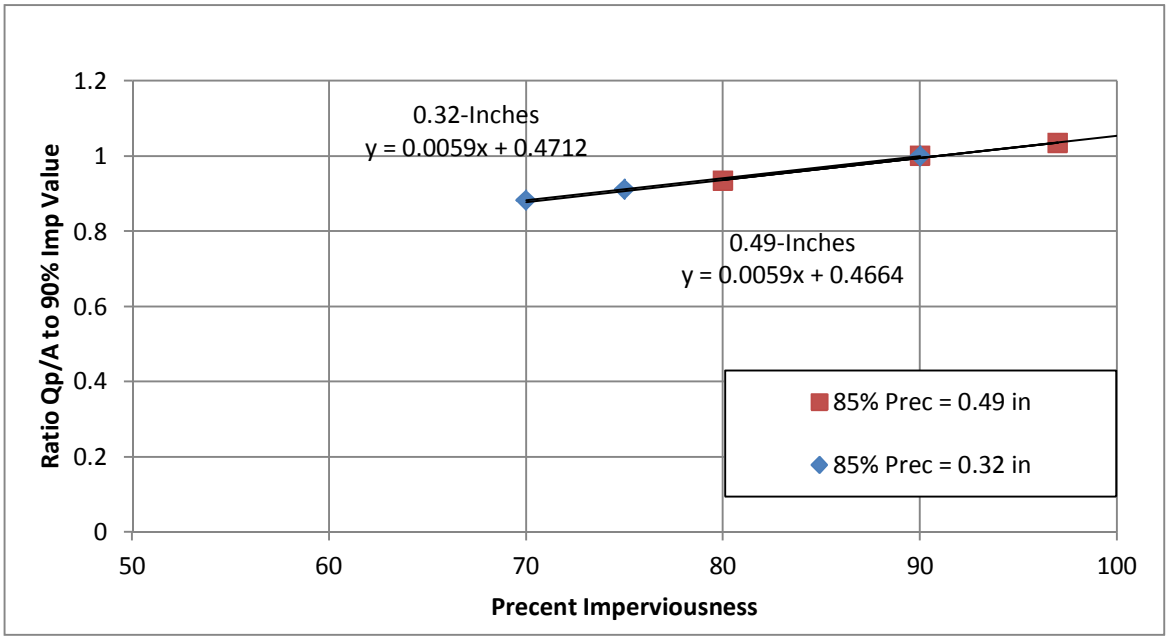



**Figure 5 Adjustment for Qp/A Relative to 90% Average Percent Imperviousness**

## 5.3 BMP Design Runoff Volume

The volume to area ratios (Vol/A) from the SWMM analysis summarized in **Table 4** were utilized to construct an average unit runoff volume versus 85th percentile precipitation graph and regression equation. The following steps were performed to derive the graph:

- Separate mean values for Vol/A ratios from the SWMM results were computed on hydrologic sub-basins with an average percent impervious area of 90 for the 85th percentile storm depths of 0.32, 0.36, 0.40, and 0.49-inches respectively.

- Separate mean values for Vol/A ratios from the modified rational method were also calculated for basins with area percentage of 90 for the 85th percentile storm depths of 0.32, 0.36, 0.40, and 0.49-inches respectively.

- The SWMM mean Vol/A ratios were divided into the modified rational method mean Vol/A values to determine an adjustment factor. The SWMM mean Vol/A ratios were then multiplied by the respective adjustment factor.

- The mean Vol/A ratios were plotted on the ordinate axis, while the corresponding 85th percentile depths were plotted on the abscissa. A linear trend line was fit to the data points. The plot is depicted in **Figure 6**.

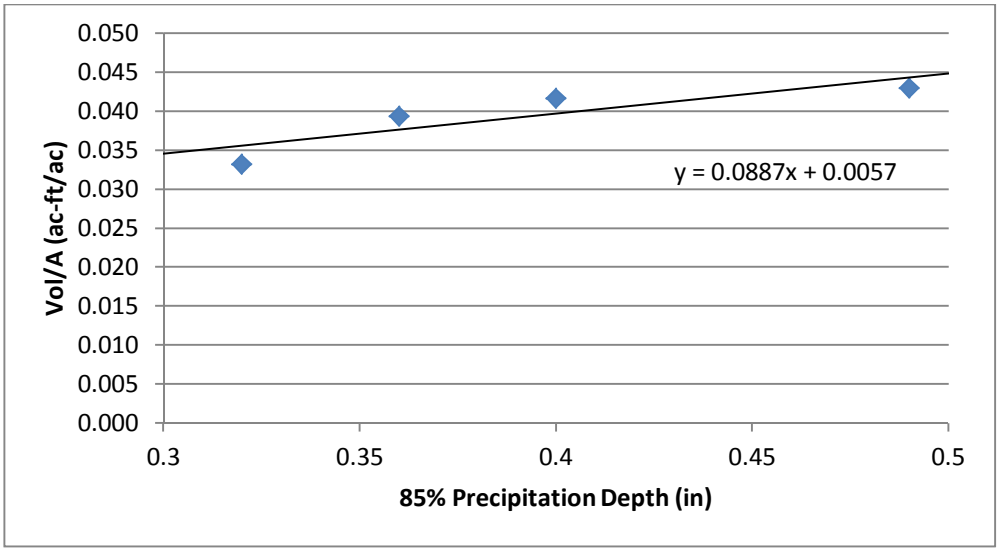



**Figure 6 Average Unit Runoff Volume vs 85% Precipitation for Average 90% Imperviousness Area**

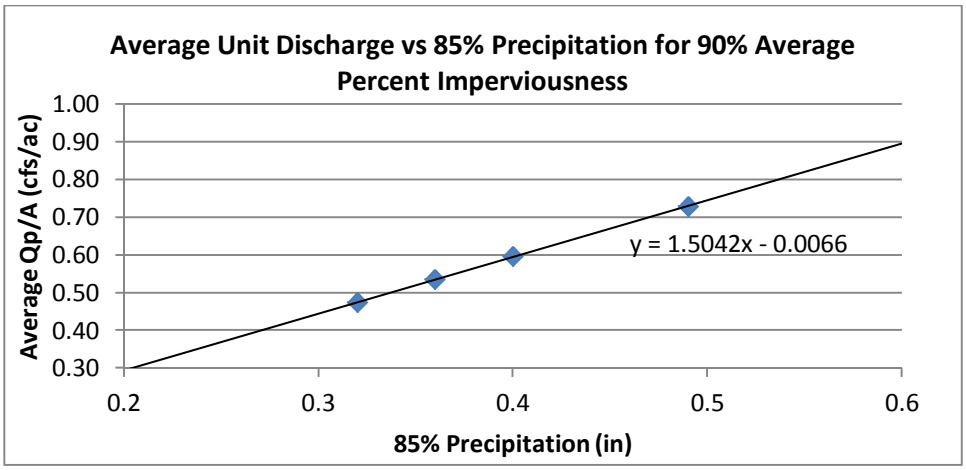
# 6 Steps to Determine Design Discharge and Volume for Parking Lot BMPs

This section describes the steps to be followed to determine the design hydrology for sizing parking lot BMPs in Las Vegas Valley.

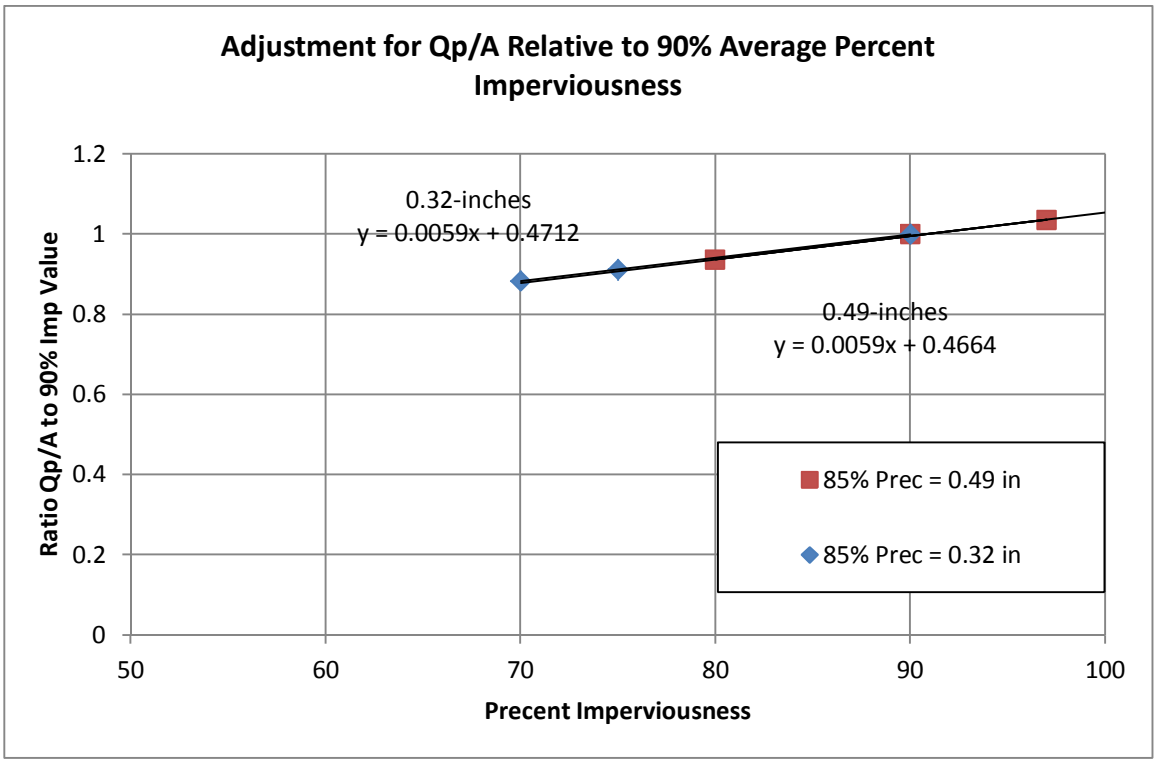
1. Determine BMP Design Precipitation - 85th Percentile Rainfall Depth
    a. Locate site on CCRFCD Design Rainfall Map for 2-year, 6-hour storm
    b. Determine the adjusted 2-year rainfall depth ($D_2$) for site, per CCRFCD methods
    c. Compute ratio of $D_2$ site : $D_2$ McCarran Area
    d. Compute 85th percentile rainfall depth ($D^{85}$) as 0.32 x $D_2$ ratio (0.32 is $D^{85}$ for McCarran Area)

2. Calculate BMP Design Peak Discharge

   a. Use the following chart or regression equation to calculate the unit discharge (Qp/A) for the 90 percent average percent impervious area condition based on the $D^{85}$ value.

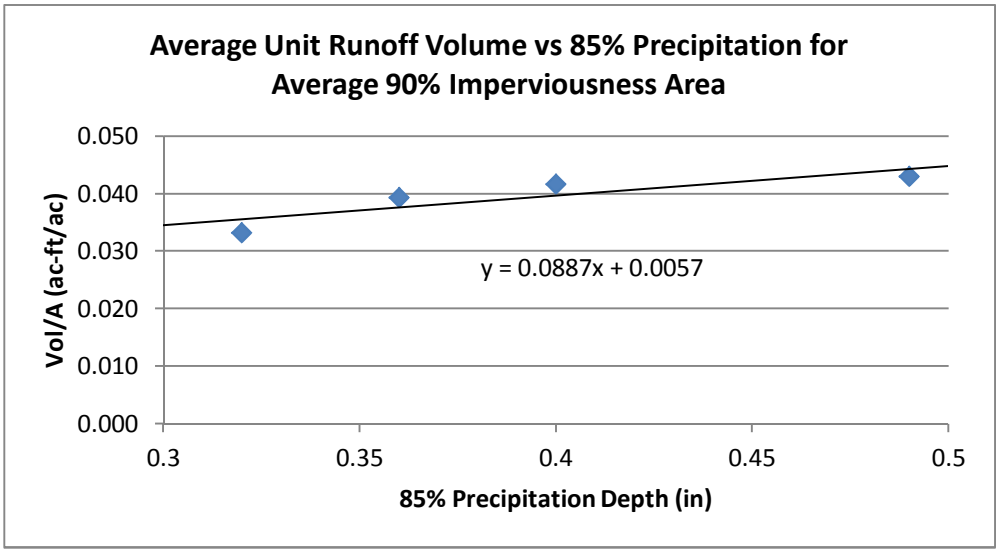



   b. Use the following chart or regression equation to calculate the unit discharge for the site based on the actual percent impervious area of the parking lot and associated landscaped areas




   c. Calculate the peak design discharge in cfs as Qp = Qp/A x A where Qp/A is from step (2b) and A is in acres

3. Calculate BMP Design Runoff Volume
    a. Use the following chart or regression equation to calculate the unit runoff volume (Vol/A) for the 90 percent imperviousness condition based on the $D^{85}$ value.




    b. Use the chart or regression equation in step (2b) to calculate the unit runoff volume for the site based on the actual average percent impervious area of the parking lot and associated landscaped areas

    c. Calculate the design runoff volume in acre-feet as Vol = Vol/A x A where Vol/A is from step (3b) and A is in acres

# 7 SAMPLE CALCULATION

Given: New Walmart in Summerlin area
Site Area = 100 acres
$D_2$ site / $D_2$ McCarran Area = 1.25
Average percent impervious area = 85% (parking lot and associated landscaped area)

1. Determine BMP Design Precipitation - 85th Percentile Rainfall Depth ($D^{85}$)
$D^{85}$ = 1.25 x 0.32 = 0.40 inches

2. Calculate BMP Design Discharge
Qp/A (90%) = 1.5042 x (0.40) - 0.0066 = 0.60

Find Adjustment Factor for percent imperviousness:
Qp/A = 0.60 x [(0.0059[85]) + 0.4688] = 0.58

Qp = 0.58 x 100 acres = 58 cfs

3. Calculate BMP Design Runoff Volume
   Vol/A (90%) = 0.0887 x 0.40 + 0.0057 = 0.04
   Vol/A = 0.04 x [(0.0059 x [85] + 0.4688)] = 0.04
   Vol = 0.04 x 100 acres = 4.0 ac-ft

# 8 REFERENCES

MWH 2009, "Unique Factors Influencing the Las Vegas Valley Municipal Separate Storm Sewer System Permit Program.

CCRFCD Clark County Regional Flood Control District Hydrologic Criteria and Drainage Design Manual

TECHNICAL MEMORANDUM

# LAS VEGAS VALLEY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

# STORMWATER MANAGEMENT PLAN DOCUMENTATION

## Technical Memorandum

## Maintenance of Public Facilities (MM-4) for Las Vegas Valley

October 31, 2013

*Prepared for*

**Stormwater Quality Management Committee**

*Prepared by*

MWH®

BUILDING A BETTER WORLD

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Appendix D – Entity-Owned and Operated Public Facilities With SWPPPs

Appendix E – General Maintenance Plan for Entity-Owned and Operated Facilities

# 1 Introduction

On February 9, 2010 the Nevada Division of Environmental Protection (NDEP) issued the Las Vegas Valley Municipal Separate Storm Sewer System Permit Renewal (MS4 Permit) for a period of five years. The 2010-2015 MS4 Permit is a "permit for authorization to discharge from municipal separate storm sewer systems to waters of the United States under the National Pollutant Discharge Elimination System." The Permittees include the City of Las Vegas, City of North Las Vegas, City of Henderson, Clark County, and the Clark County Regional Flood Control District. The MS4 Permit requires a source control measure program for existing and new development to mitigate the impacts of urbanization on stormwater quality, including a maintenance program to help remove sediment and other pollutants from the MS4 system.

A Storm Water Management Plan (SWMP) was prepared by the Permittees to outline the specific measures that were adopted to comply with the MS4 Permit requirements. This technical memorandum (TM) provides clarification on the maintenance of public facilities (best management practice [BMP] MM-4), which is one of the Permittees' responses to these permit requirements as outlined in the SWMP. This TM includes the following:

1. the permit requirements in the MS4 Permit;
2. BMP MM-4 as approved in the SWMP;
3. the proposed clarifications to BMP MM-4;
4. existing Municipally-owned facilities required to have maintenance plans per MM-4 and SWPPPs required through NDEP industrial site permitting; and
5. the proposed inspection and monitoring program.

# 2 MS4 Permit Requirement

The renewed 2010-2015 MS4 Permit for Las Vegas Valley includes the following requirements for the maintenance program to reduce pollutants in stormwater runoff.

*IV.E.1 The updated SWMP shall include a description of structural and source control measures expected to reduce pollutants from stormwater runoff from commercial and residential areas that are discharged into the MS4. This section shall also discuss the basis for the expected reduction of pollutant loads and a proposed schedule for implementing such controls. At a minimum, the description shall include:*

> *IV.E.1.a A description of maintenance activities and a maintenance schedule to reduce pollutants in discharges from MS4's;*

The focus of this part of the permit is on maintenance activities that would be performed on a regular basis to help reduce pollutants from entering the MS4 system. One of the BMPs described in the SWMP is MM-4, which addresses maintenance procedures to be applied to municipally owned facilities. The following sections describe existing and proposed elements of maintenance activities for municipal facilities to meet the requirements proposed in MM-4.

# 3 Maintenance and Inspection Program

## 3.1 Stormwater Management Plan Best Management Practice MM-4

To address the previously mentioned MS4 permit requirement, the Permittees proposed BMP MM-4 Maintenance of Public Facilities. This BMP provides that the Permittees will help reduce pollutants from entering the MS4 system by ensuring entity-owned sites with urban land uses such as parking lots, vehicle garages, and maintenance and washing areas are properly maintained. Maintenance activities may include, but are not limited to, drain inlet cleaning, proper vehicle maintenance activities and street sweeping. BMP MM-4 as approved by NDEP is included in Appendix A.

## 3.2 Revisions to Best Management Practice MM-4

As the Permittees put programs in place to address BMP MM-4, it was identified that the language in the BMP required an update. The original language implies that any entity-owned facility with a parking lot could be subject to the provisions of MM-4. It was not the intent of the BMP to include all public facilities with parking lots; there is a separate parking lot BMP that could address this situation. Additionally, the term "publicly owned and operated facility" is clarified to exclude properties that the entity owns but leases to a private company or individual. Appendix B provides the proposed revised language for BMP MM-4. The amendment to the language provides clarification on public facility categories that should have a maintenance plan.

## 3.3 Facility Maintenance Plans and Storm Water Pollution Prevention Plans

The Development Guidelines Working Group (DGWG) reviewed the following categories of publicly owned facilities to determine which categories will require a maintenance plan.

- buildings (including sidewalk)
- schools
- fire and police stations
- wastewater treatment plants
- parks
- vehicle garages and maintenance lots
- golf courses

After review and discussion by the DGWG, it was determined that golf courses, parks, vehicle garages and maintenance lots and vehicle washing areas will require a maintenance plan. These facility categories were selected based on their potential to contribute pollutants to the MS4.

As indicated in the updated BMP MM-4, each Permittee will have a maintenance plan for either each category of public facility or individual facilities, where necessary. The Permittees prepared a list of facilities that fit into the categories listed above; this is shown in Appendix C. Maintenance plans will be prepared for any facilities identified as requiring a maintenance plan that do not currently have one.

Storm Water Pollution Prevention Plans (SWPPPs) are prepared for sites that are required to have an industrial stormwater permit issued by NDEP. This applies to entity owned and operated facilities as well as privately owned and operated facilities. The SWPPP defines the specific onsite measures required to minimize the potential for discharging pollutants to the MS4 to the maximum extent practicable. For facilities requiring a maintenance plan and with an established SWPPP, the SWPPP may take the place of the maintenance plan. A spill prevention control and countermeasure

plan (SPCC) may be prepared by the Permittees in lieu of a maintenance plan or SWPPP as long as the SPCC meets the minimum stormwater mitigation requirements. The Permittees prepared a list of public facilities that currently have a SWPPP or SPCC; this is included in Appendix D.

### 3.4 Inspection and Maintenance Program

The Permittees will have maintenance plans in place by November 2013 as stated in BMP MM-4. Each facility requiring a maintenance plan will be inspected by maintenance staff at a minimum of once annually. Guidance for selecting minimum inspection and maintenance measures for a variety of site features is included in Appendix E. Also included in Appendix E is a sample maintenance checklist the Entity may utilize during site inspections. This checklist serves as a template and may be modified by each entity.

The Permittees will track the number of maintenance plans that are modified annually. This will be reported in the Annual Report under the Source Control and MS4 Maintenance Program.

## 4 Conclusion

The MS4 Permit which took effect on February 9, 2010 includes requirements for the Permittees to perform maintenance activities to reduce pollutants from entering the MS4 system. One of the BMPs adopted by the Permittees is BMP MM-4 Maintenance of Public Facilities. During implementation of the BMP, the Permittees identified proposed revisions to BMP MM-4 for approval by NDEP. The Permittees further identified categories of facilities which required maintenance plans. A General Maintenance Plan was developed by the Permittees that identifies the minimum inspection and maintenance measures to be included in site specific maintenance plans. Significant revisions to maintenance plans will be reported in the Annual Report. The proposed amendment to BMP MM-4 and NDEP approval will help the Permittees meet the maintenance requirements of the MS4 permit.

# 5 References

MWH. *Las Vegas Valley Municipal Separate Storm Sewer System Permit Stormwater Management Plan.* Prepared for Las Vegas Valley Stormwater Quality Management Committee. 2011.

Nevada Division of Environmental Protection. *2010 Las Vegas Valley MS4 Permit NV0021911.* February 2010.

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# Appendices

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# Appendix A –
# BMP MM-4 Maintenance of Public Facilities

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# MM-4 Maintenance of Public Facilities

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Source Control and Maintenance Measures

### Description

This BMP consists of measures for maintaining entity-owned sites with urban land uses such as parking lots, garages, and vehicle storage and maintenance areas. These measures are similar to MM-1 and MM-2 and involve street sweeping, drain inlet cleaning and vehicle maintenance on publicly owned parcels, as well as other BMPs that may be unique to the specific site conditions. In some cases public sites are cleaned on a regular schedule (ex., monthly) and in other cases maintenance occurs on an as-needed basis. In each case maintenance is the responsibility of the entity. Specific examples of maintenance criteria include the following.

- Clark County Real Property Management Department manages County property and cleans parking lots as needed.
- CNLV parking lots are swept monthly; washing bay at City Central Garage is cleaned daily.

A Stormwater Pollution Prevention Plan (SWPPP) will be prepared for entity-owned sites, if an industrial stormwater permit is required by NDEP. The SWPPP will define the specific onsite measures required to minimize the potential for discharging pollutants to the MS4 to the maximum extent practical. Each public facility will have a maintenance plan that describes measures required to minimize the potential for discharging pollutants to the MS4.

Clark County Department of Aviation manages McCarran Airport, Henderson Airport, North Las Vegas Airport and McCarran Bus Facility. All of these facilities have individual SWPPPs that identify specific maintenance activities to minimize contributions to stormwater pollutant loads.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Number of maintenance plans modified annually

### Measureable Goals

- Each public facility will have a maintenance plan in place 2 year from acceptance of the SWMP.
- Maintenance plans will be reviewed every other year for revisions.
- Develop SWPPPs as appropriate.

# Appendix B –
# BMP MM-4 Maintenance of Public Facilities
# Proposed Revised Language

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# MM-4 Maintenance of Public Facilities (Proposed Revision)

### Stormwater Management Plan Section(s)

This measure is proposed to meet permit requirements for the following SWMP sections:

- Source Control and Maintenance Measures

### Description

This BMP consists of measures for maintaining entity-owned sites with urban land uses such as garages, and vehicle storage and maintenance areas. The measures are similar to MM-1 and MM-2 and involve street sweeping, drain inlet cleaning and vehicle maintenance on publically owned parcels as other BMPs that may be unique to the specific site conditions. In some cases public sites are cleaned on a regular schedule (ex., monthly) and in other cases maintenance occurs on an as-needed basis. In each case maintenance is the responsibility of the entity. Each Permittee will have either an agency wide maintenance plan for applicable categories of public facilities, a maintenance plan for each public facility, or a Storm Water Pollution Prevention Plan (SWPPP) in place two years from the acceptance of the SWMP.

Each entity prepared an inventory of all publicly owned and operated sites. For the purpose of this BMP, a publicly owned and operated facility excludes properties that the entity owns but leases to a private company / individual. The DGWG reviewed the categories of publicly owned and operated facilities and identified those that could have the potential to contribute pollutants to the MS4. Based on this review, the DGWG determined that municipal maintenance plans or SWPPPs would be required for facilities in the following categories:

- Parks
- Golf Courses
- Vehicle Garages and Maintenance Areas
- Vehicle Washing Areas

Facilities in these categories that do not require a SWPPP will have a maintenance plan in place within two years from approval of the SWMP.

A SWPPP will be prepared for entity-owned sites, if an industrial stormwater permit is required by NDEP. The SWPPP will define the specific onsite measures required to minimize the potential for discharging pollutants to the MS4 to the maximum extent practical. Each public facility will have a maintenance plan that describes measures required to minimize the potential for discharging pollutants to the MS4.

Clark County Department of Aviation manages McCarran Airport, Henderson Airport, North Las Vegas Airport and McCarran Bus Facility. All of these facilities have individual SWPPPs that identify specific maintenance activities to minimize contributions to stormwater pollutant loads.

### Responsible Party

This measure is implemented by the following parties:

- Clark County
- City of Las Vegas
- City of North Las Vegas
- City of Henderson

### Monitoring and Tracking Information

- Number of maintenance plans modified annually

### Measureable Goals

- Each public facility will have a maintenance plan in place 2 year from acceptance of the SWMP.
- Maintenance plans will be reviewed every other year for revisions.
- Develop SWPPPs as appropriate.

# Appendix C –
# Entity-Owned and Operated Public Facilities
# With Maintenance Plans

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**Entity-Owned and Operated Public Facilities With Maintenance Plans**

| Facility Category | Permittee | | | |
|---|---|---|---|---|
| | **Clark County** | **City of Las Vegas** | **City of North Las Vegas** | **City of Henderson** |
| **Municipal Parks** | Alexander Villas Park | All American Park | Aviary Park | Acacia Park & Demonstration Gardens |
| | Myrna Torme Williams Campus / Cambridge Bath House/Playground, Pool, Skate | Aloha Shores Park | Boris Terrace Park | Allegro Park |
| | Cannon, Helen C School Park | Angel Park Detention Basin | Brooks Tot Lot | Amador Vista Park |
| | Chavez, Cesar Park | Angel Park South | Cheyenne Ridge Park | Anthem Hills Park & Anthem East Trailhead |
| | Davis Park | Ansan Sister Park | Cheyenne Sports Complex | Arroyo Grande Sports Complex |
| | Desert Breeze Park | Baker Park | City View Park | Avellino Park |
| | Desert Bloom Park | Betty Wilson Annex | College Park | Basic High Ball Fields |
| | Desert Inn Park | Betty Wilson Soccer Complex | Craig Ranch Regional Park | Bird Viewing Preserve |
| | Duck Creek Park | Bill Briare Family Park | Deer Springs Park | Brown Junior High School Park |
| | Grapevine Springs Park | Bob Baskin Park | Desert Horizons Park | Burkholder Park |
| | Harmony Park | Bradley Bridle Park | Eldorado Park | Cactus Wren Park |
| | Harney School Park | Bruce Trent Park | Gold Crest Park | Cinnamon Ridge Park |
| | Hidden Palms Park | Buckskin Park | Hartke Park | Cornerstone Park |

| Facility Category | Permittee | | | |
|---|---|---|---|---|
| | Clark County | City of Las Vegas | City of North Las Vegas | City of Henderson |
| **Municipal Parks** | Hollywood Park | Wayne Bunker Park | Hebert Memorial Park | Discovery Park |
| | Joe Shoong Park | Cameron Community Park | James K. Seastrand Park | Dos Escuelas Park |
| | Laurelwood Park | Centennial Hills Park | Joe Kneip Park | Downtown Park |
| | Lewis Family Park | Charleston Heights Park | Monte Vista Park | Equestrian Park North |
| | Lone Mountain Park | Charleston Preservation Park | Nature Discovery Park | Equestrian Park South & Trailhead |
| | Magdalenas Vegas Mountain Park | Childrens Memorial Park | Nicholas E. Flores Jr. Park | Esselmont Park |
| | Martin Luther King Park | Cimarron Rose Park & Center | Petitti Park | Fox Ridge Park |
| | Maslow Park | Coleman Park | Prentiss Walker Memorial Park | Galloway School Park |
| | Mccarran Market Soccer Park | Cragin Park & Fire Station 5 | Richard Tam Park | Green Valley Park |
| | Dr. William U. Pearson Park / Mlk Carey Early Childhood Dev Ctr | Desert Pines Golf Course | Rotary Tot Lot | Hayley Hendricks Park |
| | Molasky Park | Dexter Park | Sandstone Ridge Park | Heritage Park |
| | Mountain Crest Park | Doc Romero Park | Theron H. Goynes Park | Hidden Falls Park & Amargosa Trailhead |
| | Mountain View School Park | Doolittle Park & Center, Art Center | Tom Williams Park | Madeira Canyon Park |
| | Nellis Meadows Park | Douglas Selby Park | Tonopah park | Mission Hills Park |
| | Nevada Trails Park | Durango Hills Golf Course (&YMCA) | Valley View Park | Morrell Park |
| | Old Spanish Trail Park | East City Service Center | Willie McCool Regional Park | Mountain View Park |

| Facility Category | Permittee | | | |
|---|---|---|---|---|
| | Clark County | City of Las Vegas | City of North Las Vegas | City of Henderson |
| **Municipal Parks** | Orr, William E School Park | East Las Vegas Community Center | Windsor Park | O'Callaghan Park |
| | Parkdale Park | Ed Fountain Park | | Paseo Verde Park |
| | Paradise Vista Park | Ethyl Pearson Park | | Paseo Verde/Amargosa Trailhead |
| | Paul Meyer Park | Firefighters Park | | Paseo Vista Park |
| | Paradise Park | Fitzgerald Tot Lot Park | | Pecos Legacy Park |
| | Pebble Park | Floyd Lamb Park | | Puccini Park |
| | Potosi Park | Freedom Park | | Railroad Pass Trailhead |
| | Robert E. (Bob) Price Park | Garehime Park | | Reunion Trails Park & Amargosa Trailhead |
| | Prosperity Park | Gilcrease Brothers Park | | River Mountain Park |
| | Shadow Rock Park | Hadland Park | | Roadrunner Park |
| | Old Silver Bowl Park | Heers Park | | Rodeo Park |
| | New Silver Bowl Park | Heritage Park | | Russell Road Recreation Complex |
| | Silverado Ranch Park | Huntridge Circle Park | | Saguaro Park |
| | Spring Valley Community Park | James Gay III Park | | Sewell School Park |
| | Sunrise Park | Johnson Community School | | Shaded Canyon Trailhead |
| | Sunset Park | Justice Myron E Leavitt Family Park | | Siena Heights/Amargosa Trailhead |
| | Sunset Park Warm Springs | Kellogg Zaher Sports Complex | | Silver Springs Park |

| Facility Category | Permittee | | | |
|---|---|---|---|---|
| | Clark County | City of Las Vegas | City of North Las Vegas | City of Henderson |
| **Municipal Parks** | Western Trails Park | Las Vegas Sportspark | | Solista Park |
| | Wetlands Park | Lorenzi Park | | Sonata Park |
| | Whitney Park | Lubertha Johnson Park | | Stephanie Lynn Craig Park |
| | William Bennett Air Park | Majestic Park | | Sunridge Park |
| | Winchester Park | Mary Dutton Park | | Trail Canyon Park |
| | Winterwood Park | Mike Morgan Park | | Tuscany Park |
| | Walnut Park | Mirabelli Park & Center | | Vivaldi Park |
| | Charlie Frias Park | Mountain Ridge Park | | Wells Park & Pool |
| | Community Park | Muni Golf Club | | Weston Hills Park |
| | Guinn, Kenny Middle School Park | Pioneer Park | | White School Park |
| | Red Ridge Park | Police Memorial Park | | Whitney Mesa Nature Preserve |
| | Dog Fanciers & Horseman's Parks | Rainbow Family Park | | Whitney Mesa Recreation Area |
| | Cora Coleman Senior Center | Rotary Park | | |
| | Cashman, James School Park | Satellite Yard | | |
| | Ravenwood Park | Sky Ridge Park | | |
| | Silvestri, Charles A School Park | Stewart Place Park | | |
| | Von Tobel, Ed School Park | Teton Trails Park | | |

| Facility Category | Permittee | | | |
|---|---|---|---|---|
| | Clark County | City of Las Vegas | City of North Las Vegas | City of Henderson |
| **Municipal Parks** | West Flamingo Park | Raptor Park | | |
| | Shooting Park | Viper Lacrosse Fields | | |
| | Lamb Wayside | Veterans Memorial | | |
| | Charlie Frias Park | West Charleston Lions Park | | |
| | Pecos-Di Trailhead | West City Service Center | | |
| | Sloan Trailhead | Wildwood park | | |
| | Sunrise Trailhead | Widning Trails Park | | |
| | Wetlands Park - Pabco Trailhead | Woofter Family Park | | |
| | Wetlands Park - Wells Trailhead | | | |
| **Municipal Golf Courses** | | | Municipal Golf Course | |
| | | | Aliante Golf Course | |
| **Municipal Garages and Maintenance Areas** | Auction Yard | | Central Garage on Brooks | |
| | Automotive Stephanie | | | |
| | Bldg Department Russell Cameron Campus/ Auto Shop | | | |
| | Arden Site (Lease) / Maintenance/ Def. Shelter | | | |

| Facility Category | Permittee | | | |
|---|---|---|---|---|
| | Clark County | City of Las Vegas | City of North Las Vegas | City of Henderson |
| **Municipal Garages and Maintenance Areas** | Craft Shop Flamingo | | | |
| | Public Works Sweeper Truck Cleanout Facility | | | |
| | Stephanie Street | | | |
| | Public Works Stephanie Campus | | | |
| | Public Works Traffic Building | | | |
| | Public Works Welding Shop | | | |
| | Public Works Crew Building | | | |
| | Vector Control Storage 1 | | | |
| | Parks & Rec Stephanie Maintenance Campus | | | |
| **Municipal Vehicle Washing Area** | Clark County Government Center Campus | | | |

# Appendix D –
# Entity-Owned and Operated Public Facilities
# With SWPPPs

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**Entity-Owned and Operated Public Facilities With SWPPPs or SPCC Plans**

| Permittee | | | |
|---|---|---|---|
| **Clark County** | **City of Las Vegas** | **City of Henderson** | **City of North Las Vegas** |
| Clark County Water Reclamation District Waste Water Treatment Plant | Water Pollution Control Facility | Kurt R Segler Water Reclamation Facility | Water Reclamation Facility |
| Clark County Water Reclamation District Desert Breeze Facility | | Southwest Water Reclamation Facility | |
| McCarran Airport | | Water Treatment Plant | |
| Henderson Airport | | | |
| North Las Vegas Airport | | | |
| McCarran Airport Ground Transportation Facility | | | |

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# Appendix E –
# Guidance for Selecting Maintenance Measures for Entity-Owned and Operated Facilities

## Maintenance of Public Facilities Site Inspection Checklist

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## Guidance for Selecting Maintenance Measures for Entity-Owned and Operated Facilities

| Feature | Inspection Schedule | Inspection and Maintenance Measures |
|---|---|---|
| Vegetated Areas | Annually and after heavy rains | Inspect slopes and embankments |
| | | Stabilize erosion areas |
| | | Mow vegetation as specified for the area |
| Ditches, Swales, and Open Stormwater Channels | Late spring, late fall, and after heavy rains | Remove obstructions, sediments, or debris from ditches, swales, and other open channels |
| | | Stabilize erosion areas |
| Culverts | Annually and after heavy rains | Remove obstructions, sediments, and debris |
| | | Repair significant damage at the culvert's inlet and outlet |
| Drain Inlet Cleaning | Annually and after heavy rains | Inspect drain inlets |
| | | Remove obstructions or debris |
| | | Repair significant damage |
| Catch Basins | Annually | Remove sediments and debris from the bottom of the basin and inlet grates |
| Roadway and Parking Areas | Annually and after heavy rains | Sweep pavement, drivable concrete areas, and gutters to remove sediment |
| | | Grade gravel roads and gravel shoulders as necessary |
| Buffer Areas | Annually and after heavy rains | Inspect buffers for evidence of erosion or concentrated flow |
| | | Repair signs of erosion within a buffer |
| | | Inspect and remove debris |
| Detention/Retention Basins | Annually and after heavy rains | Inspect embankments for erosion |
| | | Inspect the outlet structure for obstructions and plugged trash racks |
| | | Remove and dispose of sediments and debris |
| | | Repair any damage |
| Proprietary Devices | As specified by manufacturer | Follow the manufacturer's plan for cleaning of devices |
| Fertilizers / Pesticides | Per BMP | Public landscaping crew supervisors should be trained within 12 months, per BMP SC-3. |
| | | Review "green" products to replace traditional fertilizers / pesticides per BMP SC-4. |
| Vehicle Maintenance & Storage | As needed and before heavy rain | Trash and debris shall be removed and properly stored or disposed of daily |
| | | Recycle used motor oils and other vehicle fluids and parts when possible |
| | | Material for spill control/containment must be on site |
| Other Practices | As specified for devices | Contact the local entity for appropriate inspection and maintenance requirements for other drainage control and runoff treatment measures |

***Maintenance of Public Facilities***
***Municipal Separate Storm Sewer System Permit***

# Site Inspection Checklist

| **Facility Name / Address:** | |
|---|---|
| **Inspector Completing Inspection :** | **Date / Time of Inspection:** |
| **Jurisdiction:** *(circle one)*<br>***COH CLV CNLV CC*** | |

| **Inspection Criteria for Parks, Golf Course and Landscape Areas** | **Yes** | **No** | **N/A** |
|---|---|---|---|
| 1. Were slopes and embankments inspected? | | | |
| 2. Are erosion areas stabilized? | | | |
| 3. Is vegetation mowed as specified for the area? | | | |
| 4. Were drain inlets inspected and cleaned if needed? | | | |
| 5. Were drivable concrete areas and gutters swept to remove sediment? | | | |
| 6. Is vegetation mowed as specified for the area? | | | |
| 7. Are "green" or alternative products used in place of traditional fertilizers / pesticides? | | | |
| 8. Were obstructions, sediments, and debris removed from ditches and swales? | | | |
| **Inspection Criteria Vehicle Maintenance & Storage** | | | |
| 1. Are trash and debris removed and properly stored or disposed of daily? | | | |
| 2. Are used motor oils and other vehicle fluids and parts recycled when possible? | | | |
| 3. Are proper materials onsite for spill control/containment? | | | |
| 4. Is the storage area in a clean and orderly manner (containers in good condition, containers in a secure location, lids secure)? | | | |
| **Actions Required** | **Yes** | **No** | **N/A** |
| 1. Are corrections needed? | | | |
| 2. Is a follow up inspection needed? | | | |
| 3. Other | | | |

**Comments:** *(include location/description of problems observed; continue on back)*