DRAFT TECH SUPPORT DATA VOLUME I

Technical Support Data Notebook

For

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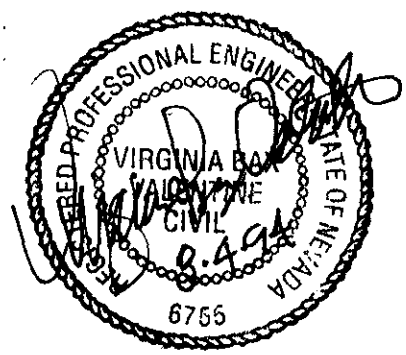
FLOOD INSURANCE STUDY

RESTUDY

HIKO SPRINGS & BRIDGE CANYON WASHES

Clark County, Nevada
(Unincorporated Areas)

VOLUME I OF III



Submitted by:	Clark County Regional Flood Control District
Study Contractor:	Post, Buckley, Schuh & Jernigan, Inc.
Date Submitted:	March 4, 1994

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SECTION 1

GENERAL DOCUMENTATION

1.1 Certification Forms for Study Contractors

1.2 Telephone Contact Reports

1.3 Meeting Minutes/Reports

1.4 General Correspondence

SECTION 1.1

Certification Forms for Study Contractors

FORM 1

CERTIFICATION OF COMPLIANCE

This form must be signed by a senior representative of the firm who is registered as a Professional Engineer (private study contractors) or by the responsible official (government agencies).

This is to certify that all work accomplished in the conduct of this Flood Insurance Study for the community of: Clark County, Nevada (Unincorporated Areas) Hiko Springs and Bridge Canyon Washes _____ was done in accordance with the Statement of Work and General Provisions of Contract Number _____ (or, in the case of Federal agencies, Inter-Agency Agreement Number _____), and all amendments thereto, together with all such modifications, either written or oral, as the Regional Project Officer (PO) and/or the Contracting Officer or their representatives have directed, as such modifications affect this contract, and that all such work has been accomplished in accordance with the provisions contained in Guidelines and Specifications for Study Contractors, and in accordance with sound and accepted engineering practice within the contract provisions for respective phases of the work.

This is also to certify that:

- For Contiguous Communities: (Check one or more which apply)

X The draft FIS is entirely within the corporate limits of the studied community and no contiguous communities are impacted.

___ The Base (100-year) Flood Elevations (BFEs), floodplains, and floodways computed and depicted for this draft Flood Insurance Study (FIS), are in complete agreement with all effective FISs for the contiguous communities and all discrepancies have been resolved, or

___ Draft FIS revisions have also been submitted for affected contiguous communities, or

___ The discrepancies with the effective FISs for the contiguous communities could not be resolved; these discrepancies have been coordinated with the PO and documented and approved by the PO (attach documentation).

CERTIFICATION OF COMPLIANCE

This is also to certify that:

- Within the Flood Insurance Study for this Community: (Check one or both if applicable)

X The BFEs, 100-year floodplain and floodway for the revised portion(s) of the stream(s) restudied in this draft FIS, tie into the effective FIS (BFEs must tie-in within 0.5 foot), or

___ if a tie-in could not be achieved, it was coordinated with the PO and documented and approved by the PO. (attach documentation)

- For each flooding source studied:

  An Internal Agreement (consistency) check has been performed to ensure agreement between maps, profiles, hydrologic and hydraulic models, and FIS report for channel distances, BFEs, and floodway widths as recommended in the Flood Insurance Study Guidelines and Specifications for Study Contractors.

- Levee/floodwall systems shown in the draft FIS as providing protection from the 100-year flood meet the provisions of Section 65.10 of the National Flood Insurance Program (NFIP) regulations.

Name: Virginia Valentine
(please type or print)

Title: Vice President
(please type or print)

Firm/Agency: Post, Buckley, Schuh & Jernigan, Inc.
(please type or print)

Registration No. 6755 (if applicable) Expiration Date: 12/95 (if applicable)

State Nevada (if applicable)

Signature

3.4.94
Date

Seal
(optional)

FORM 2

CHECKLIST OF SUBMITTED ITEMS FORM

All items described in the Guidelines and Specifications for Study Contractors (G&S) shall be organized in the form of a Technical Support Data Notebook (TSDN) and shall be submitted to the Technical Evaluation Contractor as identified by the Regional Project Officer.

The specific requirements for the data to be included in the five major sections of the TSDN are described in the G&S. Check each item that has been included.

General Documentation

X	i)	Special Problem Reports
X	ii)	Contact (Telephone Conversation) Reports
X	iii)	Meeting Minutes/Reports
X	iv)	General Correspondence

Engineering Analyses

X	i)	Hydrologic Analyses (in printout form and computer diskette if applicable)
X	ii)	Hydraulic Analyses (in printout form and computer diskette)
X	iii)	Supporting hand calculations, sketches, and figures used to compute hydrologic and hydraulic analyses.
	iv)	Key to Cross-Section Labeling
	v)	Key to Transect Labeling

Draft FIS Report Data

	i)	Profiles for all detailed study streams
	ii)	Tables
		Summary of Discharges
		Summary of Stillwater Elevations
		Floodway Data
		Transect Description
		Transect Data
	iii)	General descriptive paragraphs
	iv)	Photographs of historic flooding
	v)	Elevation Reference Mark Descriptions

Mapping Information

	i)	Riverine Mapping
	ii)	Coastal Mapping
X	iii)	Alluvial Fan Mapping

CHECKLIST OF SUBMITTED ITEMS FORM

Forms Included:

Check forms submitted:

Forms 1, 2, and 3 must be submitted.

X	Form 1	Certification of Compliance Form
X	Form 2	Checklist of Submitted Items Form
X	Form 3	Scope of Study and Community Information Form

The following forms must be included, as applicable to the study:

(check forms included)

X	Form 4	Hydrologic Analysis Form
	Form 5	Riverine Hydraulic Analysis Form
	Form 6	Riverine Mapping Form
	Form 7	Coastal Analysis Form
	Form 8	Coastal Structures Form
	Form 9	Coastal Mapping Form
X	Form 10	Levee/Floodwall System Analysis Form
	Form 11	Dam Form
X	Form 12	Alluvial Fan Analysis Form
	Form 13	Ice Jam Analysis Form

Miscellaneous Reference Materials

Provide a list of all reference materials submitted with this draft study.

See attached list

REFERENCE MATERIAL SUBMITTED WITH DRAFT FIS

1. Boyle, 1989. *Facilities Plan for Hiko Springs and Unnamed Wash Laughlin - Big Bend Area, Clark County, Nevada* (Chapter 3). Prepared by Boyle Engineering Corporation, for Clark County Regional Flood Control District, May, 1989.

2. CVL, 1990. *Bridge Canyon Wash Flood Control Master Plan, Laughlin, Nevada* (Chapter 6). Prepared by Coe & Van Loo Consulting Engineers, for Clark County Regional Flood Control District, September, 1990.

3. JMM, 1988. *Improvement Plans for Crown Point Development*, Sheets C-1 through C-5. Prepared by James M. Montgomery Engineers, Inc., for Meadows Development Company, dated November 21, 1988.

4. JMM, 1989. *Improvement Plans for Crown Point Development*, Sheets SC-1 through SC-5. Prepared by James M. Montgomery Engineers, Inc., for Meadows Development Company, September 18, 1989.

5. Lenzotti, 1989. *Study for Hydraulic and Sediment Transport of Proposed Crown Point Flood Wall*. Prepared by Lenzotti & Fullerton, Consulting Engineers, Inc., for Meadows Development Company, Revised April 20, 1989.

6. NDOT, 1993. *SR-163 Construction Plans from JCT. US95 via Laughlin to NEV.-ARIZ. State Line*. State of Nevada Department of Transportation, August 18, 1993.

7. PBS&J, 1994. *Needles Highway Street Improvements, SID #91*, Sheets C20, C21, SD9, SD10 and Structural Detail Sheet 1 of 1. Prepared by Post, Buckley, Schuh & Jernigan, Inc., for Clark County Department of Public Works, 1994.

8. SEA, 1990. *Hydrology Study Laughlin High School*. Prepared by SEA Inc. Consulting Engineers, for Kittrell Garlock Associates, AIA, January, 1990, and Addendum #1, May, 1990.

9. WRC, 1993. *Hydraulic Design Report for Phase-V SR163 P059-93-010.* Prepared by WRC NEVADA, Inc. Consulting Engineers, for Nevada Department of Transportation, June, 1993.

FORM 3

SCOPE OF STUDY AND COMMUNITY INFORMATION FORM

Flood Insurance Study
Community Coordination

Unincorporated Areas	Clark	Nevada
Community Name	County	State

If study impacts more than one community, attach a listing of all impacted communities.

Study Contractor: Post, Buckley, Schuh & Jernigan, Inc.

Subcontractor (if applicable): _____

Completion Date (month and year): February 1994

Initial Consultation and Coordination Officer's (CCO's) meeting date: May 19, 1993

A list of attendees and agencies represented at the initial CCO meeting is attached. ☐ Yes ☒ No ☐ N/A

Does the state have jurisdiction over floodplains or their adoption by communities participating in the NFIP? ☐ Yes ☒ No

If yes, has the state approved the analyses? ☐ Yes ☐ No ☒ N/A

If no, has the analyses been submitted to the appropriate state agency? ☐ Yes ☐ No ☒ N/A

SCOPE OF STUDY AND COMMUNITY INFORMATION FORM

Scope of Study

Were analyses performed for the 10-, 50-, 100-, and 500-year floods? ☐ Yes ☒ No

If no, please explain:

100-year flood plain boundaries were delineated.
500-year flood plain boundaries were taken directly from previous FIS

List flooding sources studied and check type of study:

Name	Detailed		Approximate
Riverine Sources:			
	☐ with floodway	☐ w/o floodway	☐ approximate
	☐ with floodway	☐ w/o floodway	☐ approximate
	☐ with floodway	☐ w/o floodway	☐ approximate
	☐ with floodway	☐ w/o floodway	☐ approximate
	☐ with floodway	☐ w/o floodway	☐ approximate
	☐ with floodway	☐ w/o floodway	☐ approximate
	☐ with floodway	☐ w/o floodway	☐ approximate
	☐ with floodway	☐ w/o floodway	☐ approximate
	☐ with floodway	☐ w/o floodway	☐ approximate
Coastal:			
	☐ detailed		☐ approximate
	☐ detailed		☐ approximate
	☐ detailed		☐ approximate
	☐ detailed		☐ approximate
Alluvial Fan Flooding:			
Hiko Springs Wash	☒ detailed		☐ approximate
Bridge Canyon Fan	☒ detailed		☐ approximate
Area downstream of Bridge Canyon Fan	☐ detailed		☒ approximate
	☐ detailed		☐ approximate

USGS Quad Maps showing the limits of study must be provided.

FIS Report Information

If there is no published FIS Report or the FIS Report contains inadequate descriptions, the following must be provided:

Community Description	Provided?		
• A general description of the community's location within the county and state.	[X] Yes	[ ] No	
• A list of surrounding communities and their locations with respect to the subject community.	[X] Yes	[ ] No	
• A brief description of the community.	[X] Yes	[ ] No	
This description may include patterns of residential and commercial development; the extent and nature of floodplain development; natural features that affect flood hazards in the community; and sufficient description of climatic, physiographic, and land use factors to support the discussion of flood problems.			
Principal Flood Problems			
• Discharges and Annual Exceedance Probability of major floods.	[X] Yes	[ ] No	
• Gage name and number for all gages used for studied streams:	[ ] Yes	[X] No	
• Photos, if available, of flooding, flood control structures, etc., with date, subject, and location of photo noted.	[ ] Yes	[X] No	
Flood Protection Measures			
• Description of all flood protection structures and floodplain management measures used to reduce potential flood damage in the watersheds studied. Provide names of government entities responsible for operations and maintenance.	[X] Yes	[ ] No	[ ] N/A
• A list of dams on the watersheds studied used for purposes other than flood control.	[ ] Yes	[ ] No	[X] N/A
Other Sections			
• Complete descriptive data as outlined in the Guidelines and Specifications for Study Contractors.	[X] Yes	[ ] No	

FORM 4

HYDROLOGIC ANALYSIS FORM

Community Name: Clark County, Nevada (Unincorporated Areas)

Flooding Source: Hiko Springs and Bridge Canyon Washes

For each flooding source to be studied by detailed methods, provide the following information:

A. **Evaluation of currently available Flood Flow Information**

1. **If the stream has not been studied by any local, State, or Federal Agency, proceed to Section C.**

2. **The stream was studied in the effective FIS as:**

   ☐ **Approximate study stream (Zone A); proceed to Section C**
   ☒ **Detailed study stream (state methodology and record the 100-year discharges from the effective FIS at appropriate locations on Attachment E).** Methodology unknown

3. **Has a flood flow frequency analysis been performed by more than one Federal (including FEMA), state, or local agency?**

   ☐ Yes ☒ No

   If no flood flow frequency analysis has been performed, proceed to Section C. If only one flood flow frequency analysis has been performed, proceed to Section A5. If more than one flood flow frequency analysis has been performed, are the discharges different?

   ☒ Yes ☐ No

   If yes, attach documentation of resolution of differences with affected agencies and select appropriate analysis.

4. **Was the effective FIS analysis selected?**

   ☐ Yes ☒ No ☐ N/A

   If yes, proceed to Section A5, unless a statistical analysis was used then proceed to Section B2.

   If no, or N/A, indicate below what type of analysis, was selected:

   ☐ Statistical analysis - proceed to Section B2
   ☐ Regional regression equations
   ☒ Rainfall/runoff model
   ☒ Other (specify) Regional standard deviation and skew

5. **If the discharges from the above analysis are to be used directly in the hydraulic analysis without any modifications, record the discharges on Attachment E and proceed to Section B2. If the above analysis is to be modified, proceed to Section B.**

B. Preliminary Analysis - A preliminary analysis is to be performed to test whether a restudy should be conducted based on revised discharges.

1. Determine the revised 100-year discharges for the existing watershed conditions at the same locations as above. Project Officer approval should be obtained to create a new model if the model for the above analysis is not available on computer disk.

An analysis different from the current analysis may be used to determine the revised discharges.

a. The revised 100-year discharges are being determined by:

- ☐ Statistical Analysis
- ☐ Regional Regression Equations
- ☒ Rainfall/Runoff Model
- ☒ Other (specify): Regional standard deviation and skew

b. Explain the reasons for selecting the analysis to determine the revised discharges:

Revised rainfall/runoff model based on 6-hour storm duration.

Current analysis based on 3-hour duration.

c. Record the revised 100-year discharges on Attachment E.

Evaluation of Effective Information N/A

2. a. If a statistical analysis of gage records was performed, the confidence limits must be evaluated (complete Attachment F).

b. Is the effective 100-year discharge within the 50% confidence interval of the revised 100-year discharge?

☐ Yes ☐ No

1) If no, proceed to Section B2c.

2) If yes, is there reason to update the hydraulic analysis? ☐ Yes ☐ No

If no, the flooding source should not be restudied.

If yes, the flooding source should be restudied using revised discharges.

c. If effective 100-year water-surface elevations are available, do the revised 100-year flood discharges cause a change in the effective water-surface elevations of more than 0.5 foot? (Use Attachment E). (Revised 100-year water-surface elevations for the revised discharges may be interpolated from the effective study printouts, profiles, or computations).

☐ Yes ☐ No ☐ N/A

If yes, the hydrologic analysis should be revised. Provide any additional reasons below why a restudy based on revised hydrology is justified, and proceed to Section C.

If no, the flooding source should not be restudied unless there are reasons to update the hydraulic analysis. If so, proceed to Section C.

C. Methodology for Final Analysis

Before selection of methodology for final analysis, the following should be evaluated:

1. Is watershed being developed and/or is it projected to undergo development? ☐ Yes ☒ No

2. Are there reservoirs or flood control features in the watershed? ☐ Yes ☒ No

3. Refer to Guidelines and Specifications for Study Contractors for selection of appropriate *hydrologic methods*. Indicate method selected.

- ☐ Current discharges will be used in the hydraulic analysis
- ☐ Statistical analysis of gage records (use Attachment B)
- ☐ Regional regressional equations (use Attachment C)
- ☒ Rainfall/Runoff Model (use Attachment D)
- ☒ Other (specify): Regional standard deviation and skew and provide a full bibliographical reference and pertinent analysis

Explain the reasons for selecting the method to determine the discharges.
Since there are no stream flow records in the study area, rainfall/runoff methods are used.
Regional statistical data was recommended by FEMA's TEC.

Record the computed discharges at selected locations on Attachment A.

D. Approval of Analysis

☐ Approved by FEMA Region _____ Project Officer
(Name: _____)
(Date: _____)

Approved by other Federal, State, or *local government agency*(ies) if required: (Please provide evidence of approval.)

☒ Agency *Clark County Regional Flood Control District (CCRFCD) date 1989, 1990
date
date

☐ Approval by other Federal, State, or local government agency not required.

* Study performed under contract with CCRFCD.

Attachment A - Summary of Discharges

Stream	Location	Drainage Area (mi^2)	Peak Discharges (cfs)			
			10-year	50-year	100-year	500-year
Hiko Springs Wash	Apex	18.3	1607	6096	9759	25301
Bridge Canyon Wash	Apex	8.0	771	3207	5304	14689

HYDROLOGIC ANALYSIS FORM

Attachment B: Statistical Analysis of Gage Records

Flooding Source: N/A

Gaging Station Name and Number: _____

Gage Location (relative to the Limit of Study): _____

Drainage Area at the gage: _____

1. Was Log-Pearson Type III distribution used? ☐ Yes ☐ No

   If no, attach explanation.

2a. Systematic record _____ years
   From: _____ To: _____
   From: _____ To: _____

   b. Are there any historical records available? ☐ Yes ☐ No

   If yes, indicate historical period. _____ years

   List the historical events. _____ cfs _____ year; _____ cfs _____ year
   _____ cfs _____ year; _____ cfs _____ year

   Comparison of results from systematic and historically adjusted analyses and decisions made in selection of analysis must be submitted.

3. *Does record represent a mixed population?* ☐ Yes ☐ No
   (e.g., rainfall and snowmelt).

   If yes, submit frequency analysis for each population and analysis of combined frequency curves.

   Explain why a combination was necessary and how the combination was made.

4. Is the data homogeneous? ☐ Yes ☐ No

   If no, attach an explanation of how the data was analyzed, based upon Bulletin 17B recommendations.

5. Were there any adjustments made to the data? ☐ Yes ☐ No

   If yes, attach an explanation of how the data was adjusted, based upon Bulletin 17B recommendations.

6. Are there any discharges above the high outlier threshold? ☐ Yes ☐ No

   If yes, does the analysis include historical period? ☐ Yes ☐ No

   If no, attach explanation.

7. Are there any discharges below the low outlier threshold? ☐ Yes ☐ No

   If yes, is the threshold value input into the model? ☐ Yes ☐ No

If yes, justify inputting a low outlier value.

8. Number of zero events _____

Explain how the zero events are considered in the analysis:

_____

_____

9. Are the final discharges based on expected probability? ☐ Yes ☐ No

[FEMA does not accept expected probability analyses for the purpose of reflecting flood hazard information in a FIS].

10. Were the results compared with other analyses? ☐ Yes ☐ No

If yes, indicate which attachments are included.

☐ Attachment C: Regional Regression Equation
☐ Attachment D: Rainfall/Runoff Model
☐ Attachment E: Comparison of Results

If no, explain why the results were not compared.

_____

_____

11. Provide the following information:

a.	Mean	_____	cfs
b.	Standard deviation	_____	
c.	Generalized skew	_____	
d.	Station skew	_____	
e.	Adopted skew	_____	

12. Results

10-year discharge	_____	cfs
50-year discharge	_____	cfs
100-year discharge	_____	cfs
500-year discharge	_____	cfs

13. Were any other methods used to determine the discharges at ungaged locations, (such as regional frequency curves, transfer equations, etc.). ☐ Yes ☐ No

If yes, specify method, equations, and provide sketch showing the locations.

_____

_____

_____

_____

_____

_____

Attach analysis including plot of flood frequency curve.

HYDROLOGIC ANALYSIS FORM

Attachment C: Regional Regression Equation Analysis

Flooding Source: N/A

1. State the publication used:

   _____

   _____

   (Attach a copy of title page, table of contents, and pertinent pages including equations.)

2. Does the stream under study have a gaging station? ☐ Yes ☐ No

   If no, use regional regression equations directly.

   If yes, provide the following information, and compute weighted discharges as recommended in the publication, where applicable.

   a. Station number: _____
   b. Drainage area at the gaging station: _____ mi^2;
   c. Location: relative to the limit of study: _____

3. Is the watershed under study within one hydrologic region? ☐ Yes ☐ No

   If no, attach an explanation of how the discharges are computed.

4. State the limitations of equations:

   _____

   _____

5. Equation Parameters and Results (use separate sheet if necessary)

   a. Complete for rural conditions (less than 10% urbanized) using the stated publication.

Reference Point(s)*	1	2	3	4	5	6
Parameters:						
Results						
10-year discharge (cfs)						
50-year discharge (cfs)						
100-year discharge (cfs)						
500-year discharge (cfs)**						

*Describe reference points in Summary of Discharges Table (Attachment A).
**The 500-year discharge should be extrapolated from the flow frequency curve.

Attach computations, figures, and maps.

Attachment C: Regional Regression Equation Analysis (Cont'd)

b. Complete for urban conditions, (more than 10% urbanized) by adjusting the rural discharges from the previous table if the equations from USGS Water Supply Paper 2207 dated 1983 Flood Characteristics of Urban Watersheds in the United States are used,or obtain parameters and discharges from other urban studies.

Reference Point(s)*	1	2	3	4	5	6
Parameters:						
Results						
10-year discharge (cfs)						
50-year discharge (cfs)						
100-year discharge (cfs)						
500-year discharge (cfs)**						

Attach any supplementary calculations, maps, and figures.

*Describe reference points in Summary of Discharges Table (Attachment A)
**The 500-year discharge should be extrapolated from the flow frequency curve if necessary.

Flooding Source: Hiko Springs and Bridge Canyon Washes

Model Used: HEC-1 Version: IBMXT512K Date: Feb. 1, 1985

Type of model: [X] Single Event Model [ ] Continuous Streamflow Simulation Model

If continuous model is used, attach separate technical report.

For each flooding source, provide the following information. If the response is "no" to any of the following questions, attach an explanation for each.

A. Preparation of Hydrology Model and Data submitted.

1. The following information is submitted.

   a. [X] A disk copy of the rainfall/runoff model.

   b. [X] A topographic map with basin boundaries

   c. [X] Schematic diagram of the hydrologic model.

   d. [X] Information to support the selection of parameters relating to initial loss and loss rates.

   e. [ ] Information to support the selection of parameters related to impervious areas/urbanization. N/A

   f. [X] Information to support the selection of parameters for unit hydrograph/kinematic wave method.

   g. [X] Information to support the selection of parameters for routing methods.

2. Was a U.S. Geological Survey (USGS) 7.5-minute quadrangle map used to delineate the basin boundaries? [X] Yes [ ] No

3. Was the watershed subdivided into subbasins in such a way that each tributary to the main stream is considered in the modeling? [X] Yes [ ] No

4. Were channel routing reaches considered between the tributaries of the main stream, where applicable? [X] Yes [ ] No

5. Was reservoir routing performed at the locations of structures where there is impoundment? [ ] Yes [X] No

6. Are consistent identification symbols for subbasins, nodes, reach lengths, etc., shown on the schematic diagram, watershed map and the printout? [X] Yes [ ] No

B. Total Rainfall and Rainfall Distribution

1. If rainfall selected is not determined from National Weather Service (NWS) publications, was the NWS consulted? If no, attach explanation. ☐ Yes ☒ No

* CCRFCD Design Manual

2. Rainfall distribution is selected from Soil Conservation Service distribution, or U.S. Army Corps of Engineers' hypothetical distribution, or others (localized storm from cloud burst or general winter storm): Check one box.

☐ SCS ☒ COE ☐ Other (attach explanation)

3. Rainfall duration selected: Check one box.

☐ 3 hrs ☒ 6 hrs ☐ 12 hrs ☐ 24 hrs ☐ Others _____

Does the selected duration produce maximum peak discharges? ☒ Yes ☐ No

If no, please explain:

_____

_____

_____

4. Computation time interval, Δt is 3 minutes. If Δt is greater than 0.29 of the smallest lag time used in the watershed model, attach explanation.

5. Timing of maximum rainfall increment (e.g., 3rd hour, 12th hour) 3rd hour

6. Point rainfall values are adjusted for areal distribution? ☒ Yes ☐ No

If no, please explain:

_____

_____

_____

C. Loss Rate Method

1. The following loss rate methods are used.

☐ Initial and uniform ☒ Curve number ☐ Green-Ampt ☐ Holtan
☐ Other (specify) _____

2. Are the loss rates determined from hydrograph reconstitution/calibration runs? ☐ Yes ☒ No

3. Do the loss rates vary with different storm frequencies? ☐ Yes ☒ No

D. Unit Hydrograph/Transformation Method.

1. The following unit hydrograph method/transformation method is selected.

☐ Snyder ☐ Clark ☒ SCS ☐ Kinematic Wave ☐ Other (Explain):

2. Were unit hydrograph or transformation method parameters obtained from calibration runs? ☐ Yes ☒ No

3. Is base flow considered in the modeling? ☐ Yes ☐ No ☒ N/A

4. Is snowmelt considered in the modeling? ☐ Yes ☐ No ☒ N/A

E. Routing Method

The following routing method is used.

☐ Muskingum-Cunge ☐ Muskingum ☐ Modified Puls

☐ Att-Kin ☐ Other (specify) Kinematic Wave

1. Were roughness coefficients in Muskingum-Cunge method obtained from calibration runs? ☐ Yes ☐ No ☒ N/A

2. Were Parameters K and X in Muskingum method obtained from calibration runs? ☐ Yes ☐ No ☒ N/A

3. Was the number of steps in the Modified Puls channel routing method obtained from calibration runs? ☐ Yes ☐ No ☒ N/A

F. General Consideration

1. If the model was calibrated to known flood events, is a summary of the calibration procedures, calibrated parameters, and the results attached? N/A ☐ Yes ☐ No

2. Were watershed development conditions are for existing conditions and not for the future conditions? (FEMA does not accept future conditions.) ☒ Yes ☐ No

3. Were the results compared with the results from other methods? ☐ Yes ☒ No

If yes, indicate which attachments are included:

☐ Attachment B, Statistical Analysis of Gage Records
☐ Attachment C, Regression Analysis
☐ Attachment E, Comparison of Results

G. Evaluation of results for each subbasin. Complete the following form with requested information and use it for evaluating the reasonableness of rainfall, losses, lag time, and discharges.

Number of Subbasins: See section 2 of TSDN

Subbasin						
Drainage Area (mi^2)						
Longest Hydraulic length (ft.)						
Rainfall						
Total Depth: 10-year (in)						
50-year (in)						
100-year (in)						
500-year (in)						
100-Year Initial Loss, inch						
100-Year Total Loss, inch						
Impervious Area (%)						

Lag time (hours)						
Final Results						
10-year discharges (cfs)						
50-year discharges (cfs)						
100-year discharges (cfs)						
500-year discharges (cfs)						
100-year discharge/drainage area (cfs/mi^2)						

Note: Attach additional sheets if necessary.

Attach rainfall/runoff model, Hydrologic Model Schematic, and supporting maps.

[X] Preliminary* [ ] Final [X] Discharges [ ] Water-Surface Elevations

Stream: _____

Method (1): FIS Methodology Unknown

Method (2): FIS Restudy - Rainfall/Runoff and Regional Statistics

Location	Drainage Area (SQMI)	10-year		50-year		100-year		500-year	
		1	2	1	2	1	2	1	2
Hiko Springs Wash Apex	18.3	1221	1067	5065	6096	8370	9759	23140	25301
Bridge Canyon Wash Apex	8.0	647	771	2681	3207	4430	5304	12242	14689

Note: *Only 100-year discharge and corresponding water-surface elevations should be considered for preliminary analysis.

HYDROLOGIC ANALYSIS FORM

Attachment F: Confidence Limits Evaluation N/A

Flooding Source: _____

Gaging Station Name and Number: _____

100-year discharge	
Effective	Revised
_____ cfs	_____ cfs

Confidence intervals of the revised 100-year discharge

90% Confidence Interval:	5% limit _____	cfs
	95% limit _____	cfs
50% Confidence Interval:	25% limit _____	cfs
	75% limit _____	cfs

An example of confidence limits analysis can be found in Appendix 9 of Bulletin 17B.

FORM 10

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Community Name: Clark County (Unincorporated Areas)

Flooding Source: Hiko Springs Wash

Reach Being Restudied

Downstream limit of levee: Crown Pointe Floodwall Plans Station 1+77.50

Upstream limit of levee: Crown Pointe Floodwall Plans Station 10+03.61

Attach a sketch showing levee location.

Levee/Floodwall Evaluation

1. **Has this levee/floodwall system been certified by a Federal agency to provide protection against the 100-year flood event?** ☐ Yes ☒ No

   If yes, by which agency? _____
   (Enclose a copy of the documentation from the agency providing the certification).

   If yes, complete only the interior drainage section and the operation and maintenance section of this form.

2. **Is the levee/floodwall system only partially constructed?** ☐ Yes ☒ No

   If yes, could the levee/floodwall system meet the criteria outlined in NFIP regulation Section 44 CFR Ch.1, Part 61.12? ☐ Yes ☐ No

   If yes, contact the Regional Project Officer for guidance.

3. **Is the levee/floodwall system in full compliance with the freeboard criteria outlined in NFIP Regulations Section 44 CFR Ch.1. Part 65.10(b)(1)? (See Freeboard Section on Page 3 of 9).** ☒ Yes ☐ No

   Is the levee/floodwall system in full compliance with the maintenance criteria outlined in NFIP Regulation Section 44 CFR Ch.1. Part 65.10(d)? ☒ Yes ☐ No

   If the answer to both is yes, please complete this form.

   If the answer to either is no, please explain and refer to Chapter 7 of the Guidelines and Specification for Study Contractors for correct floodway and profile determination and floodplain delineation.

   _____
   _____
   _____

   Note: If any one item outlined in NFIP Regulation Section 44 CFR Ch.1, Part 65.10 is not satisfied, the levee should not be credited.

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Levee/Floodwall System Elements

1. This Levee/Floodwall analysis is based on:

   [X] reanalysis of an existing levee/floodwall system*
   [ ] a newly constructed levee/floodwall system
   [ ] upgrading of an existing levee/floodwall system

   *If this is a reanalyses of an existing levee/floodwall system presented on the effective FIRM as providing protection from the 100-year flood event and the levee/floodwall system has not been physically changed, complete only the Freeboard section and Maintenance Section of this form.

2. Levee/Floodwall locations are:

[ ]	earthen embankment, dike, berm, etc.	Station	_____	to	_____
[X]	monolithic cast-in place reinforced concrete	Station	1+77.50	to	10+03.60
[ ]	reinforced concrete masonry block	Station	_____	to	_____
[ ]	sheet piling	Station	_____	to	_____
[ ]	others (describe)	Station	_____	to	_____

   Does the levee/floodwall system fall within more than one local jurisdiction? [ ] Yes [X] No

   If yes, separate operations and maintenance plans are required for each levee section under a different jurisdiction.

3. Has the impact of the levee/floodwall system on contiguous reaches been assessed? [X] Yes [ ] No

4. Attach certified "as-built" drawings containing the following information (indicate drawing sheet numbers):

   a. Plan of the levee embankment and floodwall structures. Sheet Numbers _____

   b. A layout detail for the embankment protection measures. Sheet Numbers _____

   c. Location, layout and size and shape of the levee embankment features, foundation treatment, floodwall structure, closure structures, and pump stations. Sheet Numbers _____

   d. A profile of the levee/floodwall system showing the 100-year water surface elevation, levee and/or wall crest and foundation, and closure locations for the total levee system. Sheet Numbers _____

   e. Closure detail showing the 100-year water surface , elevations closure opening outlet and inlet invert elevations,type and size of opening, and kind of closure device. Sheet Numbers _____

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Freeboard

1. The minimum freeboard provided above the 100-year water surface elevation is:

Riverine

3.0 feet or more at the downstream end and throughout	☒ Yes	☐ No
3.5 feet or more at the upstream end	☒ Yes	☐ No
4.0 feet immediately upstream of all structures and constrictions	☐ Yes	☐ No N/A

Coastal

1.0 feet above the height of the one percent wave for the 100-year stillwater surge elevation or maximum wave runup (whichever is greater.)	☐ Yes	☐ No
2.0 feet above 100-year stillwater surge elevation	☐ Yes	☐ No

2. Tabulate the elevations at each levee crest grade change. See section 5 of TSDN

Station	Location	100-Year Water Surface Elevation	Levee Crest	Freeboard (ft.)
	Upper end			
	Lower end			

(Extend table on an added sheet as needed and reference)

Sediment Transport Considerations

1. Based on historical records or conditions such as vegetative cover, development of the watershed, and stream bed and bank conditions, is there a potential for debris and sediment transport (including scour and deposition) to affect the 100-year water-surface elevations and/or the freeboard for the levee/floodwall?

☒ Yes ☐ No

If the answer is yes: See section 5 of TSDN

a. What is the estimated sediment (bed material) load?

_____ cfs (attach gradation curve)

Explain method used to estimate the sediment transport and the depth of scour and/or deposition

_____

_____

_____

b. Will there be any significant sediment accumulation along the levee/floodwall (such as along any bends in the channel)? ☐ Yes ☐ No

If yes, what is the minimum freeboard at these locations? _____ feet.

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Closures

1. Openings through the levee system:

☐ exist ☒ do not exist

If openings exist, list all closures:

Channel Station	Left or Right Bank	Opening Type	Highest Elevation for Opening Invert	Type of Closure Device

(Extend table on an added sheet as needed and reference)

Geotechnical and geological data:

In addition to the required detail analysis reports, data obtained during field and laboratory investigations and used in the design analysis for the following levee system features should be submitted in a tabulated summary form. (Reference U.S. Army Corps of Engineers EM-1110-2-1906 Form 2086).

Embankment Protection N/A

1. The maximum levee slope landside is _____

2. The maximum levee slope floodside is _____

3. The range of 100-year riverine flood velocities along the levee embankment?
_____ (min.)
to _____ (max.)

4. Describe embankment protection:
☐ Gabions
☐ Rip Rap
☐ Grouted Rip Rap
☐ Jute Mesh - Vegetation
☐ Other (Describe)
_____

5. Riprap Design Parameters: (Include references) ☐ Velocity; ☐ Tractive stress

Maximum Permissible Velocity _____

Reach	Sideslope	Flow depth	Velocity	Curve or Straight	Stone Riprap D_{100}	Stone Riprap D_{50}	Stone Riprap Thickness	Depth of Toedown
Sta ___ to ___								
Sta ___ to ___								
Sta ___ to ___								

(Extend table on an added sheet as needed and reference)

Embankment Protection (Cont'd)

6. Has a bedding/filter analysis & design been included? ☐ Yes ☐ No

Describe the analysis used for other kinds of protection used (including copies of the design analysis):

_____

_____

_____

NOTE: Attach engineering analysis to support construction plans.

Embankment and Foundation Stability

1. Describe the basis for selection of critical location for analysis:

_____

_____

_____

☐ Overall height: Sta _____, height _____ ft.
☐ Limiting foundation soil strength:
Sta _____, depth _____ to _____
strength ∅ = _____ degrees, c = _____ psf
☐ slope: SS = _____ (h) to _____ (v)

(Repeat as needed on an added sheet for additional locations)

2. Specify the embankment stability analyses methodology used (e.g., circular arc, sliding block, infinite slope, etc.):

_____

_____

_____

3. Summary of stability analysis results:

Loading Conditions	Critical Safety Factor	Criteria (Min.)
End of construction	_____	1.3
Sudden drawdown	_____	1.0
Critical flood stage	_____	1.4
Steady seepage at flood stage	_____	1.4
Earthquake (Case I or III)	_____	1.0

(Reference: U.S. Army Corps of Engineers EM-1110-2-1913 Table 6-1)

4. Was a seepage analysis for the embankment performed? ☐ Yes ☐ No
Describe methodology used:

_____

_____

5. Was a seepage analysis for the foundation performed? ☐ Yes ☐ No
Were uplift pressures at the embankment landslide toe checked? ☐ Yes ☐ No
Were seepage exit gradients checked for piping potential? ☐ Yes ☐ No

6. The duration of 100-year flood hydrograph against the embankment is _____ Hrs.

NOTE: Attach engineering analysis to support construction plans.

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Floodwall and Foundation Stability

1. Design analysis submittal *is* based on Code:

   ☐ UBC (1988) or ☐ Other (specify) _____

2. Stability analysis submitted provides for:

   ☐ Overturning: ☐ Sliding; *If not, explain* _____

   _____

3. Loading included in the analyses were:

   ☐ Lateral earth @ P_A = _____ psf; P_P = _____ psf
   ☐ Surcharge-Slope@ _____, ☐ surface _____ psf
   ☐ Wind@P_w = _____ psf
   ☐ Seepage (Uplift); ☐ Earthquake @ P_{eq} = _____ %g
   ☐ 100-year significant wave height _____ ft.
   ☐ 100-year significant wave period _____ sec.

4. Summary of Stability Analysis Results: Factors of Safety. Itemize for each range in site layout dimension and loading condition limitation for each respective reach.

Loading Condition	Criteria (Min)		Sta __ To __		Sta __ To __	
	Overturn	Sliding	Overturn	Sliding	Overturn	Sliding
Dead & Wind	1.5	1.5	___	___	___	___
Dead & Soil	1.5	1.5	___	___	___	___
Dead, Soil, Flood & Impact	1.5	1.5	___	___	___	___
Dead, Soil & Seismic	1.3	1.3	___	___	___	___

(Ref: FEMA 114 Sept 1986; COE EM 1110-2-2502)

(NOTE: Extend table on an added sheet as needed and reference)

5. Foundation bearing strength for each soil type:

Bearing Pressure	Sustained Load	Short Term Load
Computed design maximum	_____ psf	_____ psf
Maximum allowable	_____ psf	_____ psf

6. Foundation scour protection ☐ is provided ☐ is not provided

   Describe:

   _____
   _____
   _____
   _____

   NOTE: Attach engineering analysis to support construction plans.

Settlement

1. Has anticipated potential settlement been *determined* and incorporated into the specified construction elevations to maintain the established freeboard margin?
   ☐ Yes ☒ No

2. The computed range of settlement is _____ ft. to _____ ft.

3. Settlement of the levee crest is determined to be primarily from:

   ☐ Foundation consolidation
   ☐ Embankment compression
   ☐ Other (describe) _____

4. Differential settlement of floodwalls ☐ has ☐ has not been accommodated in the structural design and construction.

   NOTE: Attach engineering analysis to support construction plans.

Interior Drainage N/A

1. Specify size of each interior watershed:
   Draining to pressure conduit _____
   Draining to ponding area _____

   Provide map showing interior drainage area

2. Relationships Established

Ponding elevation vs. storage	☐ Yes	☐ No
Ponding elevation vs. gravity flow	☐ Yes	☐ No
Differential head vs. gravity flow	☐ Yes	☐ No

3. The river flow duration curve is enclosed ☐ Yes ☐ No

4. Specify the discharge capacity of the pressure conduit _____

5. Which flooding conditions were analyzed?

• Gravity flow (Interior Watershed)	☐ Yes	☐ No
• Common storm (River Watershed)	☐ Yes	☐ No
• Historical ponding probability	☐ Yes	☐ No
• Coastal wave overtopping	☐ Yes	☐ No

   If no, explain why:
   _____
   _____

6. Has interior drainage has been analyzed based on joint probability of interior and exterior flooding and the capacities of pumping and outlet facilities to provide the established level of flood protection? ☐ Yes ☐ No

   If no, explain why not.
   _____
   _____

7. The rate of seepage through the levee system for the 100-year flood is _____ cfs

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Interior Drainage (Cont'd)

8. The length of levee system used to derive this seepage rate is _____ ft.

9. Will a pumping plant(s) be used for interior drainage? ☐ Yes ☐ No

If yes, indicate the number of pumping plants: _____

For each pumping plant, list:

	Plant #1	Plant #2
The number of pumps	_____	_____
The ponding storage capacity	_____	_____
The maximum pumping rate	_____	_____
The maximum pumping head	_____	_____
The pumping starting elevation	_____	_____
The pumping stopping elevation	_____	_____
Is the discharge facility protected?	_____	_____
Is there a flood warning plan?	_____	_____
How much time is available between warning and flooding?	_____	_____
Will the operations be automatic?	☐ Yes ☐ No	☐ Yes ☐ No
If the pumps are electric, are there backup power sources?	☐ Yes ☐ No	☐ Yes ☐ No

(Reference: U.S. Army Corps of Engineers EM 1110-3101, 3102, 3103, 3104, and 3105)

NOTE: Include a copy of supporting documentation of data and analysis. Provide a map showing the flooded area and maximum ponding elevations for all interior watersheds that result in flooding.

Other Design Criteria

1. The following items have been addressed as stated:

Liquefaction ☐ is ☐ is not a problem
Hydrocompaction ☐ is ☐ is not a problem
Heave/differential movement due to soils of high shrink/swell
☐ is ☐ is not a problem

2. For each of these problems encountered, state the basic facts and corrective action taken.

_____
_____
_____
_____
_____
_____
_____
_____

If the levee or floodwall is new or enlarged, will the structure adversely impact flood levels and/or flow velocities floodside of the structure?

☐ Yes ☐ No

NOTE: Attach supporting documentation

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Operational Plan and Criteria N/A

1. Does the operation plan incorporate all the provisions for closure devices as required in Section 65.10(c)(1), of the NFIP regulations? ☐ Yes ☐ No

2. Does the operation plan incorporate all the provisions for interior drainage as required in Section 65.10(c)(2), of the NFIP regulations? ☐ Yes ☐ No

If no to either of the above, please explain:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Maintenance

1. Inspection of the levee/floodwall system will be conducted periodically by _____ with a maximum interval of _____ months between inspections.

2. Based on the results of scheduled periodic inspections, appropriate maintenance of the levee/floodwall system will be conducted by _____ _____ to ensure the integrity and degree of flood protection of the structure.

3. A formal plan of operation, including documentation of the flood warming system, specific actions and assignments of responsibility by individual name or title, and provisions for testing the plan at intervals not more than one year, ☐ has ☐ has not been prepared for the levee/floodwall system.

4. The community is willing to assume responsibility for ☐ performing ☐ overseeing compliance with the maintenance and operation plans of the _____ _____ levee/floodwall system. If not performed promptly by an owner other than the community, the community will provide the necessary services without cost to the Federal government.

Attach operation and maintenance plans.

FORM 10

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Community Name: Unincorporated Areas, Clark County, Nevada

Flooding Source: Bridge Canyon Wash

Reach Being Restudied

Downstream limit of levee: Laughlin Senior High School Plans Station 12+92

Upstream limit of levee: Laughlin Senior High School Plans Station 1+55

Attach a sketch showing levee location.

Levee/Floodwall Evaluation

1. Has this levee/floodwall system been certified by a Federal agency to provide protection against the 100-year flood event? ☐ Yes ☒ No

   If yes, by which agency? _____
   (Enclose a copy of the documentation from the agency providing the certification).

   If yes, complete only the *interior* drainage section and the operation and maintenance section of this form.

2. Is the levee/floodwall system only *partially* constructed? ☐ Yes ☒ No

   If yes, could the levee/floodwall system meet the criteria outlined in NFIP regulation Section 44 CFR Ch.1, Part 61.12? ☐ Yes ☐ No

   If yes, contact the Regional Project Officer for guidance.

3. Is the levee/floodwall system in full compliance with the freeboard criteria outlined in NFIP Regulations Section 44 CFR Ch.1. Part 65.10(b)(1)? (See Freeboard Section on Page 3 of 9). ☒ Yes ☐ No

   Is the levee/floodwall system in full compliance with the maintenance *criteria outlined* in NFIP Regulation Section 44 CFR Ch.1. Part 65.10(d)? ☒ Yes ☐ No

   If the answer *to* both is yes, please complete this form.

   If the answer to either is no, please explain and refer to Chapter 7 of the Guidelines and Specification for Study Contractors for correct floodway and profile determination and floodplain delineation.

   _____

   _____

   _____

   Note: If any one item outlined in NFIP Regulation Section 44 CFR Ch.1, Part 65.10 is not satisfied, the levee should not be credited.

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Levee/Floodwall System Elements

1. This Levee/Floodwall analysis is based on:

   - ☐ reanalysis of an existing levee/floodwall system*
   - ☒ a newly constructed levee/floodwall system
   - ☐ upgrading of an existing levee/floodwall system

   *If this is a reanalyses of an existing levee/floodwall system presented on the effective FIRM as providing protection from the 100-year flood event and the levee/floodwall system has not been physically changed, complete only the Freeboard section and Maintenance Section of this form.

2. Levee/Floodwall locations are:

☐	earthen embankment, dike, berm, etc.	Station	1+55	to	12+92
☐	monolithic cast-in place reinforced concrete	Station	_____	to	_____
☐	reinforced concrete masonry block	Station	_____	to	_____
☐	sheet piling	Station	_____	to	_____
☐	others (describe)	Station	_____	to	_____

   Does the levee/floodwall system fall within more than one local jurisdiction? ☐ Yes ☒ No

   If yes, separate operations and maintenance plans are required for each levee section under a different jurisdiction.

3. Has the impact of the levee/floodwall system on contiguous reaches been assessed? ☒ Yes ☐ No

4. Attach certified "as-built" drawings containing the following information (indicate drawing sheet numbers):

   a. Plan of the levee embankment and floodwall structures. Sheet Numbers _____

   b. A layout detail for the embankment protection measures. Sheet Numbers _____

   c. Location, layout and size and shape of the levee embankment features, foundation treatment, floodwall structure, closure structures, and pump stations. Sheet Numbers _____

   d. A profile of the levee/floodwall system showing the 100-year water surface elevation, levee and/or wall crest and foundation, and closure locations for the total levee system. Sheet Numbers _____

   e. Closure detail showing the 100-year water surface, elevations closure opening outlet and inlet invert elevations, type and size of opening, and kind of closure device. Sheet Numbers _____

Freeboard

1. The minimum freeboard provided above the 100-year water surface elevation is:

Riverine

3.0 feet or more at the downstream end and throughout	[X] Yes	[ ] No
3.5 feet or more at the upstream end	[X] Yes	[ ] No
4.0 feet immediately upstream of all structures and constrictions	[ ] Yes	[ ] No N/A

Coastal

1.0 feet above the height of the one percent wave for the 100-year stillwater surge elevation or maximum wave runup (whichever is greater.)	[ ] Yes	[ ] No
2.0 feet above 100-year stillwater surge elevation	[ ] Yes	[ ] No

2. Tabulate the elevations at each levee crest grade change.

See Laughlin Senior High School Offsite Drainage Improvement Plans Section 5 of TSDN

Station	Location	100-Year Water Surface Elevation	Levee Crest	Freeboard (ft.)
	Upper end			
	Lower end			

(Extend table on an added sheet as needed and reference)

Sediment Transport Considerations

1. Based on historical records or conditions such as vegetative cover, development of the watershed, and stream bed and bank conditions, is there a potential for debris and sediment transport (including scour and deposition) to affect the 100-year water-surface elevations and/or the freeboard for the levee/floodwall?

[X] Yes [ ] No

If the answer is yes: See Hydrology Study Laughlin High School Section 5 of TSDN

a. What is the estimated sediment (bed material) load?

_____ cfs (attach gradation curve)

Explain method used to estimate the sediment transport and the depth of scour and/or deposition

_____

_____

_____

b. Will there be any significant sediment accumulation along the levee/floodwall (such as along any bends in the channel)? [ ] Yes [ ] No

If yes, what is the minimum freeboard at these locations? _____ feet.

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Closures

1. Openings through the levee system:

☐ exist ☒ do not exist

If openings exist, list all closures:

Channel Station	Left or Right Bank	Opening Type	Highest Elevation for Opening Invert	Type of Closure Device

(Extend table on an added sheet as needed and reference)

Geotechnical and geological data:

In addition to the required detail analysis reports, data obtained during field and laboratory investigations and used in the design analysis for the following levee system features should be submitted in a tabulated summary form. (Reference U.S. Army Corps of Engineers EM-1110-2-1906 Form 2086).

Embankment Protection

1. The maximum levee slope landside is 3:1 (Horizontal:Vertical)

2. The maximum levee slope floodside is 3:1 (Horizontal:Vertical)

3. The range of 100-year riverine flood velocities along the levee embankment?
   6.5 FPS (min.)
   to 7.0 FPS (max.)

4. Describe embankment protection:
   - ☐ Gabions
   - ☒ Rip Rap
   - ☐ Grouted Rip Rap
   - ☐ Jute Mesh - Vegetation
   - ☐ Other (Describe)

   _____

5. Riprap Design Parameters: (Include references) ☒ Velocity; ☐ Tractive stress

   Maximum Permissible Velocity _____

Reach	Sideslope	Flow depth	Velocity	Curve or Straight	Stone Riprap D_{100}	Stone Riprap D_{50}	Stone Riprap Thickness	Depth of Toedown
Sta ___ to ___	See Hydrology Study Addendum							
Sta ___ to ___								
Sta ___ to ___								

(Extend table on an added sheet as needed and reference)

Embankment Protection (Cont'd)

6. Has a bedding/filter analysis & design been included? [X] Yes [ ] No

Describe the analysis used for other kinds of protection used (including copies of the design analysis):

See Hydrology Study Laughlin High School

NOTE: Attach engineering analysis to support construction plans.

Embankment and Foundation Stability

1. Describe the basis for selection of critical location for analysis:

[ ] Overall height: Sta _____, height _____ ft.
[ ] Limiting foundation soil strength:
Sta _____, depth _____ to _____
strength ⌀ = _____ degrees, c= _____ psf
[ ] slope: SS= _____ (h) to _____ (v)

(Repeat as needed on an added sheet for additional locations)

2. Specify the embankment stability analyses methodology used (e.g., circular arc, sliding block, infinite slope, etc.):

3. Summary of stability analysis results:

Loading Conditions	Critical Safety Factor	Criteria (Min.)
End of construction	_____	1.3
Sudden drawdown	_____	1.0
Critical flood stage	_____	1.4
Steady seepage at flood stage	_____	1.4
Earthquake (Case I or III)	_____	1.0

(Reference: U.S. Army Corps of Engineers EM-1110-2-1913 Table 6-1)

4. Was a seepage analysis for the embankment performed? [ ] Yes [ ] No
Describe methodology used:

5. Was a seepage analysis for the foundation performed? [ ] Yes [ ] No
Were uplift pressures at the embankment landslide toe checked? [ ] Yes [ ] No
Were seepage exit gradients checked for piping potential? [ ] Yes [ ] No

6. The duration of 100-year flood hydrograph against the embankment is _____ Hrs.

NOTE: Attach engineering analysis to support construction plans.

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Floodwall and Foundation Stability N/A

1. Design analysis submitted *is* based on Code:

   ☐ UBC (1988) *or* ☐ Other (specify) _____

2. Stability analysis submitted provides for:

   ☐ Overturning: ☐ Sliding; If not, explain _____

   _____

3. Loading included in the analyses were:

   ☐ Lateral earth @ P_A = _____ psf; P_P = _____ psf
   ☐ Surcharge-Slope@ _____, ☐ surface _____ psf
   ☐ Wind@P_w = _____ psf
   ☐ Seepage (Uplift); ☐ Earthquake @ P_{eq} = _____ %g
   ☐ 100-year significant wave height _____ ft.
   ☐ 100-year significant wave period _____ sec.

4. Summary of Stability Analysis Results: Factors of Safety. Itemize for each range in site layout dimension and loading condition *limitation* for each respective reach.

Loading Condition	Criteria (Min)		Sta __	To __	Sta __	To __
	Overturn	Sliding	Overturn	Sliding	Overturn	Sliding
Dead & Wind	1.5	1.5	___	___	___	___
Dead & Soil	1.5	1.5	___	___	___	___
Dead, Soil, Flood & Impact	1.5	1.5	___	___	___	___
Dead, Soil & Seismic	1.3	1.3	___	___	___	___

(Ref: FEMA 114 Sept 1986; COE EM 1110-2-2502)

(NOTE: Extend table on an added sheet as needed and reference)

5. Foundation bearing strength for each soil type:

Bearing Pressure	Sustained Load	Short Term Load
Computed design maximum	_____ psf	_____ psf
Maximum allowable	_____ psf	_____ psf

6. Foundation scour protection ☐ is provided ☐ is not provided

   Describe:

   _____
   _____
   _____
   _____

   NOTE: Attach engineering analysis to *support* construction plans.

Interior Drainage (Cont'd)

8. The length of levee system used to derive this seepage rate is _____ ft.

9. Will a pumping plant(s) be used for interior drainage? ☐ Yes ☐ No

If yes, indicate the number of pumping plants: _____

For each pumping plant, list:

	Plant #1	Plant #2
The number of pumps		
The *ponding storage* capacity		
The maximum pumping rate		
The maximum pumping head		
The pumping starting elevation		
The pumping stopping elevation		
Is the discharge facility protected?		
Is there a flood *warning* plan?		
How much time is available between warning and flooding?		
Will the operations be automatic?	☐ Yes ☐ No	☐ Yes ☐ No
If the pumps are electric, are there backup power sources?	☐ Yes ☐ No	☐ Yes ☐ No

(Reference: U.S. Army Corps of Engineers EM 1110-3101, 3102, 3103, 3104, and 3105)

NOTE: Include a copy of supporting documentation of data and analysis. Provide a map showing the flooded area and maximum ponding elevations for all interior watersheds that result in flooding.

Other Design Criteria

1. The following items have been addressed as stated:

Liquefaction ☐ is ☐ is not a problem
Hydrocompaction ☐ is ☐ is not a problem
Heave/differential movement due to soils of high shrink/swell
☐ is ☐ is not a problem

2. For each of these problems encountered, state the basic facts and corrective action taken.

_____
_____
_____
_____
_____
_____
_____
_____

If the levee or floodwall is new or enlarged, will the structure adversely impact flood levels and/or flow velocities floodside of the structure?

☐ Yes ☐ No

NOTE: Attach supporting documentation

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Settlement

1. Has anticipated potential settlement been determined and incorporated into the specified construction elevations to maintain the established freeboard margin?
   ☐ Yes ☒ No

2. The computed range of settlement is _____ ft. to _____ ft.

3. Settlement of the levee crest is determined to be primarily from:

   ☐ Foundation consolidation
   ☐ Embankment compression
   ☐ Other (describe) _____

4. Differential settlement of floodwalls ☐ has ☐ has not been accommodated in the structural design and construction.

   NOTE: Attach engineering analysis to support construction plans.

Interior Drainage N/A

1. Specify size of each interior watershed:
   Draining to pressure conduit _____
   Draining to ponding area _____

   Provide map showing interior drainage area

2. Relationships Established

Ponding elevation vs. storage	☐ Yes	☐ No
Ponding elevation vs. gravity flow	☐ Yes	☐ No
Differential head vs. gravity flow	☐ Yes	☐ No

3. The river flow duration curve is enclosed ☐ Yes ☐ No

4. Specify the discharge capacity of the pressure conduit _____

5. Which flooding conditions were analyzed?

• Gravity flow (Interior Watershed)	☐ Yes	☐ No
• Common storm (River Watershed)	☐ Yes	☐ No
• Historical ponding probability	☐ Yes	☐ No
• Coastal wave overtopping	☐ Yes	☐ No

   If no, explain why:
   _____
   _____

6. Has interior drainage has been analyzed based on joint probability of interior and exterior flooding and the capacities of pumping and outlet facilities to provide the established level of flood protection? ☐ Yes ☐ No

   If no, explain why not.
   _____
   _____

7. The rate of seepage through the levee system for the 100-year flood is _____ cfs

Operational Plan and Criteria N/A

1. Does the operation plan incorporate all the provisions for closure devices as required in Section 65.10(c)(1), of the NFIP regulations? ☐ Yes ☐ No

2. Does the operation plan incorporate all the provisions for interior drainage as required in Section 65.10(c)(2), of the NFIP regulations? ☐ Yes ☐ No

If no to either of the above, please explain:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Maintenance

1. Inspection of the levee/floodwall system will be conducted periodically by _____ with a maximum interval of _____ months between inspections.

2. Based on the results of scheduled periodic inspections, appropriate maintenance of the levee/floodwall system will be conducted by _____ to ensure the integrity and degree of flood protection of the structure.

3. A formal plan of operation, including documentation of the flood warming system, specific actions and assignments of responsibility by individual name or title, and provisions for testing the plan at intervals not more than one year, ☐ has ☐ has not been prepared for the levee/floodwall system.

4. The community is willing to assume responsibility for ☐ performing ☐ overseeing compliance with the maintenance and operation plans of the _____ levee/floodwall system. If not performed promptly by an owner other than the community, the community will provide the necessary services without cost to the Federal government.

Attach operation and maintenance plans.

FORM 10

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Community Name: Clark County, Nevada (Unincorporated Areas)

Flooding Source: Dripping Springs Wash

Reach Being Restudied

Downstream limit of levee: SR 163 Station 849+00

Upstream limit of levee: SR 163 Station 783+70

Attach a sketch showing levee location. (See section 5 in section 3 of TSDN)

Levee/Floodwall Evaluation

1. Has this levee/floodwall system been certified by a Federal agency to provide protection against the 100-year flood event? ☐ Yes ☒ No

   If yes, by which agency? _____
   (Enclose a copy of the documentation from the agency providing the certification).

   If yes, complete only the interior drainage section and the operation and maintenance section of this form.

2. Is the levee/floodwall system only partially constructed? ☒ Yes ☐ No

   If yes, could the levee/floodwall system meet the criteria outlined in NFIP regulation Section 44 CFR Ch.1, Part 61.12? ☒ Yes ☐ No

   If yes, contact the Regional Project Officer for guidance.

3. Is the levee/floodwall system in full compliance with the freeboard criteria outlined in NFIP Regulations Section 44 CFR Ch.1. Part 65.10(b)(1)? (See Freeboard Section on Page 3 of 9). ☒ Yes ☐ No

   Is the levee/floodwall system in full compliance with the maintenance criteria outlined in NFIP Regulation Section 44 CFR Ch.1. Part 65.10(d)? ☒ Yes ☐ No

   If the answer to both is yes, please complete this form.

   If the answer to either is no, please explain and refer to Chapter 7 of the Guidelines and Specification for Study Contractors for correct floodway and profile determination and floodplain delineation.

_____

_____

_____

Note: If any one item outlined in NFIP Regulation Section 44 CFR Ch.1, Part 65.10 is not satisfied, the levee should not be credited.

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Levee/Floodwall System Elements

1. This Levee/Floodwall analysis is based on:

   - [ ] reanalysis of an existing levee/floodwall system*
   - [X] a newly constructed levee/floodwall system
   - [ ] upgrading of an existing levee/floodwall system

   *If this is a reanalyses of an existing levee/floodwall system presented on the effective FIRM as providing protection from the 100-year flood event and the levee/floodwall system has not been physically changed, complete only the Freeboard section and Maintenance Section of this form.

2. Levee/Floodwall locations are:

[X]	earthen embankment, dike, berm, etc.	Station	783+70	to	849+00
[ ]	monolithic cast-in place reinforced concrete	Station	_____	to	_____
[ ]	reinforced concrete masonry block	Station	_____	to	_____
[ ]	sheet piling	Station	_____	to	_____
[ ]	others (describe)	Station	_____	to	_____

   Does the levee/floodwall system fall within more than one local jurisdiction? [ ] Yes [X] No

   If yes, separate operations and maintenance plans are required for each levee section under a different jurisdiction.

3. Has the impact of the levee/floodwall system on contiguous reaches been assessed? [ ] Yes [X] No

4. Attach certified "as-built" drawings containing the following information (indicate drawing sheet numbers): Dike/Channel is partially constructed.

   a. Plan of the levee embankment and floodwall structures. Sheet Numbers _____

   b. A layout detail for the embankment protection measures. Sheet Numbers _____

   c. Location, layout and size and shape of the levee embankment features, foundation treatment, floodwall structure, closure structures, and pump stations. Sheet Numbers _____

   d. A profile of the levee/floodwall system showing the 100-year water surface elevation, levee and/or wall crest and foundation, and closure locations for the total levee system. Sheet Numbers _____

   e. Closure detail showing the 100-year water surface , elevations closure opening outlet and inlet invert elevations,type and size of opening, and kind of closure device. Sheet Numbers _____

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Freeboard

1. The minimum freeboard provided above the 100-year water surface elevation is:

Riverine

3.0 feet or more at the downstream end and throughout	[X] Yes	[ ] No
3.5 feet or more at the upstream end	[X] Yes	[ ] No
4.0 feet immediately upstream of all structures and constrictions	[ ] Yes	[ ] No N/A

Coastal

1.0 feet above the height of the one percent wave for the 100-year stillwater surge elevation or maximum wave runup (whichever is greater.)	[ ] Yes	[ ] No
2.0 feet above 100-year stillwater surge elevation	[ ] Yes	[ ] No

2. Tabulate the elevations at each levee crest grade change. See Hydraulic design report section 5 of TSDN

Station	Location	100-Year Water Surface Elevation	Levee Crest	Freeboard (ft.)
	Upper end			
	Lower end			

(Extend table on an added sheet as needed and reference)

Sediment Transport Considerations

1. Based on historical records or conditions such as vegetative cover, development of the watershed, and stream bed and bank conditions, is there a potential for debris and sediment transport (including scour and deposition) to affect the 100-year water-surface elevations and/or the freeboard for the levee/floodwall?

[X] Yes [ ] No

If the answer is yes: See Hydraulic design report - section 5 of TSDN

a. What is the estimated sediment (bed material) load?

_____ cfs (attach gradation curve)

Explain method used to estimate the sediment transport and the depth of scour and/or deposition

_____

_____

_____

b. Will there be any significant sediment accumulation along the levee/floodwall (such as along any bends in the channel)? [ ] Yes [ ] No

If yes, what is the minimum freeboard at these locations? _____ feet.

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Closures

1. Openings through the levee system:

☐ exist ☒ do not exist

If openings exist, list all closures:

Channel Station	Left or Right Bank	Opening Type	Highest Elevation for Opening Invert	Type of Closure Device

(Extend table on an added sheet as needed and reference)

Geotechnical and geological data:

In addition to the required detail analysis reports, data obtained during field and laboratory investigations and used in the design analysis for the following levee system features should be submitted in a tabulated summary form. (Reference U.S. Army Corps of Engineers EM-1110-2-1906 Form 2086).

Embankment Protection

1. The maximum levee slope landside is 3:1 (Horizontal:Vertical)

2. The maximum levee slope floodside is 3:1 (Horizontal:Vertical)

3. The range of 100-year riverine flood velocities along the levee embankment?
   5.6 FPS (min.)
   to 10.8 FPS (max.)

4. Describe embankment protection:
   - ☐ Gabions
   - ☒ Rip Rap
   - ☒ Grouted Rip Rap
   - ☐ Jute Mesh - Vegetation
   - ☐ Other (Describe)

5. Riprap Design Parameters: (Include references) ☒ Velocity; ☐ Tractive stress

   Maximum Permissible Velocity See Hydraulic Design Report

Reach	Sideslope	Flow depth	Velocity	Curve or Straight	Stone Riprap D_{100}	Stone Riprap D_{50}	Stone Riprap Thickness	Depth of Toedown
Sta ___ to ___								
Sta ___ to ___								
Sta ___ to ___								

(Extend table on an added sheet as needed and reference)

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Floodwall and Foundation Stability N/A

1. Design analysis submittal is based on Code:

   ☐ UBC (1988) or ☐ Other (specify) _____

2. Stability analysis submitted provides for:

   ☐ Overturning: ☐ Sliding; If not, explain _____

   _____

3. Loading included in the analyses were:

   ☐ Lateral earth @ P_A = _____ psf; P_P = _____ psf
   ☐ Surcharge-Slope@ _____, ☐ surface _____ psf
   ☐ Wind@P_w = _____ psf
   ☐ Seepage (Uplift); ☐ Earthquake @ P_{eq} = _____ %g
   ☐ 100-year significant wave height _____ ft.
   ☐ 100-year significant wave period _____ sec.

4. Summary of Stability Analysis Results: Factors of Safety. Itemize for each range in site layout dimension and loading condition limitation for each respective reach.

Loading Condition	Criteria (Min)		Sta __	To __	Sta __	To __
	Overturn	Sliding	Overturn	Sliding	Overturn	Sliding
Dead & Wind	1.5	1.5	___	___	___	___
Dead & Soil	1.5	1.5	___	___	___	___
Dead, Soil, Flood & Impact	1.5	1.5	___	___	___	___
Dead, Soil & Seismic	1.3	1.3	___	___	___	___

(Ref: FEMA 114 Sept 1986; COE EM 1110-2-2502)

(NOTE: Extend table on an added sheet as needed and reference)

5. Foundation bearing strength for each soil type:

Bearing Pressure	Sustained Load	Short Term Load
Computed design maximum	_____ psf	_____ psf
Maximum allowable	_____ psf	_____ psf

6. Foundation scour protection ☐ is provided ☐ is not provided

   Describe:

   _____
   _____
   _____
   _____

   NOTE: Attach engineering analysis to support construction plans.

Embankment Protection (Cont'd)

6. Has a bedding/filter analysis & design been included? ☐ Yes ☒ No

Describe the analysis used for other kinds of protection used (including copies of the design analysis):

Bedding comprised of Type 2 Aggregate (12" thick) as specified in the CCRFCD Hydrologic Criteria and Drainage Design Manual.

NOTE: Attach engineering analysis to support construction plans.

Embankment and Foundation Stability

1. Describe the basis for selection of critical location for analysis:

☐ Overall height: Sta _____, height _____ ft.
☐ Limiting foundation soil strength:
Sta _____, depth _____ to _____
strength ∅ = _____ degrees, c= _____ psf
☐ slope: SS= _____ (h) to _____ (v)

(Repeat as needed on an added sheet for additional locations)

2. Specify the embankment stability analyses methodology used (e.g., circular arc, sliding block, infinite slope, etc.):

3. Summary of stability analysis results:

Loading Conditions	Critical Safety Factor	Criteria (Min.)
End of construction	_____	1.3
Sudden drawdown	_____	1.0
Critical flood stage	_____	1.4
Steady seepage at flood stage	_____	1.4
Earthquake (Case I or III)	_____	1.0

(Reference: U.S. Army Corps of Engineers EM-1110-2-1913 Table 6-1)

4. Was a seepage analysis for the embankment performed? ☐ Yes ☐ No
Describe methodology used:

5. Was a seepage analysis for the foundation performed? ☐ Yes ☐ No
Were uplift pressures at the embankment landslide toe checked? ☐ Yes ☐ No
Were seepage exit gradients checked for piping potential? ☐ Yes ☐ No

6. The duration of 100-year flood hydrograph against the embankment is _____ Hrs.

NOTE: Attach engineering analysis to support construction plans.

Settlement N/A

1. Has anticipated potential settlement been determined and incorporated into the specified construction elevations to maintain the established freeboard margin? ☐ Yes ☐ No

2. The computed range of settlement is _____ ft. to _____ ft.

3. Settlement of the levee crest is determined to be primarily from:

   ☐ Foundation consolidation
   ☐ Embankment compression
   ☐ Other (describe) _____

4. Differential settlement of floodwalls ☐ has ☐ has not been accommodated in the structural design and construction.

   NOTE: Attach engineering analysis to support construction plans.

Interior Drainage N/A

1. Specify size of each interior watershed:
   Draining to pressure conduit _____
   Draining to ponding area _____

   Provide map showing interior drainage area

2. Relationships Established

Ponding elevation vs. storage	☐ Yes	☐ No
Ponding elevation vs. gravity flow	☐ Yes	☐ No
Differential head vs. gravity flow	☐ Yes	☐ No

3. The river flow duration curve is enclosed ☐ Yes ☐ No

4. Specify the discharge capacity of the pressure conduit _____

5. Which flooding conditions were analyzed?

• Gravity flow (Interior Watershed)	☐ Yes	☐ No
• Common storm (River Watershed)	☐ Yes	☐ No
• Historical ponding probability	☐ Yes	☐ No
• Coastal wave overtopping	☐ Yes	☐ No

   If no, explain why:

   _____
   _____

6. Has interior drainage has been analyzed based on joint probability of interior and exterior flooding and the capacities of pumping and outlet facilities to provide the established level of flood protection? ☐ Yes ☐ No

   If no, explain why not.

   _____
   _____

7. The rate of seepage through the levee system for the 100-year flood is _____ cfs

Interior Drainage (Cont'd)

8. The length of levee system used to derive this seepage rate is _____ ft.

9. Will a pumping plant(s) be used for interior drainage? ☐ Yes ☐ No

If yes, indicate the number of pumping plants: _____

For each pumping plant, list:

	Plant #1	Plant #2
The number of pumps		
The ponding storage capacity		
The maximum pumping rate		
The maximum pumping head		
The pumping starting elevation		
The pumping stopping elevation		
Is the discharge facility protected?		
Is there a flood warning plan?		
How much time is available between warning and flooding?		
Will the operations be automatic?	☐ Yes ☐ No	☐ Yes ☐ No
If the pumps are electric, are there backup power sources?	☐ Yes ☐ No	☐ Yes ☐ No

(Reference: U.S. Army Corps of Engineers EM 1110-3101, 3102, 3103, 3104, and 3105)

NOTE: Include a copy of supporting documentation of data and analysis. Provide a map showing the flooded area and maximum ponding elevations for all interior watersheds that result in flooding.

Other Design Criteria

1. The following items have been addressed as stated:

Liquefaction ☐ is ☐ is not a problem
Hydrocompaction ☐ is ☐ is not a problem
Heave/differential movement due to soils of high shrink/swell ☐ is ☐ is not a problem

2. For each of these problems encountered, state the basic facts and corrective action taken.

_____
_____
_____
_____
_____
_____
_____
_____

If the levee or floodwall is new or enlarged, will the structure adversely impact flood levels and/or flow velocities floodside of the structure?

☐ Yes ☐ No

NOTE: Attach supporting documentation

LEVEE/FLOODWALL SYSTEM ANALYSES FORM

Operational Plan and Criteria N/A

1. Does the operation plan incorporate all the provisions for closure devices as required in Section 65.10(c)(1), of the NFIP regulations? ☐ Yes ☐ No

2. Does the operation plan incorporate all the provisions for interior drainage as required in Section 65.10(c)(2), of the NFIP regulations? ☐ Yes ☐ No

If no to either of the above, please explain:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Maintenance

1. Inspection of the levee/floodwall system will be conducted periodically by _____ with a maximum interval of _____ months between inspections.

2. Based on the results of scheduled periodic inspections, appropriate maintenance of the levee/floodwall system will be conducted by _____ _____ to ensure the integrity and degree of flood protection of the structure.

3. A formal plan of operation, including documentation of the flood warming system, specific actions and assignments of responsibility by individual name or title, and provisions for testing the plan at intervals not more than one year, ☐ has ☐ has not been prepared for the levee/floodwall system.

4. The community is willing to assume responsibility for ☐ performing ☐ overseeing compliance with the maintenance and operation plans of the _____ _____ levee/floodwall system. If not performed promptly by an owner other than the community, the community will provide the necessary services without cost to the Federal government.

Attach operation and maintenance plans.

FORM 12b

ALLUVIAL FAN FLOODING ANALYSIS FORM
FINAL SUBMISSION

Community Name: Clark County, Nevada (Unincorporated Areas)

Flooding Source: Hiko Springs and Bridge Canyon Washes

Project Name/Identifier: *Hiko Springs and Bridge Canyon Washes*

Area to be Revised

Attach the following:

A topographic map showing the flood insurance zones, including 100-year depths and velocities.

Backup data and calculations supporting those depths and velocities.

Give a brief description of the analysis performed.

See draft FIS report

SECTION 1.2

Telephone Contact Reports

CONTACT (TELEPHONE CONVERSATION) REPORTS INDEX

Clark County, Nevada (Unincorporated Areas)
(COMMUNITY NAME, STATE)

FLOOD INSURANCE STUDY

CONTACT REPORT DATE	FIRM/AGENCY CONTACTED
March 2, 1994	Clark County Regional Flood Control District
February 15, 1994	Clark County Regional Flood Control District
January 27, 1994	Clark County Public Works
January 24, 1994	Clark County Public Works
January 13, 1994	Clark County Public Works
January 10, 1994	Clark County Regional Flood Control District
January 3, 1994	Clark County Public Works
November 18, 1993	Montgomery Watson Consulting Engineers
October 13, 1993	Clark County Regional Flood Control District
October 5, 1993	Clark County Regional Flood Control District
September 8, 1993	Michael Baker Jr., Inc.
September 7, 1993	Clark County Public Works
August 8, 1993	WRC Engineering
August 8, 1993	Nevada Department of Transportation
May 5, 1993	Clark County Regional Flood Control District

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Hiko Springs & Bridge Canyon Washes
Flood Insurance Study Restudy
Clark County, Nevada (Unincorporated Areas)
Telephone Contact Report

Date: March 2, 1994

CONVERSATION WITH: Mr. Kevin Eubanks, P.E. 455-3139

OF: Clark County Regional Flood Control District

SUBJECT: Draft Technical Support Data Notebook (TSDN)

NOTES: Send one copy of the draft TSDN to the following agencies:

Mr. Robert Thompson - Clark County Public Works Department

Mr. Denis Cederburg - Clark County Public Works Department

Mr. Kevin Eubanks - Clark County Regional Flood Control District

RECORDER: Syndi Dudley

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Hiko Springs & Bridge Canyon Washes
Flood Insurance Study Restudy
Clark County, Nevada (Unincorporated Areas)
Telephone Contact Report

Date: February 15, 1994

CONVERSATION WITH: Mr. Gale Fraser, P.E. 455-3139

OF: Clark County Regional Flood Control District

SUBJECT: Revising Needles Highway Plans for FIS submittal

NOTES: Gale authorized changing the plan & profile on Needles Highway box culverts at Desert Road for FEMA submittal. Estimated cost for revisions $500.00.

RECORDER: Virginia Valentine

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Hiko Springs & Bridge Canyon Washes
Flood Insurance Study Restudy
Clark County, Nevada (Unincorporated Areas)
Telephone Contact Report

Date: January 27, 1994

CONVERSATION WITH: Mr. John Ainsworth, P.E. 455-8365

OF: Clark County Public Works Department

SUBJECT: Crown Pointe Flood Wall

NOTES: Ms. Vicki Scharnhorst provided John with information on the Crown Point Flood Wall. John will leave information at front desk for pick-up and copying.

RECORDER: Syndi Dudley

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Hiko Springs & Bridge Canyon Washes
Flood Insurance Study Restudy
Clark County, Nevada (Unincorporated Areas)
Telephone Contact Report

Date: January 24, 1994

CONVERSATION WITH: Mr. Ken Lambert 455-8310

OF: Clark County Public Works Department

SUBJECT: 102" RCP @ Casino Drive and Edison Way

NOTES: Pipe was designed by VTN in association with the Casino Drive Improvement Project in 1988 or 1989. He believes that Mr. Peter Jackson was the engineer.

Pipe is 102" diameter at the inlet and 90" diameter at the outlet.

The pipe was designed to convey approximately 1000 cfs which is approximately one-half of the 10-year storm peak flow rate. Flow in excess of 1000 cfs overtops Casino Drive and flows between the Edgewater and Colorado Belle Hotels. Recently, a sediment basin was constructed by Clark County Public Works upstream of the 102" RCP. This sediment basin was sized using the sediment data provided in the CVL Bridge Canyon Master Plan. The basin was designed to collect the volume of sediment associated with the capacity of the pipe.

RECORDER: Syndi Dudley

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Hiko Springs & Bridge Canyon Washes
Flood Insurance Study Restudy
Clark County, Nevada (Unincorporated Areas)
Telephone Contact Report

Date: January 13, 1994

CONVERSATION WITH: Mr. Bill Brandt, P.E. 455-7707

OF: Clark County Public Works Department

SUBJECT: Unnamed Wash CLOMR Request

NOTES: Bill will provide PBS&J with a copy of "Plate 1 - Proposed Unnamed Wash Flood Boundaries, FEMA 100- and 500-year Flood Conditions" prepared by Simons, Li & Associates, Inc., dated May 1, 1991. This map is referenced in the May 18, 1992 CLOMR for Unnamed Wash.

RECORDER: Syndi Dudley

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Hiko Springs & Bridge Canyon Washes
Flood Insurance Study Restudy
Clark County, Nevada (Unincorporated Areas)
Telephone Contact Report

Date: January 10, 1994

CONVERSATION WITH: *Mr. Tim Sutko* 455-3139

OF: Clark County Regional Flood Control District

SUBJECT: Hiko Springs & Bridge Canyon FIS Restudy

NOTES: During a recent staff meeting, PBS&J questioned the source of the information shown on the Geologic Map given in the Bridge Canyon Wash Flood Control Master Plan, prepared by Coe & Van Loo (1990). According to P. Hoskins of CVL, the map information was developed by Sergent, Hauskin, Beckwith. The accuracy of the map is not known. That is, the geologic mapping was likely a small part of the contract. The amount of effort put into developing the map is unknown.

RECORDER: Syndi Dudley

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Hiko Springs & Bridge Canyon Washes
Flood Insurance Study Restudy
Clark County, Nevada (Unincorporated Areas)
Telephone Contact Report

Date: January 3, 1994

CONVERSATION WITH: Mr. Bill Brandt, P.E. 455-7707

OF: Clark County Public Works Department

SUBJECT: CLOMR for Unnamed Wash and Unnamed Wash Improvement Plans

NOTES: Bill will provide PBS&J with copies of the relevant sheets of improvement plans for Unnamed Wash and CLOMR.

Bill expects that construction of the Unnamed Wash improvements will commence in the near future, possibly as soon as February, 1994.

RECORDER: Syndi Dudley

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Hiko Springs & Bridge Canyon Washes
Flood Insurance Study Restudy
Clark County, Nevada (Unincorporated Areas)
Telephone Contact Report

Date: November 18, 1993

CONVERSATION WITH: Ms. Vicki Scharnhorst, P.E. 878-8010

OF: Montgomery Watson Consulting Engineers

SUBJECT: Crown Pointe Flood Wall

NOTES: No LOMR was issued for the Crown Pointe Flood Wall.

Bill expects that construction of the Unnamed Wash improvements will commence in the near future, possibly as soon as February, 1994.

RECORDER: Syndi Dudley

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Hiko Springs & Bridge Canyon Washes
Flood Insurance Study Restudy
Clark County, Nevada (Unincorporated Areas)
Telephone Contact Report

Date: October 10, 1993

CONVERSATION WITH: Mr. Kevin Eubanks, P.E. 455-3139

OF: *Clark County Regional Flood Control District*

SUBJECT: Hiko Springs & Bridge Canyon Washes

NOTES: Kevin received phone call from Mr. Karl Mohr of FEMA. FEMA has forwarded a response to the Hydrologic Data Memorandum dated September 14, 1993. In general, FEMA's response to the hydrologic data developed for the Hiko Springs and Bridge Canyon apexes is favorable. He will copy the letter for PBS&J as soon as he receives it.

RECORDER: Syndi Dudley

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Hiko Springs & Bridge Canyon Washes
Flood Insurance Study Restudy
Clark County, Nevada (Unincorporated Areas)
Telephone Contact Report

Date: October 5, 1993

CONVERSATION WITH: Mr. Tim Sutko 455-3139

OF: Clark County Regional Flood Control District

SUBJECT: Historical flooding records for Laughlin area

NOTES: Tim will leave notebooks documenting flooding during the last 5 years at the front desk for PBS&J's use. He is not aware of any flooding data other than these notebooks.

Recommends reviewing Boyle's Facility Plan for Hiko Springs for historic data.

RECORDER: Syndi Dudley

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Hiko Springs & Bridge Canyon Washes
Flood Insurance Study Restudy
Clark County, Nevada (Unincorporated Areas)
Telephone Contact Report

Date: September 8, 1993

CONVERSATION WITH: Mr. Ed Mifflin 703-960-8800

OF: Michael Baker Jr., Inc.

SUBJECT: Hiko Springs & Bridge Canyon FIS Restudy

NOTES: Ed requested mylars of aerial photographs for Hiko Springs & Bridge Canyon area. PBS&J will send them as soon as possible.

No avulsion coefficient is used in the equations given in the Duck Creek Hydrologic Unit FIS prepared by MBJ for probability of a given discharge being exceeded between two points on an alluvial fan. Apparently, the equations become complicated when the potential for avulsion is considered.

RECORDER: Syndi Dudley

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Hiko Springs & Bridge Canyon Washes
Flood Insurance Study Restudy
Clark County, Nevada (Unincorporated Areas)
Telephone Contact Report

Date: September 7, 1993

CONVERSATION WITH: Mr. Bill Brandt, P.E. 455-7707

OF: Clark County Public Works Department

SUBJECT: Unnamed Wash Improvements

NOTES: Construction will commence within the next month. The improvements will be completely constructed within approximately 7 months.

RECORDER: Syndi Dudley

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Hiko Springs & Bridge Canyon Washes
Flood Insurance Study Restudy
Clark County, Nevada (Unincorporated Areas)
Telephone Contact Report

Date: August 8, 1993

CONVERSATION WITH: Mr. Alan Leak 303-757-8513

OF: WRC Engineering

SUBJECT: State Route 163 Diversion Dike

NOTES: Contact Chris Miller of Nevada Department of tranportation (1-687-5619) for permission to release copy of Hydraulic Design Report for SR-163.

RECORDER: Syndi Dudley

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Hiko Springs & Bridge Canyon Washes
Flood Insurance Study Restudy
Clark County, Nevada (Unincorporated Areas)
Telephone Contact Report

Date: August 8, 1993

CONVERSATION WITH: Mr. Chris Miller 1-687-5619

OF: Nevada Department of Transportation

SUBJECT: State Route 163 Diversion Dike

NOTES: The plans should be done within the next week. Mr. Miller will give Alan Leak of WRC Engineering permission to release the information.

RECORDER: Syndi Dudley

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Hiko Springs & Bridge Canyon Washes
Flood Insurance Study Restudy
Clark County, Nevada (Unincorporated Areas)
Telephone Contact Report

Date: May 11, 1993

CONVERSATION WITH: Mr. Gale Fraser 455-3139

OF: Clark County Regional Flood Control District

SUBJECT: Project Kick-off Meeting

NOTES: Mr. Ed Mifflin and Mr. Karl Mohr will arrive in Las Vegas on May 18, 1993.

The meeting will commence at 7:00 am on May 19, 1993 at the office of CCRFCD.

Bring field flags.

RECORDER: Syndi Dudley

SECTION 1.3

Meeting Minutes/Reports

MEETING MINUTES/REPORTS INDEX

Clark County, Nevada (Unincorporated Areas)
(COMMUNITY NAME, STATE)

FLOOD INSURANCE STUDY

MINUTES/REPORT DATE	MEETING DATE	MEETING TYPE
January 26, 1994	January 26, 1994	Progress Meeting
January 5, 1994	January 5, 1994	Progress Meeting
November 3, 1993	November 3, 1993	Progress Meeting
October 5, 1993	October 5, 1993	Progress Meeting
September 2, 1993	September 2, 1993	Progress Meeting
May 19, 1993	May 19, 1993	Kick-off Meeting

Church Engineering

A Division of
PBS&J POST, BUCKLEY, SCHUH & JERNIGAN, INC.

ENGINEERING · PLANNING · SURVEYING · CONSTRUCTION SERVICES

MEMORANDUM

SUBJECT: **January 26, 1994 Progress Meeting**

PLACE: Office of Post, Buckley, Schuh & Jernigan, Inc.

BY: Syndi Dudley (PBS&J)

PARTICIPANTS:
Mr. Gale Fraser, P.E. (CCRFCD)
Mr. Kevin Eubanks, P.E. (CCRFCD)
Mr. Tim Sutko, (CCRFCD)
Mr. Robert Thompson (CCPW)
Ms. Syndi Dudley (PBS&J)
Dr. Richard French, P.E. (Consulting Engineer)

DISTRIBUTION:
Participants
Denis Cederburg (CCPW)
Bill Brandt (CCPW)
John Ainsworth (CCPW)
Todd Kenner (PBS&J)
Virginia Valentine (PBS&J)

DISCUSSION:

1. **Minutes of the January 5, 1994 Meeting** - The minutes of the progress meeting held on January 5, 1994 were accepted.

2. **Project Schedule/Technical Support Data Notebook** - The draft Technical Support Data Notebook (TSDN) is scheduled to be submitted to the CCRFCD for review on February 28, 1994.

3. **Work Maps** - The preliminary model indicates that the Zone AO 1 ft depth boundary of the Bridge Canyon Fan will not extend to the Colorado River. However, recent flooding has occurred near the Colorado River in the vicinity of the Edison Way and Casino Drive intersection. It was agreed that this area would be identified as Zone A; a special flood hazard area subject to inundation by the 100-year flood in which no detailed hydraulic analyses have been performed. The limits of the flood hazard boundary will be based on available topographic data.

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MEMORANDUM

SUBJECT: **January 5, 1994 Progress Meeting**

PLACE: Office of Post, Buckley, Schuh & Jernigan, Inc.

BY: Syndi Dudley (PBS&J)

PARTICIPANTS:
Mr. Gale Fraser, P.E. (CCRFCD)
Mr. Kevin Eubanks, P.E. (CCRFCD)
Mr. Tim Sutko, (CCRFCD)
Ms. Virginia Valentine (PBS&J)
Ms. Syndi Dudley (PBS&J)
Dr. Richard French, P.E. (Consulting Engineer)

DISTRIBUTION:
Participants
Denis Cederburg (CCPW)
Bill Brandt (CCPW)
John Ainsworth (CCPW)
Todd Kenner (PBS&J)
Philip Alleyne (PBS&J)

DISCUSSION:

1. **Redesign of Needles Highway Flood Control Facilities** - During the last progress meeting on November 3, 1993, the results of the preliminary modeling of Bridge Canyon Fan west of Needles Highway were discussed. The model suggests that the 100-year peak flow rate may exceed the design capacity of the culvert crossing near Desert Road proposed in the Needles Highway Improvement Plans. Additionally, the model suggests that the 100-year peak flow rate at the "incised wash" on the surface of the fan may be less than the design capacity of the Needles Highway culvert crossing proposed at that location. PBS&J recommended increasing the design capacity of the Desert Road crossing and decreasing the design capacity at the "incised wash". All participants in the meeting agreed that the facilities should be sized to convey the flow rate developed in the FIS Restudy. PBS&J was instructed to proceed with the mapping of Bridge Canyon Fan east of Needles Highway based on the proposed changes. The results of the alluvial fan model for Bridge Canyon Fan east of Needles Highway were presented.

2. **Preliminary Model of Bridge Canyon Fan** - In one location on the Bridge Canyon Fan, the alluvial fan model results in an island surrounded by flood hazard Zone AO. This island be designated as Zone X (shaded). Additionally, the area "down-fan" of the Zone AO 1 ft depth boundary will be designated as Zone X (shaded). The boundaries of the Zone X (shaded) will be remain unchanged from those shown on the effective Flood Insurance Rate Maps.

   The preliminary model indicates that the Zone AO 1 ft depth boundary of the Bridge Canyon Fan will not extend to the Colorado River. However, recent flooding has occurred near the Colorado River in the vicinity of the Edison Way and Casino Drive intersection. Since that time, flood control improvements including a debris basin have been constructed at the intersection. It was agreed that this issue should be discussed with Mr. Robert Thompson of the Clark County Public Works Department. Mr. Thompson will be invited to the next progress meeting.

3. **Project Schedule** - A project schedule was distributed for review.

4. **Next meeting date** - The next progress meeting will be held at the PBS&J office at 3:30 pm on Wednesday, January 26, 1994.

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MEMORANDUM

SUBJECT: **November 3, 1993 Progress Meeting**

PLACE: Office of Post, Buckley, Schuh & Jernigan, Inc.

BY: Syndi Dudley (PBS&J)

PARTICIPANTS:
Mr. Kevin Eubanks, P.E. (CCRFCD)
Mr. Tim Sutko, (CCRFCD)
Mr. Bill Brandt, P.E. (CCPW)
Mr. John Ainsworth, P.E. (CCPW)
Ms. Virginia Valentine, P.E. (PBS&J)
Ms. Syndi Dudley (PBS&J)

DISTRIBUTION:
Participants
Todd Kenner (PBS&J)
Philip Alleyne (PBS&J)

DISCUSSION:

1. **Minutes of October 5, 1993 Meeting** - The Minutes from the progress meeting of October 5, 1993 were accepted.

2. **FEMA review of hydrologic analysis** - The Federal Emergency Management Agency (FEMA) has responded favorably to the flood frequency data developed by PBS&J for the Hiko Springs and Bridge Canyon apexes. Copies of the FEMA response letter were distributed.

3. **Discussion of possible modifications to Needles Highway Design** - As a part of the Needles Highway Improvement Project, two culvert crossings are planned to be constructed on the Bridge Canyon Alluvial Fan: three 10 ft X 5 ft culverts near Desert Road and twelve 10 ft X 6 ft culverts within the "incised wash". The results of the preliminary alluvial fan modeling suggest that the 100-year peak flow rate at the culvert near Desert Road may be more than that used in the Needles Highway design. Therefore, a break out of flow from Bridge Canyon Wash into the Hiko Springs Wash may occur if the culverts are constructed as shown on the plans. The preliminary modeling also suggests that the flow rate within the "incised wash" may be less than that used in the Needles Highway design. It was generally agreed that the Needles Highway facilities near Desert Road and at the "incised wash" should be sized to convey the flow rate developed in the FIS Restudy. PBS&J will provide CCPW with a cost for making these changes to the Needles Highway Improvement Plans.

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4. **Laughlin High School Dike Structure** - A flood control dike was constructed on the surface of the Bridge Canyon fan as a part of the Laughlin High School. The flood hazard model will include the effects of that dike.

   At this time, Mr. Gale Fraser of CCRFCD joined the meeting.

5. **Status of Work Maps** - To date, the Bridge Canyon alluvial fan modeling has been performed for the area west of Needles Highway. PBS&J will proceed with the mapping based on the proposed changes to Needles Highway drainage facilities near Desert Road and the "incised wash".

   Improvements to the Unnamed Wash include a levee that separates the Unnamed Wash from the Hiko Springs Wash. Mr. Brandt will provide PBS&J with a copy of the Improvement Plans for Unnamed Wash.

   A flood wall has been constructed within the Hiko Springs Wash in association with the Crown Pointe development. In the Hiko Springs model, the flood wall will be treated as the boundary of the wash. PBS&J will attempt to obtain the record drawings of the flood wall.

   PBS&J recommends that the Hiko Springs Wash be field surveyed at the El Mirage Drive crossing. The two sets of (6) 12 ft X 6 ft RCB culverts will be surveyed. Cross-sections of the wash may need to be taken upstream and downstream of the two structures.

6. **Next meeting date** - The next meeting date will be set following review of the field survey data by PBS&J.

7. **Project Schedule** - A project schedule was distributed. It was agreed that the schedule should be revised. PBS&J will submit work maps for CCRFCD review showing the results of both the alluvial fan floodplain and non-alluvial fan floodplain (if necessary) modeling.

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MEMORANDUM

SUBJECT: **October 5, 1993 Progress Meeting**

PLACE: Office of Clark County Regional Flood Control District

BY: Syndi Dudley (PBS&J)

PARTICIPANTS:
Mr. Gale W. Fraser II, P.E. (CCRFCD)
Mr. Kevin Eubanks, P.E. (CCRFCD)
Ms. Virginia Valentine, P.E. (PBS&J)
Ms. Syndi Dudley (PBS&J)
Dr. Richard French, P.E. (Consulting Engineer)

DISTRIBUTION:
Participants
Todd Kenner (PBS&J)
Philip Alleyne (PBS&J)

DISCUSSION:

1. **Status of FEMA's Review of Hydrologic Data** - The first item on the Agenda was the status of FEMA's review of the flood frequency analyses prepared by PBS&J for Hiko Springs, Bridge Canyon and Dripping Springs Canyon Washes. Mr. Eubanks will follow up on the status of that review with Mr. Edward Mifflin of Michael Baker Jr. Inc.

2. **Crown Pointe Flood Wall** - Mr. Fraser requested that Hydraulic and Sediment Transport of Proposed Crown Pointe Flood Wall prepared by Lenzotti & Fullerton (1989) be reviewed.

3. **Preliminary Work Maps** - During the May 19, 1993 field trip, two locations along the ridgeline at the northern boundary of the Hiko Springs Wash where field surveyed topographic data may be desirable were tentatively selected. At that time, it was concluded that the extent of survey that may be needed would be determined through further evaluation of the topographic data and preliminary modeling. Based on the results, it was generally agreed that additional topographic data would be not be necessary at the two locations flagged in the field on May 19th. The available topographic map (4 foot contour interval) indicates that there is ridgeline approximately 2 feet high separating the Bridge Canyon and Hiko Springs systems at both of these locations. The results of the preliminary modeling indicate that the energy depth at these locations is within the 1 foot range when both the single and multiple channel approaches were used.

The discussion then turned to the preliminary modeling of the Hiko Springs Wash. PBS&J noted that the mapping of Hiko Springs Wash is complicated by two streets that cross the landform. These streets may significantly alter the hydraulic environment. The uppermost street, El Mirage Way, is elevated approximately 7 feet above the flow line of Hiko Springs Wash. Two sets of 12 ft X 6 ft RCB culverts (6 each) have been provided to convey flow under the street. It appears that the street has been designed to be overtopped by flood flows. During major storm events, a backwater profile will likely develop upstream of these culverts.

Needles Highway crosses Hiko Springs Wash approximately 3000 feet downstream of El Mirage Way. At this time, the profile of the highway generally follows the natural ground contours. Stormwater crosses directly over the highway. However, Clark County Department of Public Works has plans to elevate the highway and install ten 10 ft X 6 ft RCB culverts at this crossing as a part of the Needles Highway Improvement Project. Therefore, it is likely that a backwater profile will also develop upstream of Needles Highway.

4. **Non-Alluvial Fan Mapping** - At this stage of the Restudy, the use of non-alluvial fan mapping techniques are being considered at the Hiko Springs Wash crossings of El Mirage Way and Needles Highway. Although preliminary mapping has not yet been performed for the Bridge Canyon Fan east of Needles Highway, CCRFCD suggested that PBS&J investigate the potential for shallow flooding below the limits of the Bridge Canyon Fan in the event that the alluvial fan flood hazard area does not extend to the Colorado River. The need for shallow flooding analyses will be determined from preliminary mapping of the Bridge Canyon Fan east of Needles Highway. The areas downstream of the limits of the alluvial fan flood hazard area will otherwise be designated as Zone X (shaded) similar to the effective FIRMs.

   PBS&J noted that there are several side canyons that contribute flow to the Bridge Canyon and Hiko Springs hydrologic systems. It was generally agreed that the side canyon inflows were insignificant and should not be considered in the Restudy.

5. **Project Schedule** - The project schedule will be largely governed by the non-alluvial fan mapping task. The full extent of non-alluvial fan mapping will be determined through further preliminary modeling.

6. **Next Progress Meeting** - The next progress meeting is scheduled for Tuesday, October 26, 1993 at 4:00 pm at the CCRFCD office.

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MEMORANDUM

SUBJECT: **September 2, 1993 Progress Meeting**

PLACE: Office of Post, Buckley, Schuh & Jernigan, Inc.

BY: Syndi Dudley (PBS&J)

PARTICIPANTS:
Mr. Gale W. Fraser II, P.E. (CCRFCD)
Ms. Virginia Valentine, P.E. (PBS&J)
Ms. Syndi Dudley (PBS&J)
Ms. Kelly Chuma (PBS&J)

DISTRIBUTION:
Participants
Mr. Karl Mohr (FEMA)
Mr. Edward Mifflin (MBJ)
Dr. Richard H. French, P.E., Consulting Engineer
Todd Kenner (PBS&J)
Philip Alleyne (PBS&J)

DISCUSSION:

1. **Hiko Springs Wash** - CCRFCD suggested that PBS&J review the report prepared by Lenzotti & Fullerton Consulting Engineers, Inc. entitled Hydraulic and Sediment Transport of Proposed Crown Pointe Flood Wall, Revised April 20, 1989. This study established boundaries for the Hiko Springs Wash for use in a two-dimensional flood routing model. These boundaries should be reviewed and compared with those shown on the effective FIRM.

2. **Hydrologic Data** - PBS&J presented a Memorandum showing the results of the flood frequency analyses for Hiko Springs, Bridge Canyon and Dripping Springs Canyon Washes. The analyses are based on the procedures used by Michael Baker Jr., Inc (MBJ) in the FIS for Duck Creek Hydrologic Unit described by Mr. Edward Mifflin of Michael Baker Jr., Inc. (MBJ) during a recent phone conversation. With regard to the Memorandum, CCRFCD requested that PBS&J reference that phone conversation. In addition, it should be noted that the discharge values developed for the 2- and 10-year return intervals are flood insurance purposes only and not intended to be used for design.

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3. **Previous CLOMRs** - CCRFCD noted that the Clark County Department of Public Works (CCPW) has plans to construct a levee that will separate the Hiko Springs Wash from the Unnamed Wash. The levee will be constructed as a part of the Unnamed Wash Channel improvements. Since a Conditional Letter of Map Revision has been granted by FEMA on the basis of these improvements, the Restudy shall be performed as though they exist.

4. **NDOT Dike/Channel** - PBS&J recently received a copy of the Hydraulic Design Report for Phase-V SR-163 prepared by WRC Nevada, Inc. for the Nevada Department of Transportation, June 1993. This report discusses the dike that is proposed to be constructed along the north side of SR 163 downstream of the Dripping Springs Wash apex. According to WRC, the purpose of the dike is to protect the highway from flood flows emanating from the Dripping Springs Canyon apex. CCRFCD requested that PBS&J briefly review the findings of the report. For the purposes of this project, CCRFCD instructed PBS&J to assume that the dike will eliminate the Bridge Canyon Wash and Dripping Spring Canyon Wash coalescence.

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MEMORANDUM

SUBJECT: **May 19, 1993 Project Kick-off Meeting**

PLACE: Office of Clark County Regional Flood Control District and field trip to study area

BY: Syndi Dudley (PBS&J)

PARTICIPANTS:
Mr. Gale Fraser, P.E. (CCRFCD)
Mr. Kevin Eubanks, P.E. (CCRFCD)
Mr. Edward Mifflin (MBJ)
Mr. Karl Mohr (FEMA)
Mr. Robert Thompson, P.E. (CCPW)
Ms. Syndi Dudley (PBS&J)
Dr. Richard French, P.E., (Consulting Engineer)
Dr. Jeffrey Keaton, P.E., P.G., (SHB AGRA)

DISTRIBUTION:
Participants
Todd Kenner (PBS&J)
Philip Alleyne (PBS&J)

DISCUSSION:

On May 19, 1993, a kick-off meeting for the Hiko Springs/Bridge Canyon Washes Restudy Project was held. The meeting commenced at the office of the Clark County Regional Flood Control District (CCRFCD) and was followed by a field trip to the Project site, Laughlin, Nevada. The primary objective of the trip was to field locate the ridge line between the Bridge Canyon and Hiko Spring drainage systems and identify low spots within the ridge. There were essentially two parties that investigated the ridge line at the southern boundary of the Bridge Canyon alluvial fan. From the walking of this fan by the two parties, the following tentative conclusions were made.

1. It was generally agreed that the hydrologic apex of the Bridge Canyon Fan should be moved downstream to the "bowl" created by the rock outcrop on the south side of the main channel. Cross-sections of the newly defined apex will be developed based on topographic data provided by a field survey of this area.

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2. Immediately below the apex, the lateral boundaries of the Bridge Canyon Fan are clearly defined. The southern boundary becomes less defined as one progresses downstream. There appeared to be a potential for break outs to the south into the Hiko Springs system. The break out channels deriving from the Bridge Canyon Fan were walked by one party and the more clearly defined fan boundary by the other. After some distance, the initial definition of the break out channels was lost and before definition was regained, the party found that the channels were re-directed away from the rim of Hiko Springs by a separate channel system.

   The potential for break outs to the south needs to be explored initially from the available topographic data and if necessary from further field investigations supported with current topographic data. A number of isolated locations along the southern boundary of the Bridge Canyon Fan where field surveyed topographic data may be desirable were tentatively selected. The extent of survey that may be needed will be determined from further evaluation of the current topographic data and preliminary modeling.

   While questions still remain, everyone was in general consensus that there is no obvious coalescence of the Bridge Canyon and Hiko Springs Fans except where the Needles Highway cuts through the ridge line. The mapping of the Needles Highway between Bridge Canyon and Hiko Springs Fans remains a primary and fundamental issue.

3. Below the apex and near the center of the Bridge Canyon Fan, there is an incised channel that has definite lateral boundaries. It appears that at some time in geologic history the channel may have extended to the fan apex and was later buried with sediment. The flood hazard within this incised channel must be defined. Between the fan apex and the incised channel, the FEMA alluvial fan methodology can be used to define the flood hazard boundaries. Below the point where the incised channel begins, the FEMA alluvial fan methodology can be used; and, as appropriate, the modifications in the FIS for the Blue Diamond Fan will be incorporated.

4. The effective Flood Insurance Rate Maps (FIRM) were derived from a review of the James M. Montgomery Consulting Engineers, Inc. maps and independent calculations performed by MBJ. The calculations and work maps prepared by MBJ can not be found. Therefore, any new mapping must be based on new data and analysis.

5. According to MBJ, the Bridge Canyon Fan flood hazard zone boundaries shown on the effective FIRM include the effects of the Dripping Springs alluvial fan. This is a regulatory concern that was neither recognized by CCRFCD nor CE/PBS&J and must be addressed. Given this consideration, the scope of work may need to be expanded beyond the limits of the initial contract.

6. The mapping of the alluvial fans will be based on a joint probability of flooding at a given depth and velocity with a specified return period. Therefore, the rainfall-runoff model for each tributary watershed will be separate and independent.

At this point, we examined the Hiko Springs Wash and existing development within the area.

7. The CCRFCD requested that the Hiko Springs Wash be remapped since the alluvial fan area is now crossed by streets that channelize and concentrate the flow. The improvements have significantly altered the hydraulic environment. Upstream of El Mirage Way, the FEMA alluvial fan methodology can be used. We were all in general agreement that between El Mirage Way and Needles Highway that the FEMA alluvial fan methodology is no longer an appropriate mapping technique. That is, the FIRMs should be based on effects of the existing improvements.

8. Upstream of El Mirage Way where the profile of Needles Highway approaches natural grade, there appears to be a potential for breakout of Hiko Springs flood flow across the Highway. This situation can be evaluated using the modifications to the FEMA alluvial fan methodology employed in the FIS for the Blue Diamond Wash.

SECTION 1.4

General Correspondence

Federal Emergency Management Agency
Washington, D.C. 20472

OCT 08 1993

Mr. Gale Wm. Fraser, II, P.E.
Acting General Manager/Chief Engineer
Clark County Regional Flood Control District
301 E. Clark Avenue, Suite 301
Las Vegas, Nevada 89101

Dear Mr. Fraser:

With a letter dated September 20, 1993, to Mr. Karl Mohr of my staff you enclosed information regarding flood frequency analyses for Hiko Springs, Bridge Canyon and Dripping Springs Washes in Laughlin, Nevada. The basins analyzed are sources of alluvial fan flooding shown on the Flood Insurance Rate Map (FIRM) for Clark County (both the effective map for the unincorporated areas dated September 29, 1989, and the preliminary map for the county and incorporated areas dated July 29, 1993). You indicated that you would appreciate us briefly reviewing that information and requested that we forward any comments that we feel should be considered.

We are pleased that we are able to accommodate your request. In general, we review discharge-frequency relationships for reasonableness. That review starts with a comparison of the suggested relationships with those used to develop the FIRM. That comparison demonstrated to us that the suggested flood frequency relationships are reasonable.

Please note that we do not, in general, review methodologies or the details of hydrologic analyses and, therefore cannot comment at that level. We point that out at this time so there will be no misunderstandings if at sometime in the future we review a revision request based on the same modeling with a change in one or two key parameters or based on details of the model. If, for example, a change in the infiltration rates used in a rainfall-runoff model resulted in significantly different discharge values, we would view those results as being significantly different from reasonable values and not as results of an "accepted" model in which a parameter was replaced by a more reasonable value.

We note that the minutes of the meeting you held with your contractor September 2, 1993, indicate that they will analyze the flooding situation in this area as though the floodwall along Unnamed Wash and the dike along State Road 163 were both in place and functioning properly. We want to remind you that we cannot revise our maps to show anything but existing conditions.

I trust this letter satisfies your request and enables you to proceed with the mapping portion of your study. We are encouraged by the coordination that is reflected in your letter and appreciate the opportunity to participate in that coordination. If we can assist you further please contact Mr. Mohr in Washington, DC, either by telephone at (202) 646-2770 or by facsimile at (202) 646-3445.

Sincerely,

William R. Locke
Chief, Risk Studies Division
Office of Risk Assessment

cc: Ms. Syndi Dudley
Church Engineering

CLARK COUNTY
REGIONAL FLOOD CONTROL DISTRICT



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SEP 23 1993
CHURCH ENGINEERING

Gale Wm. Fraser, II, P.E.
ting Chief Engineer/General Manager

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September 20, 1993

Karl Mohr
Federal Emergency Management Agency
Office of Risk Assessment
500 C Street Southwest, Room # 434
Washington, D.C. 20427

Bridge Canyon/Hiko Springs Flood Insurance Study
Clark County, Nevada

Dear Mr Mohr:

Enclosed please find information submitted to me by Church Engineering regarding the flood frequency analysis for the Hiko Springs, Bridge Canyon and Dripping Springs Washes in Laughlin, Nevada. The District would appreciate your brief review of this information. Please forward any comments that you feel should be considered prior to continuing with the mapping portion of the study.

Thank you for your assistance. Should you need further information or have questions, feel free to contact me at 455-3139.

GALE WM. FRASER, II, P.E.
Acting General Manager/Chief Engineer

By: Kevin Eubanks
Kevin Eubanks, P.E.
Senior Hydrologist

Enclosure

cc: Edward Mifflin, Michael Baker, Jr., Inc., w/encl.
Syndi Dudley, Church Engineering, w/o encl.

KLE:jwp

Bridge/Hiko FIS

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MEMORANDUM

TO: **KEVIN EUBANKS, CCRFCD** **DATE:** **SEPTEMBER 14, 1993**

FROM: ***SYNDI DUDLEY***

SUBJECT: **BRIDGE CANYON/HIKO SPRINGS RESTUDY**
CE/PBS&J JOB NO. 7190.542

Please find attached a table which presents the results of the flood frequency analyses for Hiko Springs, Bridge Canyon and Dripping Springs Washes. These data were derived using the references given below. The following procedure for developing the flood frequency discharge values was suggested by Mr. Edward Mifflin of Michael Baker Jr., Inc. (MBJ) during a phone conversation on August 16, 1993.

- Hydrologic Documentation for Feasibility Study, Las Vegas Wash and Tributaries, Nevada. U.S. Army Corp of Engineers (COE), Los Angeles District, April, 1988, Plate 32.
- Facilities Plan for Hiko Springs and Unnamed Wash Laughlin -Big Bend Area, Clark County, Nevada. Prepared by: Boyle Engineering Corporation; for Clark County Regional Flood Control District; May, 1989, Table 3.3.
- Bridge Canyon Wash Flood Control Master Plan, Laughlin Nevada. Prepared by: Coe & Van Loo Consulting Engineers; for Clark County Regional Flood Control District; September, 1990, Table 6.4.
- Guidelines for Determining Flood Flow Frequency. United States Water Resources Council, Bulletin 17B, Revised September, 1981, pp. 5-2 and 5-3.

The flood frequency analyses are based on the 100-year peak flow rates developed by Boyle Engineering Corporation for Hiko Springs Wash and Coe & Van Loo Consulting Engineers for Bridge Canyon and Dripping Springs Washes. According to Table 3.3 (attached) prepared by Boyle Engineering Corporation, the 100-year peak flow rate at the apex of the Hiko Springs Wash is 9700 cfs (Node I). According to Table 6.4 (attached) prepared by Coe & Van Loo Consulting Engineers, the 100-year peak flow rates at the apex of Dripping Springs Canyon and Bridge Canyon Washes are 4290 cfs and 5270 cfs, respectively.

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On Figure 14-1 from Bulletin 17B (attached) the regional log-Pearson III (LP3) skew coefficients for the United States are shown schematically. In the Southwest, the skew coefficient is very close to zero. On Plate 32, the regional LP3 standard deviation relationship given in the COE Feasibility Study are shown. According to Plate 32, the standard deviation varies from 0.55 to 1 depending on the size of the drainage area.

The Water Resources Council Bulletin 17B provides guidelines for developing frequency curves. For an LP3 distribution, the values of the discharges associated with the 0.10 and 0.50 exceedance probabilities can be derived from the synthetic logarithmic statistic equations given in Bulletin 17B. These equations are given in the attached reference material.

The frequency relationships shown on the attached table were derived by adopting a zero skew coefficient, using the standard deviation versus drainage area relationship given on Plate 32, and solving the synthetic logarithmic statistic equations for the 10-year and 2-year discharge values.

Please note that Coe & Van Loo Consulting Engineers developed 2- and 10-year flow rates at the apexes of Bridge Canyon and Dripping Springs Washes (Table 6.4). These flow rates are significantly higher than those developed in this study. CE/PBS&J would emphasize that the values developed in this study are intended to be used for flood insurance purposes and not for use in drainage design. The Facilities Plan for Hiko Springs and Unnamed Wash prepared by Boyle Engineering Corporation reports only the results of the 100-year hydrologic analysis (Table 3.3).

DEVELOPMENT OF FLOOD FREQUENCY RELATIONSHIPS USING SYNTHETIC LOGARITHMIC STATISTIC EQU
AND REGIONAL STATISTIC RELATIONSHIPS

Location	Basin Area (sqmi)	100-year peak flow @ fan apex (cfs)	10-year peak flow @ fan apex (cfs)	2-year peak flow @ fan apex (cfs)	Regional Statistics		Mean
					Skew Coefficient	Standard Deviation	
Hiko Springs	18.3	9700	1625	175	0.00	0.75	2.24
Bridge Canyon	8.0	5270	780	72	0.00	0.80	1.86
Dripping Springs	4.3	4290	565	45	−0.00	0.85	1.65

Table 6.4: Summary of Computed Peak Discharges - Existing Conditions

CP[1]	Location/Description	Basin Area (mi^2)	Peak Discharge(cfs) 2yr-6hr	10yr-6hr	25yr-6hr	100yr-6hr
1	Dripping Springs Canyon Wash @ Fan Apex:	4.7	240.0	1040.0	1870.0	4290.0
2	Dripping Springs Canyon Wash @ Sportsmans' Park:					
	a) Sub-basin D5 only	5.4	50.0	580.0	1170.0	2910.0
	b) CP1 routed thru D5	10.1	150.0	1400.0	2400.0	5120.0
3	Dripping Springs Canyon Wash @ Laughlin Bridge:					
	a) Sub-basin D4 only	1.4	0.0	120.0	250.0	860.0
	b) CP1 routed thru D4	6.1	170.0	1010.0	1750.0	4050.0
4	Bridge Canyon Wash @ HWY 163 Crossing: (2)	5.8	90.0	940.0	1580.0	3850.0
5	Bridge Canyon Wash @ Fan Apex: (2)	8.0	140.0	1260.0	2150.0	5270.0
6	Bridge Canyon Wash @ Edison Way:					
	a) CP1 routed thru D5	14.7	70.0	1030.0	2200.0	4890.0
	b) CP1 routed thru D3	19.4	125.0	1380.0	3040.0	6330.0
7	Concentration Pt. of Sub-basin U4:	1.3	10.0	160.0	360.0	1100.0
8	Emerald River:					
	a) Sub-basin U5 only	1.9	0.0	160.0	330.0	1250.0
	b) CP7 routed thru U5	3.2	0.0	230.0	520.0	1410.0
	c) CP5 routed thru U5	11.2	80.0	1100	2160.0	4430.0
9	Hiko Springs Wash @ Canyon Mouth: (3)	18.3	---	---	---	9700.0
10	Hiko Springs Wash @ Colorado River: (3)	20.0	---	---	---	9500.0

Notes:

(1) Flow Concentration Point (CP). Refer to Figure 6.1.

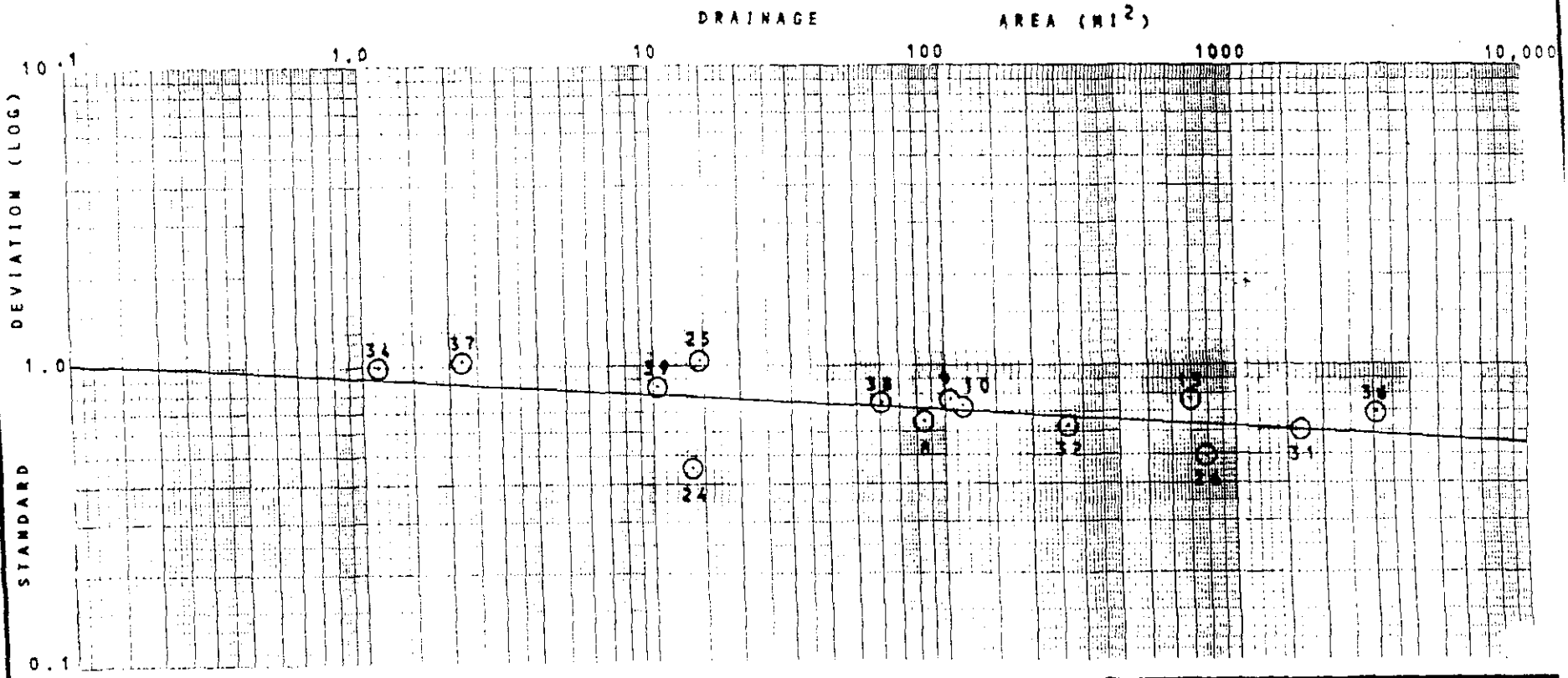
(2) SR 163 roadway embankment and reservoir not evaluated in HEC-1 model.

(3) Discharges for existing conditions from the "Facilities Plan for Hiko Springs and Unnamed Wash Laughlin - Big Bend Area" (CCRFCD, 1989).

TABLE 3.3

100-YEAR HYDROLOGIC ANALYSIS RESULTS

NODE	CUMULATIVE AREA (sq.mi.)	PEAK DISCHARGE (cfs)		TOTAL VOLUME (Ac-Ft)	
		Storm Duration		Storm Duration	
HIKO SPRINGS WASH		6-Hour	3-Hour	6-Hour	3-Hour
A	2.7	2500		300	
B	6.9	5700		790	
C	10.5	6900		1110	
D	12.1	7500		1260	
E	12.6	7600		1320	
F	13.7	8000		1410	
G	16.0	9100		1640	
H	17.0	9200		1730	
I	18.3	9700		1870	
J	19.2	9600		1900	
K	19.7	9500		1910	
L	20.0	9500	9000	1910	1600
UNNAMED WASH					
UA	.5	1400		88	
UB	1.6	3700		280	
UC	2.4	4400		360	
UD	3.8	5600		540	
UE	3.9	5200	4700	550	465



STREAMGAUGES

8. FLAMINGO WASH AT LAS VEGAS
9. FLAMINGO WASH AT MARYLAND PKWY
10. FLAMINGO WASH NEAR MOUTH
13. LAS VEGAS WASH AT N. LAS VEGAS
24. TYSON WASH TR. NEAR QUARZITE
25. SACTO WASH TR. NEAR TOPOC
26. SACTO WASH NR. YUCCA, ARIZONA
31. SAN FELIPE CRK NR. WSTMRELND
32. SALT CREEK NEAR MECCA, CALIF.
34. CARUTHERS CRK NR. IVANPAH, CA
36. AMARGOSA RIVER AT TECOPA
37. AMARGOSA R TR. #1 NR. JOHNNIE
38. SALT WELLS CRK NR. WESTEND, CA
39. NINEMILE CREEK NEAR BROWN, CA

LAS VEGAS WASH AND TRIBUTARIES, NEVADA
FEASIBILITY STUDY

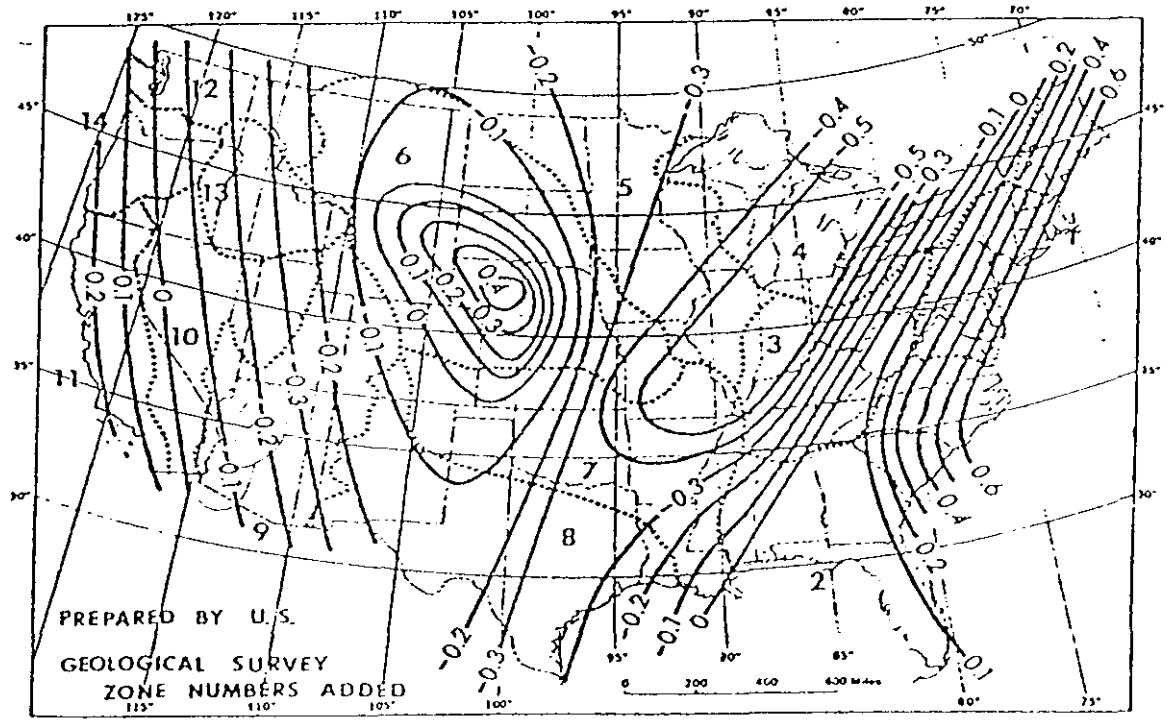
STANDARD DEVIATION
VERSUS
DRAINAGE AREA

U.S. ARMY CORPS OF ENGINEER
LOS ANGELES DISTRICT

PLATE 32

FIGURE 14-1

GENERALIZED SKEW COEFFICIENTS OF ANNUAL MAXIMUM STREAMFLOW LOGARITHMS



$$G_s = -2.50 + 3.12 \left(\frac{\text{Log}(Q_{.01}/Q_{.10})}{\text{Log}(Q_{.10}/Q_{.50})} \right)$$

$$S_s = \frac{\log (Q_{.01}/Q_{.50})}{K_{.01} - K_{.50}}$$

$$\overline{X}_s = \log(Q_{.50}) - K_{.50}(S_s)$$

where G_s, S_s, and $\overline{X}_s$ are the synthetic logarithmic skew coefficient, standard deviation, and mean, respectively; $Q_{.01}$, $Q_{.10}$, and $Q_{.50}$ are discharges with 0.01, and 0.10, and 0.50 exceedance probabilities respectively; and $K_{.01}$ and $K_{.50}$ are Pearson Type III deviates for exceedance probabilities of 0.01 and 0.50 respectively, and skew coefficient G_s.

Federal Emergency Management Agency

Washington, D.C. 20472

JUL 13 1993

RECEIVED
JUL 19 1993
CHURCH ENGINEERING

Mr. Gale Wm. Fraser II, P.E.
Assistant General Manager
Clark County Regional Flood
Control District
P.O. Box 396
Las Vegas, Nevada 89125

Dear Mr. Fraser:

This is to thank you for arranging the field trip and meeting of May 19, 1993, with Mr. Karl Mohr of my staff, Mr. Ed Mifflin from our Technical Evaluation Contractor, Michael Baker Jr., Inc. (MBJ), staff, and representatives of your contractor, Church Engineering, and their consultants. Because the study that Church Engineering is performing for the Clark County Regional Flood Control District involves analyses of alluvial fan flooding and will eventually be submitted to us to revise the effective Flood Insurance Rate Map for Clark County, we are particularly encouraged by the desire by all parties to maintain an open dialogue throughout the study process.

On June 11, 1993, we received a copy of the May 19 meeting minutes (copy enclosed) from Ms. Syndi Dudley of Church Engineering. Reading those minutes reinforces the optimistic report Mr. Mohr filed when he returned from the meeting. Two items in the minutes caught our eye:

- In Item 4 it is mentioned that the calculations and work maps prepared by MBJ cannot be found. We have located the missing calculations and work maps and have enclosed copies of them with this letter.

- In Item 7 it is mentioned that between El Mirage Way and Needles Highway, the Federal Emergency Management Agency alluvial fan methodology is no longer an appropriate mapping technique. Not recalling the exact conversation, we believe that the discussion about this area centered on the applicability of the simple boundary conditions and assumptions inherent in our computer model, rather than in what we would refer to, in general, as our methodology.

If you have any questions regarding the study, including strategies for modeling the flood risks in the area, please contact Mr. Mohr in Washington, DC, either by telephone at (202) 646-2770, or by facsimile at (202) 646-3445.

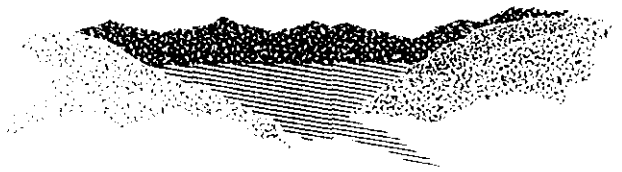
Sincerely,

William R. Locke
Chief, Risk Studies Division
Federal Insurance Administration

Enclosures

cc: Ms. Syndi Dudley
Church Engineering

C L A R K C O U N T Y
REGIONAL FLOOD CONTROL DISTRICT



Virginia Valentine, P.E.
Chief Engineer/General Manager

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Bruce L. Woodbury
Clark County

April 2, 1993

RECEIVED
APR 9 1993
CHURCH ENGINEERING

Ms. Syndi J. Dudley
Church Engineering/
Post, Buckley, Schuh & Jernigan, Inc.
6600 W. Charleston Blvd., Suite 140
Las Vegas, Nevada 89102

Dear Ms. Dudley:

Enclosed please find information taken from the draft FIS Technical Appendix for the Duck Creek Hydrologic Unit prepared by Michael Baker Jr., Inc. This information may be used as an example of procedures that might be applied to the Hiko Springs/Bridge Canyon FIS. I hope you find this information helpful. Should you need further information or have questions, feel free to contact me at 455-3139.

Sincerely,

Kevin Eubanks, P.E.
Senior Hydrologist

Enclosure

KLE:jwp

File: Hiko Bridge FIS

301 E. Clark Avenue, Suite 301 • Las Vegas, Nevada 89101
(702) 455-3139 • FAX: (702) 455-3870

CLARK COUNTY
REGIONAL FLOOD CONTROL DISTRICT



Virginia Valentine, P.E.
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May 13, 1993

Mr. Todd Kenner, P.E., Vice-President
Church Engineering
A Division of Post, Buckley, Schuh & Jernigan, Inc.
6400 West Charleston Boulevard
Suite 140
Las Vegas, Nevada 89102

Hiko/Bridge Canyon FIS Restudy

Dear Mr. Kenner:

On May 13, 1993, the Clark County Regional Flood Control District Board of Directors approved and authorized the Chairman to sign the Agreement for Professional Services between the District and Church Engineering, a Division of Post, Buckley, Schuh & Jernigan, Inc., a Nevada Corporation, to perform the Hiko Springs and Bridge Canyon Washes Flood Insurance Restudy. Enclosed is a copy of the executed Agreement for your files. The District has retained a file copy.

This letter will serve as Notice To Proceed on May 14, 1993 with the services outlined in the Agreement (Exhibit C - Statement of Work, Tasks 1 through 6) and designate Kevin Eubanks, P.E., Senior Engineer, as the District's Project Manager.

The District looks forward to working with Church Engineering on this project.

Sincerely,

Virginia Valentine, P.E.
General Manager/Chief Engineer

cc: Gale Wm. Fraser, II, Regional Flood Control District
Kevin Eubanks, Regional Flood Control District

VBV:GWF:jwp

Enclosure

FILE: Hiko/Bridge FIS Restudy

GWF:m:\wpfiles\hiko.ntp

301 E. Clark Avenue, Suite 301 • Las Vegas, Nevada 89101
(702) 455-3139 • FAX: (702) 455-3870

SECTION 2

ENGINEERING ANALYSES

2.1 Hydrologic Analyses

2.1.1 Hiko Springs Wash
2.1.2 Bridge Canyon Wash

2.2 Hydraulic Analyses

2.2.1 Hiko Springs Fan
2.2.2 Bridge Canyon Fan

SECTION 2.1

Hydrologic Analyses

Study Contractor: Post, Buckley, Schuh & Jernigan, Inc.

HYDROLOGIC ANALYSES INDEX

Unincorporated Areas, Clark County, Nevada

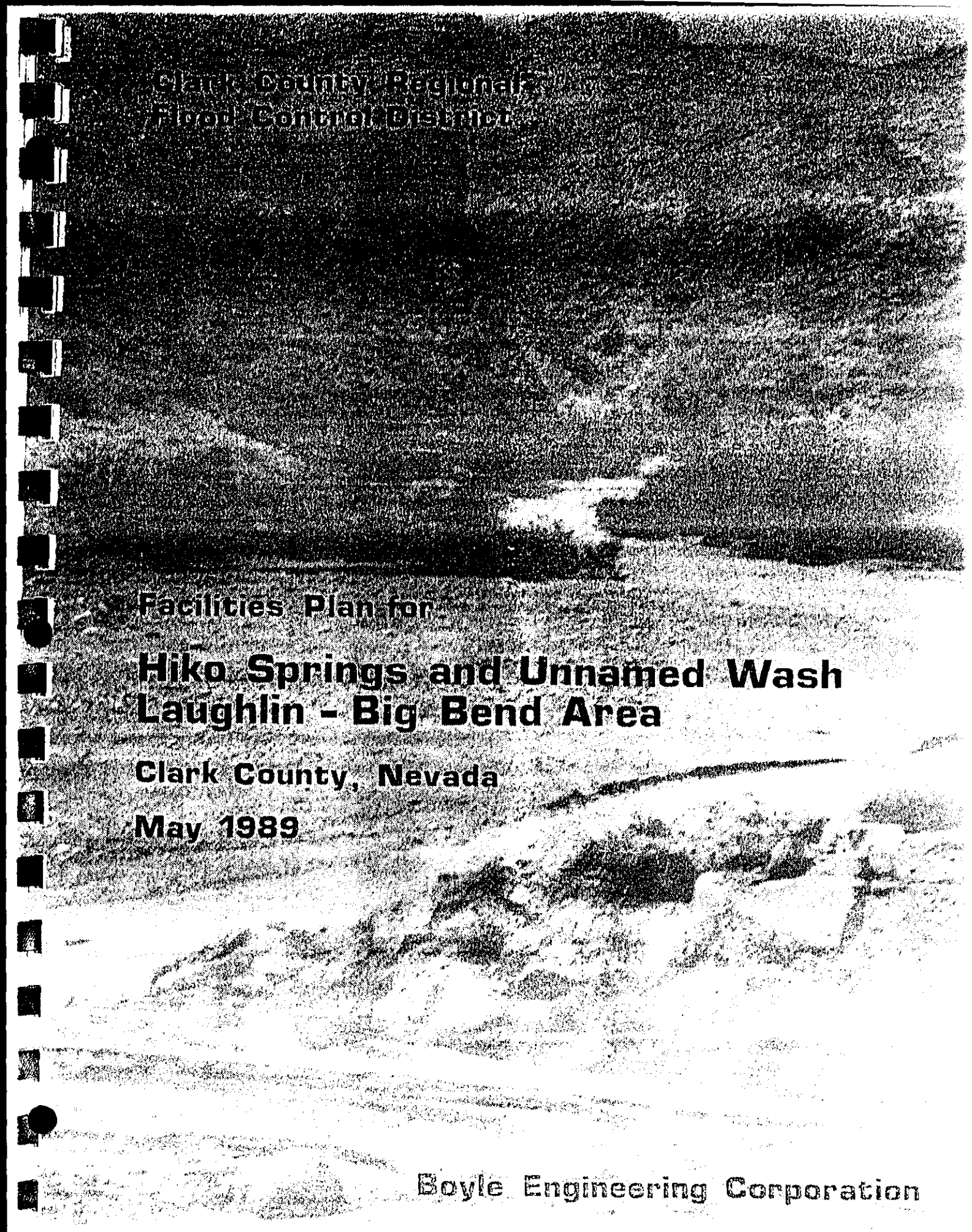
FLOOD INSURANCE STUDY

HYDROLOGIC ANALYSIS INDEX

FLOODING SOURCE/ STREAM NAME	HYDROLOGIC METHOD/ MODEL USED	METHOD/MODEL ANALYSIS DATE	SECTION NO. PAPER COPY	SECTION NO. FLOPPY DISKETTES
Hiko Springs	HEC-1	May 1989	2.1.1	INSERT
Bridge Canyon	HEC-1	September 1990	2.1.2	INSERT

SECTION 2.1.1

Hiko Springs Wash



Facilities Plan for

Hiko Springs and Unnamed Wash Laughlin - Big Bend Area

Clark County, Nevada

May 1989

Boyle Engineering Corporation

CHAPTER 3

HYDROLOGY

INTRODUCTION

This chapter presents the results of the hydrologic analyses of the Hiko Springs Wash and the Unnamed Wash. Included is a presentation of the methodologies and assumptions used in the study.

METHODOLOGY

Hydrologic Model

The hydrologic model utilized for this study is the HEC-1 Flood Hydrograph Package developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center.

HEC-1 is a rainfall-runoff event simulation model utilizing an interconnected system of hydrologic and hydraulic components to simulate the surface runoff response of a drainage area to precipitation.

Precipitation

Precipitation values and parameters were utilized in accordance with the guidelines of the manual Rainfall For The Clark County Regional Flood Control District Area (CCRFCD Rainfall Manual). This manual is presently in draft format. The draft utilized was received by Boyle April 20, 1988.

Loss Rate

Precipitation excess over each sub-basin was generated using the United States Department of Agriculture Soil Conservation Service (SCS) curve number option built into HEC-1. In this method, runoff curve numbers are used to determine rainfall abstractions and are a function of soil group, antecedent moisture conditions, soil cover, and land-use type.

Hydrograph Development

The SCS Dimensionless Unit Hydrograph option in HEC-1 was used, in conjunction with excess precipitation, to develop flood hydrographs for each sub-basin.

Flood Routing

Routing of hydrographs was performed using the Kinematic Wave method. This method assumes that the energy grade line is parallel to the channel bottom. This method of routing was selected based upon the observation that slopes are generally steep within the basin and that backwater effects on flood flows are negligible.

PARAMETERS

Basin and Sub-basin Delineation

For hydrological modeling purposes the Hiko Springs Wash basin and the Unnamed Wash basin were divided into 19 and 6 sub-basins respectively. The basins and sub-basins are delineated in Figure 3.1. Sub-basin and basin boundaries were delineated based upon topography, flow concentration points, and design points of interest. The majority of the sub-basins were determined by utilizing the United State Geological Survey (USGS) 7.5 minute quadrangle maps for this area. A USGS 15 minute quadrangle map was utilized for the westerly portion of the Hiko Springs Wash Basin. For portions of each basin on the alluvial apron, 1-inch = 400-feet scale maps with 4-foot contour intervals prepared for the FEMA Flood Insurance Study were utilized.

Precipitation

A single event storm of 100-year recurrence interval was utilized for this study.

Point precipitation values were obtained using the NOAA Atlas 2, Precipitation - Frequency Atlas of the Western United States, Volume VII - Nevada, published by the U.S. Department of Commerce, National Weather Service in 1973. These point precipitation values were multiplied by a 1.43 adjustment factor to reflect the best available information in accordance with the CCRFCD Rainfall Manual.

Design storm durations of 3-hours and 6-hours were initially modeled. Based on initial modeling, the 6-hour design storm produced a greater peak discharge and greater runoff volume; therefore, only the 6-hour design storm was considered. The results of the 3-hour simulation for the entire watershed are presented along with the results of the 6-hour simulation in Table 3.3. The total rainfall utilized was 4.58 inches in the

Clark County Regional Flood Control District

Hiko Springs and Unnamed Wash Facilities Plan

DRAINAGE BASINS AND SUB-BASINS

Figure 3.1

Hiko Springs Basin

Unnamed Wash Basin

Legend

A1 Sub-basin Designation

(A) Hydrologic Node

Sub-basin Boundary

Basin Boundary

SCALE IN FEET

Boyle Engineering Corporation

model for the 6-hour design storm, and was 4.10 inches for the 3-hour design storm.

For the 6-hour design storm, five different storm distributions, each assigned a Storm Distribution Number (SDN), have been developed by the Los Angeles District of the Corps of Engineers. The appropriate SDN was utilized based on the size of the contributing drainage area. SDN 4 was used for the total area of the Hiko Springs Basin. Table 3.1 includes the SDN utilized at each hydrological node.

Depth Area Reduction Factors (DARF) were obtained from NOAA Technical Memorandum NWS HYDRO-40, Depth-Area Ratios in the Semi-Arid Southwest United States, published by the U.S. Department of Commerce, National Weather Service, in August of 1984. The appropriate DARF were obtained directly from the published table and curves, or interpolated for intermediate areas.

Table 3.1 shows the DARF utilized at each hydrological node.

Curve Numbers

Runoff curve numbers were developed based on vegetation, soils group information, land use, and antecedent soil moisture condition in accordance with the standard methods of the SCS.

Curve numbers for undeveloped area were based on a condition of desert shrub in poor hydrologic condition (less than 30 percent ground cover).

TABLE 3.1

PRECIPITATION PARAMETERS

NODE	CUMULATIVE AREA (SQ.MI)	DEPTH-AREA REDUCTION FACTOR	STORM DISTRIBUTION NUMBER
HIKO SPRINGS WASH			
A	2.7	.92	2
B	6.9	.89	3
C	10.5	.86	4
D	12.1	.84	4
E	12.6	.84	4
F	13.7	.83	4
G	16.0	.81	4
H	17.0	.80	4
I	18.3	.79	4
J	19.2	.79	4
K	19.7	.78	4
L	20.0	.78	4
UNNAMED WASH			
UA	.5	.99	1
UB	1.6	.96	*
UC	2.4	.95	*
UD	3.8	.91	*
UE	3.9	.91	3

* NOT APPLICABLE - PEAK DISCHARGES AND VOLUMES DETERMINED BY INTERPOLATION BETWEEN SIMULATIONS WITH SDN OF 1 AND 3.

Soils information was obtained from the SCS Soil Survey for the southern Clark County area. This survey delineates families of soil types and percentages of each hydrologic soil group in each family. Figure 3.2 delineates the boundaries of each family of soil types.

More than 90 percent of both basins is assumed to remain as undeveloped land. Estimates of future land use were made based on the available planning and zoning information. Future land use was lumped into three general categories: rural, residential, and resort hotel. Rural was assumed to be 30% impervious, residential - 60% impervious and resort hotel - 80% impervious.

An average antecedent soil moisture condition (Condition II) was used. Curve numbers used were based on desert shrub curve numbers published by the SCS in Technical Release 55, Second Edition, June 1986.

Based on the above factors, composite curve numbers for each sub-basin were developed. Table 3.2 shows the curve numbers for each sub-basin.

Basin Lags

Basin lags were estimated for each sub-basin. These values were used in the calculation of a unit hydrograph for each sub-basin. The following equations were used to calculate sub-basin lag times:

$$\text{Lag}_{COE} = 24n\ (L\ Lc/\ S^{1/2})^{0.38}$$

$$\text{Lag}_{SCS} = .78\ \text{Lag}_{COE}$$

where

n = Roughness coefficient for overland flow,

L = Length of the main stream in miles.

Lc = Distance from the basin outlet to the centroid of the basin, in miles.

S = Average slope of the main water course, in feet/mile.

Lag_{COE} = Corps of Engineers lag time in hours.

Lag_{SCS} = Soil Conservation Service lag time, in hours.

Area	Soil Association Family				
14	Canutio	Bitter Springs	Akela	Arizo	Impervious
17	Carrizo	Gunsight	Cavelt		
18	Carrizo	Gunsight	Cavelt		
24	Gunsight	Carrizo	Aig	Rinamt	
34	Arizo	Bermesa	Nickel	McCullough	
38	Impervious	Aftaden	Arizo	Gar	
39	Gachado	Carrizo	Lomitas	Impervious	
44	Whitlock	McCullough	Isom	Skyhaven	

Hiko Springs Basin

Unnamed Wash Basin

Legend

- 24 Soil Group Designation
- Soil Group Boundary
- Basin Boundary

Clark County Regional Flood Control District

Hiko Springs and Unnamed Wash Facilities Plan

SOIL ASSOCIATION MAP

Figure 3.2

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TABLE 3.2

SUB-BASIN LAG AND BASIN PARAMETERS

SUB-BASIN NUMBER	AREA (sq.mi)	CN	L (mi.)	Lc (mi.)	n	SLOPE (ft/mi.)	LAG SCS
HIKO SPRINGS WASH							
A1	2.730	78	3.428	1.212	.06	162	.73
B1	1.080	83	2.121	1.080	.05	521	.39
B2	.610	82	1.761	.814	.05	330	.36
B3	2.500	81	3.240	1.890	.06	251	.78
C1	1.910	80	3.068	1.818	.06	298	.73
C2	1.680	79	2.652	1.155	.08	241	.79
D1	.524	80	1.610	.795	.05	293	.35
D2	.301	80	1.023	.644	.05	313	.27
D3	.753	85	1.591	.985	.05	289	.38
E1	.495	87	1.856	.758	.05	323	.36
F1	1.080	82	2.481	1.383	.05	391	.48
G1	1.360	83	2.765	1.477	.05	293	.53
G2	1.020	88	1.913	1.023	.05	364	.39
H1	.560	83	1.742	.871	.05	416	.35
H2	.373	90	.890	.455	.05	1056	.18
I1	1.350	89	2.614	1.098	.05	321	.47
J1	.847	75	1.894	1.023	.04	232	.34
KI	.517	68	1.136	.606	.04	216	.23
L1	.308	69	1.136	.511	.04	189	.22
UNNAMED WASH							
UA1	.481	90	1.288	.682	.05	517	.27
UB1	.495	90	1.553	.947	.05	386	.35
UB2	.631	90	1.629	1.061	.05	587	.34
UC1	.775	77	1.402	.663	.05	549	.27
UD1	1.435	84	2.159	1.383	.05	454	.44
UE1	.100	70	.841	.341	.04	166	.18

When using the SCS dimensionless unit hydrograph method, the U.S. Soil Conservation Service definition of lag is required. The relationship between the SCS Lag and the Corps of Engineers (COE) Lag is derived from the San Diego County Hydrology Manual and the SCS National Engineering Handbook.

The COE Lag is defined as the elapsed time in hours from the beginning of unit effective rainfall to the instant that the hydrograph for the concentration point of an area reaches 50 percent of the ultimate discharge volume. This time can be related to the time to peak.

From the San Diego County Hydrology Manual the following relationship applies for the SCS typical dimensionless unit hydrograph.

$$Lag_{COE} = 1.16\ T_p$$

or

$$T_p = .862\ Lag_{COE} \qquad (A)$$

Where T_p = time to peak in hours, defined as the time from the beginning of effective rainfall to the time of the maximum discharge.

The U.S. Soil Conservation Service definition of lag is the time from the center of mass of excessive rainfall to the time of maximum discharge. The SCS National Engineering Handbook provides the following relationships.

$$Lag_{SCS} = .6\ Tc$$

or

$$Tc = 1.67\ Lag_{SCS} \qquad (B)$$

and

$$D = 0.133\ Tc \qquad (C)$$

Where Tc = time of concentration, defined as the time it takes for runoff to travel from the hydrologically most distant part of the storm area to the watershed outlet.

D = time of duration of the excessive rainfall.

In hydrograph analysis, Tc is the time from the end of excessive rainfall to the point on the falling limb of the hydrograph (point of inflection) where the recession curve begins.

Both lag definitions may be related to the time to peak

$$T_p = Lag_{SCS} + D/2$$

substituting in relationship (C)

$$T_p = Lag_{SCS} + 0.133/2\ T_C$$

substituting in relationship (B)

$$T_p = Lag_{SCS} + 0.133/2\ (1.67\ Lag_{SCS})$$

reducing to

$$T_p = 1.11\ Lag_{SCS}$$

substituting in relationship (A)

$$.862\ Lag_{COE} = 1.11\ Lag_{SCS}$$

solving for Lag_{SCS}

$$Lag_{SCS} = .78\ Lag_{COE}$$

The "n" values selected for the basin range from .04 to .08. The higher "n" values are representative of the mountainous areas where significant channelization does not occur. The "n" values were selected based on field observations, guidelines from the San Bernardino County Hydrology Manual, comparison to lag relationships for numerous basins complied by the U.S.Army Corps of Engineers Los Angeles District, and noting that the smaller the sub-basin the greater percentage will be shallow overland flow, with higher "n" values than channelized flow.

Values of L, Lc, and S were measured from best available mapping, primarily USGS 7.5 minute quadrangle maps, also 15 minute USGS maps and the 1-inch = 400-feet FEMA Maps.

Hydrograph Routing

The Kinematic Wave approach to channel routing requires the estimation of channel lengths, slopes, average bottom widths, side slopes, and Manning's "n" values. Channel lengths and slopes were estimated from the available mapping. Average bottom widths, side slopes, and "n" values were estimated from mapping, aerial photographs and field observations.

TABLE 3.3

100-YEAR HYDROLOGIC ANALYSIS RESULTS

NODE	CUMULATIVE AREA (sq.mi.)	PEAK DISCHARGE (cfs)		TOTAL VOLUME (Ac-Ft)	
		Storm Duration		Storm Duration	
HIKO SPRINGS WASH		6-Hour	3-Hour	6-Hour	3-Hour
A	2.7	2500		300	
B	6.9	5700		790	
C	10.5	6900		1110	
D	12.1	7500		1260	
E	12.6	7600		1320	
F	13.7	8000		1410	
G	16.0	9100		1640	
H	17.0	9200		1730	
I	18.3	9700		1870	
J	19.2	9600		1900	
K	19.7	9500		1910	
L	20.0	9500	9000	1910	1600
UNNAMED WASH					
UA	.5	1400		88	
UB	1.6	3700		280	
UC	2.4	4400		360	
UD	3.8	5600		540	
UE	3.9	5200	4700	550	465

RESULTS

Simulations were performed using several total basin depth area reduction factors and appropriate storm distribution numbers. From these simulations, peak flows and volumes were directly calculated or interpolated for each hydrologic node. Table 3 presents the tributary area, and the resulting peak flows and volumes for each hydrological node.

VERIFICATION

The Hiko Spring Wash and the Unnamed Wash are both ungaged washes, making it difficult to calibrate the model to historic floods. There is also little information available regarding historic flooding for the region in general.

Two previous studies have developed 100-year peak discharges for the Hiko Springs Wash and the Unnamed Wash. Table 3.4 compares the discharges developed by Boyle to those developed for the CCRFCD Master Plan and for the FEMA Flood Insurance Study.

TABLE 3.4

100-YEAR PEAK DISCHARGES

	Hiko Springs Wash	Unnamed Wash
CCRFCD Master Plan	12,000	5,000
FEMA FIS	8,400	1,800
Boyle	9,500	5,200

The different studies have produced differing results. Each study used different rainfall parameters. The FEMA study used less rainfall because the 1.43 adjustment factor recently adopted by the District was not utilized. The FEMA FIS and the CCRFCD Master Plan utilized a 3-hour storm distribution. The Boyle study utilized a 6-hour SDN 4 storm distribution. Another factor was that the Boyle study used lower curve numbers in accordance with updated soils information.

Since the hydrological model was not calibrated, care was taken in selecting parameters which would be representative of the basin. Curve numbers were determined based on the most recent soils information and recently published estimates of curve numbers for desert shrub cover.

Estimates of lag times using the COE methodology were checked through comparison with other methods, particularly the upland or

velocity method. Parameters used to compute lag were representative of values used in similar studies.

Results were compared to regional relationships including a 100-year peak discharge versus drainage area curve developed by The Los Angeles District of the Corps of Engineers. The higher discharge per drainage area developed for the Laughlin Area can be attributed to steep slopes and higher rainfall depths 4.58 inches compared to 2.86 inches for the Las Vegas area during the 100 year six hour storm.

1 ****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985

U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616

****

THIS HEC-1 VERSION CONTAINS ALL OPTIONS EXCEPT ECONOMICS, AND THE NUMBER OF PLANS ARE REDUCED TO 3

1 HEC-1 INPUT PAGE 1

```
LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

    1         ID
    2         ID      POST, BUCKLEY, SCHUH AND JERNIGAN, INC.
    3         ID      HIKO SPRINGS AND BRIDGE CANYON WASHES FIS RESTUDY  7190.542
    4         ID      JULY 1, 1993
    5         ID
    6         ID       INPUT FILE:  HIKO
    7         ID      OUTPUT FILE:  HIKOO
    8         ID
    9         ID      HIKO SPRINGS WASH
   10         ID
   11         ID      THIS HEC-1 RUN IS RECONSTRUCTED TO PRODUCE BOYLE ENGINEERING'S
   12         ID      RESULTS FROM THE FACILITIES PLAN FOR THE HIKO SPRINGS AND UNNAMED WASH HYD
   13         ID      PREPARED UNDER CONTRACT WITH THE CCRFCD, DATED MAY 1989.
   14         ID      REPRODUCED FROM BOYLE, 1989 VOLUME 3, TECHNICAL APPENDIX
   15         ID      HEC-1 INPUT/OUTPUT
   16         ID
   17         ID      100 YEAR FREQUENCY
   18         ID
   19         ID      6-HOUR RAINFALL, 3 MINUTE TIME INTERVAL
   20         ID      RAINFALL DISTRIBUTION = SDN4
   21         ID      SCS UNIT HYDROGRAPH METHOD
   22         ID      WITH RATIO FOR DEPTH AREA REDUCTION FACTOR (DARF) FOR:
   23         ID      RATIO 1 =  0.78  DARF FOR 20 SQ. MI.
   24         ID      RATIO 2 = 0.86  DARF FOR 10 SQ. MI.
   25         ID
              *DIAGRAM
   26         IT       3                    300
   27         IO        5
   28         IN        1
   29         JR    PREC      .78     .86

   30         KK      A1
   31         BA    2.73
   32         PB    4.56
   33         PC       0      .02     .056    .060    .100    .123    .143    .149    .160    .141
   34         PC    .144     .147    .150    .154    .160    .169    .176    .184    .195    .206
   35         PC    .213     .217    .221    .226    .239    .250    .260    .266    .269    .272
   36         PC    .280     .284    .301    .312    .318    .324    .330    .374    .424    .489
```

37	PC	.538	.610	.710	.732	.750	.782	.802	.813	.819	.823
38	PC	.830	.834	.846	.860	.885	.907	.924	.944	.968	.973
39	PC	.978	.982	.984	.986	.988	.991	.991	.993	.994	.997
40	PC	.997	.999	1.00							
41	LS		78								
42	UD	.73									
43	KK	RA									
44	RK	2200	.0364	.050		TRAP	200	25			
45	KK	B1									
46	BA	1.08									
47	LS		83								
48	UD	.39									

LINE	ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10										
49	KK	RB1									
50	RK	15500	.0503	.050		TRAP	350	25			
51	KK	B2									
52	BA	.61									
53	LS		82								
54	UD	.36									
55	KK	RB2									
56	RK	11500	.0435	.050		TRAP	200	25			
57	KK	B3									
58	BA	2.50									
59	LS		81								
60	UD	.78									
61	KK	B									
62	HC	4									
63	KK	RB									
64	RK	4500	.0389	.050		TRAP	300	25			
65	KK	C1									
66	BA	1.91									
67	LS		80								
68	UD	.73									
69	KK	C2									
70	BA	1.68									
71	LS		79								
72	UD	.79									
73	KK	C									
74	HC	3									
75	KK	RC									
76	RK	2900	.0414	.050		TRAP	300	5			
77	KK	D1									
78	BA	.524									
79	LS		80								

```
   80          UD      .35

   81          KK      RD1
   82          RK     5400     .061     .050           TRAP      100       50

   83          KK      D2
   84          BA     .301
   85          LS                80
   86          UD      .27
1                                        HEC-1 INPUT                                                    PAGE  3

   LINE         ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

   87          KK      D3
   88          BA     .753
   89          LS                85
   90          UD      .38

   91          KK       D
   92          HC       4

   93          KK      RD
   94          RK     1600     .0469     .050           TRAP      300       15

   95          KK      E1
   96          BA     .495
   97          LS                87
   98          UD      .36

   99          KK       E
  100          HC       2

  101          KK      RE
  102          RK     2560     .0364     .050           TRAP      300       50

  103          KK      F1
  104          BA    1.08
  105          LS                82
  106          UD      .48

  107          KK       F
  108          HC       2

  109          KK      RF
  110          RK     3000     .0467     .050           TRAP      300       50

  111          KK      G1
  112          BA    1.36
  113          LS                84
  114          UD      .54

  115          KK      G2
  116          BA    1.02
  117          LS                88
  118          UD      .39

  119          KK       G
  120          HC       3
```

```
     121          KK      RG
     122          RK    2600    .0346     .050            TRAP      300        5
1                                        HEC-1 INPUT                                                    PAGE  4

     LINE         ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

     123          KK      B1
     124          BA    .560
     125          LS              83
     126          UD     .35

     127          KK      H2
     128          BA    .373
     129          LS              90
     130          UD     .18

     131          KK       H
     132          HC       3

     133          KK      RH
     134          RK    9400    .0585     .070            TRAP       75        5

     135          KK      I1
     136          BA    1.35
     137          LS              89
     138          UD     .47

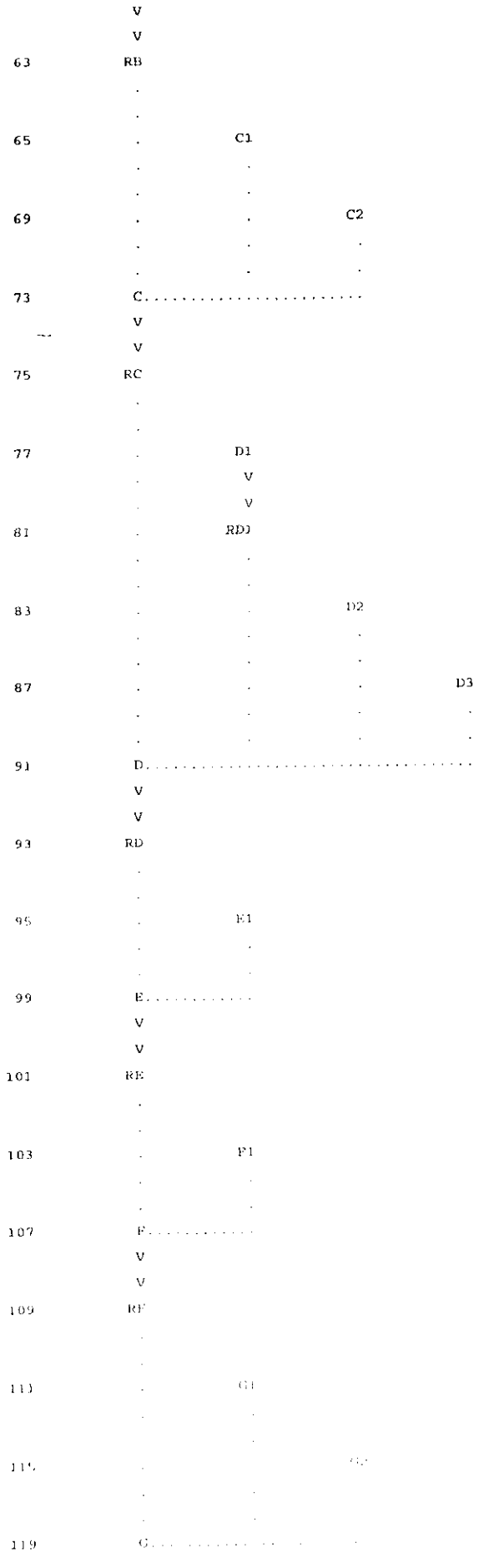
     139          KK       1
     140          HC       2
     141          ZZ
1
                  SCHEMATIC DIAGRAM OF STREAM NETWORK

  INPUT
   LINE      (V) ROUTING          (---) DIVERSION OR PUMP FLOW

    NO.      (.) CONNECTOR        (<- -) RETURN OF DIVERTED OR PUMPED FLOW

     30           A1
                   V
                   V
     43           RA
                   .
                   .
     45            .          B1
                   .           V
                   .           V
     49            .         RB1
                   .           .

     51            .           .          H2
                                           V
                   .           .          V
     55            .           .         RH2
                   .           .           .
                   .
     57            .           .           .          B3
                   .           .           .           .
                   .           .           .           .
     61           B.....................................
```


V
V
63 RB
65 C1
69 C2
73 C
V
V
75 RC
77 D1
V
V
81 RD1
83 D2
87 D3
91 D
V
V
93 RD
95 E1
99 E
V
V
101 RE
103 F1
107 F
V
V
109 RF
111 G1
115
119 G

```
                V
                V
  121           RG
                .
                .
  123           .          H1
                .           .
                .           .
  127           .           .          H2
                .           .           .
                .           .           .
  131           H.....................
                V
                V
  133           RH
                .
                .
  135           .          I1
                .           .
                .           .
  139           I............
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

1 ****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) FEB 1,1985

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****

POST, BUCKLEY, SCHUH AND JERNIGAN, INC.

HIKO SPRINGS AND BRIDGE CANYON WASHES FIS RESTUDY 7190.542

JULY 1, 1993

INPUT FILE: HIKO

OUTPUT FILE: HIKOO

HIKO SPRINGS WASH

THIS HEC 1 RUN IS RECONSTRUCTED TO PRODUCE BOYLE ENGINEERING'S
RESULTS FROM THE FACILITIES PLAN FOR THE HIKO SPRINGS AND *UNNAMED WASH HYD*
PREPARED UNDER CONTRACT WITH THE CCRFCD, DATED MAY 1989.
REPRODUCED FROM BOYLE, 1989 VOLUME 3, TECHNICAL APPENDIX
HEC-1 INPUT/OUTPUT

100-YEAR FREQUENCY

6-HOUR RAINFALL, 3 MINUTE TIME INTERVAL
RAINFALL DISTRIBUTION = SDN4
SCS UNIT HYDROGRAPH METHOD
WITH RATIO FOR DEPTH AREA REDUCTION FACTOR (DARF) FOR:
RATIO 1 = 0.78 DARF FOR 20 SQ. MI.
RATIO 2 = 0.86 DARF FOR 10 SQ. MI.

27 IO OUTPUT CONTROL VARIABLES

IPRNT 5 PRINT CONTROL

IPLOT 0 PLOT CONTROL

	QSCAL	0.	HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA

	NMIN	3	*MINUTES IN COMPUTATION INTERVAL*
	IDATE	1 0	STARTING DATE
	ITIME	0000	STARTING TIME
	NQ	300	NUMBER OF HYDROGRAPH ORDINATES
	NDDATE	1 0	ENDING DATE
	NDTIME	1457	ENDING TIME

COMPUTATION INTERVAL .05 HOURS
TOTAL TIME BASE 14.95 HOURS

ENGLISH UNITS

JP MULTI-PLAN OPTION

	NPLAN	1 NUMBER OF PLANS

JR MULTI-RATIO OPTION
RATIOS OF PRECIPITATION
.78 .86

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

					RATIOS APPLIED TO PRECIPITATION	
OPERATION	STATION	AREA	PLAN		RATIO 1	RATIO 2
					.78	.86
HYDROGRAPH AT						
+	A1	2.73	1	FLOW	1472.	1740.
				TIME	4.20	4.15
ROUTED TO						
+	RA	2.73	1	FLOW	1468.	1737.
				TIME	4.25	4.20
HYDROGRAPH AT						
+	B1	1.08	1	FLOW	999.	1155.
				TIME	3.80	3.80
ROUTED TO						
+	RB1	1.08	1	FLOW	698.	840.
				TIME	4.50	4.45
HYDROGRAPH AT						
+	B2	.61	1	FLOW	564.	655.
				TIME	3.75	3.7[illegible]
ROUTED TO						
+	RB2	.61	1	FLOW	437.	525.
				TIME	4.30	4.30
HYDROGRAPH AT						
+	B3	2.50	1	FLOW	1466.	1712.
				TIME	4.20	4.25

4 COMBINED AT						
+	B	6.92	1	FLOW	3939.	4696.
				TIME	4.30	4.30
ROUTED TO						
+	RB	6.92	1	FLOW	3926.	4692.
				TIME	4.40	4.35
HYDROGRAPH AT						
+	C1	1.91	1	FLOW	1122.	1315.
				TIME	4.15	4.15
HYDROGRAPH AT						
+	C2	1.68	1	FLOW	900.	1059.
				TIME	4.25	4.25
3 COMBINED AT						
+	C	10.51	1	FLOW	5853.	6979.
				TIME	4.35	4.30
ROUTED TO						
+	RC	10.51	1	FLOW	5849.	6979.
				TIME	4.35	4.35
HYDROGRAPH AT						
+	D1	.52	1	FLOW	455.	532.
				TIME	3.75	3.75
ROUTED TO						
+	RD1	.52	1	FLOW	413.	488.
				TIME	3.95	3.95
HYDROGRAPH AT						
+	D2	.30	1	FLOW	291.	340.
				TIME	3.70	3.65
HYDROGRAPH AT						
+	D3	.75	1	FLOW	755.	867.
				TIME	3.80	3.75
4 COMBINED AT						
+	D	12.09	1	FLOW	6478.	7712.
				TIME	4.30	4.25
ROUTED TO						
+	RD	12.09	1	FLOW	6469.	7704.
				TIME	4.35	4.30
HYDROGRAPH AT						
+	E	.50	1	FLOW	546.	622.
				TIME	3.75	3.75
2 COMBINED AT						
+	E	12.58	1	FLOW	6662.	7939.
				TIME	4.30	4.30
ROUTED TO						
+	RE	12.58	1	FLOW	6654.	7927.
				TIME	4.35	4.30

HYDROGRAPH AT

+ F1	1.08	1	FLOW	870.	1010.
			TIME	3.90	3.90

2 COMBINED AT

+ F	13.66	1	FLOW	7158.	8550.
			TIME	4.30	4.30

ROUTED TO

+ RF	13.66	1	FLOW	7148.	8535.
			TIME	4.35	4.30

HYDROGRAPH AT

+ G1	1.36	1	FLOW	1069.	1238.
			TIME	3.95	3.95

HYDROGRAPH AT

+ G2	1.02	1	FLOW	1116.	1267.
			TIME	3.80	3.80

3 COMBINED AT

+ G	16.04	1	FLOW	8409.	10052.
			TIME	4.25	4.25

ROUTED TO

+ RG	16.04	1	FLOW	8405.	10048.
			TIME	4.30	4.25

HYDROGRAPH AT

+ H1	.56	1	FLOW	545.	631.
			TIME	3.75	3.75

HYDROGRAPH AT

+ H2	.37	1	FLOW	589.	663.
			TIME	3.60	3.60

3 COMBINED AT

+ H	16.98	1	FLOW	8693.	10400.
			TIME	4.25	4.25

ROUTED TO

+ RH	16.98	1	FLOW	8642.	10338.
			TIME	4.35	4.35

HYDROGRAPH AT

+ I1	1.35	1	FLOW	1395.	1580.
			TIME	3.85	3.85

2 COMBINED AT

+ I	16.33	1	FLOW	9409.	11259.
			TIME	4.30	4.25

*** NORMAL END OF HEC 1 ***

SECTION 2.1.2

Bridge Canyon Wash

CLARK COUNTY
REGIONAL FLOOD CONTROL DISTRICT

BRIDGE CANYON WASH FLOOD CONTROL MASTER PLAN

Laughlin, Nevada



CVL

6 Hydrologic Analysis

6.1 Purpose

The purpose of the hydrologic analysis was to evaluate the hydrologic characteristics of the Bridge Canyon and Dripping Springs Canyon Washes, and to determine the location and magnitude of discharges which could impact the Laughlin area. Also included was a precipitation frequency analysis of the Davis Dam/Bullhead City rainfall gauge in order to ascertain the accuracy of existing relationships.

6.2 Precipitation-Frequency Analysis

From 1973 to 1985, most hydrologic studies within Clark County utilized the National Oceanic and Atmospheric Administration's (NOAA) Atlas 2 (NOAA, 1973). Several recent studies have suggested that the NOAA Atlas 2 may underestimate the actual precipitation frequency values in the Las Vegas area. These studies were prompted by several intense storms in the Las Vegas Valley which have occurred since the NOAA Atlas 2 was published. Specifically, Black and Veatch Engineers (B&V) conducted a precipitation frequency analysis in 1985 for the Clark County Department of Public Works, as documented in the report entitled "Study of Flood Control Facilities on Flamingo Wash" (CCDPW, 1985).

More recently, the U.S. Army Corps of Engineers (COE) has conducted a study of precipitation data on a more regional basis. The results of the COE study and an evaluation of the B&V study are contained in the report entitled "Hydrologic Documentation for Feasibility Study, Las Vegas Wash and Tributaries, Clark County, Nevada" (COE, 1988). In that report the COE concludes that the point rainfall factors proposed in the B&V are appropriate for the Las Vegas area. However, in addition to analyses of Las Vegas precipitation gauges, the COE also performed analyses for gauges at Searchlight, Overton-Logandale in Nevada, and for Baker and Needles in California.

The gauges of Searchlight and Needles have particular relevance to this study since both are within less than 30 miles of Laughlin. Not included in the COE study was an analysis of a daily precipitation gauge at Davis Dam/Bullhead City. The record period for this station is from 1948 to 1986. During that time the gauge was moved from its original location at Davis Dam to two other sites in Bullhead City. However, it has been assumed for this analysis that the data collected at the three sites is homogeneous.

The recorded data has been collected on a daily basis and was therefore assumed to represent rainfall over a uniform 24-hour period. It is, however, understood that many of the events recorded in the 24-hour periods may have actually been for short durations. Since summer thunderstorms generally produce intense, short duration storm events, the frequency analysis was conducted for the period from May to October. The year 1956 was omitted from the analysis due to an unusually low total precipitation for the year, and the year 1977 was also omitted due to an incomplete record. The Partial Duration series was evaluated in lieu of the Annual series, due to the sensitivity of the analysis to extremely low events.

Precipitation data was plotted on log-probability paper and a Log Pearson Type III distribution fitted, details of the analysis and plots are included in Appendix B.

The NOAA Precipitation-Frequency atlas indicates a rainfall amount of approximately 3.9 inches for a 100-year, 24-hour storm event. The results from the precipitation-frequency analysis indicate that a rainfall amount of 4.18 inches may be expected to occur in a 100-year, 24-hour period. This represents an increase

of approximately 8 percent over the NOAA Atlas 2. A comparison of other duration storms is not possible using this data.

As mentioned earlier, however, the COE performed analyses for the precipitation gauges of Searchlight, Nevada and Needles, California. Their results for the 100-year, 3 hours, 6-hour and 24-hour precipitations are presented in Table 6.1. Also included in Table 6.1 is the 100-year 24-hour precipitation determined for the Davis Dam/Bullhead City gauge. Assuming a linear relationship holds true for other duration storms, values for the 3-hour and 6-hour have been interpolated and included in Table 6.1.

The results presented in Table 6.1 for the Davis Dam/Bullhead City gauge represent an approximate increase of 8 percent over the values obtained from the NOAA Atlas 2. This is in contrast to the adjustment factor of 1.43 presented in the CCRFCD hydrologic manual (*CCRFCD, undated*). Use of a lower precipitation adjustment factor may be appropriate for the Laughlin area, however, this would be contrary to the currently adopted drainage regulations. All subsequent hydrologic analysis presented in this report utilize the adjustment factors presented in the CCRFCD manual.

6.3 Drainage Basin Characteristics

The Bridge Canyon Wash and Dripping Springs Canyon Wash watershed boundaries are shown in Figure 6.1. These watersheds both have two distinctly different elements, an upper mountainous region and a lower alluvial floodplain. In general, the upper mountainous watersheds are characterized by steep slopes, rocky terrain, relatively shallow soils, moderately sparse vegetation consisting primarily of grasses, creosote, and yucca, and well defined water courses. The lower alluvial floodplains are generally characterized by moderately steep slopes (typically 4% to 6%), little to no exposed bedrock, relatively deep and well drained soils, sparse vegetation consisting primarily of creosote, and poorly defined water courses.

In addition, the Bridge Canyon Wash and Dripping Springs Canyon Wash each have specific manmade and natural features that impact the hydrologic characteristics and runoff patterns within the watersheds. The following are brief descriptions of these features.

Table 6.1: Precipitation-frequency-duration Analysis

Point Precipitation for Storm Event (inches)

Location	100yr-3hr	100yr-6hr	100yr-24hr
Searchlight, Nevada	3.40	3.86	4.69
Needles, California	2.70	2.98	3.45
Bullhead City, Arizona	3.1(3)	3.5(3)	4.18(2)

(1) Taken from "Hydrologic Documentation for Feasibility Study, Las Vegas Wash and Tributaries, Clark County , Nevada (COE, 1988).
(2) Precipitation - Frequency analysis performed by CVL, Appendix B.
(3) Obtained by linear interpolation from COE data and the 100-yr, 24-hr point precipitation for Bullhead City as presented herein.

CLARK COUNTY
REGIONAL
FLOOD CONTROL DISTRICT

BRIDGE CANYON WASH FLOOD CONTROL MASTER PLAN

LEGEND:

- Approximate Sub-Basin Boundary
- (D5) Sub-Basin Number
- 1 → Location of Flow Concentration, And Corresponding Peak Discharge are Given In Table 6.4
- Potential Major Flow Splits
- * Fan Apex / Mouth Of Canyon

Note: Information Provided For Hiko Springs Wash Is Based Upon A Report Entitled "Facilities Plan For Hiko Springs and Unnamed Wash" by: Boyle Engineering.

B1 B2 B3 B4 D1 D2 D3 D4 D5 U1 U2 U3 U4 U5 E15

Dripping Springs Canyon Watershed

Bridge Canyon Watershed

Hiko Springs Watershed

LAKE MEAD

LAKE MOHAVE

COLORADO RIVER

Davis Dam

S.R.163

Highway Needles

1 2 3 4 5 6 7 8 9 10

WATERSHED BOUNDARY MAP

CVL CGE & VAN LOO

0 3,000 1,000 5,000 8,000

NORTH

Figure 6.1

CLARK COUNTY
REGIONAL
FLOOD CONTROL DISTRICT

BRIDGE CANYON WASH FLOOD CONTROL MASTER PLAN

LEGEND:

SOIL GROUP SUMMARY

NO.	NAME	HYDROLOGIC GROUP	CHARACTERISTICS
14	Akela - Bitter Spring	B	Gravelly Sandy Loam
17	Carrizo	A	Very Gravelly Sandy Loam
18	Carrizo-Gunsight	B	Sandy Loam
23	Coachella - Gilmar - McClellan	B	Loam
24	Ajo - Corrizo - Gunsight	A-C	Very Stony Loam
38	Rock Outcrop - Calvista - Aftaden	D	Extremely Stony Sandy Loam
39	Rock Outcrop - Gachado	D	Very Cobbly Loam
41	Lomitas	D	Very Stony Loam
44	McCullough	B	Gravelly Sandy Loam

NOTE: SOILS INFORMATION IS BASED UPON AN UNPUBLISHED REPORT BY THE USDA SOIL CONSERVATION SERVICE, "SOIL SURVEY OF SOUTHERN CLARK COUNTY AREA".

Location of Surface Sediment Sample
(See Gradation Curves in Appendix B)

SOIL CLASSIFICATION MAP

CVL
CHRISTENSEN, VAN LOO
ENGINEERING
LANDSCAPE ARCHITECTURE

0 3,000 1,000 5,000 8,000

NORTH

Figure 6.2

Bridge Canyon Wash

- **Upper Watershed**

  a. **Soils:** Based upon soils information from the Soil Conservation Service (SCS, undated), the eastern slopes of the Newberry Mountains consist primarily of granite rock outcrops (see Figure 6.2). Further to the west, rock outcrops are surrounded by well draining granite colluvium. The SCS has classified these soils with hydrologic soils groups of Type B and D (SCS, unpublished).

  b. **Highway 163 Crossing:** SR 163 crosses Bridge Canyon Wash at a narrow canyon. The road is constructed on fill material through which a projecting 120-inch diameter CMP culvert carries the flows of Bridge Canyon Wash. The roadway is approximately 40 feet above the invert of the culvert; therefore, the road embankment will act as a dam when the culvert capacity is exceeded. Field observations indicate that the roadway embankment may be susceptible to failure if overtopped or if piping occurs.

  c. **Channel Characteristics:** The average grade of the main channel is steep (typically 5% to 20%) and confined by canyon walls composed of highly erosion resistant bedrock. Based on field observations, however, the grade of the wash is controlled by numerous rockslides and bedrock outcroppings which appear to act as natural drop structures. Due to the steep slopes and shallow bed material, little to no transmission losses are expected.

- Lower Watershed

  a. **Soils:** The lower watershed is composed of deep alluvial deposits of very gravelly, sandy loam. This soil is predominantly of hydrologic soil group Type A, which typically has a high permeability and low runoff potential (see Figure 6.2).

  b. **Channel Characteristics:** Approximately 2100 feet downstream from the mountain front (fan apex), Bridge Canyon Wash has entrenched a wide and relatively well defined floodway, which extends almost 7600 feet longitudinally. This floodway terminates at a depositional feature, where the flow pattern is divergent and a main channel can no longer be identified. Field observations of the Bridge Canyon Wash floodway indicate that the banks can be subject to erosion and that flow breakouts do occur in various locations. One area that appears to be especially prone to erosion and shows signs of flow breakouts is the north bank approximately 4000 feet downstream of the mountain front. Hence, under existing conditions the precise paths that Bridge Canyon Wash flow events could follow are difficult to assess and appear to be subject to change over a geologic time scale.

  c. **On-Fan Drainage-Patterns:** The on fan drainage patterns have been significantly influenced by natural features, such as older alluvium deposits; and manmade features including Desert Drive, Needles Highway, and Casino Drive. As indicated in Figure 6.1, the runoff from sub-basin U4 could be diverted, in part or possibly in whole, into the entrenched Hiko Springs floodway by the Needles Highway. Desert Drive could potentially collect a significant amount of runoff from the north and act as a drainage channel. Moreover, natural erosion and deposition processes could also cause changes to the on-fan drainage boundaries, which may be subject to sudden change.

Dripping Springs Canyon Wash

- **Upper Watershed**

  a. **Soils:** The upper watersheds of Dripping Springs Canyon Wash are less mountainous than Bridge Canyon and include areas of relatively deep Type B soils (see Figure 6.2).

  b. **Channel Characteristics:** The main water courses in the upper watersheds of Dripping Springs Canyon Wash have widely varying characteristics. Portions of the watershed are characterized by very steep channels with shallow or no bed sediments; whereas, the lower half of the upper watershed is characterized by moderately steep channels, moderately deep bed sediments, and relatively wide floodplains, resulting from alluvial deposits. Based on these channel characteristics, some transmission losses would be expected in portions of the upper watershed.

- **Lower Watershed**

  a. **Soils:** The lower watershed coalesces with that of Bridge Canyon and is composed of deep alluvial deposits of very gravelly, sandy, loam, with isolated igneous rock outcroppings and small hills. The alluvial deposits are predominantly Type A soils with a high permeability and low runoff potential.

  b. **Highway 163:** Upstream of the Dripping Springs Canyon Wash fan apex, the highway parallels the wash. In places the highway, which is built partially within rock cuts and on fill, encroaches within the floodplain. Near the fan apex, the highway is built upon a natural ridgeline. This ridgeline disappears approximately 1500 feet downstream from the ancient alluvial fan apex and the highway continues in a southeasterly direction, dissecting the fan surface. There is evidence of flow having crossed the highway alignment in the past, while ditch grading has attempted to divert drainage away from the highway and to the north. Hence, the highway and associated ditches near the fan's apex direct low flows to the north of SR 163 from whence they outfall to the Colorado River, at the "Sportsmans' Park" campground.

  c. **On Fan Drainage Patterns:** Dripping Springs Canyon Wash does not have a well defined main channel on the fan surface near the apex. However, the fan surface does have a complicated network of relatively shallow swales. Hence, the on-fan drainage boundaries are not well defined and, therefore, unpredictable.

6.4 Methodology

The Corps of Engineers' rainfall-runoff model, HEC-1 (HEC, 1985), was used to model the Bridge Canyon Wash and Dripping Springs Canyon Wash watersheds. The Bridge Canyon Wash and Dripping Springs Canyon Wash sub-basins are shown in Figure 6.1. The following are descriptions of the data and the methodologies used to develop the hydrology model for the watersheds.

- **Precipitation Data**

  The 100-year, 3 hour and the 2-, 10-, 25- and 100-year, 6-hour events were modeled using point rainfall values, distributions and areal reduction factors as specified in the draft CCRFCD manual. Point rainfall values, shown in Table 6.2, were derived from the Nevada NOAA Atlas 2 (NOAA, 1973) and adjusted by a factor of 1.0 to 1.43 in accordance with the draft CCRFCD manual (CCRFCD, undated). The rainfall distributions and areal reduction factors used in this study are given in Appendix B.

Table 6.2: Point Rainfall Values for Laughlin, Nevada

Event	Rainfall per NOAA Atlas(in)	Adjust Ratio	Point Rainfall Value(in)
2-yr, 6-hr	1.2	1.000	1.20
10-yr, 6-hr	2.0	1.241	2.48
25-yr, 6-hr	2.5	1.328	3.32
100-yr, 3-hr	2.9	1.430	4.18
100-yr, 6-hr	3.2	1.430	4.58

- **Storm Distribution**

  As stated in the CCRFCD guidelines (CCRFCD, undated) the design storm will be either for the 3-hour or 6-hour duration storm. The 3-hour storm is used to develop facilities not requiring detention/retention and the 6-hour storm for detention/retention. In the concept plan development stage it was anticipated that some measure of detention would be considered, because of this and forthcoming changes to the CCRFCD's hydrologic methods the 6-hour storm was selected for all discharge computations.

  The 100-year, 3-hour storm peak discharges were also computed in order provide a comparison with previous hydrologic studies which used the 3-hour storm. Storm Distribution Numbers (SDN) 2, 3, 4, and 5 were used for the 6-hour storm based upon the cumulative drainage area and procedures outlined in the CCRFCD guidelines.

- **Area Reduction Factors**

  Point precipitation values are listed in Table 6.2. In order to account for increasing watershed size, an average depth of precipitation over the area is used instead of the point precipitation, an areal reduction factor or depth-area ratio is thus applied to the point precipitation values.

  The NOAA Atlas 2 (NOAA, 1973) explains this technique and graphs the reductions based upon total drainage area. More recent research for the arid western United States contained in "Technical Memorandum, HYDRO-40" (NOAA, 1984), gives revised reduction factors. This study utilizes the depth-area reduction factors given in HYDRO-40. The HEC-1 model was run with multiple areal reduction factors in order to account for the increasing drainage area as streamflow routing proceeds downstream.

- **Initial Rainfall Abstractions**

  The SCS curve number method was used to compute initial rainfall abstractions for all sub-basins (SCS, 1985). The curve numbers estimated for the Bridge Canyon Wash and Dripping Springs Canyon Wash watersheds were based on field observations, current vegetation cover, antecedent moisture condition "II" (AMC II), and TR-55 tables (SCS, 1986). Watershed parameters and curve number computations are summarized in Table 6.3.

- **Lag Time Computations**

  The lag times for each of the sub-basins were computed using the U.S. Army Corps of Engineers' (COE) lag time relationship (COE, 1974), multiplied by an adjustment factor. The adjustment factor accounts for the difference in definition between the COE's lag time and the SCS lag time. The COE's lag time is defined as *the elapsed time from the beginning of the unit precipitation to the instant that the summation hydrograph reaches 50% of the ultimate discharge;* whereas, the SCS defines lag time as *the time from the center of mass of rainfall excess to the peak discharge*. Lag time computations are summarized in Table 6.3.

Table 6.3: Computed Sub-Basin Hydrologic Parameters

Sub-Basin No.	Area ($mi.^2$)	Runoff Parameters: Hydrologic Soil Group (1)	Runoff Parameters: Weighted CN(2)	Lag Time Parameters: L (mi.)	Lc (mi.)	S (ft/mi.)	n(3)	SCS Lag (hrs.)
Upper Watershed								
B1	2.7	50%D, 50%B	79	3.72	1.58	384	0.07	0.83
B2	1.9	20%D, 80%B	75	1.89	1.17	363	0.07	0.58
B3	1.2	90%D, 10%B	85	1.64	0.79	309	0.07	0.49
B4	2.2	89%D, 11%A	83	2.48	1.42	245	0.07	0.74
D1	2.3	100%D	86	2.63	1.21	355	0.07	0.67
D2	2.4	60%D, 40%B	80	2.63	1.73	214	0.04	0.48
Alluvial Plain								
B5	2.3	100%A	63	4.30	2.30	195	0.04	0.67
D3	1.8	100%A	63	4.00	2.40	216	0.04	0.64
D4	1.4	100%A	63	3.70	1.50	243	0.04	0.50
D5	5.4	40%D, 65%A	72	5.60	2.60	282	0.05	0.89
U1	0.2	100%D	86	0.82	0.46	320	0.07	0.30
U2	1.6	100%A	63	4.10	1.90	246	0.04	0.58
U3	0.8	100%A	63	2.50	1.00	200	0.04	.039
U4	1.3	80%A, 20%D	68	3.20	1.50	275	0.04	0.47
U5	1.9	100%A	63	2.78	1.10	201	0.04	0.42

Notes:

(1) SCS hydrologic soil group, obtained from an unpublished report by the Soil Conservation Service entitled "Soil Survey of Southern Nevada."

(2) Curve numbers are based upon fair and poor vegetal cover for the Upper Watershed and Alluvial Plain, respectively.

(3) Roughness Coefficient used for Overland Flow. Used 0.07 for mountainous regions and 0.04 for alluvial plains.

The Lag Time Equation is defined as follows:

$$\text{Lag (SCS)} = C * 24 * n * \left[\frac{(L * Lc)}{S^{0.5}}\right]^{0.38}$$

where:

Lag(SCS) = SCS Lag Time (hrs)

C = Conversion factor (COE to SCS Lag Time = 0.78)

n = Roughness Coefficient for Overland Flow

S = Slope of Main Channel (ft/mi)

L = Length of Main Channel (mi)

Lc = Distance from the basin's concentration point to the centroid of the basin (mi)

The COE's Lag Time Equation was selected for this study for the following reasons:

a. The COE's Lag Time Equation was developed for application to relatively large watersheds in the southwestern United States.

b. Criteria for selecting Roughness Coefficients are relatively well documented by the COE's (see Appendix B).

c. Lag times were computed, for selected Bridge Canyon Wash sub-basins, using the SCS Lag Equation and the SCS Upland Method, and compared against those using the COE's equation. The COE's equation yielded shorter lag times which were deemed to be more appropriate for the Bridge Canyon Wash watershed, due to the steep desert characteristics of the watershed.

- **Reservoir Routing**

The SR 163 crossing of Bridge Canyon Wash acts as a reservoir under existing conditions. Stage versus storage values for the ponding area were estimated using United States Geological Survey (USGS) topography, while stage versus discharge values were estimated assuming inlet-control conditions for the existing 120-inch CMP culvert.

- **Channel Routing**

The kinematic wave option was used for all channel routings in this study, due to the steep slopes and minimal potential for peak attenuation. Channel widths, slopes, and lengths were estimated using USGS maps, for the upper watersheds, and 1" = 400' scale mapping for the lower watersheds. Routing parameter computations are given in Appendix B.

Field observation of the channel within Bridge Canyon indicated large boulder and rock drops within the channel bottom. Adjustments were thus made in the channel roughness factors and average bed slope.

As discussed earlier, the specific flow paths that flow events will follow on the fan surfaces are very difficult to assess and are subject to change. However, for routing purposes, it has been assumed that a flood emerging from Bridge Canyon and Dripping Springs Canyon would flow in single channels enroute to specific outfalls along the Colorado River. This is a conservative assumption, since much of the flow is likely to occur as sheet flow; however, it allows identification of the maximum computed discharges that can impact a given concentration point.

- **Transmission Losses**

Transmission losses were evaluated, on a conceptual level, using the methodology described in the *SCS National Engineering Handbook*, "Section 4, Hydrology, Chapter 19 - Transmission Losses," (NEH-4) (SCS, 1985). These computed transmission losses were incorporated into the HEC-1 model using the channel loss option in conjunction with the kinematic wave routings. The use of the methodology for determining Transmission losses, as described in NEH-4, may not be appropriate for channel flow on the lower watersheds due to the

shallow sheet flow expected on the lower watersheds. Transmission losses are not reflected in the results due to the uncertainty associated with their use on alluvial fans.

6.5 Dam Breach

The SR 163 crossing of Bridge Canyon Wash currently has one 120 inch CMP culvert for passing flows under the roadway. The roadway elevation has been estimated as 40 feet above the invert of the 120 inch CMP. Based on information provided by NDOT, the storage behind the roadway embankment has been estimated as 29 ac-ft before the roadway would be overtopped.

Due to the existing culvert's capacity limitations, the highway crossing of Bridge Canyon Wash is likely to be overtopped during the 100-year event. A more likely scenario is that the embankment will fail by seepage and piping. Under either of these conditions, embankment failure would cause a floodwave to surge downstream.

The "dam break" scenario and magnitude of such a floodwave was not evaluated in detail with HEC-1. However, the peak breach discharge during the roadway embankment failure was estimated, using an equation presented in *Design of Small Dams* (USBR, 1987), as follows:

$$Q = 370\,(HS)^{0.5} = 12{,}600 \text{ cfs}$$

Where:

Q = peak breach discharge (cfs)

H = height of water level above stream bed, 40 ft

S = reservoir storage capacity corresponding to H, 29 ac-ft

This peak discharge equation is an empirical equation based on historical dam failure data. The applicability of this equation, with respect to the SR 163 roadway embankment, may not be entirely appropriate, since the roadway embankment does not have dimensions typical of dam structures and the equation does not take into account inflow into the "reservoir" during the breach. However, the computed breach discharge may correctly indicate that the floodwave resulting from failure of the roadway embankment could be significant and potentially destructive.

6.6 Results

The HEC-1 rainfall-runoff computer model was used to compute the runoff resulting from the 100-year, 6-hour storm event for the Bridge Canyon Wash and Dripping Springs Canyon Wash watersheds. Results are presented in Table 6.4. Although the effects of the SR 163 crossing of Bridge Canyon Wash and the potential for transmission losses are evaluated they were not included in the results.

As mentioned earlier, in extreme events, the path of flood flow is unpredictable. Table 6.4 lists the computed peak discharges for existing conditions. With no flood control improvements in place, key flow concentration points near developed areas and the Colorado River outfalls are at risk from multiple flooding sources. Referring to Figure 6.1, the following concentration points (CP) and flooding sources have been identified:

CP2 Sportsmans' Park: A campground situated at the confluence of two major washes. Sub-basin D5, with a drainage area of 5.4 square miles contributes directly to this point. In addition, there is the potential for the upper watershed of Dripping Springs Canyon Wash to flow through this area.

CP3 Water Treatment Plant Site: The treatment plant is currently under design. CP3 occurs upstream of Casino Drive and the Laughlin bridge. Drainage currently impounds behind a manmade dam which has no outlet. Sub-basin D4 with a drainage area of 1.4 square miles contributes "on-fan" drainage to CP3. In addition, there is the potential for the upper watershed of Drip-

Table 6.4: Summary of Computed Peak Discharges - Existing Conditions

CP[1]	Location/Description	Basin Area (mi^2)	Peak Discharge(cfs) 2yr-6hr	10yr-6hr	25yr-6hr	100yr-6hr
1	Dripping Springs Canyon Wash @ Fan Apex:	4.7	240.0	1040.0	1870.0	4290.0
2	Dripping Springs Canyon Wash @ Sportsmans' Park:					
	a) Sub-basin D5 only	5.4	50.0	580.0	1170.0	2910.0
	b) CP1 routed thru D5	10.1	150.0	1400.0	2400.0	5120.0
3	Dripping Springs Canyon Wash @ Laughlin Bridge:					
	a) Sub-basin D4 only	1.4	0.0	120.0	250.0	860.0
	b) CP1 routed thru D4	6.1	170.0	1010.0	1750.0	4050.0
4	Bridge Canyon Wash @ HWY 163 Crossing: (2)	5.8	90.0	940.0	1580.0	3850.0
5	Bridge Canyon Wash @ Fan Apex: (2)	8.0	140.0	1260.0	2150.0	5270.0
6	Bridge Canyon Wash @ Edison Way:					
	a) CP1 routed thru D5	14.7	70.0	1030.0	2200.0	4890.0
	b) CP1 routed thru D3	19.4	125.0	1380.0	3040.0	6330.0
7	Concentration Pt. of Sub-basin U4:	1.3	10.0	160.0	360.0	1100.0
8	Emerald River:					
	a) Sub-basin U5 only	1.9	0.0	160.0	330.0	1250.0
	b) CP7 routed thru U5	3.2	0.0	230.0	520.0	1410.0
	c) CP5 routed thru U5	11.2	80.0	1100	2160.0	4430.0
9	Hiko Springs Wash @ Canyon Mouth: (3)	18.3	---	---	---	9700.0
10	Hiko Springs Wash @ Colorado River: (3)	20.0	---	---	---	9500.0

Notes:

(1) Flow Concentration Point (CP). Refer to Figure 6.1.

(2) SR 163 roadway embankment and reservoir not evaluated in HEC-1 model.

(3) Discharges for existing conditions from the "Facilities Plan for Hiko Springs and Unnamed Wash Laughlin - Big Bend Area" (CCRFCD, 1989).

ping Springs Canyon Wash to flow through this area.

CP6 Edison Way/Big Bend Drive: This concentration point is upstream of the hotel/casino area. A large "on-fan" watershed area of 6.7 square miles (sub-basins U1, U2, U3, D3 and B5) contributes to runoff at this location. Flood flows from Bridge Canyon Wash (CP5) are also likely to contribute to the drainage at this point. Additionally, there is the potential for flood flows emanating from the Dripping Springs Canyon fan apex to combine with flood flows from the Bridge Canyon fan apex.

CP8 Emerald River: Located at Casino Drive near the west end of the Emerald River project. An "on-fan" drainage area of 3.2 square miles contributes directly to this concentration point. The Needles Highway separates sub-basins U4 and U5, potentially diverting some of the runoff from sub-basin U4 into the Hiko Springs watershed. In addition, there is the potential for this location to receive flood flows from the Bridge Canyon fan apex.

Based on the soil properties of the lower watersheds and various research studies, significant transmission losses are expected as flows emerge from the upper watershed and flow down the alluvial fan surface in broad shallow channels. The results of this study cannot be confirmed due to the sensitivity of the analysis and the lack of channel confinement on the alluvial plain. However, the results suggest that the flow attenuation due to transmission losses may be significant as can be observed by the physical characteristics of alluvial fan formation. The effects of transmission losses are not included in the results presented in Table 6.4.

The results of this study indicate that SR 163 would be overtopped during the 100-year, 6-hour event. It was found that inclusion of the reservoir storage effects behind the embankment would help to attenuate peak discharges. These effects, however, are not included in Table 6.4. Since the integrity of the existing embankment cannot be ensured, the effects of overtopping of the SR 163 roadway are potentially disastrous. If failure of the embankment were to occur then a flood surge would travel downstream.

6.7 Comparison of Results

No streamflow gauge data is available for Bridge Canyon Wash, Dripping Springs Canyon Wash or other similar washes in the area. However, it is possible to make comparisons with two previous studies; a hydrologic analysis performed for the FEMA Flood Insurance Study (FEMA, 1988) and the Flood Control Master Plan prepared for the CCRFCD by JMM (CCRFCD, 1986). Comparisons are made in Table 6.5 for selected locations on the Bridge Canyon Wash and Dripping Springs Canyon Wash. Comparisons were only possible at these locations due to the limited amount of information presented in each of the referenced reports.

A true comparison of the results is not possible due to the differing methodologies employed. The hydrology for the FEMA Flood Insurance Study was performed using the SCS TR-20 computer model (SCS, 1982) and a synthetic cumulative time distribution for a 3-hour thunderstorm in Southern Nevada. Point precipitation values were obtained from the NOAA Atlas 2 (NOAA, 1973) with no conversion factor. This is in contrast to this study, which uses adjustment ratios as presented in Table 6.2. Despite these facts, the results for the 100-year, 3-hours storm presented in this study compare well with those prepared for the Flood Insurance Study. Results for Dripping Springs Canyon Wash are higher than those in the FEMA report, while results for Bridge Canyon Wash are lower. These differences may be explained in part due to the adjustments which were made in the Bridge Canyon Wash channel routing parameters.

Table 6.5: Comparison of Computed Peak Discharges

CP[1]	Location/Description	Basin Area (mi^2)	Peak Discharges(cfs) FEMA[2]	JMM[3]	100yr-3hr	100yr-6hr
1	Dripping Springs Canyon Wash @ Fan Apex	4.7	3150	---	3416	4290
5	Bridge Canyon Wash @ Fan Apex	8.0	4430	---	3870	5270
6	Bridge Canyon Wash @ Edison Way	14.7	---	8000	---	4890
6	Bridge Canyon Wash @ Edison Way, incl. Dripping Springs	19.4	---	---	---	6330

(1) Flow Concentration Point (CP). Refer to Figure 6.1.
(2) Hydrology developed by Clark County Department of Comprehensive Planning using a 3-hour duration storm and the SCS TR-20 computer model.
(3) Taken from "Comprehensive Flood Control Master Plan (CCRFCD, 1986). Assumes full saturation development.

A meaningful comparison of results with those presented in the previous Flood Control Master Plan (CCRFCD, 1986) is not possible. That report does not address the potential for flow interaction from Dripping Springs Canyon Wash impacting the Bridge Canyon Wash at Edison Way. No peak discharges are listed for the Bridge Canyon Wash at the fan apex. In addition, the peak discharges presented in that report are based upon full development of the alluvial plain watershed. Full development appears unlikely, due to the large areas of land under the control of the BLM and National Parks Service and the limited water resources.

6.8 Use of Results

The results of the HEC-1 analysis, which are summarized in Table 6.4, were obtained from multiple computer runs using various storm distributions, areal reduction factors and channel routing. Full listings of the HEC-1 output are documented in Appendix B.

All results are based upon existing conditions. Until a flood control master plan is implemented, it is recommended that the results presented herein should be used for regulatory purposes. Where several discharges are listed for a single location or concentration point, the worst case (highest peak discharge) should be used. If sub-basin boundaries, other than those listed herein are required, the HEC-1 model should be recreated using the hydrologic parameters listed in Table 6.3. The 1985 version of HEC-1 (HEC, 1985) must be used if comparable results are to be obtained.

1 ****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985

U.S. ARMY CORPS OF ENGINEERS, *THE HYDROLOGIC* ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616

****

THIS HEC-1 VERSION CONTAINS *ALL OPTIONS EXCEPT* ECONOMICS, AND THE NUMBER OF PLANS ARE REDUCED TO 3

1 HEC-1 INPUT PAGE 1

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      LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

        1           ID
        2           ID     POST, BUCKLEY, SCHUH AND JERNIGAN, INC.
        3           ID     HIKO SPRINGS AND BRIDGE CANYON WASHES FIS RESTUDY        7190.542
        4           ID     AUGUST 2, 1993
        5           ID
        6           ID
        7           ID     INPUT FILE NAME:  BRIDGE
        8           ID     OUTPUT FILE NAME: BRIDGEO
        9           ID
       10           ID     100-YEAR , 6-HOUR STORM EVENT
       11           ID
       12           ID     THIS HEC-1 RUN IS REPRODUCED FROM COE AND VAN LOO'S STUDY
       13           ID     BRIDGE CANYON WASH FLOOD CONTROL MASTER PLAN,
       14           ID     APRIL, 1990 PREPARED UNDER CONTRACT WITH THE CCRFCD.
       15           ID
       16           ID     AREA REDUCTION FACTOR 0.88
       17           ID
       18           ID     STORM DISTRIBUTION NUMBER (SDN) 3
       19           ID
*** FREE ***
       20           IT       1 15May93        0     300
       21           IO       5        0

       22           KK   SUBB1
       23           KM     BRIDGE CANYON WASH - SUBBASIN B1 (N=0.07)
       24           BA    2.70
       25           PB    4.03
       26           IN       5
       27           PC  0.000   .020   .057   .070   .087   .108   .124   .130   .130   .140
       28           PC   .130   .130   .130   .133   .140   .142   .146   .158   .172   .181
       29           PC   .190   .197   .199   .200   .201   .204   .214   .229   .241   .249
       30           PC   .251   .256   .270   .278   .284   .288   .295   .422   .452   .469
       31           PC   .499   .590   .710   .744   .781   .812   .819   .835   .851   .856
       32           PC   .860   .868   .876   .888   .910   .926   .937   .950   .970   .976
       33           PC   .982   .985   .987   .989   .990   .994   .998   .994   .995   .996
       34           PC   .998   .999  1.000
       35           LS     0    79.
       36           UD  0.829
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 37          KK    ROB1
 38          KM     ROUTE SUBB1 TO CP OF SUBB2
 39          RK   5300.     .013     .080            TRAP    100.      2.

 40          KK   SUBB2
 41          KM     BRIDGE CANYON WASH - SUBBASIN B2 (N=0.07)
 42          BA     1.9
 43          LS       0      75.
 44          UD   0.578

 45          KK    COB1
 46          KM     COMBINE ROB1 & SUBB2 @ CP OF SUBB3
 47          HC       2
```



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LINE         ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

 48          KK    ROB2
 49          KM     ROUTE CO1 TO CP OF SUBB3
 50          RK   8100.     .013     .080            TRAP      70       1

 51          KK   SUBB3
 52          KM     BRIDGE CANYON WASH - SUBBASIN B3 (N=0.07)
 53          BA     1.2
 54          LS       0      85.
 55          UD    .487

 56          KK    COB2
 57          KM     COMBINE RO2 & SUBB3 @ BRIDGE CANYON HIGHWAY CROSSING
 58          KM     (CP OF SUBB3)
 59          HC       2

 60          KK    ROB3
 61          KM     ROUTE COB2
 62          RK   6000.     .0900     .080            TRAP    100.      2.

 63          KK    ROB4
 64          KM     ROUTE ROB3 TO CP OF SUBB4
 65          RK   7600.     .0243     .050            TRAP    200.      2.

 66          KK   SUBB4
 67          KM     BRIDGE CANYON WASH - SUBBASIN B4 (N=0.07)
 68          BA     2.2
 69          LS       0      83.
 70          UD   0.743

 71          KK    COB3
 72          KM     COMBINE ROB3 & SUBB4 AT APEX OF BRIDGE
 73          KM     CANYON WASH FAN
 74          HC       2
 75          ZZ
```


**** FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) FEB 1.1985
U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616
****

POST, BUCKLEY, SCHUH AND JERNIGAN, INC.
HIKO SPRINGS AND BRIDGE CANYON WASHES FIS RESTUDY 7190.542
AUGUST 2, 1993

INPUT FILE NAME: BRIDGE
OUTPUT FILE NAME: BRIDGEO

100-YEAR , 6-HOUR STORM EVENT

THIS HEC-1 RUN IS REPRODUCED FROM COE AND VAN LOO'S STUDY
BRIDGE CANYON WASH FLOOD CONTROL MASTER PLAN,
APRIL, 1990 PREPARED UNDER CONTRACT WITH THE CCRFCD.

AREA REDUCTION FACTOR 0.88

STORM DISTRIBUTION NUMBER (SDN) 3

21 IO OUTPUT CONTROL VARIABLES

IPRNT	5	PRINT CONTROL
IPLOT	0	PLOT CONTROL
QSCAL	0.	HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA

NMIN	3	MINUTES IN COMPUTATION INTERVAL
IDATE	15May93	STARTING DATE
ITIME	0000	STARTING TIME
NQ	300	NUMBER OF HYDROGRAPH ORDINATES
NDDATE	15 93	ENDING DATE
NDTIME	1457	ENDING TIME

COMPUTATION INTERVAL .05 HOURS
TOTAL TIME BASE 14.95 HOURS

ENGLISH UNITS

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24 HOUR	72 HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	SUB1	1944.	4.30	576.	242	242.	2.70		
ROUTED TO	RES1	1966.	4.45	573.	242.	242	2.70		
HYDROGRAPH AT	SUB2	1467.	4.05	345.	139.	139.	1.96		
2 COMBINED AT	COM1	3041.	4.30	915.	378.	378.	4.66		
ROUTED TO									

+		ROB2	2943.	4.45	908.	369.	369.	4.60
	HYDROGRAPH AT							
+		SUBB3	1493.	3.90	320.	129.	129.	1.20
	2 COMBINED AT							
+		COB2	3690.	4.35	1209.	498.	498.	5.80
	ROUTED TO							
+		ROB3	3672.	4.45	1208.	498.	498.	5.80
	ROUTED TO							
+		ROB4	3628.	4.55	1204.	496.	496.	5.80
	HYDROGRAPH AT							
+		SUBB4	1970.	4.20	545.	220.	220.	2.20
	2 COMBINED AT							
+		COB3	5267.	4.45	1726.	716.	716.	8.00

*** NORMAL END OF HEC-1 ***

SECTION 2.2

Hydraulic Analyses

Study Contractor: Post, Buckley, Schuh & Jernigan, Inc.

HYDRAULIC ANALYSES INDEX

Unincorporated Areas, Clark County, Nevada

FLOOD INSURANCE STUDY

HYDRAULIC ANALYSIS INDEX

FLOODING SOURCE/ STREAM NAME	HYDROLOGIC METHOD/ MODEL USED	METHOD/MODEL ANALYSIS DATE	SECTION NO. PAPER COPY	SECTION NO. FLOPPY DISKETTES
Hiko Springs	FAN	March 1994	2.2.1	N/A
Bridge Canyon	FAN	March 1994	2.2.2	N/A

SECTION 2.2.1

Hiko Springs Fan

HIKO SPRINGS WASH APEX

AVULSION FACTOR = 1.0000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
2	175	176
10	1625	1607
100	9700	9759

MEAN = 2.245192
STANDARD DEVIATION = 0.749768
SKEW = 0.0

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 1607
50-YEAR DISCHARGE = 6096
100-YEAR DISCHARGE = 9759
500-YEAR DISCHARGE = 25301

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=0.5172+LOG(Q)

MEAN OF Z = 2.762372
STANDARD DEVIATION = 0.749768
SKEW = 0.000000
TRANSFORMATION CONSTANT = 9.990957

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	3.2899 Q	1.0000	WIDTH (FT)
0.5	0.3	49	0.76989	0.92124		8659
1.5	1.0	756	0.19928	0.43846		4121
2.5	1.7	2712	0.05830	0.18793		1766
3.5	2.3	6288	0.01934	0.08618		809

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	3.2899 Q	1.0000	WIDTH (FT)
3.5	0.4	68	0.70901	0.89118		8377
4.5	0.6	238	0.43057	0.69650		6547
5.5	0.9	649	0.22697	0.47369		4452
6.5	1.3	1496	0.10947	0.29190		2744
7.5	1.7	3059	0.04910	0.17206		1617
8.5	2.2	5719	0.02197	0.09374		881

SECTION 2.2.2

Bridge Canyon Fan

BRIDGE CANYON WASH APEX

AVULSION FACTOR = 1.0000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
2	72	72
10	780	771
100	5270	5304

MEAN = 1.859615
STANDARD DEVIATION = 0.801683
SKEW = 0.0

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 771
50-YEAR DISCHARGE = 3207
100-YEAR DISCHARGE = 5304
500-YEAR DISCHARGE = 14689

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=0.5913+LOG(Q)

MEAN OF Z = 2.450895
STANDARD DEVIATION = 0.801683
SKEW = 0.000000
TRANSFORMATION CONSTANT = 7.248380

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	3.9019 Q	1.0000	WIDTH (FT)
0.5	0.3	49	0.58578	0.82563		5630
1.5	1.0	756	0.10239	0.29713		2026
2.5	1.7	2712	0.02484	0.11278		769

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	3.9019 Q	1.0000	WIDTH (FT)
3.5	0.4	68	0.51437	0.77860		5310
4.5	0.6	238	0.26213	0.53693		3662
5.5	0.9	649	0.12125	0.32726		2232
6.5	1.3	1496	0.05059	0.18605		1267
7.5	1.7	3059	0.02136	0.09875		672

SUMMARY OF CALCULATIONS
FOR
BRIDGE CANYON WASH
PATHS 1, 2 & 3

Given the following logarithmic statistics for the frequency curve at the apex of the Bridge Canyon Wash:

Skew	= 0.0
Standard Deviation	= 0.80
Mean	= 1.86

and

Path 1	Distance between two points (Wo)	= 300 feet
	Width of fan contour (Wf)	= 2800 feet
Path 2	Distance between two points (Wo)	= 1150 feet
	Width of fan contour (Wf)	= 2800 feet
Path 3	Distance between two points (Wo)	= 1350 feet
	Width of fan contour (Wf)	= 2800 feet

The discharge that would be equaled or exceeded between two points for the specified reoccurrence interval is:

Reocurrence Interval (years)	Discharge (cfs)		
	Path 1	**Path 2**	**Path 3**
10	23	308	375
20	163	735	855
30	333	1140	1303
40	496	1495	1695
50	665	1840	2070
60	810	2120	2380
70	1017	2510	2800
80	1153	2760	3070
90	1311	3050	3370
100	1463	3315	3660
200	2857	5630	6140
500	6155	10600	11420

BRIDGE CANYON WASH PATH 1

AVULSION FACTOR = 1.0000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
10	23	25
20	163	140
30	333	310
40	496	482
50	665	665
60	810	878
70	1017	1071
80	1153	1243
90	1311	1395
100	1463	1530
200	2857	2885
500	6155	5380

MEAN = -3.447354
STANDARD DEVIATION = 4.368775
SKEW = -1.1

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 25
50-YEAR DISCHARGE = 665
100-YEAR DISCHARGE = 1530
500-YEAR DISCHARGE = 5380

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=3.0956+0.3115 LOG(Q)

MEAN OF Z = 2.021810
STANDARD DEVIATION = 1.360735
SKEW = -1.100000
TRANSFORMATION CONSTANT = 1.323321

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE *BEING EXCEEDED* AT THE APEX BY: Q	%1246.0953 Q^0.3115	WIDTH (FT)
0.5	0.3	49	0.08042	0.66002	822
1.5	1.0	756	0.01847	0.29754	368

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	%1246.0953 Q^0.3115	WIDTH (FT)
3.5	0.4	68	0.07084	0.62386	777
4.5	0.6	238	0.03831	0.46466	579
5.5	0.9	649	0.02039	0.31993	398
6.5	1.3	1496	0.01028	0.20033	208

BRIDGE CANYON WASH PATH 2

AVULSION FACTOR = 1.0000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
10	308	313
20	735	722
30	1140	1130
40	1495	1466
50	1840	1805
60	2120	2201
70	2510	2537
80	2760	2822
90	3050	3065
100	3315	3275
200	5630	5592
500	10600	10553

MEAN = 1.099720
STANDARD DEVIATION = 1.108824
SKEW = -0.2

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 313
50-YEAR DISCHARGE = 1805
100-YEAR DISCHARGE = 3275
500-YEAR DISCHARGE = 10553

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=1.1282+0.9074 LOG(Q)

MEAN OF Z = 2.126143
STANDARD DEVIATION = 1.006182
SKEW = -0.200000
TRANSFORMATION CONSTANT = 4.478015

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	0.9074 13.4346 Q	WIDTH (FT)
0.5	0.3	49	0.30722	0.67780	2856
1.5	1.0	756	0.04806	0.23375	982
2.5	1.7	2712	0.01317	0.09378	374

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	0.9074 13.4346 Q	WIDTH (FT)
3.5	0.4	68	0.26309	0.62596	2637
4.5	0.6	238	0.12618	0.41401	1744
5.5	0.9	649	0.05637	0.25563	1075
6.5	1.3	1496	0.02452	0.15289	644
7.5	1.7	3059	0.01114	0.08584	334

BRIDGE CANYON WASH PATH 3

AVULSION FACTOR = 1.0000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
10	375	382
20	855	842
30	1303	1292
40	1695	1659
50	2070	2026
60	2380	2457
70	2800	2820
80	3070	3127
90	3370	3388
100	3660	3613
200	6140	6104
500	11420	11455

MEAN = 1.320408
STANDARD DEVIATION = 0.993293
SKEW = -0.1

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 382
50-YEAR DISCHARGE = 2026
100-YEAR DISCHARGE = 3613
500-YEAR DISCHARGE = 11455

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=0.9257+0.9563 LOG(Q)

MEAN OF Z = 2.188447
STANDARD DEVIATION = 0.949891
SKEW = -0.100000
TRANSFORMATION CONSTANT = 5.053189

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	8.4282 Q	0.9563	WIDTH (FT)
0.5	0.3	49	0.36297	0.70527		3353
1.5	1.0	756	0.05683	0.23858		1132
2.5	1.7	2712	0.01496	0.09420		431

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	8.4282 Q	0.9563	WIDTH (FT)
3.5	0.4	68	0.30845	0.65069		3093
4.5	0.6	238	0.14887	0.42788		2034
5.5	0.9	649	0.06652	0.26118		1240
6.5	1.3	1496	0.02846	0.15467		735
7.5	1.7	3059	0.01288	0.08623		387

SUMMARY OF CALCULATIONS
FOR
BRIDGE CANYON WASH
PATH 4

Given the following logarithmic statistics for the frequency curve at the entrance to Path 2:

Skew	= -0.2
Standard Deviation	= 1.1088
Mean	= 1.0997

and

Path 4	Distance between two points (Wo)	= 150 feet
	Width of fan contour (Wf)	= 1000 feet

The discharge that would be equaled or exceeded between two points for the specified reoccurrence interval is:

Reocurrence Interval (years)	Discharge (cfs) **Path 4**
20	125
30	275
40	430
50	600
60	754
70	976
80	1100
90	1260
100	1480
200	3175
500	7710

BRIDGE CANYON WASH PATH 4

AVULSION FACTOR = 1.0000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
20	125	128
30	275	270
40	430	414
50	600	577
60	754	784
70	976	976
80	1100	1150
90	1260	1306
100	1480	1446
200	3175	3162
500	7710	7590

MEAN = -1.531112
STANDARD DEVIATION = 2.495056
SKEW = -0.6

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 29
50-YEAR DISCHARGE = 577
100-YEAR DISCHARGE = 1446
500-YEAR DISCHARGE = 7590

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=2.7673+0.5922 LOG(Q)

MEAN OF Z = 1.860549
STANDARD DEVIATION = 1.477557
SKEW = -0.600000
TRANSFORMATION CONSTANT = 1.524307

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q 585.1468 Q	0.5922	WIDTH (FT)
0.5	0.3	49	0.08270	0.58572	834
1.5	1.0	756	0.01706	0.26238	353

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q 585.1468 Q	0.5922	WIDTH (FT)
3.5	0.4	68	0.07143	0.54752	777
4.5	0.6	238	0.03578	0.39711	567
5.5	0.9	649	0.01873	0.27908	384

SUMMARY OF CALCULATIONS
FOR
BRIDGE CANYON WASH
PATHS 5 & 6

Given the following logarithmic statistics for the frequency curve at the entrance to Path 3:

Skew	=	-0.1
Standard Deviation	=	0.9933
Mean	=	1.32

and

Path 5	Distance between two points (Wo)	= 1100 feet
	Width of fan contour (Wf)	= 2900 feet
Path 6	Distance between two points (Wo)	= 1800 feet
	Width of fan contour (Wf)	= 2900 feet

The discharge that would be equaled or exceeded between two points for the specified reoccurrence interval is:

Reocurrence Interval (years)	Discharge (cfs)	
	Path 5	**Path 6**
10	107	225
20	318	550
30	543	890
40	752	1190
50	962	1480
60	1143	1730
70	1395	2070
80	1500	2310
90	1720	2490
100	1935	2800
200	3620	4980
500	7770	10140

BRIDGE CANYON WASH PATH 5

AVULSION FACTOR = 1.0000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
10	107	110
20	318	308
30	543	531
40	752	728
50	962	936
60	1143	1187
70	1395	1407
80	1500	1599
90	1720	1765
100	1935	1911
200	3620	3600
500	7770	7569

MEAN = 0.239128
STANDARD DEVIATION = 1.445893
SKEW = -0.3

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 110
50-YEAR DISCHARGE = 936
100-YEAR DISCHARGE = 1911
500-YEAR DISCHARGE = 7569

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=1.6432+0.8337 LOG(Q)

MEAN OF Z = 1.842549
STANDARD DEVIATION = 1.205380
SKEW = -0.300000
TRANSFORMATION CONSTANT = 2.724408

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	0.8337 43.9743 Q	WIDTH (FT)
0.5	0.3	49	0.16236	0.57111	1464
1.5	1.0	756	0.02425	0.19830	501

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	0.8337 43.9743 Q	WIDTH (FT)
3.5	0.4	68	0.13683	0.52365	1342
4.5	0.6	238	0.06244	0.34455	879
5.5	0.9	649	0.02805	0.21648	553
6.5	1.3	1496	0.01343	0.13566	324

BRIDGE CANYON WASH PATH 6

AVULSION FACTOR = 1.0000

FLOOD FREQUENCY CURVE DEFINED BY LEAST-SQUARES FIT OF DATA

RETURN INTERVAL (YEARS)	INPUT DISCHARGE (CFS)	BEST FIT DISCHARGE (CFS)
10	225	226
20	550	546
30	890	879
40	1190	1160
50	1480	1450
60	1730	1797
70	2070	2095
80	2310	2350
90	2490	2570
100	2800	2760
200	4980	4949
500	10140	9975

MEAN = 0.949585
STANDARD DEVIATION = 1.106007
SKEW = -0.1

SUMMARY OF DISCHARGES:

10-YEAR DISCHARGE = 226
50-YEAR DISCHARGE = 1450
100-YEAR DISCHARGE = 2760
500-YEAR DISCHARGE = 9975

STATISTICS AFTER TRANSFORMATION OF Y=LOG(Q) TO Z=1.1169+0.9516 LOG(Q)

MEAN OF Z = 2.020493
STANDARD DEVIATION = 1.052462
SKEW = -0.100000
TRANSFORMATION CONSTANT = 3.952643

SINGLE-CHANNEL REGION

ENERGY (FT)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	0.9516 13.0882 Q	WIDTH (FT)
0.5	0.3	49	0.25824	0.62929	2340
1.5	1.0	756	0.03784	0.20993	779
2.5	1.7	2712	0.01028	0.08959	271

VELOCITY (FT/SEC)	DEPTH (FT)	DISCHARGE (CFS)	PROBABILITY OF DISCHARGE BEING EXCEEDED AT THE APEX BY: Q	0.9516 13.0882 Q	WIDTH (FT)
3.5	0.4	68	0.21599	0.57788	2149
4.5	0.6	238	0.09716	0.37410	1390
5.5	0.9	649	0.04319	0.23033	848
6.5	1.3	1496	0.01952	0.14091	515

PROBABILITY OF A GIVEN DISCHARGE BEING EXCEEDED BETWEEN TWO POINTS ON AN ALLUVIAL FAN

FROM : DUCK CREEK HYDROLOGIC UNIT, CLARK COUNTY, NEVADA, FLOOD INSURANCE STUDY, PREPARED BY MICHAEL BAKER JR., INC., FOR FEDERAL EMERGENCY MANAGEMENT AGENCY, REVISED MAY 1993.

PROBABILITY OF A GIVEN DISCHARGE BEING EXCEEDED BETWEEN TWO POINTS ON AN ALLUVIAL FAN

Consider a rectangular channel that has a topwidth, w, which is a function of the discharge it conveys: $w = w(q)$. Assuming that the location of the channel is uniformly distributed within a width W_f and the probability density function describing the occurrence of a discharge Q somewhere within that width is $f_Q(q)$, the probability that a discharge of q_0 passes between two points, **a** and **b**, can be determined as follows.

Because the channel is rectangular, the amount of flow in a section of the channel is (roughly) proportional to the topwidth of that section. That is, if q is the discharge of the channel shown in Figure 1, then the discharge, q_r, in the cross-hatched area is

$$q_r = \frac{w_r q}{w(q)} \qquad (1)$$

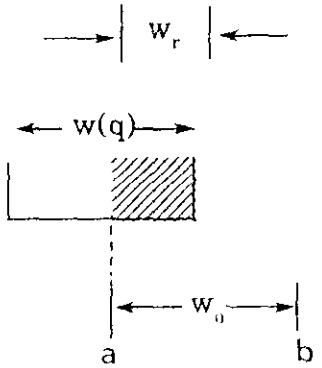


Figure 1

Thus for a discharge, q_0, to pass between points **a** and **b**, given that the total discharge in the channel is q, the right side of the channel must be between the points

$$\frac{q_0 w(q)}{q} \text{ and } W_o + w(q) - \frac{q_0 w(q)}{q}$$

where we have taken **a** to be at the origin and W_o to be the width of the opening (**b-a**). The probability density function describing the location of the right side of the

channel is $1/W_f$ and, therefore, the probability that the right side of the channel is between the two points given above is

$$\frac{1}{W_f}\left|W_o + w(q) - \frac{2q_0 w(q)}{q}\right|$$

The probability that a discharge exceeding q_0 passes between two points that define an opening of width W_o is

$$P\left[Q \text{ through } W_o > q_0\right] = \frac{1}{W_f}\int_{q_0}^{\infty}\left|W_o + w(q) - \frac{2q_0 w(q)}{q}\right| f_Q(q)dq \qquad (2)$$

Writing P as the sum of three integrals yields

$$P = I_1 + I_2 - I_3 \qquad (3)$$

where

$$I_1 = \frac{W_o}{W_f}\int_{q_0}^{\infty} f_Q(q)dq \qquad (4)$$

$$I_2 = \frac{1}{W_f}\int_{q_0}^{\infty} w(q)\, f_Q(q)dq \qquad (5)$$

$$I_3 = \frac{2}{W_f}\int_{q_0}^{\infty} \frac{q_0 w(q)}{q}\, f_Q(q)dq \qquad (6)$$

If $f_Q(q)$ is log-normal, then

$$P(Q > q_0) = \frac{1}{\sigma\sqrt{2\pi}}\int_{y_0}^{\infty} e^{-\frac{1}{2}\left(\frac{y-\mu}{\sigma}\right)^2} dy \qquad (7)$$

where

$$y_0 = \log_{10}(q_0) \qquad (8)$$

Also, note that for a power function of q, say

$$w(q) = \alpha q^{\beta} \qquad (9)$$

or, equivalently,

$$w(q) = \alpha e^{\beta y \ln(10)} \tag{10}$$

$$= \alpha e^{2.3026\beta y} \tag{11}$$

where $y = \log_{10}(q)$

$$\int_{q_0}^{\infty} w(q) f_Q(q)\, dq = \alpha C(\beta) \frac{1}{\sigma\sqrt{2\pi}} \int_{y_0}^{\infty} e^{-\frac{1}{2}\left(\frac{y-\mu'}{\sigma}\right)^2} dy \tag{12}$$

where

$$\mu' = \mu + 2.3026\beta\sigma^2 \tag{13}$$

and

$$C(\beta) = e^{2.3026\beta\mu + \frac{1}{2}(2.3026\beta\sigma)^2} \tag{14}$$

In summary, equation (2) can be solved when w(q) is defined. For the single channel region

$$w(q) = 9.408q^{0.4} \tag{15}$$

and

$$\frac{w(q)}{q} = 9.408q^{-0.6} \tag{16}$$

Thus the three integrals in equation (3) are:

$$I_1 = \frac{W_o}{W_f} \frac{1}{\sigma\sqrt{2\pi}} \int_{y_0}^{\infty} e^{-\frac{1}{2}\left(\frac{y-\mu}{\sigma}\right)^2} dy \tag{17}$$

$$I_2 = \frac{9.408}{W_f \sigma\sqrt{2\pi}} e^{.92\mu + .42\sigma^2} \int_{y_0}^{\infty} e^{-\frac{1}{2}\left(\frac{y-\mu-.92\sigma^2}{\sigma}\right)^2} dy \tag{18}$$

$$I_3 = \frac{18.816y_0}{W_f \sigma\sqrt{2\pi}} e^{-1.38\mu + .95\sigma^2} \int_{y_0}^{\infty} e^{-\frac{1}{2}\left(\frac{y-\mu+1.38\sigma^2}{\sigma}\right)^2} dy \tag{19}$$

On an alluvial fan I_1 is the probability that q_0 is exceeded at the apex times the ratio of the width of the opening to the width of the fan. I_2 is the probability that a point on the fan at the elevation where the width of the area subject to flooding is W_f is inundated. I_3 is similar to I_2. The integrands in both I_2 and I_3 are the same as that in I_1 with a change in the mean, μ, to $\mu + .92\sigma^2$ and $\mu - 1.38\sigma^2$, respectively.

SECTION 3

DRAFT FIS REPORT TEXT

DRAFT

FLOOD INSURANCE STUDY RESTUDY

HIKO SPRINGS AND BRIDGE CANYON WASHES
LAUGHLIN, NEVADA
(Unincorporated Areas, Clark County)

FEBRUARY, 1994

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1.0 INTRODUCTION

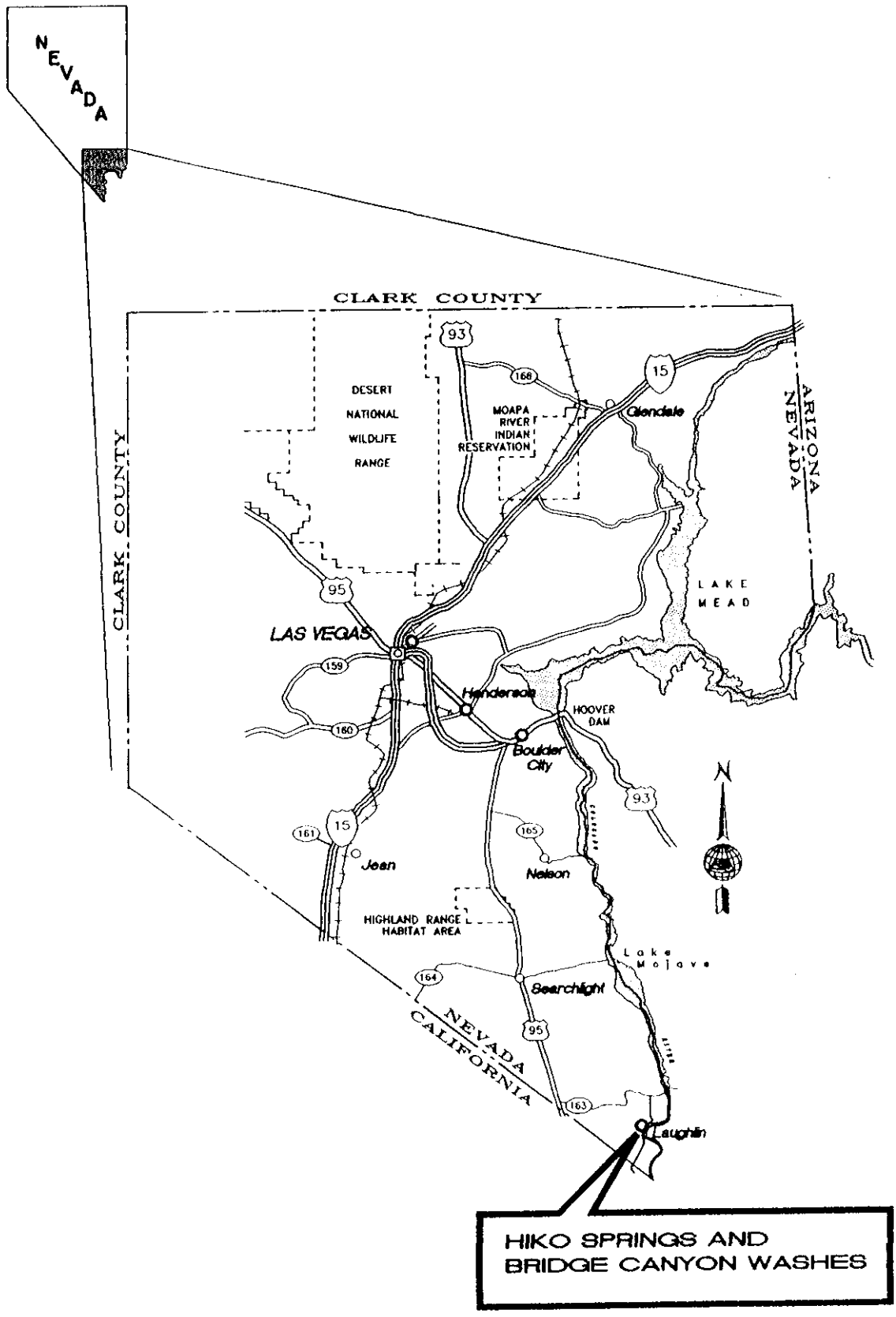
1.1 Purpose of Study

This report presents the findings of the Hiko Springs and Bridge Canyon Washes Flood Insurance Study (FIS) Restudy. The purpose of this study was to investigate the existence and severity of flood hazards due to the Hiko Springs and Bridge Canyon Washes near the Town of Laughlin, an unincorporated area of Clark County, Nevada (**Figure 1**). The results of this flood risk study will be used to update the Flood Insurance Rate Maps (FIRM) for Clark County (Unincorporated Area). The FIRMs are distributed by the Federal Emergency Management Agency (FEMA) to aid in the administration of the National Flood Insurance Program (NFIP). This program was established with the passage of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973 to enable property owners to purchase insurance protection against losses from flooding.

1.2 Authority and Acknowledgements

Post, Buckley, Schuh & Jernigan (PBS&J) was authorized by the Clark County Regional Flood Control District (CCRFCD) to perform this study of the Hiko Springs and Bridge Canyon Washes on May 14, 1993. Dr. Richard H. French, P.E., Consulting Engineer and Research Professor at the Desert Research Institute Water Resources Center, and Dr. Jeffery R. Keaton, P.E., P.G. Vice President of SHB AGRA, Inc. both provided consulting services and assistance in the flood hazard assessment.

The hydrologic analysis of the 100-year storm event for the Hiko Springs Wash was performed by Boyle Engineering Corporation as a part of the Facilities Plan for Hiko Springs and Unnamed Wash (Boyle, 1989). The hydrologic analysis of the 100-year storm event for the Bridge Canyon Wash was performed by Coe & Van Loo Consulting Engineers, Inc. in association with the Bridge Canyon Wash Flood Control Master Plan (CVL, 1990). Both of these studies were performed under the authority of the Clark County Regional Flood Control District (CCRFCD). The topographic mapping was performed by Cooper Aerial of Nevada, Inc. (Cooper, 1984) for James M. Montgomery, Consulting Engineers, Inc. under contract with FEMA in association with the FIS for Clark County, Nevada (Unincorporated Areas) (FEMA, 1989).



VICINITY MAP

POST, BUCKLEY, SCHUH & JERNIGAN

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FIGURE 1

1.3 Coordination

The area of detailed study were identified during the project kick-off meeting and field trip taken on May 19, 1993 in which representatives of the CCRFCD, FEMA, Michael Baker Jr., Inc. (MBJ), Clark County Public Works Department (CCPW) and PBS&J attended. Areas of approximate study were identified during a progress meeting held on January 26, 1993 in which representatives of the CCRFCD, CCPW and PBS&J attended.

The flood frequency discharge data for the apex of the Hiko Springs and Bridge Canyon Washes were developed early in the study. The results of the analysis were coordinated with the CCRFCD, FEMA and MBJ. Throughout the project, coordination meetings were held with the CCRFCD to discuss progress and the results of the preliminary alluvial fan analysis.

2.0 AREA STUDIED

2.1 Scope of Study

This study presents the findings of the alluvial fan flood risk analysis for the Hiko Springs and Bridge Canyon Wash located in Laughlin, Nevada, an unincorporated area of Clark County. The results of the flood risk analysis are shown graphically on **Figure 2**. **Figure 3** is a schematic drawing showing the results of the previous FIS for the study area.

This study was conducted in three phases. The objective of the first phase was to define and locate the boundaries of the Bridge Canyon Fan and to verify that an abandoned remnant of the Hiko Springs fan topographically separates the Bridge Canyon and Hiko Springs landforms. The objective of the second phase was to perform a detailed alluvial fan analysis of the Hiko Springs and Bridge Canyon Washes. The third phase was an evaluation of the floodplain downstream of the Bridge Canyon alluvial fan flood hazard area. This area was evaluated by approximate methods.

2.2 Community Description

The study area is located approximately 90 miles south and slightly east of the City of Las Vegas near the Town of Laughlin at the southern tip of Nevada. The Laughlin area is impacted by four primary flooding sources originating in the Newberry Mountains: Southwest Unnamed, Hiko Springs, Bridge Canyon, and Dripping Springs Washes (**Figure 2**). This study is primarily concerned with the Hiko Springs and Bridge Canyon Washes.

SOUTHWEST UNNAMED WASH (OUTSIDE STUDY LIMITS)

DRIPPING SPRINGS WASH (OUTSIDE STUDY LIMITS)

LIMIT OF STUDY

UNNAMED WASH LEVEE

NEEDLES HWY. FLOOD WALL

CROWN POINTE FLOOD WALL

ZONE AO (DEPTH 2) (VELOCITY 7 FPS)

ZONE AO (DEPTH 3) (VELOCITY 8 FPS)

HIKO SPRINGS Canyon

WASH

ZONE AO (DEPTH 3) (VELOCITY 8 FPS)

ZONE AO (DEPTH 4) (VELOCITY 9 FPS)

ZONE AO (DEPTH 1) (VELOCITY 5 FPS)

ZONE X

ZONE AO (DEPTH 3) (VELOCITY 8 FPS)

ZONE AO (DEPTH 2) (VELOCITY 7 FPS)

ZONE AO (DEPTH 1) (VELOCITY 6 FPS)

ZONE X (SHADED)

ZONE AO (DEPTH 1) (VELOCITY 6 FPS)

PATH 1

PATH 2

PATH 3

PATH 4

PATH 5

ZONE X (SHADED)

(6) 10'x5' RCB CULVERTS

BEGIN ELEVATED ROADWAY

ZONE AO (DEPTH 2) (VELOCITY 6 FPS)

ZONE AO (DEPTH 1) (VELOCITY 5 FPS)

ZONE AO (DEPTH 1) (VELOCITY 3 FPS)

ZONE AO (DEPTH 1) (VELOCITY 4 FPS)

ZONE AO (DEPTH 1) (VELOCITY 3 FPS)

ZONE AO (DEPTH 1) (VELOCITY 4 FPS)

ZONE X (SHADED)

ZONE AO (DEPTH 1) (VELOCITY 5 FPS)

ZONE X (SHADED)

ZONE AO (DEPTH 1) (VELOCITY 3 FPS)

ZONE X (SHADED)

LAUGHLIN HIGH SCHOOL DIKE / CHANNEL

NDOT DIKE / CHANNEL

ZONE X

ZONE X (SHADED)

ZONE X (SHADED)

ZONE X (SHADED)

ZONE X

ZONE A

ZONE X

LIMIT OF STUDY

Colorado River

EDISON ROAD

BRIDGE

FAN

CANYON

HIGHWAY

STATE ROUTE 163

GRAPHIC SCALE

1000 0 500 1000 2000 4000

(IN FEET)

1 inch = 1000ft.

Contour Interval = 20ft.

N

No.	REVISIONS	Date/Init.	Appr.	Date

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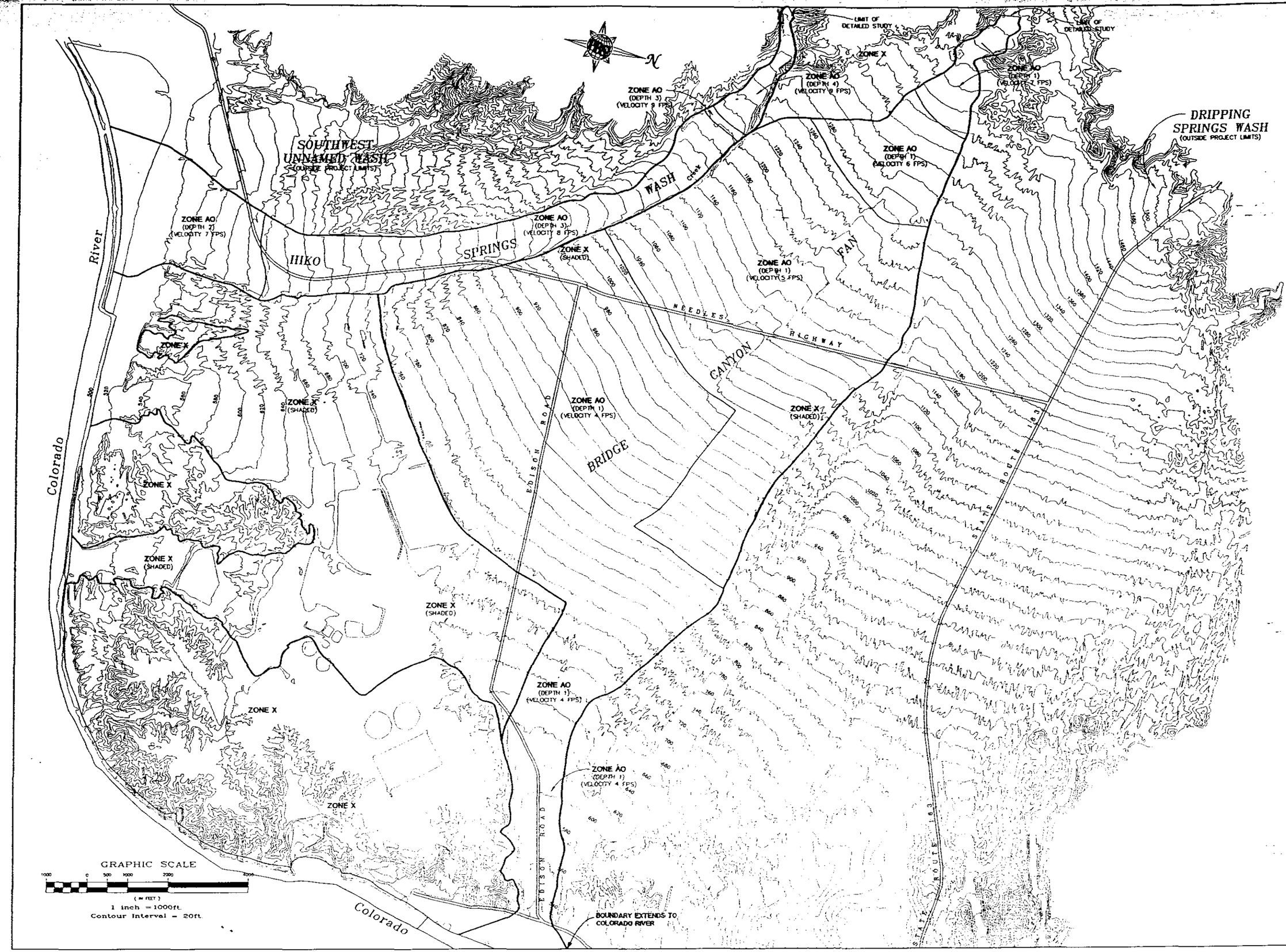
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HIKO SPRINGS AND BRIDGE CANYON WASHES FIS RESTUDY

Graphical Representation of Revised Flood Insurance Rate Map For Hiko Springs and Bridge Canyon Washes – Figure 2

Job Number	Drawn by	Scale
7190.542	T. Overbay	1" = 1000'
Sheet Number	Checked by	File No.
1 OF 1	S. Dudley	542MAP
	Date Feb. 21, 1994	

DRAWING: 542sma PLOT DATE: 2-21-94



No.	REVISIONS	Date	Init.	Appr.	Date

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HIKO SPRINGS AND BRIDGE CANYON WASHES FIS RESTUDY

FIGURE 3

Graphical Representation of part of Community Panels Number 3200003-1985B, 2005B & 2015B

Job Number 7190.542	Drawn by T.J. Overton	Scale 1" = 1000'	
Sheet Number 1 OF 1	Checked by S. Burke	File No. 542MAP	
	Date FEB. 21, 1994		

DRAWING 542-MAP PLOT DATE 2-21-94

The climate in the Laughlin area is arid and characterized by episodic rainfall and wide extremes in daily temperatures. Rainfall data for the Laughlin area are limited. Laughlin is relatively more humid and likely receives more rainfall than most of Clark County because of its proximity to the Colorado River. The precipitation gauge at the Laughlin Firestation recorded average annual precipitation values, over a period of four years from 1989 through 1992, ranging from 1.56 inches to 10.78 inches. In comparison, the average annual precipitation in the Las Vegas Valley is approximately 4.2". The average annual temperature in the Laughlin area is approximately 66°F with average daily maximums in the high 70's and average daily minimums in the mid-50's. Daily maximum temperatures during the summer usually exceed 100°F. During the winter period (October through April, inclusive), the primary source of moisture to this area is the Pacific Ocean. Precipitation results from frontal systems; and the events are low-intensity and long-duration. During the summer period (May through September, inclusive), the primary moisture sources are the Pacific Ocean, the Gulf of Mexico, and upwind land surfaces as well as reservoirs. Additional information regarding the hydrometeorologic climate of Southern Nevada is available in Moosburner and Williams (1989) and French (1983).

Vegetation at lower elevations consists of sparse desert brush, primarily Creosote Bush. Grasses, herbaceous shrubs and other vegetation species are also found in the area, within the mountain region and near more reliable water sources their number and type are more varied (CVL, 1990).

The Hiko Springs Wash watershed is approximately 18.3 square miles and characterized by steep mountainous slopes. The average slope of the watershed is approximately 0.07 ft/ft (Boyle, 1989). The watershed soils are classified by the Soil Conservation Service (SCS, undated) primarily as hydrologic soil group Type D.

Below the apex, the Hiko Springs Wash can be subdivided into two reaches of distinct character. Generally, upstream of Needles Highway, Hiko Springs Wash consists of a braided channel in an entrenched valley, 40 to 60 feet deep and 400 to 1000 feet wide. The braided channel system includes grain sizes from boulders to fine sand. Below Needles Highway, the wash widens and the boundaries are not well defined. The average slope of the fan below the apex is approximately 0.04 ft/ft. No rock varnish or other geologic evidence of substantial channel stability was observed during the field reconnaissance.

The Bridge Canyon Wash watershed is approximately 8.0 square miles and characterized by steep slopes averaging 0.07 ft/ft (CVL, 1990). The soils are classified as hydrologic soil group Types B and D (SCS, undated).

Bridge Canyon Wash discharges onto a broad alluvial fan approximately 5,000 feet north of Hiko Springs Wash. A distinctive rock outcrop is located on the south side of the mouth of the canyon across from a more substantial bedrock hill on the north. The effective apex of the Bridge Canyon Wash is defined by these bedrock hills. Immediately below the effective apex of Bridge Canyon Fan, the lateral boundaries of the fan are clearly defined. The southern boundary becomes less defined as one progresses downstream. Approximately 2,300 feet below the effective apex on the north side of the fan begins an entrenched channel.

The surface of Bridge Canyon fan appears to contain limited rock varnish or other geologic evidence of surface stability. Rock varnish could be scarce because the coarse-grained granitic rock fragments on the fan tend to disaggregate relatively rapidly which does not permit varnish to accumulate.

The remarkably different character of Hiko Springs Wash and Bridge Canyon Fan may be due to differences in sediment production in the drainage basins. It may be that the Bridge Canyon fan at one time was entrenched similar to the current condition in Hiko Springs Wash. An increase in sediment production in Bridge Canyon basin could have filled an entrenched valley and buried the apex of the fan.

2.3 Principle Flood Problems

The study area consists of alluvial fans, and the hydraulic processes that occur on these landforms in response to episodic precipitation events are complex and amenable to deterministic analysis. On classic alluvial fans, flood flows occur in channels cut by the flow itself and during a single flood event one channel may be abandoned and a new channel formed. Given the randomness of channel formation and abandonment, probabilistic methods are used to delineate flood hazards. In this study, the traditional approach to flood hazard analysis (FEMA, 1990) was used along with improvements developed by MBJ (1993), French (1992), and Flippin and French (1994). The improvements take into account that on dissected fan surfaces the potential for existing channels of finite size to divert flow must be taken into account. These improvements to the traditional method of analysis while preserving the probabilistic nature of the original method (FEMA, 1990) take into account both topographic data and the results of detailed field investigations.

2.4 Flood Protection Measures

The affects of a number of existing and proposed flood control facilities were incorporated into the alluvial fan analyses. The locations of these facilities are shown on **Figure 2**. The technical design data pertaining to each facility is contained in Section 5 of the TSDN.

Two flood control facilities proposed to be constructed in 1995 as a part of the Needles Highway Special Improvement District (SID) No. 91 were taken into consideration in the alluvial fan analysis (**Figure 2**). The first facility consists of (6) 10 ft x 5 ft RCB culverts proposed to be constructed near Desert Road (PBS&J, 1994). The culvert structure was designed to prevent stormwater originating from the Bridge Canyon Wash watershed from entering the Hiko Springs Wash system. The second facility is a flood/retaining wall proposed to be constructed at the Hiko Springs Wash crossing of Needles Highway. The structural design of the flood wall was performed by Ms. Peggy Knott, P.E. (PBS&J, 1994).

The Needles Highway flood wall is an extension of the existing Crown Pointe flood wall. The primary difference between the two structures is the Needles Highway flood wall also functions as a retaining wall and is not considered a levee. The Needles Highway and Crown Pointe flood wall define a portion of the boundary of the Hiko Springs Wash (**Figure 2**). The hydraulic design of the Crown Pointe flood wall is discussed in the Study for Hydraulic and Sediment Transport of Proposed Crown Pointe Flood Wall (Lenzotti, 1989). The structural design of the flood wall was performed by James M. Montgomery Engineers (JMM, 1988 and 1989).

In association with the Unnamed Wash Channel project, funded by the CCRFCD, a levee is proposed to be constructed on the Hiko Springs Wash between Needles Highway and the Colorado River (**Figure 2**). A Conditional Letter of Map Revision (CLOMR) was issued on May 18, 1992 (Case No. 92-09-037R) for the Unnamed Wash Channel improvements. The CLOMR states "The Hiko Springs levee, located to the east of the channel and approximately 500 feet south of Casino Drive to Needles Highway, will prevent the Hiko Springs flow from flooding areas of the Unnamed Wash floodplain protected by the proposed channel improvements." Therefore, this levee/dike defines a portion of the Hiko Springs Wash boundary.

A dike/channel is proposed on the Dripping Springs Fan as a part of the State Route 163 (SR-163) Phase-V improvements which are currently under construction. This dike was designed by WRC Nevada, Inc. (WRC, 1993 and NDOT, 1993) to prevent stormwater developed in the Dripping Springs Wash system from entering the Bridge Canyon Wash system. This facility prevents coalescence of the Dripping Springs and Bridge Canyon Fans (**Figure 2**).

The Laughlin High School dike/channel, located on the Bridge Canyon Fan, was constructed to direct stormwater away from the high school structure. This dike was designed by SEA, Inc. Consulting Engineers (SEA, 1990). The dike defines the boundary of the Bridge Canyon flood hazard area near the high school (**Figure 2**).

3.0 ENGINEERING METHODS

3.1 Hydrologic Analyses

When using the alluvial fan method of defining flood hazards, it is standard practice to assume that flood events are best described by the log-Pearson Type III (LP3) probability distribution which is a 3 parameter distribution (mean, standard deviation, and skew). In Clark County, the skew coefficient is approximately zero (USWRC, 1981). Therefore, in the alluvial fan analysis, the probability distribution used was log-normal.

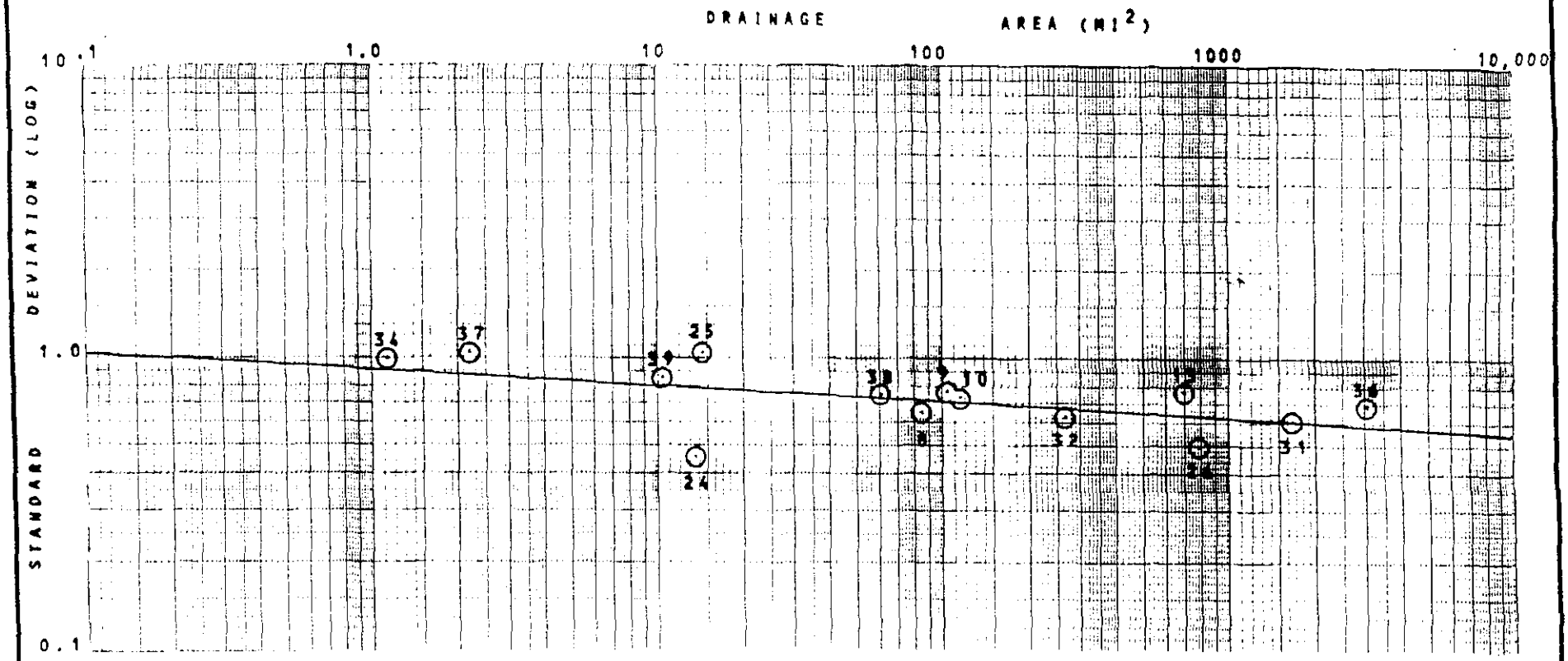
The standard deviations were determined using data given in the Hydrologic Documentation for Feasibility Study, Las Vegas Wash and Tributaries (COE, 1988). On **Figure 4**, the regional LP3 logarithmic standard deviation relationship developed in COE (1988) are given as a function of the watershed size. According to **Figure 4**, the standard deviation for Hiko Springs Wash watershed (18.3 sqmi) is approximately 0.75. The standard deviation for the Bridge Canyon Wash watershed (8.0 sqmi) is approximately 0.8.

The flood frequency curves used in the alluvial fan analyses are based on the 100-year peak flow rates at the apexes of the Hiko Springs and Bridge Canyon Washes developed by Boyle (1989) and CVL (1990), respectively. Both watersheds were modeled using the SCS Unit Hydrograph/Runoff Curve Number option in the HEC-1 Hydrograph Package (HEC, 1985). The 100-year peak flow values are 9,700 cfs at the apex of the Hiko Springs Wash and 5,270 cfs at the apex of the Bridge Canyon Wash.

Given the skew, standard deviation, and 100-year peak flow rate, the logarithmic mean was estimated using the equations for synthetic statistics given in the US Water Resources Council, Bulletin 17B (USWRC, 1981). The mean for the Hiko Springs Wash apex was estimated to be 2.24. The mean for the Bridge Canyon Wash apex was estimated to be 1.86. The flood frequency curves at the apex of the Hiko Springs and Bridge Canyon Washes are shown on **Figures 5 and 6.**

3.2 Hydraulic Analyses

The Federal Emergency Management Agency's FAN program (FEMA, 1990) was used to compute the contour widths corresponding to flood insurance zone boundaries in areas of detailed study. The computations are contained in Section 2 of the Technical Support Data Notebook (TSDN). Flood hazard areas downstream of the Bridge Canyon alluvial fan flood hazard boundary were



STREAMGAUGES

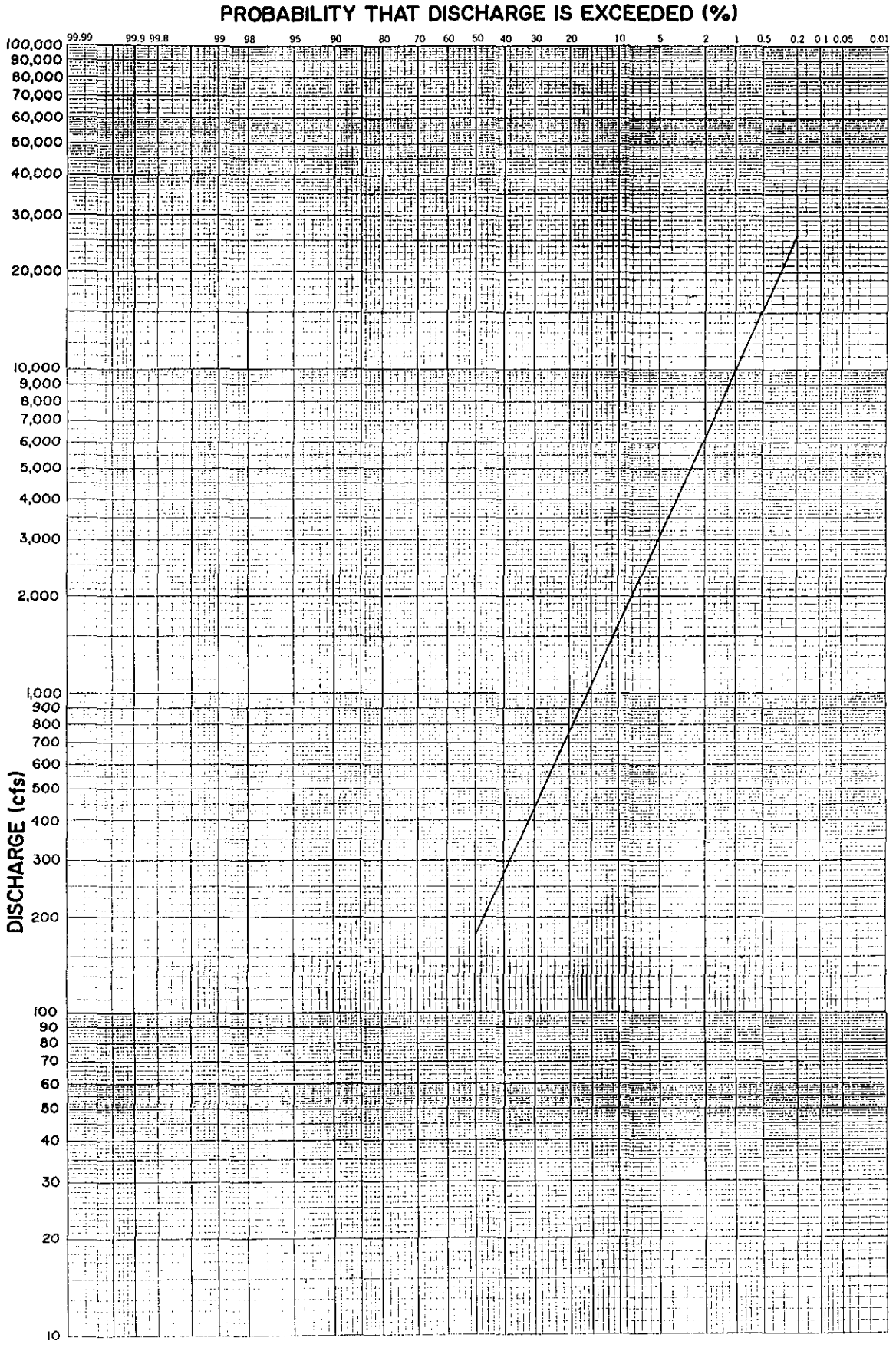
8. FLAMINGO WASH AT LAS VEGAS
9. FLAMINGO WASH AT MARYLAND PKWY
10. FLAMINGO WASH NEAR MOUTH
13. LAS VEGAS WASH AT N. LAS VEGAS
24. TYSON WASH TR. NEAR QUARZITE
25. SACTO WASH TR. NEAR TOPOC
26. SACTO WASH NR. YUCCA, ARIZONA
31. SAN FELIPE CRK NR. WSTMRELND
32. SALT CREEK NEAR MECCA, CALIF.
34. CARUTHERS CRK NR. IVANPAH, CA
36. AMARGOSA RIVER AT TECOPA
37. AMARGOSA R TR. #1 NR. JOHNNIE
38. SALT WELLS CRK NR. WESTEND, CA
39. NINEMILE CREEK NEAR BROWN, CA

LAS VEGAS WASH AND TRIBUTARIES, NEVADA
FEASIBILITY STUDY

STANDARD DEVIATION
VERSUS
DRAINAGE AREA

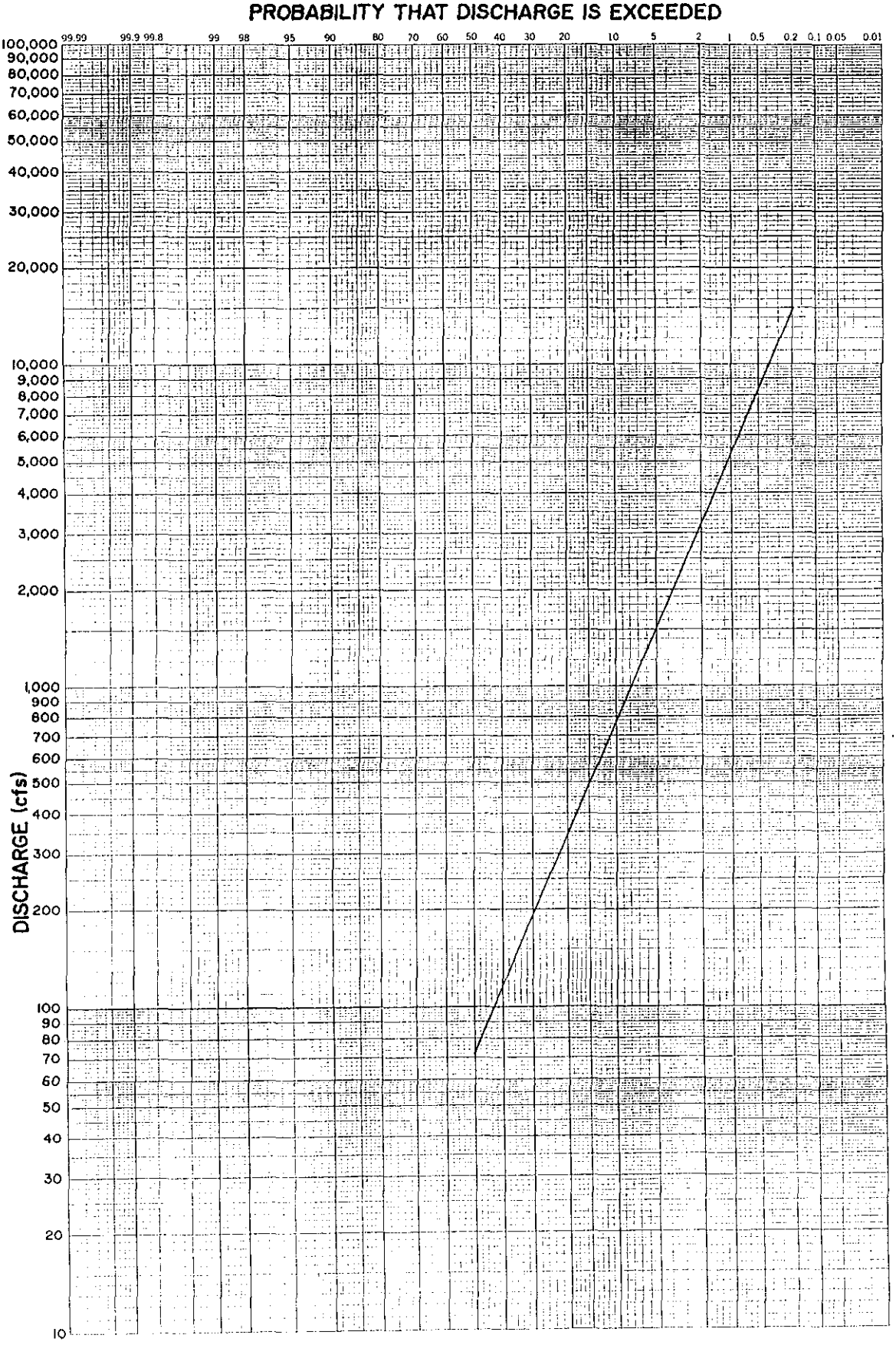
FROM COE (1988)

FIGURE 4



FREQUENCY CURVE AT APEX OF HIKO SPRINGS WASH

FIGURE 5



FREQUENCY CURVE AT APEX OF BRIDGE CANYON FAN

FIGURE 6

approximated based on historic flooding information, field investigation, available topographic data and aerial photographs. The flood hazard zone boundaries are shown on **Figure 2** which is a graphical representation of the draft work maps contained in Section 4 of the TSDN.

The flood hazard depth and velocity zone boundaries for the Hiko Springs Wash were developed directly from the flood frequency data at the apex. A single channel flow regime and avulsion coefficient of one was assumed.

The flood frequency data for the apex of the Bridge Canyon Wash was applied directly between the apex and the 1332 ft contour. A single channel flow regime and avulsion coefficient of one were assumed throughout the analysis. At the 1332 ft contour, the flood flow can potentially follow three paths, labeled as paths 1, 2 and 3 on **Figure 2**. The flood frequency curves at the entrance to each pathway were defined using the method described in the Duck Creek Hydrologic Unit FIS (MBJ, 1993) for defining the probability of a given discharge being exceeded between two points. The frequency at which a given discharge is exceeded between those points is a function of the frequency at which it is exceeded at the apex of the Bridge Canyon Wash. The frequency curves were defined by computing flow values with reoccurrence intervals of 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 200, and 500 years. Given these values, the FAN program was used to develop flood hazard zone boundaries below the entrance through which the flow passes.

The method developed in MBJ (1993) was employed once again at the 1236 ft contour to define the frequency curve at the location where a breakout of flow from path 2 can occur. This breakout is identified as path 4 on **Figure 2**.

The flood frequency curve for path 3 was re-defined at Needles Highway. According to the Needles Highway improvement plans, a section of the roadway across path 3 is proposed to be elevated 1 to 7 feet above the fan surface (PBS&J, 1994) (**Figure 2**). Therefore, at Needles Highway, two new frequency curves were defined, paths 5 and 6, **Figure 2**. Flood flows that follow path 6 pass over the highway. Flood flows that follow path 5 are passed under the highway through the culvert structure proposed as a part of the Needles Highway improvements (PBS&J, 1994).

4.0 FLOODPLAIN MANAGEMENT APPLICATION

The 100-year flood hazard boundaries were delineated on aerial-topographic maps at a scale of 1:4,800 (1" = 400') and a contour interval of 4 feet. The 500-year flood hazard boundaries were taken directly from the pre-existing FIRM (**Figure 3**) for the study area. Only the 100-year flood hazard boundaries are shown for areas studied by approximate methods.

5.0 INSURANCE APPLICATION

5.1 Flood Insurance Zones

Areas within the 100-year flood boundary are termed "Special Flood Hazard Areas (SFHAs)." A 100-year flood refers to a flood level with a 1 percent or greater chance of being equalled or exceeded in any given year. The areas within the 100-year floodplain are further subdivided into insurance risk rate zones. The SFHAs designated in the study area are defined below.

Zone A SFHAs subject to inundation by the 100-year flood. No hydraulic analyses have been performed and no base flood elevation or depths are shown. Mandatory flood insurance purchase requirements apply.

Zone A0 SFHAs subject to alluvial fan flooding. Alluvial fan flooding is defined as flooding occurring on the surface of an alluvial fan or similar landform which originates at the apex and is characterized by high-velocity flows; active processes of erosion, sediment transport, and deposition; and unpredictable flow paths. Average flood depths and velocities derived by detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements apply.

Areas between the 100-year and 500-year flood boundaries are termed "moderate flood hazard areas." The areas of moderate flooding are designated as:

Zone X (shaded) Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood. Flood insurance is available in participating communities but is not required by regulation.

The remaining areas are outside the 500-year floodplain and are termed "minimal flood hazard areas." The areas of subject to minimal flood hazard are designated as:

Zone X Areas of minimal flood hazard from the principle source of flood in the area determined to be outside the 500-year floodplain. Flood insurance is available in participating communities but is not required by regulation.

5.2 Flood Insurance Rate Map

Using the results of this FIS, a Flood Insurance Rate Map (FIRM) will be prepared that depicts the SFHAs described in Section 5.0. In addition to the SFHAs, the FIRM shows those areas subject to inundation during the 500-year flood and outside of the 500-year floodplain. FEMA publishes the FIRM and distributes it to a wide range of users. Private citizens, community officials, insurance agents and brokers, lending institutions, and Federal agencies use the FIRM to determine the degree of flood hazard in specific areas of the community so that actuarial premium rates can be assigned and full insurance coverage obtained for properties at risk.

6.0 OTHER STUDIES

This study is intended to update and supersede that portion of the Flood Insurance Study for Clark County, Nevada (Unincorporated Areas) (FEMA, 1989) that pertains to the study area. In some cases, the boundaries of the flood hazard area in which detailed analyses were performed are based on the results of previously prepared studies. These studies and their relevance to this study are discussed in Sections 2.4 and 3.1.

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15. Lenzotti, 1989. *Study for Hydraulic and Sediment Transport of Proposed Crown Point Flood Wall*. Prepared by Lenzotti & Fullerton, Consulting Engineers, Inc., for Meadows Development Company, Revised April 20, 1989.

16. NDOT, 1993. *SR-163 Construction Plans from JCT. US95 via Laughlin to NEV.-ARIZ. State Line*. State of Nevada Department of Transportation, August 18, 1993.

17. PBS&J, 1994. *Needles Highway Street Improvements, SID #91*. Prepared by Post, Buckley, Schuh & Jernigan, Inc., for Clark County Department of Public Works, 1994.

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SECTION 4

MAPPING INFORMATION

Study Contractor: Post, Buckley, Schuh & Jernigan, Inc.

MAPPING INFORMATION INDEX

Unincorporated Areas, Clark County, Nevada

FLOOD INSURANCE STUDY

TYPE OF MAP	MAP DATE	NO. OF SHEETS	EXHIBIT NO.
Draft Work Map	March 3, 1994	5	Sheets Index, 1, 2, 4, 5
Draft Work Map	March 3, 1994	6	Sheets 7-12
Graphic	February 21, 1994	1	Figure 2

Study Contractor: Post, Buckley, Schuh & Jernigan, Inc.

MAPPING INFORMATION

WORK MAP DELINEATION SUMMARY

Hiko Springs Wash, Clark County, Nevada (Unincorporated Areas)

FLOOD INSURANCE STUDY RESTUDY

The 100-year flood hazard boundaries for the Hiko Springs Wash were developed using the Federal Emergency Management Agency's Fan Program and the flood flow frequency data at the apex of the fan. The frequency curve was assumed to be log-normal with the following logarithmic statistics: skew = 0; standard deviation = 0.75; and, mean = 2.25. The flow was assumed to be conveyed from the apex to the Colorado River within a single channel. The avulsion coefficient was assumed to be 1.0. The floodplain boundaries were delineated using aerial photography and topographic maps with a scale of 1:4,800. The contour interval of the topographic maps was 4 feet. Approximately 825 feet of the southwestern boundary of the fan is defined by the existing Crown Pointe flood wall. The Crown Point flood wall is classified as a levee. The Crown Point flood wall is proposed to be extended in association with the Needles Highway Improvement Project. The extended portion of the flood wall also functions as a retaining wall and is not considered a levee. Further down the fan, the floodplain boundary is defined by the Hiko Springs levee proposed to be constructed in association with the Unnamed Wash Channel improvements. A Conditional Letter of Map Revision (CLOMR) was issued by FEMA on May 18, 1992 (Case No. 92-09-037R) for the Unnamed Wash Channel improvements. The technical support data for the Crown Point flood wall, the Needles Highway flood/retaining wall and a copy of the CLOMR are contained in Section 5 of the TSDN.

Study Contractor: Post, Buckley, Schuh & Jernigan, Inc.

MAPPING INFORMATION

WORK MAP DELINEATION SUMMARY

Bridge Canyon Fan, Clark County, Nevada (Unincorporated Areas)

FLOOD INSURANCE STUDY RESTUDY

The flood hazard boundaries for the Bridge Canyon Fan were determined using the Federal Emergency Management Agency's FAN computer program. The flood hazard area (Zone A) downstream of the Bridge Canyon Fan flood hazard boundary were approximated based on historic flooding information, field investigation available topographic data and aerial photographs.

The basis of the flood hazard analysis for the Bridge Canyon Fan between the apex and the 1332 contour is the flood frequency data at the apex of the fan. The frequency curve was assumed to be log-normal with the following logarithmic statistics: skew = 0; standard deviation = 0.85; and, mean = 1.86. Throughout the Bridge Canyon alluvial fan analysis, an avulsion coefficient of one was used and the flow was assumed to be conveyed within a single flow formed channel.

At the 1,332 foot contour, the flood flow can potentially follow the three paths labeled as 1 through 3 on **Figure 2** (included in this section). The flood frequency curves at the entrance to each pathway were defined using the modified alluvial fan method described in the Duck Creek Hydrologic Unit FIS for defining the probability of a given discharge being exceeded between two points (see Section 2 - Engineering Analysis).

Study Contractor: Post, Buckley, Schuh & Jernigan, Inc.

MAPPING INFORMATION

WORK MAP DELINEATION SUMMARY

Bridge Canyon Fan, Clark County, Nevada (Unincorporated Areas)

FLOOD INSURANCE STUDY RESTUDY

Path 1 - The distance between the two points that define Path 1 is 300 feet. The width of the fan at the 1332 foot contour is 2,800 feet. Given these values and the frequency curve at the fan apex, a new flood frequency curve was defined for Path 1 by using the modified alluvial fan methodology to compute values with reoccurrence intervals of 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 200 and 500-years. Using these data, the FAN program was used to develop flood hazard zone boundaries below the entrance of Path 1.

Path 2 - The distance between the two points that define Path 2 is 1,150 feet. The width of the fan at the 1,332 foot contour is 2,800 feet. Using these values, a new flood frequency curve was developed using the procedure described for Path 1. The flood hazard boundaries below the entrance to Path 2 were computed using the FAN program.

Path 3 - The distance between the two points that define Path 3 is 1,350 feet. The width of the fan at the 1,332 contour is 2,800 feet. Using these values, a new flood frequency curve was developed using the procedure described for Path 1. The flood hazard boundaries below the entrance to Path 3 were computed using the FAN program.

Study Contractor: Post, Buckley, Schuh & Jernigan, Inc.

MAPPING INFORMATION

WORK MAP DELINEATION SUMMARY

Bridge Canyon Fan, Clark County, Nevada (Unincorporated Areas)

FLOOD INSURANCE STUDY RESTUDY

Path 4 - The modified alluvial fan method was employed at the 1,236 contour to define the frequency curve at the location where a breakout of flow from Path 2 can occur. The distance between the two points that define Path 4 is 150 feet. The width of Path 2 at the 1,236 contour is 1,000 feet. Using these values and the flood frequency data for Path 2, a new flood frequency curve for Path 4 was developed using the procedure described for Path 1. The flood hazard boundaries below the entrance to Path 4 were defined using the FAN program with one exception. The results of the FAN model indicate that 1 foot depth boundary for Path 4 does not extend to Needles Highway. At the direction of the Clark County Regional Flood Control District, the flood hazard boundary was extended to Needles Highway. The flood frequency curve for Path 2 was assumed to remain unchanged below the Path 4 breakout.

Path 5 and 6 - The flood frequency curve for Path 3 was re-defined at Needles Highway to account for a section of Needles Highway that is proposed to be elevated 1 to 7 feet above the fan surface. Two new frequency curves were defined at the 1,020 foot contour using the frequency data developed previously for Path 3. Flood flows that follow Path 5 are passed under the highway through (6) 10 ft X 5 ft RCB culverts. The design data for these culverts is given in Section 5 - Miscellaneous Reference Materials. Flood flow that follow Path 6 pass over the highway. The flood hazard boundaries downstream of the culverts (Path 5) and the entrance to Path 6 was computed using the FAN program.

Study Contractor: Post, Buckley, Schuh & Jernigan, Inc.

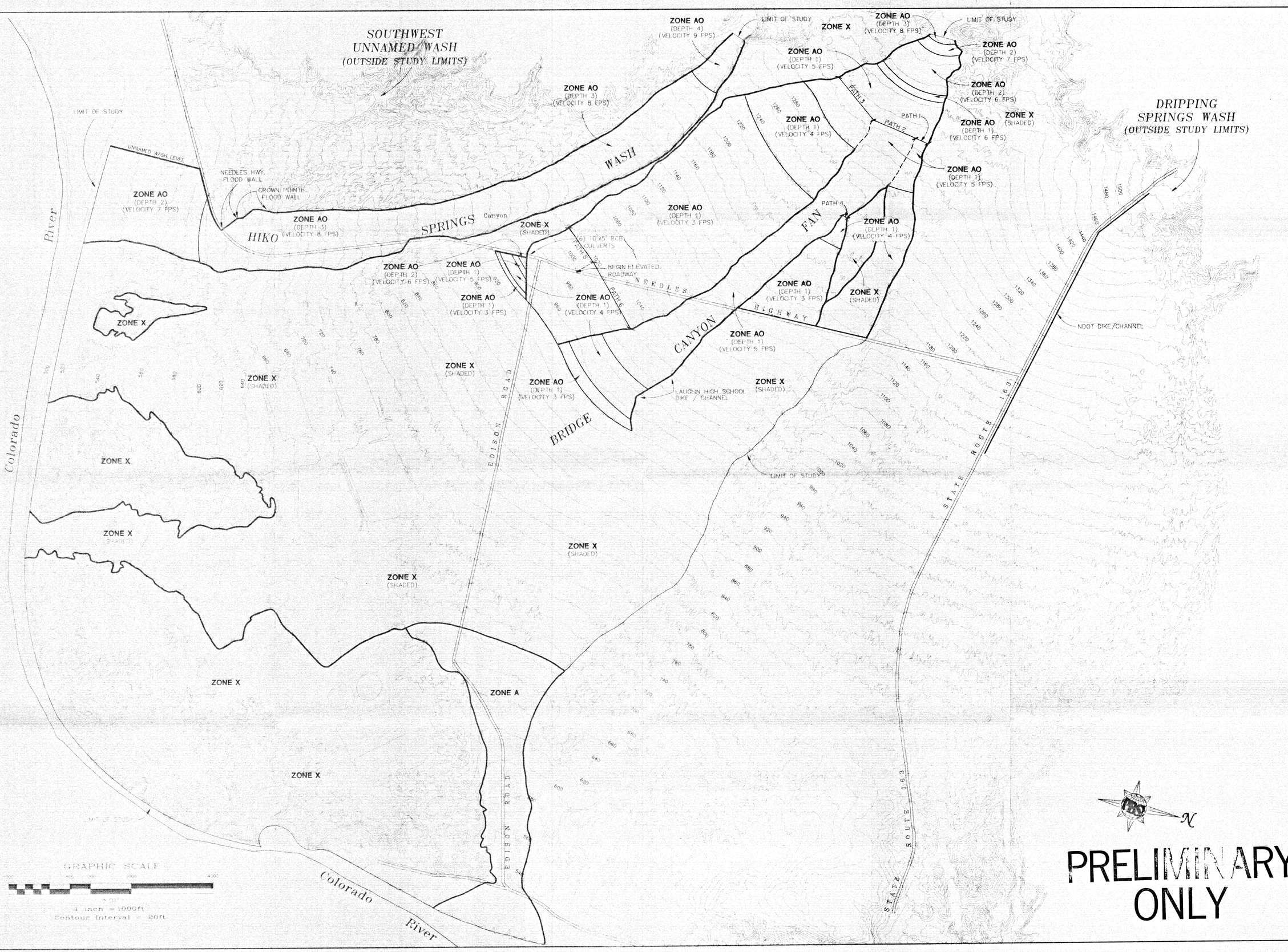
MAPPING INFORMATION

WORK MAP DELINEATION SUMMARY

Bridge Canyon Fan, Clark County, Nevada (Unincorporated Areas)

FLOOD INSURANCE STUDY RESTUDY

Shortly downstream of Needles Highway, the potential for coalescence of flood flow conveyed through Paths 2 and 6 was investigated. The results of the analysis indicate that the influence of each path on the other is negligible.



No.	REVISIONS	Date/Init.	Appr.	Date

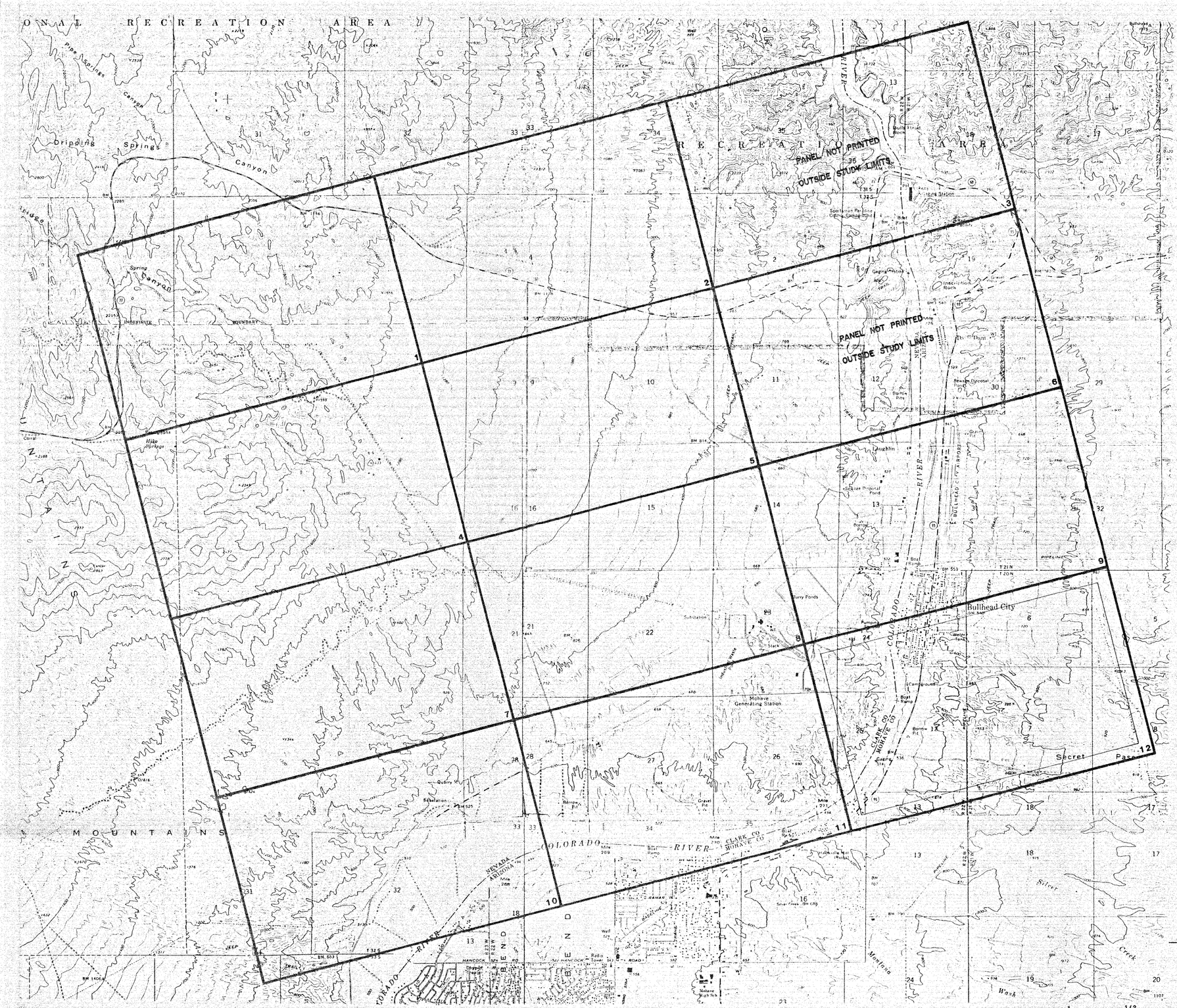
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HIKO SPRINGS AND BRIDGE CANYON WASHES FIS RESTUDY

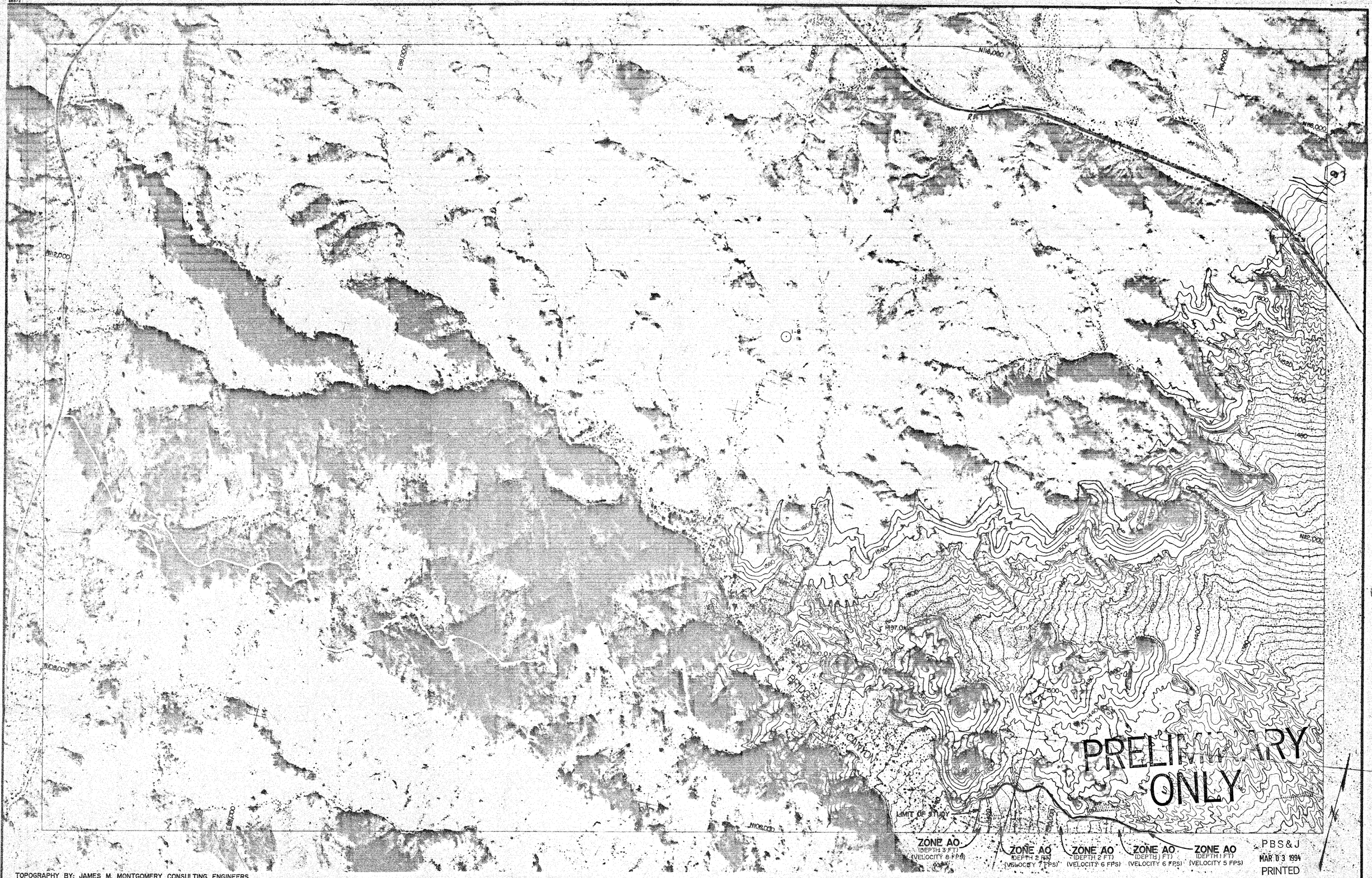
Graphical Representation of Revised Flood Insurance Rate Map For Hiko Springs and Bridge Canyon Washes – Figure 2

Job Number 7190.542	Scale 1" = 1000'
Sheet Number 1 OF 1	File No. 542MAP
	Drawn by T. Overby
	Checked by S. Dudley
	Date Feb. 21, 1994

DRAWING: 542exhibit PLOT DATE: 2-22-94


ONAL RECREATION AREA
Pipe Springs Canyon
Dripping Springs Canyon
Spring Canyon
INDEFINITE BOUNDARY
PANEL NOT PRINTED
OUTSIDE STUDY LIMITS
R E C R E A T I O N A R E A
PANEL NOT PRINTED
OUTSIDE STUDY LIMITS
Bullhead City
Laughlin
Mohave Generating Station
Secret Pass
Davis Dam
Inscription Rock
Boulder Island
Burro Pits
Borrow Pit
Gravel Pit
Quarry
Substation
Sewage Disposal Ponds
Boat Ramp
Campground
Radio Tower
Mohave High Sch.
Silver Creek
Montana Wash
COLORADO RIVER
CLARK CO
MOHAVE CO
NEVADA
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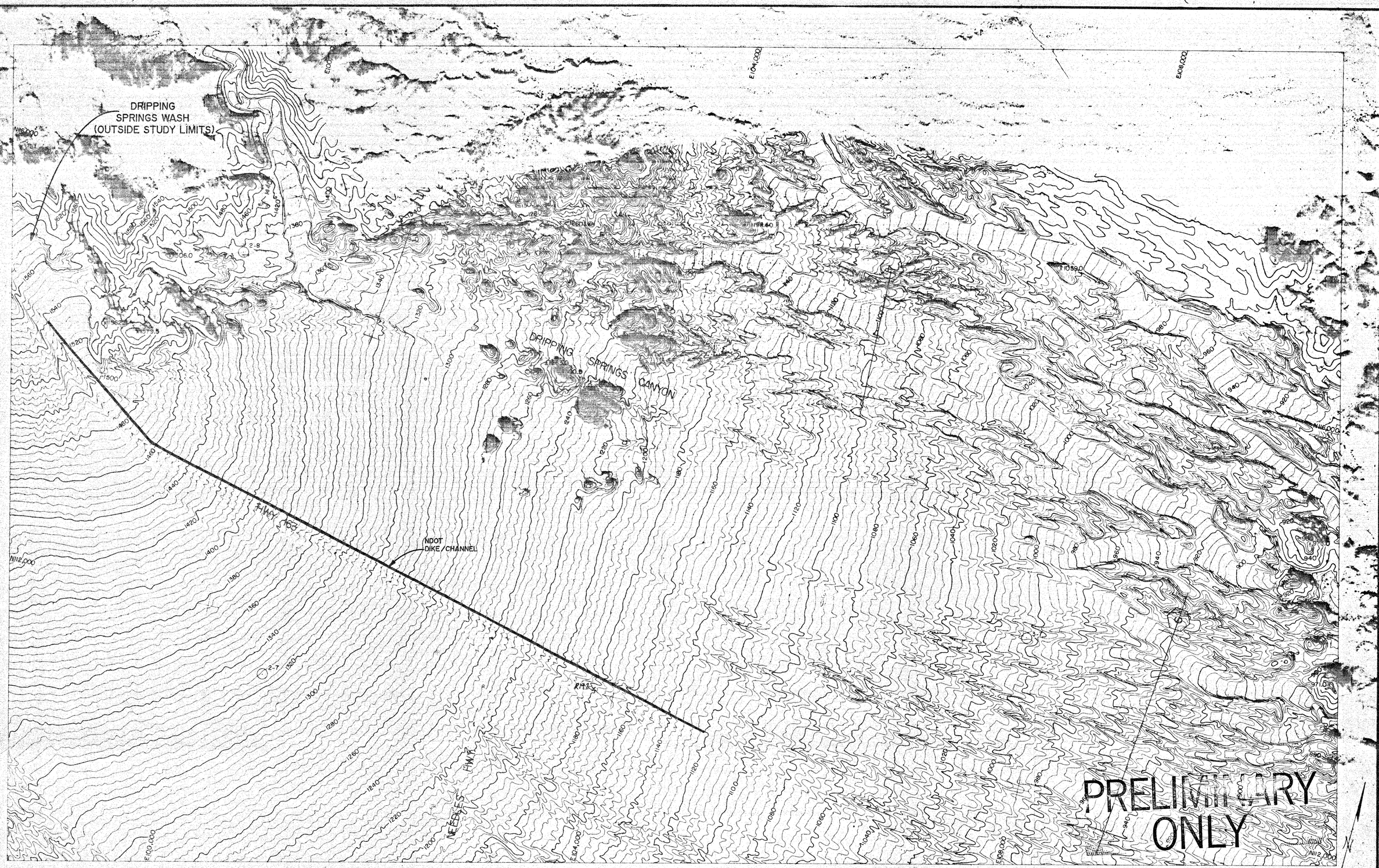
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SHEET 2 OF 12 SHEETS
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ZONE AO
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(VELOCITY 7 FPS)

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(SHADED)

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LIMIT OF STUDY

LIMIT OF STUDY

BRIDGE CANYON

HIKO SPRINGS

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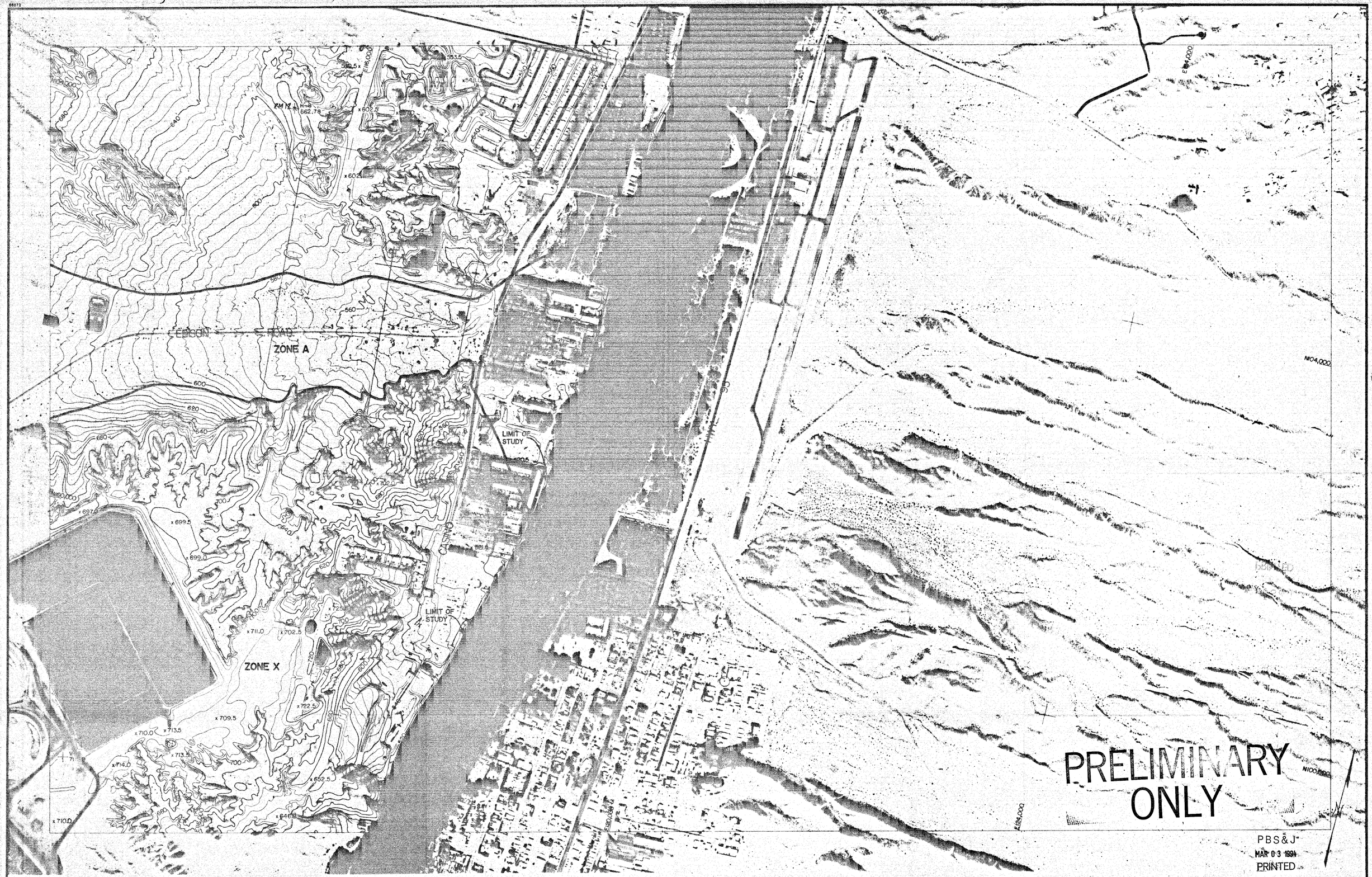
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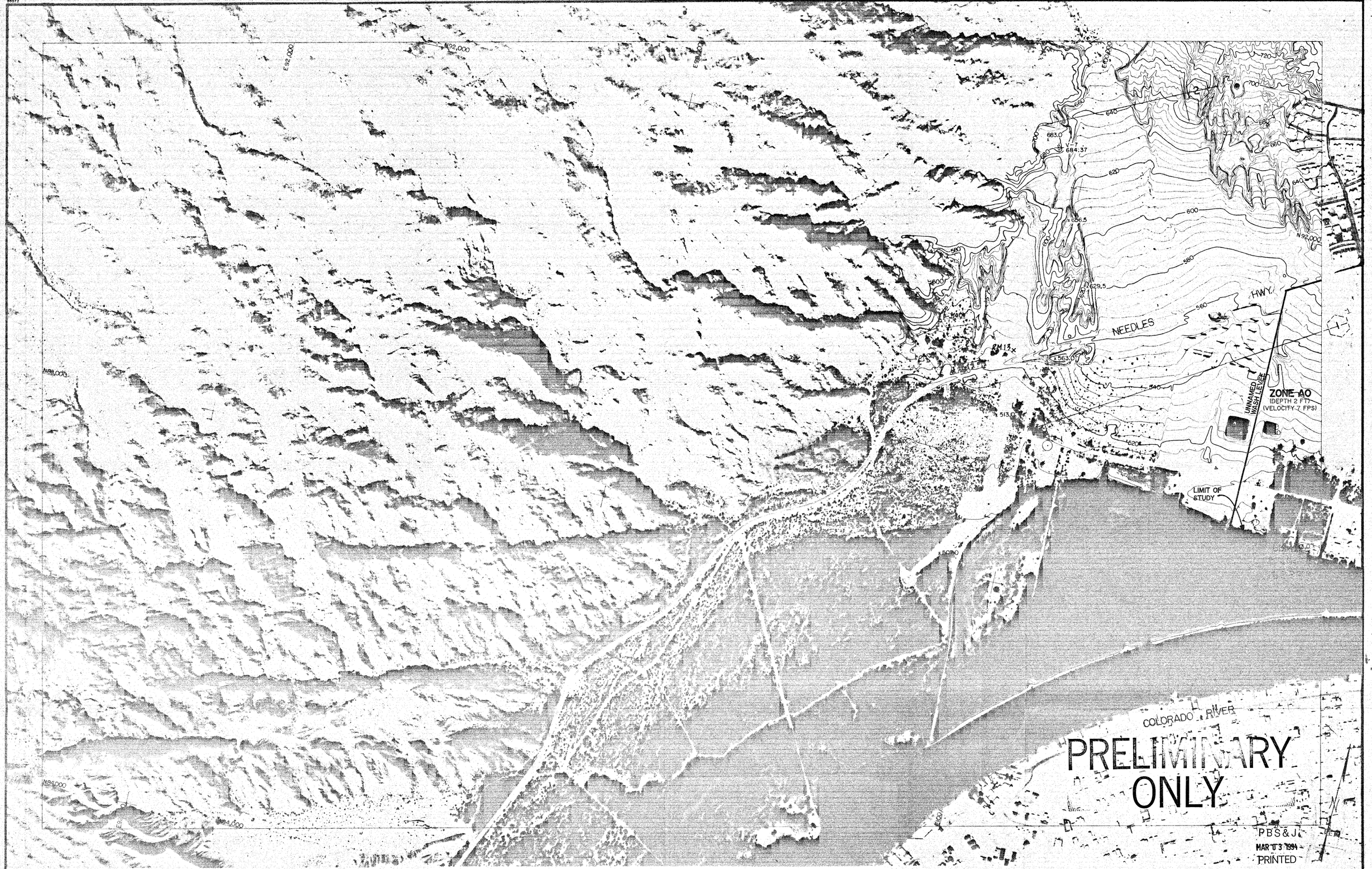
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UNINCORPORATED AREAS OF CLARK COUNTY, NV.

SHEET 10 OF 12 SHEETS
DATE:

JOB NO. 860.0041

86572

CROWN POINTE FLOOD WALL

RM11

ZONE AO
(DEPTH 3 FT)
(VELOCITY 8 FPS)

HWY.

NEEDLES HWY. FLOOD WALL

ZONE AO
(DEPTH 2 FT)
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ZONE X
(SHADED)

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W/L 582.0

LIMIT OF STUDY

COLORADO RIVER

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HIKO SPRINGS AND BRIDGE CANYON WASHES FLOOD INSURANCE STUDY RESTUDY
LAUGHLIN
UNINCORPORATED AREAS OF CLARK COUNTY, NV.

SHEET 11 OF 12 SHEETS
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66572

ZONE X

LIMIT OF STUDY

COLORADO RIVER

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N92,000

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UNINCORPORATED AREAS OF CLARK COUNTY, NV.

SHEET 12 OF 12 SHEETS
DATE:

JOB NO. 960.0041

DRAFT TECH SUPPORT DATA VOLUME II

Technical Support Data Notebook

For

FLOOD INSURANCE STUDY

RESTUDY

HIKO SPRINGS & BRIDGE CANYON WASHES

RECEIVED
MAR 4 1994
REGIONAL
FLOOD CONTROL DISTRICT

Clark County, Nevada
(Unincorporated Areas)

VOLUME II OF III

Submitted by:	Clark County Regional Flood Control District
Study Contractor:	Post, Buckley, Schuh & Jernigan, Inc.
Date Submitted:	March 4, 1994

SECTION 5

MISCELLANEOUS REFERENCE MATERIALS

VOLUME II

5.1 CLOMR Unnamed Wash Improvements

5.2 Technical Support Data for Laughlin High School Dike

5.3 Technical Support Data for Crown Pointe Flood Wall

VOLUME III

5.4 Technical Support Data for Needles Highway Improvements

5.5 Technical Support Data for SR-163 Dike/Channel Improvements

SECTION 5.1

CLOMR Unnamed Wash Improvements

Washington, D.C. 20472

MAY 18 1992

RECEIVED
MAY 22 1992
DESIGN & CONST.
MGMT. DIVISION

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

The Honorable Jay Bingham
Chairman, Clark County
Board of Commissioners
225 Bridger Avenue, Sixth Floor
Las Vegas, Nevada 89155

Case No. 92-09-037R
Re: Unnamed Wash near Laughlin
Community: Clark County, Nevada (unincorporated areas)

Dear Mr. Bingham:

This is in response to a letter dated March 27, 1992, from Mr. Yen Hsu Chen, P.E., Simons, Li & Associates, Inc. (SLA), regarding the request for a Conditional Letter of Map Revision (CLOMR) to the effective Flood Insurance Rate Map (FIRM) for the unincorporated areas of Clark County, Nevada. Mr. Chen's March 27 letter was in response to our October 23, 1991, letter to Mr. M. J. Manning, Director, Clark County Department of Public Works. These data were requested to support Mr. Manning's initial request for a CLOMR, dated May 21, 1991.

The proposed project will collect the flows near the apex of the Unnamed Wash alluvial fan, channelize through the following system of flood control mitigation structures, and divert them to the Colorado River. The project will consist of a 145-foot-long soil-cement entrance transition structure located at the apex of the alluvial fan; a 65-foot-wide channel with soil-cement banks protection and grade stabilization structures; a soil-cement confluence structure to merge tributary flows; a 100-foot-wide channel with soil-cement banks protection and grade stabilization structures; a reinforced concrete baffle-chute drop structure located approximately 1,500 feet north of Needles Highway; a sediment basin north of Needles Highway; a 5-cell box culvert (10 feet by 15 feet) under Needles Highway; and an 80-to-100-foot-wide earthen channel with soil cement bank protection from Needles Highway to the Colorado River. In addition, two levees will be constructed. The Tributary K levee, located to the west of the channel and approximately 1,500 feet south of Needles Highway, will divert Tributary K flows into the channel for Unnamed Wash and protect a proposed state park from Tributary K flows. The Hiko Springs levee, located to the east of the channel and approximately 500 feet south of Casino Drive to Needles Highway, will prevent the Hiko Springs flow from flooding areas of the Unnamed Wash floodplain protected by the proposed channel improvements.

All data required to evaluate this request were received from Mr. Chen with his letters dated between July 31, 1991, and March 27, 1992; from Mr. Manning with his letters dated between May 21, 1991, June 25, 1991, and September 3, 1991; and from Mr. William C. Brandt, P.E., Clark County Department of Public Works, with his letter dated July 1, 1991. Mr. Manning's June 25, 1991, letter certified that the project is for public

Federal law is primarily intended for flood loss reduction to existing development in identified flood hazard areas. Therefore, in accordance with Section 72.5 of the National Flood Insurance Program (NFIP) regulations, the fees associated with our review of this request for a CLOMR have been waived.

We have completed our review of the data submitted and the data used to produce the effective Flood Insurance Study report and FIRM for the unincorporated areas of Clark County, Nevada. We believe that if the project is constructed as shown on Sheets 2 through 30 of 30 of the plans entitled "1991 Construction Plans for the Improvement of Unnamed Wash Channel, Laughlin, Nevada," prepared for the Department of Public Works, Clark County, Nevada, the revised 100- and 500-year flood boundaries will be as shown on Plate 1, entitled "Proposed Unnamed Wash Flood Boundaries, FEMA 100- and 500-year Flood Conditions," prepared by SLA, and dated May 1, 1991. In addition, the area between the proposed Hiko Springs levee and the effective Western floodplain boundary for Hiko Springs, which is protected by the Hiko Springs levee would be designated as a Zone X flood zone.

Upon completion of the project and receipt of the data listed below, we will make a final determination on revising the FIS report and FIRM.

1. "As-built" plans of the project, certified by a registered professional engineer.

2. An annotated copy of the effective FIRM, certified by a registered professional engineer, which shows the revised 100- and 500-year floodplain boundaries.

3. An officially adopted maintenance and operation plan for the project. This plan, which may be in the form of a written statement from the community Chief Executive Officer and ordinances or other legislation, must describe the nature of the maintenance activities, the frequency with which they will be performed, and the title of the local community official who will be responsible for ensuring that the maintenance activities are accomplished.

This CLOMR is based on the proposed construction of levees, as well as on a channel modification project. The NFIP regulations, as cited in Paragraph 60.3(b)(7), require that communities ensure the flood-carrying capacity of an altered or relocated watercourse. This provision is incorporated into your community's floodplain management regulations. Consequently, upon completion of the proposed project, the ultimate responsibility for maintenance will rest with your community.

Please note that the Federal Emergency Management Agency (FEMA) is currently developing detailed application and certification forms for use in requesting revisions or amendments to NFIP maps. These forms will be available this summer and will be mandatory for all requests received by FEMA on or after October 1, 1992. These forms will highlight technical considerations in a fashion that facilitates an efficient review; therefore, use of these forms prior to October 1, while voluntary, is strongly recommended. Application forms should be available after July 1 for Letter of Map Amendment and Letter of Map Revision Based on Fill requests, and after August 1 for all other revision requests.

Should you have any questions regarding this matter, please contact the Chief, Natural and Technological Hazards Division, Federal Emergency Management Agency in San Francisco, California, at (415) 923-7177, or Mr. Karl F. Mohr of my staff in Washington, D.C., at (202) 646-2770.

Sincerely,

William R. Locke
Chief, Risk Studies Division
Federal Insurance Administration

cc: Mr. M. J. Manning
Director, Clark County
Department of Public Works

Mr. Gale Wm. Fraser II, P.E.
Clark County Regional Flood
Control District

Mr. William C. Brandt, P.E.
Project Coordinator,
Clark County Department
of Public Works

Mr. Yen Hsu Chen, P.E.
Project Manager
Simons, Li & Associates, Inc.

SECTION 5.2

Technical Support Data for Laughlin High School Dike

15-32-66

R

DRAINAGE

DRAINAGE STUDY NUMBER:

00 2646

NAME:

LAUGHLIN HIGH SCHOOL

SECTION / TOWNSHIP/ RANGE:

SEC 15 T32S R66E

CROSS STREETS:

APPR: 1/2 MILE E/O DAVIS DAM NEEDLES HWY

ASSESSOR'S PARCEL NUMBER:

630-530-

NEW ASSESSOR'S PARCEL NUMBERS:

ACREAGE:

± 320 AC

SUBMITTAL DATE:

1-12-90

ATA/ORK/DRAINAGE

LAUGHLIN HIGH SCHOOL 15-32-66

54

Clark County

Department of Public Works

M. A. MANNHEIMER
DIRECTOR

401 SOUTH FOURTH STREET
LAS VEGAS, NEVADA 89101
(702) 455-4181

DATE: February 22, 1990

TO: SEA Incorporated
Consulting Engineers
1109 Grier Drive
Las Vegas, Nevada 89119

SUBJECT: DRAINAGE STUDY - LAUGHLIN HIGH SCHOOL
ACTION 9C442-89/VC767-89; APN 630-530-001;
located on the S½(2), NW¼(4) of Section
15-32-66, approximately 1/2 mile east of
Davis Dam - Needles Highway turnoff road.

Referenced drainage study has been reviewed and is accepted as complying with minimum improvement standards, except for conditions herein set forth. No liability is assumed by the County for information, data and conclusions of the consulting engineer.

Compliance with minimum improvement standards requires the following:

1. The lowest (including basement) elevated above the highest adjacent grade of the building site, at least 12 inches or above the depth number specified on the FIRM (at least 2 feet if no depth number is specified).

2. Together with attendant utility and sanitary facilities, be completely floodproofed to or above the 100 year flood level so that any space below that level is watertight with walls substantially impermeable to the passage of water. The structure shall have the ability to resist flotation and hydrodynamic and hydrostatic loads.

3. For [illegible] be designed adequately to anchor the structure to prevent flotation, collapse or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads. Storage of other non-hazardous material that at a time of flooding are buoyant, flammable, explosive or could be injurious to human, animal or plant life is prohibited.

cc: Chairperson
Board of County Commissioners

LAUGHLIN HIGH SCHOOL DRAINAGE STUDY
SEA CONSULTING ENGINEERS

02-22-90
PAGE 2

4. Substantiate how the curve numbers where determined.

[redacted]

6. Storage of other non-hazardous material or equipment may be allowed if not subject to major damage by floods and are firmly anchored to prevent floatation or if readily removable from area within the time available after flood warning.

7. Analyze the effects of sediment transportation to assure appropriate design and location of the proposed bank and site protection from channel migration that may occur at the upper reach closest to the apex.

8. The 100-year Bridge Canyon apex discharge of 5300 cfs as determined with the Coe and Van Loo, consultants by the Regional Flood Control District, has not been officially adopted. Therefore no permits will be issued until the District accepts the 5300 cfs and concurs with the referenced drainage study.

Please be aware that if additional information becomes available and/or revisions of flood insurance studies are performed, the information presented by SEA Consulting Engineers may be superseded.

M. A. MANNHEIMER
Director of Public Works

By: William Arnold
William Arnold, P.E.
Civil Engineer
Development Management

WA:ja

cc: Public Works - Community Development Manager
Building Permits, Development Management Section, P

CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

[illegible]
Las Vegas, Nevada 89101
(702) 455-3330

[illegible], P.E.
General Manager

January 25, 1990

STORMWATER MGMT.
JAN 26 1990
RECEIVED

Mr. Kenneth W. Ackeret, P.E.
Project Manager
SEA Inc., Consulting Engineers
1109 Grier Drive
Las Vegas, NV 89119

Re: Laughlin High School

Dear Mr. Ackeret:

I have reviewed your hydrology study for Laughlin High School, dated January 9, 1990. The District's review is limited to the Bridge Canyon Wash and does not address local drainage issues which are the responsibility of Clark County Public Works.

The 100-year Bridge Canyon apex discharge of 5300 cfs appears to be reasonable based on information received from Coe and Van Loo under District contract. The District has not officially adopted this study, and you are cautioned to verify the results.

Your analysis appears to represent the Bridge Canyon Wash using a fixed-bed model, overlooking the possibility of sediment transport. Since this site appears to lie on an alluvial fan, the effects of sediment transport should be evaluated in order to assure site protection. Even though there appears to be a well-defined channel adjacent to the site, the possibility of channel migration appears to exist near the apex of the alluvial fan. Therefore, the potential effects of channel migration should also be analyzed. It should be verified that the site is protected from any stormwater and sediment which might impact it.

Calculations should be provided to verify that any proposed berms are properly armored and are adequately designed to accommodate any aggradation and/or degradation which may occur.

Board Members

Bruce L. Woodbury, Chairman (Clark County) • Carlton Lawrence, Vice-Chairman, City of Henderson
Thomas Goumas, City of North Las Vegas • Craig Pellegrini, City of Mesquite • Stan Nelson, City of Las Vegas
Myrna Williams, Clark County • Gene Ververka, City of Las Vegas • Eric Lundgaard, City of Boulder City

Kenneth W. Ackeret -
January 25, 1990
Page 2

These comments are intended to alert you to the major concerns of the District staff. This review is not to be construed as being all-inclusive. Additional comments may follow receipt and review of the requested information. Please be aware that as additional information becomes available and/or restudies of Flood Insurance Studies are performed, the information presented by SEA Inc., Consulting Engineers may be superseded. No liability is assumed by the District, its officials or employees for information, data, and conclusions of the consulting engineer. We therefore make no warranties, either expressed or implied, in conducting this review.

VIRGINIA DAX-VALENTINE, P.E.
General Manager/Chief Engineer

BY: [signature]
Derek de Bruin, P.E.
Civil Engineer II

JGA:fam

cc: William C. Branch, P.E., Clark County Public Works

CA1-25:DISK10

J2-66-15, Bridge Canyon

SEA Consulting Engineers

January 9, 1990
Project No. 2 479 022

KITTRELL GARLOCK ASSOCIATES, AIA
4130 S. Decatur Boulevard, Suite 14A
Las Vegas, Nevada 89103

Attn: M. Ed Kittrell

Re: Hydrology Study - Laughlin High School

Dear Sir

Submitted herewith is the hydrology study for the proposed Laughlin High School to be located approximately 2,700 feet west of Arizona Highway and 2,500 feet north of Desert Trails in Laughlin, Nevada (see vicinity map, Figure 1). The study was prepared for an approximately 80 acre site in accordance with Clark County requirements.

The rainfall quantities calculated with respect to the 10-year, 25-year, and 100-year storm events indicate that the 100-year flow that currently sheet flows across the project site can be routed adequately through and around the proposed school site.

If you have any questions, or if we can be of further assistance, please do not hesitate to call.

Sincerely,

SEA, INCORPORATED
Consulting Engineers

Ali R. Toghanipour
Project Engineer

Kenneth W. Ackeret, P.E.
Project Manager

ARTghar:jk

Las Vegas
Reno/Sparks
Phoenix

HYDROLOGY STUDY

LAUGHLIN HIGH SCHOOL

CLARK COUNTY, NEVADA

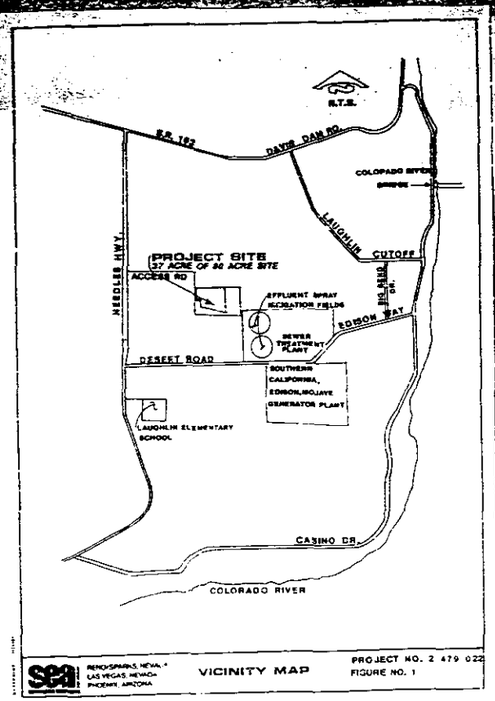
A Portion of the Northeast Quarter (NE 1/4) of Section 15, Township 32 South, Range 66 East, M.D.M.

January 1990

Prepared for: KITTRELL GARLOCK ASSOCIATES, AIA.

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V. APPENDIX	
1. HEC-1 HYDROLOGIC CRITERIA	
2. STREET DRAINAGE CALCULATION	
3. HYDRAULIC CALCULATIONS	
4. HEC-1 INPUT AND OUTPUT	



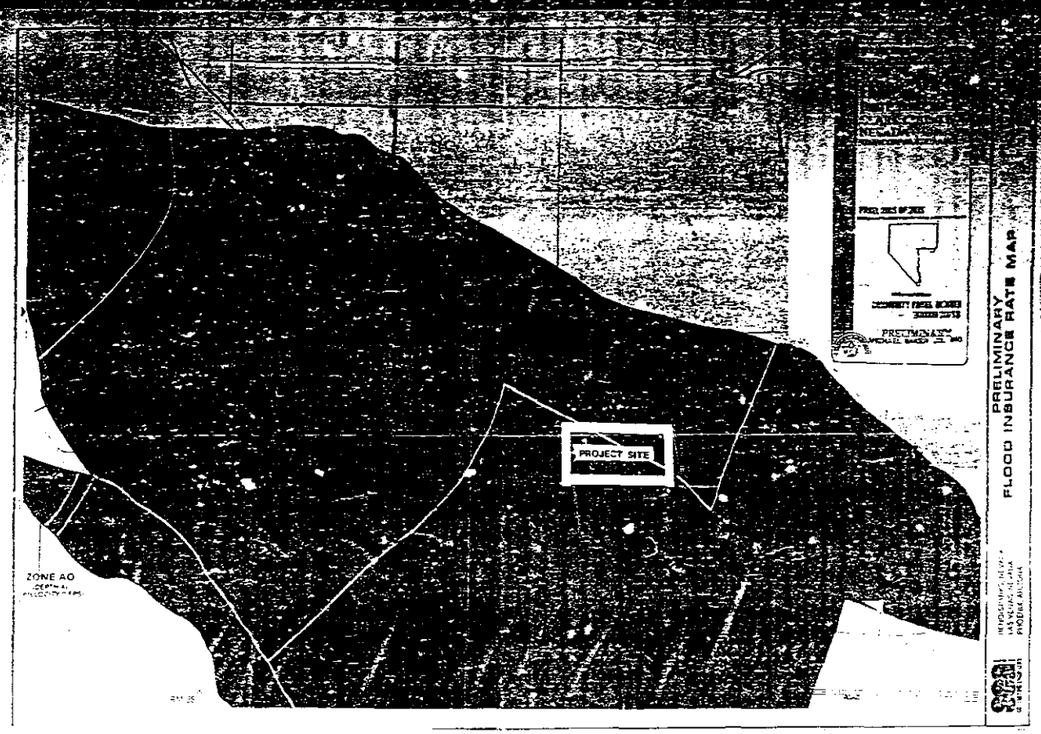
VICINITY MAP

PROJECT NO. 2 479 022
FIGURE NO. 1

II EXISTING DRAINAGE PATTERNS

The project site lies in an undeveloped [illegible] be within a special flood hazard area (AE Zone), with flow depth of [illegible] foot and a velocity of 6 feet per second as shown on preliminary Community Panel No. 320003 2005B (see Figure 2).

The topography of the site slopes from the northwest to the southeast at an average slope of approximately 4 percent. The proposed school is located on the alluvial fan deposits of Bridge Canyon located along the west side of the Colorado River. Under contract with the Clark County Regional Flood Control District, the firm of Coe and Van Loo Engineering has determined the 100-year apex flow for the alluvial fan impacting the subject project at 5,300 cfs. The storm water on the alluvial fan that currently sheet flows through the project site travels down the fan into the Colorado River located east of the subject project. An existing 500 to 600 foot wide channel has been established within the alluvial fan approximately 900 feet west of the project. The 100-year flow depth in this channel upstream of the project is estimated at 1.4 feet with the velocity of approximately 6.3 feet per second for the established apex flow of 5,300 cfs. See Figure 3, Sections 1, 2, 3 & 4 and Appendix for calculations.



III PROPOSED DRAINAGE SYSTEM

A. CRITERIA

1. HEC-1 (Surface Runoff)

The methodology developed by the U.S. Army Corps of Engineers at the Hydrologic Engineering Center (HEC) is HEC-1 Flood Hydrograph Package was selected to compute the peak storm water flows. This method of analysis was used to determine the on-site and off-site storm water runoff.

A complete discussion of the applied HEC-1 method may be found by reviewing the HEC-1 Flood Hydrograph Package Users Manual as published by the U.S. Army Corps of Engineers Water Resources Support Center, dated September 1981 (revised January 1985). The following is a general outline of the data used in the procedures:

1. Physical Characteristics of the Drainage Region
   a. Drainage Area
   b. Overland Slope
   c. Soil Types and Land Use
2. Drainage Characteristics
   a. Lag Time (Tl) - the lag time from the centroid of rainfall to peak discharge (hr).
   b. SCS (Soil Conservation Service) Hydrology Curve Number (CN) - a number that reflects the percentage of storm rainfall that is converted to runoff, as the curve number increases, runoff increases.
3. Rainfall Quantities
   a. Rainfall Depth - the total depth of rainfall estimated to fall during a storm.

The curve number of a drainage area can vary with the existing soil wetness, or the Antecedent Moisture Condition (AMC). If the soil is already moist or saturated from previous rainfall, the capacity for infiltration and water retention is reduced. The SCS groups all AMC's into three (3) main categories. Antecedent Moisture Condition 2 (AMC 2) represents the normal condition, or the average moisture situation, in which some moisture in the soil is assumed. AMC 1 reflects the driest condition (i.e. the best condition for infiltration), and AMC 3 symbolizes the situation in which the basin soils are extremely wet. Since some prior soil moisture is often observed during major storm events in the study region, the curve numbers selected for design purposes are based on AMC 2. Soil types used to estimate the curve number (CN) were based on information supplied in the U.S. Soil Conservation Service, Soil Survey.

The 10, 25, and 100 year 3-hour storms were analyzed for on site and off-site storm water runoff. Precipitation depths were obtained from National Oceanic and Atmospheric Administration (NOAA), Atlas 2, Precipitation - Frequency Atlas of the Western United States, Volume VII, Nevada, and were found to be the following as adjusted to reflect recent increases in precipitation depths as presented in the Clark County Regional Flood Control District Flood Control Master Plan:

	NOAA ATLAS PRECIPITATION DEPTHS	%DJUSTED PRECIPITATION DEPTHS
	(Master Plan)	
10 year	0.0 inches	1.82 inches
25 year	0.4 inches	2.23 inches
100 year	0.7 inches	2.93 inches

B. RUNOFF

The determined on-site and off-site storm discharge is given in the following Table 1 (see Figures 3, 4 & Appendix for calculations):

TABLE 1

Drainage Area	Area Acres	CN	Peak Flow (cfs) 10 yr.	25 yr.	100 yr.
Off-Site Existing					
Area A	11.41	98	6	7	9
Area B	13.53	98	8	9	12
Area C	60.95	98	35	42	53
Area D	33.17	98	0	1	7
(Apex flow from Coe & Van Loo Study for Bridge Canyon) 5300					
On-Site Existing					
Area 2	35.7	98	0	1	
Off-Site Future					
Area A1	11.91	98	11	17	23
Area B1	43.94	98	26	42	57
Area C1	60.95	98	39	56	77
Area D1	33.17	98	22	32	47
Combined C1 & D1	94.12	98	62	91	140
On-Site Future					
Area I	2.2	98	5	6	9
Area J	2.4	98	6	7	10
Area K	4.63	98	0	0	2
Area L	5.28	98	3	5	8
Area M	5.33	98	12	15	23
Area N	5.21	98	11	14	22
Area O	3.79	98	7	9	15
Area P	2.1	98	4	5	8
Area Q	2.1	98	4	5	8

Table 1 shows the 10, 25 and 100-year discharge for each drainage area. Based upon the work conducted by the Clark County Regional Flood Control District's consultant, Coe & Van Loo Engineering, the 100-year estimated peak discharge for the 100-year flood at the apex of the Bridge Canyon fan has been established at 5,300 cfs. This flow is the naturally sheet flows flow that [illegible] Highway by an established channel approximately 600 feet wide by 7 feet deep located about 1/2 mile west of Needles Highway (see Figure 3). In order to convey this flow along the south side of the project site, a 400 lineal feet of 10 foot wide berm with a height of at 3.5 feet is recommended. The berm is recommended to be [illegible] with 2:1 to 3 rise slopes from the southwest corner of the project site to the western edge of the development (see Figures 3 & 4 for details). Due to the anticipated high velocity of 7 feet per second, a minimum of 12 inch D50 riprap is recommended to be placed along the south side of the proposed embankment (see Figure 4, Sections B & B'). The school building finished floor elevation should be set a minimum of 3 feet above the flow line of the existing drainage swale along the south side of the school site.

A school access road is proposed to be constructed from the northwest corner of the school site to Needles Highway (see Figure 3). The offsite future storm flow from Area C is expected to flow eastward on into the undeveloped flow paths of the [illegible] and will required 80 foot wide by 2 foot deep V type swale [illegible] to direct flows [illegible] the south side of the [illegible] (see Figure 3).

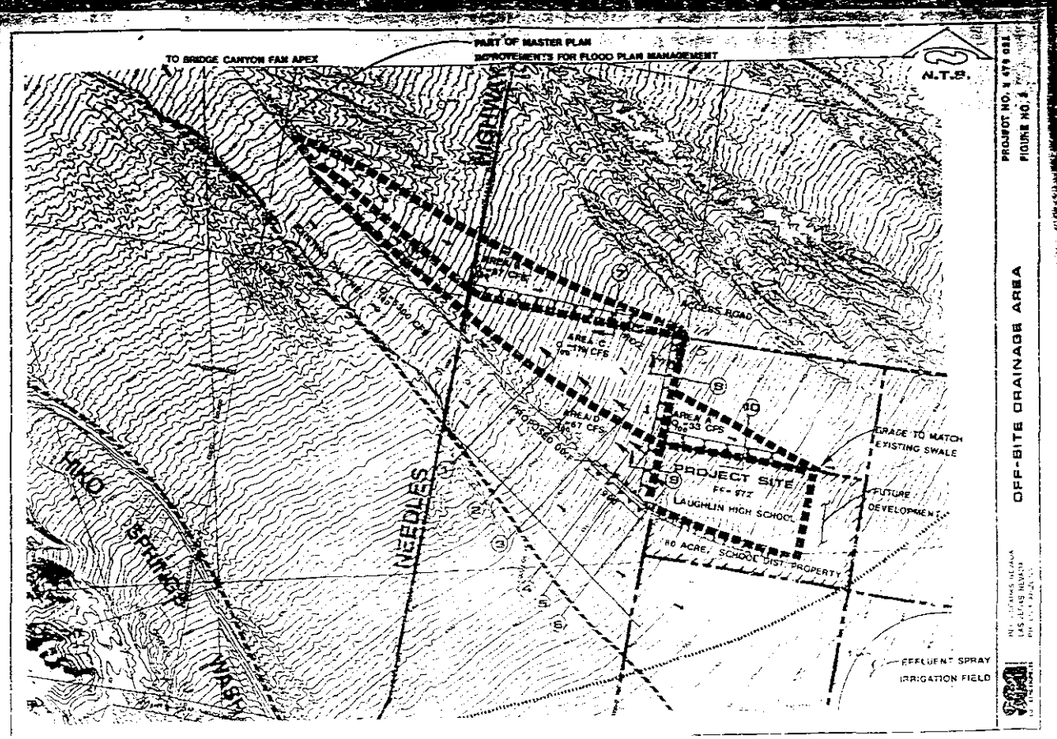
The storm flow from Areas C1 & D1 is expected to be collected along the west side of the access road and be transported southward via a proposed 20 foot wide by 2.5 foot deep and 24 foot wide by 3.0 foot deep V type channel (see Figures 3 & 4 and Appendix for calculations).

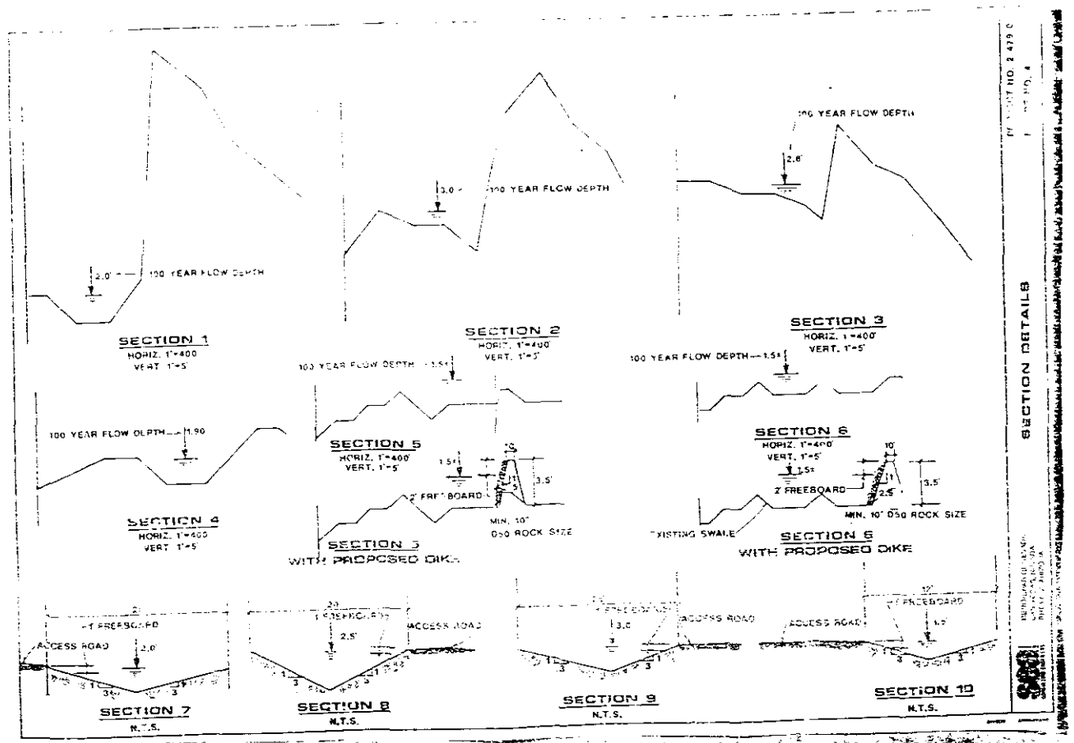
The storm flow from Area A located on the north side of the project site is expected to be intercepted by means of the proposed 12 foot wide by 1.5 foot deep swale to be constructed along the north side of the subject project (see Figures 3 & 4).

On-site area storm water flow from Areas O, M, Q & I (see Figure 5) will be directed into the proposed public street to be built along the north side of the school and flow eastward.

While the storm water flow from Areas N, K, P, L & J is expected to sheet flow southward and be conveyed eastward via the pre-existing swales of the alluvial fan.

To accommodate the proposed grading of the football and track field, Areas Q & P of Figure 5, an 18 inch storm drain pipe with appropriate inlet structures is recommended to be installed at the north and southeast corners of the football field to intercept the storm flow and transport it beneath the field into Areas I & L, respectively.





C. STREET DRAINAGE

An 80 foot right-of-way public street is proposed along the west side of the project site while a 60 foot right-of-way public road is proposed along the north property line. The 100-year flow of 91 cfs generated from Areas O, M, Q & I is to be intercepted by the street north of the school site. This flow is expected to have a depth of 0.55 feet from the proposed gutter flow line (see Appendix for calculations).

The storm flow from the western boundary street is to be conveyed southward into the pre-existing swales of the alluvial fan.

IX. CONCLUSIONS

[illegible] to provide adequate [illegible] the proposed [illegible] will have the benefit of [illegible] the existing [illegible] currently undeveloped site will not [illegible] storm water depths.

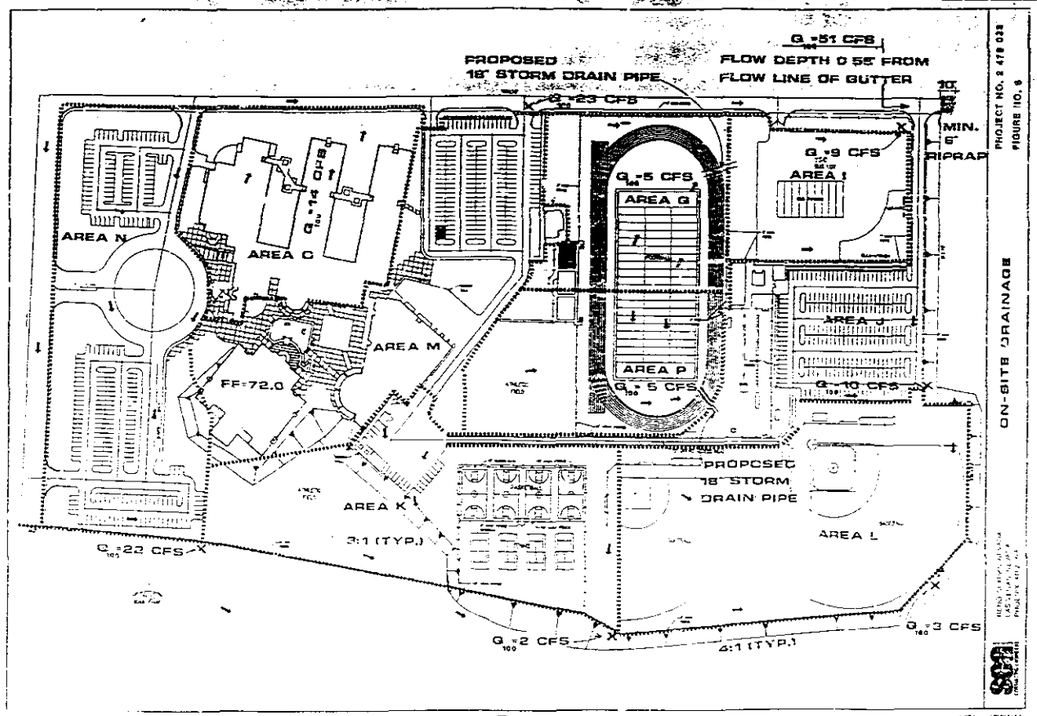
[illegible] on-site areas of [illegible] the proposed [illegible] right-of-way [illegible] the following two [illegible] will be provided:

[illegible] the grading [illegible] the [illegible] [illegible] type swale [illegible]

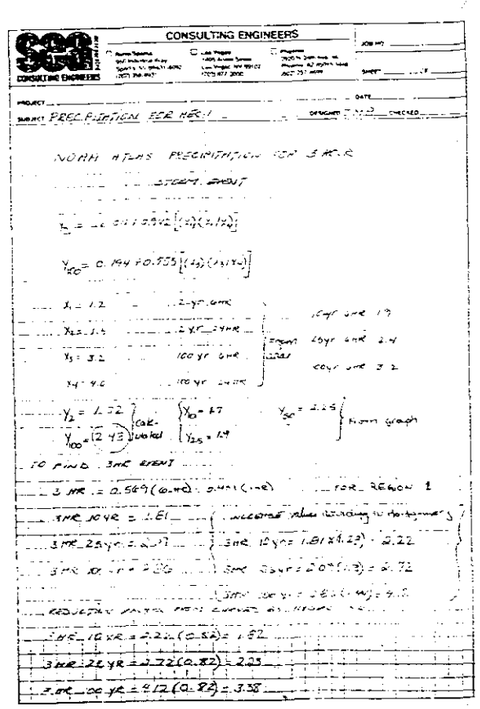
Eighteen inch storm drain [illegible] recommended to be installed at the northeast and [illegible] of the football field (Areas Q & P, [illegible]

[illegible] drainage swales [illegible] [illegible] [illegible]

5. A 10 foot wide by 3.5 foot high dike is proposed along with a minimum 10 inch D50 riprap on the channel side of the embankment. The dike is recommended to be constructed from the southwest corner of the project site to the west side of the school for a total length of approximately 900 feet (see Figures 3 & 4 and Appendix for calculations.



APPENDIX



NOAH ATLAS PRECIPITATION FOR 3 HR. STORM EVENT

$I_2 = 28.5 \left[\frac{0.54}{(0.5)+25}\right]^{0.645}$

$Y_{100} = 0.194 + 0.555 \left[\frac{(1.2)}{(2.11)}\right]$

$X_1 = 1.2$ — 2-yr 6HR — 10yr 6HR 1.9
$X_{2.5} = 1.5$ — 2.5YR — 25YR — Equal Log Interval — 50yr 6HR 2.4
$X_3 = 3.2$ — 100 yr 6HR — 100yr 6HR 3.2
$X_4 = 4.0$ — 100 yr 24HR

$Y_2 = 1.32$ Calculated $Y_{10} = 2.17$ $Y_{50} = 2.25$ From graph
$Y_{100} = 12.43$ Calculated $Y_{2.5} = 1.9$

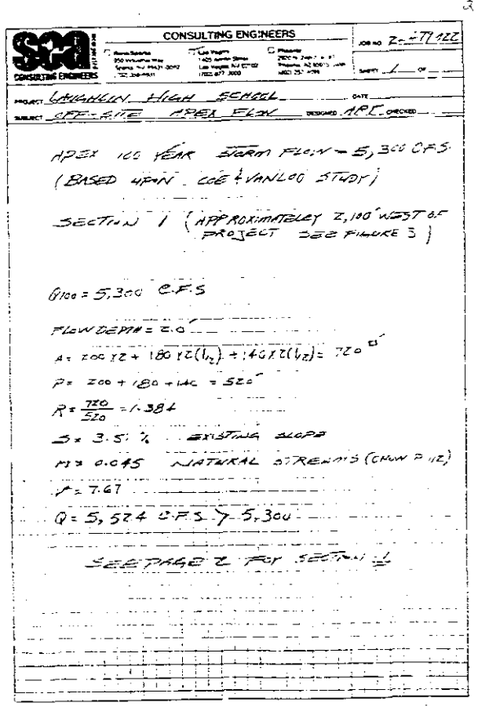
TO FIND 3HR EVENT

3 HR = 0.569 (6 HR) 0.441 (24HR) — FOR REGION 1

3HR 10 YR = 1.61 (Allowable values according to Montgomery)
3HR 25 YR = 2.07 — 3HR 10 YR = 1.81 (1.22) = 2.22
3HR 50 YR = 2.36 — 3HR 25 YR = 2.07 (1.3) = 2.72
3HR 100 YR = 2.61 (1.11) = 2.9

REDUCTION FACTOR FROM CHANGE OF INTENSITY

3HR 10 YR = 2.22 (0.58) = 1.82
3HR 25 YR = 2.72 (0.82) = 2.23
3 HR 100 YR = 3.12 (0.82) = 3.38



CONSULTING ENGINEERS
JOB NO 2-471122
PROJECT LAUGHLIN HIGH SCHOOL
SUBJECT OFF-SITE APEX FLOW DESIGNED ARL CHECKED

APEX 100 YEAR STORM FLOW = 5,300 CFS
(BASED UPON CDE & VANLOO STUDY)

SECTION 1 (APPROXIMATELY 2,100' WEST OF PROJECT SEE FIGURE 3)

$Q_{100} = 5,300$ C.F.S

FLOW DEPTH = 2.0'

$A = 200(2) + 180(2)(\frac{1}{2}) + 140(2)(\frac{1}{2}) = 720$ SF

$P = 200 + 180 + 140 = 520'$

$R = \frac{720}{520} = 1.384$

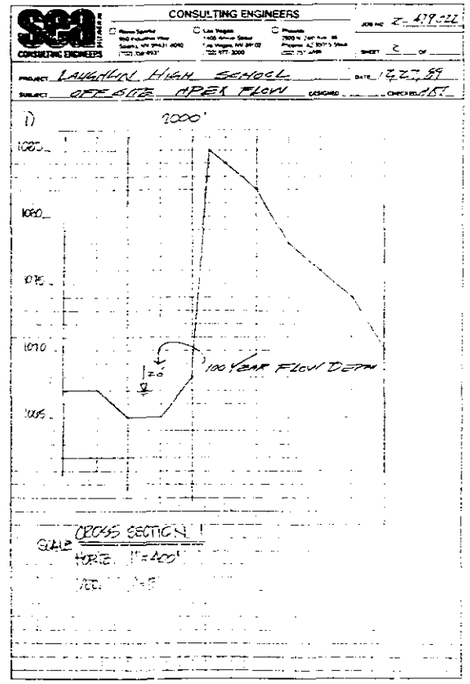
$S = 3.5\%$ EXISTING SLOPE

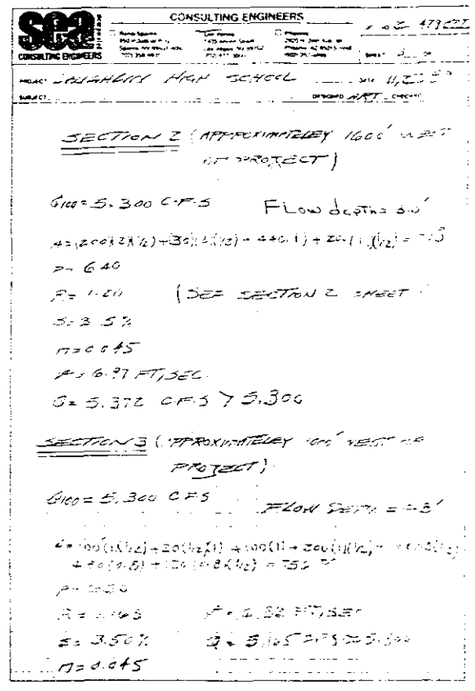
$n = 0.045$ NATURAL STREAMS (CHOW P 112)

$V = 7.67$

$Q = 5,524$ C.F.S. > 5,300

SEE PAGE 2 FOR SECTION 2

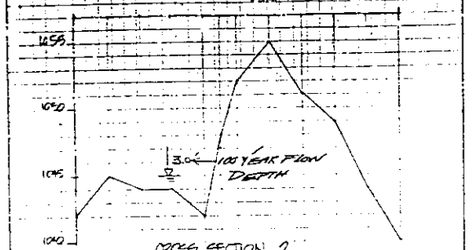




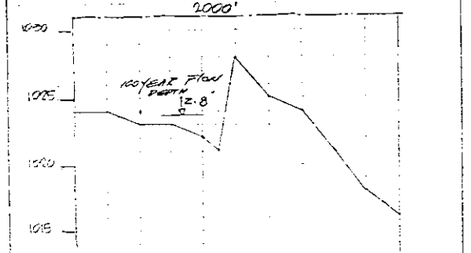
CONSULTING ENGINEERS

PROJECT: LAUGHLIN HIGH SCHOOL
SUBJECT: HYDROLOGY

VERT 1"=5' HORIZ 1"=400'



CROSS SECTION 2

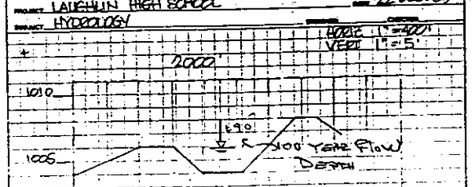


CROSS SECTION 3 HORIZ 1"=400' VERT 1"=5'

CONSULTING ENGINEERS

PROJECT: LAUGHLIN HIGH SCHOOL
SUBJECT: HYDROLOGY

HORIZ 1"=400' VERT 1"=5'



CROSS SECTION 4

CONSULTING ENGINEERS

PROJECT: LAUGHLIN HIGH SCHOOL
SUBJECT: HYDROLOGY CROSS SECTIONS

CHANNEL SECTION REQUIRED WITH FLOW DEPTH OF 1.4 FEET

$A = 340 - 600 \times (0.4) = 910$ ft²

$P = 650'$

$R = 1.13$

$V = 6.70$ FT/SEC

$Q = 6099$ C.F.S > 5300 C.F.S OK

STATE OF FLOW FOR CHANNEL SECTION

4.5 ft 6'

$\bar{V} = \frac{7.58 + 7.71 + 6.70}{3} = 7.37$ FT/SEC

$\bar{T} = \frac{550 + 603 + 800}{3} = 651$ FEET

$F = \frac{V}{\sqrt{gD}}$

D = HYDRAULIC DEPTH

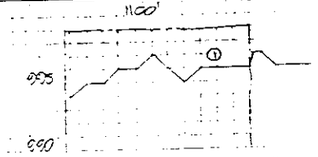
$D = \frac{A}{T} = \frac{861}{521} = 1.65$

$F = \frac{7.37}{\sqrt{(32.2)(1.65)}} = 1.14 < 1$ — SUPERCRITICAL FLOW

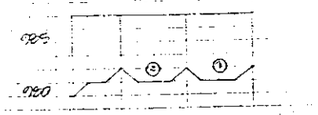
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SCALE: HORIZ 1"=400' VERT 1"=5'

CROSS SECTION 5



CROSS SECTION 6 SCALE SAME AS ABOVE



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LAUGHLIN HIGH SCHOOL 12 FEB 87
SAFETY ANALYSIS ART

SECTION 1 (APPROXIMATELY 650 WEST OF PROJECT)

$Q_{100} = 5300$ C.F.S FLOW DEPTH = 1.90'

$A = 240(1.9) + 150(1.9)(1/2) + 160(1.9)(1/2) = 754.5$ ft²

$P = 550$

$R = 1.36$ SEE PAGE 5

$S = 3.5\%$

$n = 0.045$

$V = 7.58$ FT/SEC $Q = 5692 > 5300$ C.F.S OK

SECTION 5 (APPROXIMATELY 400' WEST OF PROJECT)

$Q_{100} = 5300$ C.F.S

EXISTING SWALE CAPACITY SEE PAGE 9

$A = [90(1)(1/2) + 100(1)(1/2) + 50(2)(1) + 20(1)(1/2) + 70(1/2)(1)] = 640$ ft²

$P = 600'$ EXISTING FLOW DEPTH = 1.0'

$R = 1.06$

$S = 3.5\%$

$n = 0.045$

$V = 6.42$ $Q = 4110$ C.F.S < 5300 C.F.S

CONSULTING ENGINEERS

REQUIRED FREEBOARD FOR SUPERCRITICAL FLOW.

$F = 2 - 0.025(V)^{1/3} d$

$V = 7.39$

$d = 1.4'$

$F = 2.2$ USE 2 FEET OF FREEBOARD

CONSULTING ENGINEERS

SWALE ① & ② CAPACITY

$A = [(200)(1) + 100(1)(1/2) + 90(1/2)(1)](2) = 590$ ft²

$P = 800'$

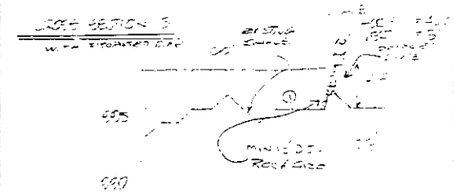
$R = 0.73$

$V = 5.0$ FT/SEC $Q = 2,950 < 5300$

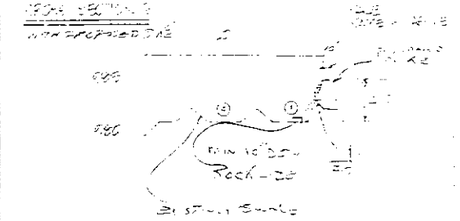
CONSULTING ENGINEERS

PROJECT: LAUGHLIN HIGH SCHOOL
SUBJECT: HYDROLOGY CROSS SECTIONS

CROSS SECTION 3



CROSS SECTION 4



CONSULTING ENGINEERS

JOB NO. 2-477-002

PROJECT: LAUGHLIN HIGH SCHOOL — DATE: 12-26-89

SUBJECT: HYDROLOGY — DESIGNED: AF — CHECKED:

AREA D — EXISTING OFFSITE AREA

AREA = 45.14 Ac. = 0.0682 mi²

SLOPE = 4.5%

CN = 56 SOIL TYPE B

L = 4000'

V = 2.2 fps

$t_c = \frac{4000}{3600(2.2)} = 0.5051$ HR

$t_r = 0.6(0.5051 + 0.0833) = 0.3530$ HR

CONSULTING ENGINEERS

JOB NO. 2-477-002

PROJECT: LAUGHLIN H.S. — DATE: 12-26-89

SUBJECT: HYD. — DESIGNED: AF — CHECKED:

AREA C — EXISTING OFFSITE AREA

AREA = 10.05 Ac. = 0.0392 mi²

SLOPE = 4.5%

CN = 56 SOIL TYPE B

L = 5000'

V = 2.2 fps

$t_c = \frac{5000}{3600(2.2)} = 0.6566$ HR

$t_r = 0.6(0.6566 + 0.0833) = 0.4439$ HR

CONSULTING ENGINEERS

JOB NO. 2-477-002

PROJECT: LAUGHLIN H.S. — DATE: 12-26-89

SUBJECT: HYD. — DESIGNED: AF — CHECKED:

AREA A — EXISTING OFFSITE AREA

AREA = 33.17 Ac. = 0.0518

SLOPE = 4.07%

CN = 56 SOIL TYPE B

L = 4000'

V = 2.1 fps

$t_c = \frac{4000}{3600(2.1)} = 0.5291$ HR

$t_r = 0.6(0.5291 + 0.0833) = 0.3674$ HR

CONSULTING ENGINEERS

PROJECT: LAUGHLIN H.S. — DATE: 12-26-89

SUBJECT: HYDROLOGY — DESIGNED: AF — CHECKED:

AREA E1 — FUTURE OFFSITE AREA (FOR AREA B)

AREA = 1.79 Ac. = 0.0028 mi²

SLOPE = 4%

CN = 85 SOIL TYPE B

L = 400'

V = 4 fps

$t_c = \frac{400}{3600(4)} = 0.0278$ HR

$t_r = 0.6(0.0278 + 0.0833) = 0.0667$ HR

CONSULTING ENGINEERS

JOB NO. 2-477-002

PROJECT: LAUGHLIN H.S. — DATE: 12-27-89

SUBJECT: HYDROLOGY — DESIGNED: AF — CHECKED:

AREA B1 — FUTURE OFFSITE AREA (FOR AREA B)

AREA = 4.24 Ac. = 0.0066 mi²

SLOPE = 4.0%

CN = 85 SOIL TYPE B

L = 400

V = 4 fps

$t_c = \frac{400}{3600(4)} = 0.0278$ HR

$t_r = .06(0.0278 + 0.0833) = 0.0667$ HR

AREA C1 — FUTURE OFFSITE AREA (FOR AREA B)

AREA = 47.05 Ac. = 0.0766 mi²

SLOPE = 4.0%

CN = 85 SOIL TYPE B

L = 2640

V = 4 fps

$t_c = \frac{2640}{3600(4)} = 0.1833$ HR

$t_r = .06(0.1833 + 0.0833) = 0.1566$ HR

CONSULTING ENGINEERS

JOB NO. 2-477-002

PROJECT: LAUGHLIN H.S. — DATE: 12-27-89

SUBJECT: HYDROLOGY — DESIGNED: AF — CHECKED:

AREA D1 — FUTURE OFFSITE AREA (FOR AREA D)

AREA = .28 Ac. = .0044 mi²

SLOPE = 4%

CN = 85 SOIL TYPE D

L = 2800

V = 4 fps

$t_c = \frac{2800}{3600(4)} = 0.1944$ HR

$t_r = .06(0.1944 + 0.0833) = 0.1656$ HR

CONSULTING ENGINEERS

PROJECT: LAUGHLIN H.S. — DATE: 12-26-89

SUBJECT: HYDROLOGY — DESIGNED: — CHECKED:

ONSITE (EXISTING)

AREA 2

AREA = 35.7 Ac. = 0.0558 mi²

SLOPE = 4.5%

CN = 82

L = 1840

V = 0.2 fps

$t_c = \frac{1840}{3600(2.2)} = 0.2591$ HR

$t_r = .06(0.2591 + 0.0833) = 0.1955$ HR

CONSULTING ENGINEERS

PROJECT: LAUGHLIN H.S. — DATE: 12-26-89

SUBJECT: HYDROLOGY — DESIGNED: — CHECKED:

AREA I — FUTURE ONSITE

AREA = 0.2 Ac. = 0.0031 mi²

SLOPE = 4%

CN = 98

L = 147

V = 4 fps

$t_c = \frac{147}{3600(4)} = 0.0102$ HR

$t_r = 0.6(0.0102 + 0.0833) = 0.0561$ HR

AREA J — FUTURE ONSITE

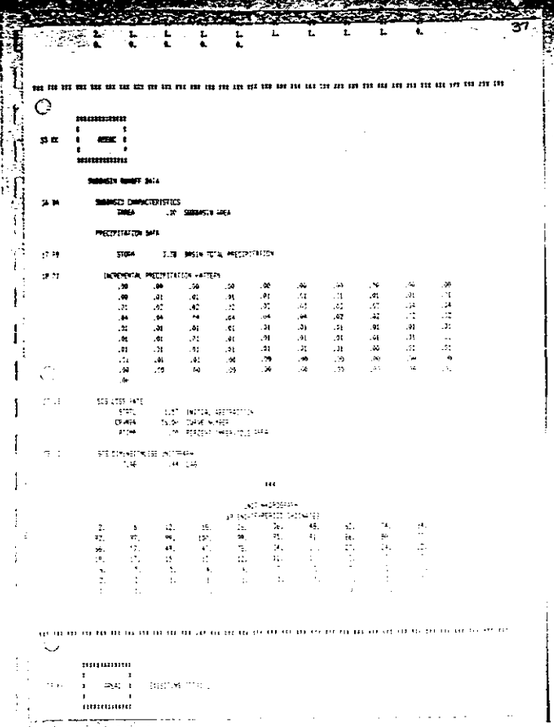
AREA = 2.4 Ac. = 0.0038 mi²

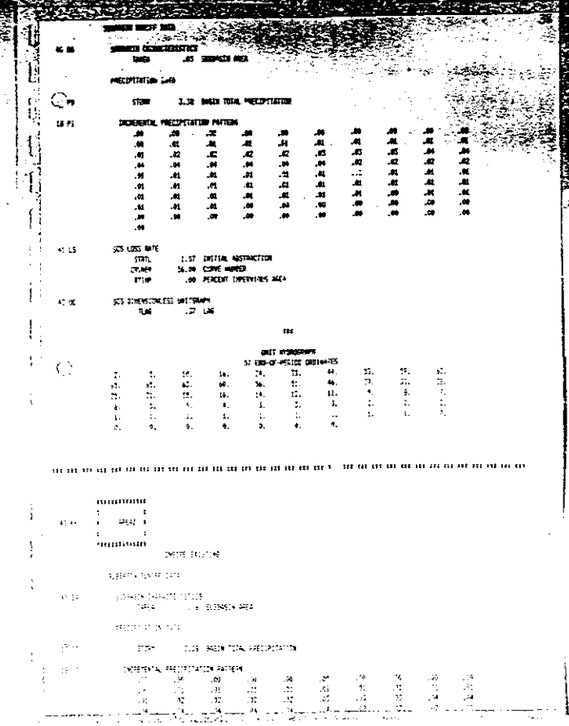
SLOPE = 3.65%

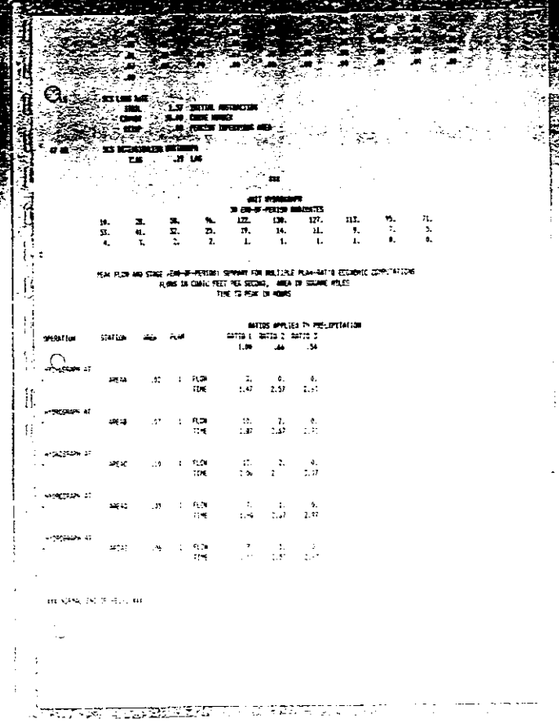
CN = 98

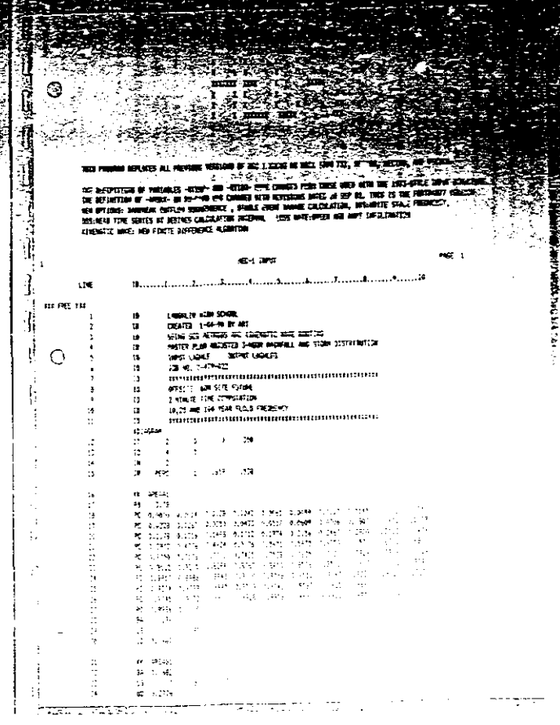
L = 528'

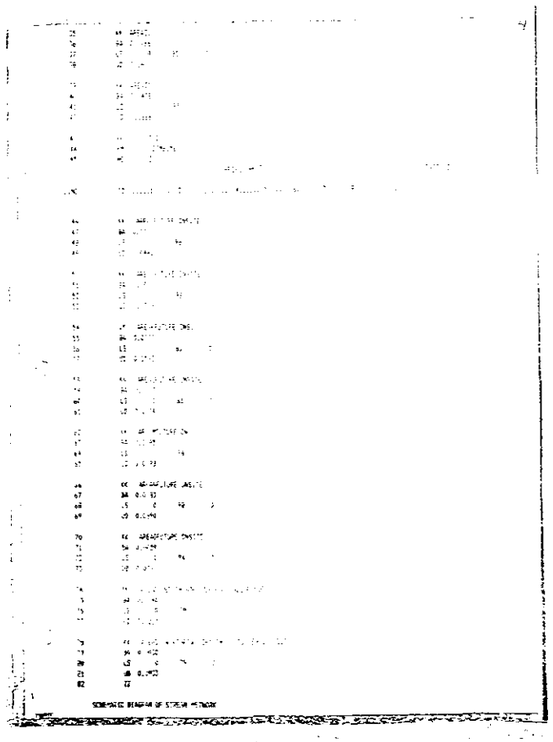
$t_c = \frac{528}{3600(4)} = 0.0367$ HR

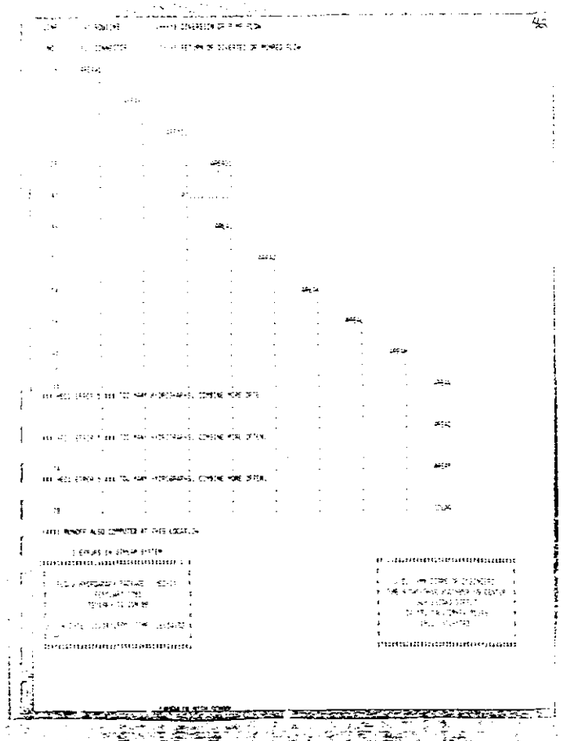


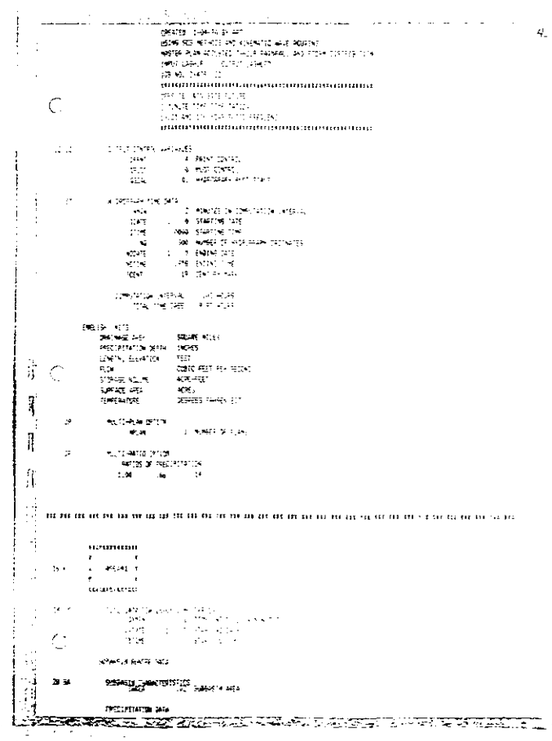


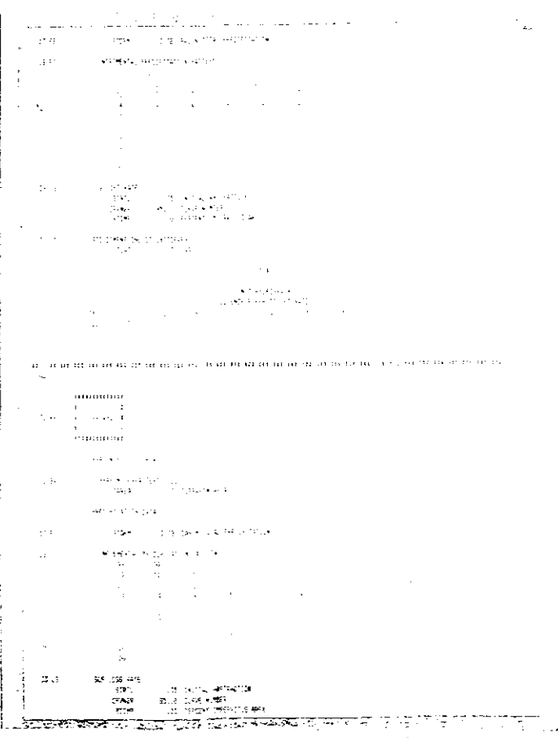












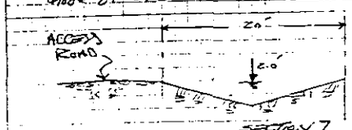
CONSULTING ENGINEERS — JOB NO. 2-479-002

PROJECT: LAUGHLIN H.S. DATE: 4/3/90

SUBJECT: DET. SIZE CHANNEL DESIGN BY: ART CHKD.

FUTURE AREA B1 — SEE FIGURE 3

Q_{100} = 87 CFS



$A = \frac{1}{2} Y^2 \cdot S (2)^2 = 20.0$

$P = 2Y\sqrt{1+S^2} = 20.40$

$R = 0.98$

$S = 4.0\ \%$

$n = 0.045$ NATIVE MATERIAL

$V = 6.50$ FT/SEC

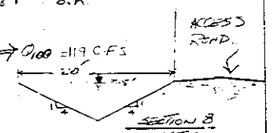
$Q = 130$ CFS > 87 O.K.

AREA C1 FLOW ⇒ Q_{100} = 119 CFS

$\theta = 25^\circ$, P = 20.61'

R = 1.21, S = 1.8 %

n = 0.045



V = 5 FT/SEC Q = 125 > 119 O.K.

CONSULTING ENGINEERS — JOB NO. 2-479-002

PROJECT: LAUGHLIN H.S. DATE: 1390

SUBJECT: DET. SIZE CHANNEL DESIGN BY: ART CHKD.

FUTURE AREA D1 SEE FIGURE 3



Q_{100} FROM AREA C1 = 119

119 + 67 = 186 CFS

$A = 4(9) = 36$ — SECTION 9 N.T.S

$P = 2(9)\sqrt{17} = 24.73$

R = 1.45

S = 1.8 %

n = 0.045

V = 5.7 FT/SEC

A = 204 CFS > 186 O.K.

FUTURE AREA A1

Q_{100} = 33 CFS



$A = 4(2.25) = 9$

P = 3(4.12) = 12.36 — SECTION 10 N.T.S

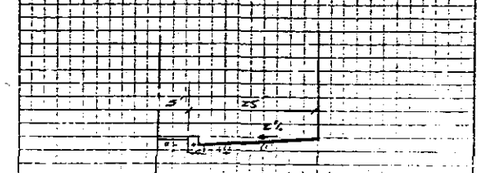
R = 0.73

S = 4.0 %, n = 0.045, V = 5.85 FT/SEC Q = 68 > 33 O.K.

CONSULTING ENGINEERS — JOB NO. 2-479-002

PROJECT: LAUGHLIN H.S. DATE: 1/5/89

SUBJECT: NORTH STREET CAPACITY BY: ART CHKD.



$A = 0.5(2+25)(2\frac{1}{2}) + 0.05(30) = 7.62$

P = 30.5

R = 0.25

S = 4.3 %

n = 0.017

V = 7.35 FT/SEC

Q = 56 CFS > 51 CFS for ½ street flow

HEC-1 INPUT AND OUTPUT

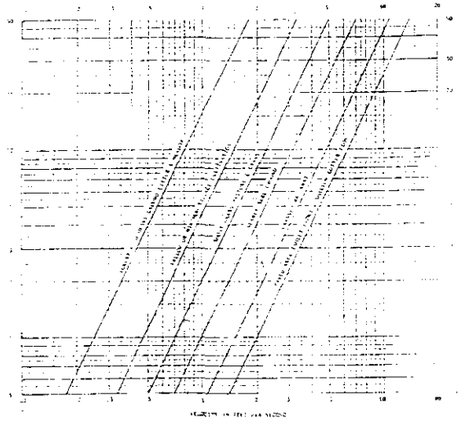


Figure 3-1 --Average velocities for estimating travel time for overland flow.

Table 2-2a.--Runoff curve numbers for urban areas[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type and hydrologic condition	Average percent impervious area[2]	A	B	C	D
Fully developed urban areas (vegetation established):					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
½ acre or less (town houses)	65	77	85	90	92
¼ acre	38	61	75	83	87
⅓ acre	30	57	72	81	86
½ acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas:					
No grass cover (barrenness) area only, no vegetation)		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1] Average runoff conditions, and $I_a = 0.2S$.

[2] The average percent impervious area values are used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, streets have curbs and storm sewers, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's are computed for the area only after the impervious portion has been deducted. The composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's assume the irrigated desert landscaping pervious area is in good hydrologic condition; CN's for poor hydrologic condition may be computed by using figure 2-3 or 2-4 based on the impervious and pervious percentages and the pervious CN's. Assumes drainage from impervious areas is directed to pervious areas and not directly to the drainage system.

Table 2-2c.--Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	–	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30[4]	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30[4]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	–	59	74	82	86

[1] Average runoff conditions, and $I_a = 0.2S$.

[2] Poor: < 50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

[3] Poor: < 50% ground cover.
Fair: 50 to 75% ground cover.
Good: > 75% ground cover.

[4] Actual curve number is less than 30; use CN = 30 for runoff computations.

[5] CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and grass.

[6] Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

CONSULTING ENGINEERS — JOB NO. 2-479-002

PROJECT: LAUGHLIN HIGH SCHOOL DATE: 12-90

SUBJECT: HYDROLOGY BY: ART CHKD.

AREA A EXISTING OFFSITE AREA

AREA = 119 AC = 0.186 mi²

SLOPE = 4.5%

CN = 52 SEE TABLE 2-2c

L = 1765'

V = 2.2 (FPS) SEE FIGURE 3-1

$T_t = \frac{1760}{3600(2.2)} = .2222$

$T_c = .06(.2222)^{.7}(.0833)^{-.3} = .1438$ HR

CONSULTING ENGINEERS — 2-477-002

LAUGHLIN H.S. — 12-23-89

HYDROLOGY — AE

AREA "K"

AREA = 4.9% Ac = 0.0077 mi²

SLOPE = ½ (3.97% + 1.41%) = 2.5%

CN = 61

L = 845'

V = 1.3 fps

$t_c = \frac{845}{3600(1.3)} = 0.1806$

$t_p = .06(0.1806 + 0.0833) = 0.1585$ HR

AREA L

AREA = 5.3% Ac = 0.0094 mi²

SLOPE = 4.0%

CN = 61

L = 650'

V = 1.4 fps

$t_c = \frac{650}{3600(1.4)} = 0.1250$ HR

$t_p = .06(0.1250 + 0.0833) = 0.1274$ HR

CONSULTING ENGINEERS — 2-477-002

LAUGHLIN H.S. — 12-23-89

HYDROLOGY — AE

AREA "M" FUTURE UNBUILT

AREA = 5.4% Ac = 0.0085 mi²

SLOPE = 4%

CN = 98

L = 715'

V = 1 fps

$t_c = \frac{715}{3600(1)} = 0.1987$ HR

$t_p = .06(0.1987 + 0.0833) = 0.0782$ HR

AREA N FUTURE ONSITE

AREA = 5.3% Ac = 0.0085 mi²

SLOPE = ¼(6% + 1% + 0.6% + 4%) = 2.65%

CN = 98

L = 80

V = 3.5 fps

$t_c = \frac{80}{3600(3.5)} = 0.0635$ HR

$t_p = .6(0.0635 + 0.0833) = 0.0890$ HR

CONSULTING ENGINEERS — 2-477-002

LAUGHLIN H.S. — 12-23-89

HYDROLOGY — AE

AREA "S" FUTURE ONSITE

AREA = 3.7% Ac = 0.0059 mi²

SLOPE = ½(10% + 2%) = 6%

CN = 98

L = 286'

V = 1.7 fps

$t_c = \frac{286}{3600(1.7)} = 0.0467$ HR

$t_p = .06(0.0467 + 0.0833) = 0.0780$ HR

AREA P SOUTHERN PORTION OF FOOTBALL FIELD

AREA = 8.9 Ac = 0.0139 mi²

SLOPE = 0.4%

CN = 79

L = 307'

V = 0.47 fps

$t_c = \frac{307}{3600(.47)} = 0.2614$

$t_p = .06(0.2614 + 0.0833) = 0.2224$ HR

AREA "Q" NORTHERN PORTION OF FOOTBALL FIELD

AREA = 1.3 Ac = 0.0020 mi²

SLOPE = 0.6%

CN = 79

L = 198'

V = 1.1 fps

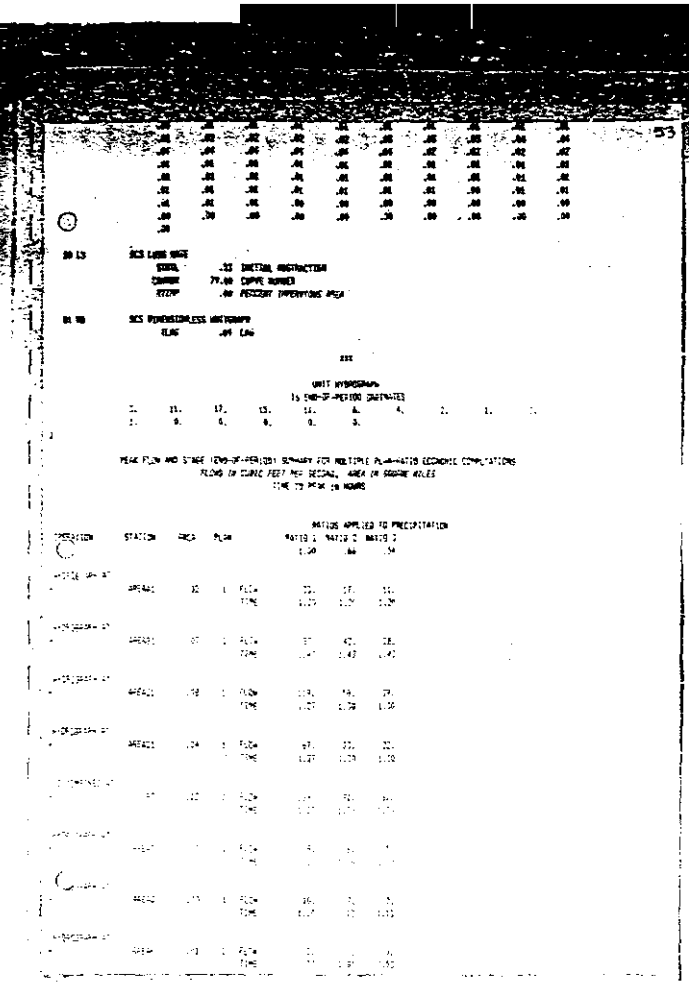
$t_c = \frac{198}{3600(1.1)} = 0.0500$ HR

$t_p = .06(0.0500 + 0.0833) = 0.0800$ HR

```
SCS DIMENSIONLESS UNITGRAPH
   TLAG      .30 LAG

UNIT HYDROGRAPH
44 END-OF-PERIOD ORDINATES
   4.   14.   27.   44.   67.   96.  122.  144.  162.  177.
 188.  195.  199.  201.  200.  197.  192.  185.  177.  168.
 157.  145.  133.  121.  109.   98.   87.   77.   68.   59.
  51.   44.   38.   32.   27.   23.   19.   16.   13.   11.
   9.    8.    6.    5.

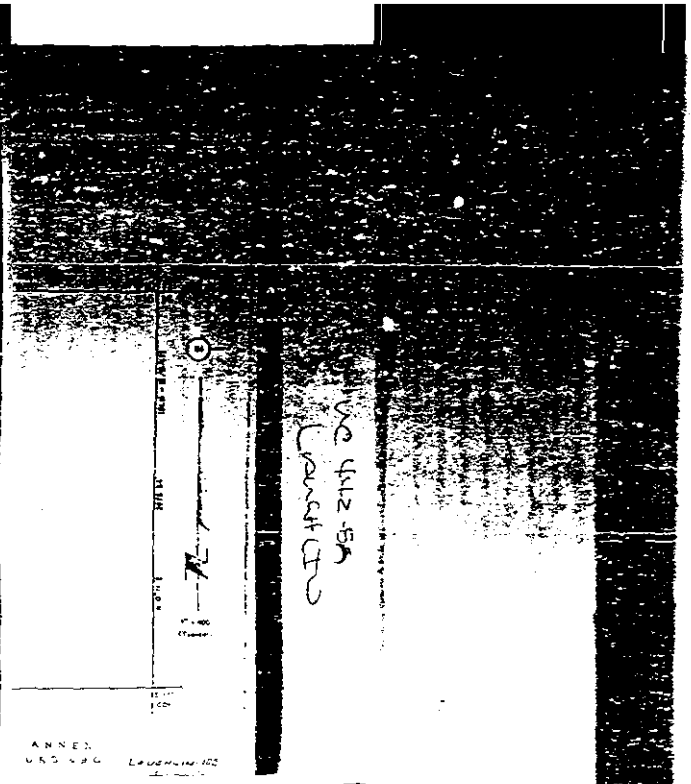
SUBAREA RUNOFF DATA
  SUBAREA CHARACTERISTICS
     TAREA      .12 SUBAREA AREA
  PRECIPITATION DATA
     STORM     3.30 BASIN TOTAL PRECIPITATION
  INCREMENTAL PRECIPITATION PATTERN
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    .00   .01   .01   .01   .01   .01   .01   .01   .01   .01
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  SCS LOSS RATE
     STRTL      .20 INITIAL ABSTRACTION
     CRVNBR    98.00 CURVE NUMBER
     RTIMP      .00 PERCENT IMPERVIOUS AREA
  SCS DIMENSIONLESS UNITGRAPH
     
```



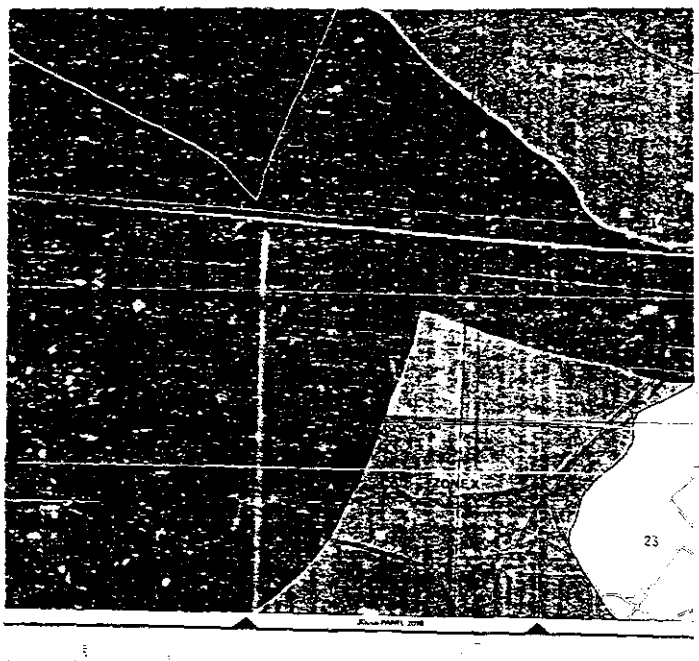
UNIT HYDROGRAPH
15 END-OF-PERIOD ORDINATES

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

RATIOS APPLIED TO PRECIPITATION

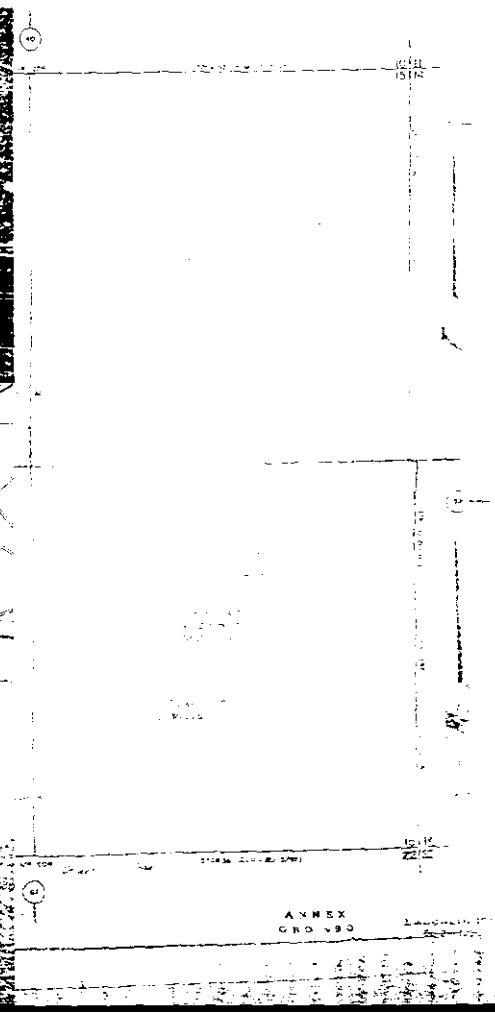


ANNEX

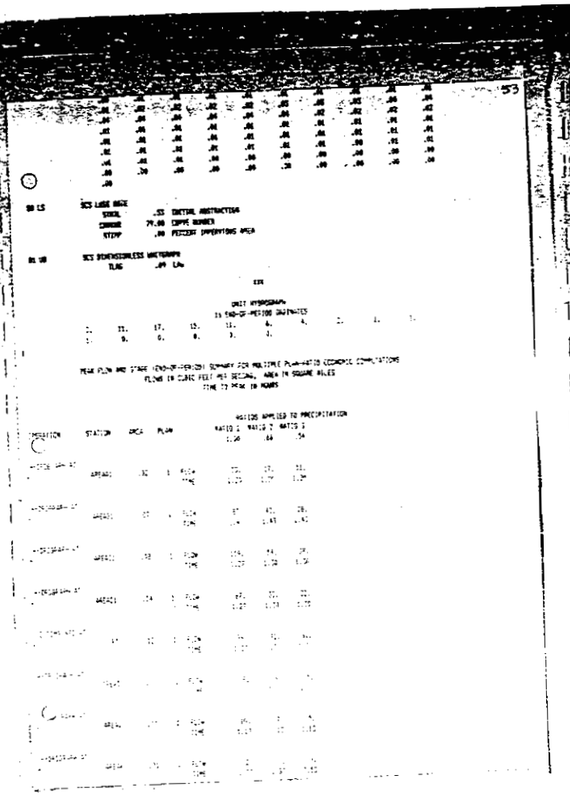


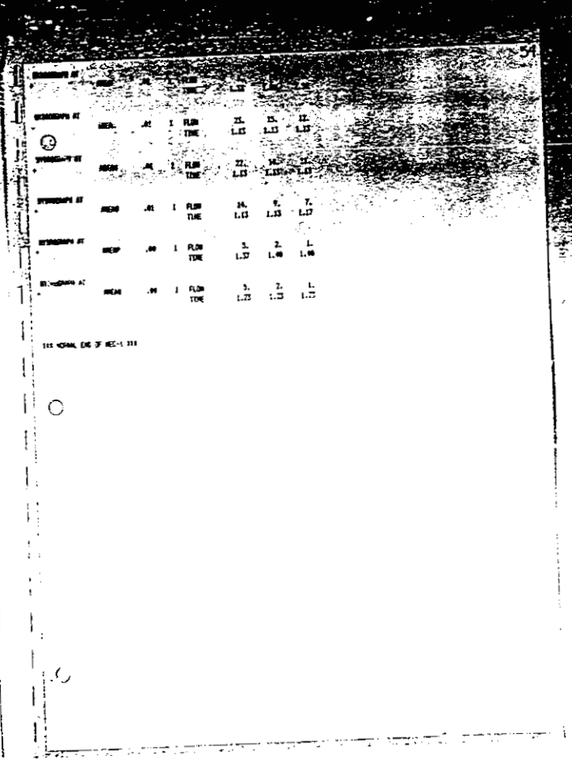
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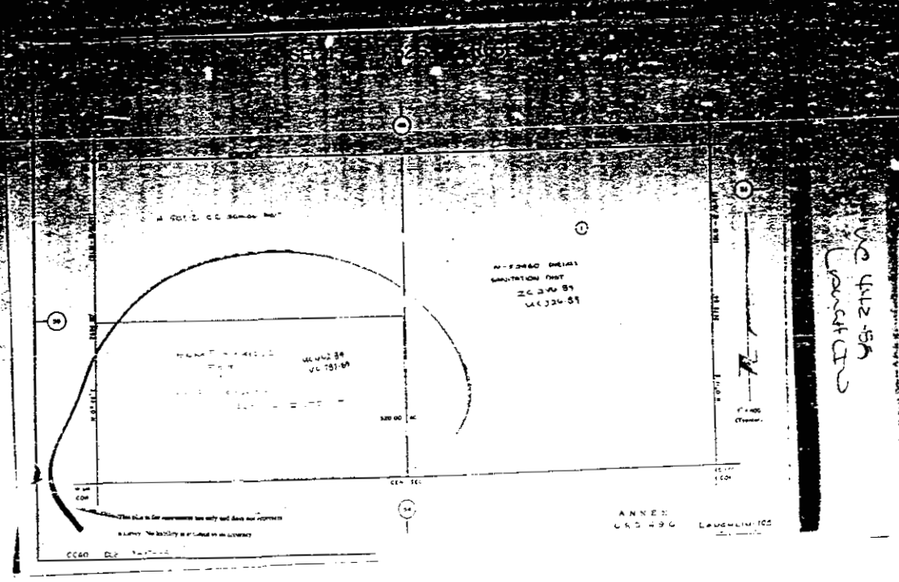
23



ANNEX



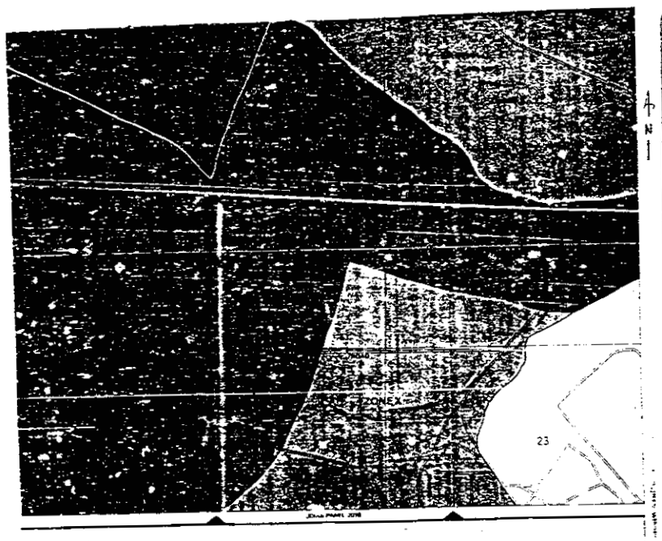


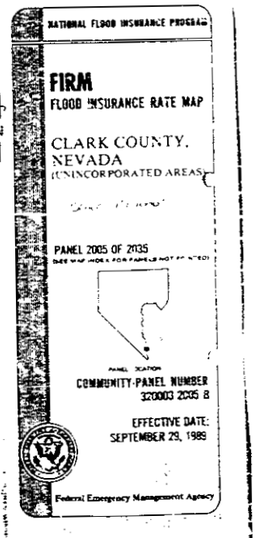


S½ SEC. 16 T. 32S. R. 66E.

N½ SEC. 15 T. 32S R. 66E.

63-53







Berm
A = 4.75'
d = 1.44'
dup = 0.33'
FB = 3.0'

DRAINAGE

DRAINAGE STUDY NUMBER:

00 26 48 Addendum #1

NAME:

Laughlin High School

SECTION / TOWNSHIP/ RANGE:

Sec 15 T32S R66E

CROSS STREETS:

ASSESSOR'S PARCEL NUMBER:

630-530-001

NEW ASSESSOR'S PARCEL NUMBERS:

ACREAGE:

SUBMITTAL DATE:

5/31/90

A:\WORK\DRAINAGE

24

Clark County

Department of Public Works

Mr. H. Andrew Asgarian, P.E.
SEA, Inc.
1100 Grier Dr.
Las Vegas, NV 89119

LAUGHLIN HIGH SCHOOL (DC 442-89, VC 787-89)
APN 630-530-001 - HYDROLOGY STUDY ADDENDUM NO. 1

We have reviewed referenced submittal dated May 30, 1989, together with its cover letter and find the documents to be acceptable for incorporation with the original study. Kindly merge this information onto the final plans as may be applicable for final grade and finished floor elevations.

Should there be questions, please contact me at 455-7413 or FAX (702) 739-1558. Please direct any correspondence to 5051 Paradise Rd., Las Vegas, Nv 89119.

M. J. MANNING
DIRECTOR OF PUBLIC WORKS

BY: William C. Brandt
WILLIAM C. BRANDT, P.E.
Design Engineering Division

WCB:slp

cc: Carla Pearson
Phu Simpson
Barbara Ginoulias

COMMISSIONERS
Bruce L. Woodbury, Chairman • Paul J. Christensen, Vice-Chairman
Jay Bingham, Manuel J. Cortez, Thalia M. Dondero, Karen Hayes, William U. Pearson
Donald L. "Pat" Sherry, County Manager

WERC PLANNING

DEPARTMENT OF PUBLIC WORKS

TO:
FROM:
SUBJECT:
DATE:

Attached for your review is our comments and conditions regarding the drainage impact study for:

LAUGHLIN HIGH SCHOOL ADDENDUM

Submitted By: SEA, Inc.

If you have no questions or concerns, please forward the attached letter to the consultant engineer and send copies to distribution.

COMMENTS:

REVIEWED BY COMMUNITY DEVELOPMENT UNIT

Signature

Date 6/16/89

WCB:slp

SEA

Consulting Engineers

1100 GRIER DRIVE
LAS VEGAS, NEVADA 89119
(702) 384-4012
FAX: 384-0286

May 30, 1990
Project No. 2 479 022

KITTRELL GARLOCK ASSOCIATES, AIA
4170 S. Decatur Boulevard, Suite B-5
Las Vegas, Nevada 89103

Attn: Mr. Ed Kittrell

Re: Hydrology Study, Laughlin High School

Dear Sir:

Submitted herewith is detailed calculations for evaluation of effects of sediment transport in the area of the proposed berm for the proposed Laughlin High School project. These calculations are provided at the request of the Clark County Flood Control District. The District's other comments, together with comments made by the Clark County Department of Public Works, regarding the Hydrology Study conducted for the subject project, have been addressed and pertinent information is attached.

If you have any questions, or if we may be of further assistance, please do not hesitate to call.

Sincerely,

SEA, INCORPORATED
Consulting Engineers

H. Andrew Asgarian, P.E.
Project Engineer

Stuart A. Vertimes, P.E.
Engineering Manager

HAA:SAV:slr

attachments

H. ANDREW ASGARIAN — No. 8884 — CIVIL — STATE OF NEVADA — PROFESSIONAL ENGINEER

May 31, 1990

HYDROLOGY STUDY
ADDENDUM NO. 1

LAUGHLIN HIGH SCHOOL

CLARK COUNTY, NEVADA

A Portion of the Northeast Quarter (NE¼) of Section 15, Township 32 South, Range 66 East, M.D.M.

May 1990

Prepared for: KITTRELL GARLOCK ASSOCIATES, A.I.A.

SEA

Las Vegas
Reno/Sparks
Phoenix

Letter of Review dated February 22, 1990 for the Preliminary Study Laughlin High School... Action: DC442-89/VC787-89; APN 630-530-001; Located on the S(1/2), NW(1/4), NW(1/4) of Section 15, Township 32 South, Range 66..., M.D.M., Approximately 1/2 Mile East of Davis Dam-Needles Highway/Tarnoff Road...

Dear Mr. Brandt:

This letter is in response to your letter of Review, dated February 22, 1990 for the subject project. The following is an item by item response to your concerns:

Item 1) The recommended lowest *Finished Floor elevation* for the school building is a minimum of 5 feet above the flow line of the existing drainage swale along the south side of the school site. The proposed finished floor elevation for the school building is at 972.0 feet. This elevation is 18 inches or more above the adjacent streets to the south, east and north of the structure. The proposed finished floor elevation of 972 feet is 4 feet or more above the adjacent street to its southern half of the west side. The proposed elevation of the northern half of the adjacent street is higher than the proposed finished floor elevation of the school building. In this area, the grading is recommended to drain away from the structure. This runoff, together with runoff generated from the northern one-third of Area R (see Figure No. 5, original study), is collected in the street to the west of the building and is conveyed south with an average street slope of 4.1% in this area.

Item 2) Project Architect has been notified of this condition.

Item 3) Project Architect has been notified of this condition.

Item 4) Tables 2-2C and 2-2A of the Technical Release 55, "Urban Hydrology for Small Watersheds" were used for existing and future (developed) conditions, respectively. Table 2-2C's "brush-weed-grass mixture with brush the major element" section for "fair" hydrologic conditions was used for existing site conditions. This is believed to represent the closest cover type conditions with respect to existing site conditions.

SEA

Item 5) [illegible] berm as stated have been [illegible] average Peak discharges [illegible] Pertinent data is enclosed. Additional [illegible] protected from channel migration, [illegible] along the north side of the access [illegible] northwest side of project site, and [illegible] to be cut along the north side of the [illegible]

Item 8) Correspondence has been made with the [illegible] the anticipated date of official adoption [illegible] conducted by Coe & Van Loo... It is to [illegible] that while the Bridge Canyon Study has [illegible] cially adopted by the District, the [illegible] cfs has been accepted by the District. [illegible] discharge under existing conditions at the [illegible] apex.

Please call me at your convenience if you have [illegible] need additional information.

Sincerely,

SEA, INCORPORATED
Consulting Engineers

H. Andrew Asgarian, P.E.
Project Engineer

HAA:slr

I. INTRODUCTION

This report is prepared as an Addendum to the Hydrology Study for the Laughlin High School project, Job No. 2 479 022, dated January 1990. The purpose of this Addendum is to provide detailed analysis for the Sediment Transportation in the area of the proposed dike for the existing natural channel on Bridge Canyon Wash.

II. EXISTING PATTERNS

The proposed school is located on alluvial fan deposits of Bridge Canyon, located along the west side of the Colorado River. An existing 500 to 600 foot wide shallow channel has been established within the alluvial fan, approximately 900 feet west and south of school site. [redacted] and Van Loo Bridge Canyon Wastewa[illegible] Flow Opinion Study, [illegible] the Clark County Regional Flood Control District).

III. CRITERIA

Equations derived by Meyer-Peter and Einstein in "Contribution of Sediment Transport" by Walter Hans Graf, were [illegible] the expected rates of deposition, erosion, and

sediment transportation for the existing channel in [redacted] the proposed berm for the Laughlin High School [redacted] existing channel was divided into different Reaches ([redacted] 1) and equations developed by Meyer-Peter and Einstein [redacted] to evaluate the effects of sediment transport for the [redacted] (see Appendix for calculations). The methodology [redacted] the concept that erosion commences at the apex of the [redacted] 1, see Figure 2). As the flow enters Reach 2 depo[redacted] occur because the slope of Reach 2 is less than R[redacted] the transport capacity of Reach 2 is encountered.

At this time, only sediment transportation [redacted] this flow enters Reach 3 deposition will occur [redacted] transport capacity (bed load) of Reach 3 is approached [redacted] this point until Reach 4 is encountered, [redacted] transportation occurs.

In Reach 4 erosion will occur at a rate [redacted] difference between Reach 3 and Reach 4 bedload [redacted] processes (erosion, deposition and transportation) [redacted] rates of occurrence are summarized in the tables [redacted] Appendix for calculations).

TABLE I

RUNOFF RATE CORRESPONDING TO THE 3 HOUR 100-YEAR HYDROGRAPH FLOWS

Reach No.	Water Flow Q-(cfs)	Bed Load Rate qs (lbs/sec.-ft)
2	1,500	12.82
	5,400	66.35
3	1,500	7.11
	5,300	48.30
4	1,500	11.26
	5,300	59.38

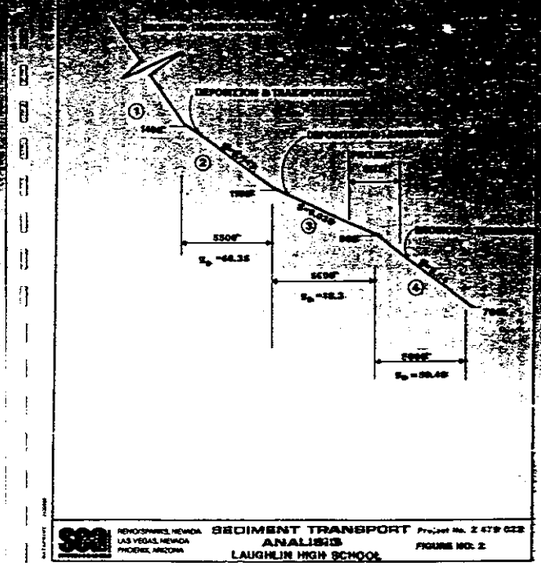
TABLE II

RATES OF DEPOSITION AND EROSION FOR REACH 3 AND 4

Reach	Water Flow cfs	Rate of Erosion lbs/sec-ft	Rate of Deposition lbs/sec-ft
3	Q1 = 1,500	no	5.71
	Q2 = 5,300	no	18.05
4	Q1 = 1,500	4.13	no
	Q2 = 3,500	11.18	no

3





IV. CONCLUSION

As seen in Figure 2, the project site is located within Reaches 3 and 4 where both a deposition depth of 0.99 feet and an erosion depth of 0.66 feet (see Appendix for calculations) are expected to occur. This results in a net deposition of 0.33 feet over the basin area for the Laughlin High School project. The height of berm of 6.75 feet proposed above natural grade is equal to the one thousand year flow depth of 1.4 feet, plus 3.0 feet of freeboard per FEMA requirements, plus 0.33 foot for deposition.

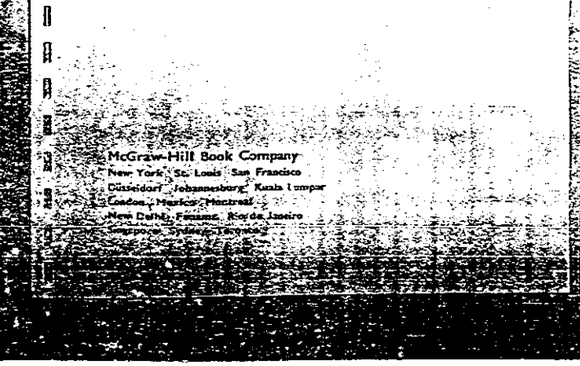
APPENDIX

Hydraulics of Sediment Transport

Walter Hans Graf

Ecole Polytechnique Fédérale
Lausanne, Suisse

McGraw-Hill Book Company
New York St. Louis San Francisco
Düsseldorf Johannesburg Kuala Lumpur
London Mexico Montreal
New Delhi Panama Rio de Janeiro
Singapore Sydney Toronto



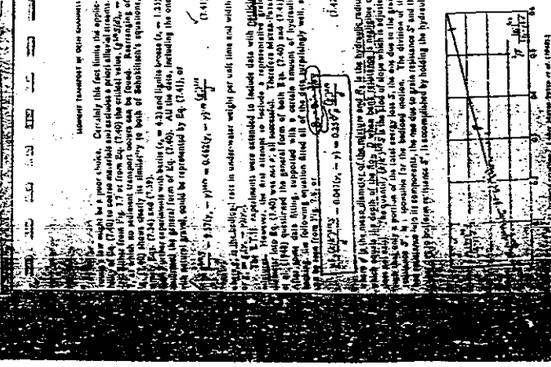


Fig. 7.14. Comparison of the bedload equation by Einstein and Meyer-Peter et al. (after Graf [1984])

Einstein's bedload fun. (7.23) and the bedload Eq. (7.41) by Meyer-Peter et al. (1948) are considered to represent the most reliable equations for the movement of particles in the bedload mode. Therefore, each of particular interest to see where (given different values for ψ_*) the two equations agree. This has been done by Graf (1984). As far as bedload is concerned, Einstein divides the hydraulic radius $R_b = R_b' + R_b''$ and keeps the slope constant, whereas Meyer-Peter et al. divide the slope $S = S' + S''$ and keep the hydraulic radius constant. Both assumptions are questionable, but they are necessary to obtain explicit solutions for the roughness and bedform. Under these conditions Graf (1984) has shown that Eq. (7.41) by Meyer-Peter et al. can be written in terms of ψ_* and Ψ_* as

$$\psi_* = \left(\frac{4}{\Psi_*} - 0.188\right)^{3/2} \qquad (7.23)$$

Equation (7.23) and (7.31) are plotted in Fig. 7.14 for uniform material, and the agreement between the two equations is quite good, especially in the practical range of ψ_* between 0.1 and 10. This may safely conclude that bedload transport equations by Einstein and Meyer-Peter et al. are of similar reliability and of the same order of magnitude.

7.4.5 Similar Kinds of Bedload Equations

7.4.5.1 Bagnold's model. With his strictly different approach than the one followed by Einstein (1941, 1950), Bagnold (1956) developed a bedload equation for gravel streams like one of Einstein. Bagnold's model assumes that the energy required to move the bed material is supplied by the flow and that all the supplied energy is used for bedload transport. As far as hydraulics is concerned, Bagnold neither accounts

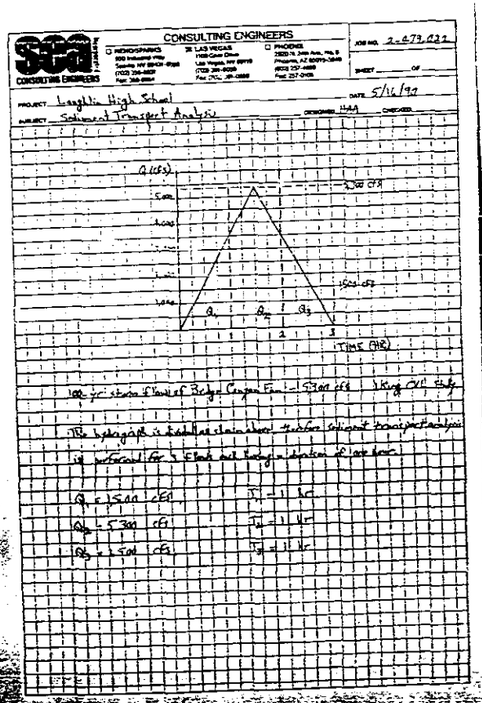
the hydraulic radius nor the "grain" roughness. Instead, he introduces a parameter for the effect of the pulsation. Graf (1984) has shown that Bagnold may not be generally applicable as a bedload equation because the model is based on a number of assumptions that are not always involved and lengthy. For left upon the interested reader to study the original contribution. However, Bagnold's model is an important approach to sediment transport problems, and it has been applied in some gravel-bed streams.

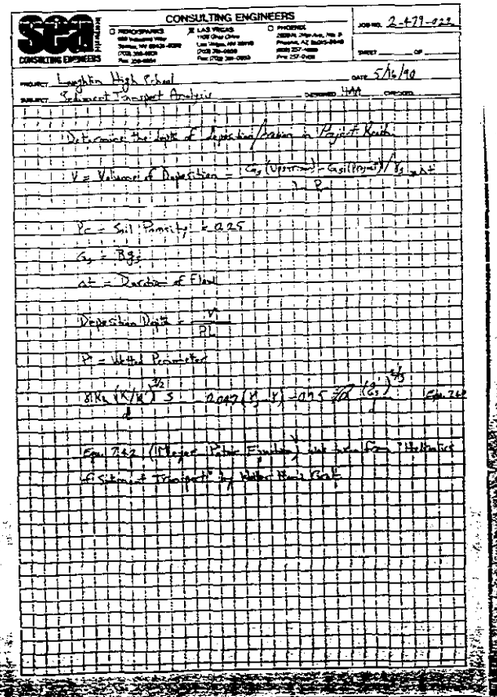
7.4.5.2 Yalin's model. The average pick-up rate of particles is the starting point of a bedload equation. The particle motion is described by the saltation of particles (movement that will be discussed in Section 7.5.2). Yalin's model and Einstein's model are somewhat similar. Both are based on probability concepts, and both use the logarithmic velocity distribution. Yalin's model, however, is more general than Einstein's. Yalin suggests that the bedload transport equation is one of several possible forms of the dimensionless bedload transport equation. Yalin's model has been criticized by several investigators, mainly, Chabert's (1956) data do not support Yalin's model. Chabert's (1947) relationship, which is quite similar to Einstein's (1942) relationship, also does not support Yalin's model. Ashida and Michiue (1971), who think that for the model are in better agreement with Einstein's (1950) bedload function than with Yalin's model. Yalin's (1963) model is probably the most theoretical bedload transport equation. Unfortunately, it is not easy to apply to plane bed, without ripples and dunes, and it is probably not applicable to natural streams. Yalin's model has not found widespread application.

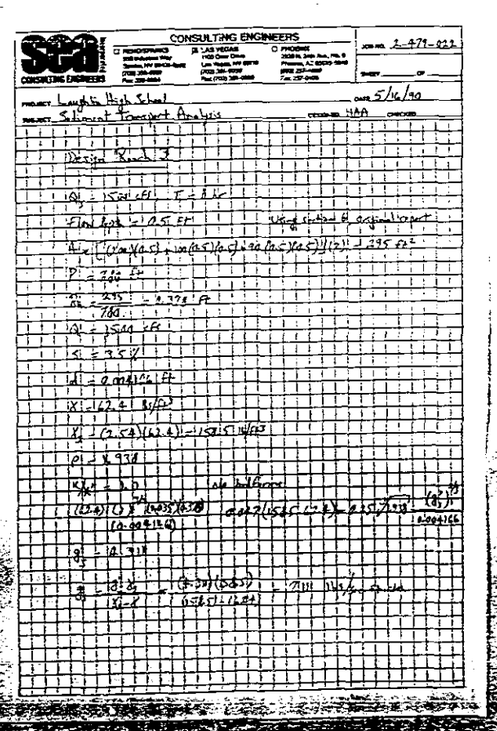
7.5 Equations Concerning Saltation

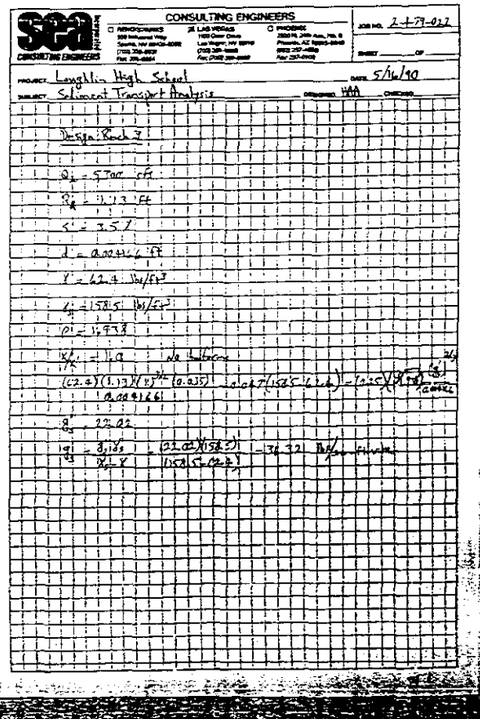
7.5.1 Theoretical Considerations

The concept of bedload, as they exist in nature, is a complex one. Bedload is the material moving in almost continuous contact with the bed. Particles are set in motion by the lift force and the drag force of the flow. Once in motion, the particles are accelerated by the flow until they settle out again. The lower flow region which ripples and dunes exist is the area where most of the bedload transport occurs. It is assumed that all the bedload particles are moved by saltation. The saltation of bedload particles is a complex process. Only a few theoretical investigations of saltation are available. Most of the theoretical approaches are based on the mechanics of single-sized rigid, spherical particles resting on a flat bed of identical particles. Particle movement is described by the forces acting on the particles. Paintal (1971) has made a theoretical investigation of the probability of sediment motion. Based on the theory of probability, Paintal has derived a probability function for the initiation of motion of sediment particles. Paintal's theoretical probability function is in good agreement with experimental data. Lavelle et al. (1984) have developed a mathematical model for the simulation of saltation over a flat bed. The model is based on the mechanics of single-sized rigid, spherical particles resting on a flat bed of identical particles. Particle movement is described by the forces acting on the particles. Lavelle et al. (1984) have developed a mathematical model for the simulation of saltation over a flat bed. The model is based on the mechanics of single-sized rigid, spherical particles resting on a flat bed of identical particles. Particle movement is described by the forces acting on the particles.









SCA CONSULTING ENGINEERS — Job No. 2-479-022

Project: Laughlin High School — Date: 5/16/90

Subject: Sediment Transport Analysis — Designed: HAA — Checked:

Using Einstein's Method:

$\psi = \frac{i_b}{(\rho_s - \rho)d_{50}}$ Eqn. 7.57 "Hydraulics of Sediment Transport"

$\psi = \frac{(2.1357)(.938)(0.00466)}{(1.938)(1.94)(0.035)}$ Assuming $R_b = R_s$

$\psi = 0.1738$

$\Phi = \left(\frac{\psi}{0.188}\right)^{3/2}$ Eqn. 7.73 "Hydraulics of Sediment Transport"

$\Phi = \left(\frac{0.1738}{0.188}\right)^{3/2}$

$\Phi = 109.06$

$\Phi = \frac{q_s}{d_s}\sqrt{\frac{\rho}{\rho_s - \rho}\frac{1}{gd}}$ Eqn. 7.52 "Hydraulics of Sediment Transport"

$109.06 = \frac{q_s}{(.035)}\sqrt{\frac{1.938}{(2.1357 - 1.938)}\frac{1}{32.2(.00466)}}$

$q_s = 2.83$ Using Einstein's Method → To Results From Both Methods are within 25%

$q_s = 3.63$ Using Meyer-Peter's Method

SCA CONSULTING ENGINEERS — Job No. 2-479-022

Project: Laughlin High School — Date: 5/16/90

Subject: Sediment Transport Analysis — Designed: HAA — Checked:

for Q = 1500 cfs, W = 0.0469

$\psi_s = 0.1738$

$\Phi_s = 109.06$

$q_{s_1} = 12.82$ lbs/ft-sec

for Q = 5300 cfs, W = 0.0469

$\psi_s = 0.1913$

$\Phi_s = 149.98$

$q_{s_2} = 66.35$ lbs/ft-sec

SCA CONSULTING ENGINEERS — Job No. 2-479-022

Project: Laughlin High School — Date: 5/16/90

Subject: Sediment Transport Analysis — Designed: HAA — Checked:

for Q = 1500 cfs, W = 0.0469

$\psi_s = 0.1738$

$\Phi_s = 109.06$

$q_{s_1} = 12.82$ lbs/ft-sec

for Q = 5300 cfs, W = 0.0469

$\psi_s = 0.1913$

$\Phi_s = 149.98$

$q_{s_2} = 59.48$ lbs/ft-sec

SCA CONSULTING ENGINEERS — Job No. 2-479-022

Project: Laughlin High School — Date: 5/16/90

Subject: Sediment Transport Analysis — Designed: HAA — Checked:

for Q = 1500 cfs, W = 0.0469

$q_{s_1} = 12.82$ lbs/ft-sec

$q_{s_2} = 66.35$ lbs/ft-sec

$W_{Total} = \frac{(66.35 - 12.82)(1500)}{2}\left(\frac{1}{32.2}\right) + (66.35)(3800)\left(\frac{1}{32.2}\right) = 247,400$ lbs

Depth of Deposition = $\frac{W}{\gamma(1-\eta)L} = \frac{247,400}{(1-0.45)(62.4)(3800)} = 0.17$ ft

for Q = 1500 cfs:

$q_{s_1} = q_{s_3} = 12.82$ lbs/ft-sec

$q_{s_2} = q_{s_4} = 12.82 - 7.13 = 5.71$ lbs/ft-sec

$V_{Total} = \frac{(5.71)(1500)(3600)}{2} = 154,575$ ft²

Depth of Deposition = $\frac{W}{\gamma(1-\eta)L} = \frac{154,575}{(62.4)(0.55)(3800)} = 0.10$ ft

Total Deposition for Reach 3 = 0.667 + 2(0.10) = 0.867 ft

SCA CONSULTING ENGINEERS — Job No. 2-479-022

Project: Laughlin High School — Date: 5/18/90

Subject: Sediment Transport Analysis — Designed: HAA — Checked:

Determine Depth of Erosion (Scale #1):

for Q = 1500 cfs:

Depth of Erosion = [illegible]

= 0.37 ft

for Q = 5700 cfs:

Depth of Erosion = [illegible]

= 0.37 + 0.10 = 0.47 ft

Total Depth of Erosion = 0.47 ft

SCA CONSULTING ENGINEERS — Job No. 2-479-022

Project: Laughlin High School — Date: 5/18/90

Subject: Riprap Size for River Protection — Designed: HAA — Checked:

$V = 3.11 y^{1/6} S^{1/3} D^{1/3}$ Eqn. 3.18 MANNING

$V = (11.4)(0.44)^{1/6}(.15)^{1/3}$ Check V at Toe of Bank

$V = 4.5$ ft/s

$d_{50} = \frac{(5)^{2.57}(.44)}{(62.4)(.15)} = 1.05$ ft

For Protection → $d_{50} = 2.0$ ft

Using Blinn Method: $d_{50} \geq 2(1.05) = 2.1$ ft

Use 2.5 ft

SECTION 5.3

Technical Support Data for Crown Pointe Flood Wall

NOV

Meadows Development Company

Study for

Hydraulic and Sediment Transport of Proposed Crown Pointe Flood Wall

Revised April 20, 1989

Submitted by
Lenzotti & Fullerton Consulting Engineers, Inc.

HYDRAULIC AND SEDIMENT TRANSPORT STUDY OF THE PROPOSED CROWN POINTE FLOOD WALL

RECEIVED

NOV [illegible] 1991

SUBMITTED TO:
JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.
2915 WEST CHARLESTON BOULEVARD, SUITE 12
LAS VEGAS, NEVADA 89102

SUBMITTED BY:
DR. J.S. O'BRIEN, P.E.
MR. WILLIAM T. FULLERTON, P.E.

LENZOTTI & FULLERTON CONSULTING ENGINEERS, INC.
POST OFFICE BOX 491
BRECKENRIDGE, COLORADO 80424-0491

REVISED
APRIL 20, 1989

SUMMARY

An analysis of the flow hydraulics and potential sedimentation and scour problems for the proposed Crown Pointe Flood Wall associated with the passage of the 100-year flood was conducted by Lenzotti & Fullerton Consulting Engineers, Inc. for James M. Montgomery Consulting Engineers, Inc. The Crown Pointe Flood Wall is located in the lower portion of Hiko Springs Wash and is designed to protect the Crown Pointe apartment complex which has been partially developed on the wash flood plain. The study included a geomorphological investigation of Hiko Springs watershed and wash, a hydrology investigation of the 100-year flood, a two-dimensional computer model simulation of hyperconcentrated sediment flow routed down the wash, and an analysis of flow hydraulics and scour in the vicinity of the wall.

Hiko Springs Wash is incising through an ancient alluvial fan which at one time, long ago, was developed primarily from the sediment yield from the Hiko Springs watershed. The wash is limited to about 1500 feet in width and does not represent a typical alluvial fan developed by flows from an ephemeral drainage. The 100-year flood was estimated at 11,100 cfs and would not inundate the entire wash bottom. The results reveal that the proposed wall would perform adequately during the passage of the 100-year flood. The 6 foot high wall will not overtop considering a wave analysis for velocity head and antidunes, and the 11 foot subsurface extension of the wall is sufficient protection against scour. Sediment deposition along the wall during the flood event would be minor and would not affect the flood hydraulics or the performance of the wall. Riprap or other acceptable measures for the flow side of wall is suggested for protection against progressive local scour. The report is organized into three principal chapters: an introduction presenting the geomorphology of the wash, a chapter on hydrology, and one describing the analysis of hydraulics, sediment transport, and routing of the flood flows.

The engineering analysis and preparation of the report were conducted under the supervision of William T. Fullerton, registered engineer in the State of Colorado.

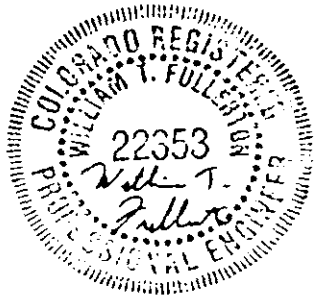


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I. INTRODUCTION

1.1 PURPOSE OF STUDY

Lenzotti & Fullerton Consulting Engineers, Inc. was contracted by James M. Montgomery Consulting Engineers, Inc. to study the hydrology, hydraulics and sediment transport of Hiko Springs, watershed and alluvial wash near Laughlin, Nevada with the express purpose of delineating and investigating potential hydraulic and sedimentation problems of the proposed Crown Pointe Flood Wall. The flood wall will be constructed to protect the Crown Pointe development complex for the 100-year flood near the lower terminus of the 3.3 mile Hiko Springs Wash. The structural design and engineering of the Crown Pointe Flood Wall was performed by James M. Montgomery Consulting Engineers, Inc.(JMM) of Las Vegas, Nevada. This study as undertaken by Lenzotti & Fullerton Consulting Engineers, Inc. does not address the appropriateness of the site location or possible downstream impacts during a flood event.

1.2 SCOPE OF WORK

The scope of work for this hydraulic and sediment investigation was focused on the following specific tasks:

A. Review the existing hydrologic studies and data for the Hiko Springs watershed.

B. Review the existing flood hazard and hydraulic criteria for establishing the Flood Insurance Rate Maps (FIRMs) for the Hiko Springs Wash.

C. Determine the 100-year flood hydrograph at the apex of the Hiko Springs Wash using the existing 100-year total precipitation and rainfall volume as furnished by JMM. This includes the determination of watershed geometry, infiltration variables, excess rainfall and other watershed parameters.

D. Route the 100-year flood hydrograph across the Hiko Springs Wash from the fan apex to the Crown Pointe Flood Wall.

E. Estimate the sediment transport at various cross sections along the wash and at the Crown Pointe Flood Wall for a worst case scenario using hydrology and hydraulics based on hyperconcentrated sediment flow from the upstream watershed.

F. Determine the hydraulic conditions and identify any sedimentation or scour problems associated with the passage of the flood discharge along the wall.

G. Prepare a report documenting the methodology used and description of the model, its theory and applications.

H. Discuss the hydraulic and sedimentation conditions along the wall in the context of the existing design criteria.

1.3 FLUVIAL GEOMORPHOLOGY OF THE HIKO SPRINGS WATERSHED AND ALLUVIAL WASH

The Hiko Springs drainage is one of three ephemeral basins whose flow has created an extensive alluvial fan on which part of the community of Laughlin, Nevada, near the southern tip of Clark County, is developing. The other two basins are Bridge Canyon and Dripping Springs. Together the three coalescing fans have, over geologic time, created an alluvial fan that has forced the Colorado River against the far east side of the valley. The alluvial fan is approximately one third as large as the three combined upstream watershed areas (about 29 square miles). The 17 square mile Hiko Springs basin upstream of the fan apex is more than twice the size of the next largest watershed, Bridge Canyon; 7.3 square miles. Dripping Springs is only 4.5 square miles. This simple geophysical aspect is crucial to the understanding of the physical features and the geomorphic processes evident today on the large complex alluvial fan.

Dripping Springs and Bridge Canyon are steep watersheds comprised principally of exposed and weathered Precambrian granites and diorities of the southern extension of the Newberry Mountains. Hiko Springs, on the other hand, has steep slopes of exposed granites in the upper most extensions of the watershed and a relatively flat alluvial valley upstream of its short steep canyon (See Plate 1). This stored alluvium represents a major source of sediment for the alluvial fan downstream of the canyon. The younger granitic pluton, which is prominent in this region has weathered into the sand sized material comprising the alluvial fan (Western Technologies, Inc. 1988, p.3). During a period when a wetter climate existed in this region, prior to the end of the last ice age, the fan was in a building or aggrading phase with the Hiko Springs basin playing the major role. Although now entering the alluvial fan lower in elevation from its canyon mouth than either the Dripping Springs or Bridge Canyon drainages, Hiko Springs once provided most of the foundation material for the fan to build up to their present canyon mouths.

With the dramatic change to a drier climate, the rate of sediment production in the watersheds upstream of the alluvial fan was severely reduced. This region is now representative of the Mojave Desert ecosystem with an annual average rainfall of around 4 inches, most of which occurs in the form of intense summer thunderstorms. The alluvial fan, in this drier period, has crossed the threshold from being in an aggradational phase to one that is degradational. Consequently, the Hiko Springs basin has reversed roles, switching from being the major contributor to the construction of the fan to being the drainage most quickly eroding the fan and depositing it into the Colorado River. In doing so, the Hiko Springs channel starting from the apex of the fan has sought out the shortest, steepest route across the fan to the Colorado River. This route is now located along the edge of the southern extension of the main alluvial fan and the Hiko Springs channel has entrenched itself as a separate wash 50 to 60 feet lower in elevation than the original paleo-fan surface. This wash, up to 1,500 feet wide in some locations, is only partially inundated during a given flood event.

The wash is currently in a continual state of downcutting through the old alluvial fan deposits. The fan itself now serves as a source of sediment that the flood waters carry to the Colorado River; most likely at a rate nearing its hydraulic capacity to transport sediment down the steep wash slope (in excess of 4.4 percent). The channels of the other two watersheds are also observed to be in a state of degradation. Each channel is slightly entrenched from 10 to 20 feet. The difference in degree of channel entrenchment in the alluvial fan is attributed to the size of the upstream watershed and the magnitude of the flood events responsible for transporting the fan sediments to the Colorado River.

As Hiko Springs Wash downcuts through the old alluvium of the fan, several unique and interesting physical processes of sedimentation can be observed. Boulders that may roll into the flow in the canyon during the flood event are discharging onto the wash and come to rest near the apex of the fan where the flow begins to spread and loses its "competence" to carry larger sized rocks. Numerous rocks, however, are found on the surface dispersed throughout the upper half of the wash which have not been deposited by recent events. These boulders have been left behind by flows long ago and now are only shifted around in a downstream direction as the flood events scour the substrate from around them. Movement of large sediment downslope in the wash is a slow, discontinuous process.

Near the fan apex, evidence of scour and backfilling is apparent. When a flood event occurs, in the wash near the canyon mouth and for a short distance upstream to where the channel is constricted by the canyon escarpments, the channel bed is scoured until after the passage of the peak flow. Eventually some of the scoured area

of channel is backfilled with sediment during the recessional limb of the hydrograph.

In recent times, flood discharges in Hiko Springs Wash at the canyon mouth, have had a capacity to transport more sediment than is supplied from the upstream watershed. Although in the present condition the channel in the upstream watershed and through the canyon is relatively free of debris, the potential for debris flows and debris frontal waves exists and have occurred in the past. The lack of fine material (silts and clays) in the upstream watershed and on the alluvial wash will prevent flows usually referred to as mud flows from being generated in the watershed. Any debris and large boulders transported through the canyon would deposit shortly after flows left the canyon and began spreading. From that point, the sediment load in the wash would be transported by the processes of bed load and suspended load. Such flow, in the most conservative estimate, would be in the upper range of sediment concentration categorized as water flow (10-20% by volume) and the fluid properties would be those of water. This concentration is lower than the range of sediment concentrations for mud flood and mud flows commonly grouped under the classification of hyperconcentrated sediment flows (NRC, 1982) where the properties of the fluid matrix such as density, viscosity and yield stress are altered by high concentrations of fine sediment (Table 1).

1.4 FIELD RECONNAISSANCE

Hydrologic and sediment data were collected for the Hiko Springs watershed and alluvial wash during a field reconnaissance trip to JMM, Las Vegas and to the Crown Pointe development site. The entire Hiko Springs drainage was observed on foot from the headwaters to the Colorado River. Sediment samples of the surface and subsurface were collected for seven sites throughout the Hiko Springs Wash and upstream watershed at locations where recent flow deposits were evident. The purpose of the site reconnaissance was multifarious:

1. To investigate the general watershed characteristics, including geology, topography, and drainage development.

2. To identify the degree of natural channelization in the wash and upstream watershed.

3. To investigate recent construction and development in the wash or upstream watershed which may effect the flood hydrograph or the flow hydraulics at the wall.

4. To examine the watershed and wash physical characteristics that would assist in estimating flow roughness coefficient and curve numbers for use in an HEC-1 analysis.

5. To observe riparian vegetation and upstream watershed vegetation and estimate its contribution to flow resistance.

6. To observe the Hiko Springs Canyon and its potential for flow constriction, debris loading and possible temporary damming and storage of the flood hydrograph.

7. To examine the potential for channel migration, channel avulsion and channel scour in the wash.

8. To examine the existing Crown Pointe development and flood wall and the proposed location of the new wall.

TABLE 1 - FLUID MATRIX CHARACTERISTICS

Type of Flow	Concentration by Volume, C_v percent	Concentration by Weight, C_w percent	Flow Characteristics
Landslide	>64	>88	Will not flow, failure by block sliding or tumbling. Unsaturated soil conditions.
Landslide	50-64	73-88	Will not flow, block sliding failure with some internal deformation, slow creep prior to failure, saturated.
Mud flow	45-50	69-73	Flow initiates, plastic deformation with slow sustained creep. Begins spreading, moves subject to repeated vibration.
Mud flow	40-45	65-69	Mixes easily, shows some fluid properties. Surface may be inclined at rest. Waves dissipate rapidly.
Mud flood	35-40	59-65	Spreads on horizontal surface, marked particle settling, liquid horizontal surface, two phase separation in quiescent condition, waves travel easily.
Mud flood	30-35	54-59	Sand and gravel settle, distinct wave action.
Mud flood	20-30	41-54	Particles rest on bottom in wave motion.
Water flood	<20	<41	Water flood with bed and suspended load.

From O'Brien, 1986

With this focus the following reconnaissance observations are reported:

The upstream watershed's steep topography is associated with the Precambrian intrusions which constitute the impervious areas in the drainage. Both the drainage and wash have low density vegetation typical of a desert ecosystem (desert brush and cactus). The upstream drainage is undeveloped, crossed only by a two lane highway and some range fences. At the present time, alteration of the watershed would not produce additional runoff or sediment yield. There is limited channel development in the upstream watershed and most of the flow is confined to a swale in the valley alluvium. Near the canyon entrance, the water course becomes more confined and some evidence of recent bankcuts of up to five feet were observed. The base level of the upstream watershed is controlled by the geology of the canyon entrance and possibly some episodic filling and downcutting of the swale near the mouth.

At the present time, the short mile and a half canyon appears relatively free of detritus and debris obstruction. The next major flood event is not expected to produce a significant debris flow. The canyon is very constricted by the geology, however, and there is potential for damming by a single large boulder. In one location, the entire flow passes a narrow slot in the canyon outcrop that is on the order of 10 feet wide at the bottom. Large immobile boulders with 10 feet and larger diameters constrict the watercourse upstream of this narrow slot.

In the alluvial wash the channel is free to migrate back and forth across 1,000 to 1,500 feet of width. The channel could be slightly constrained by the minor banks that may be created while the channel is incising. The potential for channel avulsion and migration across the wash is unlimited. The vegetation of the upstream watershed and downstream wash is similar in type and density.

Recent construction activity in the wash may effect the flow hydrograph and flow hydraulics in the vicinity of the Crown Pointe development. These developments include two newly constructed unpaved roads across the fan, one paved road with two bridge culverts of approximately 13,000 cfs combined discharge capacity, and a fill site which cuts off an old channel. The unpaved roads would only impact the downstream flow if the smaller discharges are diverted. The paved road would be overtopped in the event that the peak discharge exceeds the bridge culvert capacity. This possibility has conceivably been addressed by soil grouting the roadway embankment between the two bridges. The fill site extends a few hundred feet from the Needles Highway out into the wash approximately 500 feet downstream of the east bridge. It lies directly in the flow path of the discharge from the east bridge. It is our understanding that this fill will be removed and therefore the fill material and associated potential diversion of the flow was not considered in the analysis.

II. HYDROLOGY

2.1 INTRODUCTION

To analyze the hydraulic and sediment transport conditions at the proposed Crown Pointe flood wall, a 100-year flood hydrograph must be routed down the wash and past the proposed wall to estimate the worst hydraulic conditions to which the wall would be exposed. The U.S. Army Corps of Engineers HEC-1 model was utilized to determine the hydrograph at the apex of the wash. A state of the art, two-dimensional (2-D) routing model for unconstrained flows was utilized in the analysis to route the flows down the wash and past the wall. The 2-D model input requires a discharge hydrograph for the 100-year event. A discussion of the development of the hydrograph is presented in the following sections after a brief review of the historical flooding problems.

2.2 PRINCIPAL FLOOD PROBLEMS, HISTORIC FLOODS AND EXISTING FLOOD PROTECTION MEASURES

Existing developments subject to flooding by the Hiko Springs Wash consist of the Crown Pointe development and residences within the wash boundary near the Colorado River. Also, there is a hazard to cars and pedestrians on the Needles Highway and on the El Mirage road and bridges during the flood event. Any future development and road construction in the wash may increase the potential flooding problems within the vicinity of the Crown Pointe development or downstream. This would include additional road and culvert construction, or planned development on sites contiguous to Crown Pointe.

Historic flooding of Hiko Springs Wash is undocumented. The physical evidence of the wash does not give any indication of the magnitude of past historical flood events. Estimates of possible peak discharges in the canyon from scour marks on the canyon outcrops would be distorted by the unpredictable scour of the alluvial bed. No data exists to verify the magnitude or frequency of past floods.

As was previously discussed, the only existing mitigation measure against the possible flooding of Hiko Springs Wash is the concrete block wall protecting the Crown Pointe development. This wall is in disrepair and may fail in the course of a 100-year flood event given that the flows were to impinge and scour against the wall. No other upstream flood control exists in Hiko Springs and no future plans for flood control were considered in this investigation.

2.3 HYDROLOGIC ANALYSIS

2.3.1 Previous Studies

Previous hydrologic studies for the Hiko Springs watershed include a hydrologic analysis by the Clark County Department of Comprehensive Planning, the Clark County Flood Control Master Plan by JMM, a draft report on the Hiko Springs and Unnamed Wash Facilities Plan by Boyle Engineering Corporation (1988) and "Flood Damage Report for August 29, 1988 Storm Event" for the Unnamed Wash by Summit Engineering Corporation (1988). The Comprehensive Planning study applied a computer program (TR-20) developed by the Soil Conservation Service (SCS) to estimate peak flows using the SCS unit hydrograph procedure. It computed a peak of 8,370 cfs for the 100-year flood. The TR-20 model results were incorporated into the flood insurance study for Hiko Springs. JMM employed the HEC-1 model using the SCS unit hydrograph method with three subbasins. With a design storm of 3.35 inches of precipitation and a curve number (CN) of 88, a peak flow of 11,234 cfs was calculated at the wash apex for the 100-year event.

Boyle Engineering (1988) performed a HEC-1 analysis for the Hiko Springs watershed. The basin was divided into twelve subbasins and the various return period flows for the subbasins were estimated using the SCS dimensionless unit hydrograph procedure with lag times based on the Corps of Engineers methodology. Flow routing in the channel units connecting the subbasins was calculated using the HEC-1 kinematic wave routing procedure. A six hour rainfall volume of 4.58 inches was employed in the analysis. The result was a peak discharge of 9,500 cfs.

Summit Engineering (1988) reported that the August 29, 1988 storm and flood event in the Unnamed Wash was 1.35 inches over a 2.5 hour duration. They estimated this was a 10-year return period storm.

2.3.2 Design Storm

A three hour rainfall volume of 2.90 inches was used as the 100-year design storm to determine the flood hydrograph at the apex of the wash for use in this study. This rainfall volume is based on a three hour storm derived from the NOAA Atlas for Nevada (NOAA, 1973). No area reduction factor was applied to this rainfall. The original temporal rainfall distribution factors used by JMM on their HEC-1 analysis were employed in this study.

2.3.3 100-Year Flood Hydrograph - HEC-1 Analysis

To determine the 100-year flood hydrograph at the apex of the wash for this study, the kinematic wave routine of HEC-1 was applied to both the overland flow and channel units in the upstream Hiko Springs watershed. The basin was divided into ten subwatersheds (Plate 1), each with channels and subchannels. The basin's main channel in the watershed was assumed to be very wide and shallow

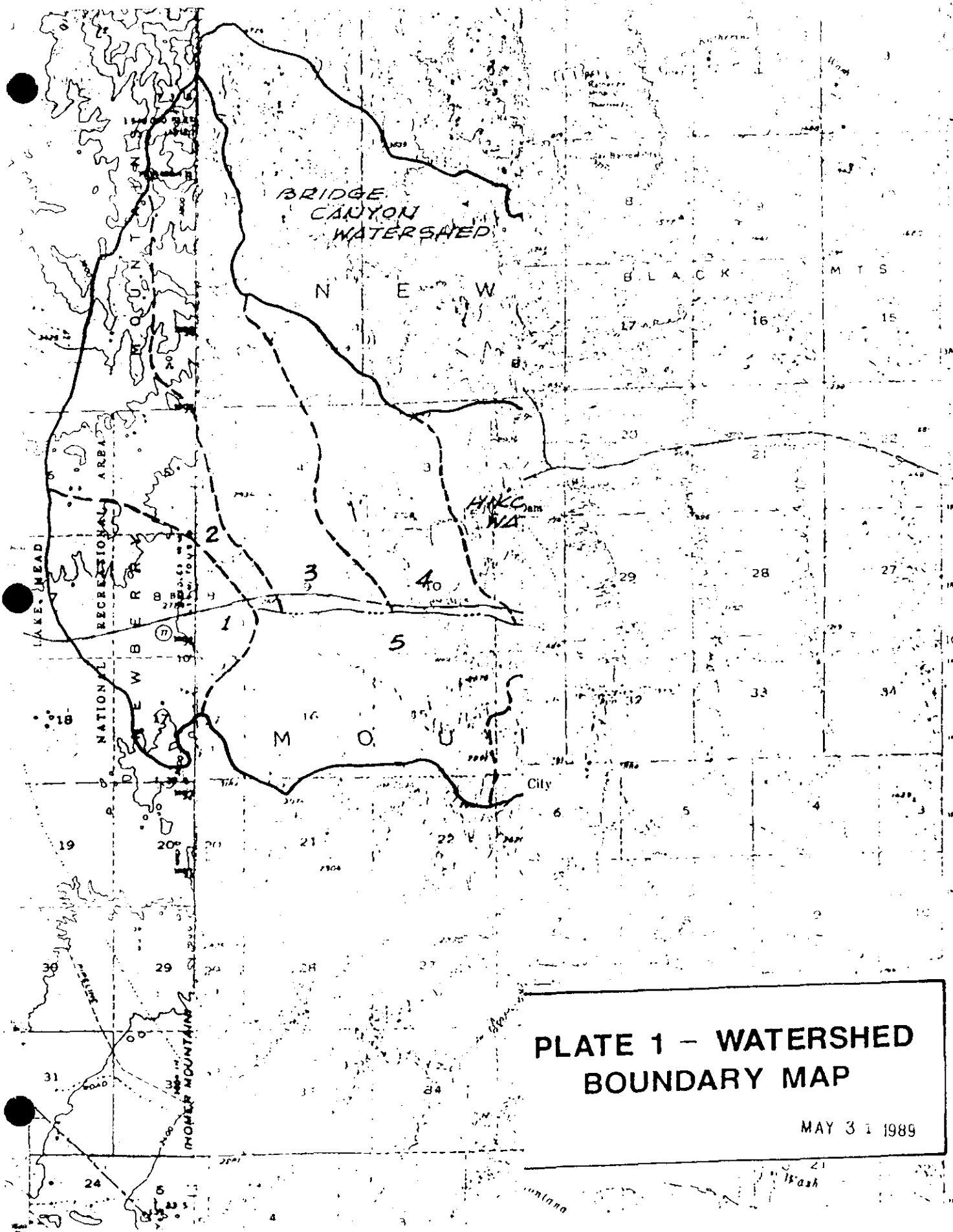


PLATE 1 – WATERSHED BOUNDARY MAP

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near the headwaters and narrow and deep in the canyon. Curve numbers were revised to reflect the pervious and impervious areas of the basin and ranged from 80 to 88.

The resulting 100-year peak flow at the Hiko Springs Wash is 11,100 cfs occurring 1 hour 18 minutes after the inception of the storm. The flood hydrograph is displayed in Table 2. The total hydrograph volume is approximately 1,100 acre-feet corresponding to a peak runoff of about 1.0 cfs per acre. This hydrograph constituted the inflow hydrograph for a two-dimensional, diffusive wave routing model for unconfined flows. (The pertinent data and information regarding the basin can be gleaned from the HEC-1 data input file appended to the report as Appendix C-1.)

As a comparison, the JMM HEC-1 analysis was rerun using a precipitation volume of 2.90 inches and curve numbers of 85 and 86, to produce a peak discharge of 8,370 cfs. This HEC-1 output is presented in Appendix C-2.

TABLE 2 - INFLOW HYDROGRAPH AT WASH APEX (FROM HEC-1 ANALYSIS)

HOUR AFTER RAINFALL INITIATES	WATER DISCHARGE (CFS)	BULKED DISCHARGE (CFS)
0.9	131	164
1.0	1378	1723
1.1	4687	5859
1.2	9261	11576
1.3	11127	13910
1.4	10368	12960
1.5	9434	11793
1.6	8587	10734
1.7	7719	9648
1.8	6971	8714
1.9	6344	7930
2.0	5840	7300
2.5	3803	4754
3.0	1975	2469
3.5	959	1199
4.0	509	636
4.5	301	376
5.0	192	240
6.0	92	115
7.0	51	64
8.0	0	0

III. HYDRAULIC ANALYSIS OF THE 100-YEAR FLOOD

3.1 GENERAL APPROACH

The existing methodology for determining flood hydraulics on alluvial fans, thus establishing FEMA Flood Hazard Maps, is known as the Dawdy Method and is presented in Appendix 6 of "Guidelines and Specifications for Study Contractors" (FEMA, 1982). This methodology estimates velocity and depth zones using empirical relationships based on the assumptions that unconfined flow will be limited to a certain fan arc width. This fan arc width is a probabilistic function whose derivation has no supporting laboratory or field verification or calibration. The method is based on generalized relationships for the hydraulic geometry of rivers. Applying the Dawdy Method to Hiko Springs Wash is inappropriate because the alluvial fan is confined between the limits of the wash's incised banks. Unrealistic depths and velocities computed with the Dawdy Method are shown in the existing FIRMs along the entire wash. The three basic assumptions inherent in the Dawdy Method are:

1. The flood discharges at the fan apex follow a log Pearson type III distribution.

2. Each event creates a single channel which contains the flow throughout the event.

3. Flood channels are uniformly distributed across any contour.

The latter two assumptions are not applicable to Hiko Springs Wash. In addition, the model also relies on the assumption that for channel stability, the hydraulic geometry relationships apply to channels that are formed by the discharge flowing at critical depth. This assumption is also questionable for the Hiko Springs Wash.

After a review of a the (FIRMs) for Hiko Springs Wash, it was evident that to simulate hydraulic conditions at the proposed Crown Pointe wall, the flood hydrograph must be routed from the wash apex to the wall. A two-dimensional, diffusive wave, hyperconcentrated sediment flow model designed by Dr. J.S. O'Brien was chosen for this purpose. A description of the model, MUDFLOW, is provided in the next section.

3.2 TWO-DIMENSIONAL FLOOD ROUTING MODEL FOR UNCONFINED FLOWS ON ALLUVIAL FANS

Flood hazards on alluvial fans are characterized by transient phenomena such as debris laden frontal waves, surging and channel avulsion. The most practical approach to modeling water and hyperconcentrated sediment flows on alluvial fans is to consider

the flows as a continuum, combining the water and sediment components. This satisfies the objective for predicting a general range of flow properties including velocity, depth, and the area of inundation of the flood as it progresses down the fan . The two dimensional routing model for hyperconcentrated sediment flows on alluvial fans (MUDFLOW) is a modified version of a model developed for routing overbank river channel floods. The original model, called the Diffusive Hydrodynamic Model (DHM), was designed by T.V. Hromadka II and C. C. Yen, and published by the U.S. Geological Survey (USGS, 1987).

3.2.1 Model Description

The MUDFLOW model, like original DHM model, simulates the flow of floodwater for both in-channel and overland flows. Overland flow is modeled by a two-dimensional diffusive approximation of the momentum equation. Channel flow is modeled one-dimensionally using either the diffusive or kinematic wave approximation of the complete momentum equation. Both the DHM and the MUDFLOW models can simulate supercritical and subcritical flow, backwater effects from constrictions and bridges, and overland or return flow to the channel. Additionally, MUDFLOW can simulate hyperconcentrated sediment flows.

Simulation of water or mud flow over an unconfined alluvial fan requires two-dimensional flow routing which distributes the flows across the fan laterally and longitudinally. Alluvial fans are often very steep and have complex physical and topographical conditions. The diffusive pressure gradient term of the momentum equation is important for modeling diverse topographical conditions. It permits simulation of ponding, water flow over adverse slopes, and backwater effects due to channel constrictions which a kinematic wave model cannot. The model also has a new channel-flood plain interface routine which is an integral part of the two-dimensional aspect of the MUDFLOW model.

A brief description of the constitutive equations, the numerical scheme and modification of the equations for simulating hyperconcentrated sediment flow is presented in Appendix A.

Flows over alluvial fans are simulated using a central difference, finite difference routing scheme to solve the continuity and momentum equations using uniform grid elements. The entire Hiko Springs Wash fan area was discretized into an excess of 450 grid elements, each a 200 foot square (Plate 2). At each grid node the discharge flux across the four boundaries from the four contiguous grid elements is calculated. The net volume change and change in depth for a given time step are approximated using a linear trial function between nodal points of the grids. Each grid node is assigned an elevation, roughness factor, and area and width reduction factors. The flow simulation progresses over the grid elements using an explicit numerical technique. The simulation of split flows on the wash are possible.

The original DHM model was verified by evaluation of the one- and two-dimensional routing components separately. The results of diffusive wave model were compared against the USGS K-634 dam break model (Hromadka and Yen, 1987). Other applications of the model are reported in Guymon and Hromadka, 1986; Hromadka and Durbin, 1986; and Hromadka, et. al.,1985. O'Brien applied the MUDFLOW model to two alluvial fan cases, one involving the 1984 mud flow at Rudd Creek, Utah; and the second, a prediction of the mud flooding on the Cornet Creek alluvial fan in Telluride, Colorado. Excellent results were obtained in both cases (O'Brien and Grindeland, 1989).

3.2.2 Model Limitations and Assumptions

MUDFLOW is a generalized routing model with the capabilities of simulating water and mud flows based on their physical processes. The representation of shear stresses in the mud flow equation are empirical by nature. The viscosity and yield stress relationships, and the turbulent flow Manning's equation all have limitations to their application based on the assumptions inherent in their derivation.

The physical process limitations of the MUDFLOW model are straightforward. The diffusive wave model has eliminated the inertial acceleration terms from the full dynamic wave equation; this eliminates the special cases of unsteady phenomena such as surging and hydraulic jumps. The flow is assumed to be gradually varied with a hydrostatic pressure distribution. The momentum equation coefficient is assumed to be equal to one. A rigid boundary is assumed and thus aggradation and scour, channel avulsion, flow competence are not simulated.

The model predicts average flow values including discharge, depth, velocity, and sediment concentration between nodes for a chosen time step and channel or alluvial fan reach. There is variation in fluid properties both spatially and temporally in the flow. This includes vertical variation in such fluid properties as concentration, density and viscosity. The model's usefulness arises from its ability to accurately simulate average flow properties and general areas of inundation.

3.2.3 MUDFLOW Model Modifications

MUDFLOW provides an opportunity to use a three-phased approach to the problem of simulating flows in ephemeral watersheds, watercourses, and alluvial fans. In the first phase, excess rainfall can be routed overland in the upstream watershed. In the second phase, water floods, mud floods, and mud flows can be simulated temporally and spatially in the watershed channel. Finally, for the third phase the outflow hydrograph from the watershed channel can be routed two-dimensionally over the alluvial fan as either a water flood, mud flood, or mud flow, whether or not

a channel exists on the fan. Since the watershed was modeled using HEC-1, only the third phase of the MUDFLOW model was used for Hiko Springs Wash.

Hiko Springs Wash displays evidence that a granular type of debris flow is possible but the effects of the debris flow would not extend downstream beyond the upper one third of the wash. A water flood with high concentration of sediment transported as bed load and suspended load is the type of flood most characteristic of the Hiko Springs Wash. The application of the hyperconcentrated sediment flow component of the model was limited to a concentration of 20% by volume. Its effect on the hydrograph was discerned to be minor except for the bulking of the discharge. Therefore, the discussion regarding the derivation of this sediment component was relegated to Appendix A-3.

Other revisions to the original code have been designed to permit adjustments to individual grid elements for flow width reductions and flow volume (planimetric area) reductions based on the characteristics of each element. Such reductions are justified on the basis that a portion of the grid may be outside the wash, that large structures may occupy a major portion of the grid element or may block the flow between grids. These modifications make the model more sensitive to the physical attributes of the alluvial fan. A modification to model bridge and culvert outflow using stage-discharge relationships has also been included.

3.2.4 Model Sensitivity

The MUDFLOWM model employs an explicit numerical advancement scheme, thus the choice of time increment and grid size is theoretically dependent on the Courant condition, which states that

$$C_c \frac{\Delta t}{\Delta x} < 1 \qquad (1)$$

where C_c is the wave celerity. The model may perform poorly if the time step (Δt) versus the grid size (Δx) ratio becomes too large. The model has an inherent procedure to alleviate this instability by decreasing the time step increment until convergence in the computed results is achieved. In essence, the sensitivity to the time step selected is dependent on the wave celerity or slope of the discharge hydrograph $\Delta Q/\Delta t$. If the time step is decreased, the calculation of the inflow and outflow discharges will be refined and the depth variation at the nodal points will be smoother. Increasing the grid spacing has a similar effect by creating additional water storage. For large variations in discharge (i.e., large $\Delta Q/\Delta t$), the lag in outflow from the source volume can generate unacceptable computational error.

In the model verification, slope, discharge hydrographs, and Manning's roughness coefficient were varied. The most sensitive

parameter was the friction factor (Hromadka et al. (1985). Conversely, the model spacing was relatively insensitive. The model has been adapted for application to complex problems involving flood flows on alluvial fans or flood plains. The nature of hyperconcentrated flows required modification of the constitutive equations to include viscous shear stress terms.

3.3 MODEL APPLICATION TO HIKO SPRINGS WASH

To predict the hydraulic conditions for the 100-flood at the proposed Crown Pointe Wall, the MUDFLOW model was applied twice. First, the entire wash was discretized into 200 foot square grids (477 grids) from the wash apex to just upstream of the proposed wall location. The remainder of the wash from the end of the 200 foot grid layout to just downstream of the Needles Highway was discretized into 100 foot square grids, quadrupling in detail the modeling simulation. Application of the outflow hydrograph from the first set of 200 foot grids constituted the inflow hydrograph to the second set of 100 foot grids. Grid characteristics were modified to represent the proposed wall as "in-place". Velocities and depths and their spatial and temporal variation were computed along the proposed wall. Maximum depths and velocities were compiled in a summary table at the end of the computer printout. Three scenarios were modeled for the wash's upstream grid layout:

1. Water flows without the El Mirage bridge culverts in place.

2. Water flows with the El Mirage bridge culverts in place.

3. Hyperconcentrated sediment flows of 20% concentration by volume without the bridge culverts in-place.

The data input required Manning's "n" roughness coefficients and representative elevations for each grid. Roughness values ranged from 0.05 near the wash apex to 0.03 near the proposed Crown Pointe wall site. The inflow hydrograph at the fan apex was discretized into time steps, shorter near the peak, longer on the recessional limb. Other data requirements included grid area reduction factors and flow width reduction factors for those grids constricted by the physical aspects of the fan such as the wash banks or by construction such as bridges or buildings.

The El Mirage bridge culverts were modeled as follows: A grid node was assigned to each of the two bridge culverts. Field measurements revealed that each bridge consisted of six 12'x 6' box culverts. An equivalent discharge coefficient for each bridge was calculated using a culvert length of 42 feet and upstream control of the discharge (i.e., the box-culvert was not flowing full). The

discharge coefficient formula (Brater and King, 1976) is

$$C = (1+0.4\ r^{0.3} + \frac{.0045L}{r^{1.25}})^{-0.7} \qquad (2)$$

where r is the hydraulic radius and L is the length of the culvert. The bridge culverts are identical and the coefficient C was 0.79 for each. Discharge through the culverts was calculated using the equation:

$$Q = 456.46\ h^{2} \qquad (3)$$

Where h represents the depth of flow at the culvert entrance or the depth for the grid that contains the bridge. The purpose of this bridge analysis was to determine if the peak discharge and overall hydrograph was altered by the rate at which the bridge culverts pass the discharge. Ponding may ensue upstream of the bridge. Based on Equation 3 the peak discharge capacity of the bridge is 13,400 cfs, sufficient to pass the 100-year water flood.

The results for the upper portion of the wash are presented in a series of computer outputs for the scenarios described previously. At each model time increment the computer prints out the results for ten representative cross sections along the wash (Plate 2). These results include water surface elevation, flow depth, four directional velocities, the discharge component to the south, the resultant velocity and the average depth for each node in the cross section. The average hydraulic values for each cross- section including discharge, velocity, width and depth are tabulated after the individual grid information. In addition, the inflow hydrograph discharge for that model time increment, the model time, and minimum, maximum and average computational time step are reported. At the conclusion of the simulation, a summary table displaying the maximum depth and velocity, and the corresponding times when they occurred for each node can be found.

The most important result from the upstream wash computations is the hydrograph at the last cross section which will constitute inflow for the more detailed examination of the flow in the vicinity of the wall. For verification of the models accuracy, each cross section discharge can be summed for the simulation time to insure that continuity is preserved. The flow hydrograph volume was 1,100 acre-feet. Scenario I, water flow without bridge culverts and without hyperconcentrated sediment component, the volume of the outflow hydrograph at the last cross section was 1,050 acre-feet. A retention factor of 0.1 feet was assumed in the model to simulate the infiltration of water on the fan. This accounts for 30 to 40 acre-feet that is still on the fan at the end of the simulation and has not reached the final cross section.

The second scenario for the bridge culvert without the sediment component indicated that the impact of the bridge culverts on outflow hydrograph was inconsequential. Further, it was determined that the east bridge actually directed the flow away from the wall. The final computer simulation was performed without the bridges to insure that a worst case scenario for the flow against the wall was analyzed.

Elevations for the last several rows of the grid nodes were slightly revised. The purpose of revising the elevation was to lessen the impact of the existing small swale downstream of the east bridge culvert. In the advent the swale will be obliterated during construction activities, more flow would be directed towards the Crown Pointe wall. Part of the swale has already been eliminated by road fill. Again, the elevation revisions were imposed to insure that a worst case scenario for flow in the vicinity of the wall was examined.

The existing high berm roadway that extends north and south bisecting the wash downstream of the El Mirage bridge culverts was modeled. Flows between the grids straddling the berm were computationally prevented. In the field, the flow path after passing the bridges could access either side of the berm, but flow across the berm was impossible. This condition was simulated in the model computations.

Results from a study of hyperconcentrated sediment flows by O'Brien, (1986) and O'Brien and Julian, (1987), were incorporated into the analysis of flows with the sediment component. Table 1 indicates the range of concentrations for various classifications of hyperconcentrated sediment flows. This table reflects the categories promulgated by the National Research Council (NRC, 1982). After a review of the sediment size distributions for various locations along the Hiko Springs drainage, it was determined that the watershed was incapable of producing the category of flows referred to as mud flows or mud floods. The factors supporting this conclusion are the lack of fines in the bed material, the uniform elevations across the wash, and the general lack of debris in the wash or in the canyon. Although a given flood event may produce a frontal wave carrying some debris and boulders, most of the large material would be deposited near the fan apex as the flow starts to spread out. Granular flows, such as those which might occur in Hiko Springs Wash, has an interstitial fluid matrix that is essentially water and are characterized by such phenomena as low competence, high dispersive stress, and rapid but uniform deposition with changes in slope and loss of energy. From the physical features of the fan, it is obvious that most of the sediment is being transported by water floods with high concentrations of bed and suspended load. O'Brien (1986) provides experimental data on the viscosity and yield stress of high sand concentrations with small percentages of fines (>0.0625mm, see Figure 1). This information was employed in this

analysis to define the shear stress for the hyperconcentrated sediment component (see discussion in Appendix A-3).

In the worst case scenario, a uniform concentration of 20% by volume run represented the upper limit of sediment transport by the phenomena of bed and suspended load. This is slightly unrealistic as the high concentration in such event will only occur near or prior to the peak discharge. Variations in the concentration are controlled by the sediment supply and the hydrograph from the watershed, but without this data, a worst case concentration of 20% was chosen. The results show that the

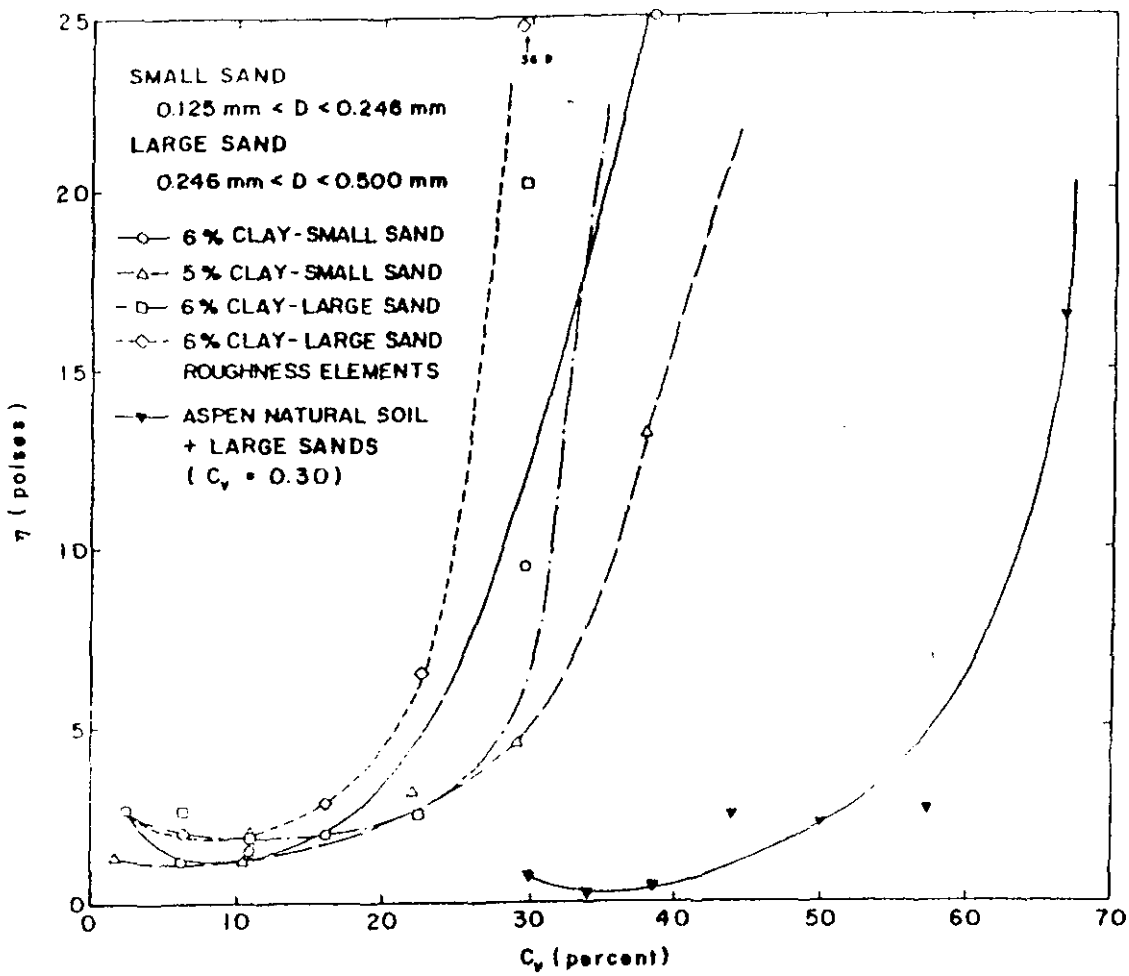


FIGURE 1. Clay and Sand Composite Viscosity Versus Total Concentration by Volume (from O'Brien, 1986)

dominant effect of the sediment is the bulking of the hydrograph. A bulking factor (BF) of 1.25

$$BF = \frac{1.}{1.-C_v} \qquad (4)$$

was incorporated into the calculations. The viscous and dispersive stresses arising from the 20% concentration are minor compared to the friction stress losses associated with the boundary roughness. The higher discharges resulting from the increased sediment concentration were used in the hydraulic analysis of the wall described below. The results from the upper wash simulation (Appendix C-3) were considered to be valid and thus the simulation of flow hydraulics in the vicinity of the proposed Crown Pointe wall were performed using the upper wash hydrograph as the inflow hydrograph (Table 3). Only the computer results from the hyperconcentration sediment flow analysis without the bridges are appended to the report. The other two scenarios, water flow with the bridges and water flow without the bridges produce similar results but lower discharges.

In the lower wash simulation, a 100 foot square grid system of 246 grids was created and the proposed Crown Pointe wall was superimposed on the system (Plate 2). Again, elevations and roughness values were assigned for each grid element. The hydrograph was distributed across the upstream row of grids according to the outflow distribution from the upper wash grids. Five cross-sectional rows of grids were tabulated in the output file together with the grids containing the proposed wall. The velocity, depth, width, for each grid of interest and the discharge and average cross-sectional velocity, depth and width were determined. The final hydrograph for the outflow of the lower wash is presented in Table 4.

Using the hydraulic data from the model simulation, the following analyses were performed:

1. Sediment continuity analysis for the entire wash.

2. An analysis of the maximum wave height and flow depth in the vicinity of the wall.

3. Analysis of the possible scour depth due to flow along the wall.

The results of the flood routing and hydraulic simulation are discussed in the following section.

TABLE 3 - OUTFLOW HYDROGRAPH FROM UPPER WASH (USING MUDFLOW MODEL)

HOUR AFTER RAINFALL INITIATES	WATER DISCHARGE (CFS)	BULKED DISCHARGE (CFS)
0.9	0	0
1.0	0	0
1.1	0	0
1.2	0	0
1.3	0	0
1.4	0	0
1.5	0	0
1.6	9730	12162
1.7	9564	11955
1.8	9054	11318
1.9	8320	10400
2.0	7511	9389
2.5	5074	6343
3.0	3209	4011
3.5	1801	2251
4.0	972	1215
4.5	741	926
5.0	461	576
6.0	186	232
7.0	87	109
8.0	62	78

TABLE 4 - OUTFLOW HYDROGRAPH FROM LOWER WASH (USING MUDFLOW MODEL)

HOUR AFTER RAINFALL INITIATES	WATER DISCHARGE (CFS)	BULKED DISCHARGE (CFS)
0.9	0	0
1.0	0	0
1.1	0	0
1.2	0	0
1.3	0	0
1.4	0	0
1.5	0	0
1.6	9730	12162
1.7	9564	11955
1.8	9053	11316
1.9	8374	10467
2.0	7621	9525
2.5	5120	6400
3.0	3657	4571
3.5	1925	2406
4.0	1166	1457
4.5	793	991
5.0	473	591
6.0	191	239
7.0	96	120
8.0	66	82

3.4 RESULTS OF THE FLOOD ROUTING AND HYDRAULIC ANALYSIS

3.4.1 Soil Analysis

The discussion of the results begins with the soil analysis of seven Hiko Springs sites, two in the upstream watershed, five distributed along the wash from the apex to below the El Mirage bridge (Table 5). All of samples were collected in or near recently reworked channels. Several observations can be drawn from the soil analysis.

i) The bed material is composed of the sediment available from the upstream watershed. Samples from Sites 2 and 14 are virtually identical.
ii) There is a uniform distribution of bed sediment in the wash.
iii) The quantity of fines in the bed material is insufficient for the floods in the wash to be categorized as mud flows.
iv) There is some desert or surface armoring probably the result of aeolian erosion and raindrop impact. This phenomena is demonstrably shown in the comparison between the Site 3 surface and subsurface sample. The armoring layer appears to be only one mean grain diameter thick.
v) In areas where the flow has higher velocities or is accelerating, the bed material is slightly coarser (Site 11 near the fan apex and Site 6, upstream of the El Mirage bridge).
vi) Sorting and deposition of transported material occurs for the gravel to boulder sized material near the wash apex, but the flow matrix material remains the same along the wash.

TABLE 5 - SEDIMENT SIZE DISTRIBUTION FROM SITES IN THE HIKO SPRINGS DRAINAGE

SITE	DESCRIPTION	% FINES	(IN MM) D_{16}	D_{50}	D_{84}
2	Near Headwaters	4.0	0.36	1.2	3.5
3	U/S of Canyon (subsurf.)	11.2	0.14	1.0	3.9
3	U/S of Canyon (surface)	0.4	2.3	4.2	9.4
6	U/S of El Mirage Bridge	10.3	0.22	2.3	6.6
8	Near Canyon Mouth	2.0	0.45	1.6	4.3
11	Near Wash Apex	1.4	1.2	2.4	4.8
13	Near Cross Section #3	5.2	0.42	1.2	3.3
14	Near Cross Section #4	8.1	0.26	1.2	3.7

The sediment size analysis was used in the sediment continuity analysis described below.

3.4.2 Hydraulic Analysis

The travel time for the peak discharge down the wash to the final cross section in the watershed computations is between 0.3 and 0.4 hours. This represents a celerity of the peak discharge of 10 to 13 feet per second. The water peak discharge attenuates from 11,100 cfs to about 10,000 cfs traveling down the fan. The peak arrives at the final cross section much closer to the frontal wave than when it arrived at the wash apex. Spreading the discharges on the wash near the apex prior to peak discharge sufficiently reduces the depths to slow the flows and enable the peak flow to propagate towards the frontal wave. The roughness has a greater effect on the shallow flows and thus causes them to flow slower. The discharge hydrographs at the fan apex, at the end of the upper wash and at the end of the lower wash across the Needles Highway were presented in Tables 2 through 4.

Reviewing the cross sections in the upper wash output and the summary table at the end of the computer printout in Appendix C-3, the path of the flow down the wash can be discerned. In the upper half of the wash the flow is on the east side, and then it crosses to the west side before it reaches the El Mirage bridge. The flows remain on the west side until the wash widens near the proposed Crown Pointe wall.

Maximum velocities and depths are found near the wash apex and canyon mouth. The maximum velocity ranges from 13 to 17 feet per second with the velocity for one grid element reaching 19 feet per second. The maximum depths range from 4 to 6.5 feet. Near the middle of the wash, the maximum velocities are limited to 10 to 15 feet per second and the maximum depths to 2 to 3.5 feet. In the lower wash, velocities of 8 to 10 feet per second are obtained with maximum depths on the order of 1.5 to 2.5 feet.

3.4.3 Sediment Continuity Analysis

Ten cross sections through the wash were identified to perform a sediment continuity analysis for the passage of the hydrograph. These are located on Plate 2 with five cross sections identified in both the upper and lower wash. The results are presented in Appendix B as the Sediment Transport Summation. The discharge, average width, depth and top width were used in the calculation of the sediment transport capacity at each cross section.

The bed material discharge in cfs per unit width for sand bed channels was determined by an empirical power relationship developed by Zeller and Fullerton (1983). The empirical relationship is a computer generated solution of the Meyer-Peter, Muller bed-load transport equation combined with Einstein's integration of the suspended bed material discharge.

$$q_s = 0.0064 \frac{n^{1.77} V^{4.32} G^{0.45}}{Y_h^{0.30} D_{50}^{0.61}} \quad (5)$$

where n is Manning's roughness coefficient (based on bed forms and grain size roughness), V is the mean velocity, G is the gradation coefficient, Y_h is the hydraulic depth, and D_{50} is the median diameter. In this equation all units are in the ft-lb-sec system, except D_{50}, which is in millimeters.

Sediment transport rates are highly dependent on velocity and depth. The equation provides for the influence of sediment size fractions on transport rates. The measured sediment sizes (Table 5) was used as input in equation 5. The results for q_s and the total sediment transport load (W_s in tons) for the eight hour hydrograph are tabulated in Appendix B.

The results show that the maximum sediment transport will occur at the wash apex where the sediment load will be controlled by the supply from the watershed. By the time the discharge has reached the second cross section the transport rates have dropped significantly. The sediment load into the reaches downstream of this cross section will be limited by the sediment transport capacity of the wash, and the bed material will provide an undiminishable supply. Whereas the sediment transport at the first cross section may have been controlled by the upstream watershed supply, the transport capacity through a given reach will constitute the supply to the next cross section. The sediment transport at cross sections 3, 4, and 5 are fairly uniform showing a slight decrease in the downstream direction. This reflects the slope and width of the wash. When the discharge reaches the cross sections near the proposed Crown Pointe wall, there is a marked decrease in the sediment transport capacity. The ground elevation across the wash is more uniform and the flow is more evenly distributed. The first three cross sections of the lower wash, 6, 7, and 8, have relatively low transport capacities. Here the wash is not yet constricted by the wall. Sediment would be deposited in this area. The last two cross sections reveal the nature of the constriction of the wash by the proposed wall and the transport capacity almost doubles. The bed material would be scoured in the vicinity of the downstream third of the wall. With this knowledge a detailed analysis of sediment deposition and scour in the vicinity of the wall was conducted.

3.4.4 Hydraulic Analysis of Flow Near the Wall

The hydraulic values for the grid elements containing the wall are tabulated in Appendix C-4, the computer printout for the lower

wash. Some deposition near the wall upstream of the wall corner may occur. Here the wall grid velocities are less than the average velocities for the cross section. Flow depths along the upstream half of the wall are limited to less than 1.5 feet. Deposition in such shallow flows would not effect the flow near the wall. Effects of deposition on the functionality of the wall throughout the remainder of the hydrograph will be minor because the flow in the wash is unconstrained. Any deposition near the wall will force subsequent flows away from the wall. Cumulative effects from sediment deposition resulting from equilibrium flow conditions near the wall is not a concern.

A frontal wave laden with debris and boulders impacting the wall is a transient flow condition that should be addressed. As previously mentioned the probability of large sediment from the upstream watershed being carried as far as the El Mirage bridge is small. Severe channelization without interruption would have to extend the length of the wash prior to the event for this to occur. The spreading flow depths and velocities over the wash would be insufficient to transport large boulders very far beyond the mouth of the canyon. Transport of the large boulders is not a continuous process during a given flood event. Any debris and boulders impacting the wall would be those existing in the wash downstream of the bridges. The quantity of debris downstream of the bridge is minuscule, limited to a few scattered boulders. Only a few one to two foot boulders found in the wash downstream of the El Mirage bridge could impact the wall.

3.4.4.1 Wave height analysis

A wave height analysis was performed for the wall based on the flow hydraulics. The worst conditions for possible overtopping would be during the peak discharge which occurs near the frontal wave. The posssibility of overtopping would be greatest where the flow depths along the wall are highest. The highest flow depths are along the downstream one-third of the wall where the wash is constricted by the wall and scour, not deposition, would be the dominant sediment process. The wave height analysis as shown in Table 6 encompasses the maximum depth and velocities along the wall which increase in the downstream direction. Grid element 184 has the worst hydraulic conditions. To conduct the investigation of flow depth and wave height along the wall, the stagnation velocity head, wave height due to surface instability and antidune wave height must be analyzed. The maximum flow depth is less than three feet and alone presents no overtopping problems. The analysis of the wall freeboard follows.

Accounting for the angle of inclination of the wall with the resultant flow velocity vector, the velocity component along the wall V_s and the velocity component perpendicular to the wall V_p are calculated as shown in Table 6. The stagnation pressure or velocity head h_v is determined using the equation

$$h_v = \frac{(V_o)^2}{2g} \quad (6)$$

where g is the gravitational acceleration.

The wave height h_s due to surface instabilities such as surface roughness, air bulking, splash and spray are determined according to the formula

$$h_s = 0.025\ V_o \sqrt{Y_o} \quad (7)$$

The reference for this equation is: Bureau of Reclamation (1977, p. 393).

Finally the wave heights due to antidunes h_a resulting from upper regime flow of a mobile bed are tabulated in Table 6. Assuming the water wave height associated with the antidune as twice the height of the antidune bed and allowing one half of the antidune bed form height for scour below the ground surface and further limiting the maximum wave height to the flow depth, the wave height is determined using the equation

$$h_a = 0.28\ \frac{(V_o)^2}{g} \quad (8)$$

The summation of the velocity stagnation head, maximum wave height due to surface instabilities and the maximum wave height associated with antidunes constitutes the required freeboard. The flow depth plus freeboard is the maximum height that the wall should be constructed, and is tabulated in the final column in Table 6. The proposed wall is six feet high and this is sufficiently high to prevent overtopping due to the cumulative wave heights. The maximum wave height plus flow depth is estimated to be 5.8 feet. It is probable that antidunes would not develop quickly enough to occur with the peak flow and may not be initiated until scour begins, so this analysis is conservative. Also, since the magnitude of the peak discharge is conservatively high, overtopping the wall is not predicted.

3.4.4.2 Scour analysis

The primary concern regarding the functioning of the wall during the passage of the 100 year flood is local scour. The wall constricts the wash along the downstream one third of the wall, this results in higher velocities and depths. The scour analysis of the flow along the wall is presented in Table 7 and takes into account the angle of inclination of the wall with the flow direction and the maximum scour depths for flow conditions that deviate from equilibrium.

Local scour in the vicinity of a vertical wall or embankment is the result of the vortices generated by divergent flow patterns. For

the proposed Crown Pointe wall, vortex generation is caused by abrupt momentum change with the piling of water against the wall and acceleration of the flow along the base of the wall. Table 7 shows the flow to be supercritical for the downstream 800 feet of wall. The scour equation for embankments is empirical in nature and is based on data collected for subcritical flows and equilibrium conditions (Richardson, et. al, 1987).

$$Y_s = 4\ Y_m\ F_e^{1/3} \qquad (9)$$

The average local scour depth predicted by Equation 9 was multiplied by a factor of 1.3 to estimate the maximum depth of scour for supercritical flows. The calculated maximum scour depth was adjusted for the angle of inclination to the flow direction. The adjustment factor reduces the maximum scour depth by a factor R to allow for streamlining of the flow by the wall (see Figure 2).

The final scour depth is estimated at approximately 6 feet (Table 7). As the scour holes along the wall develop more flow will be captured and the scour depth may become self perpetuating. Appropriate measures to limit local scour are required. For example, a buried riprap apron along the wall on the flow side would impede the scouring process. The riprap would drop into the scour hole as it develops. Riprap size and location should be carefully designed based on the flow hydraulics provided in this study. Other scour protection could be used instead of riprap. If placed near the surface, the protection should conform to the shape of the scour hole as it develops, inferring that it should be flexible. Rigid protection, such as soil cement could be used, but it should be installed deeper, near the wall footing.

TABLE 6 - HYDRAULICS ALONG WALL

GRID ELEMENT	MAX. DEPTH (FT) Y_m	MAX. VELOCITY (FPS) V_m	FROUDE[2] NUMBER F_e	VELOCITY ALONG WALL (FPS) V_s	VELOCITY PERPENDICULAR (FT) V_p	VELOCITY[3] HEAD (FT) h_v	WAVE[4] HEIGHT (FT) h_w	ANTI-[5] DUNE WAVE (FT) h_3	TOTAL DEPTH (FT)
62	.48	2.91	.74	2.52	1.46	.03	.05	.17	.73
79	.76	4.63	.94	4.01	2.32	.06	.09	.44	1.37
95	.57	3.51	.62	3.05	1.76	.05	.06	.25	.93
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
153	2.35	9.81	1.02	8.57	1.54	.04	.13	[illegible]	[illegible]
171	2.10	8.21	1.00	7.93	2.12	.07	.25	1.72	4.14
184	2.66	10.97	1.16	10.81	1.84	.05	.36	2.68	5.79
196	1.98	9.86	1.23	8.75	4.54	.32	.27	1.98	4.55

NOTE:

1. Maximum velocities and depths occur at essentially the same time.
2. $F_e = \frac{V_m}{\sqrt{Y_m g}}$
3. Equation 6
4. Equation 7
5. Equation 8

TABLE 7 - SCOUR DEPTH ANALYSIS

GRID ELEMENT	MAX. DEPTH (FT) Y_m	FROUDE NUMBER F_p	SCOUR DEPTH (FT) Y_s	MAX. SCOUR DEPTH (FT) Y_{max}	ANGLE OF INCLINATION	R	FINAL SCOUR DEPTH Y_r (FT)
62	.48	.74	1.74	2.26	30°	.58	1.31
78	.96	.94	2.98	3.87	30°	.58	2.25
95	.57	.82	2.13	2.77	30°	.58	1.61
112	1.35	1.07	5.52	7.18	30°	.58	4.16
144	2.20	1.05	8.94	11.63	15°	.40	4.65
159	2.33	1.02	9.38	12.20	10°	.35	4.27
171	2.10	1.00	8.40	10.92	15°	.40	4.70
184	2.68	1.18	11.33	14.73	10°	.35	5.17
196	1.98	1.23	8.49	11.03	27°	.56	6.18

1. $F_p = \frac{V_m}{\sqrt{gY_m}}$
2. $Y_s = 4Y_m F_p^{0.33}$
3. $Y_{max} = 1.3\ Y_s$
4. Angle wall makes with flow direction
5. R = Reduction factor due to wall inclination with flow direction (Figure 2)
6. $Y_r = R\ Y_{max}$

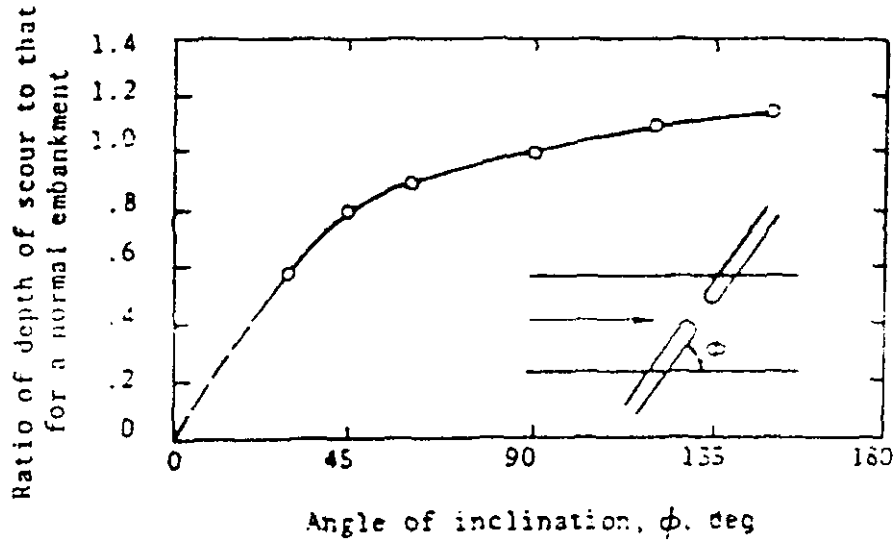


Figure 2 - Scour Reduction Due to Embankment Inclination (from Richardson, et. al., 1987)

3.4.5 Summary of Results

Summarizing, the flow hydraulics along the proposed Crown Pointe Wall were determined by routing the 100-year flood hydrograph down the Hiko Springs Wash. These flow hydraulics were used to predict scour depth, maximum wave height and sediment deposition. Scour depth is estimated to be six feet or less, but progressive local scour and possible capture of additional wash flows could be a problem and should be prevented. Wave heights based on the worst hydraulic conditions will not overtop the wall. Sediment deposition will have little or no effect on the flood hydraulics along the wall and will not contribute to overtopping.

IV. DISCUSSION AND RECOMMENDATIONS

The objective of this study was to determine the hydraulic conditions for the 100 year flood at the proposed Crown Pointe wall and analyzed the effect of sediment and debris loading. FEMA posed the following concerns related to the operation of the proposed wall in a February 16, 1989 letter to JMM:

> * Alluvial fan floods often carry heavy loads of sediment and debris. Engineering analyses must be submitted that quantify the design discharges and volumes of water flow, debris flow, and sediment movement associated with the flood that has a one-percent probability of being equaled or exceeded in any year at the apex of the fan. The potential for debris flow and sediment movement must be assessed using an engineering method acceptable to FEMA. The assessment should consider the characteristics and availability of sediment in the drainage basin above the apex and on the alluvial fan.
>
> • Engineering analyses must be submitted that show the proposed wall is designed to survive the impact of the peak discharge, including the expected sediment and debris loads determined in the analyses described above and their hydrodynamic and hydrostatic forces. The required engineering analyses must include analyses of overturning, sliding, eccentricity, and soil pressure, and any other structural analyses that were considered in the design of the flood wall.
>
> * Sudden changes in the velocity of an alluvial fan flood can trigger the deposition of tremendous amounts of sediment. A floodwall on a alluvial fan can cause such changes in velocity by either slowing or redirecting the floodflow. Concentrated sediment deposition can result in overtopping that would render the wall ineffective. An engineering analysis must be submitted that shows that the floodwall will not be overtopped.
>
> * An engineering analysis must be submitted that assesses the method of disposal of concentrated flood water and associated sediment load on adjacent properties.
>
> * An engineering analysis must be submitted that demonstrates that flooding from local runoff, or sources other than the apex of the Hiko Springs alluvial fan, is insignificant or has otherwise been accommodated by the appropriate flood control or drainage measures.

To address these concerns a new hydrologic study of the Hiko Springs watershed was undertaken to develop the 100 year flood hydrograph at the wash apex. An assessment was made based on the geomorphic characteristics of the watershed and the entrenched wash that the sediment load transported in the vicinity of the proposed wall is limited to the transport capacity in the various reaches

of the upstream wash and not by the supply of sediment from the upstream watershed. Debris in a frontal wave erupting from the mouth of Hiko Springs Wash would not reach the proposed wall.

To summarize the sediment transport analysis including the impact of the peak discharge, sediment deposition, wall overtopping and scour:

i. Sediment deposition will occur in the vicinity of the wall upstream of cross section 8.

ii. Sediment deposition near the wall will be minor and will have little effect on the flow hydraulics along the wall during the passage of the flood because:

*the flow depth near the wall in this reach is 1.5 feet or less.

*any sediment deposition near the wall will force subsequent flows away from the wall.

*grading the ground surface away from the wall will keep shallow flows from impinging on the wall.

iii. Maximum flow depth at the wall is less than three feet. This estimate is made using a conservatively high peak discharge and bulking factor of 1.25 for a hyper-concentrationed sediment flow of 20% concentration by volume. Further, the analysis was accomplished using wash elevations that would encourage the flow to be closer to the wall. The El Mirage bridges were not included in the final analysis to further sustain the flows near the wall. Overtopping due to velocity head, wave instability, and antidune waves would not ensue for a design wall height of six feet.

iv. The maximum computed scour depth was six feet. The wall was designed to extend eleven feet below the ground surface for scour protection. This is sufficient for equilibrium flow conditions. Mitigation measures are recommended to hinder progressive local scour and possible headcutting.

A structural stability analysis of the flood wall was beyond the scope of this study.

The proposed wall will constrict the flood to a smaller area of the wash when it passes over the Needles Highway onto presently undeveloped property within the wash boundaries. Some residences are located within the wash boundaries on properties contiguous to the Colorado River. The impact of the 100-year flood on these properties and the final destination of the sediment load is outside the scope of this study.

Finally, the boundaries of the watershed of the Hiko Springs Wash are essentially limited to the wash walls. No other appreciable flooding from tributary washes will add to the discharge once the peak has passed the wash apex. Flood discharges from Bridge Canyon and Dripping Springs watersheds still flow across the paleo-fan surface elevated 60 feet above the surface of the Hiko Springs Wash. Both of these watersheds are producing flood flows from rainstorms and, like the flood flows from the Hiko Springs watershed, are entrenching into the fan surface. This phenomena reflects the fact none of watersheds are producing as much sediment yield as they have in the past. During this current downcutting episode, the channels will have the propensity for following a shorter route to the Colorado River. If a large debris flow from Bridge Canyon blocks the existing channel and the flow spreads over the fan, some of it could eventually reach the Hiko Springs Wash. Headcutting could capture more of the flow as it poured into the wash. The possibility that a Bridge Canyon flow avulse from its channel and cut across to reach Hiko Springs Wash is remote. Nevertheless, it is important to monitor this situation. Should Hiko Springs capture the flows from Bridge Canyon the danger of having the peaks from each canyon timed to pass the proposed wall simultaneously is remote.

Lenzotti and Fullerton propose the following recommendations:

1. The structural analysis of the wall should include the potential for overturning with a six foot scour hole and appropriate hydraulic water pressure.

2. An analysis of the total forces on the wall due to the frontal wave should consider the impact of a one foot diameter boulder traveling at a velocity of ten feet per second.

3. The proposed wall should be partially backfilled with riprap or other flexible apron that will limit the depth of scour at the wall and possible concentration of flows along the wall in the scour hole. The size of the apron and its location should be designed based on the hydraulics of the flow along the wall. As scour progresses the apron will drop into the scour hole thus protecting the wall from further scour. A typical scour apron may extend ten feet from the wall. Another alternative would be to use rigid protection such as soil cement; however, this type of protection should be placed near the wall footing.

4. The backfill should be graded so that the ground surface slopes away from the wall. This would keep shallow flows from contacting the wall. The grading should extend as far from the wall as practical.

5. The wash area in the vicinity of the wall should be

leveled if possible and any existing channels or high spots removed. This would maximize flow spreading and minimize flow depths near the wall. Channelization in the wash to keep the flow away from the wall should be considered only in view of potential downstream impacts.

6. Site mitigation and leveling following a flood event should be mandatory.

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APPENDIX A

MUDFLOW MODEL FORMULATION

APPENDIX A-1

Constitutive Equations - MUDFLOW Model

The DHM model is derived from the complete dynamic momentum and mass continuity equations for shallow water, open-channel flow in two-dimensions. The reader is referred to Hromadka and Yen (1987) for additional discussion. The fully dynamic two-dimensional unsteady, shallow water equations consists of the continuity equation

$$\frac{\partial q_x}{\partial x} + \frac{\partial q_y}{\partial y} + \frac{\partial H}{\partial t} = 0 \qquad (A.1)$$

and two equations of motion. In the x-direction (flow direction)

$$\frac{\partial q_x}{\partial t} + \frac{\partial}{\partial x}\left(\frac{q_x^2}{h}\right) + \frac{\partial}{\partial y}\left(\frac{q_x q_x}{h}\right) + gh\left(S_{fx} - \frac{\partial H}{\partial x}\right) = 0 \qquad (A.2)$$

and in the horizontal direction perpendicular to the flow

$$\frac{\partial q_y}{\partial t} + \frac{\partial}{\partial y}\left(\frac{q_y^2}{h}\right) + \frac{\partial}{\partial y}\left(\frac{q_x q_y}{h}\right) + gh\left(S_{fy} + \frac{\partial H}{\partial t}\right) = 0 \qquad (A.3)$$

where q_x and q_y are discharges per unit width in the x- and y-directions and S_{fx} and S_{fy} represent friction slopes in the x and y directions, H is the water-surface elevation, h is the flow depth, and g is the gravitational acceleration. The variables x, y, and t are the spatial and temporal coordinates. These equations represent incompressible fluid flow with an assumption of hydrostatic pressure distribution. To derive the diffusive equation, it is simpler to present a one-dimensional form of Equation A.2.

$$S_f = S_o - \frac{\partial y}{\partial x} - \frac{V}{g}\frac{\partial V}{\partial x} - \frac{1}{g}\frac{\partial V}{\partial t} \qquad (A.4)$$

Kinematic wave equation
(steady uniform flow)

Diffusive wave equation
(steady nonuniform flow)

Quasi-dynamic equation
(steady nonuniform flow)

Full dynamic equation
(unsteady, nonuniform flow)

where V is the mean flow velocity in the x-direction and S_o is the channel bed slope. The full dynamic equation for unsteady, nonuniform flow represents a nonlinear, second-order hyperbolic partial differential equation. In this form, it is a difficult equation to apply in a computer model to simulate flow over variable topography that is cost effective and computer time efficient. Fortunately, several reasonable assumptions permit the development of a more simple, yet applicable equation. For example, the inertial terms can be considered negligible when compared with the bed slope and resistance or friction slope. This is particularly true for the steep slopes of alluvial fans and their contributing watersheds. First, the assumption of steady flow eliminates the $\frac{1}{g}\frac{\partial V}{\partial x}$ term. Assuming that the nonuniform flow term $\frac{V}{g}\frac{\partial V}{\partial x}$ is also negligible eliminates both the inertial terms and leaves only the diffusive equation terms

$$S_o - S_f = \frac{\partial y}{\partial x} \qquad (A.5)$$

Simply stated, the variation in velocity over one time step and one grid spacing in the numerical scheme is small compared to the other terms. For flow regimes with Froude number less than 4 or a velocity less than 25 fps, the diffusion equation can be considered an adequate representation of the full momentum equation. It should be noted that the two-dimensional, quasi-dynamic equation with the convective acceleration term requires about 50 percent more computational effort than the diffusive model.

For steep slopes, the variation of the water surface in the flow direction is comparatively small and only the kinematic wave approximation to the momentum equation remains

$$S_f = S_o \qquad (A.6)$$

Equations A.5 and A.6 are used in the MUDFLOW model. The friction slope term is represented by the S_f value in Manning's equation for fully developed, rough turbulent flow

$$V = \frac{1.486}{n} h^{2/3} S_f^{1/2} \qquad (A.7)$$

and n is Manning's roughness coefficient. No viscous or internal shear stress terms are considered in the resistance slope equation. The model represented by Equations A.1, A.5, A.6, and A.7 in two dimensions is inappropriate for high concentrations of sediment flow.

Wave attenuation in the diffusive model is the result of the

interaction of the friction slope and diffusive pressure gradient terms with the bed slope. It should be made clear that the MUDFLOW model does not have the ability to simulate shock waves or hydraulic jumps and tends to smooth out these abrupt changes in the flow profile. Also the model assumes a rigid bed, and does not simulate the transient phenomena of surging or channel avulsion.

A more complete treatise of the constitutive equations and information regarding application and use of the model is presented in "MUDFLOW: A TWO DIMENSIONAL, HYPERCONCENTRATED SEDIMENT FLOW ROUTING COMPUTER MODEL, TECHNICAL REPORT AND USERS MANUAL," prepared by J. S. O'Brien.

APPENDIX A-2

Numerical Scheme

The numerical approximation of the continuity and momentum equations, referred to as nodal domain integration (NDI) methods (Hromadka et al., 1985), employs a finite difference technique to solve the linearized equations using uniform grid elements. The net water volume and the change in the depth of water are established assuming a linear trial function between nodal points. The model advances in time using an explicit method

$$H_c^{i+1} = \Delta H_c^i + H_c^i \qquad (A.8)$$

in which c denotes the center nodal point of the four surrounding grids for time steps i and i+1. Each cell-centered node is equal to a function of the four neighboring cell nodal points. The solution algorithm takes the following steps:

1. The flow area is discretized by uniform nodal points, each possessing a unique roughness value and elevation.

2. Average geometry and Manning's value are computed between nodal points.

3. The flow depth for the nodal point being examined is estimated for the next time step and evaluated explicitly using the diffusive wave equation and continuity equation.

$$\frac{\partial}{\partial x} K_x \left(\frac{\partial H}{\partial y}\right) = \frac{\partial A_x}{\partial t} \qquad (A.9)$$

where

$$K_x = \frac{1.486}{n} A_x R^{2/3} / \left|\frac{\partial H}{\partial x}\right|^{1/2} \qquad (A.10)$$

and K_x is the hydraulic conductivity,

The iteration then proceeds as flollows until a pre-established tolerance criteria for the change in depth is met.

4. The hydraulic conductivity is recalculated.

5. New flow depths at the nodes are determined for time $(t + \Delta t)$ using Equation A.9 and linear approximation for a new depth. The net change in the volume of water at each node is simply the summation of the discharge flux across the grid boundaries

in the four directions. The resultant change in depth for the time step i and grid element of area A, is

$$\Delta H_c^i = \frac{\Delta q_c^i \, \Delta t}{A_x} \qquad (A.11)$$

6. Re-evaluate K_c until mid-time-step depth estimates H_c are matched.

The computer model permits adjustment of the time increment to optimize the variation of storage volume.

APPENDIX A-3

Hyperconcentrated Sediment Flow Theory

The highly variable nature of the fluid properties of mud flows make accurate prediction of flow properties a difficult task. Mud flows are characterized by surging, abrupt flow stoppage, channel aggradation and degradation, and channel avulsion on alluvial fans. Flows often abandon the normal clear water channel, creating new flow paths across the alluvial fans. Due to the transient nature of these phenomena, the most practical approach is to treat the flow as a continuum, combining the water and sediment components and ignoring such factors as particle fall velocity, scour and aggradation, sorting and flow competence. The focus of modeling mud flows is to determine a reasonable general range of flow properties, such as velocity and depth, a flood hydrogrpah, and the potential area of inundation of the alluvial fan.

To derive the equation for hyperconcentrated sediment flow, the fluid shear must be investigated. The internal stresses of hyperconcentrated sediment flow can be represented mathematically as

$$\tau = \tau_y + \tau_v + \tau_d + \tau' \qquad (A.12)$$

where τ is the total fluid shear stress, τ_y is the yield stress associated with cohesive soils, τ_v is the viscous shear stress given by $\eta \partial u/\partial y$ where η is the fluid viscosity, τ_d is the dispersive shear stress arising from the collision between particles, and τ' is the turbulent shear stress.

In general form

$$\tau = \tau_y + \eta \frac{du}{dy} + C' \left(\frac{du}{dy}\right)^2 \qquad (A.13)$$

where C'is coefficient of the inertial shear stresses (the dispersive plus the turbulent shear stress).

The first two terms are referred to as the Bingham shear stress and represent the internal resistance stresses of a Bingham fluid. The sum of the yield stress and viscous stress defines the shear stress of a cohesive, hyperconcentrated sediment fluid in a laminar flow regime. The last term represents the sum of the dispersive and turbulent shear stress which are a function of the vertical velocity gradient squared. A more complete treatment of these stresses and their role in hyperconcentrated sediment flows can be found in O'Brien (1986) or O'Brien and Julien (1987). A mud flow model that incorporates only the Bingham stresses and ignores the inertial stresses assumes the mud and debris flows being simulated are laminar flows. This assumption is not particularly favorable

as all mud floods and most mud flows are primarily turbulent over the steep watershed and rough alluvial fan slopes on which they flow and have velocities from 10 to 25 fps. Further, most mud flows have been shown to be highly turbulent for concentrations less than 35 to 40 percent by volume (O'Brien, 1986).

To continue with the derivation of the equations for hyperconcentrated sediment flows, the friction slope of the channel is represented by

$$S_f = \frac{1}{\gamma_m} \frac{\partial \tau}{\partial y} \qquad (A.14)$$

Neglecting the inertial terms, the momentum equation is written as

$$\frac{\partial h}{\partial x} - S_o + \frac{1}{\gamma_m} \frac{\partial}{\partial y} \left[\tau_y + \eta \frac{du}{dy} + C' \left(\frac{du}{dy} \right)^2 \right] = 0 \qquad (A.15)$$

By further neglecting the dispersive stress and representing the last term as turbulent shear stress by Manning's equations, the following equation would result:

$$\frac{\partial h}{\partial x} - S_o + \frac{1}{\gamma_m} \frac{\partial \tau_y}{\partial y} + \frac{\eta}{\gamma_m} \frac{\partial^2 u}{\partial y^2} + S_{ft} = 0 \qquad (A.16)$$

where S_{ft} is given by

$$S_{ft} = \left(\frac{1.486}{n} \right)^2 \frac{V^2}{h^{4/3}} \qquad (A.17)$$

and V is velocity, h is the mean flow depth, n is average Manning's roughness value for the channel reach. If the flow is controlled primarily by the viscous stress, it will result in lower velocities and a smaller contribution by the turbulent stress term. Conversely if the viscosity and yiled and stress are small, the turbulent stress will dominate and the velocities will be higher. This effect was shown in O'Brien (1986). If the flow is approaching laminar flow, the contribution by the turbulent term in Equation A.16 is small, yet there may still be some momentum transferred out of the flow as a result of channel constrictions, bends, or obstructions.

The yield stress τ_y and the viscosity, η are determined by the empirical equations

$$\eta = \alpha_1 e^{\beta_1 C_v} \tag{A.18}$$

and

$$\tau_y = \alpha_2 e^{\beta_2 C_v} \tag{A.19}$$

where α and β have been defined by laboratory experiment Table A-1 (O'Brien, 1986). The viscosity and yield stress are shown to be functions of the volumetric concentration. Varying the concentration spatially and temporally in the program has a dramatic effect on the flow parameters of discharge, velocity, and depth.

The objective of modeling hyperconcentrated sediment is to predict the general flow properties at specific points on the alluvial fan and in the channel. The viscous friction slope term can be approximated as follows:

For steady, shallow, uniform laminar flow of depth (h) in a wide, open channel of slope (S_o) with a smooth bed, the Darcy-Weisbach friction slope:

$$S_f = \frac{h_f}{l} = \frac{f V^2}{8gh} \tag{A.20}$$

where h_f is the friction head loss, l is the channel length, and S_f is the friction slope. For laminar, stable flow, the Darcy-Weisbach friction factor f is:

$$f = \frac{K}{R_e} \tag{A.21}$$

where R_e is the Reynolds and K is a variable factor dependent on slope, channel roughness, and channel shape (K equals 24 for laminar flow on smooth bed).

Substitution of Equation A.21 into Equation A.20 yields:

$$S_f = \frac{K\eta}{8\gamma_m} \frac{V}{h^2} \tag{A.22}$$

which is now valid for laminar flow with a rough surface. Equation A.22 can be substituted into Equation A.16 for

$$\frac{\eta}{\gamma_m}\frac{\partial^2 u}{\partial y^2} = \frac{Kn}{8\gamma_m}\frac{V}{h^2} \qquad (A.23)$$

Now all the terms have been defined in Equation A.16. Values of K can be estimated using empirical relationships of friction coefficients f versus R for natural grass surfaces.

Combining Equations A.16, A.17, and A.20 results in a quadratic equation where the velocity is solved as a function of depth, viscosity, yield stress, slope and roughness. A subroutine was designed to perform the calculations for the mud flow velocity.

TABLE A-1 MUD FLOW SAMPLE VISCOSITY AND YIELD STRESS AS A FUNCTION OF CONCENTRATION

	$\eta = \alpha_1 e^{\beta_1 C_v}$				$\tau_y = \alpha_2 e^{\beta_2 C_v}$			
	Points	α_1	β_1	r^2	Points	α_2	β_2	r^2
1. Aspen Pit 1	10	3.60×10^{-2}	22.1	.99	10	1.81×10^{-1}	25.7	.92
2. Aspen Pit 4	10	5.38×10^{-2}	14.5	.95	10	2.72×10^{-0}	10.4	.93
3. Aspen Natural Soil	9	1.36×10^{-3}	28.4	.96	10	1.52×10^{-1}	18.7	.83
4. Aspen Mine Fill	9	1.28×10^{-1}	12.0	.87	9	4.73×10^{-2}	21.1	.91
5. Aspen Natural Soil Source	16	4.95×10^{-4}	27.1	.83	14	3.83×10^{-2}	19.6	.92
6. Aspen Mine Fill Source	10	2.01×10^{-4}	33.1	.85	10	2.91×10^{-1}	14.3	.84
7. Glenwood #1	14	2.83×10^{-3}	23.0	.93	14	3.45×10^{-2}	20.1	.96
8. Glenwood #2	8	6.48×10^{-1}	6.2	.94	8	7.65×10^{-2}	16.9	.97
9. Glenwood #3	10	6.32×10^{-3}	19.9	.95	8	7.07×10^{-4}	29.8	.91
10. Glenwood #4	9	6.02×10^{-4}	33.1	.96	9	1.72×10^{-3}	29.5	.75
11. Iida (1938)	8	3.73×10^{-5}	36.6	.99				

(From O'Brien, 1986)

APPENDIX B

SEDIMENT CONTINUITY ANALYSIS

APPENDIX B

SEDIMENT CONTINUITY ANALYSIS

SEDIMENT TRANSPORT SUMMATION

SECTION #=
[illegible]

Time Step #	Total Time (Hrs)	Time Inc. (Hrs)	Veloc. (Ft/Sec)	Depth (Ft)	Q (CFS)	Top Width (Ft)	qs (CFS/Ft)	Qs (CFS)	Ws (Tons)
0	1.10	0.10	[illegible]	1.32	4254	320	0.204[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	1.50	0.10	15.45	2.45	12014	320	[illegible]	[illegible]	10257.1
5	1.60	0.10	14.87	2.30	10944	320	0.93344	[illegible]	8925.1
6	1.70	0.10	14.25	2.16	9850	320	0.79134	253.22	7566.5
7	1.80	0.10	13.69	2.04	8937	320	0.67701	216.64	6475.3
8	1.90	0.10	13.17	1.92	8092	320	0.58325	186.63	5576.6
9	2.00	0.10	12.63	1.82	7356	320	0.49483	158.27	4729.2
10	2.10	0.10	12.34	1.75	6910	320	0.45266	144.85	4328.3
11	2.20	0.10	12.41	1.75	6950	320	0.46866	149.94	4435.4
12	2.30	0.10	12.93	1.84	7261	320	0.59824	191.54	5814.0
13	2.40	0.10	13.31	1.90	7550	320	0.70213	224.68	7806.1
14	2.50	0.10	10.41	1.41	4697	320	0.25165	74.11	2215.9
15	2.60	0.10	9.66	1.30	4102	320	0.18775	60.08	1795.2
16	2.70	0.10	9.85	1.26	3972	320	0.18869	60.38	1804.2
17	2.80	0.10	9.12	1.15	3356	320	0.13906	44.50	1329.8
18	2.90	0.10	6.56	1.07	2951	320	0.10807	34.58	1033.3
19	3.00	0.10	6.16	0.99	2585	320	0.08996	28.79	860.1
20	3.10	0.10	7.86	0.93	2339	320	0.07797	24.95	745.5
21	3.20	0.10	7.18	0.84	1930	320	0.05437	[illegible]	[illegible]
22	3.30	0.10	6.22	0.75	1453	320	0.03051	[illegible]	291.7
23	3.40	0.10	6.67	0.76	1622	320	0.03407	[illegible]	389.[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
27	5.90	[illegible]	[illegible]	0.32	265	320	0.000[illegible]	0.10	42.4
28	5.50	0.50	2.11	0.28	189	320	[illegible]	0.12	18.2
29	6.00	0.50	1.81	0.25	129	320	0.00811	0.04	5.9
30	6.50	0.50	1.50	0.23	96	320	0.00005	0.02	2.4
31	7.00	0.50	1.02	0.21	69	320	0.00002	0.01	0.9
32	7.50	0.50	0.37	0.18	21	320	0.00001	0.00	0.0
33	8.00	0.50	0.01	0.01	0	0	0.00000	0.00	0.0

TOTAL [illegible]

SEDIMENT TRANSPORT SUMMATION

X-SECTION #=
D50 (MM) =
=
=

Time Step #	Total Time (Hrs)	Time Inc. (Hrs)	Veloc. (Ft/Sec)	Depth (Ft)	Q (CFS)	Top Width (Ft)	qs (CFS/Ft)	Qs (CFS)	ws (Tons)
0	1.10	0.10	5.84	0.84	2960	660	0.02683	17.74	524.9
1	1.20	0.10	5.91	1.63	9575	660	0.14501	95.71	2948.7
2	1.30	0.10	10.69	2.00	13547	660	0.21530	142.01	4297.1
3	1.40	0.10	10.23	1.96	13084	660	0.20744	136.91	4156.1
4	1.50	0.10	9.64	1.87	12145	660	0.19014	125.49	3844.1
5	1.60	0.10	9.46	1.77	11051	660	0.17413	114.91	3521.7
6	1.70	0.10	9.07	1.67	9997	660	0.21560	142.30	4251.9
7	1.80	0.10	8.69	1.06	6068	660	0.20551	135.62	4052.7
8	1.90	0.10	8.34	1.49	8202	660	0.15527	102.48	3062.0
9	2.00	0.10	8.05	1.41	7473	660	0.13403	88.46	2643.2
10	2.10	0.10	7.74	1.35	6896	660	0.11584	76.45	2284.5
11	2.20	0.10	7.50	1.37	7284	660	0.13303	87.80	2623.4
12	2.30	0.10	7.30	1.27	6119	660	0.09262	61.13	1826.9
13	2.40	0.10	7.11	1.14	5049	660	0.06557	43.27	1293.1
14	2.50	0.10	6.91	1.12	5106	660	0.07500	49.50	1479.2
15	2.60	0.10	6.24	1.01	4160	660	0.04982	32.89	982.7
16	2.70	0.10	5.83	0.97	3732	660	0.03761	24.82	741.6
17	2.80	0.10	5.45	0.88	3171	660	0.02917	19.25	575.3
18	2.90	0.10	5.66	0.87	3250	660	0.03419	22.57	674.3
19	3.00	0.10	4.65	0.77	2465	660	0.01820	12.01	358.9
20	3.10	0.10	4.55	0.72	2162	660	0.01409	9.30	277.9
21	3.20	0.10	4.22	0.65	1810	660	0.01050	6.93	207.0
22	3.30	0.10	4.10	0.60	1624	660	0.00949	6.27	187.2
23	3.40	0.10	3.85	0.60	1525	660	0.00723	4.77	142.7
24	3.50	0.10	4.02	0.58	1545	660	0.00871	5.75	515.5
25	4.00	0.50	3.73	0.42	725	660	0.00247	1.63	48.7
26	4.50	0.50	2.66	0.33	440	660	0.00067	0.44	13.1
27	5.00	0.50	1.45	0.28	274	660	0.00015	0.10	3.0
28	5.50	0.50	1.15	0.26	197	660	0.00005	0.03	1.0
29	6.00	0.50	0.87	0.23	132	660	0.00002	0.01	0.5
30	6.50	0.50	0.67	0.22	97	660	0.00001	0.00	0.3
31	7.00	0.50	0.52	0.21	72	660	0.00000	0.00	0.2
32	7.50	0.50	0.25	0.19	31	660	0.00000	0.00	0.0
33	8.00	0.50	0.03	0.16	3	660	0.00000	0.00	0.0

TOTAL 57510.9

SEDIMENT TRANSPORT SUMMATION

X-SECTION # = 1
D50 mm = 1.0
S = 0.0
n = 0.04

Time Step #	Total Time (Hrs)	Time Inc. (Hrs)	Veloc (Ft/Sec)	Depth (Ft)	Q (CFS)	Tot Width (Ft)	qs (CFS/Ft)	Qs (CFS)	Ws (Tons)
0	1.00	0	0	0	0	0	0	0	0
1	1.10	0.10	11.94	1.82	13022	600	0.[illegible]04	412.41	12359.1
2	1.20	0.10	11.94	1.82	13022	600	0.68704	412.41	12359.1
3	1.30	0.10	11.61	1.74	12090	600	0.[illegible]	[illegible]	[illegible]
4	1.40	0.10	11.22	1.65	11105	600	0.54241	325.45	9764.4
5	1.50	0.10	10.86	1.57	10220	600	0.47821	286.93	8607.8
6	1.60	0.10	10.44	1.48	9271	600	0.41050	246.30	7389.0
7	1.70	0.10	10.14	1.40	8518	600	0.36800	220.80	6624.0
8	1.80	0.10	9.77	1.32	7738	600	0.31899	191.39	5741.7
9	1.90	0.10	9.44	1.26	7137	600	0.27885	167.31	5019.3
10	2.00	0.10	9.20	1.21	6679	600	0.25254	151.52	4545.7
11	2.10	0.10	8.95	1.16	6224	600	0.22700	136.20	4086.0
12	2.20	0.10	8.65	1.10	5709	600	0.19511	117.07	3512.1
13	2.30	0.10	8.34	1.04	5214	600	0.17295	103.77	3113.1
14	2.40	0.10	8.02	0.99	4764	600	0.14621	87.73	2632.0
15	2.50	0.10	7.67	0.93	4280	600	0.12456	74.74	2242.1
16	2.60	0.10	7.30	0.88	3854	600	0.10229	61.37	1841.1
17	2.70	0.10	6.93	0.82	3410	600	0.08345	50.07	1502.1
18	2.80	0.10	6.59	0.77	3045	600	0.06843	41.06	1231.8
19	2.90	0.10	6.19	0.71	2657	600	0.05350	32.10	963.1
20	3.00	0.10	5.76	0.66	2269	600	0.04067	24.40	732.1
21	3.10	0.10	5.36	0.62	2002	600	0.03433	20.60	618.2
22	3.20	0.10	5.27	0.59	1868	600	0.02821	16.93	507.8
23	4.00	0.80	5.71	0.42	935	600	0.00586	4.22	126.7
24	4.50	0.50	1.47	0.33	569	600	0.00243	1.46	43.8
25	5.00	0.50	1.06	0.27	434	600	0.00133	0.80	24.0
26	5.50	0.50	1.01	0.24	405	600	0.00113	0.68	20.3
27	6.00	0.50	1.05	0.22	376	600	0.00093	0.56	16.8
28	6.50	0.50	1.02	0.21	354	600	0.00080	0.48	14.4
29	7.00	0.50	0.91	0.20	97	600	0.00003	0.01	1.1
30	7.50	0.50	0.64	0.19	73	600	0.00000	0.00	0.4
31	8.00	0.50	0.37	0.18	40	600	0.00000	0.00	0.0

TOTAL 108143.2

SEDIMENT TRANSPORT SUMMATION

X-SECTION # = 4
D50 mm = 1.2
[illegible] = [illegible]
[illegible] = [illegible]

Time Step #	Total Time (Hrs)	Time Inc. (Hrs)	Velocity (Ft/Sec)	Depth (Ft)	Q (CFS)	Top Width (Ft)	qs (CFS/Ft)	Qs (CFS)	Ws (Tons)
0	1.30	0	0	0	0	0	0	0	0
1	1.40	0.10	3.80	0.46	365	200	0.00839	1.68	50.1
2	1.50	0.10	9.74	1.14	13052	1000	0.35955	359.55	10742.5
3	1.60	0.10	9.64	1.19	12619	1100	0.35833	391.16	11711.4
4	1.70	0.10	9.34	1.13	11610	1100	0.31569	347.26	10378.1
5	1.80	0.10	9.07	1.07	10675	1100	0.28271	310.98	9292.0
6	1.90	0.10	8.75	1.01	9721	1100	0.24630	270.93	8095.4
7	2.00	0.10	8.42	0.95	8799	1100	0.21248	233.73	6983.8
8	2.10	0.10	8.12	0.91	8128	1100	0.18402	202.42	6048.2
9	2.20	0.10	7.87	0.86	7445	1100	0.16351	179.86	5374.3
10	2.30	0.10	7.64	0.83	6975	1100	0.14539	159.93	4778.6
11	2.40	0.10	7.40	0.80	6512	1100	0.12807	140.87	4209.3
12	2.50	0.10	7.16	0.76	5986	1100	0.11279	124.07	3707.1
13	2.60	0.10	6.91	0.73	5549	1100	0.09791	107.70	3218.2
14	2.70	0.10	6.65	0.70	5074	1100	0.08079	88.87	2655.3
15	2.80	0.10	6.29	0.66	4567	1100	0.06723	73.96	2209.9
16	2.90	0.10	5.97	0.63	4137	1100	0.05441	59.85	1788.4
17	3.00	0.10	5.64	0.60	3722	1100	0.04319	47.51	1419.5
18	3.10	0.10	5.33	0.57	3342	1100	0.03435	37.79	1129.2
19	3.20	0.10	5.00	0.54	2970	1100	0.02649	29.14	870.7
20	3.30	0.10	4.64	0.50	2552	1100	0.01962	21.59	645.2
21	3.40	0.10	4.39	0.48	2315	1100	0.01564	17.21	514.2
22	3.50	0.30	4.10	0.45	2029	1100	0.01187	13.06	1170.7
23	4.00	0.50	3.10	0.39	1088	900	0.00370	3.33	498.0
24	4.50	0.50	2.21	0.31	617	900	0.00092	0.83	125.7
25	5.00	0.50	1.58	0.26	401	900	0.00038	0.34	51.2
26	5.50	0.50	1.26	0.25	284	900	0.00019	0.17	25.8
27	6.00	0.50	0.96	0.23	203	900	0.00008	0.07	10.0
28	6.50	0.50	0.89	0.23	143	700	0.00002	0.01	2.1
29	7.00	0.50	0.68	0.22	105	700	0.00001	0.00	0.7
30	7.50	0.50	0.55	0.21	81	700	0.00000	0.00	0.3
31	8.00	0.50	0.53	0.22	58	500	0.00000	0.00	0.2
							TOTAL		97668.1

SEDIMENT TRANSPORT SUMMATION

X-SECTION # = 5
D50 (mm) = [illegible]
G = [illegible]
[illegible] = [illegible]

Time Step #	Total Time (Hrs)	Time Inc. (Hrs)	Veloc. (Ft/Sec)	Depth (Ft)	Q (CFS)	Top Width (Ft)	qs (CFS/Ft)	Qs (CFS)	Ws (Tons)
0	1.30	0	0	0	0	0	0	0	0
1	1.40	0.10	0.01	0.01	0	0	0.000000	0.00	0.0
2	1.50	0.10	9.10	1.15	12840	1200	0.282211	338.65	10215.4
3	1.60	0.10	9.13	1.15	12844	1200	0.282405	338.89	10220.4
4	1.70	0.10	8.99	1.12	12065	1200	0.268659	322.07	9715.3
5	1.80	0.10	8.74	1.08	11527	1200	0.24021	288.25	8612.9
6	1.90	0.10	8.10	0.92	10433	1400	0.18147	254.06	7591.3
7	2.00	0.10	7.77	0.86	9355	1400	0.15472	216.61	6472.4
8	2.10	0.10	7.47	0.82	8576	1400	0.13240	185.36	5538.6
9	2.20	0.10	7.20	0.78	7862	1400	0.11464	160.50	4795.6
10	2.30	0.10	6.98	0.75	7326	1400	0.10126	141.76	4235.7
11	2.40	0.10	6.76	0.72	6814	1400	0.08942	125.19	3740.8
12	2.50	0.10	6.55	0.69	6317	1400	0.07905	110.64	3306.0
13	2.60	0.10	6.35	0.66	5849	1400	0.06991	97.87	2924.7
14	2.70	0.10	6.09	0.63	5371	1400	0.05950	83.30	2488.5
15	2.80	0.10	5.83	0.60	4897	1400	0.04983	69.77	2084.7
16	2.90	0.10	5.59	0.57	4461	1400	0.04220	59.08	1765.4
17	3.00	0.10	5.33	0.54	4029	1400	0.03492	48.88	1460.6
18	3.10	0.10	5.06	0.51	3613	1400	0.02838	39.73	1187.0
19	3.20	0.10	4.81	0.48	3232	1400	0.02322	32.50	971.2
20	3.30	0.10	4.53	0.45	2854	1400	0.01827	25.57	764.1
21	3.40	0.10	4.26	0.42	2505	1400	0.01430	20.02	598.2
22	3.50	0.30	4.02	0.40	2251	1400	0.01130	15.81	1417.6
23	4.00	0.50	3.01	0.34	1228	1200	0.00340	4.08	609.2
24	4.50	0.50	2.61	0.30	940	1200	0.00191	2.29	341.6
25	5.00	0.50	2.34	0.27	771	1200	0.00131	1.57	234.1
26	5.50	0.50	2.09	0.24	651	600	0.00244	1.46	52.5
27	6.00	0.50	1.78	0.22	527	600	0.00088	0.53	19.1
28	6.50	0.50	1.28	0.20	154	600	0.00010	0.06	2.3
29	7.00	0.50	0.96	0.19	109	600	0.00005	0.02	1.6
30	7.50	0.50	0.86	0.18	93	600	0.00002	0.01	0.8
31	8.00	0.50	0.73	0.18	79	600	0.00001	0.01	0.8

TOTAL 91006.9

SEDIMENT TRANSPORT SUMMATION

X-SECTION # = 5
Dst [illegible] = [illegible]
S = [illegible]
[illegible] = [illegible]

Time Step #	Total Time (Hrs)	Time Inc. (Hrs)	Veloc. (Ft/Sec)	Depth (Ft)	Q (CFS)	Top Width (Ft)	qs (CFS/Ft)	Qs (CFS)	Ws (Tons)
0	1.30	0	0	0	0	0	0	0	0
1	1.40	0.10	0.01	0.01	0	0	0.00000	0.00	0.0
2	1.50	0.10	6.97	1.09	10560	1390	0.09012	125.27	3743.0
3	1.60	0.10	7.34	1.15	12234	1490	0.09e41	148.e4	43e1.5
4	1.70	0.10	7.05	1.13	11e3e	1490	0.0525[illegible]	13[illegible].e5	411e.9
5	1.80	0.10	6.83	1.09	11093	1490	0.08256	123.01	3675.6
6	1.90	0.10	6.58	1.04	10196	1490	0.07127	106.19	3173.1
7	2.00	0.10	6.32	0.99	9323	1490	0.06077	90.55	2705.6
8	2.10	0.10	6.08	0.93	8425	1490	0.05238	78.05	2332.2
9	2.20	0.10	5.87	0.89	7784	1490	0.04560	67.95	2030.3
10	2.30	0.10	5.69	0.85	7206	1490	0.04042	60.22	1799.3
11	2.40	0.10	5.52	0.82	6744	1490	0.03584	53.40	1595.9
12	2.50	0.10	5.35	0.79	6297	1490	0.03166	47.17	1409.6
13	2.60	0.10	5.18	0.75	5789	1490	0.02797	41.67	1245.2
14	2.70	0.10	4.99	0.72	5355	1490	0.02409	35.90	1072.6
15	2.80	0.10	4.79	0.68	4853	1490	0.02054	30.60	914.4
16	2.90	0.10	4.60	0.65	4455	1490	0.01748	26.04	778.2
17	3.00	0.10	4.40	0.61	3999	1490	0.01470	21.91	654.6
18	3.10	0.10	4.20	0.58	3630	1490	0.01221	18.19	543.6
19	3.20	0.10	4.04	0.57	3224	1400	0.01038	14.53	434.1
20	3.30	0.10	3.82	0.54	2886	1400	0.00828	11.59	346.4
21	3.40	0.10	3.63	0.51	2541	1400	0.00676	9.46	282.7
22	3.50	0.30	3.42	0.48	2296	1400	0.00532	7.45	667.6
23	4.00	0.50	2.63	0.37	1362	1400	0.00185	2.59	386.8
24	4.50	0.50	2.24	0.32	932	1300	0.00097	1.26	187.5
25	5.00	0.50	1.79	0.27	551	1300	0.00051	0.37	55.2
26	5.50	0.50	1.25	0.24	333	1300	0.00031	0.41	33.3
27	6.00	0.50	1.25	0.24	331	700	0.00018	0.24	13.3
28	6.50	0.50	1.10	0.23	169	800	0.00006	0.04	5.0
29	7.00	0.50	0.88	0.21	111	800	0.00002	0.01	1.7
30	7.50	0.50	0.78	0.20	94	800	0.00001	0.01	1.0
31	8.00	0.10	0.67	0.20	80	800	0.00001	0.00	0.1
							TOTAL		38571.2

SEDIMENT TRANSPORT SUMMATION

X-SECTION #=
D50 mm =
S =
n =

Time Step #	Total Time (Hrs)	Time Inc. (Hrs)	Veloc. (Ft/Sec)	Depth (Ft)	Q (CFS)	Top Width (Ft)	qs (CFS/Ft)	Qs (CFS)	Ws (Tons)
0	1.30	0	0	0	0	0	0	0	0
1	1.40	0.10	0.01	0.01	0	1400	0.00000	0.00	0.0
2	1.50	0.10	6.74	1.06	10052	1400	0.07e+1	2[illegible]	3285.8
3	1.60	0.10	7.43	1.16	12239	1420	0.11e+1	165.54	4946.4
4	1.70	0.10	7.34	1.14	11882	1420	0.1111e	157.87	4717.3
5	1.80	0.10	7.17	1.10	11200	1420	0.10156	144.21	4309.0
6	1.90	0.10	6.94	1.04	10249	1420	0.08971	127.39	3806.4
7	2.00	0.10	6.68	0.98	9296	1420	0.07744	109.96	3285.7
8	2.10	0.10	6.47	0.93	8544	1420	0.06852	97.31	2907.5
9	2.20	0.10	6.25	0.88	7810	1420	0.06000	85.20	2545.7
10	2.30	0.10	6.05	0.84	7216	1420	0.05287	75.07	2243.1
11	2.40	0.10	5.87	0.81	6752	1420	0.04691	66.61	1990.3
12	2.50	0.10	5.69	0.78	6302	1420	0.0414[illegible]	58.84	1759.6
13	2.60	0.10	5.51	0.74	5790	1420	0.0386[illegible]	52.07	1555.8
14	2.70	0.10	5.32	0.71	5354	1420	0.03165	44.94	1342.7
15	2.80	0.10	5.11	0.67	4862	1420	0.02728	38.74	1157.5
16	2.90	0.10	4.90	0.64	4453	1420	0.02307	32.76	978.9
17	3.00	0.10	4.52	0.64	4050	1400	0.01628	22.79	681.0
18	3.10	0.10	4.33	0.60	3637	1400	0.01379	19.30	576.7
19	3.20	0.10	4.12	0.57	3288	1400	0.01129	15.81	472.5
20	3.30	0.10	3.99	0.53	2886	1400	0.00901	12.62	376.8
21	3.40	0.10	3.69	0.50	2583	1400	0.00739	10.22	305.3
22	3.50	0.10	3.48	0.47	2290	1400	0.00577	8.08	724.3
23	4.00	0.50	2.66	0.37	1578	1400	0.00194	2.72	406.3
24	4.50	0.50	2.24	0.33	1035	1400	0.00094	1.32	200.2
25	5.00	0.50	1.91	0.27	567	1400	0.00051	0.71	83.4
26	5.50	0.50	1.49	0.25	363	1400	0.00027	0.38	57.1
27	6.00	0.50	1.46	0.24	245	700	0.00051	0.36	17.3
28	6.50	0.50	1.05	0.21	159	700	0.00005	0.03	4.9
29	7.00	0.50	0.81	0.20	113	700	0.00001	0.01	1.4
30	7.50	0.50	0.71	0.19	94	700	0.00001	0.01	0.8
31	8.00	0.50	0.61	0.19	81	700	0.00000	0.00	0.4
							TOTAL		44713.1

SEDIMENT TRANSPORT SUMMATION

X-SECTION #= [illegible]
D50 (mm) = [illegible]
S = [illegible]
n = [illegible]

Time Step #	Total Time (Hrs)	Time Inc. (Hrs)	Veloc (Ft/Sec)	Depth (Ft)	Q (CFS)	Top Width (Ft)	qs (CFS/Ft)	Qs (CFS)	Ws (Tons)
0	1.30	0	0	0	0	0	0	0	0
1	1.40	0.10	0.01	0.01	0	0	0.00000	0.00	0.0
2	1.50	0.10	6.13	1.27	8914	1145	0.04943	56.60	1691.1
3	1.60	0.10	6.00	1.44	12191	1245	0.07451	92.78	2771.8
4	1.70	0.10	6.71	1.42	11880	1245	0.07109	88.51	2644.8
5	1.80	0.10	6.55	1.38	11254	1245	0.06419	79.92	2388.0
6	1.90	0.10	6.33	1.31	10324	1245	0.05628	70.04	2092.8
7	2.00	0.10	6.08	1.24	9386	1245	0.04805	59.83	1787.6
8	2.10	0.10	5.85	1.18	8594	1245	0.04129	51.40	1536.0
9	2.20	0.10	5.64	1.12	7864	1245	0.03581	44.59	1332.3
10	2.30	0.10	5.47	1.07	7267	1245	0.03181	39.60	1183.4
11	2.40	0.10	5.30	1.03	6796	1245	0.02807	34.95	1044.4
12	2.50	0.10	5.14	0.99	6335	1245	0.02489	30.98	925.8
13	2.60	0.10	4.98	0.95	5890	1245	0.02196	27.33	816.6
14	2.70	0.10	4.81	0.90	5390	1245	0.01923	23.94	715.2
15	2.80	0.10	4.62	0.86	4947	1245	0.01636	20.39	609.2
16	2.90	0.10	4.44	0.81	4478	1245	0.01404	17.48	522.4
17	3.00	0.10	4.25	0.77	4074	1245	0.01180	14.69	439.1
18	3.10	0.10	4.07	0.73	3699	1245	0.00995	12.39	370.1
19	3.20	0.10	3.88	0.69	3333	1245	0.00823	10.25	306.2
20	3.30	0.10	3.68	0.64	2932	1245	0.00670	8.34	249.1
21	3.40	0.10	3.50	0.60	2615	1245	0.00550	6.85	204.5
22	3.50	0.10	3.32	0.57	2356	1245	0.00444	5.53	496.0
23	4.00	0.50	2.62	0.43	1403	1245	0.00174	2.17	323.5
24	4.50	0.50	2.17	0.36	973	1245	0.00081	1.01	151.2
25	5.00	0.50	1.79	0.32	595	1045	0.00057	0.57	55.8
26	5.50	0.50	1.55	0.28	371	1245	0.00030	0.37	34.1
27	6.00	0.50	1.33	0.27	247	745	0.00033	0.25	0.5
28	6.50	0.50	1.02	0.25	184	645	0.00028	0.02	5.3
29	7.00	0.50	0.77	0.23	114	645	0.00009	0.01	1.0
30	7.50	0.50	0.69	0.22	96	645	0.00001	0.00	0.8
31	8.00	0.10	0.58	0.21	79	645	0.00000	0.00	0.1
								TOTAL	24685.3

SEDIMENT TRANSPORT SUMMATION

X-SECTION # = [illegible]
D50 mm = [illegible]
S = [illegible]
P = [illegible]

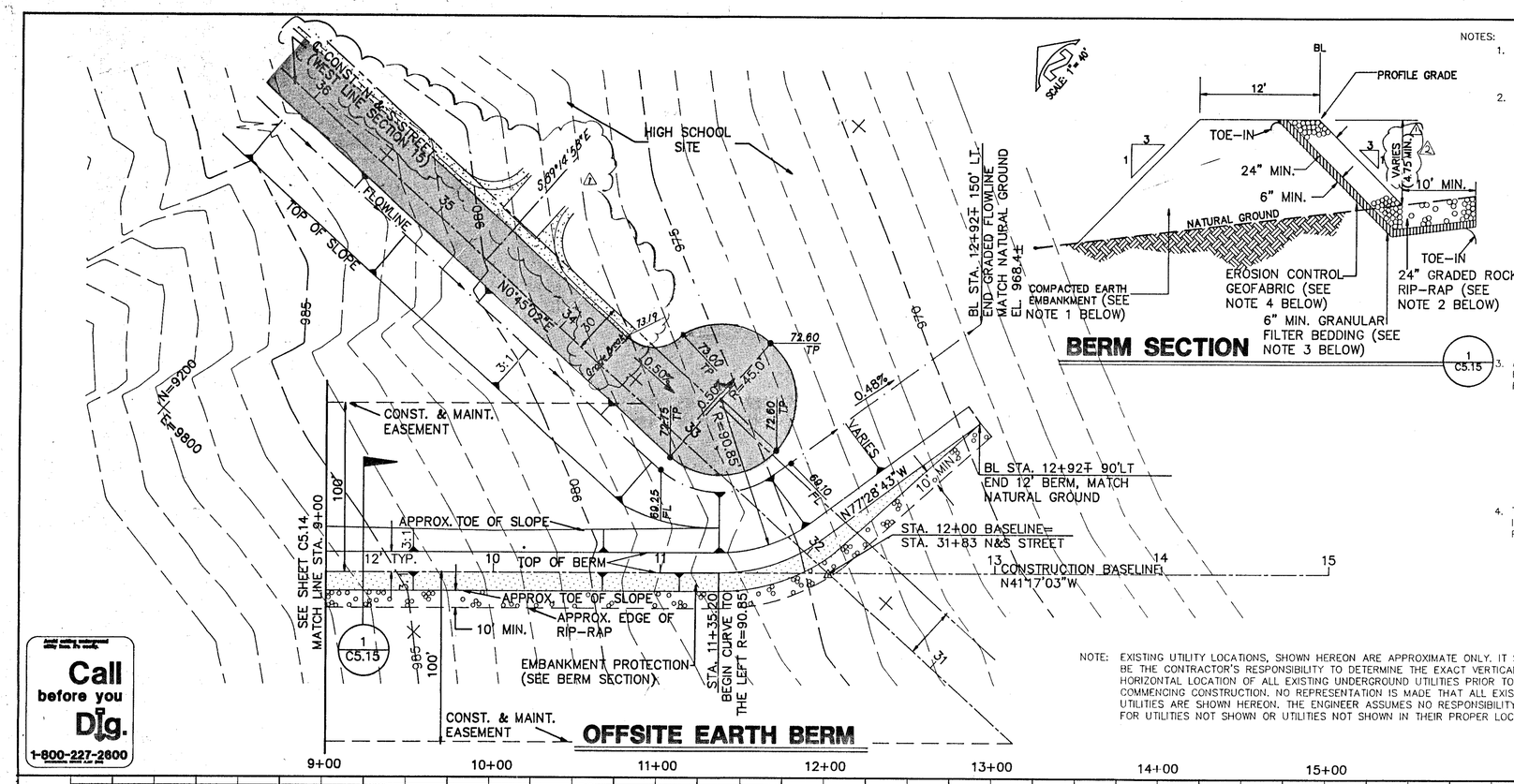
Time Step #	Total Time (Hrs)	Time Inc. (Hrs)	Velocity (Ft/Sec)	Depth (Ft)	Q (CFS)	Top Width (Ft)	qs (CFS/Ft)	Qs (CFS)	Ws (Tons)
0	1.30	0	0	0	0	0	0	0	0
1	1.40	0.10	0.01	0.01	0	0	0.00000	0.00	0.0
2	1.50	0.10	7.35	1.17	8202	975	0.10090	98.38	2949.6
3	1.60	0.10	6.92	1.50	12188	975	0.17545	171.08	5128.0
4	1.70	0.10	6.61	1.49	11956	975	0.16821	164.01	4900.5
5	1.80	0.10	6.83	1.44	11234	975	0.15241	148.59	4451.8
6	1.90	0.10	7.77	1.38	10455	975	0.13426	130.90	3911.4
7	2.00	0.10	7.46	1.30	9456	975	0.11464	111.77	3339.8
8	2.10	0.10	7.17	1.23	8599	975	0.09821	95.76	2861.2
9	2.20	0.10	6.91	1.18	7950	975	0.08477	82.66	2469.7
10	2.30	0.10	6.69	1.13	7371	975	0.07468	72.81	2175.7
11	2.40	0.10	6.48	1.08	6823	975	0.06596	64.31	1921.5
12	2.50	0.10	6.29	1.04	6378	975	0.05866	57.19	1709.0
13	2.60	0.10	6.09	1.00	5926	975	0.05161	50.32	1503.9
14	2.70	0.10	5.97	0.95	5427	975	0.04472	43.60	1302.8
15	2.80	0.10	5.84	0.90	4949	975	0.03824	37.29	1114.1
16	2.90	0.10	5.42	0.86	4545	975	0.03264	31.83	951.0
17	3.00	0.10	5.29	0.81	4099	975	0.02756	26.87	802.9
18	3.10	0.10	4.96	0.77	3724	975	0.02300	22.43	670.2
19	3.20	0.10	4.73	0.73	3367	975	0.01904	18.56	554.7
20	3.30	0.10	5.23	0.80	4079	975	0.02859	27.88	833.1
21	3.40	0.10	4.93	0.75	3605	975	0.02259	22.02	658.0
22	3.50	0.10	4.24	0.68	2363	975	0.01022	9.96	893.1
23	4.00	0.50	3.19	0.48	1431	975	0.00399	3.89	581.0
24	4.50	0.50	2.85	0.36	982	975	0.00190	1.85	276.1
25	5.00	0.50	2.03	0.30	594	975	0.00064	0.63	93.7
26	5.50	0.50	1.61	0.21	380	975	0.00028	0.28	41.8
27	6.00	0.50	1.41	0.18	299	700	0.00018	0.18	26.7
28	6.50	0.50	1.07	0.15	172	700	0.00004	0.04	6.4
29	7.00	0.50	0.75	0.11	115	700	0.00001	0.01	1.2
30	7.50	0.50	0.68	0.11	100	700	0.00001	0.00	0.7
31	8.00	0.10	0.58	0.20	81	700	0.00000	0.00	0.1

TOTAL 46087.9

SEDIMENT TRANSPORT SUMMATION

X-SECTION # = 10
D50 mm = [illegible]
S = [illegible]
f = [illegible]

Time Step #	Total Time (Hrs)	Time Inc. (Hrs)	Veloc. (Ft/Sec)	Depth (Ft)	Q (CFS)	Top Width (Ft)	qs (CFS/Ft)	Qs (CFS)	Ws (Tons)
0	1.30	0	0	0	0	0	0	0	0
1	1.40	0.10	0.01	0.01	0	0	0.00000	0.00	0.0
2	1.50	0.10	[illegible]	[illegible]	1299	300	0.06962	20.89	626.0
3	1.60	0.10	[illegible]	[illegible]	[illegible]	1100	[illegible]	[illegible]	5685.1
4	1.70	0.10	[illegible]	[illegible]	11921	1100	[illegible]	[illegible]	5484.3
5	1.80	0.10	7.97	1.29	11504	1100	0.15290	[illegible]	5025.5
6	1.90	0.10	7.72	1.23	10445	1100	0.13515	148.67	4442.2
7	2.00	0.10	7.43	1.17	9562	1100	0.11628	127.91	3821.9
8	2.10	0.10	7.15	1.10	8652	1100	0.10034	110.37	3298.0
9	2.20	0.10	6.90	1.05	7970	1100	0.08725	95.97	2867.7
10	2.30	0.10	6.69	1.00	7359	1100	0.07747	85.22	2546.2
11	2.40	0.10	6.49	0.96	6853	1100	0.06879	75.67	2260.9
12	2.50	0.10	6.30	0.92	6374	1100	0.06128	67.41	2014.1
13	2.60	0.10	6.11	0.88	5914	1100	0.05441	59.85	1788.2
14	2.70	0.10	5.93	0.84	5452	1100	0.04743	52.18	1559.0
15	2.80	0.10	5.76	0.80	4996	1100	0.04025	44.28	1342.5
16	2.90	0.10	5.45	0.76	4556	1100	0.03470	38.17	1140.4
17	3.00	0.10	5.23	0.72	4142	1100	0.02951	32.46	970.0
18	3.10	0.10	5.00	0.68	3740	1100	0.02472	27.19	812.6
19	3.20	0.10	4.78	0.65	3416	1100	0.02063	22.70	678.1
20	3.30	0.10	4.54	0.61	3046	1100	0.01683	18.52	553.3
21	3.40	0.10	4.36	0.57	2696	1100	0.01359	14.95	446.6
22	3.50	0.30	4.02	0.54	2424	1100	0.01101	12.11	1085.2
23	4.00	0.50	3.18	0.42	1469	1100	0.00404	4.45	664.6
24	4.50	0.50	2.66	0.37	992	1000	0.00201	2.01	299.7
25	5.00	0.50	2.09	0.30	600	1000	0.00060	0.60	90.1
26	5.50	0.50	[illegible]	[illegible]	412	900	0.00051	0.46	61.6
27	6.00	0.50	2.43	0.28	350	700	0.00015	0.10	15.4
28	6.50	0.50	1.87	0.25	171	500	0.00012	0.06	9.1
29	7.00	0.50	1.07	0.23	125	500	0.00004	0.02	3.8
30	7.50	0.50	1.03	0.23	118	500	0.00004	0.02	2.8
31	8.00	0.10	0.95	0.22	84	400	0.00003	0.01	0.3
							TOTAL	49556.8	



BERM SECTION 1 C5.15

NOTES:

1. THE EARTH EMBANKMENT SHALL BE CONSTRUCTED OF NATIVE MATERIALS, COMPACTED TO A MIN. OF 90% IN ACCORDANCE WITH ASTM D-1557-78, IN LIFTS NOT TO EXCEED 8" (LOOSE) THICHNESS.
2. ROCK FOR RIP-RAP SHALL CONFORM TO THE FOLLOWING SPECIFICATIONS:
   A. INDIVIDUAL ROCK FRAGMENTS SHALL BE DENSE, SOUND AND FREE FROM CRACKS, SEAMS AND OTHER DEFECTS CONDUCIVE TO ACCELERATED WEATHERING. THE ROCK FRAGMENTS SHALL BE ANGULAR IN SHAPE. THE LEAST DIMENSION OF AN INDIVIDUAL ROCK FRAGMENT SHALL BE NOT LESS THAN ONE-THIRD (1/3) THE GREATEST DIMENSION OF THE FRAGMENT.
   B. BULK SPECIFIC GRAVITY (SATURATED SURFACE-DRY BASIS) NOT LESS THAN 2.5.
   C. ABSORPTION NOT MORE THAN 3 PERCENT.
   D. FOR UPSTREAM SLOPE PROTECTION THE ROCK SHALL BE AT LEAST SIX INCHES (6")BUT NOT THAN TWENTY-FOUR INCHES (24") IN DIAMETER. A MINIMUM OF 50% OF THE PARTICLES SHOULD EXCEED 12" IN DIAMETER.
   E. RIPRAP SHALL NOT BE PLACED UNTIL THE FOUNDATION PREPARATION IS COMPLETED AND THE SUBGRADE SURFACES HAVE BEEN INSPECTED AND APPROVED BY THE ENGINEER.
3. A MIN. 6" THICK BEDDING LAYER SHALL BE PLACED OVER THEGEOFABRIC BEFORE PLACING RIP-RAP. THE BEDDING MATERIAL SHALL MEET THE FOLLLOWING GRADATION REQUIREMENTS:

SIEVE SIZE	% PASSING
2"	100
3/4"	50-100
NO. 4	30-70
NO. 200	0-8

   AS AN ALTERNATE, TYPE I OR TYPE II AGGREGATE BASE MAY BE USED FOR BEDDING.
4. THE GEOFABRIC SHALL CONSIST OF "MIRAFI" 700X (OR APPROVED EQUAL), INSTALLED IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS. PROPER TOE-IN AT THE TOP AND BOTTOM IS CRITICAL.

NOTE: EXISTING UTILITY LOCATIONS, SHOWN HEREON ARE APPROXIMATE ONLY. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO DETERMINE THE EXACT VERTICAL AND HORIZONTAL LOCATION OF ALL EXISTING UNDERGROUND UTILITIES PRIOR TO COMMENCING CONSTRUCTION. NO REPRESENTATION IS MADE THAT ALL EXISTING UTILITIES ARE SHOWN HEREON. THE ENGINEER ASSUMES NO RESPONSIBILITY FOR UTILITIES NOT SHOWN OR UTILITIES NOT SHOWN IN THEIR PROPER LOCATION.

SCALES
1"=40' H.
1"=10' V.

Call before you Dig. 1-800-227-2600

REVISIONS			
NO.	DESCRIPTION	DATE	BY
1	Revised Cul de Sac Width & Min. Height of Berm	05-07-90	
2	change EL. & min.%	6-12-90	SV
3	changed Elev. & Slope, Added Grade Break	8-29-90	JA

BENCHMARK

USGS BENCHMARK 10WR. BRASS CAP – 220'± WEST OF NE CORNER OF SECTION 15 – WEST OF POWER LINE.

ELEVATION = 814.485'

BASIS OF BEARING

THE NORTH LINE OF SECTION 15, TOWNSHIP 32 SOUTH, RANGE 66 EAST, M.D.M., CLARK COUNTY, NEVADA, BEARS NORTH 88°53'00"EAST PER 1937 GLO DEPENDENT RESURVEY PLAT.

CLARK COUNTY
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION

ACCEPTANCE OF PLANS FOR FILING BY Larry Bowler 10/12/90 ACCEPTANCE OF THESE PLANS FOR FILING SHALL NOT BE CONSTRUED TO BE A PERMIT FOR OR AN APPROVAL OF ANY VIOLATION OF ANY OF THE PROVISIONS OF THE STATE OR COUNTY LAWS AND/OR SPECIFICATIONS. CLARK COUNTY SHALL BE HELD FREE FROM DAMAGES WHICH MAY RESULT FROM THE CONSTRUCTION OF THE ENGINEERING DESIGN DEPICTED HEREIN.

STATE OF NEVADA — REGISTERED ENGINEER — SCOTT A. VERHINES — No. 8121 — PROFESSIONAL ENGINEER — SEAL — 9-12-90

CCSD PROJECT NO.	0612
CCSD REVIEW	
APPROVED BY	
DATE	

DATE	JAN. 29, 1990
DRAWN BY	L.L.
CHECKED BY	S.A.V.
SUBMITTAL	FINAL
A/E PROJECT NO.	88-335

Incorporated SCI CONSULTING ENGINEERS

KGA KITTRELL GARLOCK and ASSOCIATES AIA ARCHITECTS
470 SOUTH DECATUR BLVD. • SUITE B-3 • LAS VEGAS, NV. • 89107 • (702) 362-6900

CLARK COUNTY SCHOOL DISTRICT — LAS VEGAS, NEVADA 89121
SPECIAL PROJECTS 4260 EUCALYPTUS ANNEX 799-5025

LAUGHLIN SENIOR HIGH SCHOOL
LAUGHLIN NEVADA

PROJECT

DRAWING TITLE: OFFSITE DRAINAGE IMPROVEMENTS

SHEET NO. C5.15

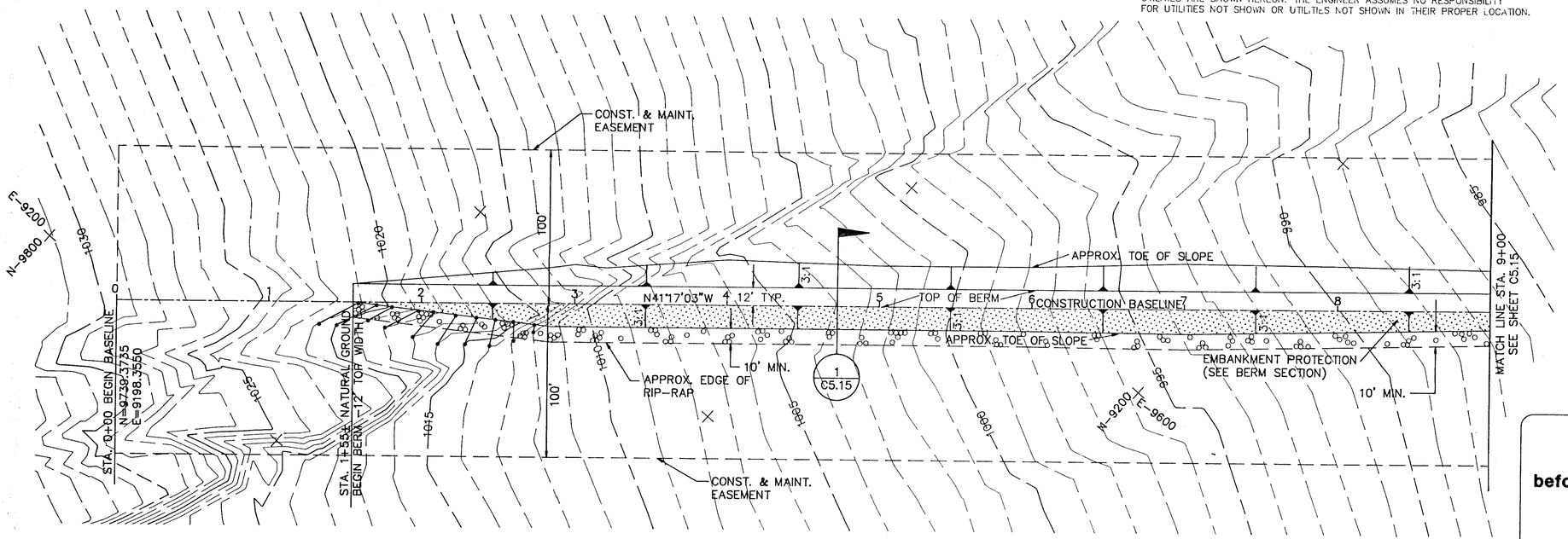
ADDENDUM NO.1

Time: 11:24:28
Date: 10/12/1990
Drawing File: k79025A
Directory: D:\ACAD10\LAUGHLIN\

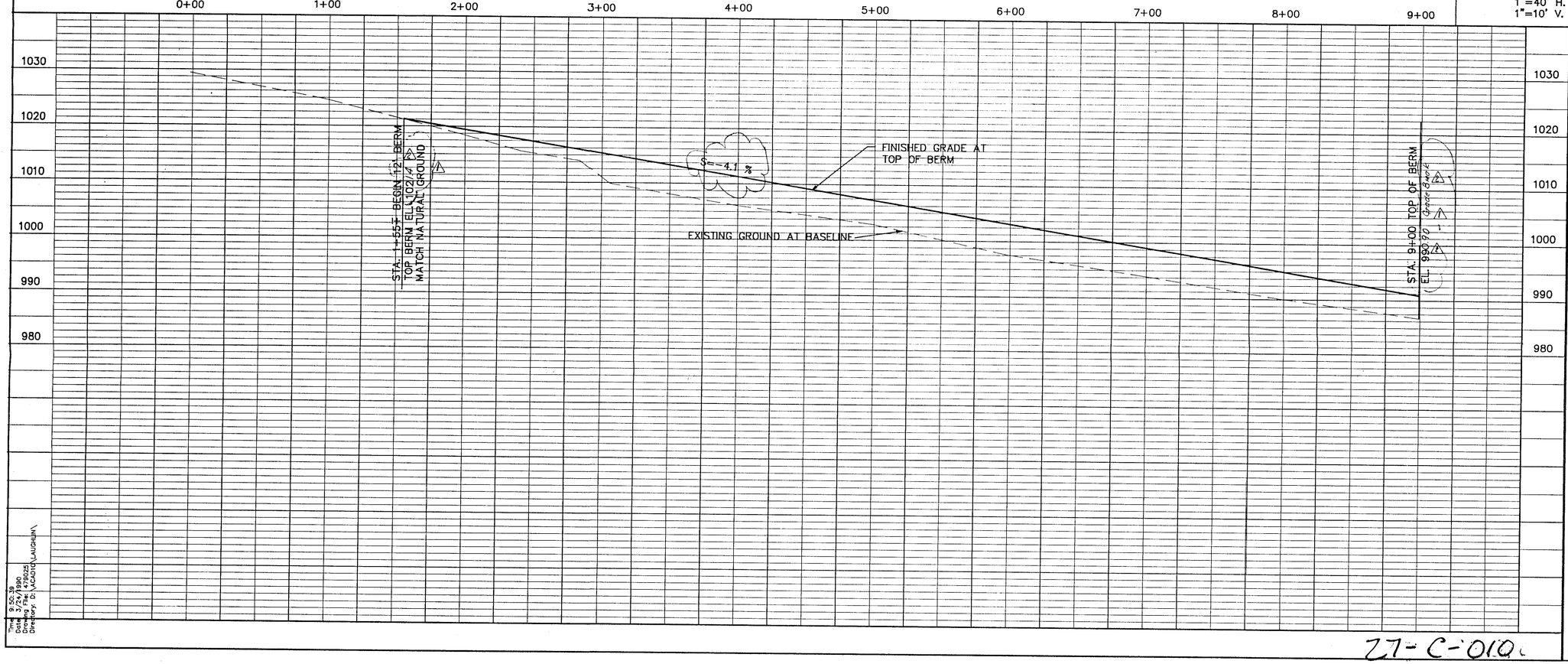
27-C-0610

NOTE: EXISTING UTILITY LOCATIONS, SHOWN HEREON ARE APPROXIMATE ONLY. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO DETERMINE THE EXACT VERTICAL AND HORIZONTAL LOCATION OF ALL EXISTING UNDERGROUND UTILITIES PRIOR TO COMMENCING CONSTRUCTION. NO REPRESENTATION IS MADE THAT ALL EXISTING UTILITIES ARE SHOWN HEREON. THE ENGINEER ASSUMES NO RESPONSIBILITY FOR UTILITIES NOT SHOWN OR UTILITIES NOT SHOWN IN THEIR PROPER LOCATION.

SCALE: 1" = 40'



OFFSITE EARTH BERM



SCALES:
1"=40' H.
1"=10' V.

Time 9:50:39
Date 1/24/90
Drawing File: 479025
Directory D:\ACAD10\LAUGHLIN\

REVISIONS			
NO.	DESCRIPTION	DATE	BY
1	Change EL.	4/13/90	SV
2	Changed Elev. & Slope	8.29.90	JA

BENCHMARK

USGS BENCHMARK 10WR. BRASS CAP - 220'± WEST OF NE CORNER OF SECTION 15 - WEST OF POWER LINE.

ELEVATION = 814.485'

BASIS OF BEARING

THE NORTH LINE OF SECTION 15, TOWNSHIP 32 SOUTH, RANGE 66 EAST, M.D.M., CLARK COUNTY, NEVADA, BEARS NORTH 88°53'00"EAST PER 1937 GLO DEPENDENT RESURVEY PLAT.

CLARK COUNTY
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION

ACCEPTANCE OF PLANS FOR FILING BY Stacey Bowler 10/15/90 ACCEPTANCE OF THESE PLANS FOR FILING SHALL NOT BE CONSTRUED TO BE A PERMIT FOR OR AN APPROVAL OF ANY VIOLATION OF ANY OF THE PROVISIONS OF THE STATE OR COUNTY LAWS AND/OR SPECIFICATIONS. CLARK COUNTY SHALL BE HELD FREE FROM DAMAGES WHICH MAY RESULT FROM THE CONSTRUCTION OF THE ENGINEERING DESIGN DEPICTED HEREIN.

Call before you Dig. 1-800-227-2600

SEAL ENGINEER - STATE OF NEVADA - SCOTT A. VERNILLO - No. 8721 - PROFESSIONAL ENGINEER - 9/12/90

CCSD PROJECT NO.	0612
CCSD REVIEW	
APPROVED BY	
DATE	

DATE	JAN. 29, 1990
DRAWN BY	L.L.
CHECKED BY	S.A.V.
SUBMITTAL	FINAL
A/E PROJECT NO.	88-335

Incorporated SGA CONSULTING ENGINEERS

KGA KITTRELL GARLOCK and ASSOCIATES ARCHITECTS AIA
4770 SOUTH DECATUR BLVD. • SUITE B-5 • LAS VEGAS, NV. • 89103 • (702) 367-4900

CLARK COUNTY SCHOOL DISTRICT
LAS VEGAS, NEVADA 89121
SPECIAL PROJECTS 4260 EUCALYPTUS ANNEX 799-5025

PROJECT: LAUGHLIN SENIOR HIGH SCHOOL
NEVADA
LAUGHLIN

DRAWING TITLE: OFFSITE DRAINAGE IMPROVEMENTS

SHEET NO. C5.14

ADDENDUM NO.1

27-C-0102

MATCH LINE - SEE SHEET 1

MATCH LINE - SEE SHEET 1

WASH STUDY AREA BOUNDARY

RM1

BRIDGE CANYON

NIORATO

MAY 31 1989

REV	DATE	BY	DESCRIPTION

SCALE: 1"=400'

DESIGNED

DRAWN

CHECKED

COOPER AERIAL OF NEVADA, INC.
3750 S. VALLEY VIEW NO 7, LAS VEGAS
PHOTO DATE 10-24-84
NATIONAL GEODETIC VERTICAL DATUM
CONTOUR INTERVAL 4 FEET

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
1100 EAST SAHARA AVENUE, SUITE 2-E, LAS VEGAS, NEVADA 89104

MEADOWS DEVELOPMENT COMPANY
LAUGHLIN
PLATE 2 - HIKO SPRINGS WASH FLOOD ROUTING MAP

SHEET 1 OF 4 SHEETS
DATE

MATCH LINE - SEE SHEET 5

MATCH LINE - SEE SHEET 7

NEBLES HWY

EDISON ROAD

RM10

RM11

RM14

EDGE CANYON

WASH STUDY AREA BOUNDARY

WASH STUDY AREA BOUNDARY

1ST EL MIRAGE BRIDGE WEST

BERM

BERM

LOWER HIKO SPRINGS WASH

PROPOSED CROWN POINTE WALL

3

4

5

6

7

8

9

10

MAY 31 1989

	DESIGNED	COOPERATIVE AERIAL OF NEVADA, INC. 1750 S. VALLEY VIEW BLVD NO 7, LAS VEGAS	JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.	MEADOWS DEVELOPMENT COMPANY LAUGHLIN	4
	DRAWN	PHOTOGRAPHED		PLATE 2 - HIKO SPRINGS WASH FLOOD ROUTING MAP	4
	CHECKED	NATIONAL GEODETIC VERTICAL DATUM OF 1929			
NO.	DESCRIPTION	CONTOUR INTERVAL 10 FEET			

MATCH LINE - SEE SHEET 4

UPPER HIKO SPRINGS WASH

WASH STUDY AREA BOUNDARY

MATCH LINE - SEE SHEET 3

MATCH LINE - SEE SHEET 10

MAY 3 1 1988

REV	DATE	BY	DESCRIPTION

SCALE: 1" = 400'

DESIGNED

DRAWN

CHECKED

COOPER AERIAL OF NEVADA, INC.
5750 S. VALLEY VIEW NO. 7, LAS VEGAS
PHOTO DATE 10-24-84
NATIONAL GEODETIC VERTICAL DATUM
CONTOUR INTERVAL 4 FEET

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
1900 EAST FLAMINGO AVENUE, SUITE 5, LAS VEGAS, NEVADA 89119

MEADOWS DEVELOPMENT COMPANY
LAUGHLIN

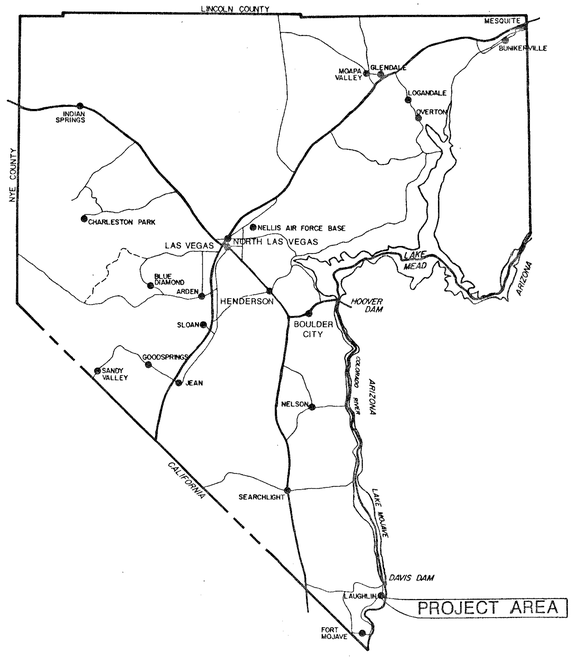
PLATE 2 - HIKO SPRINGS WASH FLOOD ROUTING MAP

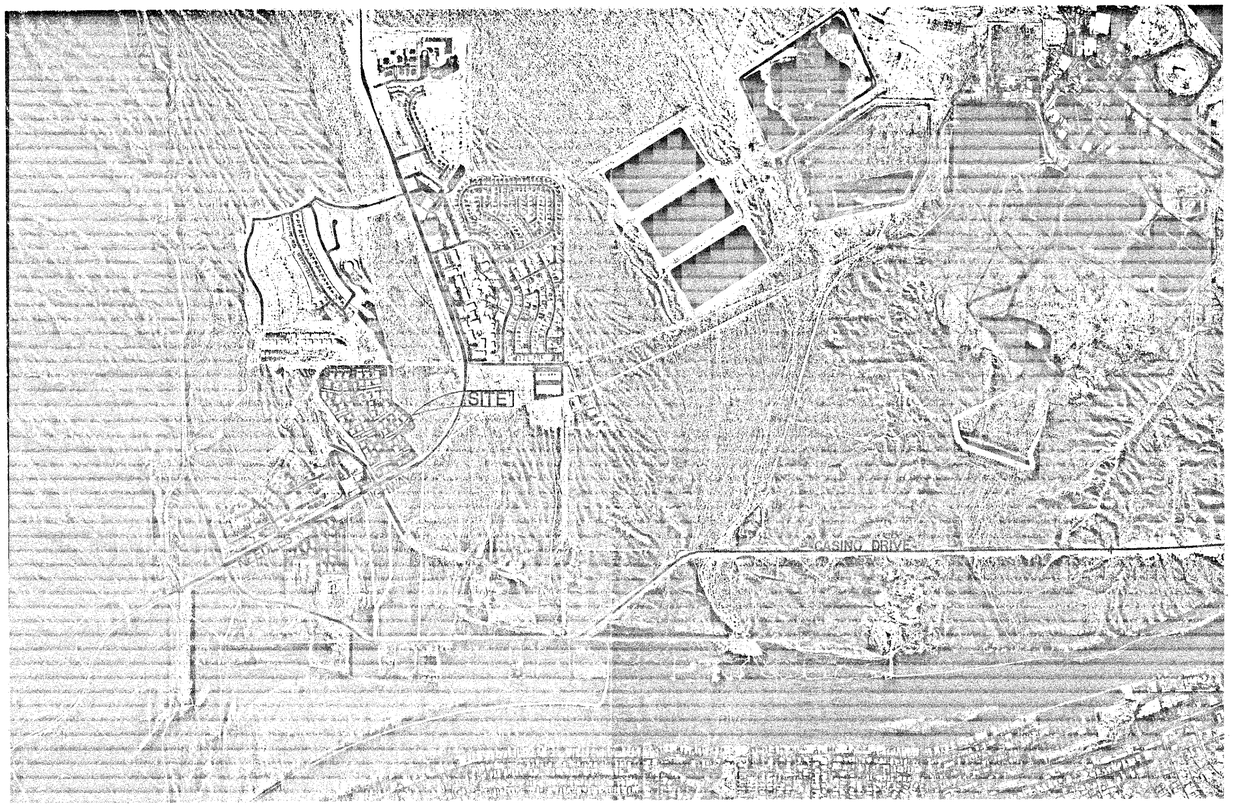
SHEET 2 OF 4 SHEETS

MEADOWS DEVELOPMENT COMPANY

CROWN POINTE FLOOD WALL

1989





GENERAL NOTES

1. ALL CONSTRUCTION SHALL CONFORM TO THE UNIFORM STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION OF OFFSITE IMPROVEMENTS. CLARK COUNTY AREA, NEVADA UNLESS OTHERWISE STATED IN THE CONTRACT DOCUMENTS.

2. THE CONTRACTOR SHALL TAKE ALL PRECAUTIONARY MEASURES NECESSARY TO PROTECT EXISTING IMPROVEMENTS. ALL SUCH IMPROVEMENTS OR STRUCTURES DAMAGED BY THE CONTRACTOR'S OPERATIONS SHALL BE REPAIRED OR RECONSTRUCTED TO THE ENGINEER'S SATISFACTION AT THE EXPENSE OF THE CONTRACTOR.

3. LOCATIONS OF UNDERGOUND UTILITIES SHOWN ON THE DRAWINGS WERE OBTAINED FROM AVAILABLE RECORDS. NEITHER THE OWNER NOR ENGINEER ASSUMES ANY RESPONSIBILITY FOR UTILITIES OR STRUCTURES NOT SHOWN OR NOT IN THE LOCATION SHOWN ON THE DRAWINGS.

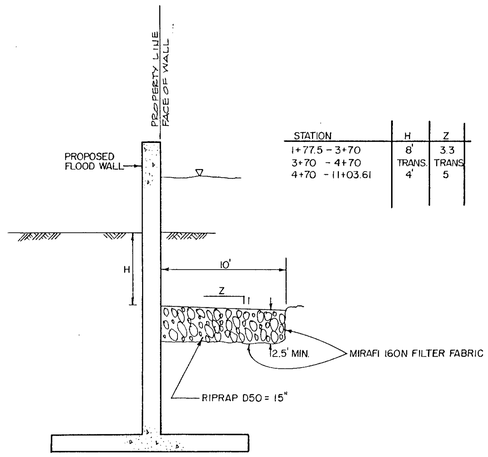
4. ALL WORK DONE WITHIN THE PUBLIC RIGHT-OF-WAY AND OUTSIDE OF THE PROJECT BOUNDARIES REQUIRES A SEPARATE ENCROACHMENT PERMIT ISSUED BY THE CLARK COUNTY DEPARTMENT OF PUBLIC WORKS.

ABBREVIATIONS

℄	- CENTERLINE
CONC.	- CONCRETE
CONST.	- CONSTRUCT OR CONSTRUCTION
C.M.P.	- CORRUGATED METAL PIPE
EA.	- EACH
EX. OR EXIST.	- EXISTING
F.G.	- FINISH GRADE
F.L.	- FLOW LINE
HWY.	- HIGHWAY
LT.	- LEFT
O.C.	- ON CENTER
RT.	- RIGHT
R/W	- RIGHT OF WAY
TYP.	- TYPICAL
T.P.O.B.	- TRUE POINT OF BEGINNING
BLK.	- BLOCK
AC	- ASPHALTIC CONCRETE
RET.	- RETAINING
BLDG.	- BUILDING
SAN.	- SANITARY
ELEC.	- ELECTRIC OR ELECTRICAL
C/C	- CENTER TO CENTER
CLR.	- CLEAR
EQU.	- EQUATION
E.P.	- EDGE OF PAVEMENT
AH.	- AHEAD
BK.	- BACK
P.I.	- POINT OF INFLECTION
P.T.	- POINT OF TANGENCY

LIST OF DRAWINGS

SHEET No.	DRAWING No.	TITLE
1.	–	COVER SHEET
2.	C-1	GENERAL NOTES, APPROVALS, ABBREVIATIONS, & LIST OF DRAWINGS, RIPRAP DETAIL
3.	C-3	PLOT & GRADING PLAN
4.	C-4	PLOT & GRADING PLAN
5.	C-5	PLOT & GRADING PLAN
6.	GS-1	GENERAL NOTES & DETAILS
7.	SC-1	CAST IN PLACE CONC. WALL PANEL PROFILE
⚠1 8.	SC-2	CAST IN PLACE CONC. WALL PANEL PROFILE
9.	SC-3	CAST IN PLACE CONC. WALL PANEL PROFILE
10.	SC-4	CAST IN PLACE CONC. SECTIONS & DETAILS



STATION	H	Z
1+77.5 – 3+70	8'	3.3
3+70 – 4+70	TRANS.	TRANS.
4+70 – 11+03.61	4'	5

RIPRAP DETAIL A ⚠2

REVIEWED BY:

CLARK COUNTY DEPARTMENT OF PUBLIC WORKS — DATE 12/15/88

RECORD DRAWING
These record drawings have been prepared based on information provided by others. The Engineer has not verified the accuracy of such information and shall not be responsible for any errors or omissions which may be incorporated herein as a result.

REGISTERED PROFESSIONAL ENGINEER — STATE OF NEVADA — No. 7647 — CHRISTOPHER J. HURST
11-21-88

REV	DATE	BY	DESCRIPTION
2	9/13	KMR	ADDITION OF RIPRAP DETAIL
1	8/89	PJS	REVISED LIST OF DRAWINGS. OMIT DWG No. C-2 & C-6

SCALE: NO SCALE
DESIGNED —
DRAWN K. ROSENSTRAUCH
CHECKED L. Evenson

SUBMITTED: Christopher J. Hurst — PROJECT ENGINEER — 7647 R.C.E. NO. — 11-21-88 DATE
RECOMMENDED: Wm M Brown — JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC. — 5818 R.C.E. NO. — 1-19-90 DATE

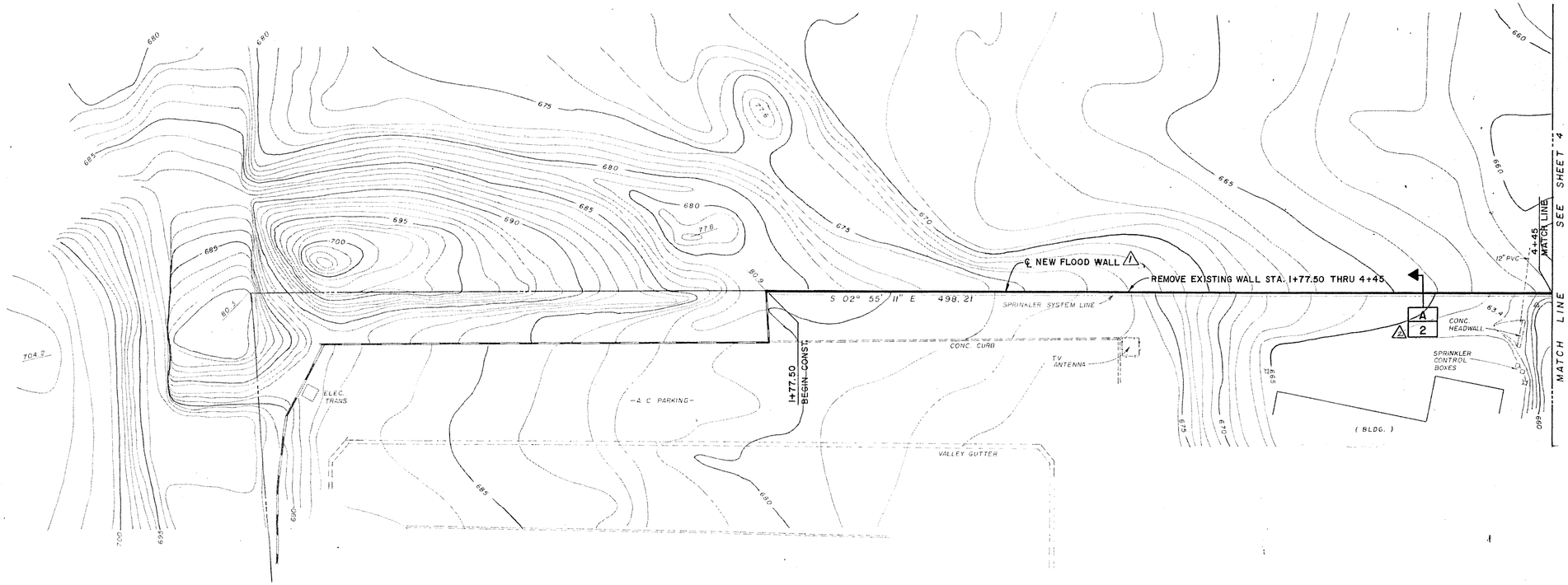
JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.
2915 WEST CHARLESTON BLVD., LAS VEGAS, NEVADA 89102

APPROVED — DATE
APPROVED — DATE

MEADOWS DEVELOPMENT COMPANY
CROWN POINTE FLOOD WALL
GENERAL NOTES, APPROVALS, ABBREVIATIONS & LIST OF DRAWINGS

DWG. NO. C-1
SHEET 2 OF 10

SCALE 1" = 20'



RECORD DRAWING

These record drawings have been prepared based on information provided by others. The Engineer has not verified the accuracy of such information and shall not be responsible for any errors or omissions which may be incorporated herein as a result.

REGISTERED PROFESSIONAL ENGINEER STATE OF NEVADA No. 7847

11-21-88

REV	DATE	BY	DESCRIPTION
2	9-13	KMR	RIPRAP DETAIL SECTION
1	8-89	RJS	REV. LOCATION NEW FLOOD WALL

SCALE: 1"=20'

DESIGNED VJS
DRAWN K. ROSENSTRAUCH
CHECKED JRE

SUBMITTED
PROJECT ENGINEER — R.C.E. NO. 7647 — DATE 11.21.88

RECOMMENDED
JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC. — R.C.E. NO. 3818 — DATE 1-19-90

JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.
2915 WEST CHARLESTON BLVD., LAS VEGAS, NEVADA 89102

APPROVED _____ DATE _____
APPROVED _____ DATE _____

MEADOWS DEVELOPMENT COMPANY
CROWN POINTE FLOOD WALL
PLOT & GRADING

DWG. NO. C-3
SHEET 3 OF 10

JOB NO. 1925.0011

SCALE 1" = 20'

MATCH LINE SEE SHEET 3

4+46 MATCH LINE

4+98.21
46°20'37" LT.

S 02° 55' 11" E

℄ NEW FLOOD WALL ⚠1

S 51° 15' 48" E 489.94

REMOVE EXIST. WALL STA. 4+45 THRU 10+48

A
2
⚠2

8+63.65
29°03'05" RT.

S 22°12'43" E

10+03.61

10+48 MATCH LINE

MATCH LINE SEE SHEET 5

CONSTRUCTION CURVE DATA
Δ = 05°19'47"
R = 1075.00'
L = 100.00'

MATCH LINE SEE SHEET 5

ELEC. CONDUIT O/PENING
8+48
8" HIGH 24" LG.

RET. WALL

A.C. DRIVE

CONC. CURB

BLDG.

VALLEY GUTTER

SAN.

A.C. PARKING

SPRINKLING SYSTEM LINE

SPRINKLER CONTROL BOXES

ELEC. TRANS.

ELEC. OUTLET ON WALL

RECORD DRAWING

These record drawings have been prepared based on information provided by others. The Engineer has not verified the accuracy of such information and shall not be responsible for any errors or omissions which may be incorporated herein as a result.

REGISTERED PROFESSIONAL ENGINEER — STATE OF NEVADA — No. 7647 — 11-21-89

REV	DATE	BY	DESCRIPTION
2	9-13	KMR	RIPRAP DETAIL SECTION
1	8-89	PJS	REV. LOCATION NEW FLOOD WALL

SCALE: 1"=20'

DESIGNED WTS
DRAWN K. ROSENSTRAUCH
CHECKED WRE

SUBMITTED
PROJECT ENGINEER — R.C.E. NO. 7647 — DATE 11-21-89

RECOMMENDED
JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC. — R.C.E. NO. 5818 — DATE 1-19-90

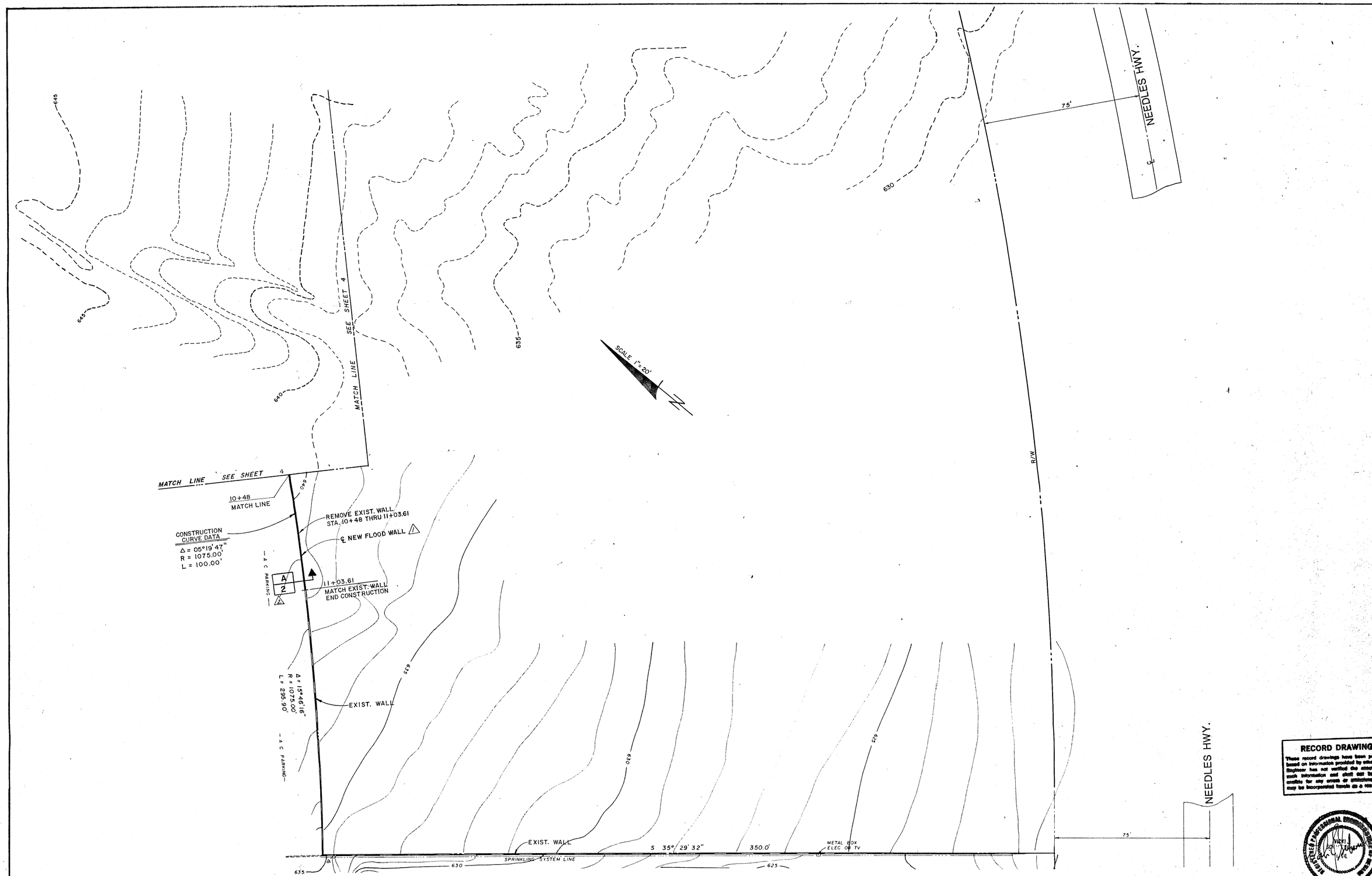
JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.
2915 WEST CHARLESTON BLVD., LAS VEGAS, NEVADA 89102

APPROVED — DATE
APPROVED — DATE

MEADOWS DEVELOPMENT COMPANY
CROWN POINTE FLOOD WALL
PLOT & GRADING

DWG. NO. C-4
SHEET 4 OF 10

JOB NO. 1925.0011



RECORD DRAWING

These record drawings have been prepared based on information provided by others. The Engineer has not verified the accuracy of such information and shall not be responsible for any errors or omissions which may be incorporated herein as a result.

11-21-88

REV	DATE	BY	DESCRIPTION
2	9-13	KMR	RIPRAP DETAIL SECTION
1	8-89	RJS	REV. LOCATION NEW FLOOD WALL

SCALE 1"=20'

DESIGNED VJS
DRAWN K. ROSENSTRAUCH
CHECKED URE

SUBMITTED Victor J. Salvant 7647 11.21.88
PROJECT ENGINEER R.C.E. NO. DATE

RECOMMENDED
JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC. R.C.E. NO. DATE

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
2915 WEST CHARLESTON BLVD., LAS VEGAS, NEVADA 89102

APPROVED DATE
APPROVED DATE

MEADOWS DEVELOPMENT COMPANY
CROWN POINTE FLOOD WALL
PLOT & GRADING

DWG. NO. C-5
SHEET 5 OF 10

1925.0011

GENERAL NOTES

GENERAL

STRUCTURAL DIMENSIONS CONTROLLED BY OR RELATED TO MECHANICAL OR ELECTRICAL EQUIPMENT SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION.

MECHANICAL AND ELECTRICAL EQUIPMENT SUPPORTS, ANCHORAGES, OPENINGS, RECESSES AND REVEALS NOT SHOWN ON THE STRUCTURAL DRAWINGS BUT REQUIRED BY OTHER CONTRACT DRAWINGS, SHALL BE PROVIDED FOR PRIOR TO PLACING CONCRETE.

STRUCTURAL DRAWINGS SHALL BE USED IN COORDINATION WITH MECHANICAL, ELECTRICAL, ARCHITECTURAL, CIVIL DRAWINGS AND SHOP DRAWINGS PROVIDED BY MANUFACTURERS OF EQUIPMENT.

STRUCTURES HAVE BEEN DESIGNED FOR OPERATIONAL LOADS ON THE COMPLETED STRUCTURES. DURING CONSTRUCTION, THE STRUCTURES SHALL BE PROTECTED BY BRACING AND BALANCING WHEREVER EXCESSIVE CONSTRUCTION LOADS MAY OCCUR.

STRUCTURAL

DESIGN IN ACCORDANCE WITH THE 1982 EDITION OF THE UNIFORM BUILDING CODE, EXCEPT WHERE OTHER APPLICABLE CODES OR THE FOLLOWING NOTES ARE MORE RESTRICTIVE.

LOCATION OF ALL CONSTRUCTION JOINTS SHALL BE AS SHOWN ON THE DRAWINGS OR APPROVED BY THE ENGINEER. ALL CONSTRUCTION JOINTS LOCATED ON THE DRAWINGS OR REQUIRED FOR CONSTRUCTION BUT NOT SHOWN ON THE DRAWINGS, SHALL HAVE A 6" CENTER-BULB WATERSTOP, IF IN MEMBERS IN CONTACT WITH WATER. IN ALL SLABS COVERED WITH WATER, CONSTRUCTION JOINTS SHALL HAVE A 6" CENTER-BULB WATERSTOP AND A SEALANT GROOVE.

STRUCTURAL STEEL

STEEL CONSTRUCTION SHALL CONFORM TO THE SPECIFICATIONS AND STANDARDS AS CONTAINED IN THE LATEST EDITION OF THE AISC STEEL CONSTRUCTION MANUAL.

ALL STRUCTURAL SHAPES, BARS, PLATES AND SHEETS SHALL BE OF STEEL MEETING ASTM A-36 SPECIFICATIONS.

ALL WELDING SHALL BE BY THE SHIELDED ARC METHOD AND SHALL CONFORM TO AWS CODE FOR ARC AND GAS WELDING IN BUILDING CONSTRUCTION. QUALIFICATIONS OF WELDERS SHALL BE IN ACCORDANCE WITH THE SPECIFICATIONS FOR STANDARD QUALIFICATION PROCEDURE OF THE AWS.

CONCRETE

UNLESS OTHERWISE NOTED OR SPECIFIED, ALL STRUCTURAL CONCRETE SHALL DEVELOP A MINIMUM COMPRESSIVE STRENGTH OF 4,000 PSI IN 28 DAYS.

REINFORCEMENT STEEL SHALL BE DEFORMED BARS CONFORMING IN QUALITY TO THE REQUIREMENTS OF THE "SPECIFICATIONS FOR DEFORMED BILLET-STEEL BARS FOR CONCRETE REINFORCEMENT" ASTM DESIGNATION A-615, GRADE 60.

COLUMN SPIRALS SHALL CONFORM TO "SPECIFICATION FOR COLD-DRAWN STEEL WIRE FOR CONCRETE REINFORCEMENT" ASTM DESIGNATION A-82.

ALL DETAILING, FABRICATION AND PLACING OF REINFORCING BARS, UNLESS OTHERWISE NOTED, SHALL BE IN ACCORDANCE WITH THE "MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE STRUCTURES" ACI-315, LATEST EDITION.

TOLERANCES IN PLACING REINFORCEMENT SHALL BE:
±3/8 INCH FOR MEMBERS WITH D≤ 8 INCHES
±1/2 INCH FOR MEMBERS WITH D> 8 INCHES

ALL KEYWAYS IN CONSTRUCTION JOINS SHALL BE ROUGH AND THOROUGHLY CLEANED FOR BOND

DOWELS, PIPES, WATERSTOPS AND OTHER INSTALLED MATERIALS AND ACCESSORIES SHALL BE HELD SECURELY IN POSITION WHILE CONCRETE IS BEING PLACED.

UNLESS OTHERWISE SHOWN, ASIDE FROM NORMAL ACCESSORIES USED TO HOLD REINFORCING BARS FIRMLY IN POSITION, THE FOLLOWING SHALL BE ADDED:
A) IN SLABS #5 IRISER BARS AT 36 INCHES O.C. MAXIMUM TO SUPPORT TOP REINFORCING BARS.
B) IN WALLS WITH 2 CURTAINS #3 U OR Z SHAPE SPACERS AT 6 FEET O.C. EACH WAY.

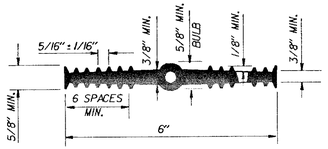
METAL CLIPS OR SUPPORTS SHALL NOT BE PLACED IN CONTACT WITH THE FORMS OR THE SUBGRADE. CONC. BLOCKS (OR DOBBIES) SUPPORTING BARS ON SUBGRADE SHALL BE IN SUFFICIENT NUMBERS TO SUPPORT THE BARS W/O SETTLEMENT, BUT IN NO CASE SHALL SUPPORT BE CONTINUOUS.

DOWELS SHALL BE WIRED OR OTHERWISE HELD IN POSITION. THEY SHALL NOT BE SHOVED INTO FRESHLY PLACED CONCRETE.

UNLESS OTHERWISE NOTED ON THE DRAWINGS, SPLICES OF REINFORCEMENT SHALL BE AS SHOWN ON DETAIL E PER SHEET GS-1.

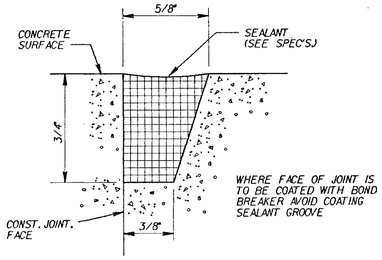
LOCATE TWO 3/4 "GALV. RICHMOND ROCKET INSERTS, HOHMANN & BARNARD OR EQUAL, STRADDLING CENTER LINE OF EQUIPMENT OVER ALL PUMPS, METERS OR OTHER MECHANICAL UNITS OF MORE THAN 100 LBS. FOR INSERTING LIFTING EYES IF NOT OTHERWISE SHOWN ON THE DRAWINGS.

REINFORCING BARS AND ACCESSORIES SHALL NOT BE IN CONTACT WITH ANY PIPE, PIPE FLANGE OR METAL PARTS EMBEDDED IN CONCRETE. A MINIMUM OF 2 INCHES CLEARANCE SHALL BE PROVIDED AT ALL TIMES.



6" CENTER-BULB WATERSTOP — A — VAR

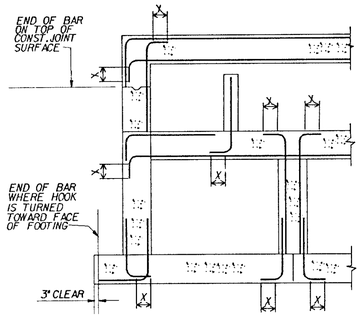
ALL FLOOR JOINTS OF HYDRAULIC STRUCTURES (MEMBERS COVERED WITH WATER) SHALL HAVE A SEALANT GROOVE



SEALANT GROOVE — B — VAR

BAR SIZE	f'C - 3000 psi		f'C - 4000 psi	
	GRADE 40	GRADE 60	GRADE 40	GRADE 60
#3	20"	20"	20"	20"
#4	20"	20"	20"	20"
#5	20"	26"	20"	26"
#6	22"	33"	20"	31"
#7	31"	45"	26"	39"
#8	39"	59"	34"	51"
#9	49"	74"	43"	65"
#10	63"	95"	55"	82"
#11	78"	116"	67"	101"

STANDARD BAR SPLICES (UNLESS OTHERWISE NOTED ON THE DWGS.) — C — VAR

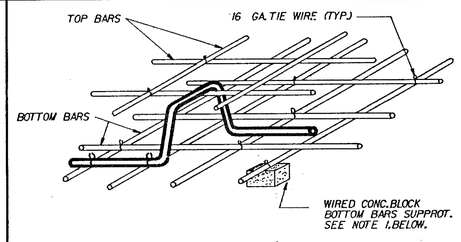


SECTION

GRADE 40 OR 60 REINF. STEEL

BAR SIZE	90 HOOKS "X"
#3	6"
#4	8"
#5	10"
#6	12"
#7	14"
#8	16"
#9	19"
#10	22"
#11	24"

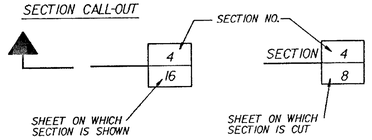
STANDARD 90° BAR HOOKS — D — VAR
UNLESS OTHERWISE NOTED ON DWGS.



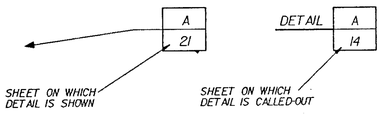
1. METAL BAR SUPPORTS, IF USED IN SLABS NOT ON GROUND, SHALL NOT MAKE CONTACT WITH FORMS.
2. REINFORCING BARS AND ACCESSORIES SHALL NOT BE IN CONTACT WITH ANY OTHER METAL INSTALLATION OR ACCESSORY EMBEDDED IN CONCRETE. A MINIMUM OF 2" CLEARANCE SHALL BE PROVIDED IN ALL CASES.

BAR CHAIR REINFORCEMENT SUPPORT — E — VAR

SECTION CALL-OUT



DETAIL CALL-OUT



THE DETAILS ILLUSTRATED ON SHEETS GS-1 ARE PART OF JAMES M. MONTGOMERY STANDARD DETAILS.

THESE DETAILS ARE TO BE USED WHEN REFERRED TO OR WHEN NO OTHER MORE RESTRICTIVE OR DIFFERENT DETAILS ARE SHOWN ON THE DRAWING.

DETAILS NOT PERTAINING TO THE PROJECT ARE MARKED THUS ▨ N. I. C. (NOT IN CONTRACT)

UNLESS OTHERWISE SHOWN ON THE DRAWINGS CONCRETE COVER FOR REINFORCING BARS SHALL BE AS FOLLOWS:

FOR CONCRETE PLACED AGAINST EARTH ----- 3"

FOR SURFACES IN CONTACT WITH WATER, COLUMNS AND FORMED SURFACES IN CONTACT WITH EARTH -- 2"

FOR UNDERSIDE OF SLABS OVER WATER IN ENCLOSED CONDUITS AND BEAMS ---------- 1 ½"

FOR SURFACES EXPOSED TO WEATHER AND INTERIOR SURFACES (EXCEPT BEAMS AND COLUMNS) NOT IN CONTACT WITH EARTH OR WATER ---------- 1"

UNLESS OTHERWISE NOTED, WALLS AND SLABS SHOWN WITH A SINGLE LAYER OF REINFORCEMENT SHALL HAVE THAT REINFORCEMENT CENTERED

CONCRETE PROTECTION FOR REINFORCEMENT (CAST-IN-PLACE CONCRETE) — F — VAR

RECORD DRAWING
These record drawings have been prepared based on information provided by others. The Engineer has not verified the accuracy of such information and shall not be responsible for any errors or omissions which may be incorporated herein as a result.

REGISTERED PROFESSIONAL ENGINEER — MICHAEL J. MONTGOMERY — CIVIL — 12-15-88 — No. 7641

REV	DATE	BY	DESCRIPTION

SCALE: NONE
DESIGNED JMM
DRAWN JMM
CHECKED MJM

SUBMITTED — PROJECT ENGINEER — 7647 R. C. E. NO. — 1-19-90 DATE
JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC. — 5818 R. C. E. NO. — 1-19-90 DATE

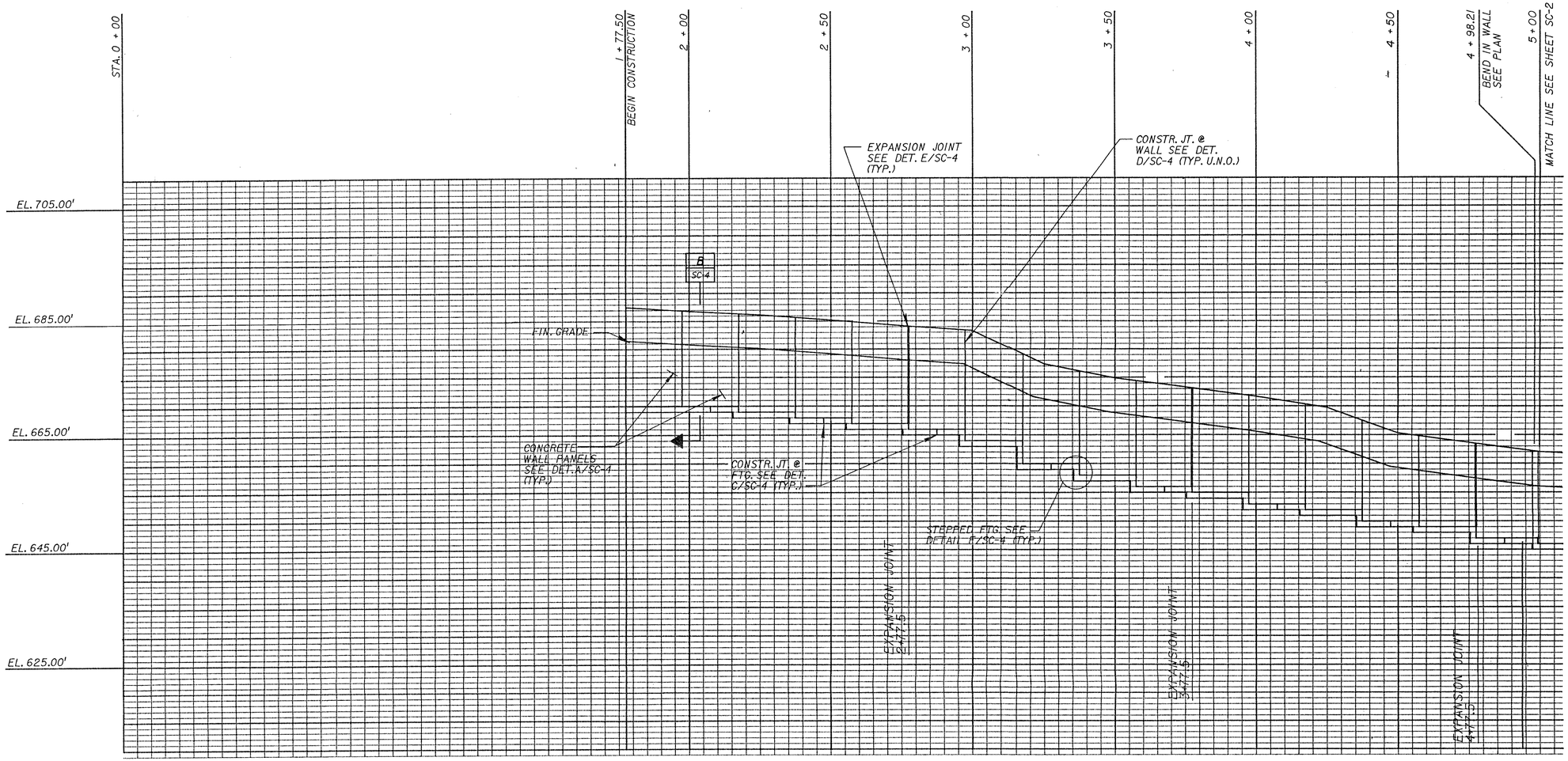
JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.
2915 WEST CHARLESTON BLVD., LAS VEGAS, NEVADA 89102

APPROVED ____ DATE ____
APPROVED ____ DATE ____

MEADOWS DEVELOPMENT COMPANY
CROWN POINTE DEVELOPMENT
GENERAL NOTES AND DETAILS

SHEET GS-1 OF 10 SHEETS

JOB No. 1925.0011 FILE No. ZFAHEDL3TOJGSLDGN



WALL PANEL PROFILE

HORIZONTAL SCALE : 1" = 20'-0"
VERTICAL SCALE : 1" = 10'-0"

1-19-90

REV	DATE	BY	DESCRIPTION

SCALE: AS NOTED

DESIGNED I.GONZALEZ
DRAWN HTM/IEG
CHECKED

SUBMITTED
PROJECT ENGINEER — 7647 R. C. E. NO. — 1-19-90 DATE

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC. — 5818 R. C. E. NO. — 1-19-90 DATE

JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.
2915 WEST CHARLESTON BLVD., LAS VEGAS, NEVADA 89102

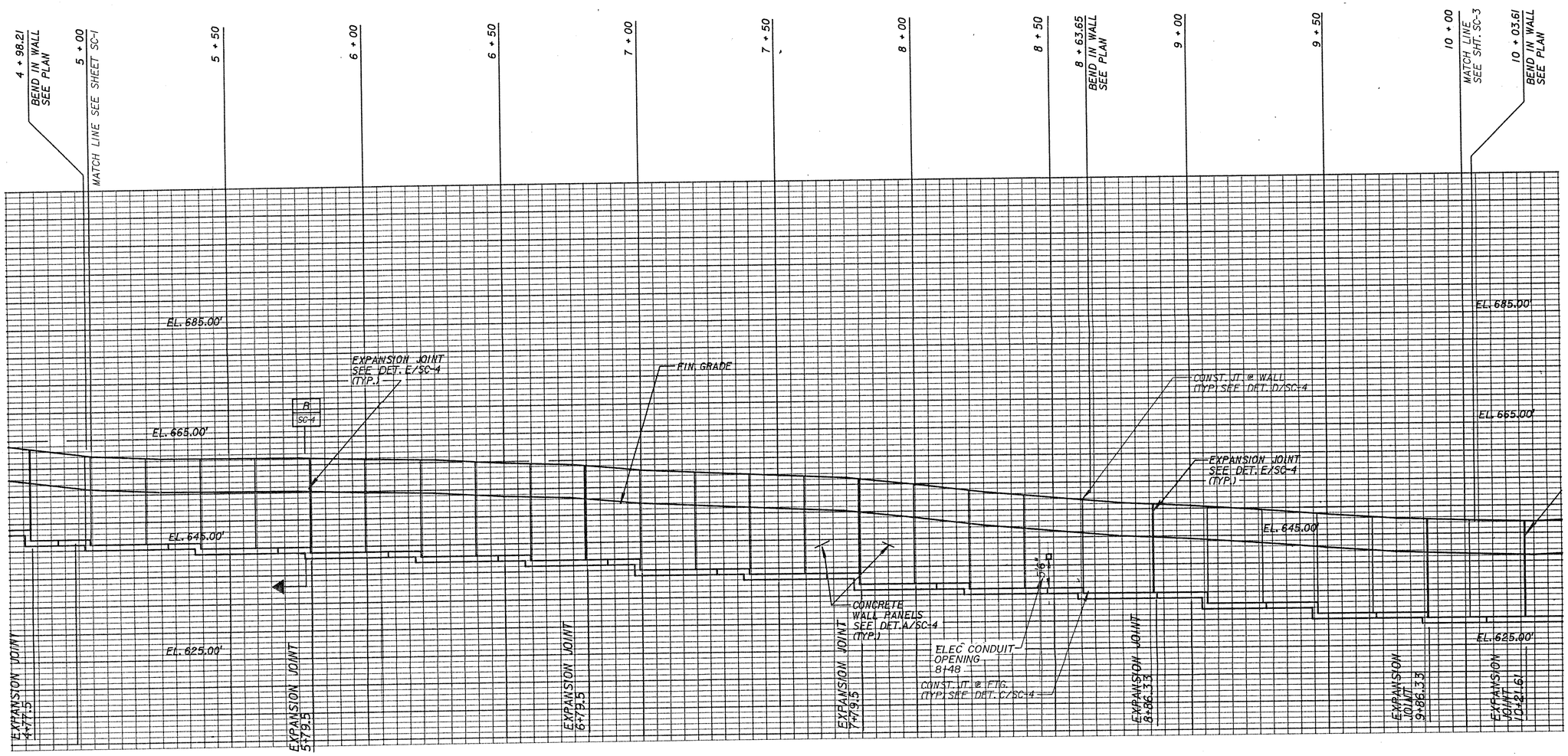
APPROVED _____ DATE _____
APPROVED _____ DATE _____

MEADOWS DEVELOPMENT COMPANY
CROWN POINTE DEVELOPMENT

CAST IN PLACE CONC. WALL PANEL PROFILE

DWG. NO. SC-1
SHEET 7 OF 10

JOB No. 1925.0011 FILE No. ZFA\12\L3701SC1.DGN



WALL PANEL PROFILE

HORIZONTAL SCALE : 1" = 20'-0"
VERTICAL SCALE : 1" = 10'-0"

RECORD DRAWING

REV	DATE	BY	DESCRIPTION

SCALE: AS NOTED

DESIGNED I.GONZALEZ
DRAWN HTM/IEG
CHECKED

SUBMITTED
PROJECT ENGINEER — R. C. E. NO. 7647 — DATE 1-19-90

JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC. — R. C. E. NO. — DATE

JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.
2915 WEST CHARLESTON BLVD., LAS VEGAS, NEVADA 89102

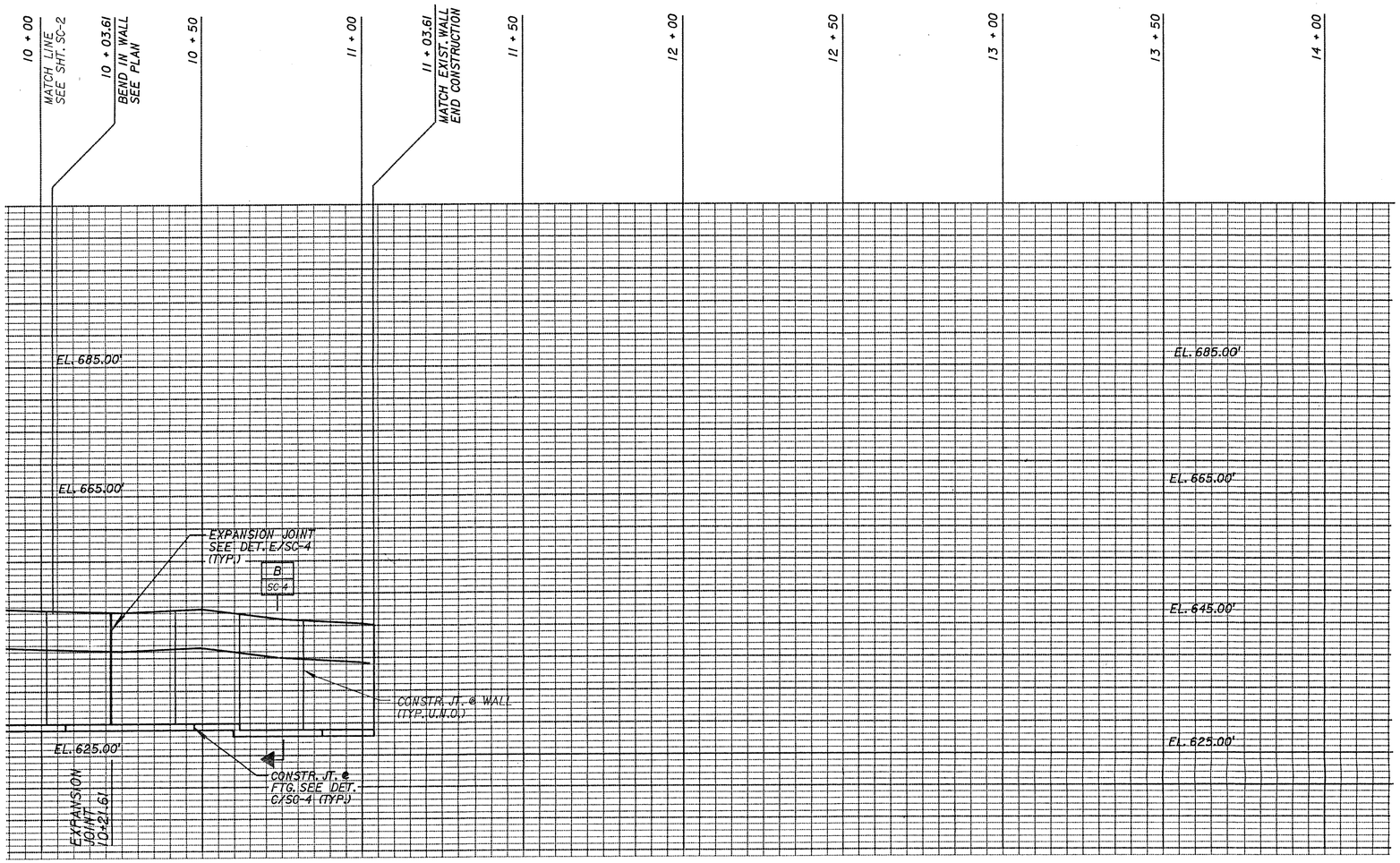
APPROVED — DATE
APPROVED — DATE

MEADOWS DEVELOPMENT COMPANY
CROWN POINTE DEVELOPMENT

CAST IN PLACE CONC. WALL PANEL PROFILE

DWG. NO. SC-2
SHEET 8 OF 10

JOB No. 1925.0011 FILE No. ZEAS12\L3703SC2.DGN



WALL PANEL PROFILE

HORIZONTAL SCALE : 1" = 20'-0"
VERTICAL SCALE : 1" = 10'-0"

PROFESSIONAL ENGINEER — No. 7647 — 1-19-90

RECORD DRAWING

These record drawings have been prepared based on information provided by others. The Engineer does not warrant the accuracy of such information and shall not be responsible for any errors or omissions which may be incorporated herein as a result.

REV	DATE	BY	DESCRIPTION

SCALE: AS NOTED

DESIGNED I.GONZALEZ
DRAWN HTM/IEG
CHECKED

SUBMITTED
PROJECT ENGINEER — 7647 R. C. E. NO. — 1-19-90 DATE

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC. — 5818 R. C. E. NO. — 1-19-90 DATE

JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.
2295 WEST CHARLESTON BLVD., LAS VEGAS, NEVADA 89102

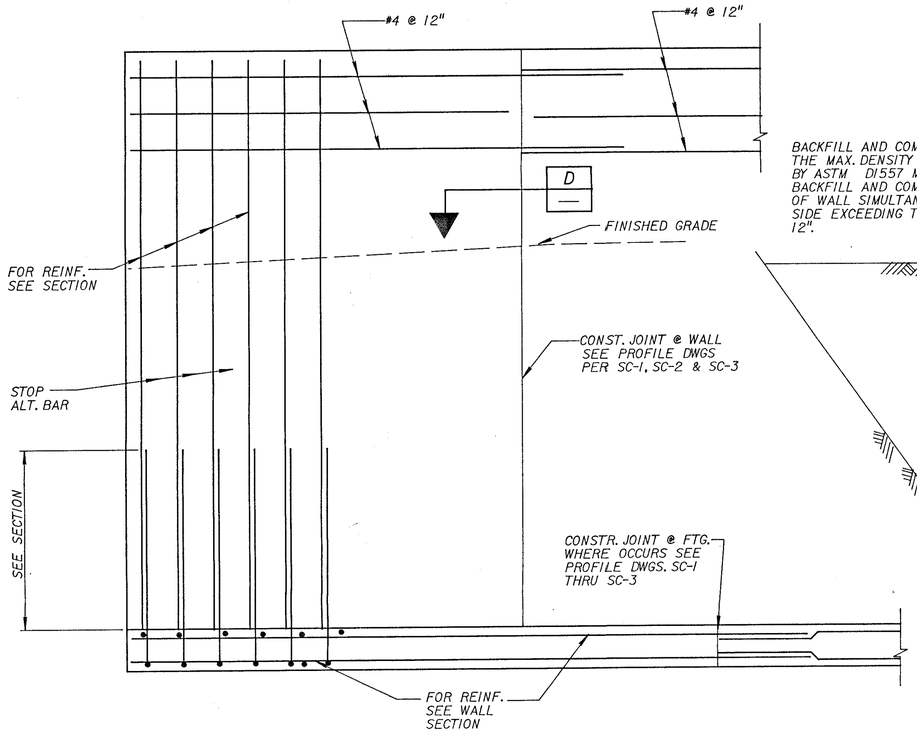
APPROVED _____ DATE _____
APPROVED _____ DATE _____

MEADOWS DEVELOPMENT COMPANY
CROWN POINTE DEVELOPMENT

CAST IN PLACE CONC. WALL PANEL PROFILE

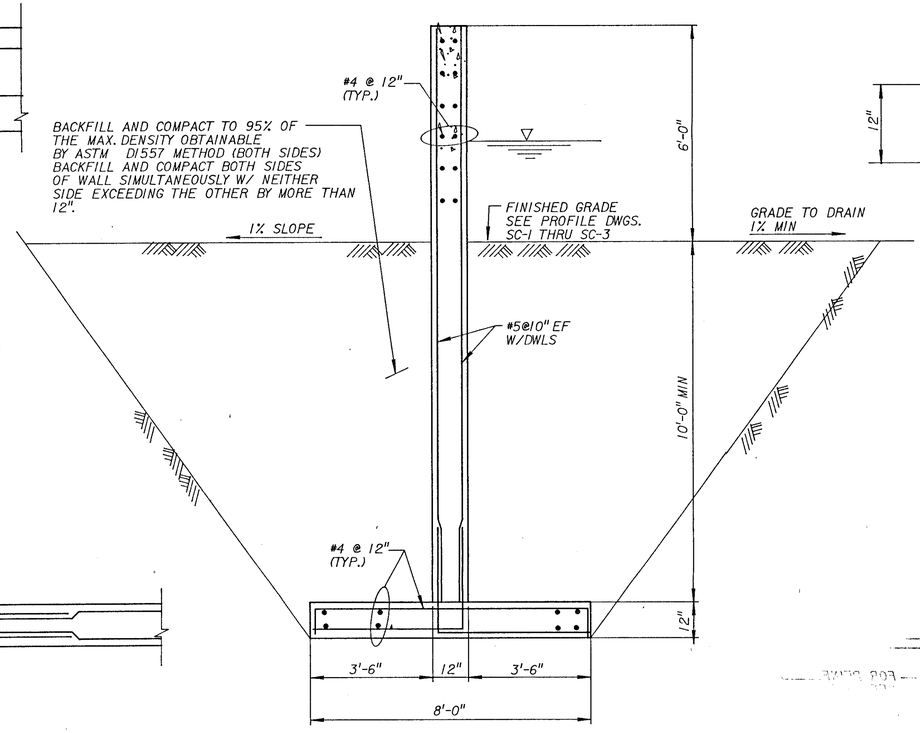
DWG. NO. SC-3
SHEET 9 OF 10

JOB No. 1925.001 FILE No. ZFA#121.3703SC3.DGN



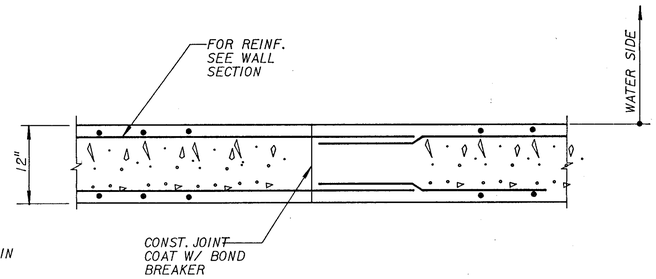
TYPICAL PANEL ELEVATION
SCALE : N.T.S

A
SC-1
SC-2
SC-3



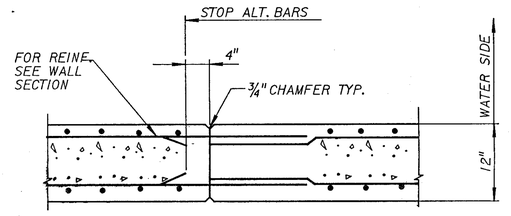
CAST-IN-PLACE CONCRETE PANEL SECTION
SCALE: 1/2" = 1'-0"

B
SC-1
SC-2
SC-3



FOOTING AT CONSTRUCTION JOINT
N.T.S.

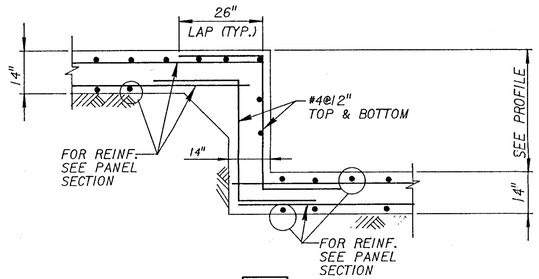
C
SC-1
SC-2
SC-3



PLAN VIEW

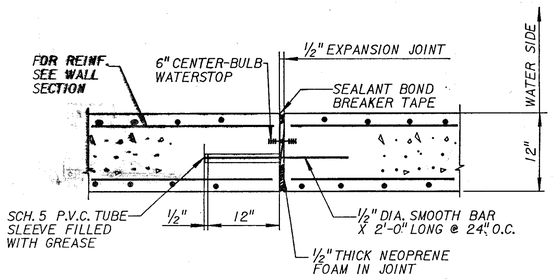
WALL DETAIL AT CONSTRUCTION JOINT
N.T.S.

D
SC-1
SC-2 SC-3



STEPPED FOOTING DETAIL
SCALE: 1/2" = 1'-0"

F
SC-1
SC-2
SC-3



PLAN VIEW

CONNECTION AT EXPANSION JOINT
N.T.S.

E
SC-1
SC-2
SC-3

RECORD DRAWING
These record drawings have been prepared based on information provided by others. The Engineer has not verified the accuracy of said information and shall not be responsible for any errors or omissions which may be incorporated herein as a result.

REV	DATE	BY	DESCRIPTION

SCALE: AS NOTED
DESIGNED I.GONZALEZ
DRAWN HTM/IEG
CHECKED

SUBMITTED
PROJECT ENGINEER — R. C. E. NO. 7647 — DATE 1-17-90
JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC. — R. C. E. NO. 5818 — DATE 1-19-90

JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.
2195 WEST CHARLESTON BLVD., LAS VEGAS, NEVADA 89102

APPROVED — DATE
APPROVED — DATE

MEADOWS DEVELOPMENT COMPANY
CROWN POINTE DEVELOPMENT
CAST IN PLACE CONC. SECTIONS AND DETAILS

DWG. NO. SC-4
SHEET 10 OF 10

JOB No. 1925.001 FILE No. ZFAIL121.370JSC4.DGN

DRAFT TECH SUPPORT VOLUME III

Technical Support Data Notebook

For

FLOOD INSURANCE STUDY

RESTUDY

HIKO SPRINGS & BRIDGE CANYON WASHES

RECEIVED
MAR 4 1994
REGIONAL
FLOOD CONTROL DISTRICT

Clark County, Nevada
(Unincorporated Areas)

VOLUME III OF III

Submitted by:	Clark County Regional Flood Control District
Study Contractor:	Post, Buckley, Schuh & Jernigan, Inc.
Date Submitted:	March 4, 1994

SECTION 5.4

Technical Support Data for Needles Highway Improvements

PROJECT: HI'KO SPRINGS & BRIDGE CANYON WASHES RESTUDY

STATION: WEBER HWY 479+50

SHEET _____ OF _____

CULVERT DESIGN FORM

DESIGNER / DATE: SJD / 2/17/94

REVIEWER / DATE: _____ / _____

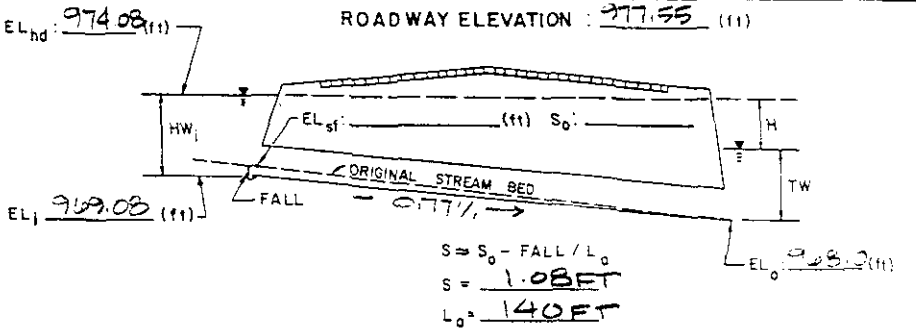
HYDROLOGICAL DATA

SEE ADD'L SHTS.

- ☑ METHOD: MODIFIED ALLUVIAL FAN ANALYSIS
- ☑ DRAINAGE AREA: 8 mi^2 ☐ STREAM SLOPE: _____
- ☐ CHANNEL SHAPE: _____
- ☐ ROUTING: _____ ☐ OTHER: _____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
100-YR	1911 CFS	0



CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
(6) 10' x 5' RCB	1911	319	1.0	5.0	—	974.08	0	3.16	4.08	4.08	0.5	1.13	973.20	974.08	14.4	VELOCITY CORRECTED USING MANNING EQUATION

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) HW_i/D = HW /D OR HW_i/D FROM DESIGN CHARTS

(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29 n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

For $k_e = 0.5$ $n = 0.012$

$R = A/P = 50/30 = 1.67$ FT $V = Q/A = 319/50 = 6.38$ FT/S

$H = \{1 + 0.5 + (29(0.012^2)(140)/1.67^{1.33}\}\ 6.38^2/64.4$

$H = 1.13$ FT

CULVERT BARREL SELECTED:

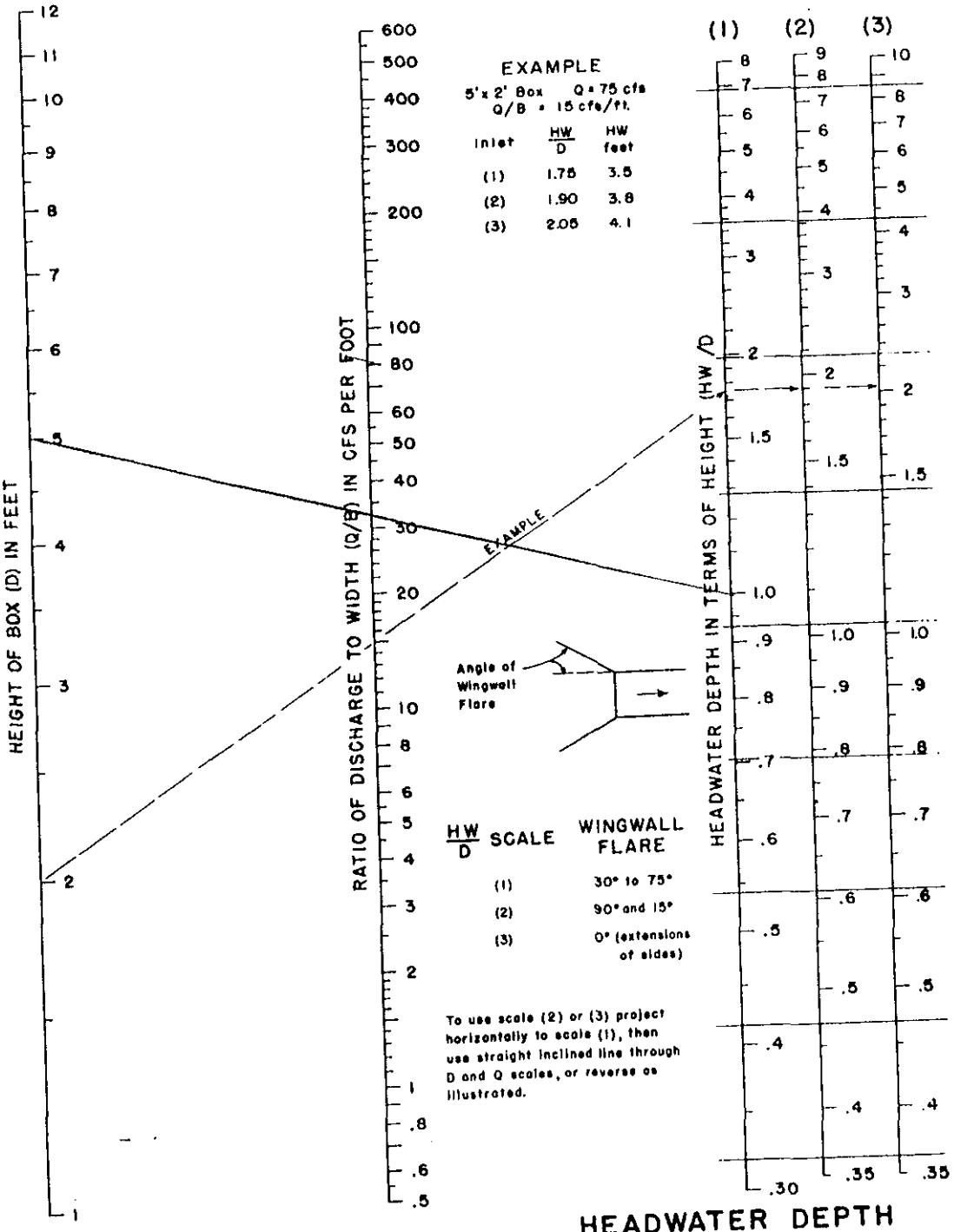
SIZE: _____

SHAPE: _____

MATERIAL: _____ n _____

ENTRANCE: _____

CHART 8



HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

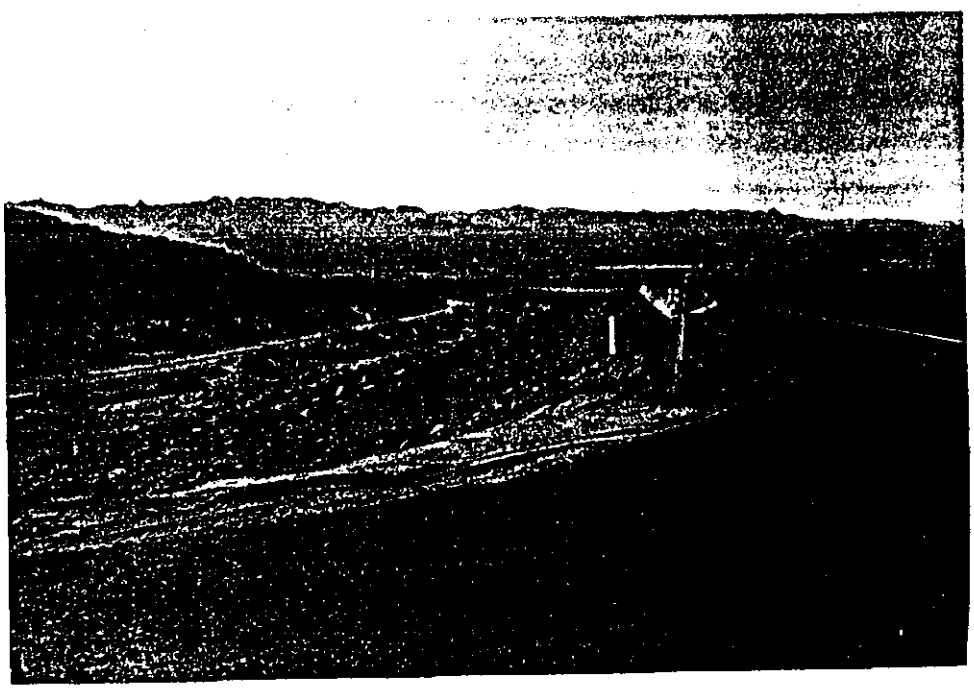
DESERT ROAD
CULVERTS
(6) 10' x 5' RCB

SECTION 5.5

Technical Support Data for SR-163 Dike/Channel Improvements

HYDRAULIC DESIGN REPORT
FOR PHASE - V
SR-163
P059-93-010

NEVADA
DEPARTMENT OF
TRANSPORTATION



WRC NEVADA, INC.
CONSULTING ENGINEERS

HYDRAULIC DESIGN REPORT

FOR PHASE - V

SR-163

P059-93-010

Prepared For:

NEVADA DEPARTMENT OF TRANSPORTATION

1263 STEWART STREET

CARSON CITY, NEVADA 89712

Prepared By:

WRC NEVADA, INC.

1771 EAST FLAMINGO ROAD, SUITE 200A

LAS VEGAS, NEVADA 89119

(702) 893-6266

JUNE 1993

WRC NEVADA, INC.

June 29, 1993

Mr. Amir M. Soltani, P.E.
Senior Hydraulic Engineer
Nevada Department of Transportation
1263 South Stewart Street
Carson City, Nevada 89712

NDOT: P059-93-010
WRC File: 2016/3

Dear Mr. Soltani:

Transmitted herewith is the final hydraulic design report for SR-163. This work was performed in accordance with the terms and conditions of the agreement No. P059-93-010, and covers the work outlined in task order No. 1 issued to us by the Nevada Department of Transportation.

Different tasks were coordinated with NDOT staff throughout the project duration. Applicable design information was submitted to NDOT as it was completed, to insure that it was incorporated in the Roadway Design in a timely manner.

We would like to thank you and the other staff of NDOT, for your cooperation, timely reviews, and help in providing us with the information needed to complete this report.

Very truly yours,

WRC NEVADA, INC.

A. S. Andrews, P.E.
Project Manager

Alan J. Leak, P.E.
Project Engineer

ASA/mag

Enclosure

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I. INTRODUCTION

A. AUTHORIZATION

The Nevada Department of Transportation (NDOT) is planning to reconstruct approximately the last three miles of SR-163 to Laughlin from the existing two lane to a four lane highway. The project is located immediately northwest of the City of Laughlin as shown in Figure-1 (Page 2). This phase V of the project extends from milepost 16.40 to 19.12. WRC Nevada, Inc. (WRC) was retained by NDOT, and was issued task order No. 1 for on-call program, to perform the requested engineering services under the terms and conditions of the Agreement No. P059-93-010 dated January 1, 1993. The Notice to Proceed was issued on March 26, 1993, and the work commenced on March 29, 1993. A preliminary hydraulic report was completed on April 16, 1993; followed by 90% complete hydraulic report on May 6, 1993; and a draft and final hydraulic report on June 11, 1993, and June 29, 1993, respectively.

B. PURPOSE AND SCOPE

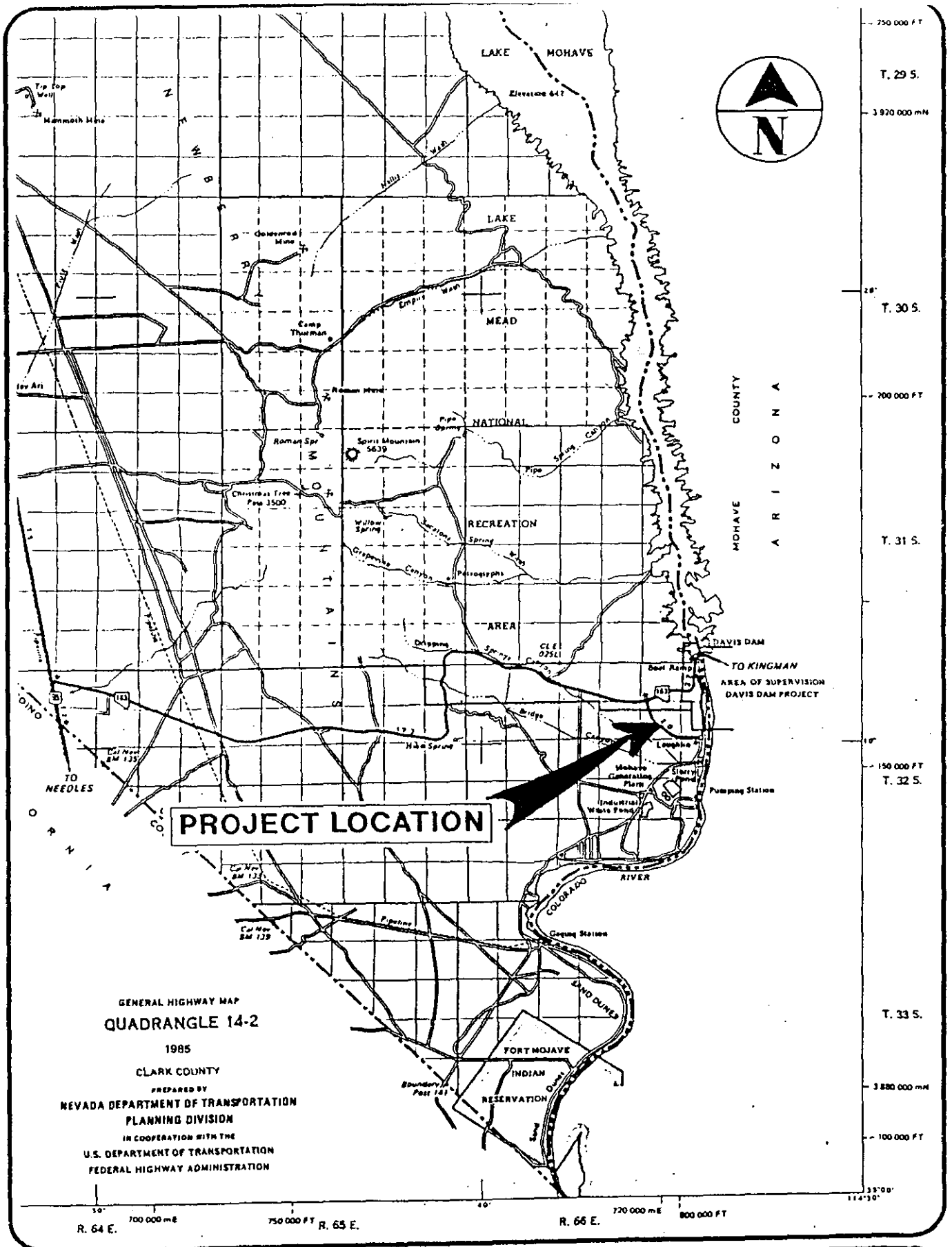
The purpose of this study is to document the existing drainage conditions in the project vicinity, perform detailed hydrologic analyses to determine design peak flows, perform detailed hydraulic analyses to size drainage facilities, hydraulic design of the selected onsite and cross drainage facilities, determine the impact of the proposed drainage facilities on the adjacent properties, and coordinate the work with the Clark County Regional Flood Control District (CCRFCD).

Specifically, the Scope of Work as defined in the agreement is as follows:

1. Perform hydrology study to determine peak flows that impact SR 163.
2. Perform hydrology study to determine onsite flows for roadway and median areas.
3. Design cross drainage facilities for offsite flows.
4. Design pavement and median drainage facilities for onsite flows.
5. Coordination of drainage design with the Clark County Regional Flood Control District concerning their Bridge Canyon Wash Flood Control Master Plan. The NDOT drainage design of SR 163 should be adaptable to the future CCRFCD flood control plans in the area.

C. MAPPING AND SURVEYS

The topographic maps for this project included 1) strip mapping along the proposed alignment and for the highway right-of-way with a 2 foot contour intervals and a scale of 1 inch equal to either 40 feet or 50 feet, 2) topographic mapping available from Clark County with a contour interval of 4 feet and a scale of 1 inch equal to



WRC

PROJECT LOCATION

FIGURE 1

400 feet, and 3) United States Geological Survey (USGS) quadrangle maps with a 40 foot contour interval and a scale of 1 inch equal to 2,000 feet.

The strip mapping was used to conduct hydrology to determine onsite flows, determine and setting elevations for different hydraulic structures, and to provide for proper grading. The Clark County topographic mapping was used to conduct hydrology to determine offsite flows. The USGS quadrangle maps were used to conduct basinwide hydrology.

No detailed surveys were conducted or needed for this job, except spot elevations were conducted for verification of relative elevations and assessment purposes.

D. INFORMATION PROCUREMENT

A number of agencies, organizations, and individuals were contacted by the WRC staff members to obtain data relevant to the drainage within the study area. All those who were contacted were very cooperative and provided us with the available information. The bulk of the information came from NDOT (mapping, highway design, hydraulic reference manuals, ...etc.). Others included Clark County Public Works Department, Clark County Regional Flood Control District, and private consultants who have provided drainage and flood control services in Clark County.

Special thanks to Mr. Amir M. Soltani, Mr. Chris Miller, and Ms. Tracy Larkin who were extremely helpful in providing us with the needed information, and providing a timely review and input for this project.

E. PROJECT COORDINATION

Due to the short duration of the project, coordination was expedited by meetings, telephone calls, and transmittals via facsimile. The meetings were held to obtain and disseminate information, review project progress, and secure approval of NDOT before proceeding with the next phase of the project. The project coordination dates, information discussed and project submittals are as follows:

Coordination Effort No.	Date	Parties Involved, Items Discussed, and Submittals
1.	March 15, 1993	Initial meeting to negotiate contract, discuss project requirements, and data collection.
2.	March 31, 1993	Request for information/documents by Mr. Leak of WRC from Messrs. Soltani and Lightfoot of NDOT. Information requested included design cross-section geometry, current highway profile, Big Bend Water Treatment Plant plans, design drawings for contract No. 2478, aerial photography, ... etc.
3.	April 1 & 2, 1993	Coordination between Mr. Leak and Ms. Larkin of NDOT regarding information/documents and conversion of data to AutoCAD.
4.	April 6, 1993	Meeting of Mr. Leak with Mr. Fraser of CCRFCD to discuss design flows.
5.	April 12, 1993	Discussion of April 9, 1993, letter from Messrs. Andrews and Leak with Mr. Soltani.
6.	April 13 & 14, 1993	Discussions between Mr. Leak and Ms. Larkin and Mr. Soltani regarding the status of drawings for the revised highway profile.
7.	April 16, 1993	Submittal of the Preliminary Hydraulic Design Report.
8.	April 19 & 20, 1993	Verbal and written comments received from NDOT related to the review of the preliminary hydraulic report.
9.	April 28, 1993	Receipt of the revised highway plan and profile sheets from NDOT. These revisions were based on recommendations in the preliminary hydraulic report to raise the highway profile to accommodate proposed culverts.
10.	April 29 - May 6, 1993	Numerous discussions between WRC and NDOT staff related to design cross-sections, dike design, roadside ditch design, and Casino Drive intersections.
11.	May 6, 1993	Meeting of Mr. Buttner of WRC and Mr. Miller (NDOT) and Ms. Larkin with the National Park Service in Boulder City.
12.	May 6, 1993	Submittal of the 90% Complete Hydraulic Report.
13.	May 12, 1993	Submittal of three alternative outfalls at Casino Drive.
14.	May 12 and 13, 1993	Verbal and written comments received from NDOT related to the review of the 90% complete Hydraulic Report.
15.	May 18, 1993	Submittal of Construction drawing/drainage design blueline rolls plus revised Table-7 (culvert summary).
16.	May 23, 1993	Submittal of barrier rail locations.
17.	May 28, 1993	Submittal of the design for culvert #8, the riprap channel, and storm sewer outfall
18.	June 2, 1993	Submittal of the final hydraulic calculations for culverts #1 thru #7.
19.	June 3, 1993	Submittal of the final hydraulic calculations for item 17 of this table.
20.	June 11, 1993	Submittal of the draft of the final hydraulic report.
21.	June 16 and 18, 1993	Verbal comments received from NDOT related to review of the draft final hydraulic report.
22.	June 29, 1993	Submittal of Final Hydraulic Report.

II. DESCRIPTION OF THE STUDY AREA

A. GENERAL

The study area is located immediately northwest of the City of Laughlin, Nevada. The highway reach is located in Sections 3, 4, 5, 10, 11, and 12 (USGS Davis Dam Quadrangle), Township 32 South, Range 66 East, of the Mt. Diablo Base Meridian. It traverses the Watersheds of the Dripping Springs Canyon, and the Bridge Canyon Washes. These two water courses, originate in the Newberry Mountains, and discharge their flow into the Colorado River. Both water courses lack a defined channel at their confluence with the Colorado River. The lower reaches of these water courses are represented by broad alluvial fans and runoff occurs as sheet flow before it flows across Casino Drive and ultimately discharge into the Colorado River.

The Big Bend Water District facilities and the Civic Center building are located south and near the terminal point of this phase of SR-163. These facilities will impact the proposed highway in terms of its alignment and required drainage facilities.

B. TOPOGRAPHIC FEATURES AND WATERSHED CHARACTERISTICS

The study area contributing flows to SR-163 (excluding Dripping Springs Canyon and Bridge Canyon Watersheds) ranges in elevation from 530 to 1,510 feet above mean sea elevation. The Dripping Springs and Bridge Canyon Watersheds have two distinct features. The upper region is mountainous and has steep slopes, rocky in nature, very shallow and erosive soils, well defined channels, and sparse vegetation. It ranges in elevation from 1,600 feet to about 4,700 feet above mean sea elevation. The lower regions, primarily alluvial flood plain ranges in elevation from 530 feet to 1,600 feet above M.S.L. and has slopes ranging from 4.5% to 6.0%. The soils are deep and well drained. The vegetation is also sparse in this region.

C. BASIN BOUNDARIES

The basin and sub-basin boundaries for this study were delineated using the U.S.G.S. quandrangle sheets, and the 4 foot contour interval mapping secured from Clark County Department of Public Works. This delineation can be found in Figure-3 (Page 10) and Figure-5 (Pages 37-41) of this report.

D. EXISTING DRAINAGE CONDITIONS

The existing drainage facilities in the study area are mostly culverts to convey storm runoff underneath the existing highway. WRC staff visited the project area on at least two separate occasions and documented the status

of existing culverts. It was found that the majority of the existing culverts underneath the road slated for improvement to be heavily silted. The majority of these culverts would not be able to carry the 50-year design storm flows. Two photographs showing an example of existing culverts under the Laughlin Cutoff Road are presented in Figure-2 (Pages 7 and 8).

E. PREVIOUS STUDIES OF THE AREA

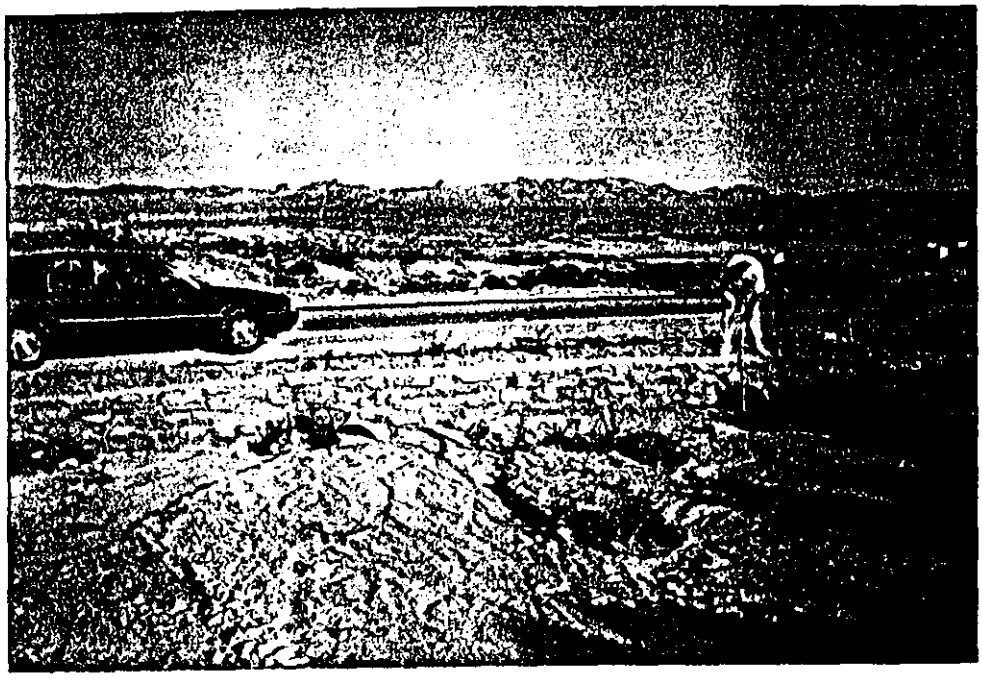
Prior to 1985, very little in the way of drainage studies or drainage improvements were completed in the study area. In 1985, the Nevada State Legislature created the Clark County Regional Flood Control District (CCRFCD). In September 1985, CCRFCD entered into an agreement with James M. Montgomery Consulting Engineers, Inc. to prepare a flood control master plan to cover the District's service area, i.e. the entire Clark County. In October 1986, the master plan was published, and covered the study area identified as Unincorporated Laughlin. In September 1990, the Bridge Canyon Wash Flood Control Master Plan was published by the District. This document represents the most comprehensive and detailed flood control master plan of the area.

In recent years, Laughlin has experienced one of the fastest growth rates in Clark County and the Nation. As a result of this growth, a number of drainage studies have been completed and specific facilities implemented. Examples of such efforts would include drainage studies for Casino Drive Road Improvements, developments along the Casino Drive, and drainage facilities for the Big Bend Water Treatment Plant. In 1990, CCRFCD published the Hydrologic Criteria and Drainage Design Manual, that is used to plan and implement drainage facilities in the study area.

Over the last three years, NDOT has planned, designed, and constructed onsite and offsite drainage facilities for the reconstruction of SR-163 to a four lane highway. During the field assessment phase of this work, WRC checked the status of the highway drainage facilities.

A detailed study and analysis of the previous work in the area is considered to be outside the Scope of Services for this study. However, the plans included in the September 1990, Master Plan, do impact the design of the drainage facilities for SR-163. For this reason, a preliminary analysis of the potential design flows for SR-163 drainage facilities as they are impacted by the CCRFCD Master Plan and the SR-163 alignment and its construction was undertaken by WRC. The findings and recommendation of this preliminary analysis are included in the April 9, 1993, letter from Messrs. Andrews and Leak to Mr. Soltani of NDOT. A copy of this letter is included in Appendix-A of this report.

ROLL NO. 1 NEG. NO. 17



NOTES: Inlet view of two-24" CMP existing culverts crossing the Laughlin cutoff road approximately 0.25 miles south of SR-163, located in Section 10, Township 21 North, Range 66 East.

ROLL NO. 1 NEG. NO. 18



NOTES: Outlet view of the same culverts.

WRC

EXISTING CULVERTS IN THE STUDY AREA
P059-93-010

FIGURE-2
Page- 7

JOB NO.
2016

WRC NEVADA, INC
CONSULTING ENGINEERS
CENTURY PARK
1771 EAST FLAMINGO ROAD, SUITE 200A
LAS VEGAS, NEVADA 89119
(702) 893-6266

ROAD DRAINAGE FEATURES FIELD REPORT

BY: DM DATE: 3/10/93
REVIEWED BY: ASA DATE: 4/14/93

General Location: Approximately 0.25 miles south of SR-163 on the Laughlin cutoff road.

Surface Type: Paved road.

Roadside Ditches:

General Comments on Drainage Features: The existing two 24" CMP culverts are heavily silted. Flows from Dripping Springs Canyon Wash Watershed are conveyed underneath the road through these culverts. Approximately at this location culverts will be designed to convey runoff underneath the new SR-163 alignment.

III. HYDROLOGIC ANALYSIS

A. GENERAL

A detailed hydrologic analysis for the study area was performed to determine design peak flows and water volumes at selected design points. The computed flows were then used to evaluate existing drainage facilities, determine existing and potential future drainage problems, evaluate alternative drainage improvement plans and facilities for the proposed new highway, and complete hydraulic design of the proposed onsite and offsite highway drainage improvements.

The drainage area contributing flows and impacting the highway was divided into a total of 14 drainage sub-basins as shown on Figure-3 (Page 10). Peak flows at the selected design points (shown on Figure-5, pages 37 - 41) were computed for the applicable design frequency.

B. SOIL CHARACTERISTICS

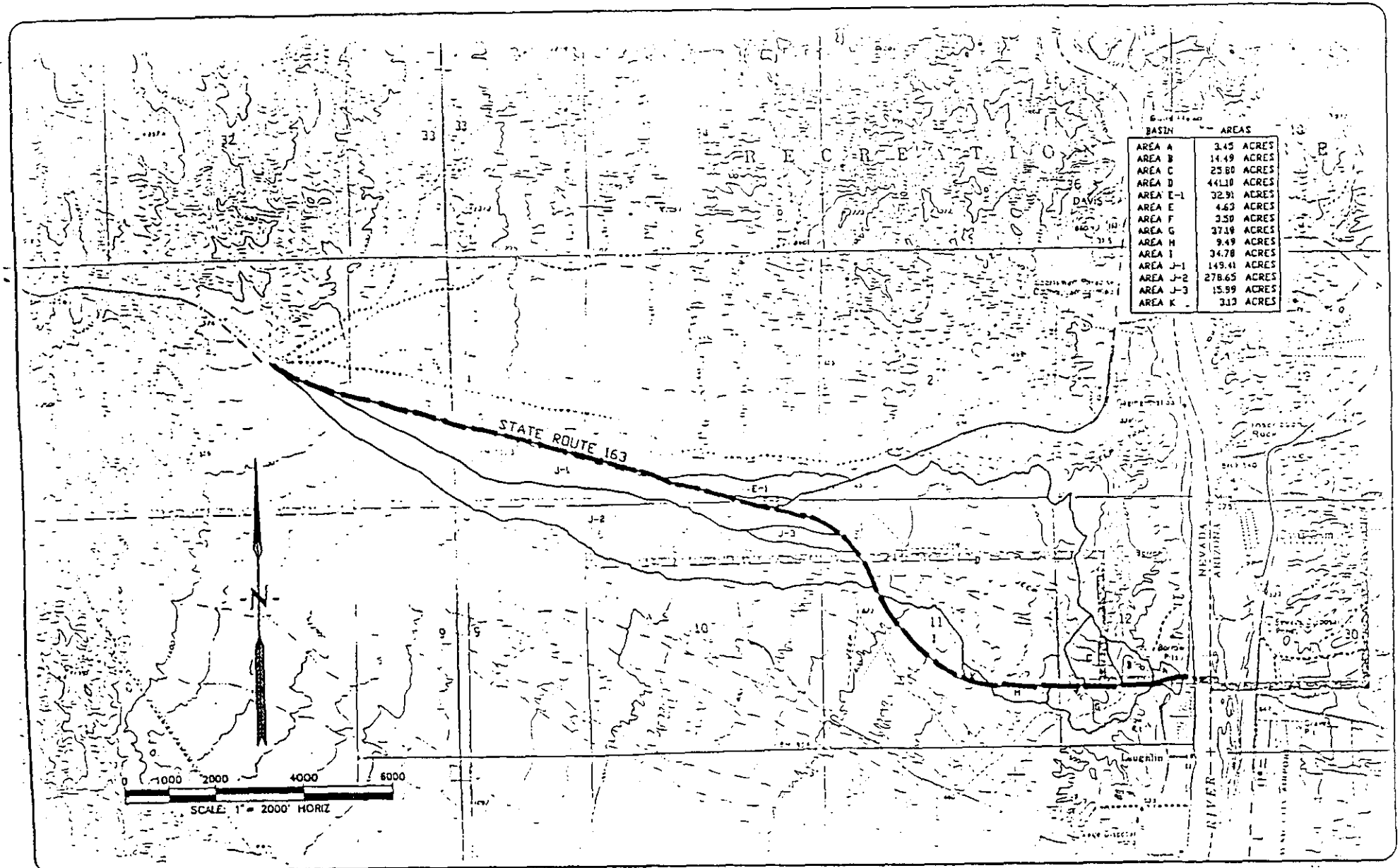
The soils in the study area fall into 3 hydrologic groups; Types A, B and D. Type A soils have the highest infiltration rate with Type D soil having the smallest infiltration rate.

The Type A soils are found along majority of the roadway alignment. These soils have high infiltration and transmission rates and consist mainly of deep, well to excessively drained sands or gravels. The Type B soils are found in the lower reaches of the highway and immediately west of the Colorado River. These soils have moderate infiltration rates and consist mainly of moderately deep, drained, and fine to coarse textures. They also have a moderate rate of water transmission. The Type D soils are found primarily in the upper reaches of the watersheds. They have very slow infiltration rates, and consist chiefly of clay soils with swelling potential, and shallow soils over nearly impervious material. These soils have a very slow rate of transmission.

C. DESIGN CRITERIA AND METHODS OF ANALYSIS

In this study, all cross drainage facilities were designed for the 50-year frequency storm, while the highway pavement and median drainage facilities were designed to accommodate the 10-year frequency storm. Further, flows for the 100-year frequency storm at cross drainage design points were computed, and their impact on the cross drainage facilities was determined. These impacts were next used to formulate measures to mitigate or lessen their impact on the NDOT facilities within the highway right-of-way and the adjacent properties.

Offsite runoff was calculated utilizing the SCS Curve Number Method to compute rainfall excess/loss and



WRC | SR - 163 / DRAINAGE DESIGN | DRAINAGE SUB-BASINS | FIGURE-3 | JOB NO. 2016

the SCS Unit Hydrograph Method to generate runoff hydrographs for each sub-basin under consideration. Routing of runoff from the said sub-basins was accomplished using the Kinematic Wave Method of hydrograph routing.

Onsite or highway ditch and median runoff was computed utilizing the Rational Formula.

D. DESIGN RAINFALL

The design rainfall used for the hydrologic analysis is based on the NOAA Atlas 2, "Precipitation-Frequency Atlas of the Western United States, Volume VII-Nevada". Point rainfall values for the subject area were obtained from the atlas for various storm frequencies, and are presented in Table-1 (Page 12). These values were then adjusted by factors contained in the Clark County Regional Flood Control District's (CCRFCD's) Hydrologic Criteria and Drainage Design Manual. Said adjustment is recommended based on previous analysis of rainfall data in the Clark County area by WRC and the United States Army Corps of Engineers (USACE). These studies concluded that the NOAA Atlas 2 values do not necessarily reflect the trend of observed and recorded rainfall values which have occurred following publication of the Atlas in 1973. The adjusted rainfall values are also presented in Table-1 (Page 12).

These rainfall values reflect rainfall expected to occur at a single point on the basin. However, for larger basin areas, less intense rainfall usually occurs around the perimeter of a given storm. Therefore, depth area reductions were applied to the adjusted rainfall values in relation to the basin size under consideration. The depth area reduction factors utilized are based on analyses prepared by the USACE and have been adopted by the CCRFCD for use in the Clark County area.

The design storm utilized for this analysis is a six-hour duration storm with the largest intensity occurring during the middle two hours. The storm distribution is based on the CCRFCD design storms which were developed by the USACE. The specific design storm used for this study is the SDN 3 (Storm Distribution Number 3) from said manual. For the Rational Analysis, the said precipitation data was utilized to develop a Time-Intensity-Frequency values for the subject area. These values are shown on the lower half of Table-1 (Page 12).

Many methods of developing design rainfall/storms are available for use in the subject area. However, we believe the use of the CCRFCD hydrologic criteria is the best available information for the study area. In addition, its use allows for consistency in runoff analysis when used to compare runoff rates for adjacent developments (i.e. Big Bend Water District) and analyze the effect of NDOT's proposed road construction on said facilities.

TABLE-1

RAINFALL VALUES

(DURATION-6 HOURS)

FREQUENCY	RAINFALL DEPTH NOAA (INCHES)	LINE VALUES (INCHES)	ADJUSTMENT FACTOR (1)	ADJUSTED VALUES (INCHES)
2-YEAR	1.20	1.20	1.00	1.20
5-YEAR	1.60	1.70	1.16	1.97
10-YEAR	2.00	2.05	1.24	2.54
25-YEAR	2.50	2.50	1.33	3.33
50-YEAR	2.80	2.85	1.39	3.96
100-YEAR	3.20	3.20	1.43	4.58
(1) ADJUSTMENT TO NOAA DATA USING TABLE-5.01 FROM CCRFCD CRITERIA MANUAL.				

TIME-INTENSITY-FREQUENCY VALUES

(Inches Per Hour)

RECURRENCE INTERVAL						
TIME	2 YR.	5 YR.	10 YR.	25 YR.	50 YR.	100 YR.
5	3.36	5.52	6.84	8.76	10.56	12.12
10	2.64	4.26	5.28	6.84	8.16	9.36
15	2.24	3.56	4.48	5.76	6.92	7.92
30	1.54	2.48	3.10	4.00	4.78	5.48
30	0.98	1.57	1.96	2.53	3.03	3.47

E. BASIN AND HYDROLOGIC PARAMETERS

The basin and hydrologic parameters needed for the offsite hydrologic analysis are:

1. Basin Area
2. Basin Length
3. Basin Centroidal Length
4. SCS Curve Number (CN)
5. Basin Slope
6. Minimize roughness factor for the basin channels

A summary of these parameters developed for the basins in this study are presented in Table-2 (Page14). These factors were developed from the maps with four foot contour interval and a scale of 1 inch equal to 400 feet, and the SCS Soil Survey information for the subject area.

The lag times for different sub-basins were computed using CCRFCD equation 613 and verified using equations 601, 602, and 612. These computations are also presented in Table-2.

For the onsite (or roadside ditch) areas, Rational Method time of concentration and runoff coefficients were determined for each of the onsite basins. A summary of these parameters is presented in Table-3 (Page 15). A further discussion of onsite basin sizing is presented in the Hydraulic Analysis section of this report.

F. COMPUTER MODEL RUNS AND RESULTS

HEC-1 computer runs were prepared for the offsite basins for the 50-year and the 100-year frequency storm events. Runoff from each sub-basin was computed and routed downstream design points to obtain the required design flows. Presented in Table-4 (Page 16) is a summary of the 50-year and 100-year peak runoff values for each of the offsite basins as well as for the specific design points under consideration. Copies of the said HEC-1 output are included in Appendix-B.

Results of the Rational Method Analysis for the onsite or roadside ditch basins is presented in Table-5 (Page 17).

TABLE-2

SUB-BASIN HYDROLOGIC PARAMTERS

SUB-BASIN I.D.	AREA (MI^2)	WEIGHTED CURVE NO. CN	LAG TIME PARAMETERS			
			L (MI)	LC (MI)	S (FT/MI)	LAG (HRS)
A	.005	68	0.16	0.08	375	.07
B	.023	64	0.27	0.13	611	.09
C	.040	63	0.42	0.27	371	.15
D	.689	63	1.59	0.76	201	.35
E1	.051	64	0.80	0.34	207	.22
E2	.007	71	0.27	0.10	222	.10
F	.005	68	0.14	0.12	214	.09
G	.058	65	0.51	0.29	200	.18
H	.015	67	0.26	0.12	377	.10
I	.054	65	0.49	0.23	196	.16
J1	.233	65	2.27	1.21	255	.45
J2	.436	63	2.65	1.06	249	.45
J3	.025	64	0.47	0.27	217	.17
K	.005	68	0.12	0.06	200	.07

NOTE: LAG COMPUTATIONS BASED ON CCRFCD EQUATION 613
L = GREATEST HYDROLOGIC LENGTH - MILES
L_c = LENGTH TO CENTROID - MILES
S = AVERAGE SLOPE - FEET/MILE
K_n = MANNING ROUGHNESS COEFFICIENT OF CHANNELS = 0.040

TABLE-3

ONSITE BASIN HYDROLOGIC PARAMETERS

SUB-BASIN	SIDE	LOCATION STATION TO STATION		DRAINAGE AREA (AC.)	TIME OF CONCENTRATION (MIN.)	RAINFALL INTENSITY (IN./HR.)	RUNOFF COEFFICIENT
1	Left	783+00	799+50	3.07	8.7	5.6	.65
2	Left	799+50	811+00	2.46	6.5	6.2	.60
3	Left	811+00	826+00	3.75	7.7	5.8	.56
4	Left	826+00	848+66	5.67	11.7	4.9	.56
10	Left	866+00	878+00	2.22	8.0	5.7	.63
10	Middle	866+00	899+00	1.97	16.3	4.3	.40
10	Right	867+00	884+50	3.01	10.4	5.2	.65
11	Left	879+50	885+50	1.15	5.3	6.7	.62
12	Left	887+00	896+00	1.46	6.6	6.2	.65
12	Right	889+00	897+50	1.85	6.4	6.2	.60
13	Middle	906+00	915+00	1.28	6.1	6.4	.69
14	Middle	915+00	928+50(B)	1.93	8.3	5.6	.69
20	Left	930+50	950+50	2.94	11.5	5.0	.66
20	Middle	928+50(B)	944+00(B)	2.21	8.8	5.6	.69
20	Right	928+50	949+50	2.66	12.2	4.9	.46
21	Middle	944+00(B)	959+50(B)	2.21	8.6	5.6	.69
22	Left	965+50	976+50	1.73	6.9	6.0	.69
22	Middle	959+50(B)	976+00(B)	1.77	9.2	5.4	.62
22	Right	961+00	975+00	2.34	7.4	5.8	.53
23	Left	979+50	981+00	0.21	5.0	6.9	.73
23	Middle	976+00(B)	987+00(B)	0.45	6.2	6.4	.40
23	Right	979+00	984+00	0.75	5.0	6.9	.67
24	Left	987+00	990+00	0.48	5.0	6.9	.67
24	Right	988+00	996+50	1.29	6.1	6.4	.67
25	Left	991+00	1003+00	2.43	7.7	5.8	.60
26	Left	1003+00	1010+00	3.45	6.6	6.2	.50
26	Right	995+50	1010+00	3.53	8.5	5.6	.54

TABLE-4

OFFSITE BASINS

PEAK RUNOFF SUMMARY

SUB-BASIN	DESIGN POINT (WHERE APPLICABLE)	AREA (ACRES)	PEAK 50-YEAR RUNOFF (CFS)	PEAK 100-YEAR RUNOFF (CFS)
A	10	3.45	6	9
B	9	14.5	23	32
C	-	25.8	31	44
D	-	441	349	499
E1	-	32.9	36	51
E2	-	4.63	10	13
F	-	3.50	6	8
G	-	37.2	47	66
H	6	9.49	17	23
I	4	34.8	47	65
J1	1	149	120	168
J2	2	279	192	275
J3	3	16.0	20	28
K	5	3.13	6	9
D, E1, E2, H, J1, J2, J3	7	932	569	843
C, D, E1, E2, H, J1, J2, J3	8	958	574	854
C, D, E1, E2, G, H, J1, J2, J3	11	995	589	876
B, C, D, E1, E2, G, H, J1, J2, J3	12	1010	593	882
A, B, C, D, E1, E2, F, G, H, J1, J2, J3	13	1016	593	881
DRIPPING SPRINGS CANYON WASH AT FAN APEX	14	3000	Q_{10}=1040	4290

TABLE-5

ONSITE BASINS PEAK RUNOFF SUMMARY

SUB-BASIN	PEAK 10-YEAR RUNOFF (CFS)
1L	11.2
2L	9.2
3L	12.2
4L	15.6
10L	8.0
10M	3.4
10R	10.2
11L	4.8
12L	5.9
12R	6.9
13M	5.6
14M	7.4
20L	9.7
20M	8.5
20R	6.0
21M	8.5
22L	7.1
22M	5.9
22R	7.2
23L	1.0
23M	1.2
23R	3.5
24L	2.2
24R	5.5
25L	8.5
26L	10.7
26R	10.7

IV. HYDRAULIC ANALYSIS

A. GENERAL

Based on the design flows calculated in Section III of this report, hydraulic analyses were conducted to size the proposed drainage facilities for both onsite and offsite flows. The proposed drainage facilities comprised primarily of roadside ditches, swales, channels, culverts, and a storm sewer line.

B. ONSITE DRAINAGE

The plan sheets provided by NDOT were used as a basis for determining location and extent of the roadside and roadway median ditches. Outfall locations were determined by locations where ditch capacities were equaled or exceeded, or at locations dictated by offsite drainage.

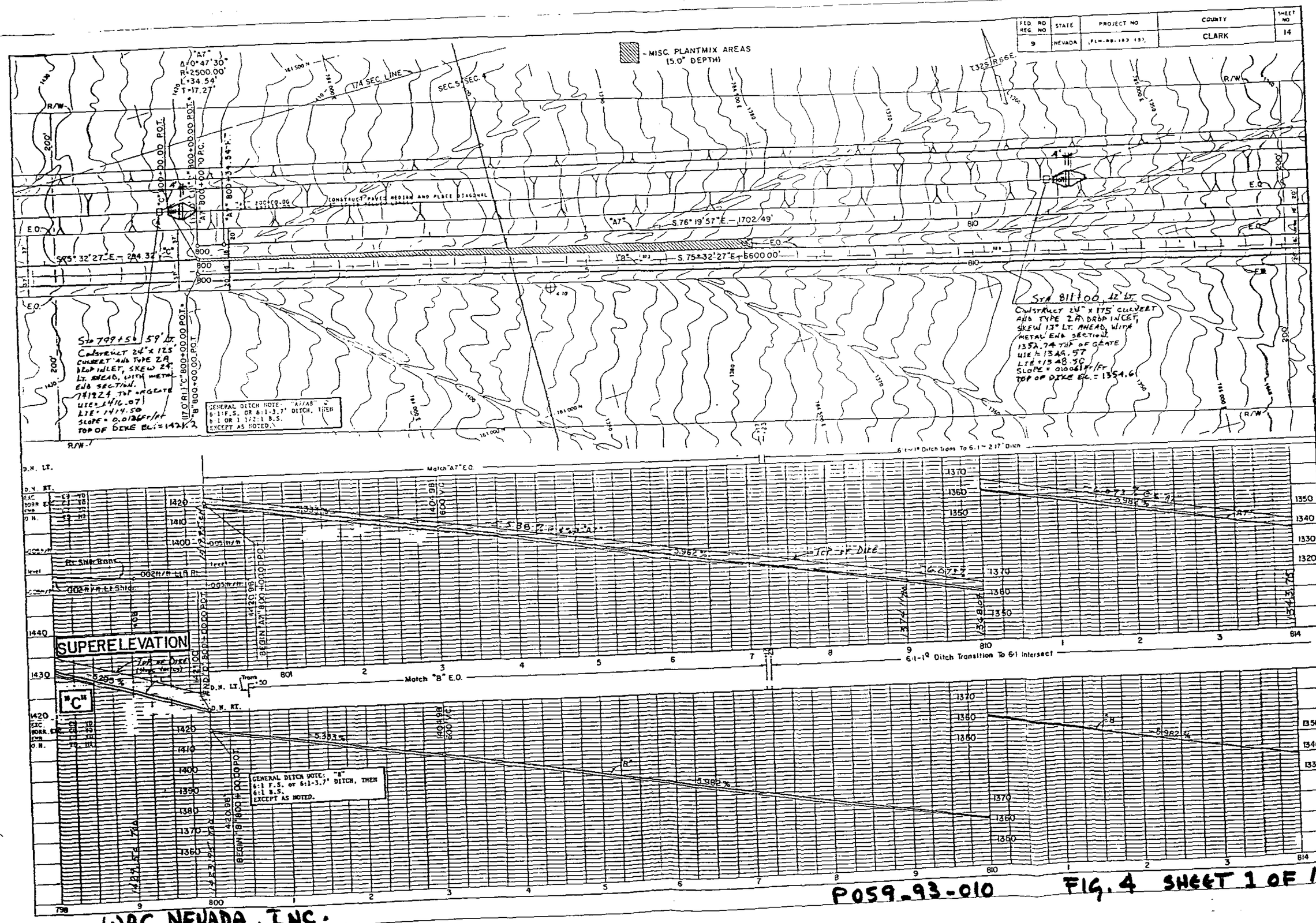
For the median ditches, the standard roadway cross-section determines the capacity of the ditch. The frequency and location of inlets was determined based on the length of the median. The inlets are connected to the cross drainage facilities draining either the offsite flow or roadside ditch flows.

The rational method was used to calculate peak flows for onsite drainage. Starting from upstream to downstream, flows were calculated using the areas based on the roadway design provided by NDOT. At or near a point where the capacity (i.e. depth) or velocity limit of either the roadside ditch or the median ditch were exceeded, a drop inlet coupled with a culvert or diversion ditch were provided to handle the flow. The type and location of these drainage facilities are shown on Figure-4 (Pages 19-34). The check of the depth and velocity limitations for each reach is presented in Table-6 (Page 35). Also, shown in Table-6 is the proposed outlet structure for the said ditch reaches.

C. OFFSITE DRAINAGE

The offsite drainage is conveyed under the highway through culverts. These culverts were sized to convey 50-year frequency peak flows as computed in the hydrologic analysis portion of this report. The sizing of the culverts were initially based on the available headwater as dictated by the roadway design. If the available headwater was insufficient to carry the design flow in a typical culvert configuration, then alternative sizes, shapes, and headwater were investigated to produce a desirable culvert for the specific location. Presented in Table-7 (Page 36), and Figure-5 (Pages 37 thru 41) is a summary of the proposed culverts at different design points.

FED. RD REG. NO	STATE	PROJECT NO	COUNTY	SHEET NO
9	NEVADA	(FLH-RR-183 (3))	CLARK	14



P059-93-010 FIG. 4 SHEET 1 OF 16

WRC NEVADA, INC.

19

FED RD REQ. NO	STATE	PROJECT NO	COUNTY	SHEET NO.
9	NEVADA	FLH-88-183 (3)	CLARK	15

T32S R66E SEC 14

"A7" Δ=0°47'30" R=2500.00' L=34.54' T=17.27'

Dike (See special Details)

"A7" 817+71.67 P.O.T. "A" 817+57.03 P.C. "A" 817+71.57 P.T. "A8" 817+71.41 P.O.T.

"A7" S.76°19'57"E. 1702.49'

"A8" S.75°32'27"E. 4828.59'

S.75°32'27"E. 6600.00'

Median Dike

STA 826+00, 42' Lt
CONSTRUCT 24" x 100' CULVERT AND TYPE 2A DROP INLET, SKEW 35° Lt. AHEAD WITH METAL END SECTION
1263.00 TOP OF GRATE
IIE = 1259.83
LIE = 1259.06
SLOPE = 0.0023' /FT
TOP OF DIKE EL = 1265.20

R/W — E.O. — D.N. LT. — D.N. RT. — 6:1 ~ 1st Ditch Trans. To 6:1 ~ 2.17' Ditch — 6:1 ~ 2.17' Ditch

EXC. BORR. EMB. O.N.

"A7" 5.98% "A8" 5.98% Top of Dike

"A7" 817+71.67 P.O.T. "A" 817+57.03 P.C. "A" 817+71.57 P.T. "A8" 817+71.41 P.O.T.

6:1 ~ 1st Ditch Trans. To 6:1 ~ Intersect — 6:1 ~ Intersect

"B" 5.98%

WRC NEVADA, INC.

P059-93-010 FIG. 4 SHEET 2 OF 16

FED RD REG NO	STATE	PROJECT NO	COUNTY	SHEET NO.
9	NEVADA	FLH-RS-163(5)	CLARK	16

LIMITS OF PLANTMIX BITUMINOUS GORE

CONSTRUCTION REVISION NO. 1

Limits of Paving "N" 0+00.00 P.C.

"A" 831+00.00 P.O.T. "N" 24 20.74 P.O.T.

S75° 32' 27" E ~ 48.28.59'

S75° 32' 27" E ~ 660.00'

"N" 2+14.17 P.I.

"N" d=13° 38' 05" R=900' L=214.12.37' T=107.5951'

6:1 ~ 2.17' Ditch — Trans. to 6:1-1° — Level — Trans. — 6:1 ~ 2.17' Ditch

6:1 ~ Intersect — 6:1-2.1 Trans. to 6:1 ~ 1° — Intersection

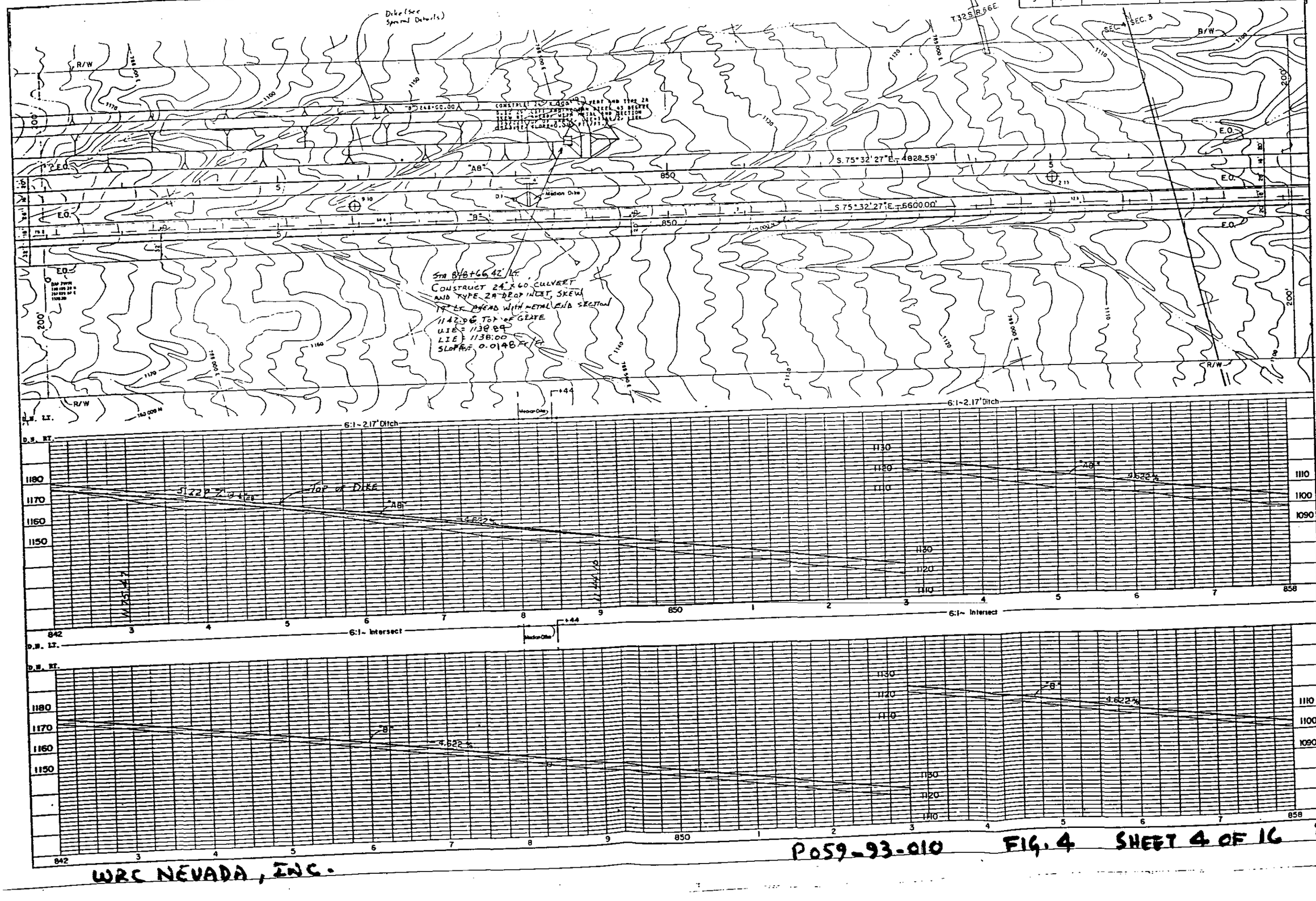
Top of Dike

5.982%

P059-93-010 FIG. 4 SHEET 3 OF 16

WRC NEVADA, INC.

FED RD REG. NO	STATE	PROJECT NO	COUNTY	SHEET NO.
9	NEVADA	FLH-RS-169(3)	CLARK	17



WRC NEVADA, INC.

P059-93-010 FIG. 4 SHEET 4 OF 16

END PROJECT FLH-RS-163(5)
"A8" 866+00.00 P.O.T.=
"TC1" 0+00.00 P.C.

END PROJECT FLH-RS-163(5)
"B" 866+00.00 P.O.T.=
"TC2" 0+00.00 ∠

S. 75°32'27"E. - 4828.59'

S.75°32'27"E. - 6600.00'

"A8"

"B"

"TC1"

"TC2"

Median Dike

CONSTRUCT 24" X 32'4" CULVERT AND TYPE 24 DIKE 25' LEFT AND MEDIAN DIKE, 45 DEGREE SKEW PT. AHEAD, WITH METAL END SECTION. 1062.13 TOP OF GRATE, U/E=1058.98, L/E= 1052.25, SLOPE=0.006 FT./FT.

NOTE: GEOMETRICS AND PROFILES FOR "TC1" & "TC2" SEE SHEET NO. 19

MATCH LINE "A"

6:1 2.17' Ditch

D.S. LT.

D.N. RT.

EXC.

BORR. EX.

FWS

O.A.

1110
1100
1090
1080
1070
1060
1050

+922 ft.

-1.552%

1067.32'
6.10' DC
1064.32'

857 8 9 860 1 2 3 4 5 866 +44 Median Dike

6:1 2.17' Ditch

D.B. LT.

D.S. RT.

EXC.

BORR. EX.

FWS

O.A.

1110
1100
1090
1080
1070
1060
1050

-1.623%

-2.333%

1080.32'
6.00' DC
1076.32'

857 8 9 860 1 2 3 4 5 866

MATCH LINE "A"

TC1

TC2

23

WRC NEVADA, INC.

P059-93-010 FIG. 4 SHEET 5 OF 16

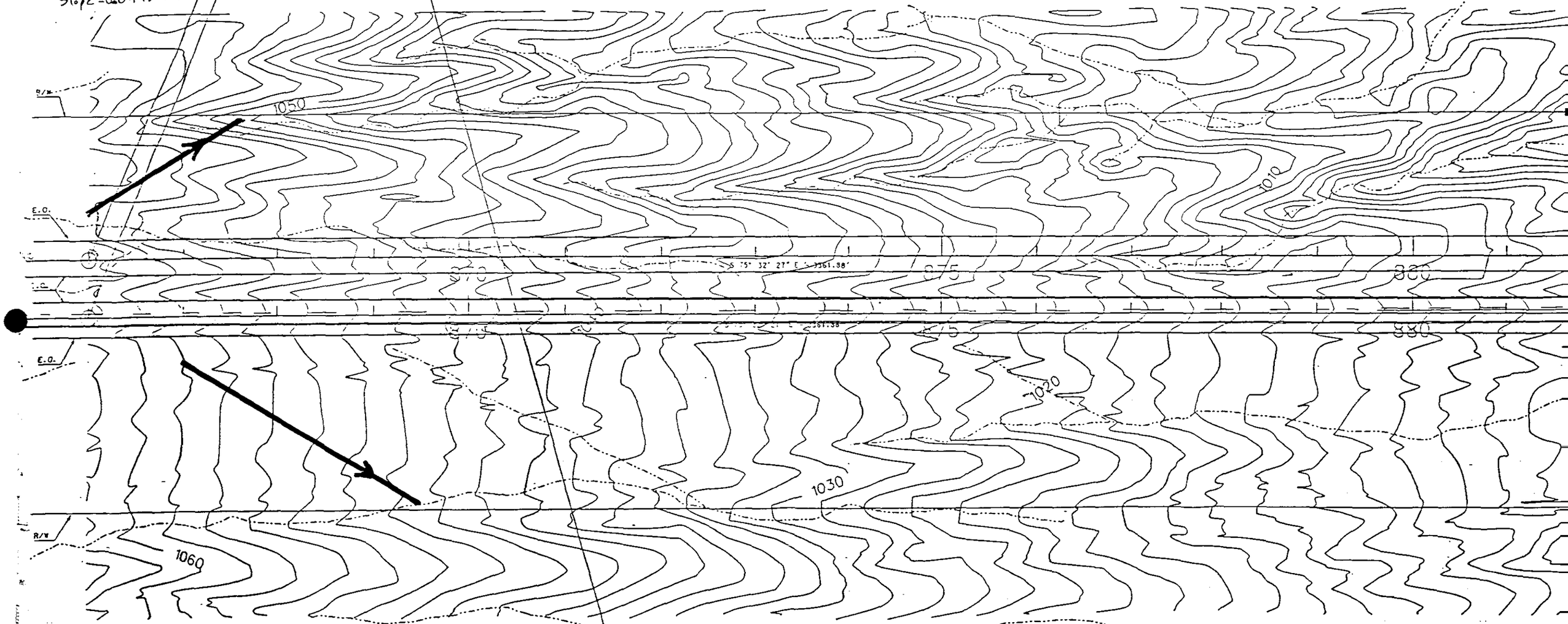
BEGIN PROJECT RS-163(1)

"A8" 866+00.00 P.O.T.

"B" 866+00.00 P.O.T.

"A8" 866+00

Construct 2' Deep (Min.) x 190' V-Shaped Ditch, 45' Lt, 60° Skew Lt. Ahead
UIE = 1059.9
LIE = 1051.0
Slope = 0.0442 Ft/Ft.



"B" 867+00

Construct 2' Deep (Min.) x 290' V-Shaped Ditch, 45' Rt, 60° Skew Rt. Ahead
UIE = 1054.1
LIE = 1047.0
Slope = 0.0245 Ft/Ft.

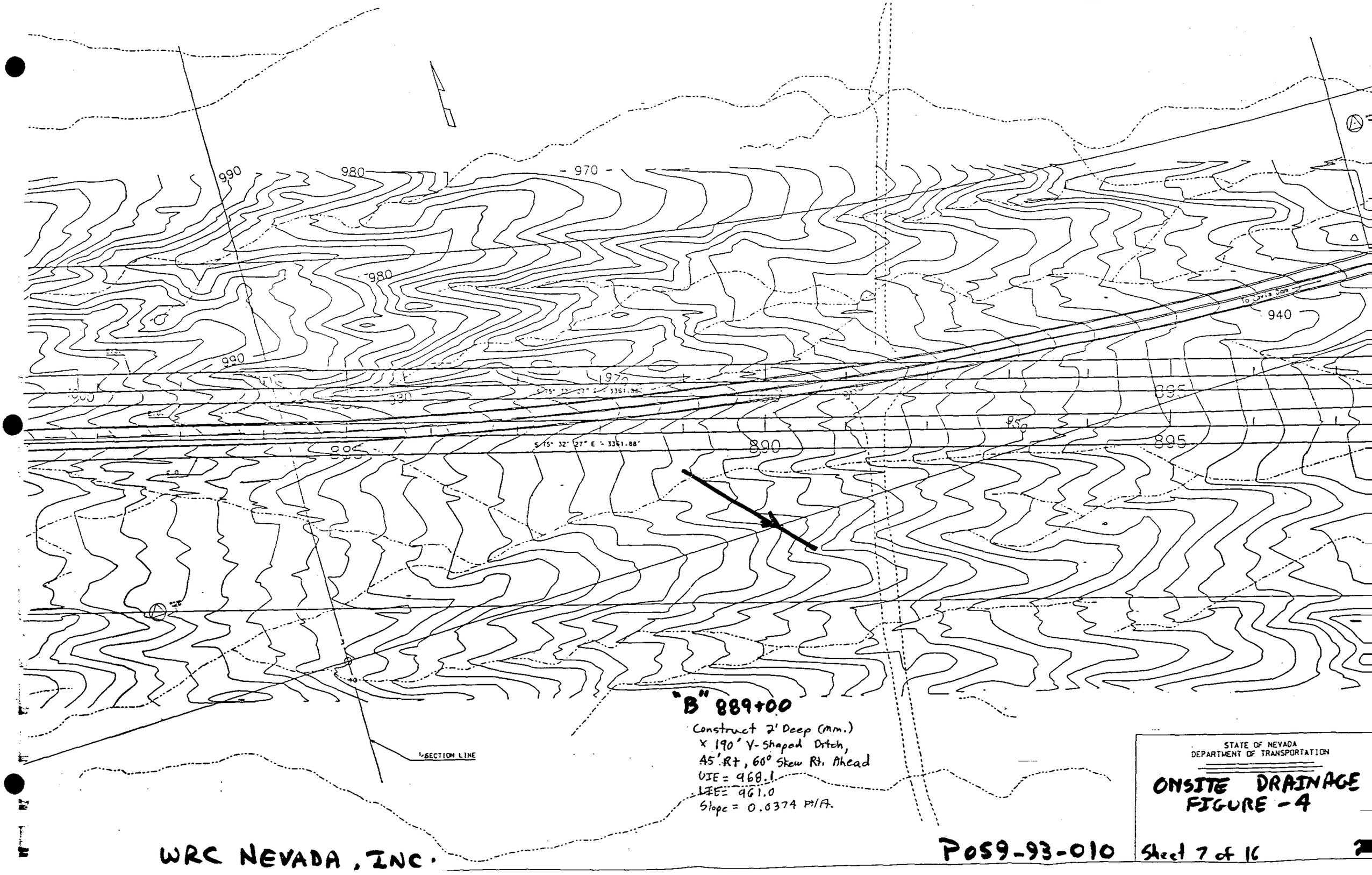
WRC NEVADA, INC.

P059-93-010

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

ONSITE DRAINAGE
FIGURE -4

Sheet 6 of 16



"B" 889+00

Construct 2' Deep (mm.)
x 190' V-Shaped Ditch,
45' Rt, 60° Skew Rt. Ahead
UIE = 968.1
~~LIE~~ = 961.0
Slope = 0.0374 ft/ft.

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

ONSITE DRAINAGE
FIGURE -4

WRC NEVADA, INC.

P059-93-010

Sheet 7 of 16

"A8" 905+36.80 P.O.I.

"D1" 0+00.00 P.O.C.

"D"

+26.51 23' LT.

+26.51 23' RT.

16'

R/W

R=50

"D"

E.O.

S 79° 32' 27" E 3361.88'

D.I.

10:1

Median Dike

E.O.

S 79° 32' 27" E 2561.88'

E.O.

"A8" ℄

Δ = 57° 56' 23"
R = 2554'
L = 2582.70'
T = 1413.95'

"B" ℄

Δ = 77° 56' 25"
R = 1496'
L = 2034.05'
T = 1381.84'

"A8"

"B"

D6+34.51 P.O.C.

D6+34.51 P.O.T.

R/W

R/W

890 900 910 920 880 870

"B" 897+50

Construct 2' Deep (Min.) x 270' V-Shaped Ditch, 45' Rt., 60° Skew Rt. Ahead
UIE = 936.2
LIE = 925.0
Slope = 0.0415

SECTION LINE

WRC NEVADA, INC.

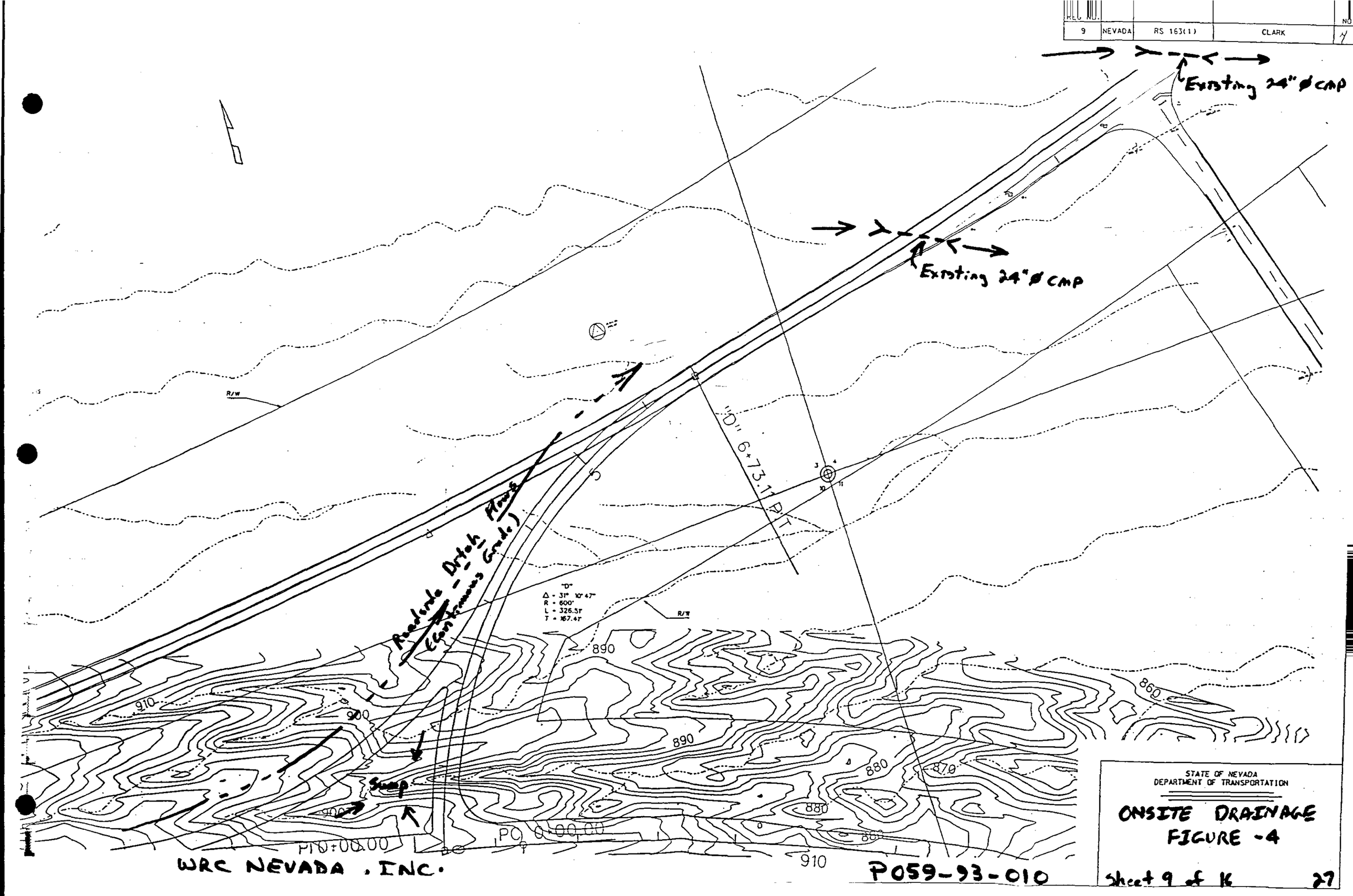
P059-93-010

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

ONSITE DRAINAGE
FIGURE-9

Sheet 8 of 16

REG NO.				NO
9	NEVADA	RS 163(1)	CLARK	7



STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

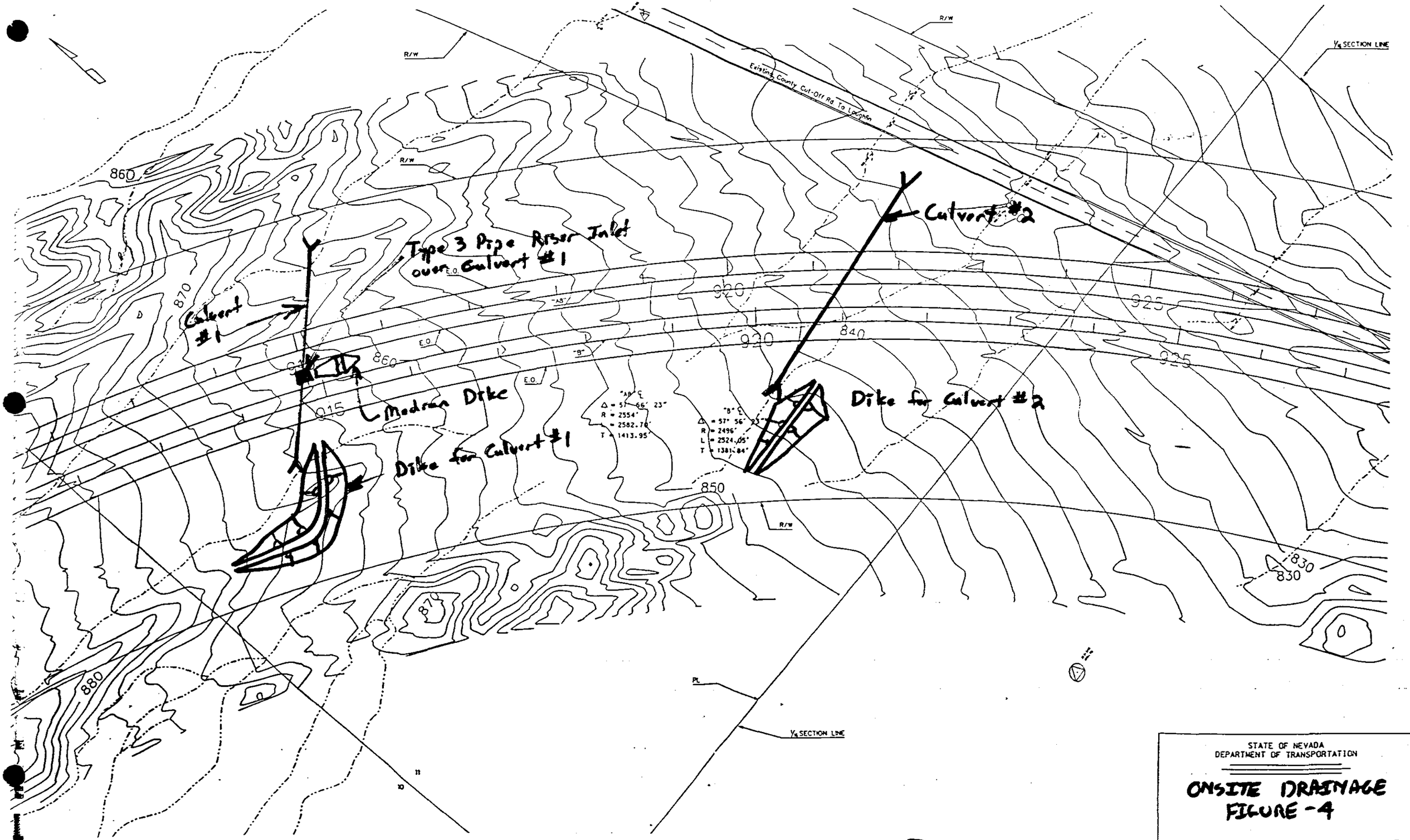
ONSITE DRAINAGE
FIGURE -4

Sheet 9 of 16

WRC NEVADA, INC.

P059-93-010

FED NO. REG NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	RS 163(1)	CLARK	5



STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

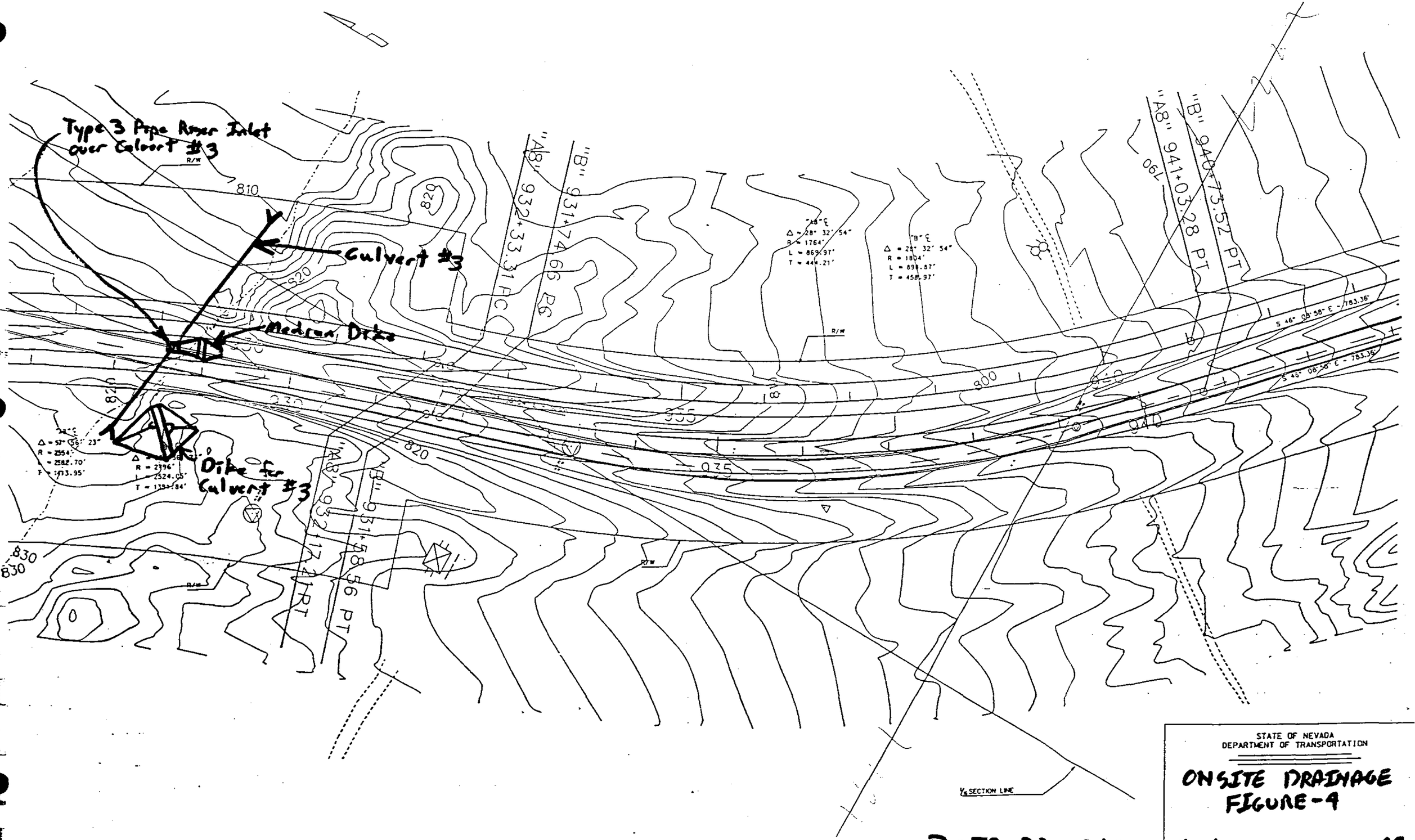
ONSITE DRAINAGE
FIGURE -4

Sheet 10 of 16

28

WRC NEVADA, INC.

P059-93-010



STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

ONSITE DRAINAGE
FIGURE-9

Sheet 11 of 16

9	NEVADA	RS 163(1)	CLARK	

1/4 SECTION LINE

R/W

"AB" ℄
Δ = 44° 26' 49"
R = 2446'
L = 1897.47'
T = 999.36'

"B" ℄
Δ = 44° 26' 49"
R = 2504'
L = 1942.47'
T = 1021.06'

"AB" 948+86.64 PC

"B" 948+56.88 PC

S 46°08'58" E (783.36')

E.O.

E.O.

E.O.

Existing County Cut-Off Rd. To Laughlin

955

955

950

780

750

750

740

740

730

1/4 SECTION LINE

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

ONSITE DRAINAGE
FIGURE-4

Sheet 12 of 16

WRC NEVADA, INC.

P059-93-010

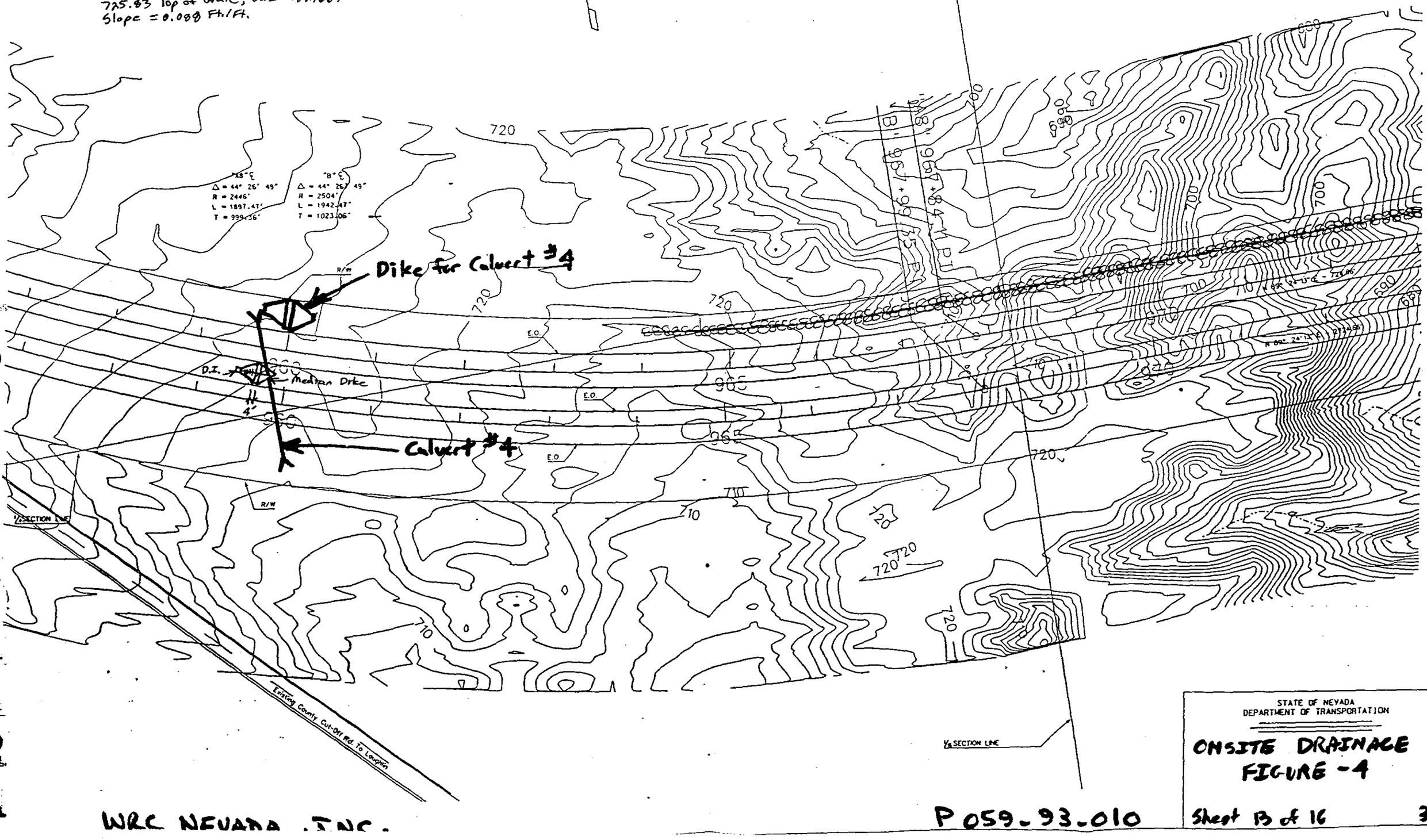
FED RD. REG NO.	STATE	PROJECT NO.	COUNTY
9	NEVADA	RS 163(1)	CLARK

"A8" 959+40

Construct 24" x 5' Culvert and Type 2A D.I. 28.4' Right and Medran Drke, 90 Degree Skew Lt. Ahead, with connection to 5'x3' RCBC, 725.83 Top of Grate, UIE=722.66, LIE=722.22, Slope = 0.008 Ft./Ft.

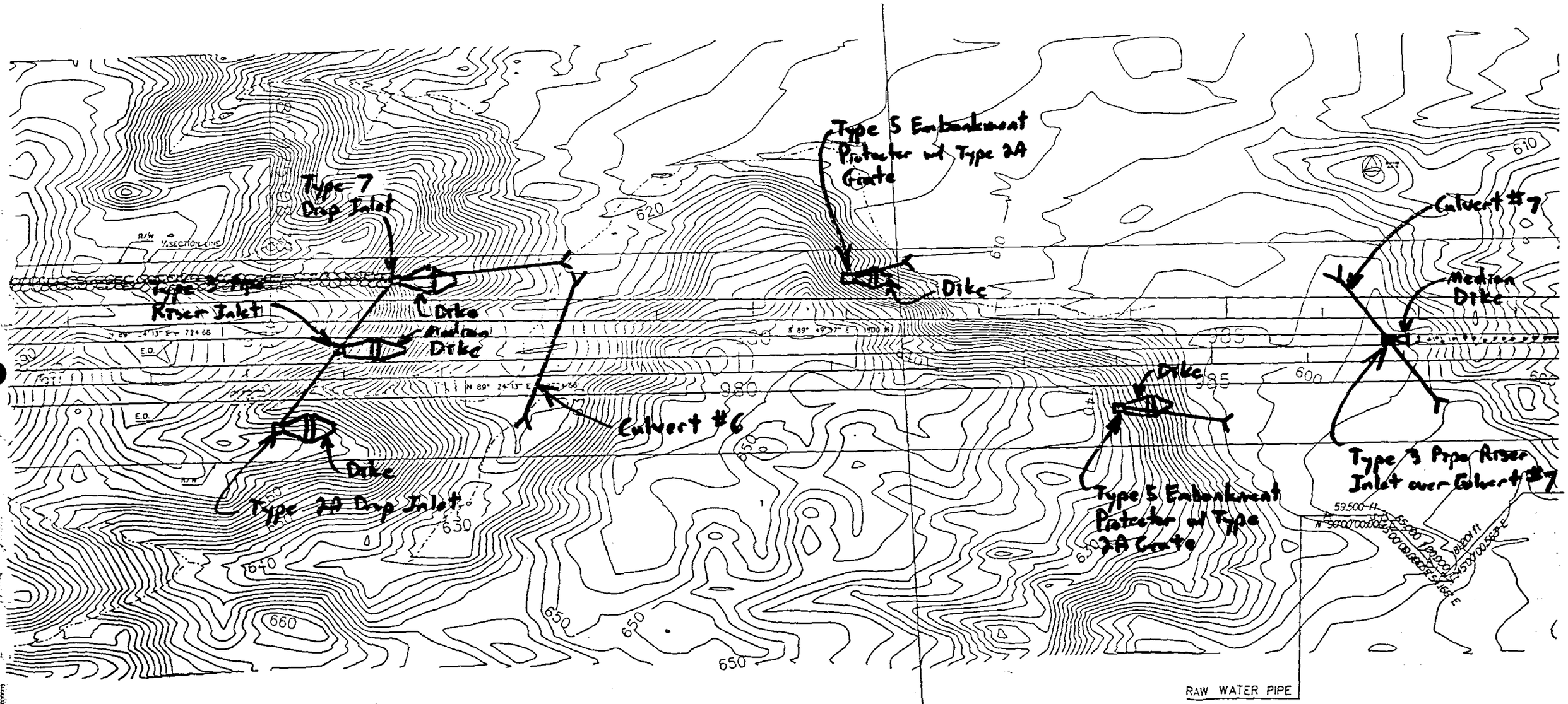
"A8" 964+00 to 976+32

Construct Light Riprap Lmmy of ℄ Roadside Ditch, 4' Wide by 1.0' Thickness of Riprap on 1.0' Thickness of Type 2 Class B Aggregate Base



FED AID REG NO.	STATE	PROJECT NO.	COUNTY
9	NEVADA	RS 163(1)	CLARK

LOT 13



STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

ONSITE DRAINAGE
FIGURE-A

REG NO.	STATE	PROJECT NO.	COUNTY	NO.
9	NEVADA	RS 163(1)	CLARK	10

LOT 13

LOT 12

LOT 33

Slope Tapered Inlet

Dike for Culvert #8

Dike for Culvert #9

Type 7 Drop Inlet

Roadside Ditch Flows

Culvert #9

Slope Tapered Inlet

Roadside Ditch Flow

Culvert #8

Riprap Lined Channel

Grouted Riprap Drop Structure

78" Storm Sewer

"A" 99308.94

"B" 99524.02 PI

"C" 99524.02 PT

"C" 99743.13 PC

"C" ℄
Δ = 17° 37' 12"
R = 2002.5'
L = 615.82'
T = 310.36'

S 54° 19' 57" E - 1800.16'

S 89° 24' 13" E - 200.00'

N 89° 24' 13" E - 2724.66'

N 89° 24' 13" E - 215.11'

N 90°00'00.000" E

179.550 ft

N 90°00'00.000" E

R/W

E.O.

1/4 SECTION LINE

RAW WATER PIPE

LOT 14

LOT 15

LOT 16

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

ONSITE DRAINAGE
FIGURE-A

Sheet 15 of 16

33

INRC NEVADA, INC.

P059-93-016

END PROJECT RS-163(1)

"C" 1010+12.68 P.T.

LOT 33

LOT 32

LOT 31

LOT 28

Roadside Ditch Flows

Impact Stilling Basin

1005 Roadside Ditch Flows

78" Storm Sewer

84" Storm Sewer

1005+98.57 P.C.

"C" ℄
Δ = 17° 36' 05"
R = 2002.0'
L = 615.02'
T = 309.95'

390640 ft
N 90°00'00.000" E

RAW WATER PIPE

Casino Drive

To Davis Dam

Bridge to Airport

1/4 SECTION LINE

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

ONSITE DRAINAGE
FIGURE-4

Sheet 16 of 16

TABLE-6

HYDRAULIC CAPACITY/VELOCITY CHECK

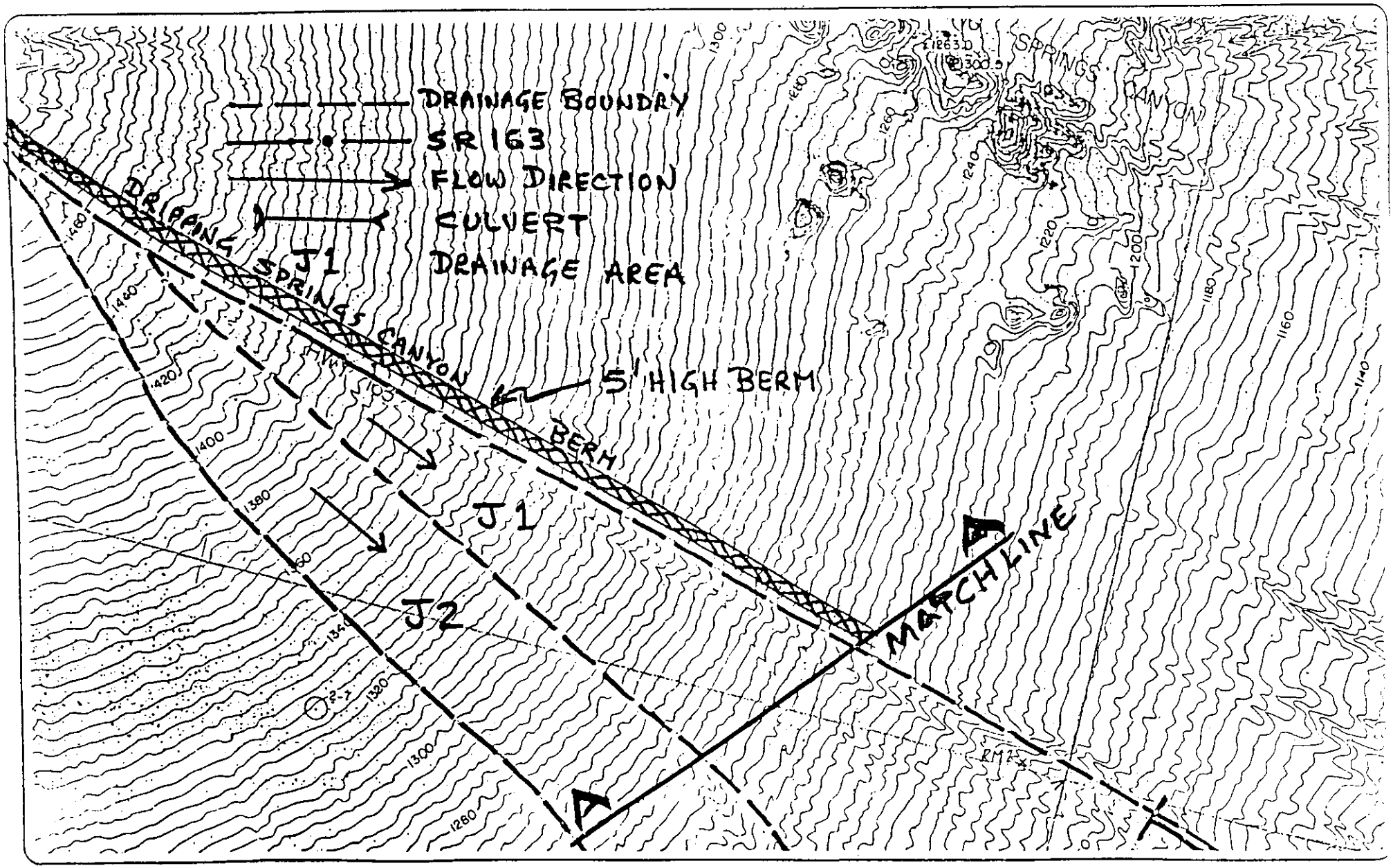
SUB-BASIN	MAX. D_{10} (FT)	AVAILABLE DEPTH (FT)	MAX. V_{10} (FPS)	ALLOWABLE V_{10} (FPS)	OUTLET STRUCTURE
1L	.72	3.67	4.9	5.0	Type 2A D.I.
2L	.65	3.67	4.8	5.0	Type 2A D.I.
3L	.65	3.67	4.9	5.0	Type 2A D.I.
4L	.74	3.67	4.7	5.0	Type 2A D.I.
10L	.71	3.67	4.0	5.0	Natural Channel
10M	.44	1.50	2.9	5.0	Type 2A D.I.
10R	.78	3.67	4.2	5.0	Natural Channel
11L	.58	3.67	3.5	5.0	Natural Channel
12L	.63	3.67	3.7	5.0	Natural Channel
12R	.67	3.67	3.8	5.0	V-Ditch
13M	.53	1.81	3.3	5.0	Type 3 Inlet
14M	.60	1.32	3.4	5.0	Type 3 Inlet
20L	.69	2.10	3.7	5.0	Natural Channel
20M	.63	2.17	3.5	5.0	Reach 21M
20R	.65	4.17	3.6	5.0	Natural Channel
21M	.73	2.07	4.2	5.0	Type 2A D.I.
22L	1.25	2.00	5.7	10.0	Type 2A D.I.
22M	.52	2.02	3.6	5.0	Type 3 Inlet
22R	1.0	2.00	4.9	5.0	Type 2A D.I.
23L	.47	2.00	3.0	5.0	Type 5 Emb. Prot.
23M	.29	0.82	2.4	5.0	Type 3 Inlet
23R	.75	2.00	4.1	5.0	Type 5 Emb. Prot.
24L	.38	2.10	2.8	5.0	Natural Channel
24R	.60	4.17	3.9	5.0	Grouted Riprap Channel
25L	.76	2.10	3.9	5.0	Type 7 Inlet
26L	.77	2.10	3.3	5.0	Natural Channel
26R	1.1	2.00	4.1	5.0	Natural Channel

TABLE-7

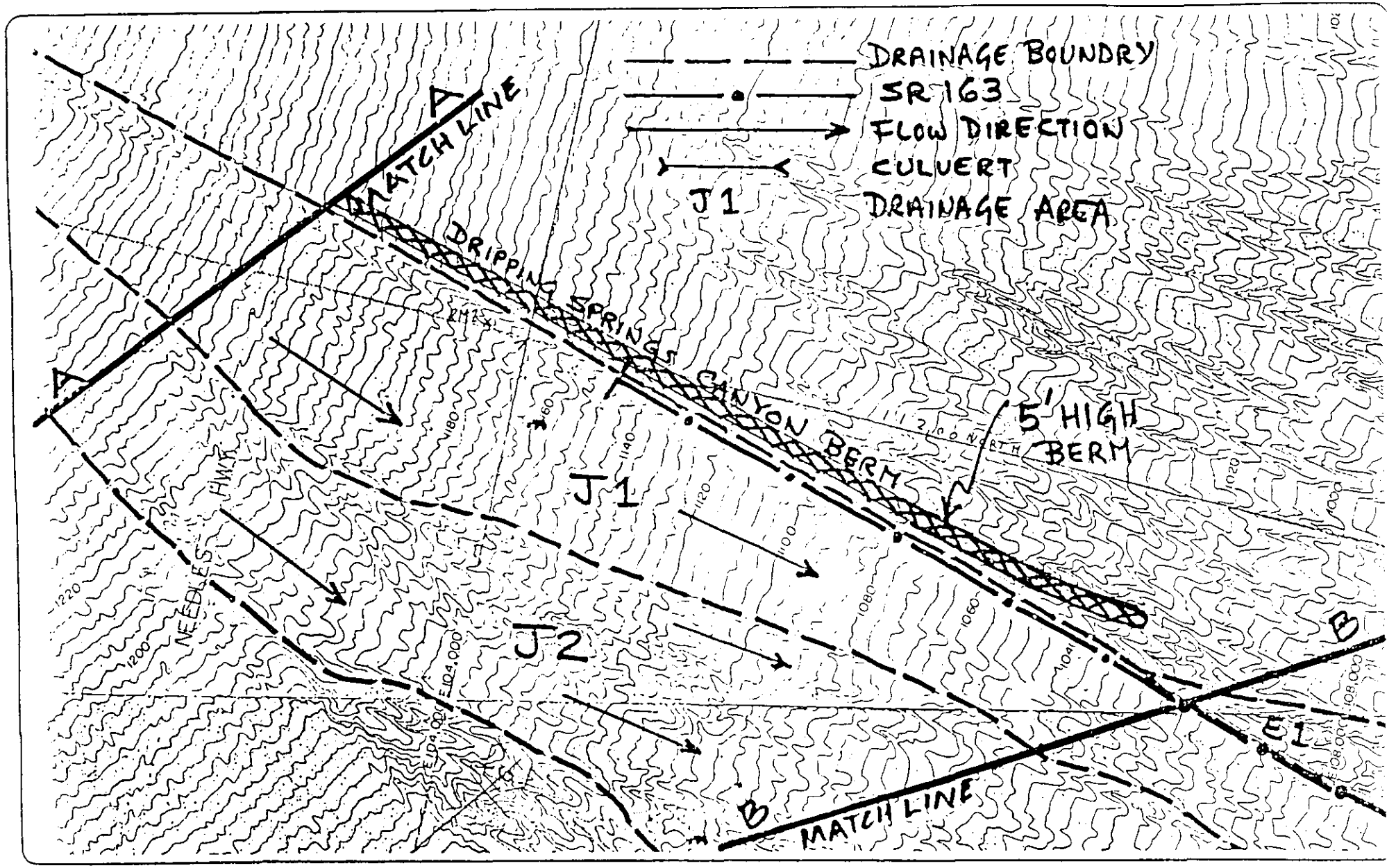
CULVERT SUMMARY

HYDRAULICS								
DESIGN POINT	STATION	Q_{50} (CFS)	Q_{DESIGN} (CFS)	SIZE	REQUIRED HW (FT.)	AVAILABLE HW (FT.)	OUTLET VELOCITY (FPS)	OUTLET PROTECTION TYPE
1	"B" 914+72	120	120	5'x3' RCBC	4.5	5.8 With dike	15.8	Grouted RipRap Basin
2	"B" 920+95	20	20	30" CMP	2.3	3.9 With dike	8.4	Modified Standard RipRap Basin
3	"B" 928+50	192 (317 with DP 1 & 2)	317	8'x 4' RCBC	6.2	7.0 With dike	24.0	Grouted RipRap Basin
4	"A8" 959+28	47	47	5'x3' RCBC	2.2	2.2 With dike	12.2	Modified Standard RipRap Basin
5	N/A							
6	"B" 978+00	17	17	30" CMP	2.1	16	7.9	Modified Standard RipRap Basin
7	"A8" 986+58	569	569	12'x7' RCBC	6.8	8.0 With dike	20.7	Grouted RipRap Basin
8	"C" 995+80	574	574	10'x3' RCBC	4.0 Above apron lip	5.0 Above apron lip with dike	25.0	Grouted RipRap Basin
9	"C" 1003+32	23	23	30" RCP	3.0	6.8 With dike	–	Storm Sewer

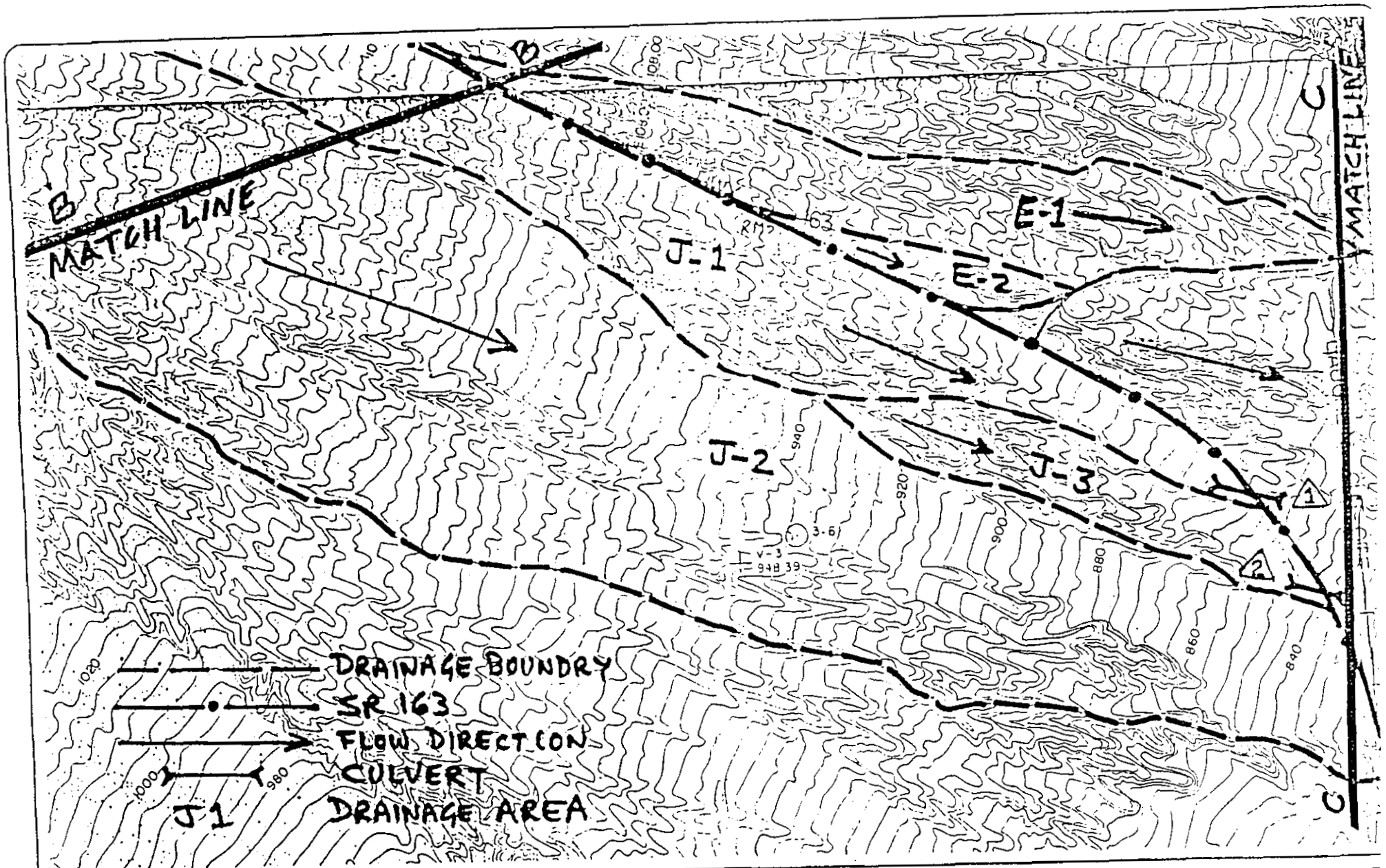
DESIGN								
DESIGN POINT	STATION	INVERT ELEVATIONS		LENGTH (FT.)	SLOPE (PERCENT)	SKEW (DEGREES)	INLET DESIGN	OUTLET DESIGN
		UPSTREAM	DOWNSTREAM					
1	"B" 914+72	865.7	862.0	218	1.70	15	Type I Headwall	Type I Headwall
2	"B" 920+95	844.1	833.7	292	3.56	30	Metal End Section	Metal End Section
3	"B" 928+50	821.5	813.5	210	3.81	30	Type I Headwall	Type I Headwall
4	"A8" 959+28	722.7	719.7	157	1.91	30	Type I Headwall	Type I Headwall
5	N/A							
6	"B" 978+00	625.3	619.7	167	3.35	23	Metal End Section	Metal End Section
7	"A8" 986+58	600.5	596.4	139	2.95	45	Type I Headwall	Type I Headwall
8	"C" 995+80	567.2 With lip @ 576.2	559.2	167	4.79	45	Sloping Tapered Inlet	Type I Headwall
9	"C" 1003+32	536.2 With grate at 539.37	533.5	158	1.71	30	Type 7 Drop Inlet	N/A



WRC	SR-163 / DRAINAGE DESIGN P059-93-010		FIGURE-5 SHEET 1 OF 5
			JOB NO. 2016



WRC	SR – 163 / DRAINAGE DESIGN P-059-93-010	OFFSITE DRAINAGE	FIGURE – 5 SHEET 2 OF 5	JOB NO. 2016



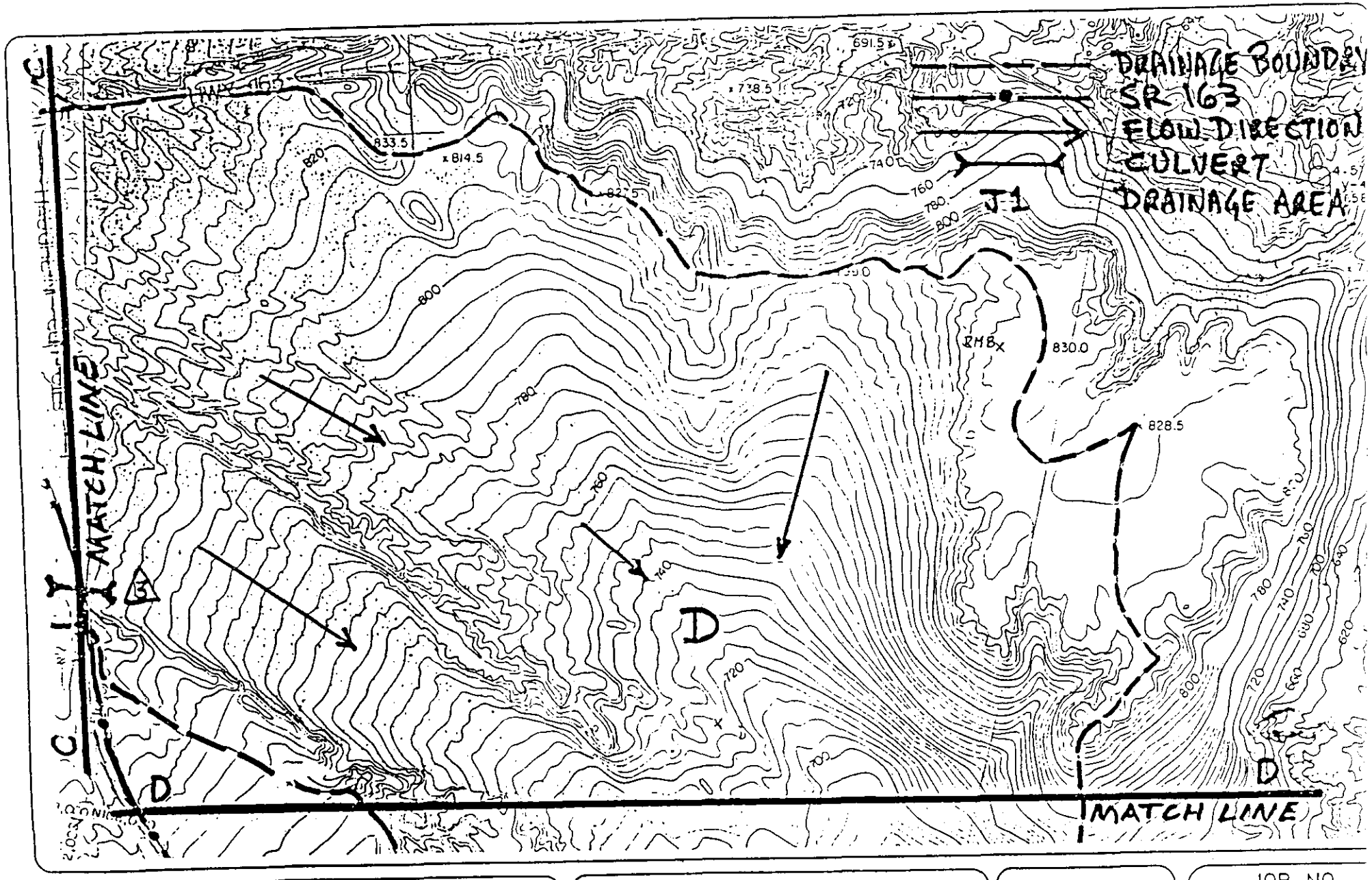
WRC

SR – 163 / DRAINAGE DESIGN
P-059-93-010

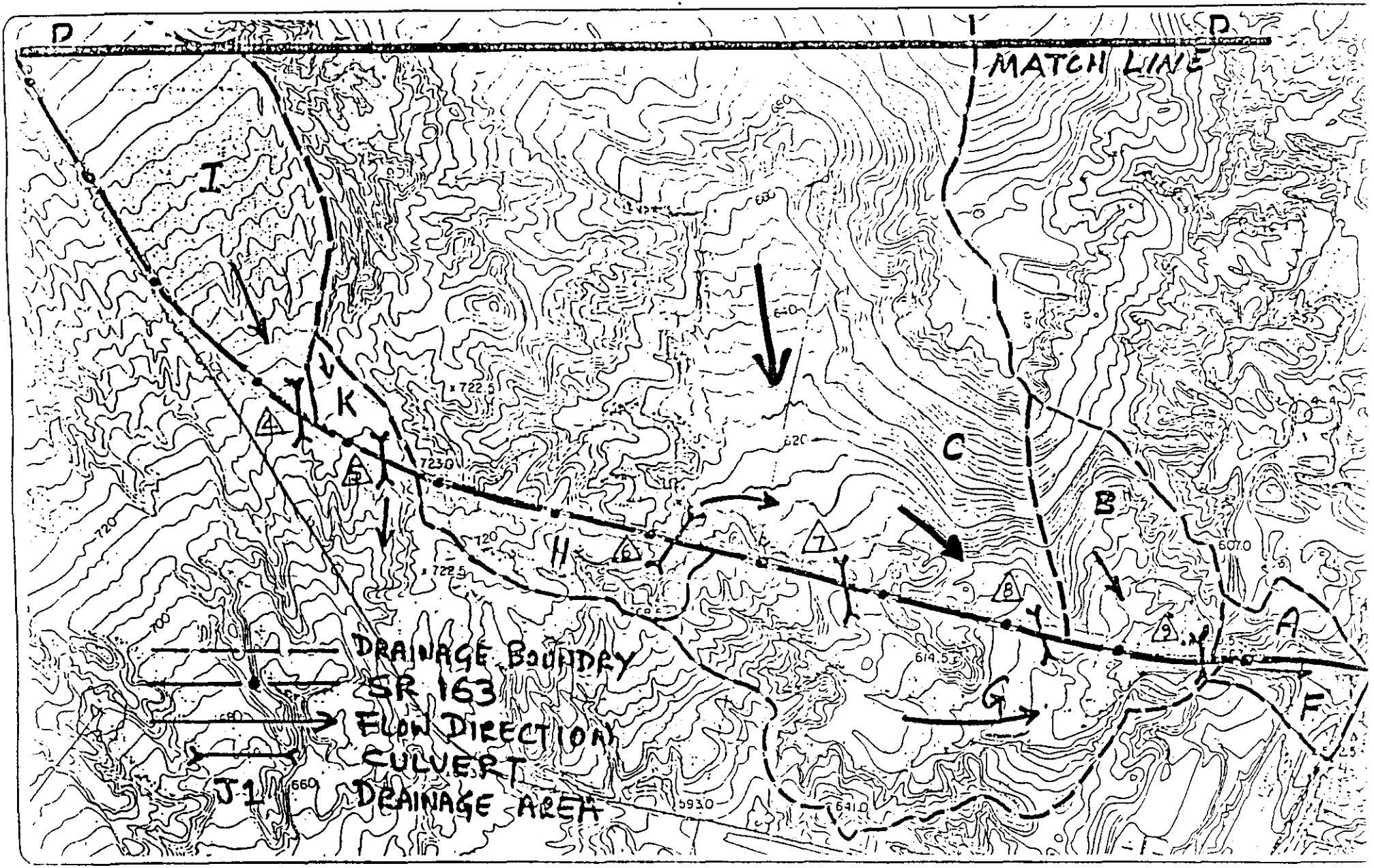
OFFSITE DRAINAGE

FIGURE – 5
SHEET 3 OF 5

JOB NO.
2016



WFC	SR 163 DRAINAGE DESIGN P-059-93-010	OFFSITE DRAINAGE	FIGURE-5 SHEET 4 OF 5	JOB NO. 2016



WRC	SR 163 DRAINAGE DESIGN P-059-93-010	OFFSITE DRAINAGE	FIGURE- 5 SHEET 5 OF 5	JOB NO. 2016

We analyzed several potential outfall drainage facilities (storm sewer and lined channels) to convey the offsite runoff on the south side of the "B" alignment from about Station 1000+00 to Casino Drive and the Colorado River. The results of our analysis concluded that a storm sewer would be the preferred alternative due to the steep grade in this area as well as the potential future changes in the intersection alignment/geometry at Casino Drive. Presented on Figure-6 was a preliminary alignment and profile for said storm sewer. On May 12, 1993, NDOT directed WRC to design said storm sewer with an outlet to be located upstream of Casino Drive. This design would allow runoff from said storm sewer to match the historic discharge point from the tributary basins. The final RCP storm sewer begins at about Station 999+55 with an improved tapered/mitered inlet structure. A maximum pipe velocity of 25 fps is maintained in the storm sewer. This 710 feet long storm sewer ends with an outlet energy dissipation structure about 250 feet upstream of Casino Drive. Flow from the energy dissipator is then allowed to spread to approximate the historic location and extent of runoff from the tributary basins.

D. DISCUSSION

The culvert at Station "B" 928+50 is recommended to be sized for a runoff rate greater than the 50-year storm event from sub-basin J-2. The recommended runoff rate is the sum of the 50-year peak flows from sub-basins J1, J2, and J3. We believe the said culvert should be oversized to accommodate said runoff since there is a chance that runoff in said basins may easily cross over the defined sub-basin divides due to expected erosion and subsequent migration potential in said basins.

A flow path control dike is recommended as part of the construction of Phase V of SR-163. This dike is to be located along the north side of the existing SR-163 constructed under Phase IV from about Station 785+00 to about Station 849+00. The purpose of this dike is to prevent overtopping of SR-163 from runoff generated in Drippings Springs Canyon. The CCRFCD's Master Plan for this area identified this dike as being about 9,000 feet long and 4' to 5' high. The dike is designed for the 100-year flow generated from the Dripping Springs Canyon Watershed area located upstream of design point No. 14 (see attachment to our letter of April 9, 1993, in Appendix-A). The flow at this location is that used in the Bridge Canyon Wash Flood Control Master Plan, prepared by the Clark County Regional Flood Control district (see Reference-1/Page 32). By preventing overtopping of SR-163, culvert crossings at design points 1, 2, 3, and 7 are designed for only the drainage area directly tributary to said culverts.

Presented in Figure-7 (3 sheets) Pages 44-46 are the preliminary typical cross-sections of the said dike as well as a plan view of the dike modifications at the apex of Dripping Springs Canyon Wash. These figures were presented to a representative of the National Park Service (NPS) on May 6, 1993. The NPS generally accepted the proposed dike design with minor modifications which were discussed at said meeting which are currently being put in a formal memorandum. Other minor adjustments to the dike design (i.e. changes in dike sideslopes, road barrier rails, etc.) were necessary in the final design analysis further east of the apex to fit the dike and excavated channel

SLOPE METERED INLET STRUCTURE

84" RCP

1005 Raw

FUTURE CASINO DRIVE

Bridge to Jean Lane

1/4 SECTION LINE

Scale: 1"=100' Horiz.
1"=10' Vert.

EXISTING GRADE

84" RCP @ 1.0%

84" RCP @ 1.0%

84" RCP @ 1.0%

CASINO ZONE

IMPACTING AREA

EXIST 16" WATER

EXIST 24" SANITARY SEWER

COLORADO RIVER FLUCTUATIONS

560
550
540
530
520
510
500
490
480

1000+00
1002+00
1004+00
1006+00
1008+00
1010+00
1012+00
1014+00

WRC NEVADA, INC.
CENTURY PARK, SUITE 200A
1771 EAST FLAMINGO ROAD
LAS VEGAS, NEVADA 89119
PHONE NO: (702) 893-6266

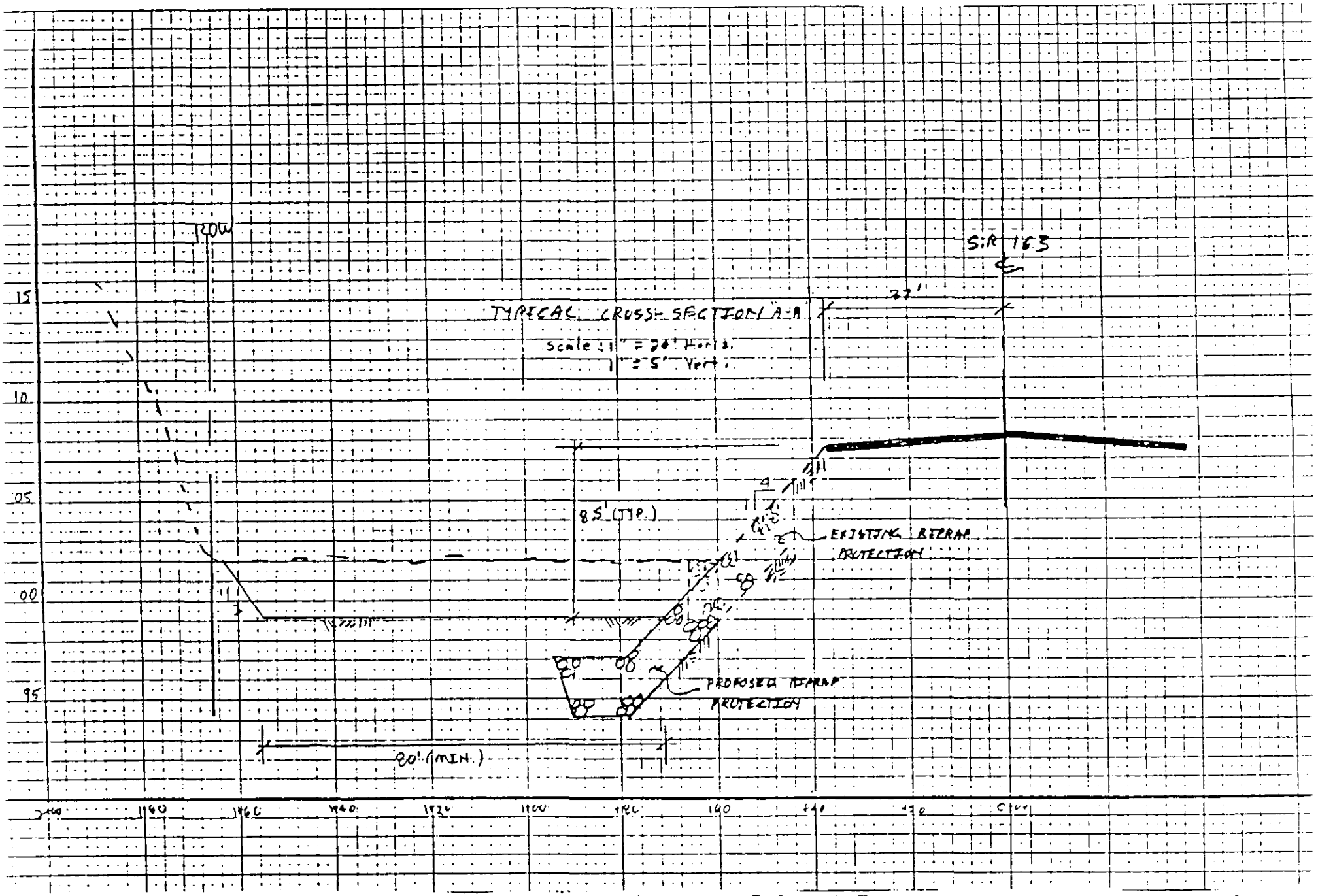
DESIGNED — DATE —
DRAWN — DATE —
CHECKED — DATE —
REVISED — DATE —

NEVADA DEPARTMENT OF TRANSPORTATION

SR 163 DRAINAGE DESIGN

STORM SEWER OUTFALL TO COLORADO RIVER

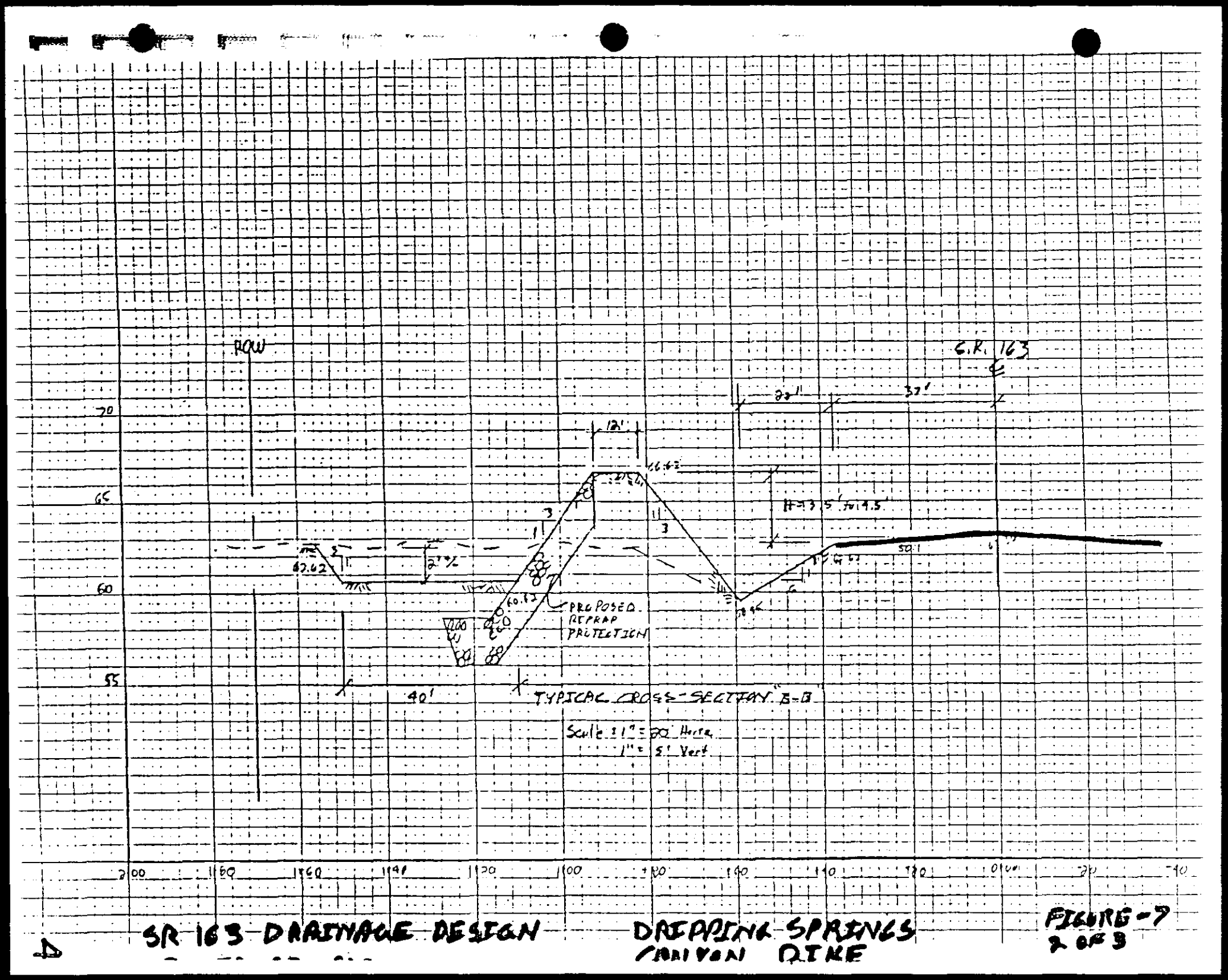
PROJECT NUMBER
WRC PROJ #



SR 163 DRAINAGE DESIGN

DRIPPING SPRINGS CANYON DIKE

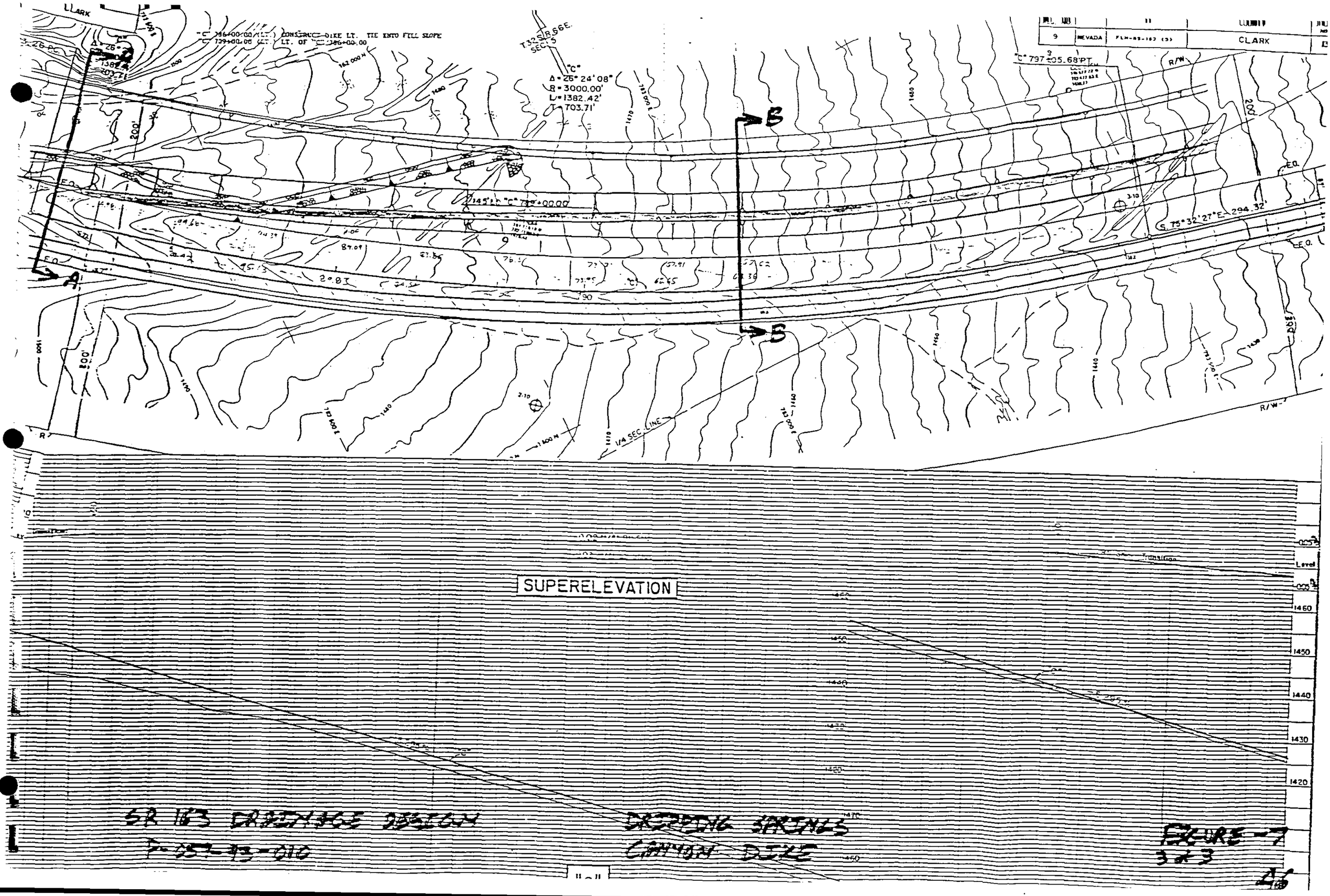
FIGURE - 7
1 OF 3



SR 163 DRAINAGE DESIGN

DRIPPING SPRINGS CANYON DIKE

FIGURE-7
2 OF 3


"C" 796+00.00 (LT.) CONSTRUCT DIKE LT. TIE INTO FILL SLOPE
"C" 739+00.00 (LT.) LT. OF "C" 796+00.00
"C"
Δ = 26° 24' 08"
R = 3000.00'
L = 1382.42'
T = 703.71'
"C" 797+05.68 PT
S 75°32'27"E 294.32'
145' Lt "C" 739+00.00
A
B
S
E.O.
R/W
200'
100'
1400
1410
1420
1430
1440
1450
1460
V/4 SEC. LINE
SUPERELEVATION
SR 163 DRAINAGE DESIGN
F-057-1(3)010
DRAINAGE STRUCTURES
CANYON DIKE
FIGURE-7
3 x 3
46

within the existing right-of-way of S.R. 163.

In the preliminary hydraulic design report, a second dike located just upstream of SR-163 near design point 7 was proposed. The purpose of this dike was to prevent the runoff approaching SR-163 at design point 7 from inadvertently diverting east and impacting the culvert crossing at design point 8. Because of the lack of the right-of-way availability for the dike at this late stage of the highway planning, coupled with the April 20, 1993, written input received from NDOT, the culvert at design point 8 was upsized to accommodate any overflow from Basin D to Basin C.

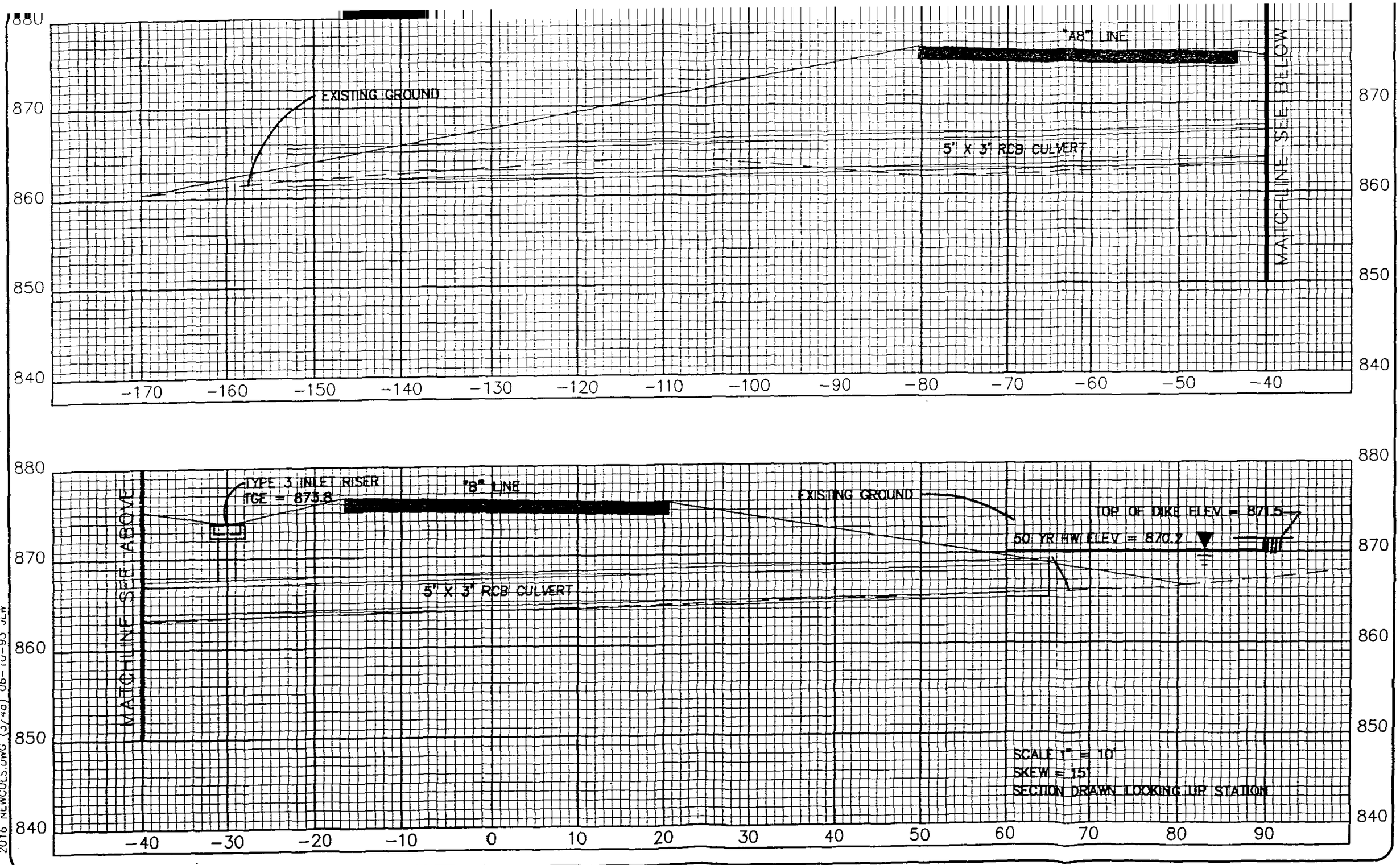
E. DESIGN

Presented on Figure-8 (Pages 48 thru 55) are cross-sections of the proposed offsite culverts. These cross-sections are prepared to assist in visually verifying that all design constraints (i.e. minimum clearance, minimum cover, headwater, construction method (trench or embankment), headwall and wingwall alignment) are addressed. Design information for these culverts and on-site drainage facilities (including construction plan drawings and construction notes) were submitted to NDOT at various times during the progress of the project.

The Dripping Spring Canyon Wash Dike design calculations are presented in Appendix B. The major design assumptions used to design this dike are as follows:

1. The dike height from Station 783+70± to 796+00 was set equal to the 100-year water surface elevation based on critical depth analysis plus four feet (one foot sedimentation plus three feet of freeboard). From Station 796+00 to the downstream end of the dike, the dike height was set four feet above the average ground surface of the alluvial fan. (One foot 100-year water/sedimentation depth plus three feet freeboard.)
2. Riprap sizing and scour analysis was based on normal depth calculations (super critical flow).
3. A minimum 9 foot wide access road for the National Park Service was included at the fan apex (about Station 783+70) and was elevated two feet above the channel invert. This allows the road at this location to remain approximately above the 10-year water surface.

Final design drawings and cross-sections for the Dripping Springs Canyon Wash Dike are included in Appendix C. Also included in Appendix C are the final design notes and drawings for the outfall system extending from Culvert #8 (Sta. "C" 995+80) to Casino Drive.



2016 NEWCULS.DWG (3/48) 06-10-93 JLW

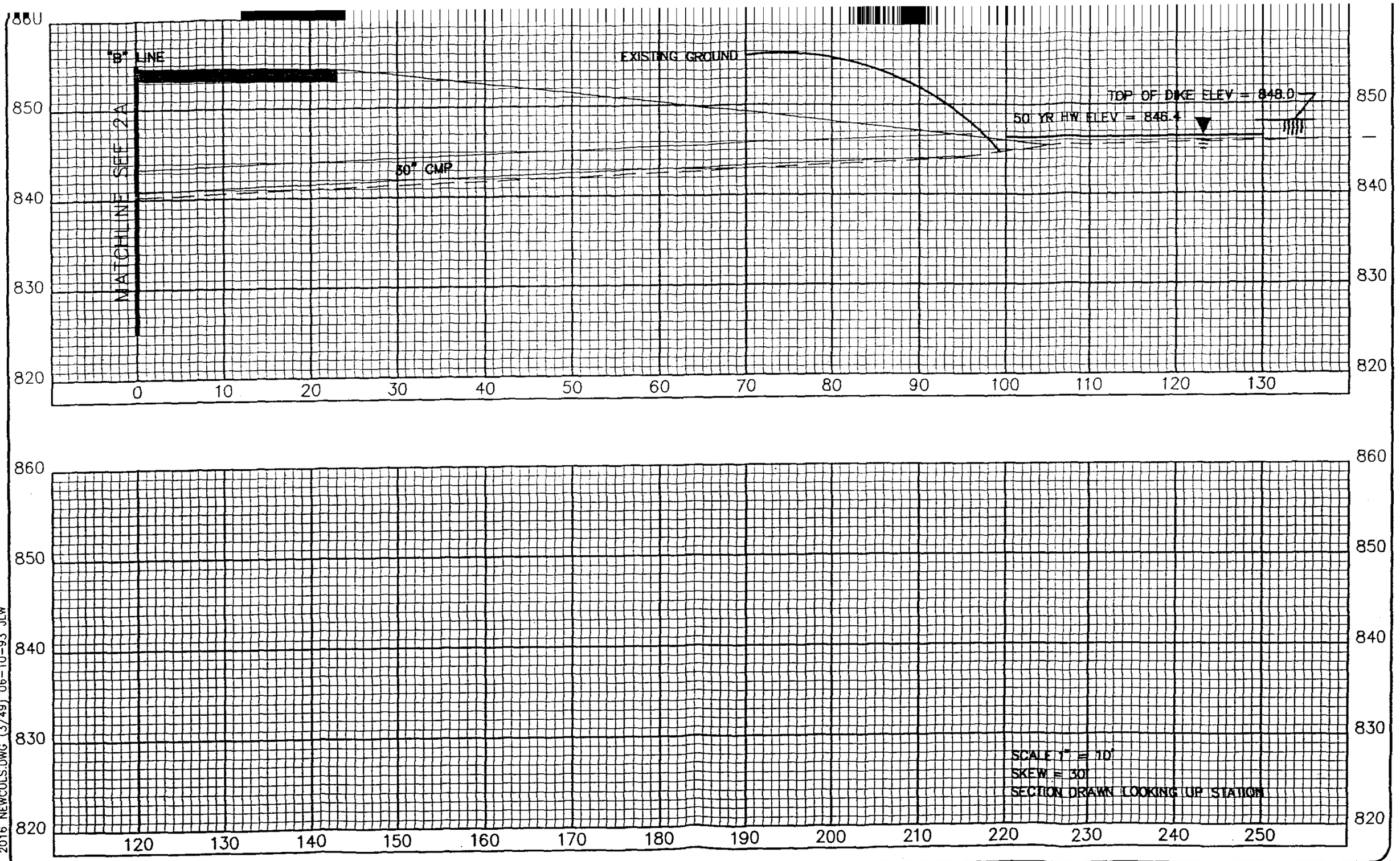
WRC

SR 163 DRAINAGE DESIGN
P-059-93-010

CROSS SECTION – CULVERT NO.1
"B" LINE STATION – 914+72.00

FIGURE – 8
SHEET 1 OF 9

JOB NO.
2016



2016 NEWCULS.DWG (3/49) 06-10-93 JLW

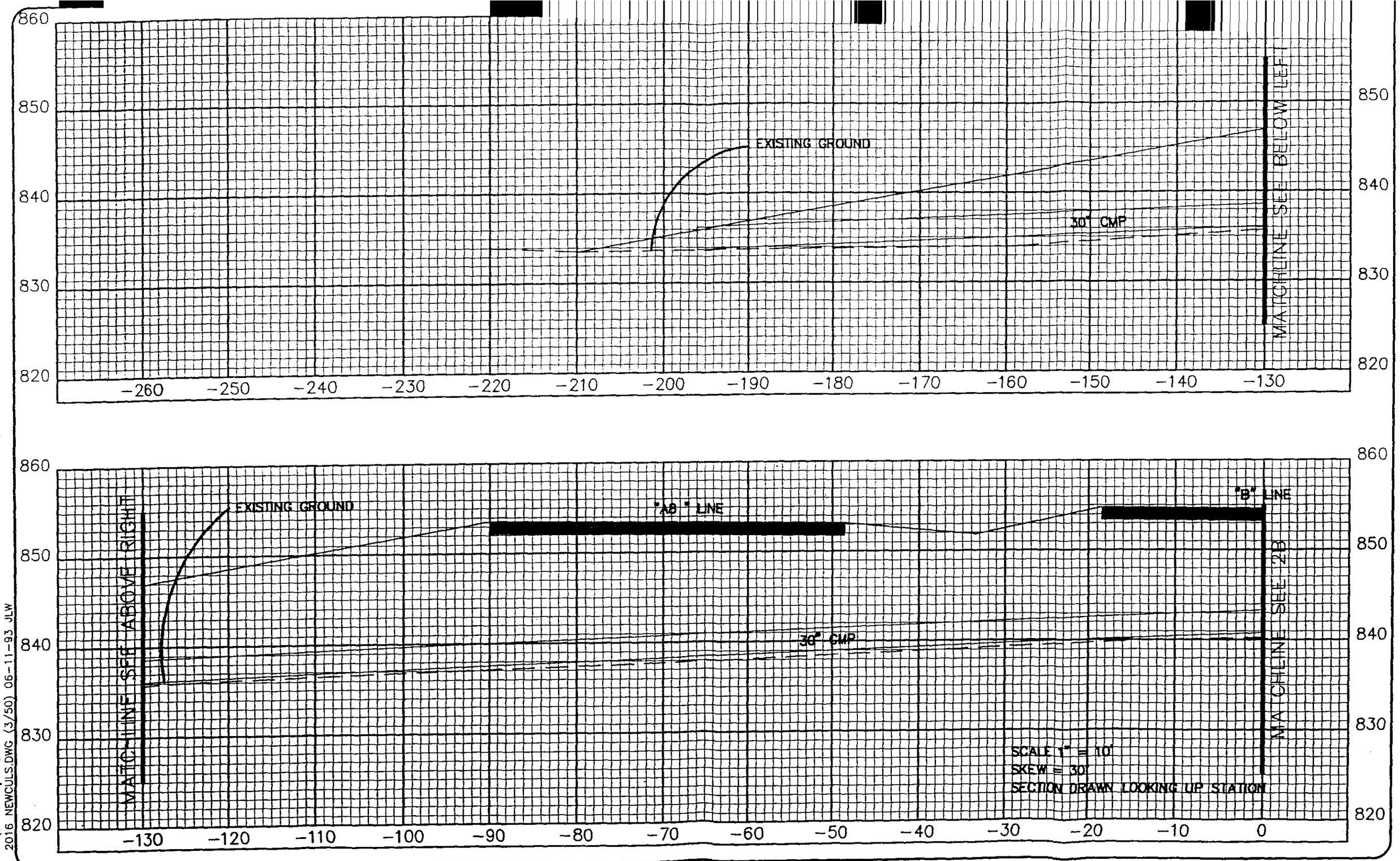
WRC

SR 163 DRAINAGE DESIGN
P-059-93-010

CROSS SECTION – CULVERT NO. 2
"B" LINE STATION – 920+95.00

FIGURE – 8
SHEET 2 OF 9

JOB NO.
2016



2016 NEWCULS.DWG (3/50) 06-11-93 JLW

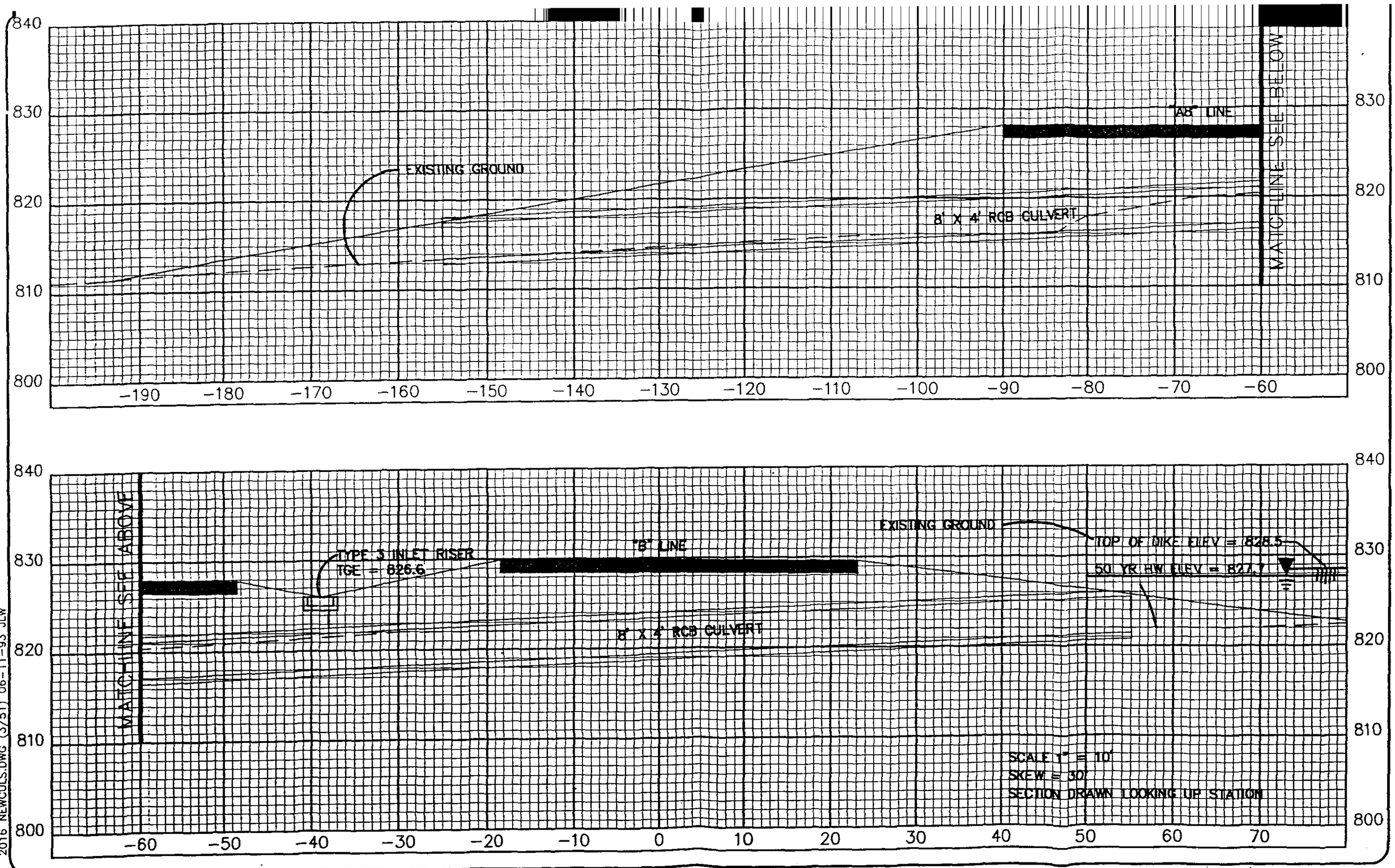
WRC

SR 163 DRAINAGE DESIGN
P-059-93-010

CROSS SECTION – CULVERT NO. 2
"A8" LINE STATION – 921+60.59

FIGURE – 8
SHEET 3 OF 9

JOB NO.
2016



2016 NEWCULS.DWG (3/51) 06-11-93 JLW

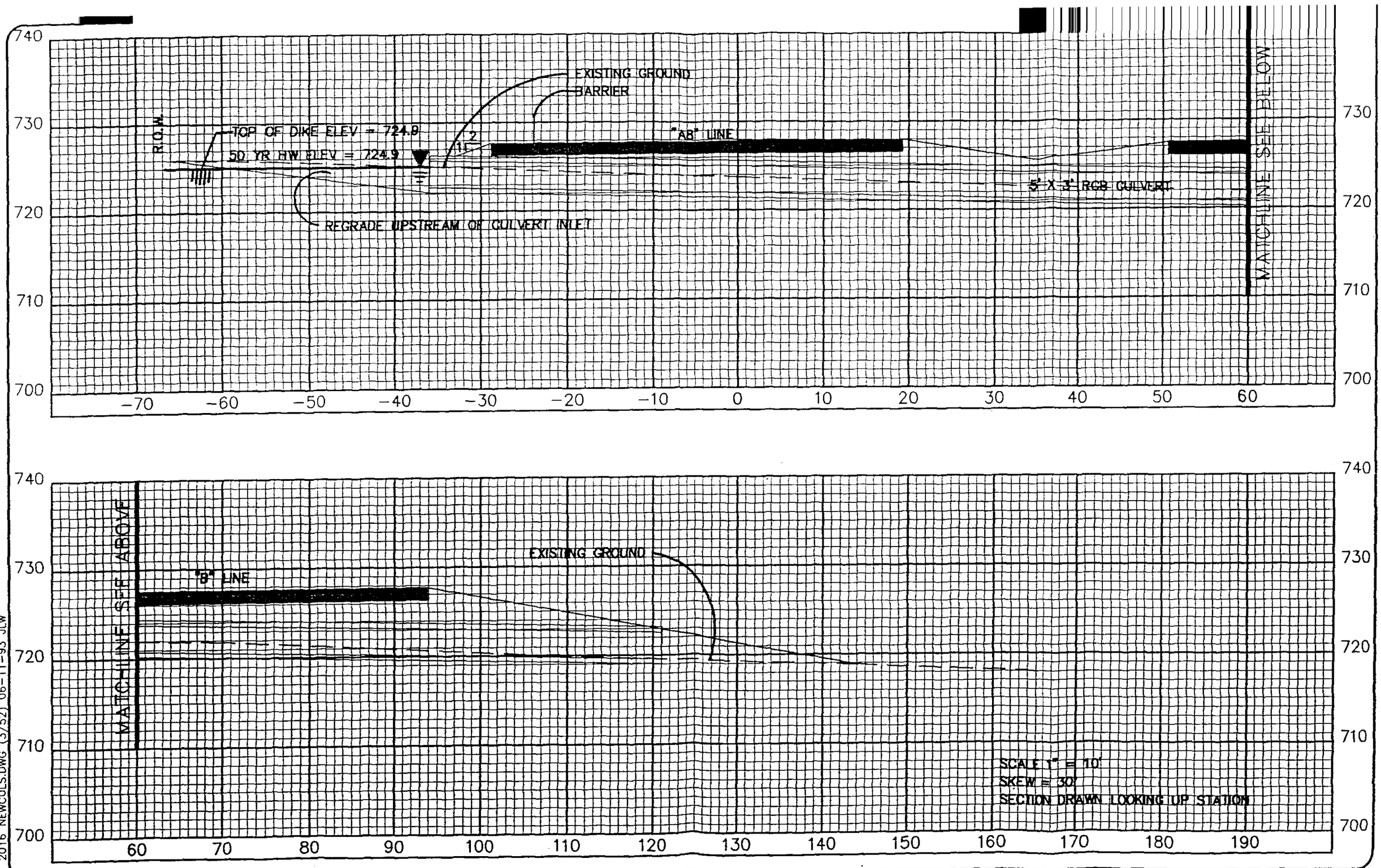
WRC

SR 163 DRAINAGE DESIGN
P-059-93-010

CROSS SECTION – CULVERT NO. 3
"B" LINE STATION – 928+50.00

FIGURE – 8
SHEET 4 OF 9

JOB NO.
2016



2016 NEWCULS.DWG (3/52) 06-11-93 JLW

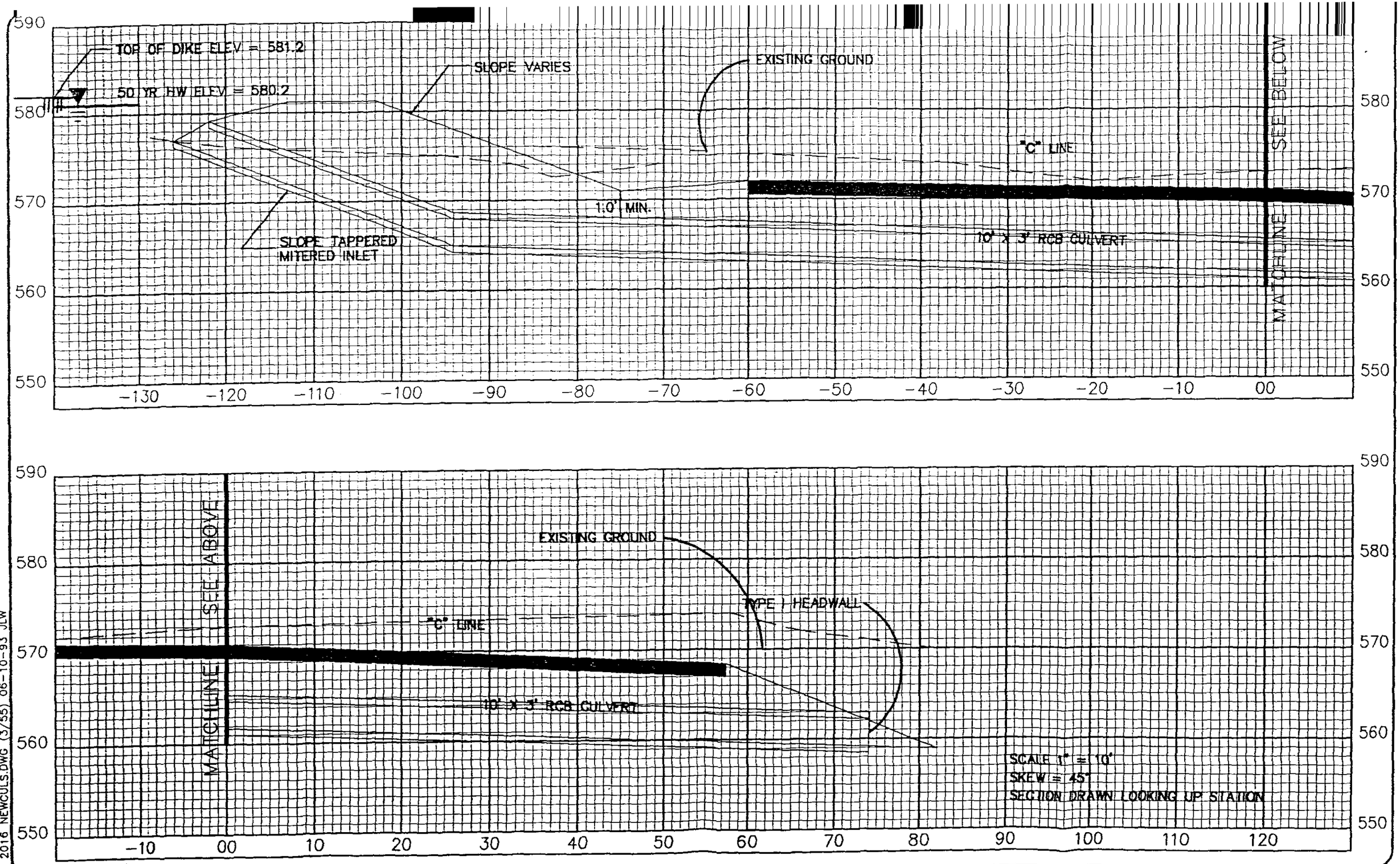
WRC

SR 163 DRAINAGE DESIGN
P-059-93-010

CROSS SECTION – CULVERT NO. 4
"A8" LINE STATION – 959+28.00

FIGURE – 8
SHEET 5 OF 9

JOB NO.
2016



2016 NEWCULS.DWG (3/55) 06-10-93 JLW

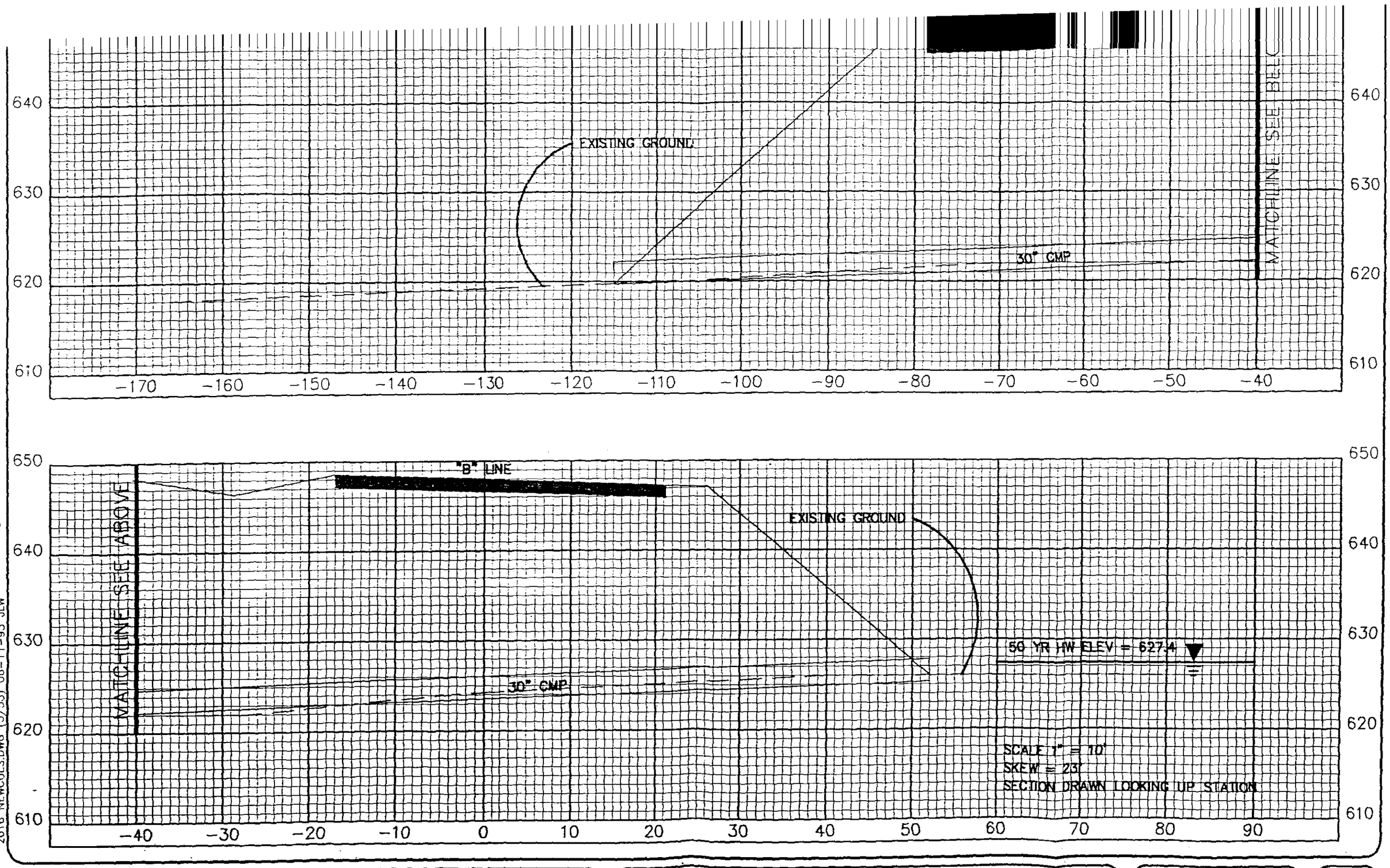
WRC

SR 163 DRAINAGE DESIGN
P-059-93-010

CROSS SECTION – CULVERT NO. 8
"C" LINE STATION – 995+80.00

FIGURE – 8
SHEET 8 OF 9

JOB NO.
2016



2016 NEWCULS.DWG (3/53) 06-11-93 JLW

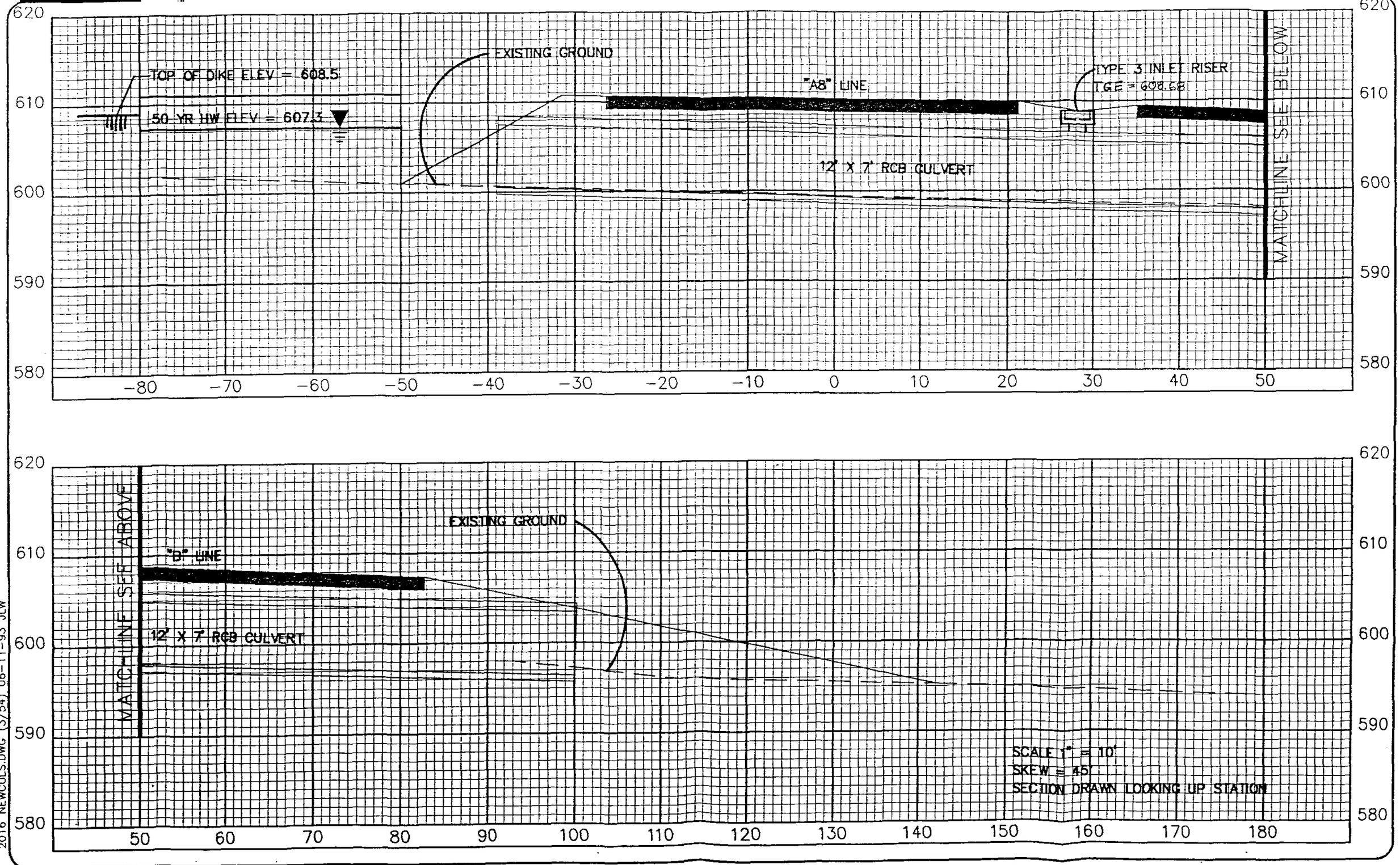
WRC

SR 163 DRAINAGE DESIGN
P-059-93-010

CROSS SECTION - CULVERT NO. 6
"B" LINE STATION - 978+00.00

FIGURE - 8
SHEET 6 OF 9

JOB NO.
2016



2016 NEWCULS.DWG (3/54) 06-11-93 JLW

WRC

SR 163 DRAINAGE DESIGN
P-059-93-010

CROSS SECTION – CULVERT NO. 7
"A8" LINE STATION – 986+58.00

FIGURE – 8
SHEET 7 OF 9

JOB NO.
2016

V. COST ESTIMATE

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT COST	ITEM COST
203 0800	V-TYPE DITCH	10	STA	$150	$1,500
302 0200	TYPE 2 CLASS B AGGREGATE BASE	320	CU YD	25	8,000
603 0073	30-INCH RCP (CL III)	158	LIN FT	50	7,900
	78-INCH RCP (CL III)	439	LIN FT	300	131,700
	84-INCH RCP (CL III)	271	LIN FT	350	94,850
604 0291	24-INCH CMP	715	LIN FT	30	21,450
604 0331	30-INCH CMP	624	LIN FT	35	21,840
604 6091	24-INCH METAL ENDSECTION	5	EACH	200	1,000
604 6112	30-INCH METAL ENDSECTION	4	EACH	300	1,200
	MODIFIED CONCRETE MANHOLE (TYPE 4)	2	EACH	4,000	8,000
608 0050	EMBANKMENT PROTECTOR (TYPE 5)	2	EACH	1,500	3,000
608 0320	12-INCH DOWNDRAIN PIPE	130	LIN FT	25	3,250
609 0310	DROP INLET (TYPE 2A)	7	EACH	1,200	8,400
609 0307	DROP INLET (TYPE 7)	2	EACH	2,000	4,000
609 0403	PIPE RISER INLET (TYPE 3)	5	EACH	700	3,500
610 0300	GROUTED RIPRAP	370	CU YD	80	29,600
610 0120	MEDIUM RIPRAP	160	CU YD	50	8,000
	CONCRETE CLASS	600	CU YD	300	180,000
	REINFORCING STEEL	130,000	POUND	0.75	97,500
	PVC WEEPS	350	EACH	40	14,000
			TOTAL		$648,690.00

NOTES:

1) *ITEMS THAT ARE NOT INCLUDED IN THE ABOVE ARE:*
   - EARTHWORK FOR DIKES, BERMS, CHANNEL EXCAVATION AND TRENCH EXCAVATION.
   - SLOPE TAPERED INLETS, AND IMPACT STILLING BASIN. THESE ITEMS ARE BEING STRUCTURALLY DESIGNED BY N.D.O.T. AND PLANS HAVE NOT BEEN MADE AVAILABLE.
   - DRIPPING SPRINGS CANYON DIKE AND CHANNEL.
2) ITEM NUMBERS THAT ARE BLANK WILL BE ASSIGNED BY N.D.O.T.

REFERENCES

1. Clark County Regional Flood Control District, "Bridge Canyon Wash Flood Control Master Plan, Laughlin, Nevada", prepared by Coe and Van Loo Consulting Engineers, Inc., September 1990.

2. Clark County Regional Flood Control District, "Hydrologic Criteria and Drainage Design Manual", prepared by WRC Engineering, Inc., October 1990.

3. Clark County Regional Flood Control District, "Flood Control Master Plan, Volumes 1-5", prepared by James M. Montgomery, Consulting Engineers, Inc., October 1986.

4. Big Bend Water District, "Drainage Report-Laughlin Water Treatment Plan", prepared by CH2M Hill, October 1990.

5. State of Nevada, Department of Transportation, "Design Manual - Parts 1 and 2", Third Edition 1986.

6. Soil Conservation Service, "Urban Hydrology for Small Watersheds", TR-55, June 1986.

7. Soil Conservation Service, "National Engineering Handbook, Section 4 - Hydrology", 1985.

8. U.S. Bureau of Reclamation, "Design of Small Dams", 1987.

9. Nevada Department of Transportation, "SR-163, From the Junction with US95 East to Laughlin Cutoff Road, Environmental Assessment", FHWA-NV-EA 87.02, May 1987.

10. Soil Conservation Service, "Computer Program for Project Formulation - Hydrology, TR-20", 1982.

APPENDIX - A

PROJECT CORRESPONDENCE

WRC NEVADA, INC.

April 9, 1993

Mr. Amir M. Soltani, P.E.
Senior Hydraulic Engineer
Nevada Department of Transportation
1263 South Stewart Street
Carson City, Nevada 89712

WRC File: 2016/4

Dear Mr. Soltani:

Our preliminary analysis of the potential design flows for SR-163 drainage facilities, shows that they are impacted by the proposed plans by the Clark County Regional Flood Control District (CCRFCD), and the SR-163 alignment and its construction as proposed by NDOT.

As shown on Figure-1, flows from both the Dripping Springs Canyon and Bridge Canyon Watersheds could impact the phase V of the highway. For **Dripping Springs Canyon Watershed**, flows from areas D-1 and D-2 are proposed to be kept north of SR-163 and into area D-5. This diversion is proposed to be implemented by constructing a berm along the north side of SR-163. The length of this proposed berm as shown in Figure-2 is approximately 9,000 feet long. The cost of this berming as shown in the Bridge Canyon Wash Flood Control Master Plan is approximately $262,000. Our preliminary field observations shows that the existing dike presently at the site may not be sufficient to keep the 50-year frequency flood from overtopping the highway and thus contributing flows to area D-4A. We estimate that the design flow for the 50-year storm to be in the range of 500 to 600 cfs if flows from Areas D-1 and D-2 are confined to area D-5. Otherwise, the same frequency flow would be in the rage of 2,500 to 3,500 cfs. Thus SR-163 drainage facilities at stations 994+00 and 937+00 would have to be designed to accommodate these flows and thus increase the project cost. While we are unable at this time to estimate this increase in cost, due to lack of design data, we believe the increase will exceed the cost of $262,000 for berming. For **Bridge Canyon Watershed**, it is proposed by the CCRFCD that at point 5, see Figure-1, flows will be diverted into area D-4A and thus further increasing the design flows for SR-163 drainage facilities by approximately an additional 4,000 cfs for the 50-year storm. If this diversion is expedited, it is assumed that Dripping Springs Canyon Watershed flows will be kept north of SR-163 and into area D-5.

As you can see, any diversions into area D-4A will increase the design flows for SR-163 drainage facilities substantially. We have discussed these alternatives on a preliminary basis with Mr. Gale Fraser of the CCRFCD. The focus of our discussion with Mr. Fraser was the potential design flows for SR-163 under the different alternatives. Also, during the meeting of May 12, 1992, held at the NDOT/District I headquarters, the drainage facilities required for SR-163 to accommodate CCRFCD future plans were discussed. At that meeting, as documented in a memorandum from Mr. Talas to Files dated May 18, 1992; Ms. Virginia Bax-Valentine of CCRFCD stated that "funding for these facilities will not be available for at least another 10 years". She further "indicated that perhaps SR-163 should be designed for present flow conditions and that the County's master plan could be constructed at a future date".

From this preliminary analysis, it is clear that it is more cost effective for NDOT, if flows from both Dripping Springs Canyon Watershed (areas D-1 and D-2) and Bridge Canyon Watershed (areas above point 5 on Figure-1) are kept away from area D-4A. This would be extremely helpful in, not only reducing costs, but reducing impacts of SR-163 on the existing facilities in the lower reaches of the highway. However, if possible, it is equally desirable to fund and construct CCRFCD's future planned drainage facilities at the time SR-163 is constructed.

Because of the desire to complete the schedule V of SR-163 now, and lack of availability of funding to construct CCRFCD's future drainage facilities at this time, we would recommend that our proposed work be based on the flow conditions excluding diversions from Dripping Springs Canyon and Bridge Canyon Watersheds. This would require construction of the proposed berming to keep Dripping Springs Canyon Watershed flows from areas D-1 and D-2 north of SR-163 and into area D-5. The funding of the berming is a matter that needs to be addressed by NDOT and CCRFCD.

We would appreciate it if you could review this information and provide us with your input at the earliest possible time. Further, we would be interested in any information NDOT may have related to the berming referenced in this letter, since that reach of SR-163 has already been reconstructed to a four lane highway. It is possible that Figures 1 and 2 may not transmit clearly over the facsimile, and thus we have shown on the figures the numbering from the Bridge Canyon Master Plan for easy reference. After you have had the opportunity to review this information, please give me or Alan a call to further discuss and clarify the contents of this letter. Thank you.

Very truly yours,

WRC NEVADA, INC.

A. S. Andrews, P.E.
President

Alan J. Leak, P.E.
Project Engineer/Hydrology & Hydraulics

ASA/mag

Attachments

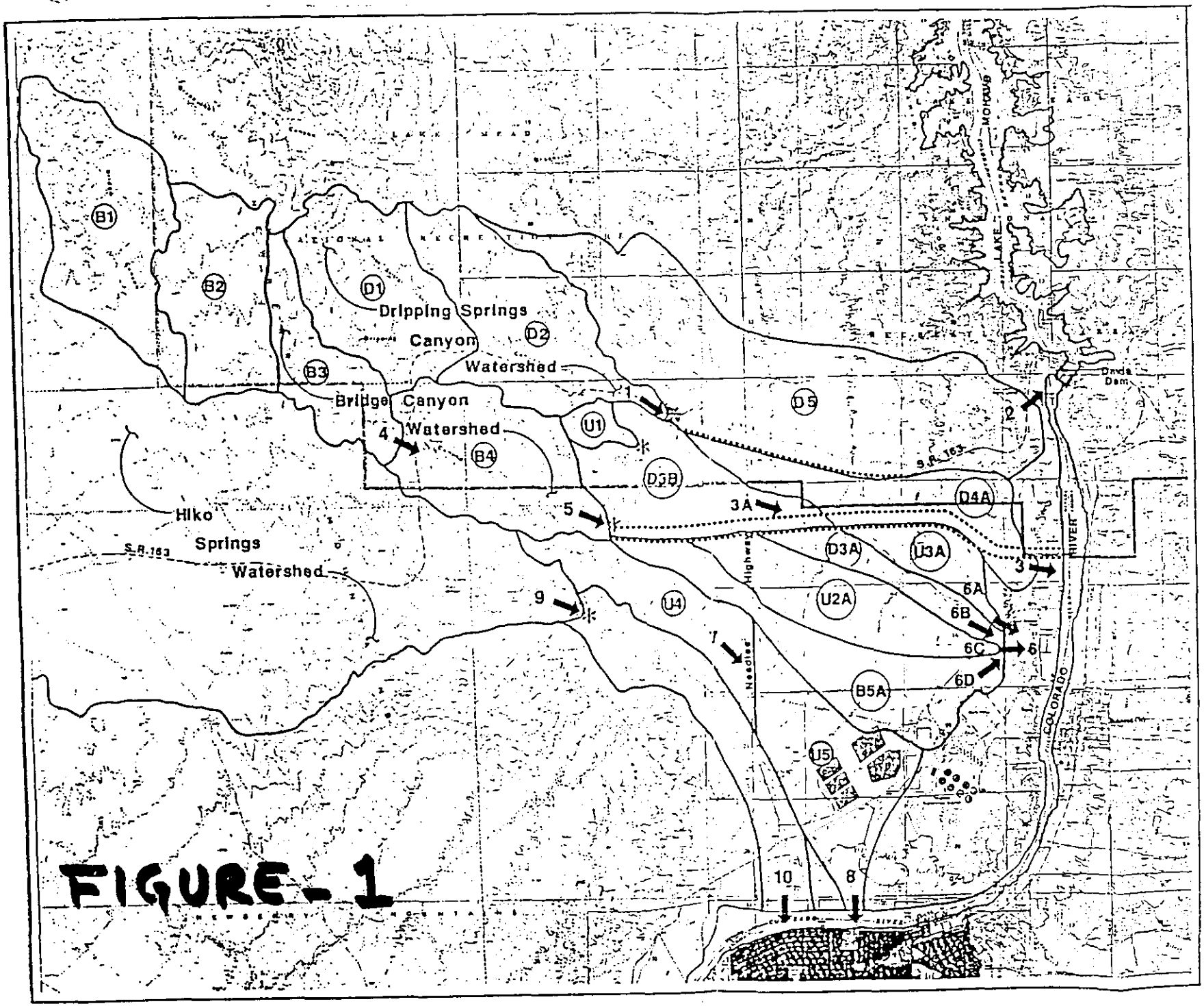


FIGURE-1

SAME AS FIGURE 1 IN THE BRIDGE WASH MASTER PLAN

NOTE

SAME AS FIGURE 11.1 (II.1) IN THE BRIDGE CANYON WASH MASTER PLAN.



FIGURE - 2

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION
1263 S. Stewart Street
Carson City, Nevada 89712

BOB MILLER, Governor

GARTH F. DULL, Director

April 20, 1993

In Reply Refer to

Mr. Andy Andrews, P.E.
Principal in Charge
WRC Nevada, Inc.
1660 S. Albion St. #500
Denver, CO 80222

SR 163, 71303-1
Preliminary
Hydraulic Report
Review

Dear Mr. Andrews:

The Preliminary Hydraulic Report for Phase V of the SR 163 reconstruction project was received on April 16, 1993. This report has been reviewed and found to be acceptable with the following comments made:

1. The design flows used for design points 2 and 6 appear to be larger than the 50 year flows calculated for these points in the HEC-1 model. Is there a reason for this?

2. Inlet control nomographs were included in the hydraulic calculations. This is sufficient for preliminary design but the final culvert designs will have to be checked for the outlet control condition also.

3. It appears that the proposed berm between drainage basins C and D will not be feasible within the time constraints of this project. It is therefore recommended, as discussed with Mr. Alan Leak on April 19, 1993, that the culvert at design point 8 be upsized to accommodate any overflow from Basin D to Basin C.

4. The recommended profile changes listed in Table 7 have been forwarded to the designer (Tracy Larkin). The profile is now being revised to incorporate these changes and it will be forwarded to you as soon as it is available so that the hydraulic design work can be completed.

5. The feasibility of constructing a berm along the north side of SR 163 (as described in your letter to Amir Soltani dated April 9, 1993) is partly dependent on whether it can be constructed within the present limits of NDOT right-of-way. Please proceed with a preliminary design of this berm and let us know if this is the case.

As requested by Mr. Alan Leak in our conversation of April 19, I have enclosed a copy of the Environmental Assessment and past contract plans relevant to this project.

Thank you for your timely progress on this project and please call me at 687-5619 with any questions.

Sincerely,

Frederick Droes
for Amir Soltani
Hydraulic Engineer

AMS:CM:lmg

cc: Daryl James, Environmental
Tracy Larkin, Roadway Design

WRC NEVADA, INC.

MEMORANDUM

TO: Mr. Amir Soltani

FROM: Bruce J. Buttner BJB

SUBJECT: Meeting with National Park Service

DATE: May 10, 1993

WRC FILE: 2016/7 NDOT

A meeting was held at the National Park Service (NPS) in Boulder City on May 6, 1993. The purpose of the meeting was to discuss the berming/channel excavation that is proposed along the north side of SR 163 from approximately Station 785 to Station 871. The meeting was attended by Tracy Larkin (NDOT), Chris Miller (NDOT), James Vanderford (NPS), and Bruce Buttner (WRC). This memorandum summarizes discussions at the meeting.

PRELIMINARY DESIGN DRAWINGS

Bruce Buttner presented three preliminary drawings that related to the proposed berm (copies of the drawings are attached to this memorandum). The drawings are: 1) 1" = 100' scale NDOT plan/profile sheet that shows the approximate horizontal location of the berm from Station 'A8' 785+00 Lt. to Station 'A8' 797+00 Lt. 2) typical channel Section A-A at Station 'A8' 784+00 Lt.; and 3) typical channel/berm Section B-B at Station 'A8' 792+00 Lt.

The berm/channel concept is a measure that would prevent overtopping of SR 163 during a 100-year event and would keep the related runoff north of the road. If implemented NDOT would incur substantial cost savings associated with downstream drainage facilities. The berm has been designed to comply with the Federal Emergency Management Agency (FEMA) requirements which include 3-feet of available freeboard. It was explained that Section B-B represents a worst case situation wherein the top of berm is 3.5 to 4.5 feet above the road surface.

NPS COMMENTS REGARDING PLANS

1. On Section A-A, the existing NPS access road should be kept above the channel bottom. The road should be 9-feet wide, and constructed with native material. Where the road parallels the channel, the channel should have capacity to convey runoff from the 10-year event. NPS does not want a culvert beneath the road where it crosses the channel and does not feel any flood protection is needed for the road and its crossing of the channel.

2. NPS suggested that NDOT install a warning sign that advised motorists not to drive the road during times of flooding.

3. In the area where the channel ends (Station 'A8' 871+00± Lt.) the channel should fan out to better distribute the concentrated flow.

4. It was represented by Bruce Buttner that riprap may be loose or grouted. If it is to be grouted NPS asked that colored grout be used. It was agreed that colored grout would be acceptable to all. NPS will fax WRC their color specification.

5. The channel and berm must be covered with native topsoil and revegetated. It was agreed that the NDOT contractor would strip 6-inches of topsoil, stockpile it, and then spread the topsoil over the final berm/channel. If native topsoil is used NPS would not require any additional seeding.

   If native topsoil is not used then the berm/channel would have to be revegetated with native seeds. NDOT could retain a private firm to collect the seeds or buy the seeds from the NPS seed bank that was recently established.

   It was agreed that the best approach would be to re-distribute the native topsoil over the disturbed area.

OTHER ITEMS

1. Mr. Vanderford inquired about the berm/channel in respect to environmental compliance. Ms. Larkin stated that she would look into its effect on the 404 Permit and the 4F Statement and if necessary make the appropriate revisions to these documents.

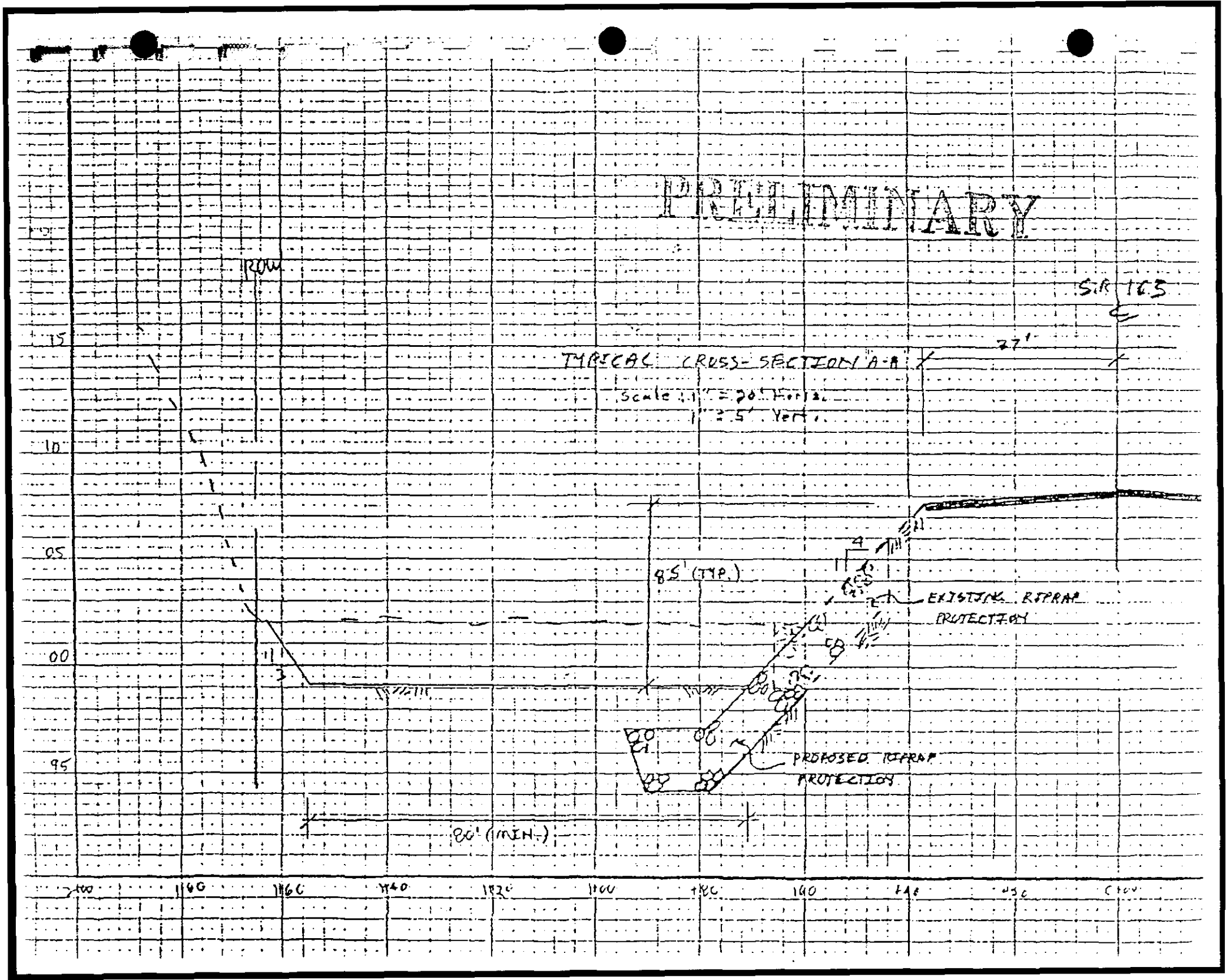
2. NDOT will submit a set of final plans and specifications to NPS for their records.

BJB/mag

Attachments

cc: Ms. Tracy Larkin
Mr. Chris Miller
Mr. James Vanderford, *NPS*

PRELIMINARY



START SEC B-E TOP OF BERM 1-2' ABO ROAD

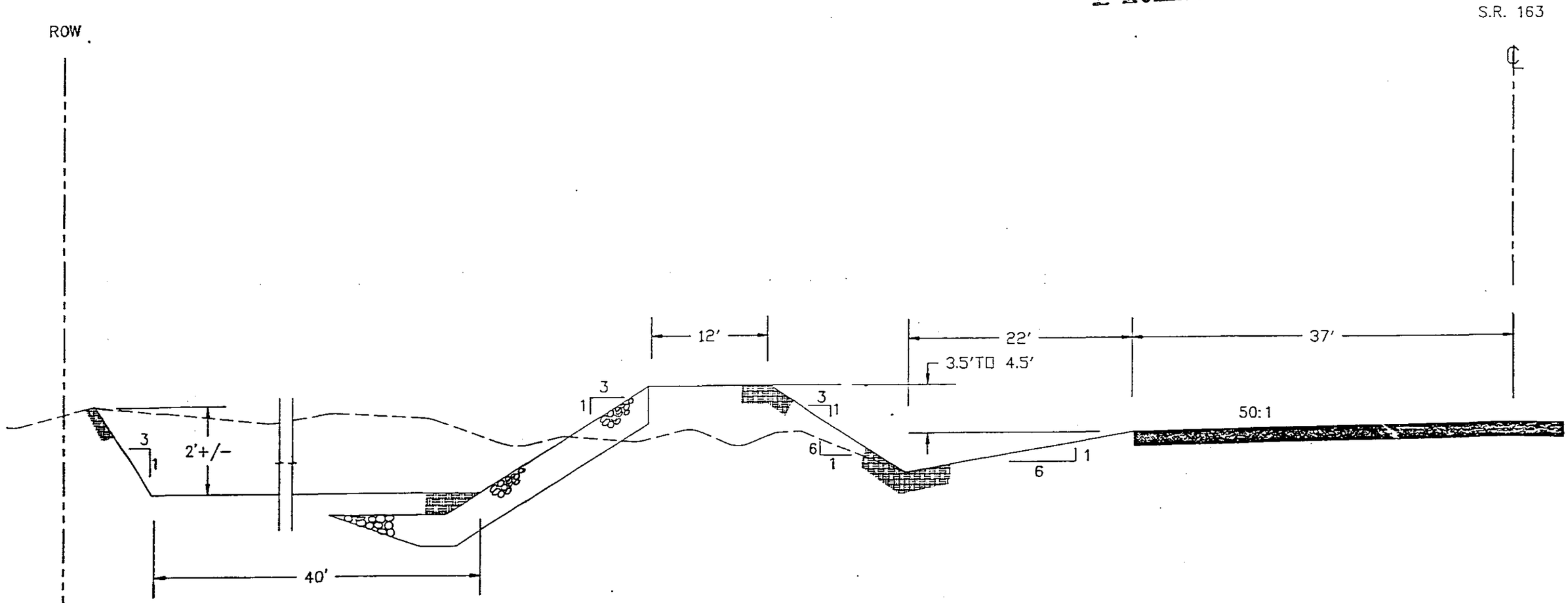
TOP OF BERM 3.5-4.5' ABOVE ROAD (MAX. HEIGHT ABOVE ROAD)

BERM STOPS AT STA 871+

SUPERELEVATION

PRELIMINARY

PRELIMINARY



TYPICAL CROSS-SECTION "B-B"

N.T.S.

WRC NEVADA, INC.

MEMORANDUM

TO: Messrs. Amir Soltani and Chris Miller

FROM: Alan J. Leak, P.E.

SUBJECT: S.R. 163 Outfall upstream of Casino Drive

DATE: May 12, 1993

WRC FILE: 2016/8 - NDOT P059-93-010

Per my recent discussions with Chris Miller, we have developed three alternatives for conveying the 50 year runoff along S.R. 163 from about station 1000+00 to about Station 1008+00. These alternatives, along with some subjective comparison evaluations are presented on the attached Table-1. Other issues not included in Table-1 that should be considered include:

1. If intersection geometry and ROW were finalized immediately or soon after bid, then the 84" RCP storm sewer would be the recommended alternative due to the minimal changes required to incorporate said storm sewer into the design and physical constraints.

2. The riprap and concrete channels would be more expensive to construct if the intersection is modified.

Considering all of the above factors, we would recommend constructing the 84" RCP storm sewer as the preferred alternative. Please review the enclosed information and advise us as to your preferred alternative.

If you have any questions, please call.

Attachment

AJL/kap

TABLE-1
ALTERNATIVE S.R. 163 OUTFALLS AT CASINO DRIVE

ALTERNATIVE	APPROXIMATE SIZE	AVAILABILITY OF MATERIALS	ESTIMATED COST ($1000)	COMPATIBILITY WITH REVISED INTERCHANGE	ADVANTAGES	DISADVANTAGES
Storm Sewer	84" RCP	Available with lead time.	300 TO 350	Pipe salvageable, inlet and upper 300 feet remains.	Minimize potential for erosion/reduced maintenance.	Large concrete inlet and energy dissipation structures (up to 20'W for 20 fps).
Concrete Channel	10'W x 2.5'D	Readily available	275 to 325	Not salvageable	Fairly small channel.	Large energy dissipation structure. Some barrier rail required. Safety issues due to high velocities (30 fps).
Riprap Channel	20'W x 3'D w/3:1 ss	Unknown. Costs reflect readily available riprap.	275 to 325	Riprap salvageable	Flexible in cross-section (side slopes to match ROW).	Significant barrier rail may be required. Not as stable as RCP or concrete.

STATE OF NEVADA

DEPARTMENT OF TRANSPORTATION

1263 S. Stewart Street
Carson City, Nevada 89712

5/21 5/21 File - 2016

BOB MILLER, *Governor*

May 12, 1993

GARTH F. DULL, *Director*

In Reply Refer to:

Mr. Andy Andrews, P.E.
Principal in Charge
WRC Nevada, Inc.
1660 S. Albion St. #500
Denver, CO 80222

SR 163, 71303-1
90% Complete
Hydraulic Design
Report Review

Dear Mr. Andrews:

The following comments are made following review of the 90% complete Hydraulic Design Report for Phase V SR 163 (P059-93-010). These comments have mostly already been discussed in telephone conversations with Alan Leak.

1. New onsite drainage pipes are indicated under the newly constructed highway between Stations "B" 800+00 and "B" 866+00. Flows for these pipes should be kept on the north side of SR 163 (piped under Dripping Springs Dike?) in order to avoid tearing up the new pavement.

2. At an NDOT meeting attended by Steve Oxoby, Fred Droes, Susan Martinovich, Daryl James, Amir Soltani and Chris Miller, it was decided that storm flows should not be piped under Casino Drive and into the Colorado River. These flows should instead be returned to their natural path as soon as possible upstream of Casino Drive. The flows will then sheet flow over Casino Drive as they have done in the past. The status of reconstructing the Casino Drive intersection remains uncertain. If the intersection is reconstructed, 50 year flows impacts to the intersection and surrounding properties will need to be analyzed and mitigated.

3. Type 5 embankment protectors are indicated in the roadside ditches left of "A8" 981+00 and right of "B" 984+00. In order to prevent clogging of these facilities, special grates (similar to those used for a Type 2A drop inlet) should be used.

4. In a telephone conversation with Alan Leak it was agreed that roadside and median ditch velocities should be kept to a maximum of 5 FPS with an assumed roughness coefficient of 0.035.

5. All roadside and median dikes within the clear zone should have side slopes of 10:1 or flatter.

Should you have any questions, please call me at 687-3799.

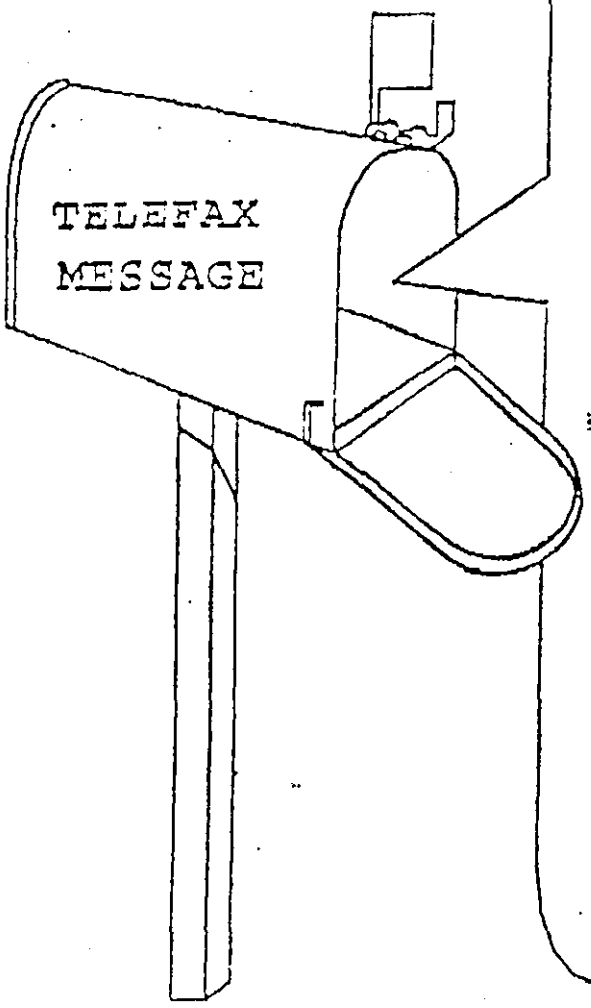
Sincerely,

Chris Miller
Hydraulic Engineer II

CM:lmg

cc: Tracy Larkin, Roadway Design
Eugene Weight, District Engineer, District I
Susan Martinovich, Roadway Design

DJD 5/12/93
AJL 5/13/93



Date: 5/12/93

To: BRUCE BUTTNER

From: JIM VANDERFORD

Subject: CONCRETE CURING

Number of pages + cover _____

Message: AS WE DISCUSSED WITH THE STATE OF NEVADA ON US 163

ANY QUESTIONS CALL ME AT 702-293-8925

, ASTM C94-84. Discharge concrete into forms
2 hours after introduction of water to cement.
rature of concrete is 85 degrees F or above, the
een introduction of water to cement and complete
ge of concrete into forms shall not exceed 45 minutes.
e manufacturer cannot meet these requirements, then the
er and cement shall be introduced into the mix at the
oject site.

2.2 PATCHING GROUT: Neat portland cement, water, and fine sand passing a No. 30 mesh sieve.

2.3 EXPANSION JOINT FILLERS: Pre-molded type, ANSI/ASTM D1751-83. Size, 1/2 inch by depth of slab minus 1/2 inch, manufacturered by W. R. Meadows, Inc., Elgin, Illinois, or approved equal.

2.4 CURING COMPOUND: ASTM C309-81, Type 1.

2.5 COLOR ADDITIVE: Davis Color, Yosemite Brown No. 641 and Jet Black No. 8084 by Davis Colors, 3700 E. Olympic Blvd., Los Angles, California, 90023, phone (213) 269-7311, or approved equal.

3.11 COLOR ADDITIVE: Provide for all concrete exposed to view. All exposed concrete shall have the same color additive mix. To each Cy.Yd. of concrete add 1.5 pounds of color no. 641, Yosemite brown, and also add 1/8 pound of black (no. 8084) per sack of cement. The concrete shall be mixed at agitation speed for 10 minutes.

3.4 PLACING: Place concrete on moistened subgrade monolithically between construction joints. Deposit to full depth in one operation. Consolidate immediately.

3.5 JOINTS: Construct all joints true to line with faces perpendicular to surface.

A. Isolation Joints: Separate walks from curbs and other structures, using expansion joint fillers.

APPENDIX - B

TECHNICAL SUPPORT DATA

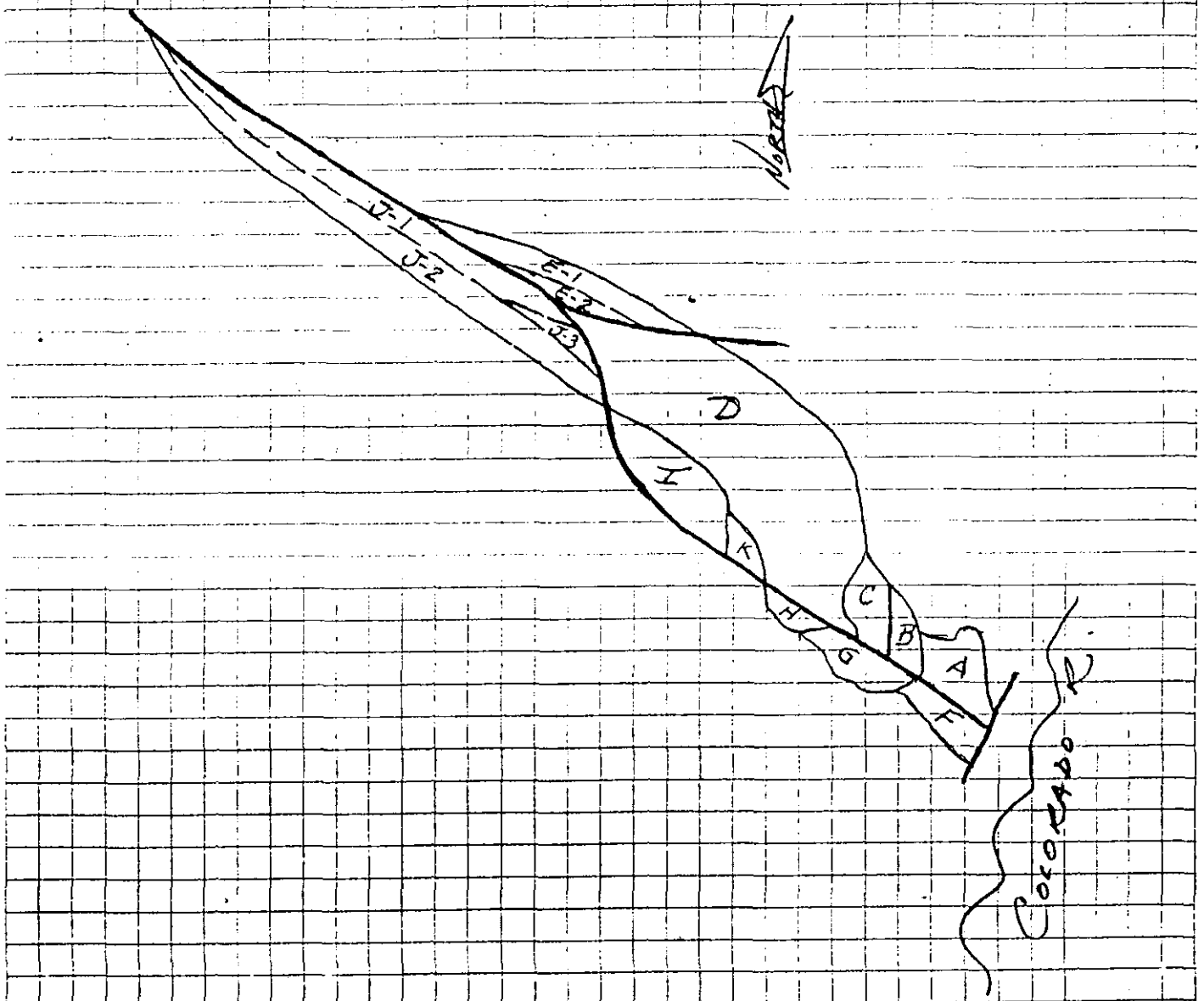
HYDROLOGIC CALCULATIONS

WRC NEVADA, INC.
CENTURY PARK
1771 EAST FLAMINGO ROAD–SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893–6266
FAX NO. (702) 893–6269

JOB NUMBER: 2016 SHEET 1 OF 9
JOB NAME: NDOT
CALC. BY: SGK DATE 4/13/95
CHKD. BY: _____ DATE __/__/__
REV. BY: _____ DATE __/__/__

SUBJECT: _____

SKETCH MAP



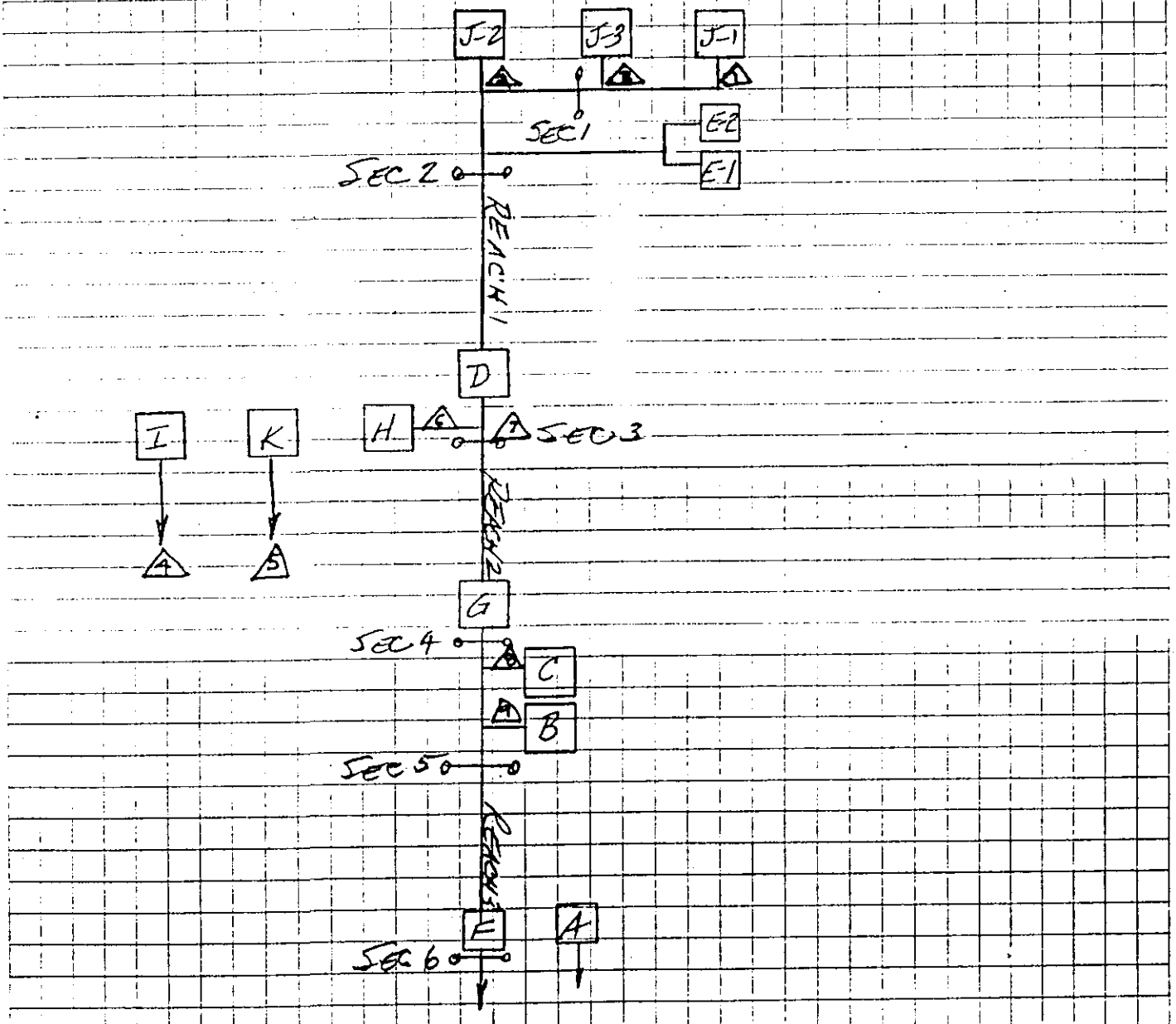
WRC NEVADA, INC.
CENTURY PARK
1771 EAST FLAMINGO ROAD–SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893–6266
FAX NO. (702) 893–6269

JOB NUMBER: 2016 SHEET 2 OF 9
JOB NAME: NDOT
CALC. BY: [illegible] DATE 4/12/92
CHKD. BY: _____ DATE __/__/__
REV. BY: _____ DATE __/__/__

SUBJECT: _____

SCHEMATIC

FILE; DRPSPR.DAT



WRC NEVADA, INC.
CENTURY PARK
1771 EAST FLAMINGO ROAD–SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893-6266
FAX NO. (702) 893-6269

JOB NUMBER: 2016 SHEET 3 OF 9
JOB NAME: NDOT
CALC. BY: [illegible] DATE 4/13/22
CHKD. BY: _____ DATE __/__/__
REV. BY: _____ DATE __/__/__

SUBJECT: _____

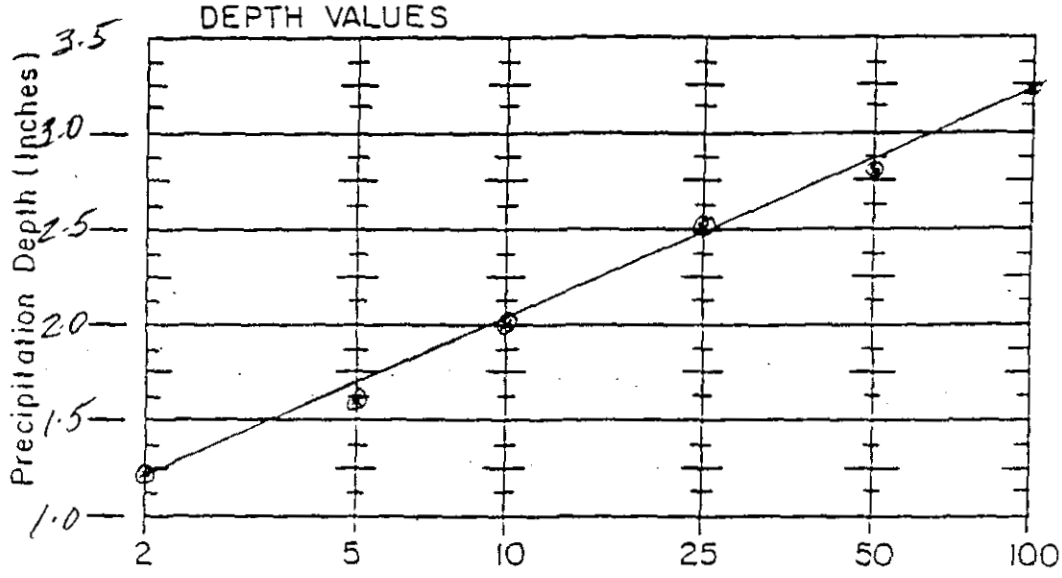
6-Hr. Rainfall Data (Point).

Freq (Yrs)	Depth (In) NOAA	Line Value (In)	Adj Fact 1/	Adj Value (In)
2 Yr.	1.20	1.20	1.00	1.20
5 Yr.	1.60	1.70	1.16	1.97
10 Yr.	2.00	2.05	1.24	2.54
25 Yr.	2.50	2.50	1.33	3.33
50 Yr.	2.80	2.85	1.39	3.96
100 Yr.	3.20	5.20	1.43	4.58

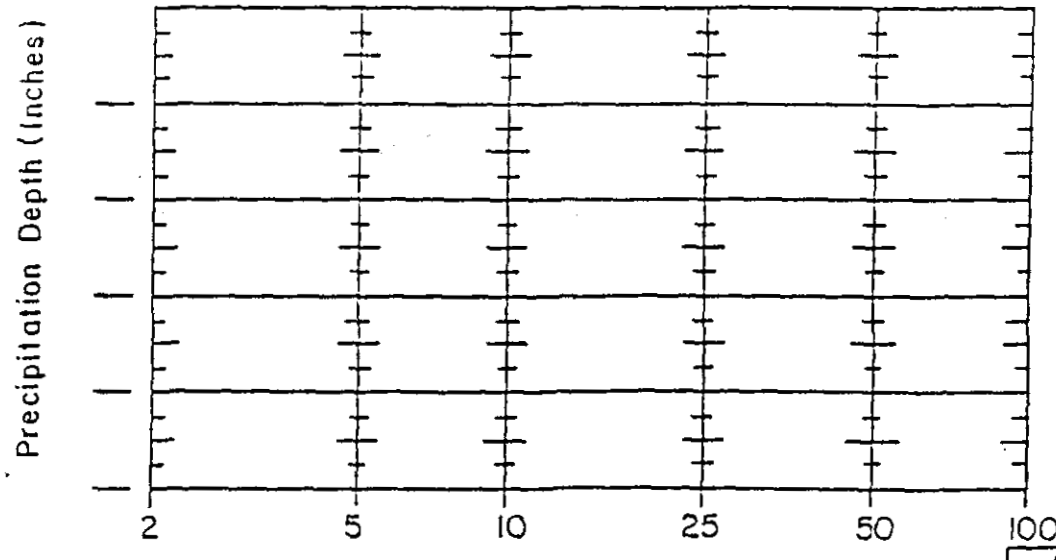
1/ Adjustment to NOAA Data Using CCRFCD TBL 501

PRECIPITATION DEPTH VERSUS RETURN PERIOD

A. PLOT OF 6-HOUR AND 24-HOUR PRECIPITATION DEPTH VALUES



B. PLOT OF 1-HOUR PRECIPITATION DEPTH VALUES



Revision	Date

REFERENCE: NOAA ATLAS 2, VOLUME VII NEVADA, 1973

STANDARD FORM 3

PRECIPITATION ADJUSTMENT RATIOS

Recurrence Interval	Ratio to NOAA Atlas 2
2-year	1.00
5-year	1.16
10-year	1.24
25-year	1.33
50-year	1.39
100-year	1.43

NOTE:
1. Multiply the values obtained from the NOAA Atlas 2 by the above ratios to obtain the adjusted precipitation values.
2. NOAA Atlas 2 values for use with TR-55 shall not be adjusted by the above ratios.
3. Tables 505 and 506 require no adjustments.

Revision	Date

SIX HOUR DEPTH-AREA REDUCTION FACTORS

Drainage Area (Square Miles)	Six-Hour Depth-Area Reduction Factor
0.0	1.00
0.5	0.98
1.0	0.97
2.0	0.93
4.0	0.91
6.0	0.90
8.0	0.88
10.0	0.86
20.0	0.79
30.0	0.74
50.0	0.68
100.0	0.60
150.0	0.55
200.0	0.51
300.0	0.46
400.0	0.42
500.0	0.39

NOTES:
1. A graphical representation of these factors is presented in Figure 514.
2. Consult with the local entity and/or the CCRFCD for guidance in using the Depth-Area Reduction Factors for drainage areas greater than 200 square miles.

Revision	Date

SIX-HOUR STORM DISTRIBUTIONS

Storm Time (In Minutes)	Percent of Total Storm Depth SDN 3	SDN 5	Storm Time (In Minutes)	Percent of Total Storm Depth SDN 3	SDN 5
0	0.00	0.00	185	32.20	43.00
5	2.00	2.00	190	35.20	47.70
10	5.70	5.90	195	40.90	51.40
15	7.00	8.00	200	49.90	56.10
20	8.70	11.00	205	59.00	63.00
25	10.80	14.40	210	71.00	71.00
30	12.40	15.00	215	74.40	72.00
35	13.00	16.00	220	78.10	73.10
40	13.00	16.80	225	81.20	75.20
45	13.00	17.10	230	81.90	77.90
50	13.00	18.00	235	83.50	79.00
55	13.00	18.20	240	85.10	79.50
60	13.00	18.70	245	85.60	80.40
65	13.30	19.00	250	86.00	81.00
70	14.00	19.70	255	86.80	82.00
75	14.20	20.20	260	87.60	82.60
80	14.80	21.00	265	88.80	84.00
85	15.80	22.00	270	91.00	85.90
90	17.20	23.00	275	92.60	88.90
95	18.10	24.10	280	93.70	91.00
100	19.00	25.00	285	95.00	93.80
105	19.70	25.90	290	97.00	96.60
110	19.90	26.50	295	97.60	97.00
115	20.00	28.00	300	98.20	97.40
120	20.10	29.00	305	98.50	97.90
125	20.40	30.00	310	98.70	98.10
130	21.40	30.50	315	98.90	98.30
135	22.90	30.90	320	99.00	98.50
140	24.10	31.00	325	99.30	98.90
145	24.90	31.70	330	99.30	99.00
150	25.10	32.10	335	99.40	99.20
155	25.60	32.70	340	99.50	99.30
160	27.00	33.30	345	99.80	99.60
165	27.80	34.60	350	99.80	99.70
170	28.10	36.10	355	99.90	99.90
175	28.30	38.10	360	100.00	100.00
180	29.50	40.80			

Notes:
1. For drainage areas less than 10 square miles in size, use SDN 3.
2. For drainage areas equal to or greater than 10 square miles in size, use SDN 5.
3. A graphical representation of these values is presented on Figure 515.

Revision	Date

WRC NEVADA, INC.
CENTURY PARK
1771 EAST FLAMINGO ROAD–SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893–6266
FAX NO. (702) 893–6269

JOB NUMBER: [illegible] SHEET [illegible] OF [illegible]
JOB NAME: NDOT
CALC. BY: AWK DATE 4/15/93
CHKD. BY: _____ DATE __/__/__
REV. BY: _____ DATE __/__/__

SUBJECT: _____

CHANNEL REACH ROUTING (KINEMATIC WAVE)
RK RECORD – HEC1

REACH	LENGTH (FT)	ΔH (FT)	SLOPE (FT/FT)	BW (FT)	Z
(THRU 1 D)	5600	220	.039	200	4
(THRU 2 G)	2000	50	.025	200	4
(THRU 3 F)	600	24	.040	100	4

TRAP SHAPE

n = 0.040

WRC NEVADA, INC.
CENTURY PARK
1771 EAST FLAMINGO ROAD—SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893-6266
FAX NO. (702) 893-6269

JOB NUMBER: 6016 SHEET 1 OF

JOB NAME: S.R. 163

CALC. BY: AJL DATE 5/11/93

CHKD. BY: DATE /__/__

REV. BY: DATE /__/__

SUBJECT: Check of CN factors for off-site basins

Sub-basin		Area(AC)	CN	CNA	Composite CN	K
A	Pavement	.51	98	49.98		
	Natural	2.94	63	185.22		
		3.45		235.2	68	.51
B	Pavement	0.5	98	49.98		
	Natural	14.0	63	882		
		14.5		931.98	64	.45
C		Minimal pavement impact			63	.44
D		Minimal pavement impact			63	.44
E-1	Pavement	0.8	98	78.4		
	Natural	32.1	63	2022.3		
		32.9		2100.7	64	.45
E-2	Pavement	1.07	98	104.86		
	Natural	3.56	63	224.28		
		4.63		329.14	71	.55
F	Pavement	0.48	98	47.04		
	Natural	3.02	63	190.26		
		3.50		237.30	68	.51
G	Pavement	1.9	98	186.2		
	Natural	35.3	63	2223.9		
		37.2		2410.1	65	.47
H	Pavement	1.16	98	113.68		
	Natural	8.33	62	524.79		
		9.49		638.47	67	.49
I	Pavement	2.2	98	215.6		
	Natural	32.6	63	2053.8		
		34.8		2269.4	65	.47

WRC NEVADA, INC.
CENTURY PARK
1771 EAST FLAMINGO ROAD–SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893-6266
FAX NO. (702) 893-6269

JOB NUMBER: [illegible] SHEET __ OF __
JOB NAME: S.R. 163
CALC. BY: AR DATE 5/11/90
CHKD. BY: ____ DATE __/__/__
REV. BY: ____ DATE __/__/__

SUBJECT: check of CN factors for offsite basins

Sub-basin		Area (Ac)	CN	CN A	Composite CN	K
J-1	Pavement	10	98	980		
	Natural	139	63	8757		
		149		9737	65	.47
J-2		Normal pavement Impact			63	.44
J-3	Pavement	0.4	98	39.2		
	Natural	15.6	63	982.8		
		16.0		1022	64	.45
K	Pavement	.41	98	40.13		
	Natural	2.72	63	171.36		
		3.13		211.5±	68	.57

CALCULATED BY: AJL

DATE: 5/11/93

CHECKED BY: Check of Log values

STANDARD FORM SF-8

TIME OF CONCENTRATION

JOB NO: 9016

PROJECT: S.R. 163

Ti=1.8(1.1-K)*SQRT(L)/(S)^1/3 Tc = Ti + Tt

	SUB-BASIN DATA			INITIAL / OVERLAND TIME (Ti)			TRAVEL TIME (Tt)				Tc CHECK (URBANIZED BASINS)			FINAL Tc	REMARKS
	DESIG	AREA AC	K	LENGTH FT	SLOPE %	Ti MIN	LENGTH FT	SLOPE %	VEL FPS	Tt MIN	COMP Tc	LENGTH FT	Tc= (L/180)+10	MIN	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1	A	3.45	.57	100	12	4.6	750	7.1	7.4	2.3				6.9	
2	B	19.5	.45	250	19	6.9	1150	11.6	6.8	2.9				9.7	
3	C	25.8	.44	150	2.7	10.4	2050	7.0	5.3	6.4				16.8	
4	D	4.41	.47	100	8	5.9	8300	3.8	3.9	35.5				41.4	
5	F-1	3.29	.45	150	4	9.0	1050	3.9	4.0	16.9				25.9	
6	F-2	4.63	.55	200	4	8.8	1200	4.2	4.1	4.9				13.7	
7	F	3.50	.51	100	16	4.2	650	4.0	4.0	2.7				6.9	
8	G	37.2	.47	100	8	5.7	2600	3.8	3.9	11.1				16.8	
9	H	9.49	.49	100	10	5.1	1300	7.1	5.4	4.0				9.1	
10	J	34.8	.47	100	6	6.2	2500	3.7	3.8	11.0				17.2	
11	J-1	14.9	.47	250	5	10.5	11750	4.8	4.4	44.5				55	
12	J-2	2.79	.44	100	4	7.5	13900	4.7	4.3	53.9				61.4	
13	J-3	16.0	.45	100	8	5.9	2400	4.1	4.1	9.8				15.7	
14	K	3.13	.51	100	6	5.8	550	3.8	3.9	2.4				8.2	
15															
16															
17															

WRC FORM 106

WRC NEVADA, INC.
CENTURY PARK
1771 EAST FLAMINGO ROAD–SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893–6266
FAX NO. (702) 893–6269

JOB NUMBER: 6016 SHEET 1 OF ____
JOB NAME: S.R. 163
CALC. BY: AJL DATE 5/11/93
CHKD. BY: ____ DATE __/__/__
REV. BY: ____ DATE __/__/__

SUBJECT: Check of CN factors for off-site basins

Sub-basin		Area(AC)	CN	CNA	Composite CN	K
A	Pavement	.51	98	49.98		
	Natural	2.94	63	185.22		
		3.45		235.2	68	.51
B	Pavement	1.5	98	49.98		
	Natural	14.0	63	882		
		14.5		931.98	64	.45
C		Minimal pavement impact			63	.44
D		Minimal pavement impact			63	.44
E-1	Pavement	5.8	98	78.4		
	Natural	33.1	63	2022.3		
		38.9		2100.7	64	.45
E-2	Pavement	1.07	98	104.86		
	Natural	3.56	63	224.28		
		4.63		329.14	71	.55
F	Pavement	0.48	98	47.04		
	Natural	3.02	63	190.26		
		3.50		237.30	68	.51
G	Pavement	1.9	98	186.2		
	Natural	35.3	63	2223.9		
		37.2		2410.1	65	.47
H	Pavement	1.16	98	113.68		
	Natural	8.33	63	524.79		
		0.49		638.47	67	.49
I	Pavement	2.2	98	215.6		
	Natural	32.6	63	2053.8		
		34.8		2269.4	65	.47

WRC NEVADA, INC.
CENTURY PARK
1771 EAST FLAMINGO ROAD–SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893–6266
FAX NO. (702) 893–6269

JOB NUMBER: 2016 SHEET 3 OF ___
JOB NAME: S.R. 163
CALC. BY: FT DATE 5 / 11 / 90
CHKD. BY: ___ DATE ___ / ___ / ___
REV. BY: ___ DATE ___ / ___ / ___

SUBJECT: Check of CN factors for offsite basins

Sub-basin		Area(Ac)	CN	CN A	Composite CN	K
J-1	Pavement	10	98	980		
	Natural	139	63	8757		
		149		9737	65	.47
J-2		Minimal Pavement Impact			63	.44
J-3	Pavement	9.4	98	39.2		
	Natural	15.6	63	932.8		
		16.9		1022.	64	.45
K	Pavement	.4	98	49.3		
	Natural	8.7	63	1-1.35		
		3.13		611.54	68	.51

WRC NEVADA, INC.
CENTURY PARK
1771 EAST FLAMINGO ROAD–SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893–6266
FAX NO. (702) 893–6269

JOB NUMBER: 2016 SHEET 8 OF 9
JOB NAME: NDOT
CALC. BY: JKC DATE 4/15/93
CHKD. BY: _____ DATE __/__/__
REV. BY: _____ DATE __/__/__

SUBJECT: _____

LAG COMPUTATIONS (CORRECD EQUA. 613)

AREA (Sq. Mi)	L (Mi.)	Lc (Mi.)	S (Ft/Mi)	Kn	LAG (Hrs)	SUBBASIN ID
.005	0.16	0.08	375 (7.1%)	.04	.07	A
.023	0.27	0.13	611 (11.6%)		.09	B
.040	0.42	0.27	371 (7.0%)		.15	C
.089	1.59	0.76	201 (3.8%)		.35	D
.051	0.80	0.34	207 (3.9%)		.22	E1
.007	0.27	0.10	222 (4.2%)		.10	E2
.005	0.14	0.12	214 (4.0%)		.09	F
.058	0.51	0.29	200 (3.8%)		.18	G
.015	0.26	0.12	377 (7.1%)		.10	H
.054	0.49	0.23	196 (3.7%)		.16	I
.233	2.27	1.21	255 (4.8%)		.45	J1
.436	2.65	1.06	249 (4.7%)		.45	J2
.025	0.47	0.27	217 (4.1%)		.17	J3
.005	0.12	0.06	200 (3.8%)		.07	K
1.646						

CORRECTED EQUA 613 $T_{LAG} = 20 K_n (L L_c / S^{.05})^{0.33}$

L = GREATEST HYD LENGTH – MI
Lc = LENGTH TO CENTROID – MI
S = AVG SLOPE = $\Delta H/L$ – FT/MI
K_n = MANN ROUGHNESS OF CHANNELS = 0.040

CALCULATED BY: AJZ

DATE: 5/11/93

CHECKED BY: Check of Lag values

STANDARD FORM SF-8

TIME OF CONCENTRATION

JOB NO: 9016

PROJECT: S.R. 163

Ti=1.8(1.1-K)SQRT(L)/(S) ^ 1/3 Tc = Ti + Tt

	SUB-BASIN DATA			INITIAL / OVERLAND TIME (Ti)			TRAVEL TIME (Tt)				Tc CHECK (URBANIZED BASINS)			FINAL Tc	REMARKS
	DESIG	AREA AC	K	LENGTH FT	SLOPE %	Ti MIN	LENGTH FT	SLOPE %	VEL FPS	Tt MIN	COMP Tc	LENGTH FT	Tc= (L/180)+10	MIN	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1	A	3.45	.51	100	12	4.6	[illegible]	7.1	[illegible]	[illegible]				6.9	
2	B	14.5	.45	250	19	6.9	1150	11.6	[illegible]	[illegible]				9.7	
3	C	25.8	.44	150	2.7	10.4	[illegible]	7.0	[illegible]	[illegible]				16.8	
4	D	4.41	.47	100	8	5.9	8300	3.8	[illegible]	[illegible]				[illegible]	
5	E-1	32.9	.45	150	4	9.0	[illegible]	3.9	[illegible]	[illegible]				25.9	
6	E-2	4.63	.55	200	4	6.8	1200	4.2	[illegible]	[illegible]				13.7	
7	F	3.50	.51	100	16	4.2	[illegible]	4.0	[illegible]	[illegible]				6.4	
8	G	37.2	.47	100	8	5.7	2600	3.8	[illegible]	[illegible]				16.9	
9	H	9.49	.49	100	10	5.1	1300	7.1	[illegible]	[illegible]				9.1	
10	I	34.8	.47	100	6	6.2	2500	3.7	[illegible]	[illegible]				17.2	
11	J-1	149	.47	250	5	10.5	11750	4.8	4.4	44.5				55	
12	J-2	27.9	.44	100	4	7.5	[illegible]900	4.7	[illegible]	[illegible]				61.4	
13	J-3	16.0	.45	100	8	5.9	[illegible]00	4.1	[illegible]	[illegible]				[illegible]	
14	K	3.13	.51	100	6	5.8	650	3.8	3.9	[illegible]				6.2	
15															
16															
17															

WRC FORM 106

```
17        ID              4                .91
18        ID              3                .92
19        ID              2                .93
20        ID              1                .97
21        ID              0.5              .98
22        ID              0               1.00
23        ID     CN's BASED ON FAIR TO POOR DESERT VEGETATION
          *
24        IT     3.                  300.
25        IO     5.
26        IN     5.0
          *DIAGRAM
27        JR     PREC     .95     .98     .99    1.00
          *

28        KK   SUBJ1
29        KM   DRIPPING SPRINGS CANYON WASH - SUBBASIN J1 (N=0.04)
30        BA    .233
31        PB    4.58
32        PC     0.0    .020    .057    .070    .087    .108    .124    .130    .130    .130
33        PC    .130    .130    .130    .133    .140    .142    .148    .158    .172    .181
34        PC    .190    .197    .199    .200    .201    .204    .214    .229    .241    .249
35        PC    .251    .256    .270    .278    .281    .283    .295    .322    .352    .409
36        PC    .499    .590    .710    .744    .781    .812    .819    .835    .851    .856
37        PC    .860    .868    .876    .888    .910    .926    .937    .950    .970    .976
38        PC    .982    .985    .987    .989    .990    .993    .993    .994    .995    .998
39        PC    .998    .999   1.00
40        LS             65.
41        UD    .45
          *

42        KK   SUBJ3
43        KM   DRIPPING SPRINGS CANYON WASH - SUBBASIN J3 (N=0.04)
44        BA    .025
45        LS             64.
46        UD    .17
          *
```



```
LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

47        KK   SEC1
48        KM   COMBINE AT SEC1
49        HC     2
          *

50        KK   SUBJ2
51        KM   DRIPPING SPRINGS CANYON WASH  - SUBBASIN J2 (N=0.04)
52        BA    .436
53        LS             63.
54        UD    .45
          *
```

```
1**************************************
*                                    *
*  FLOOD HYDROGRAPH PACKAGE (HEC-1)  *
*           SEPTEMBER 1990           *
*           VERSION 4.0              *
*                                    *
* RUN DATE 05/16/1993 TIME 22:31:43  *
*                                    *
**************************************
```


```
**************************************
*                                    *
*  U.S. ARMY CORPS OF ENGINEERS      *
*  HYDROLOGIC ENGINEERING CENTER     *
*       609 SECOND STREET            *
*     DAVIS, CALIFORNIA 95616        *
*         (916) 756-1104             *
*                                    *
**************************************
```


```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X       XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX  XXXXX          XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HECIGS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

```
LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

  1       ID  HEC-1 RUNOFF AND ROUTING INPUT FILE
  2       ID  DRIPPING SPRINGS CANYONS
  3       ID  100-YEAR 6-HOUR EVENT:
  4       ID     6-HR PRECIP DISTRIBUTION
  5       ID     STORM DISTRIBUTION NUMBER = 3
  6       ID     100-YEAR FREQUENCY 6-HOUR STORM = 4.58"
  7       ID     DEPTH-AREA ADJUSTMENT FACTORS (PER CCRFCD)
  8       ID          AREA(SQ MI)        FACTOR
  9       ID            20                .79
 10       ID            15                .82
 11       ID            10                .86
 12       ID             9                .87
 13       ID             8                .88
 14       ID             7                .89
 15       ID             6                .90
 16       ID             5                .905
```

```
55          KK  SUBJ1J2J3
56          KM  COMBINE SUB J1 J2 J3
57          HC      2
            *

58          KK  SUBE1
59          KM  DRIPPING SPRINGS WASH SUBASIN E1 (N=.04)
60          BA   .051
61          LS          64.
62          UD   .22
            *

63          KK  SUBE2
64          KM  DRIPPING SPRINGS WASH SUBASIN E2 (N=.04)
65          BA   .007
66          LS          71.
67          UD   .10
            *

68          KK  SEC 2
69          KM  COMBINE SUB E1 E2 J1 J2 J3 AT SEC 2
70          HC      3
            *

71          KK  REACH1
72          KM  ROUTE THRU SUBD
73          RK   5600   .039   .040          TRAP   200.    4.
            *

74          KK  SUBD
75          KM  DRIPPING SPRINGS WASH SUBBASIN D  (N=0.04)
76          BA   .689
77          LS          63.
78          UD   .35
            *

79          KK  SUBH
80          KM  DRIPPING SPRINGS WASH SUBBASIN H  (N=0.04)
81          BA   .015
82          LS          67.
83          UD   .10
            *
```



```
LINE        ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

84          KK  SEC3
85          KM  COMBINE SUB D AND H
86          HC      3
            *

87          KK  REACH2
88          KM  ROUTE THRU SUBG
```

```
 89          RK    2000    .025    .040           TRAP    200.      4.
             *

 90          KK   SUBG
 91          KM   DRIPPING SPRINGS WASH SUBBASIN G (N=0.04)
 92          BA    .058
 93          LS            65.
 94          UD     .18
             *

 95          KK   SEC4
 96          KM   COMBINE AT SEC4
 97          HC       2
             *

 98          KK   SUBC
 99          KM   DRIPPING SPRINGS WASH SUBBASIN C (N=0.04)
100          BA    .040
101          LS            63.
102          UD     .15
             *

103          KK   SEC4A
104          KM   COMBINE AT SEC4A
105          HC       2
             *

106          KK   SUBB
107          KM   DRIPPING SPRINGS WASH SUBBASIN B (N=0.04)
108          BA    .023
109          LS            64.
110          UD     .09
             *

111          KK   SEC5
112          KM   COMBINE AT SEC5
113          HC       2
             *

114          KK   REACH 3
115          KM   ROUTE THRU SUBF
116          RK     600    .040    .040           TRAP    100.      4.
             *
```



```
LINE         ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

117          KK   SUBF
118          KM   DRIPPING SPRINGS WASH SUBBASIN F (N=0.04)
119          BA    .005
120          LS            68.
121          UD     .09
             *
```

```
122          KK   SEC6
123          KM   COMBINE AT SEC6
124          HC      2
             *

125          KK   SUBA
126          KM   DRIPPING SPRINGS WASH SUBBASIN A (N=0.04)
127          BA    .005
128          LS             68.
129          UD    .07
             *

130          KK   SUBI
131          KM   DRIPPING SPRINGS WASH SUBBASIN I (N=0.04)
132          BA    .054
133          LS             65.
134          UD    .16
             *

135          KK   SUBK
136          KM   DRIPPING SPRINGS WASH SUBBASIN K (N=0.04)
137          BA    .005
138          LS             68.
139          UD    .07
140          ZZ
```

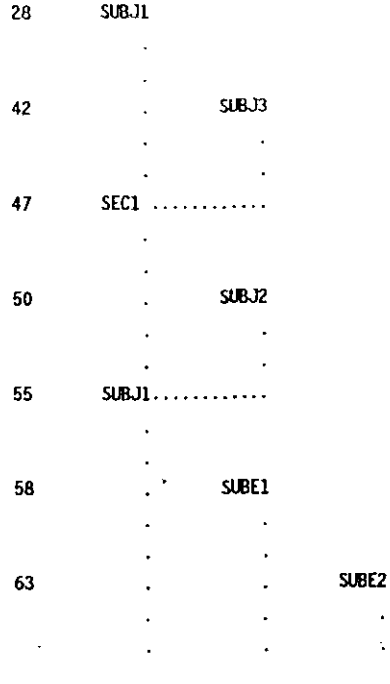
1

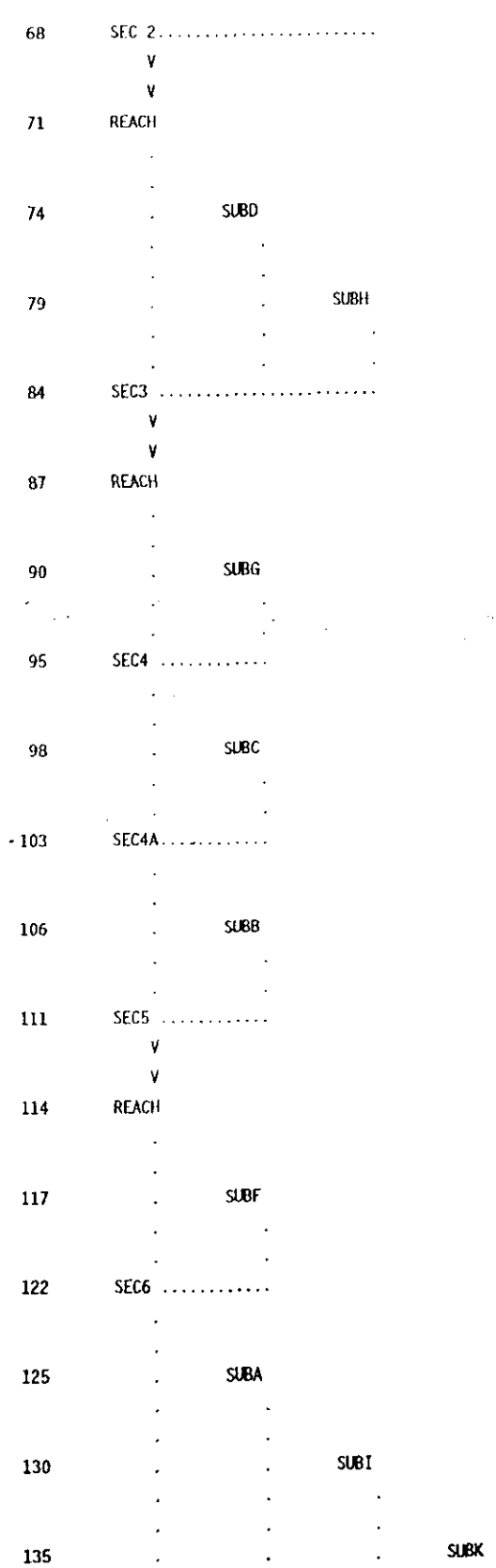
SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT LINE NO.

(V) ROUTING (---->) DIVERSION OR PUMP FLOW

(.) CONNECTOR (<----) RETURN OF DIVERTED OR PUMPED FLOW





(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
1*************************************
*                                   *
*  FLOOD HYDROGRAPH PACKAGE (HEC-1) *
*          SEPTEMBER 1990           *
*           VERSION 4.0             *
*                                   *
* RUN DATE 05/16/1993  TIME 22:31:43 *
*                                   *
*************************************
```


```
*************************************
*                                   *
*   U.S. ARMY CORPS OF ENGINEERS    *
*   HYDROLOGIC ENGINEERING CENTER   *
*        609 SECOND STREET          *
*      DAVIS, CALIFORNIA 95616      *
*          (916) 756-1104           *
*                                   *
*************************************
```


HEC-1 RUNOFF AND ROUTING INPUT FILE
DRIPPING SPRINGS CANYONS
100-YEAR 6-HOUR EVENT:
6-HR PRECIP DISTRIBUTION
STORM DISTRIBUTION NUMBER = 3
100-YEAR FREQUENCY 6-HOUR STORM = 4.58"
DEPTH-AREA ADJUSTMENT FACTORS (PER CCRFCD)

AREA(SQ MI)	FACTOR
20	.79
15	.82
10	.86
9	.87
8	.88
7	.89
6	.90
5	.905
4	.91
3	.92
2	.93
1	.97
0.5	.98
0	1.00

CN's BASED ON FAIR TO POOR DESERT VEGETATION

25 IO OUTPUT CONTROL VARIABLES

IPRNT	5	PRINT CONTROL
IPLOT	0	PLOT CONTROL
QSCAL	0.	HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA

NMIN		3	MINUTES IN COMPUTATION INTERVAL
IDATE	1	0	STARTING DATE
ITIME		0000	STARTING TIME
NQ		300	NUMBER OF HYDROGRAPH ORDINATES
NDDATE	1	0	ENDING DATE
NDTIME		1457	ENDING TIME
ICENT		19	CENTURY MARK

COMPUTATION INTERVAL .05 HOURS
TOTAL TIME BASE 14.95 HOURS

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

JP MULTI-PLAN OPTION
NPLAN 1 NUMBER OF PLANS

JR MULTI-RATIO OPTION
RATIOS OF PRECIPITATION
.95 .98 .99 1.00

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .95	RATIO 2 .98	RATIO 3 .99	RATIO 4 1.00
HYDROGRAPH AT								
+	SUBJ1	.23	1	FLOW	153.	164.	168.	172.
				TIME	3.95	3.95	3.95	3.95
HYDROGRAPH AT								
+	SUBJ3	.03	1	FLOW	25.	26.	27.	28.
				TIME	3.60	3.60	3.60	3.60
2 COMBINED AT								
+	SECI	.26	1	FLOW	165.	176.	180.	184.
				TIME	3.90	3.90	3.90	3.90
HYDROGRAPH AT								
+	SUBJ2	.44	1	FLOW	256.	275.	282.	289.
				TIME	3.95	3.95	3.95	3.95
2 COMBINED AT								
+	SUBJ1	.69	1	FLOW	419.	450.	461.	471.
				TIME	3.95	3.95	3.95	3.95
HYDROGRAPH AT								
+	SUBE1	.05	1	FLOW	45.	48.	50.	51.
				TIME	3.65	3.65	3.65	3.65
HYDROGRAPH AT								
+	SUBE2	.01	1	FLOW	12.	12.	13.	13.
				TIME	3.55	3.55	3.55	3.55

3 COMBINED AT								
+	SEC 2	.75	1	FLOW	450.	484.	495.	507.
				TIME	3.90	3.90	3.90	3.90
ROUTED TO								
+	REACH	.75	1	FLOW	447.	482.	492.	504.
				TIME	4.05	4.05	4.05	4.05
HYDROGRAPH AT								
+	SUBD	.69	1	FLOW	464.	499.	510.	522.
				TIME	3.85	3.85	3.85	3.85
HYDROGRAPH AT								
+	SUBH	.01	1	FLOW	21.	23.	23.	23.
				TIME	3.55	3.55	3.55	3.55
3 COMBINED AT								
+	SEC3	1.46	1	FLOW	843.	912.	936.	959.
				TIME	3.95	3.95	3.95	3.95
ROUTED TO								
+	REACH	1.46	1	FLOW	841.	910.	933.	957.
				TIME	4.00	4.00	4.00	4.00
HYDROGRAPH AT								
+	SUBG	.06	1	FLOW	59.	63.	64.	66.
				TIME	3.60	3.60	3.60	3.60
2 COMBINED AT								
+	SEC4	1.51	1	FLOW	863.	934.	957.	981.
				TIME	4.00	4.00	4.00	4.00
HYDROGRAPH AT								
+	SUBC	.04	1	FLOW	39.	42.	43.	44.
				TIME	3.60	3.60	3.60	3.60
2 COMBINED AT								
+	SEC4A	1.55	1	FLOW	876.	947.	971.	995.
				TIME	4.00	4.00	4.00	4.00
HYDROGRAPH AT								
+	SUBB	.02	1	FLOW	29.	31.	31.	32.
				TIME	3.55	3.55	3.55	3.55
2 COMBINED AT								
+	SEC5	1.58	1	FLOW	882.	954.	977.	1002.
				TIME	4.00	4.00	4.00	4.00
ROUTED TO								
+	REACH	1.58	1	FLOW	879.	952.	976.	1001.
				TIME	4.00	4.00	4.00	4.00
HYDROGRAPH AT								

+	SUBF	.00	1	FLOW	8.	8.	8.	8.
				TIME	3.55	3.55	3.55	3.55

2 COMBINED AT

+	SEC6	1.58	1	FLOW	880.	954.	978.	1003.
				TIME	4.00	4.00	4.00	4.00

HYDROGRAPH AT

+	SUBA	.00	1	FLOW	8.	8.	8.	9.
				TIME	3.50	3.50	3.50	3.50

HYDROGRAPH AT

+	SUBI	.05	1	FLOW	58.	62.	64.	65.
				TIME	3.60	3.60	3.60	3.60

HYDROGRAPH AT

+	SUBK	.00	1	FLOW	8.	8.	8.	9.
				TIME	3.50	3.50	3.50	3.50

1

SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

ISTAQ	ELEMENT	DT	PEAK	TIME TO PEAK	VOLUME	INTERPOLATED TO COMPUTATION INTERVAL DT	PEAK	TIME TO PEAK	VOLUME
		(MIN)	(CFS)	(MIN)	(IN)	(MIN)	(CFS)	(MIN)	(IN)
FOR PLAN = 1 RATIO= .95									
	REACH MANE	3.00	448.66	245.31	1.16	3.00	447.30	243.00	1.16

CONTINUITY SUMMARY (AC-FT) - INFLOW= .4669E+02 EXCESS= .0000E+00 OUTFLOW= .4669E+02 BASIN STORAGE= .1682E-01 PERCENT ERROR= .0

FOR PLAN = 1 RATIO= .98									
	REACH MANE	3.00	482.56	242.70	1.25	3.00	482.43	243.00	1.25

CONTINUITY SUMMARY (AC-FT) - INFLOW= .4999E+02 EXCESS= .0000E+00 OUTFLOW= .5000E+02 BASIN STORAGE= .2075E-01 PERCENT ERROR= -.1

FOR PLAN = 1 RATIO= .99									
	REACH MANE	3.00	492.42	242.11	1.28	3.00	492.41	243.00	1.27

CONTINUITY SUMMARY (AC-FT) - INFLOW= .5110E+02 EXCESS= .0000E+00 OUTFLOW= .5114E+02 BASIN STORAGE= .1737E-01 PERCENT ERROR= -.1

FOR PLAN = 1 RATIO= 1.00									
	REACH MANE	3.00	504.47	244.58	1.30	3.00	503.60	243.00	1.30

CONTINUITY SUMMARY (AC-FT) - INFLOW= .5222E+02 EXCESS= .0000E+00 OUTFLOW= .5225E+02 BASIN STORAGE= .1717E-01 PERCENT ERROR= -.1

FOR PLAN = 1 RATIO= .95

REACH									
	MANE	1.45	842.02	240.26	1.14	3.00	840.85	240.00	1.14

CONTINUITY SUMMARY (AC-FT) - INFLOW= .8873E+02 EXCESS= .0000E+00 OUTFLOW= .8871E+02 BASIN STORAGE= .1426E-01 PERCENT ERROR= .0

FOR PLAN = 1 RATIO= .98

REACH									
	MANE	1.42	910.82	239.91	1.22	3.00	910.48	240.00	1.23

CONTINUITY SUMMARY (AC-FT) - INFLOW= .9512E+02 EXCESS= .0000E+00 OUTFLOW= .9510E+02 BASIN STORAGE= .1439E-01 PERCENT ERROR= .0

FOR PLAN = 1 RATIO= .99

REACH									
	MANE	1.34	933.33	240.18	1.25	3.00	933.12	240.00	1.25

CONTINUITY SUMMARY (AC-FT) - INFLOW= .9724E+02 EXCESS= .0000E+00 OUTFLOW= .9720E+02 BASIN STORAGE= .1611E-01 PERCENT ERROR= .0

FOR PLAN = 1 RATIO= 1.00

REACH									
	MANE	1.35	958.41	239.70	1.28	3.00	956.69	240.00	1.28

CONTINUITY SUMMARY (AC-FT) - INFLOW= .9936E+02 EXCESS= .0000E+00 OUTFLOW= .9933E+02 BASIN STORAGE= .1554E-01 PERCENT ERROR= .0

FOR PLAN = 1 RATIO= .95

REACH									
	MANE	.42	880.76	240.78	1.15	3.00	878.53	240.00	1.15

CONTINUITY SUMMARY (AC-FT) - INFLOW= .9635E+02 EXCESS= .0000E+00 OUTFLOW= .9635E+02 BASIN STORAGE= .3156E-02 PERCENT ERROR= .0

FOR PLAN = 1 RATIO= .98

REACH									
	MANE	.40	952.98	240.48	1.23	3.00	952.21	240.00	1.23

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1033E+03 EXCESS= .0000E+00 OUTFLOW= .1033E+03 BASIN STORAGE= .3172E-02 PERCENT ERROR= .0

FOR PLAN = 1 RATIO= .99

REACH									
	MANE	.31	976.75	240.44	1.26	3.00	975.89	240.00	1.26

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1056E+03 EXCESS= .0000E+00 OUTFLOW= .1056E+03 BASIN STORAGE= .3181E-02 PERCENT ERROR= .0

FOR PLAN = 1 RATIO= 1.00

REACH									
	MANE	.35	1001.42	240.32	1.28	3.00	1001.23	240.00	1.28

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1079E+03 EXCESS= .0000E+00 OUTFLOW= .1079E+03 BASIN STORAGE= .3168E-02 PERCENT ERROR= .0

*** NORMAL END OF HEC-1 ***

```
1*************************************
*                                   *
*  FLOOD HYDROGRAPH PACKAGE (HEC-1) *
*           SEPTEMBER 1990          *
*            VERSION 4.0            *
*                                   *
* RUN DATE 05/12/1993 TIME 23:51:09 *
*                                   *
*************************************
```


```
*************************************
*                                   *
*   U.S. ARMY CORPS OF ENGINEERS    *
*   HYDROLOGIC ENGINEERING CENTER   *
*         609 SECOND STREET         *
*       DAVIS, CALIFORNIA 95616     *
*         (916) 756-1104            *
*                                   *
*************************************
```


```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X       XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

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KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

LINE	ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
1	ID HEC-1 RUNOFF AND ROUTING INPUT FILE
2	ID DRIPPING SPRINGS CANYONS
3	ID 50-YEAR 6-HOUR EVENT:
4	ID 6-HR PRECIP DISTRIBUTION
5	ID STORM DISTRIBUTION NUMBER = 3
6	ID 50-YEAR FREQUENCY 6-HOUR STORM = 3.96"
7	ID DEPTH-AREA ADJUSTMENT FACTORS (PER CCRFCD)
8	ID *AREA(SQ MI)* *FACTOR*
9	ID 20 .79
10	ID 15 .82
11	ID 10 .86
12	ID 9 .87
13	ID 8 .88
14	ID 7 .89
15	ID 6 .90
16	ID 5 .905

```
17          ID              4               .91
18          ID              3               .92
19          ID              2               .93
20          ID              1               .97
21          ID              0.5             .98
22          ID              0              1.00
23          ID      CN's BASED ON FAIR TO POOR DESERT VEGETATION
            •
24          IT      3.                  300.
25          IO      5.
26          IN     5.0
            *DIAGRAM
27          JR     PREC     .95     .98     .99    1.00
            *

28          KK   SUBJ1
29          KM   DRIPPING SPRINGS CANYON WASH - SUBBASIN J1 (N=0.04)
30          BA    .233
31          PB   3.96
32          PC    0.0    .020    .057    .070    .087    .108    .124    .130    .130    .130
33          PC   .130    .130    .130    .133    .140    .142    .148    .158    .172    .181
34          PC   .190    .197    .199    .200    .201    .204    .214    .229    .241    .249
35          PC   .251    .256    .270    .278    .281    .283    .295    .322    .352    .409
36          PC   .499    .590    .710    .744    .781    .812    .819    .835    .851    .856
37          PC   .860    .868    .876    .888    .910    .926    .937    .950    .970    .976
38          PC   .982    .985    .987    .989    .990    .993    .993    .994    .995    .998
39          PC   .998    .999   1.00
40          LS            65.
41          UD    .45
            *

42          KK   SUBJ3
43          KM   DRIPPING SPRINGS CANYON WASH - SUBBASIN J3 (N=0.04)
44          BA    .025
45          LS            64.
46          UD    .17
            *
```



```
LINE        ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10


47          KK   SEC1
48          KM   COMBINE AT SEC1
49          HC      2
            •

50          KK   SUBJ2
51          KM   DRIPPING SPRINGS CANYON WASH  - SUBBASIN J2 (N=0.04)
52          BA    .436
53          LS            63.
54          UD    .45
            *
```

```
55          KK  SUBJ1J2J3
56          KM  COMBINE SUB J1 J2 J3
57          HC      2
            *

58          KK  SUBE1
59          KM  DRIPPING SPRINGS WASH SUBASIN E1 (N=.04)
60          BA   .051
61          LS          64.
62          UD   .22
            *

63          KK  SUBE2
64          KM  DRIPPING SPRINGS WASH SUBASIN E2 (N=.04)
65          BA   .007
66          LS          71.
67          UD   .10
            *

68          KK  SEC 2
69          KM  COMBINE SUB E1 E2 J1 J2 J3 AT SEC 2
70          HC      3
            *

71          KK  REACH1
72          KM  ROUTE THRU SUBD
73          RK   5600   .039   .040          TRAP   200.     4.
            *

74          KK  SUBD
75          KM  DRIPPING SPRINGS WASH SUBBASIN D  (N=0.04)
76          BA   .689
77          LS          63.
78          UD   .35
            *

79          KK  SUBH
80          KM  DRIPPING SPRINGS WASH SUBBASIN H  (N=0.04)
81          BA   .015
82          LS          67.
83          UD   .10
            *
```



```
LINE        ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

84          KK  SEC3
85          KM  COMBINE SUB D AND H
86          HC      3
            *

87          KK  REACH2
88          KM  ROUTE THRU SUBG
```

```
 89          RK    2000    .025    .040          TRAP    200.      4.
             *

 90          KK   SUBG
 91          KM   DRIPPING SPRINGS WASH SUBBASIN G (N=0.04)
 92          BA    .058
 93          LS            65.
 94          UD     .18
             *

 95          KK   SEC4
 96          KM   COMBINE AT SEC4
 97          HC       2
             *

 98          KK   SUBC
 99          KM   DRIPPING SPRINGS WASH SUBBASIN C (N=0.04)
100          BA    .040
101          LS            63.
102          UD     .15
             *

103          KK   SEC4A
104          KM   COMBINE AT SEC4A
105          HC       2
             *

106          KK   SUBB
107          KM   DRIPPING SPRINGS WASH SUBBASIN B (N=0.04)
108          BA    .023
109          LS            64.
110          UD     .09
             *

111          KK   SEC5
112          KM   COMBINE AT SEC5
113          HC       2
             *

114          KK   REACH 3
115          KM   ROUTE THRU SUBF
116          RK     600    .040    .040          TRAP    100.      4.
             *
```



```
LINE         ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

117          KK   SUBF
118          KM   DRIPPING SPRINGS WASH SUBBASIN F (N=0.04)
119          BA    .005
120          LS            68.
121          UD     .09
             *
```

```
122          KK  SEC6
123          KM  COMBINE AT SEC6
124          HC      2
             *

125          KK  SUBA
126          KM  DRIPPING SPRINGS WASH SUBBASIN A (N=0.04)
127          BA   .005
128          LS           68.
129          UD    .07
             *

130          KK  SUBI
131          KM  DRIPPING SPRINGS WASH SUBBASIN I (N=0.04)
132          BA   .054
133          LS           65.
134          UD    .16
             *

135          KK  SUBK
136          KM  DRIPPING SPRINGS WASH SUBBASIN K (N=0.04)
137          BA   .005
138          LS           68.
139          UD    .07
140          ZZ
```

I

SCHEMATIC DIAGRAM OF STREAM NETWORK

```
INPUT
 LINE     (V) ROUTING          (--->) DIVERSION OR PUMP FLOW
  NO.     (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   28     SUBJ1
             .
             .
   42        .       SUBJ3
             .          .
             .          .
   47     SEC1 ..........
             .
             .
   50        .       SUBJ2
             .          .
             .          .
   55     SUBJ1..........
             .
             .
   58        .       SUBE1
             .          .
             .          .
   63        .          .       SUBE2
             .          .          .
             .          .          .
```

```
 68      SEC 2.....................
             V
             V
 71      REACH
             .
             .
 74          .       SUBD
             .          .
             .          .
 79          .          .       SUBH
             .          .          .
             .          .          .
 84      SEC3 .....................
             V
             V
 87      REACH
             .
             .
 90          .       SUBG
             .          .
             .          .
 95      SEC4 ............
             .
             .
 98          .       SUBC
             .          .
             .          .
103      SEC4A............
             .
             .
106          .       SUBB
             .          .
             .          .
111      SEC5 ............
             V
             V
114      REACH
             .
             .
117          .       SUBF
             .          .
             .          .
122      SEC6 ............
             .
             .
125          .       SUBA
             .          .
             .          .
130          .          .       SUBI
             .          .          .
             .          .          .
135          .          .          .       SUBK
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
1*************************************
*                                   *
*  FLOOD HYDROGRAPH PACKAGE (HEC-1) *
*        SEPTEMBER 1990             *
*         VERSION 4.0               *
*                                   *
* RUN DATE 05/12/1993 TIME 23:51:09 *
*                                   *
*************************************
```


```
*************************************
*                                   *
*  U.S. ARMY CORPS OF ENGINEERS     *
*  HYDROLOGIC ENGINEERING CENTER    *
*       609 SECOND STREET           *
*     DAVIS, CALIFORNIA 95616       *
*         (916) 756-1104            *
*                                   *
*************************************
```


HEC-1 RUNOFF AND ROUTING INPUT FILE
DRIPPING SPRINGS CANYONS
50-YEAR 6-HOUR EVENT:
6-HR PRECIP DISTRIBUTION
STORM DISTRIBUTION NUMBER = 3
50-YEAR FREQUENCY 6-HOUR STORM = 3.96"
DEPTH-AREA ADJUSTMENT FACTORS (PER CCRFCD)

AREA(SQ MI)	FACTOR
20	.79
15	.82
10	.86
9	.87
8	.88
7	.89
6	.90
5	.905
4	.91
3	.92
2	.93
1	.97
0.5	.98
0	1.00

CN's BASED ON FAIR TO POOR DESERT VEGETATION

```
25 IO        OUTPUT CONTROL VARIABLES
                   IPRNT          5  PRINT CONTROL
                   IPLOT          0  PLOT CONTROL
                   QSCAL          0. HYDROGRAPH PLOT SCALE

   IT        HYDROGRAPH TIME DATA
                    NMIN          3  MINUTES IN COMPUTATION INTERVAL
                   IDATE      1   0  STARTING DATE
                   ITIME       0000  STARTING TIME
                      NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE      1   0  ENDING DATE
                  NDTIME       1457  ENDING TIME
                   ICENT         19  CENTURY MARK

                 COMPUTATION INTERVAL     .05 HOURS
                     TOTAL TIME BASE   14.95 HOURS
```

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

JP MULTI-PLAN OPTION
NPLAN 1 NUMBER OF PLANS

JR MULTI-RATIO OPTION
RATIOS OF PRECIPITATION
.95 .98 .99 1.00

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

					RATIOS APPLIED TO PRECIPITATION			
OPERATION	STATION	AREA	PLAN		RATIO 1 .95	RATIO 2 .98	RATIO 3 .99	RATIO 4 1.00
HYDROGRAPH AT								
+	SUBJ1	.23	1	FLOW	109.	117.	120.	123.
				TIME	3.95	3.95	3.95	3.95
HYDROGRAPH AT								
+	SUBJ3	.03	1	FLOW	17.	19.	19.	20.
				TIME	3.60	3.60	3.60	3.60
2 COMBINED AT								
+	SEC1	.26	1	FLOW	116.	125.	129.	132.
				TIME	3.95	3.90	3.90	3.90
HYDROGRAPH AT								
+	SUBJ2	.44	1	FLOW	177.	192.	197.	202.
				TIME	3.95	3.95	3.95	3.95
2 COMBINED AT								
+	SUBJ1	.69	1	FLOW	293.	317.	326.	334.
				TIME	3.95	3.95	3.95	3.95
HYDROGRAPH AT								
+	SUBE1	.05	1	FLOW	32.	34.	35.	36.
				TIME	3.70	3.70	3.70	3.70
HYDROGRAPH AT								
+	SUBE2	.01	1	FLOW	9.	9.	10.	10.
				TIME	3.55	3.55	3.55	3.55

3 COMBINED AT								
+	SEC 2	.75	1	FLOW	314.	340.	349.	358.
				TIME	3.95	3.95	3.95	3.90
ROUTED TO								
+	REACH	.75	1	FLOW	312.	338.	347.	357.
				TIME	4.15	4.10	4.10	4.10
HYDROGRAPH AT								
+	SUBD	.69	1	FLOW	322.	349.	358.	368.
				TIME	3.85	3.85	3.85	3.85
HYDROGRAPH AT								
+	SUBH	.01	1	FLOW	15.	17.	17.	17.
				TIME	3.55	3.55	3.55	3.55
3 COMBINED AT								
+	SEC3	1.46	1	FLOW	569.	620.	638.	657.
				TIME	4.00	4.00	4.00	4.00
ROUTED TO								
+	REACH	1.46	1	FLOW	565.	617.	635.	657.
				TIME	4.05	4.05	4.05	4.05
HYDROGRAPH AT								
+	SUBG	.06	1	FLOW	42.	45.	46.	47.
				TIME	3.65	3.65	3.65	3.65
2 COMBINED AT								
+	SEC4	1.51	1	FLOW	580.	633.	651.	673.
				TIME	4.05	4.05	4.05	4.05
HYDROGRAPH AT								
+	SUBC	.04	1	FLOW	27.	30.	31.	31.
				TIME	3.60	3.60	3.60	3.60
2 COMBINED AT								
+	SEC4A	1.55	1	FLOW	589.	642.	660.	683.
				TIME	4.05	4.05	4.05	4.05
HYDROGRAPH AT								
+	SUBB	.02	1	FLOW	20.	22.	23.	23.
				TIME	3.55	3.55	3.55	3.55
2 COMBINED AT								
+	SEC5	1.58	1	FLOW	593.	647.	665.	687.
				TIME	4.05	4.05	4.05	4.05
ROUTED TO								
+	REACH	1.58	1	FLOW	590.	643.	662.	685.
				TIME	4.10	4.05	4.05	4.05
HYDROGRAPH AT								

+	SUBF	.00	1	FLOW	6.	6.	6.	6.
				TIME	3.55	3.55	3.55	3.55

2 COMBINED AT

+	SEC6	1.58	1	FLOW	590.	644.	663.	687.
				TIME	4.10	4.05	4.05	4.05

HYDROGRAPH AT

+	SUBA	.00	1	FLOW	6.	6.	6.	6.
				TIME	3.50	3.50	3.50	3.50

HYDROGRAPH AT

+	SUBI	.05	1	FLOW	41.	44.	46.	47.
				TIME	3.60	3.60	3.60	3.60

HYDROGRAPH AT

+	SUBK	.00	1	FLOW	6.	6.	6.	6.
				TIME	3.50	3.50	3.50	3.50

1

SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

ISTAQ	ELEMENT	DT	PEAK	TIME TO PEAK	VOLUME	INTERPOLATED TO COMPUTATION INTERVAL DT	PEAK	TIME TO PEAK	VOLUME
		(MIN)	(CFS)	(MIN)	(IN)	(MIN)	(CFS)	(MIN)	(IN)
FOR PLAN - 1 RATIO- .95									
	REACH MANE	2.98	313.20	246.70	.83	3.00	312.35	249.00	.83

CONTINUITY SUMMARY (AC-FT) - INFLOW- .3337E+02 EXCESS- .0000E+00 OUTFLOW- .3340E+02 BASIN STORAGE- .1962E-01 PERCENT ERROR- -.1

FOR PLAN - 1 RATIO- .98								
	REACH MANE	2.93	339.31	247.49	.90	3.00	338.21	246.00	.90

CONTINUITY SUMMARY (AC-FT) - INFLOW- .3594E+02 EXCESS- .0000E+00 OUTFLOW- .3595E+02 BASIN STORAGE- .1796E-01 PERCENT ERROR- -.1

FOR PLAN - 1 RATIO- .99								
	REACH MANE	2.91	348.21	246.85	.92	3.00	347.27	246.00	.92

CONTINUITY SUMMARY (AC-FT) - INFLOW- .3681E+02 EXCESS- .0000E+00 OUTFLOW- .3681E+02 BASIN STORAGE- .2029E-01 PERCENT ERROR- -.1

FOR PLAN - 1 RATIO- 1.00								
	REACH MANE	2.90	357.32	246.26	.94	3.00	356.93	246.00	.94

CONTINUITY SUMMARY (AC-FT) - INFLOW- .3769E+02 EXCESS- .0000E+00 OUTFLOW- .3770E+02 BASIN STORAGE- .1790E-01 PERCENT ERROR- -.1

FOR PLAN = 1 RATIO= .95

REACH	MANE	1.59	566.94	244.37	.81	3.00	565.43	243.00	.81

CONTINUITY SUMMARY (AC-FT) - INFLOW= .6328E+02 EXCESS= .0000E+00 OUTFLOW= .6327E+02 BASIN STORAGE= .1433E-01 PERCENT ERROR= .0

FOR PLAN = 1 RATIO= .98

REACH	MANE	1.56	617.20	242.58	.88	3.00	617.17	243.00	.88

CONTINUITY SUMMARY (AC-FT) - INFLOW= .6817E+02 EXCESS= .0000E+00 OUTFLOW= .6813E+02 BASIN STORAGE= .1561E-01 PERCENT ERROR= .0

FOR PLAN = 1 RATIO= .99

REACH	MANE	1.55	636.03	243.63	.90	3.00	634.88	243.00	.90

CONTINUITY SUMMARY (AC-FT) - INFLOW= .6984E+02 EXCESS= .0000E+00 OUTFLOW= .6981E+02 BASIN STORAGE= .1520E-01 PERCENT ERROR= .0

FOR PLAN = 1 RATIO= 1.00

REACH	MANE	1.51	656.82	243.07	.92	3.00	656.56	243.00	.92

CONTINUITY SUMMARY (AC-FT) - INFLOW= .7154E+02 EXCESS= .0000E+00 OUTFLOW= .7151E+02 BASIN STORAGE= .1562E-01 PERCENT ERROR= .0

FOR PLAN = 1 RATIO= .95

REACH	MANE	.46	592.50	244.15	.82	3.00	589.53	246.00	.82

CONTINUITY SUMMARY (AC-FT) - INFLOW= .6876E+02 EXCESS= .0000E+00 OUTFLOW= .6876E+02 BASIN STORAGE= .3081E-02 PERCENT ERROR= .0

FOR PLAN = 1 RATIO= .98

REACH	MANE	.40	646.00	243.69	.88	3.00	642.86	243.00	.88

CONTINUITY SUMMARY (AC-FT) - INFLOW= .7403E+02 EXCESS= .0000E+00 OUTFLOW= .7403E+02 BASIN STORAGE= .3141E-02 PERCENT ERROR= .0

FOR PLAN = 1 RATIO= .99

REACH	MANE	.36	664.63	243.75	.90	3.00	662.12	243.00	.90

CONTINUITY SUMMARY (AC-FT) - INFLOW= .7585E+02 EXCESS= .0000E+00 OUTFLOW= .7585E+02 BASIN STORAGE= .3107E-02 PERCENT ERROR= .0

FOR PLAN = 1 RATIO= 1.00

REACH	MANE	.37	686.73	243.62	.92	3.00	685.39	243.00	.92

CONTINUITY SUMMARY (AC-FT) - INFLOW= .7775E+02 EXCESS= .0000E+00 OUTFLOW= .7775E+02 BASIN STORAGE= .3120E-02 PERCENT ERROR= .0

*** NORMAL END OF HEC-1 ***

WRC NEVADA, INC.
CENTURY PARK
1771 EAST FLAMINGO ROAD—SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893-6266
FAX NO. (702) 893-6269

JOB NUMBER: 2016 SHEET 1 OF 13
JOB NAME: S.R. 163
CALC. BY: AFL DATE 5/14/93
CHKD. BY: _____ DATE __/__/__
REV. BY: _____ DATE __/__/__

SUBJECT: Rainfall Diagram Analysis - Composite "C" Area Calculations

Basin ID	Station to Station	Area Paved (Ac)	Area Ditch (Ac)	Area Offsite (Ac)	Total Area (Ac)	Composite C
1L	783+00 to 799+50	1.51 (37'-42.5'w)	.56	—	3.07	.65
2L	799+50 to 811+00	.98 (32'w)	1.48	—	2.46	.60
3L	811+00 to 826+00	1.24 (36'w)	2.51 (72'w)	—	3.75	.56
4L	826+00 to 848+66	1.87 (36'w)	3.80 (73'w)	—	5.67	.56
10L	866+00 to 878+00	0.99 (36'w)	0.91 (33'w)	.32	2.22	.63
9M	868+00 to 880+00	—	1.97 (36'w)	—	1.97	.40
10R	867+00 to 884+50	1.45 (36'w)	1.21 (30'w)	.35	3.01	.65
11L	879+50 to 885+50	.50 (36'w)	.51 (37'w)	.14	1.15	.62
2L	885+00 to 895+00	.74 (36'w)	.70 (34'w)	.02	1.46	.65
12R	889+00 to 897+50	.70 (36'w)	.59 (30'w)	.56	1.85	.60
13M	906+00 to 915+00	.74 (36'w)	.54 (26'w)	—	1.28	.69
14M	915+00 to 928+50	1.12 (36'w)	.81 (26'w)	—	1.93	.69

C Factors: Paved = .90
Ditch = .40
Offsite = .44

CALCULATED BY: AJL
DATE: 5/14/93
CHECKED BY:

STANDARD FORM SF-8
TIME OF CONCENTRATION

JOB NO: 2016
PROJECT: S.R. 163

Ti = 1.8(1.1 − C5)SQRT(L)/(S) ^ 1/3 — Tc = Ti + Tt

	SUB-BASIN DATA			INITIAL / OVERLAND TIME (Ti)			TRAVEL TIME (Tt)				Tc CHECK (URBANIZED BASINS)			FINAL Tc	REMARKS
	DESIG	AREA AC	C5	LENGTH FT	SLOPE %	Ti MIN	LENGTH FT	SLOPE %	VEL FPS	Tt MIN	COMP Tc	LENGTH FT	Tc=(L/180)+10	MIN	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1	1L	3.07	.73 / .40 / .771	36 / 22 / 58	2.0 / 16.7 / 7.6	2.7	1650	5.3	4.6	6.0	8.7			8.7	
2	2L	2.46	composite			2.7	1150	6.0	5.0	3.8	6.5			6.5	
3	3L	3.75	Use same Ti for all exterior drainages.		for ditch	2.7	1500	6.0	5.0	5.0	7.7			7.7	
4	4L	3.78				2.7	2270	4.6	4.2	9.0	11.7			11.7	
5															
6	10L	2.22				2.7	1200	3.7	3.8	5.3	8.0			8.0	
7	10M	1.97	.40	13	16.7	1.8	3300	3.7	3.8	14.5	16.3			16.3	
8	10R	3.01				2.7	1750	3.7	3.8	7.7	10.4			10.4	
9	11L	1.15				2.7	600	3.7	4.8	2.6	5.3			5.3	
10	12L	1.46				2.7	900	3.7	3.3	3.9	6.6			6.6	
11	12R	1.85				2.7	850	3.7	3.3	3.7	6.4			6.4	
12	13M	1.78	.90 / .40 / .77	36 / 13 / 49	3.0 / 16.7 / 5.6	2.2	900	3.7	3.8	3.9	6.1			6.1	
13	14M	1.93	"	"	"	2.2	1350	3.3	4.7	6.1	8.3			8.3	
14															
15															
16															
17															

WRC FORM 106

CALCULATED BY: AJL
DATE: 5/15/93
CHECKED BY:

STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

JOB NO: 201c
PROJECT: S.R. 167
DESIGN STORM: 10-YR

	STREET	DIRECT RUNOFF: DESIGN POINT	AREA DESIGN	AREA AC	RUNOFF COEFF	Tc MIN	C*A AC	I IN/HR	Q CFS	TOTAL RUNOFF: Tc MIN	E(C*A) AC	I IN/HR	Q CFS	STREET: SLOPE %	Q CFS	PIPE: Qdesign CFS	SLOPE %	PIPE SIZE	TRAVEL TIME: LENGTH FT	VEL FPS	Tt MIN	REMARKS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
1	783+00 to 799+50	1L	1L	3.07	.65	8.7	2.00	5.6	11.2											4.9		D=.72
2	799+50 to 811+00	2L	2L	2A6	.60	6.5	1.48	6.2	9.2											4.8		n=.035 D=.65
3	811+00 to 826+00	3L	3L	3.75	.56	7.7	2.10	5.8	12.2											4.9		n=.035 D=.65
4	826+00 to 848+66	4L	4L	5.67	.56	11.7	3.18	4.9	15.6											4.7		n=.035 D=.74
5																						
6	866+00 to 878+00	10L	10L	2.22	.63	8.0	1.40	5.7	8.0											4.0		n=.035 D=.71
7	866+00 to 899+00	10M	10M	1.97	.40	16.3	.79	4.3	3.4											2.9		n=.035 D=.44
8	867+00 to 884+50	10R	10R	3.01	.65	10.4	1.96	5.2	10.2											1.2		n=.035 D=.78
9	879+50 to 885+50	11L	11L	1.15	.62	5.3	.71	6.7	4.8											3.5		n=.035 D=.58
10	857+00 to 896+00	12L	12L	1.46	.65	6.6	.95	6.2	5.9											3.7		n=.035 D=.63
11	879+00 to 897+50	12R	12R	1.85	.60	6.9	1.11	6.2	6.9											3.8		n=.035 D=.67
12	906+00± to 915+00±	13M	13M	1.28	.69	6.1	.88	6.4	5.6											3.3		n=.035 D=.53
13	915+00± to 928+50	14M	14M	1.93	.69	8.3	1.33	5.6	7.4											3.4		n=.035 D=.60
14																						
15																						
16																						
17																						

WRC FORM 107

3/13

WRC NEVADA, INC.
CENTURY PARK
1771 EAST FLAMINGO ROAD–SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893–6266
FAX NO. (702) 893–6269

JOB NUMBER: 20'K SHEET 4 OF 13
JOB NAME: S.R. 163
CALC. BY: FD DATE 5/11/93
CHKD. BY: _____ DATE __/__/__
REV. BY: _____ DATE __/__/__

SUBJECT: Overall Drainage Analysis - Composite "C" / Area Calculations

Basin ID	Station to Station	Area Paved (Ac)	Area Ditch (Ac)	Area Offsite (Ac)	Total Area (Ac)	Composite C
20 L	930+50 to 950+50	1.53 (36'w)	1.19 (28'w)	.22	2.94	.66
20 M	929+50 (B) to 950+50 (B)	1.28 (36'w)	.93 (26'w)	0	2.21	.60
20 R	929+50 to 950+50	.25 (36'w)	1.64 (28'w)	.77	2.66	.44
21 M	934+00 (B) to 954+50 (B)	1.28 (36'w)	.93 (26'w)	0	2.21	.60
22 L	956+50 to 976+50	.99 (28'w)	.60 (26'w)	.14	1.73	.57
22 M	[illegible]	.72 (20'w)	.98 (28'w)	0	1.70	.52
22 R	956+00 to 976+00	.56 (16'w)	1.06 (30'w)	.72	2.34	.53
23 L	979+50 to 982+00	.14 (4'w)	.07 (2'w)	0	.21	.73
23 M	976+00 (B) to 982+00 (B)	—	.45 (26'-10'w)	0	.45	.40
23 R	979+00 to 986+00	.41 (12'w)	.34 (10'w)	0	.75	.67
24 L	982+00 to 996+00	.25 (36'w)	.15 (22'w)	.08	.48	.67
24 R	983+00 to 996+50	.70 (36'w)	.59 (26'w)	0	1.29	.67
25 L	991+00 to 1003+00	.09 (36'w)	1.38 (40'w)	.06	2.43	.60
26 L	1003+00 to 1010+00	.51 (32'w)	0.96 (60'w)	1.98	3.45	.50
26 R	983+00 to 1010+00	.92 (98'w Pvmt.)	1.33 (95'w)	1.28	3.53	.54

C_{10} Factors: Paved = .90
Ditch = .40
Offsite = .44

CALCULATED BY: AFL

DATE: 5/14/93

CHECKED BY:

STANDARD FORM SF-8

TIME OF CONCENTRATION

JOB NO: 1016

PROJECT: C.R. 103

Ti=1.8(1.1-C5)SQRT(L)/(S)^1/3 Tc = Ti + Tt

	'SUB-BASIN DATA			INITIAL / OVERLAND TIME (Ti)			TRAVEL TIME (Tt)				Tc CHECK (URBANIZED BASINS)			FINAL Tc	REMARKS
	DESIG	AREA AC	C5	LENGTH FT	SLOPE %	Ti MIN	LENGTH FT	SLOPE %	VEL FPS	Tt MIN	COMP Tc	LENGTH FT	Tc= (L/180)+10	MIN	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1	FO L	0.1	.66			2.7	[illegible]	3.33	[illegible]	[illegible]	11.5			[illegible]	
2	20 M	[illegible]	.69	15	15.[illegible]	1.8	1550	3.28	[illegible]	[illegible]	8.8			8.8	
3	20 R	[illegible]	[illegible]			2.7	[illegible]	3.29	[illegible]	[illegible]	12.2			12.2	
4	21 M	2.21	.69			1.8	1700	Use 3.3	[illegible]	6.8	8.6			8.6	
5	22 L	1.23	.69			2.7	1050	4.29	4.2	[illegible]	6.4			[illegible]	
6	22 M	1.77	.62			2.7	[illegible]	4.36	4.2	6.5	9.2			9.2	
7	22 R	2.34	.53			1.8	1400	4.34	4.2	[illegible]	7.4			7.4	
8	23 L	0.21	.73			2.7	150	4.36	4.2	0.6	[illegible]			Use 5.0mm	
9	23 M	0.45	.40			1.8	1100	4.36	4.2	4.1	6.2			6.2	
10	23 R	0.75	.67			2.7	500	4.36	4.2	2.0	4.7			Use 5.0mm	
11	24 L	0.48	.67			2.7	300	4.36	4.2	1.2	3.9			Use 5.0mm	
12	24 R	1.29	.67			2.7	850	4.36	4.2	3.4	6.1			6.1	
13	25 L	2.43	.60			2.7	1200	4.0 Fig	4.0	5.0	7.7			7.7	
14	25 L	3.45	.50			2.7	700	2.2	3.0	3.9	[illegible]			[illegible]	
15	26 R	3.53	.54			2.7	1050	2.2	3.0	5.8	8.5			8.5	
16															
17															

WRC FORM 106

CALCULATED BY: ASL
DATE: 5/19/93
CHECKED BY:

STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

JOB NO: 2013
PROJECT: SR163
DESIGN STORM: 10YR

	STREET	DESIGN POINT	DIRECT RUNOFF AREA DESIGN	AREA AC	RUNOFF COEFF	Tc MIN	C*A AC	I IN/HR	Q CFS	TOTAL RUNOFF Tc MIN	E(C*A) AC	I IN/HR	Q CFS	STREET SLOPE %	STREET Q CFS	PIPE Qdesign CFS	PIPE SLOPE %	PIPE SIZE	TRAVEL TIME LENGTH FT	TRAVEL TIME VEL FPS	TRAVEL TIME Tt MIN	REMARKS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
1	950+50 to 950+50	20L	20L	2.99	.66	11.5	1.97	5.0	7.7											3.7		S= 3.78%, D= .69'
2	928+50 to 944+00	20M	20M	2.21	.69	8.8	1.52	5.6	5.7													
3	928+50 to 949+50	20R	20R	2.06	.71	12.2	1.46	4.9	7.1										1500	3.5	7.1	S= 3.78%, D= .63'
4	941+00 to 959+50	21M	21M	2.21	.69	8.6	1.52	5.6	8.5	12.9	3.37	4.1	13.8			4M				3.6		S= 3.78% D= .65'
5			K	2.13	.51	8.9	1.60	5.7	9.1											4.2		S= 3.78% Pipe D= .73
6	965+50 to 976+50	22L	22L	1.73	.69	6.9	1.19	6.0	7.1	12.2	2.79	4.2	11.7						1050	4.2	4.2	
7	959+50 to 976+00	22M	22M	1.77	.62	9.2	1.10	5.1	5.6											5.7		S= 4.38% D= 1.25'
8	961+00 to 975+00	22R	22R	2.34	.52	7.4	1.24	5.8	7.2	9.3	2.34	5.4	12.6							3.6	~0.1	S= 4.38% D= .52'
9										12.2	5.13	4.8	24.6							4.9	~0.1	S= 4.38 D= 1.0'
10	979+50 to 988+00	23L	23L	.21	.73	5.0	.15	6.9	1.0													10YR Runoff Q= 24.6 cfs
11	976+00 to 987+00	23M	23M	.45	.40	6.2	.18	6.1	1.2											3.0		S= 4.37 D= .47'
12	979+50 to 994+00	23R	23R	.75	.67	5.0	.50	6.9	3.5											2.4		S= 4.37 D= .29 OK
13	987+00 to 994+00	24L	24L	.48	.67	5.0	.32	6.9	2.2											4.1		S= 4.37 D= .75
14	988+00 to 996+50	24R	24R	1.29	.67	6.1	.86	6.4	5.5											2.8		S= 4.37 D= .38
15	991+00 to 1003+00	25L	25L	2.43	.60	7.7	1.46	5.8	8.5											3.9		S= 4.37 D= .60
16	1003+00 to 1010+00	26L	26L	3.45	.50	6.6	1.73	6.2	10.7											3.9		S= 3.3 D= .76
17	979+50 to 1010+00	26R	26R	3.53	.54	9.6	1.91	5.6	10.7											3.3		r= .177
																				4.1		S= .22 D= 1.1

All D = 075

WHCPGRM 1.87

CALCULATED BY:

DATE: 5/25/93

CHECKED BY:

STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

JOB NO:

PROJECT:

DESIGN STORM: 50 YR

	STREET	DIRECT RUNOFF								TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		DESIGN POINT	AREA DESIGN	AREA AC	RUNOFF COEFF	Tc MIN	C*A AC	I IN/HR	Q CFS	Tc MIN	E(C*A) AC	I IN/HR	Q CFS	SLOPE %	Q CFS	Qdesign CFS	SLOPE %	PIPE SIZE	LENGTH FT	VEL FPS	Tt MIN	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
1			K	5.13	.57	6.0	1.20	9.0	10.8													
2			22L	1.73	.59	7.9	1.19	9.2	10.9	12.2	2.74	7.5	20.9							5.8		$S = .4^{.38}$ $D = 1.3'$
3			22M	1.77	.62	7.5	1.10	9.5	10.7											6.4		$S = 4.38$ $D = 1.5'$
4			22R	2.34	.58	7.4	1.36	9.2	12.4	12.2	5.13	7.5	38.5									$\therefore D_{50} = 3''$ min. (CCRFCD Eq. 7.8)
5							K 22R, 22M, 22L															50 YR Rundown $Q = 38.5$ cfs
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						

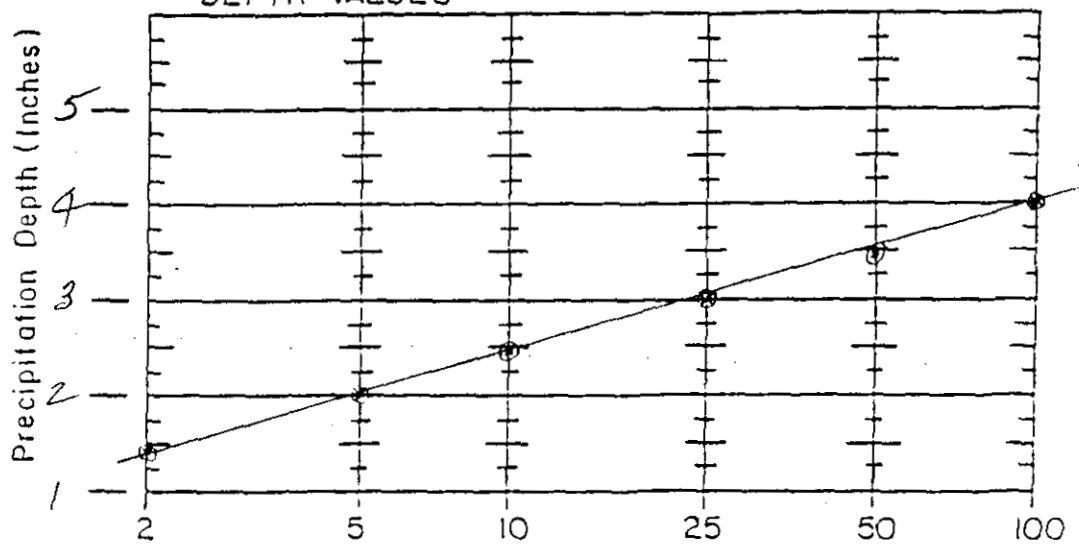
WRC FORM 107

RAINFALL VALUES
(DURATION - 24 HRS).

FREQ	RAIN DEPTH NOAA (IN)	LINE VALUE (IN)	ADJ FACT	ADJ VALUES
2 YR.	1.40	1.40	1.00	1.40
5 YR.	2.00	2.00	1.16	2.32
10 YR.	2.40	2.40	1.24	2.95
25 YR.	3.00	3.07	1.33	4.08
50 YR.	3.40	3.55	1.39	4.93
100 YR.	4.00	4.00	1.43	5.72

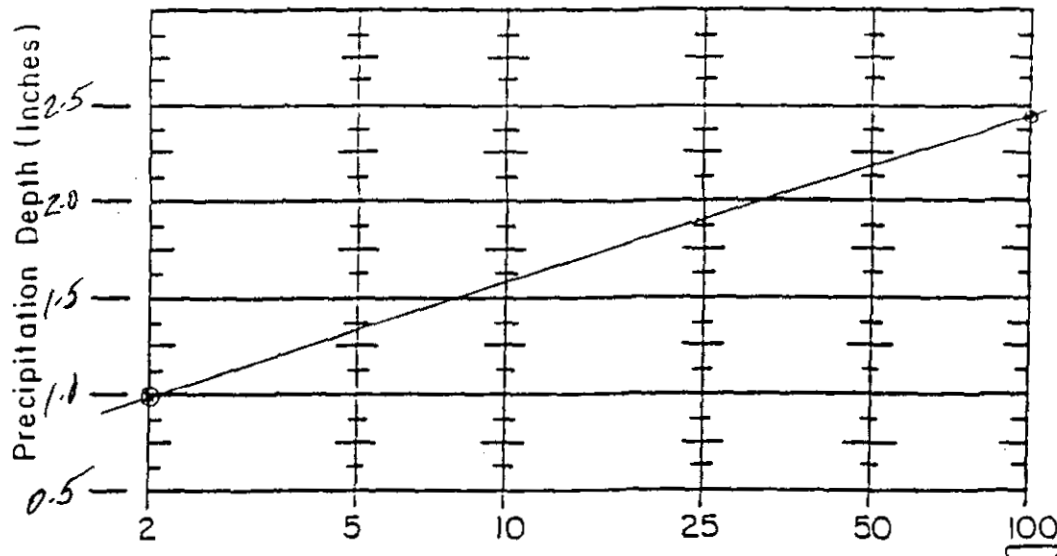
PRECIPITATION DEPTH VERSUS RETURN PERIOD

A. PLOT OF 6-HOUR AND 24-HOUR PRECIPITATION DEPTH VALUES



Return Period in Years, Partial - Duration Series

B. PLOT OF 1-HOUR PRECIPITATION DEPTH VALUES



Return Period in Years, Partial - Duration Series

Revision	Date

REFERENCE: NOAA ATLAS 2, VOLUME VII NEVADA, 1973

STANDARD FORM 3

TIME-INTENSITY-FREQ CURVES.

(NOAA LINE VALUES)

RETURN PERIOD (YRS)	6 HR. DEPTH (IN)	24 HR DEPTH (IN).
2	1.20	1.40
5	1.70	2.00
10	2.05	2.40
25	2.50	3.07
50	2.85	3.55
100	3.20	4.00

1-HR RAIN DEPTH.

$$Y_2 = 0.011 + 0.942\left(1.20 \times \frac{1.20}{1.40}\right) = 0.98" = (2\text{YR}).$$

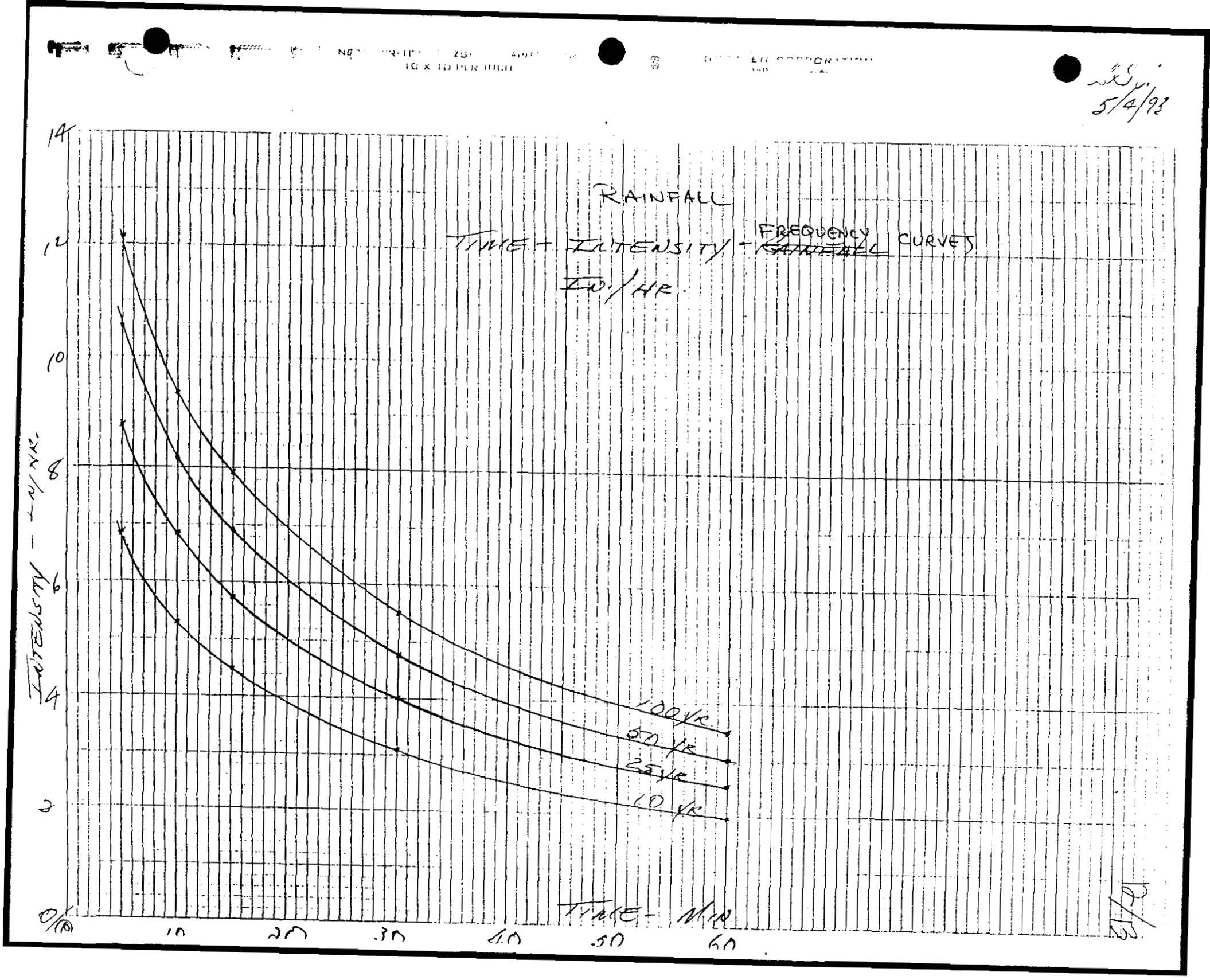
$$Y_{100} = 0.494 + 0.755\left(3.20 \times \frac{3.20}{4.00}\right) = 2.43" = (100\text{YR}).$$

ADJUSTED 1-HR. RAIN DEPTH

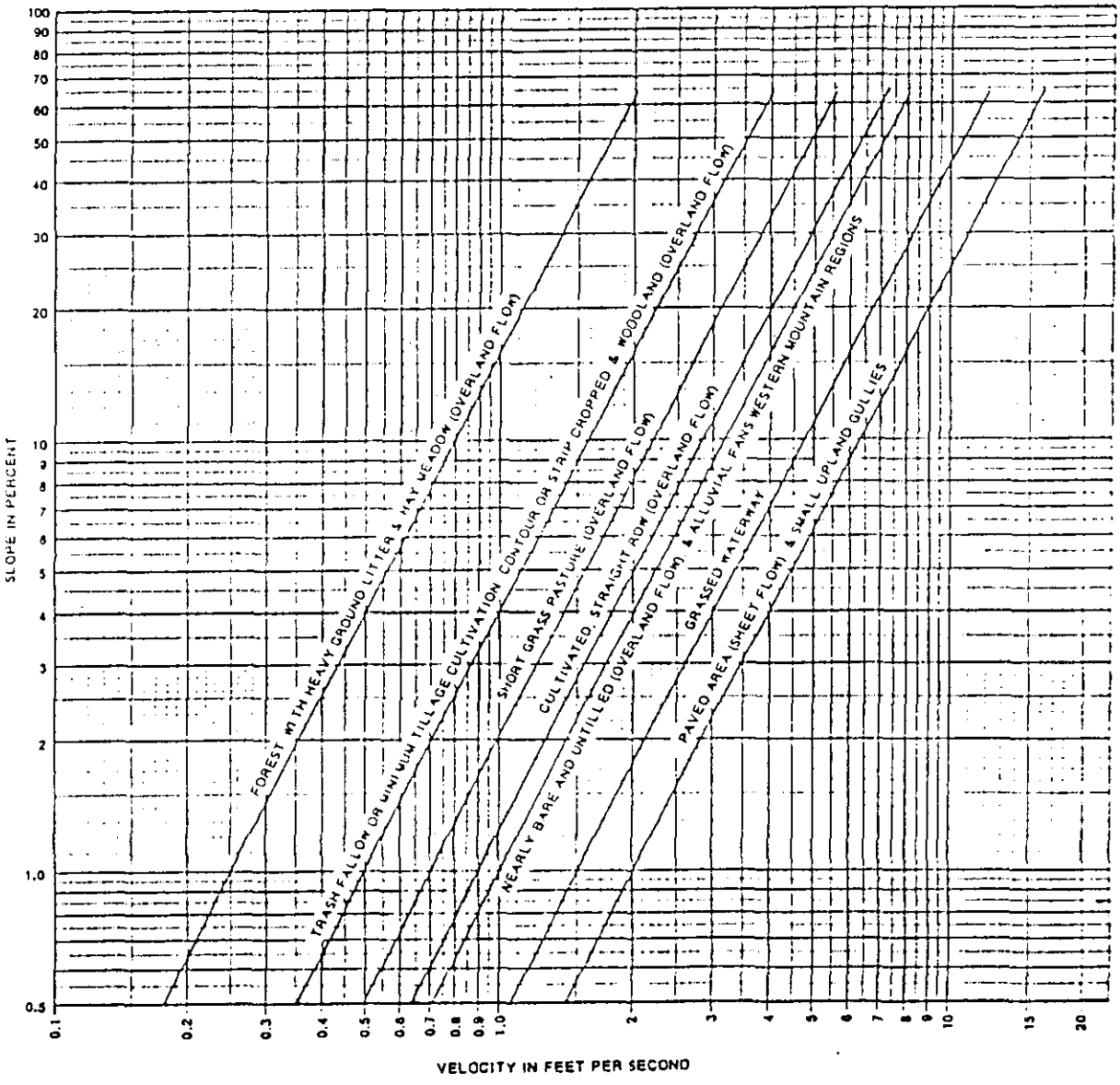
RETURN PERIOD (YR)	(LINE VALUE) 1-HR DEPTH (IN)	ADJ FACT	ADJUSTED 1-HR DEPTH (IN)
2	0.98	1.00	0.98
5	1.35	1.16	1.57
10	1.58	1.24	1.96
25	1.90	1.33	2.53
50	2.18	1.39	3.03
100	2.43	1.43	3.47

DEPTH - DURATION - FREQ. VALUES
(ADJ RAINFALL DEPTHS)
INCHES.

TIME	< 1-HR. FACT	2YR	5YR	10YR.	25YR.	50YR.	100YR.
5 MIN	0.29	0 28	0.46	0.57	0.73	0.88	1.01
10 MIN	0.45	0.44	0.71	0.88	1.14	1.36	1.56
15 MIN	0.57	0.56	0.89	1.12	1.44	1.73	1.98
30 MIN	0.79	0.77	1.24	1.55	2.00	2.39	2.74
1 HR	1.00	0.98	1.57	1.96	2.53	3.03	3.47
2 HR	—						
3 HR.	—						
6 HR.	—	1.20	1.97	2.54	3.33	3.96	4.58
24 HR.	—	1.10	2.32	2.98	4.08	4.93	5.72


5/4/93
RAINFALL
TIME - INTENSITY - FREQUENCY CURVES
IN./HR.
100 YR
50 YR
25 YR
10 YR
INTENSITY - IN/HR.
TIME - MIN
14
12
10
8
6
4
2
0
10
20
30
40
50
60

TRAVEL TIME VELOCITY



Revision	Date

WRC ENGINEERING

REFERENCE: SCS National Engineering Handbook Section 4, Hydrology, March, 1985

FIGURE 602

HYDRAULIC CALCULATION

PROJECT: S.R. 163
NDOT P-059-93-11

STATION: "B" 914+72 (#1)
SHEET 1 OF 3

CULVERT DESIGN FORM
DESIGNER / DATE: AJZ / 5/17
REVIEWER / DATE: ____ / ____

SEE ADD'L SHTS.

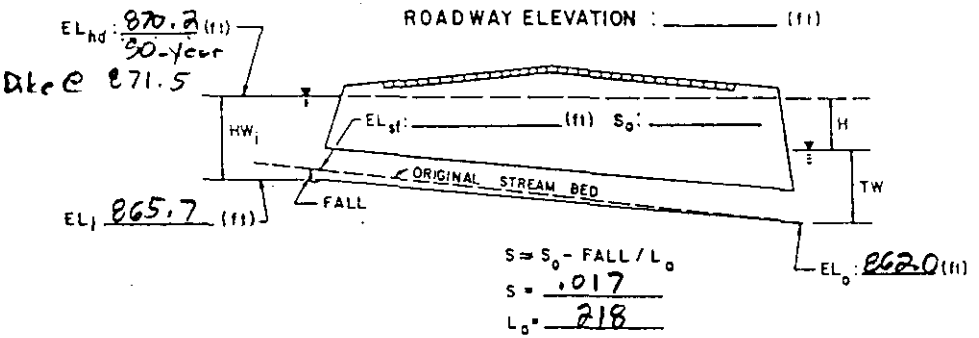
HYDROLOGICAL DATA

- ☒ METHOD: HEC-1
- ☐ DRAINAGE AREA: ____ ☐ STREAM SLOPE: ____
- ☐ CHANNEL SHAPE: ____
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
50	120	2' (Est.)
100	168	—

ROADWAY ELEVATION: ____ (ft)



$S = S_o - FALL / L_o$
$S = .017$
$L_o = 218$

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
5'x3' RCBC w/ Headwall	120	120	1.5	4.5		870.2	±2'	2.6	2.8	2.8	.2	2.3	867.1	870.2	15.8	50-Yr. Design
(w/o overtopping dike)	160	160	1.93	5.8		871.5	±2'	3.0	3.0	3.0	.2	4.0	869.0	871.5	16.9	Dike @ 871.5 (1.3' freeboard)

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) $h_o = TW$ or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

$Q_f = 232$ cfs
$Q_D/Q_f = .52$
$V_f = 15.5$ cfs
$V_D/V_f = 1.2$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
w. TAILWATER

COMMENTS / DISCUSSION:

Culvert designed for 50-year event w/ min. 1 ft. freeboard. For 100-year event, 168 cfs maximum will overtop dike and flow to culvert #2 (sta "B" 920+95)

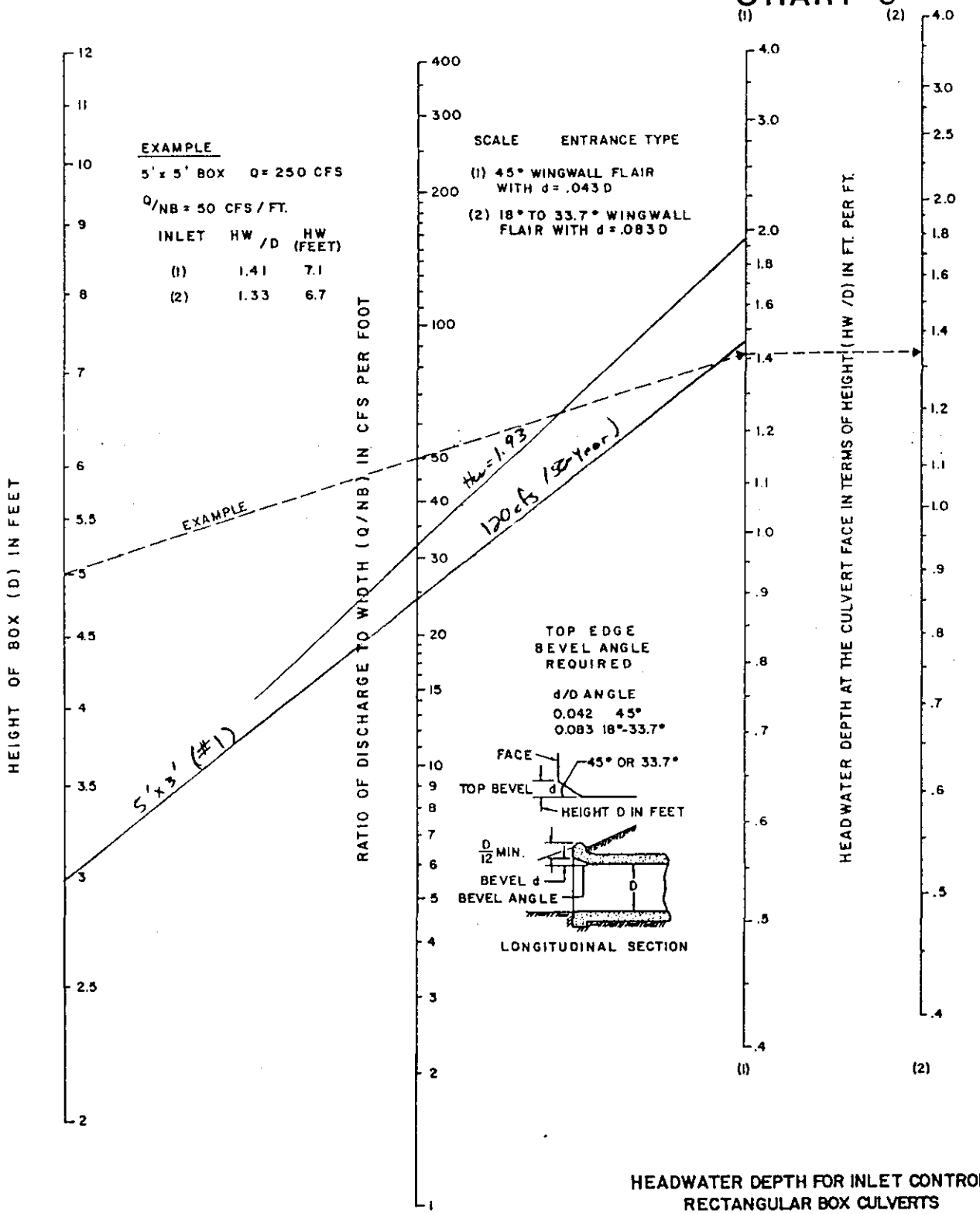
CULVERT BARREL SELECTED:

SIZE: ____
SHAPE: ____
MATERIAL: ____ n ____
ENTRANCE: ____

Culvert #1
"B" 914+72

#13

CHART 9

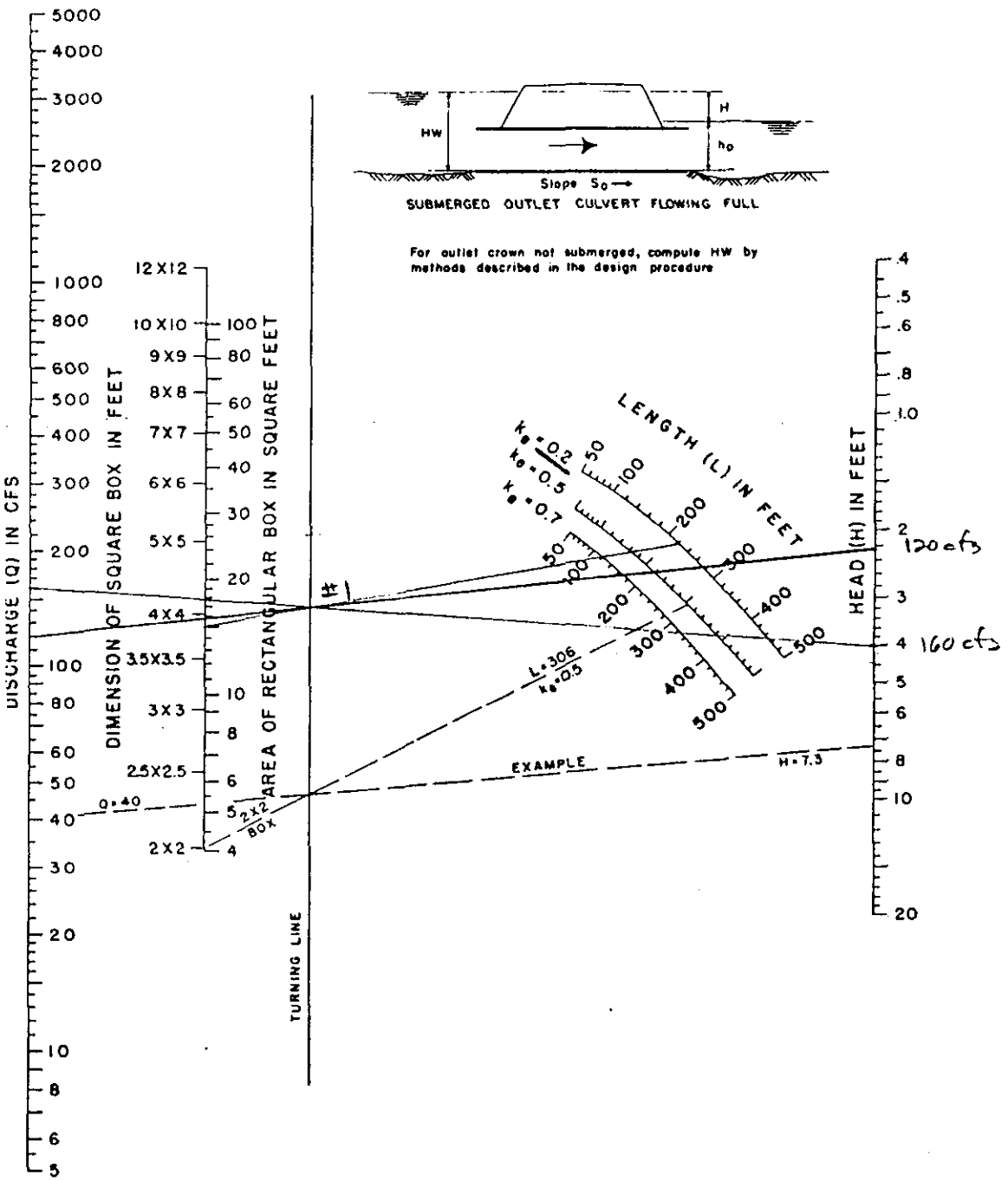


HEADWATER DEPTH FOR INLET CONTROL
RECTANGULAR BOX CULVERTS
FLARED WINGWALLS 18° TO 33.7° & 45°
WITH BEVELED EDGE AT TOP OF INLET

Culvert #1
"B" 914+72

313

CHART 15



HEAD FOR
CONCRETE BOX CULVERTS
FLOWING FULL
n = 0.012

AU OF PUBLIC ROADS JAN. 1963

PROJECT: S.R. 163
NDOT P-059-93-11

STATION: "B" 920+95 (#2)
SHEET 1 OF 3

CULVERT DESIGN FORM
DESIGNER / DATE: AJC / 5/17
REVIEWER / DATE: /

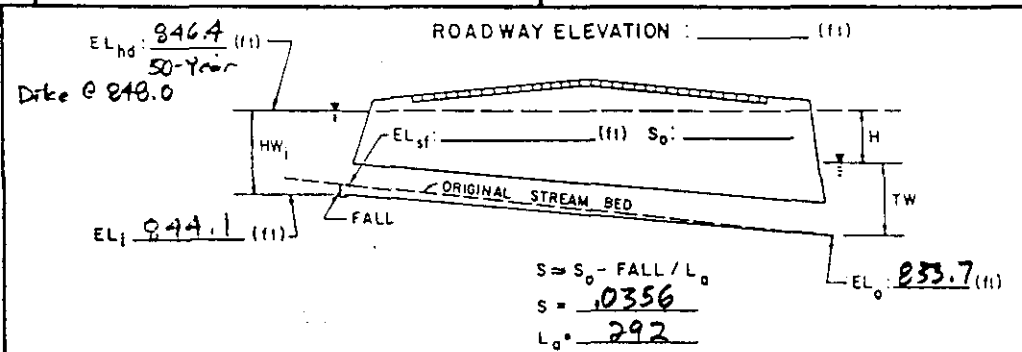
HYDROLOGICAL DATA

SEE ADD'L SHTS.

- [x] METHOD: HEC-1
- [ ] DRAINAGE AREA: ____ [ ] STREAM SLOPE: ____
- [ ] CHANNEL SHAPE: ____
- [ ] ROUTING: ____ [ ] OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
50	20	0.5' (Est.)
100	28	—



CULVERT DESCRIPTION:

MATERIAL - SHAPE - SIZE - ENTRANCE

HEADWATER CALCULATIONS

	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	INLET CONTROL HW_i/D (2)	INLET CONTROL HW_i	INLET CONTROL FALL (3)	INLET CONTROL EL_hi (4)	OUTLET CONTROL TW (5)	OUTLET CONTROL d_c	OUTLET CONTROL (d_c+D)/2	OUTLET CONTROL h_o (6)	OUTLET CONTROL k_e	OUTLET CONTROL H (7)	OUTLET CONTROL EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
30" ø CMP w/ F.E.S.	20	20	.93	2.3		846.4	I.5	1.5	2.0	2.0	.5	2.8	838.5	846.4	8.4	50-Yr. Design
(w/o overtopping dike)	36	36	1.56	3.9		848.0	I.5'	2.1	2.6	2.6	.5	9.5	845.8	848.0	9.7	Dike @ 848.0 (1.6' Freeboard)

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) HW_i/D = HW/D OR HW_i/D FROM DESIGN CHARTS

(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

$Q_f = 42$ cfs
$Q_D/Q_f = .48$
$V_f = 8.6$ fps
$V_D/V_f = .98$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
w. TAILWATER

COMMENTS / DISCUSSION:

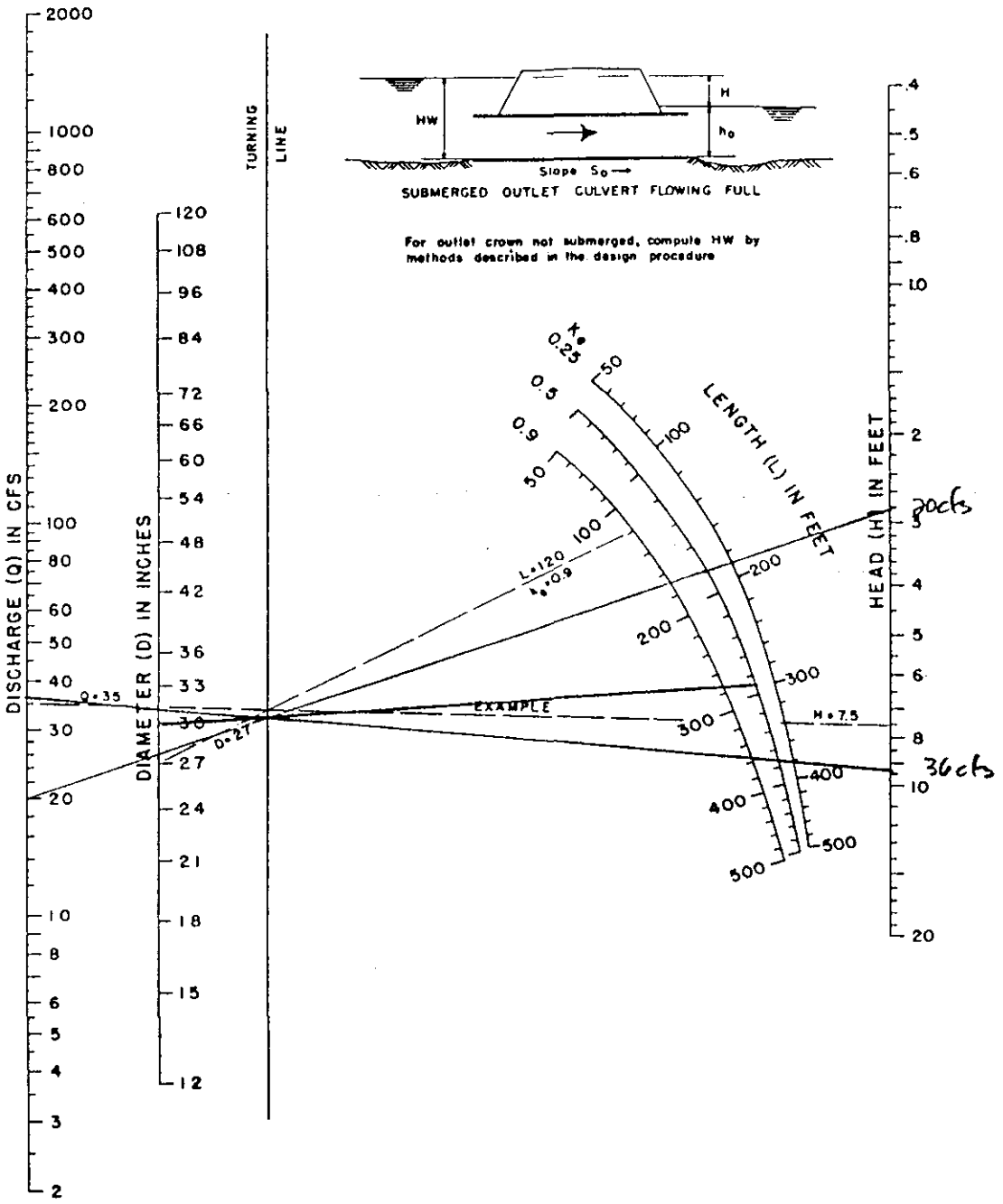
For a 100-Year event, 8 cfs (#1 max.) + plus 28 cfs (#2) = 36 cfs. Therefore, dike will accomodate 100 year runoff w/o overtopping. 30" ø used instead of 24" ø to facilitate maintenance

CULVERT BARREL SELECTED:

SIZE: ____
SHAPE: ____
MATERIAL: ____
ENTRANCE: ____

CULVERT #2 2/3
"B" 920+95

CHART 6

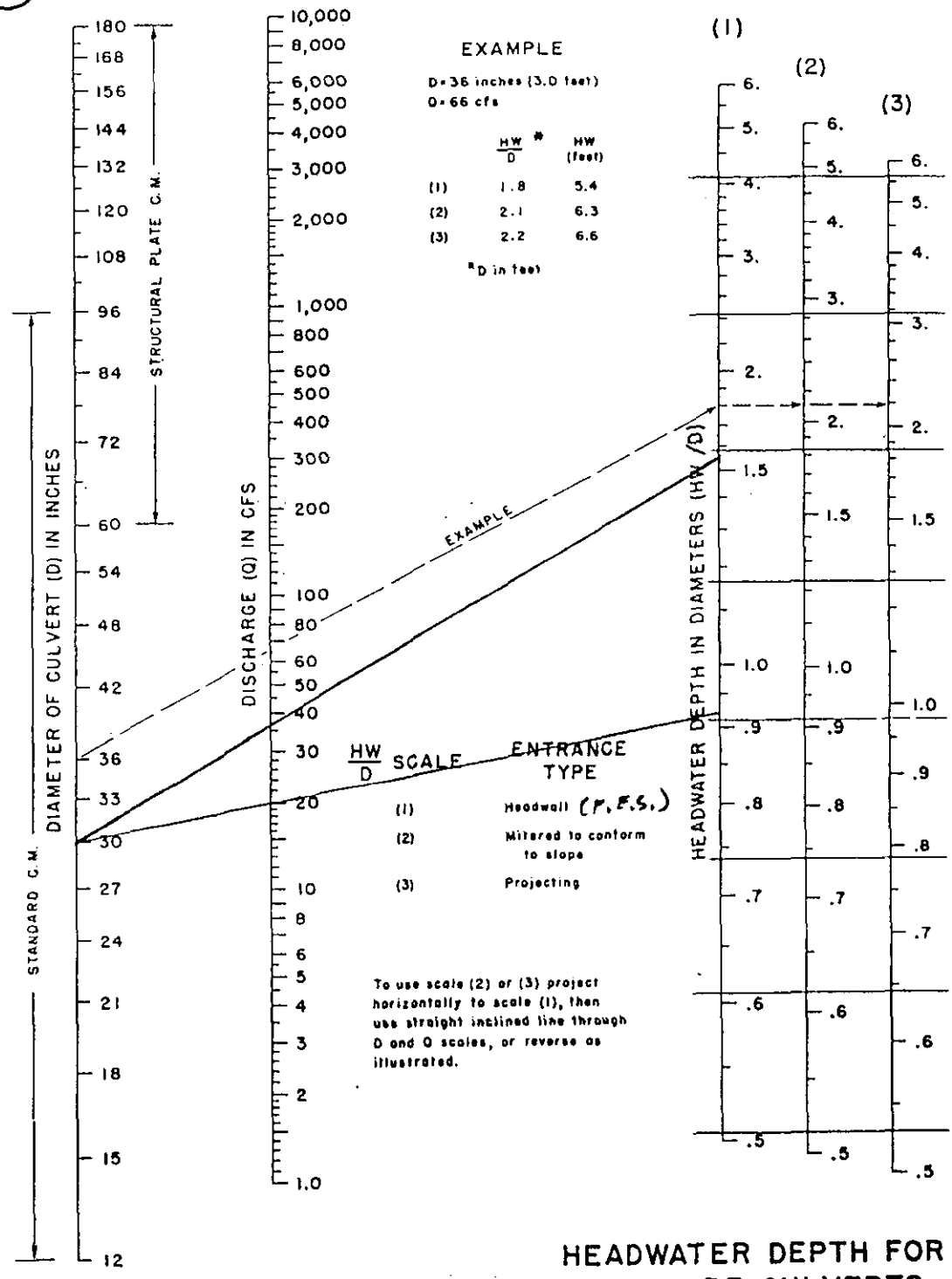


HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

BUREAU OF PUBLIC ROADS JAN. 1963

Culvert #2 3/3
"B" 920+95

CHART 2



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

PROJECT: S.R. 163.
NDOT P-059-93-11

STATION: "B" 98+50 (#3)
SHEET 1 OF 3

CULVERT DESIGN FORM

DESIGNER / DATE: AJL / 5/17
REVIEWER / DATE: ____ / ____

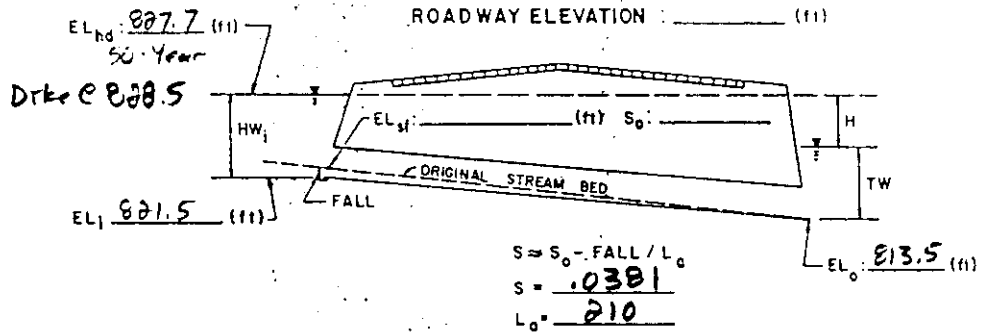
HYDROLOGICAL DATA

SEE ADD'L SHTS.

- ☒ METHOD: HEC-1
- ☐ DRAINAGE AREA: ____ ☐ STREAM SLOPE: ____
- ☐ CHANNEL SHAPE: ____
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
50 (J1, J2, J3)	317	2.5' (Est.)
100 (J2)	275	—



$S \approx S_o = FALL / L_o$
$S = .0381$
$L_o = 210$

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
8'x4' RCBC w/ Headwall	317	317	1.55	6.2		827.7	2.5	3.7	3.9	3.9	.2	2.8	820.2	827.7	29.0	50-Yr. Design
(w/o overtopping dike)	360	360	1.75	7.0		828.5	2.5'	4.0	4.0	4.0	.2	3.6	821.1	828.5	25.3	Dike @ 828.5 (0.8' Freeboard)
100-YR	275	275	1.4	5.6		827.1									↑	based on drawdown curve. D > Drawdown

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) HW_i/D = HW /D OR HW_i/D FROM DESIGN CHARTS

(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

$Q_f = 935$ cfs
$Q_D/Q_f = .34$
$V_f = 29.2$
$V_D/V_f = .88$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

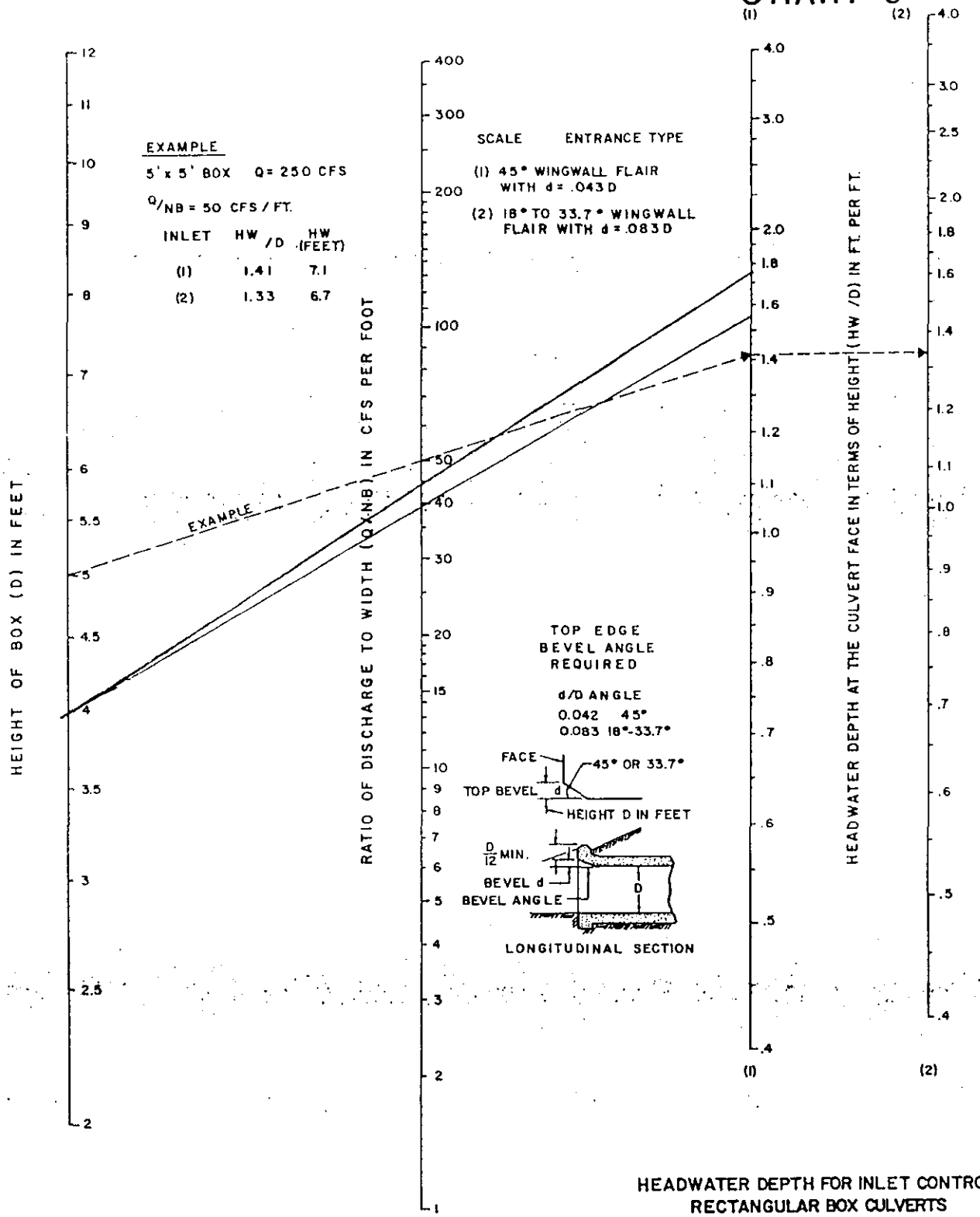
Culvert designed for 50-year event w/ min. 0.8' ft. freeboard. Culvert accomidates potential changes in upstream basin boundaries for J1 & J3 due to potential erosion/deposition on alluvial fan surface.

CULVERT BARREL SELECTED:

SIZE: ____
SHAPE: ____
MATERIAL: ____ n: ____
ENTRANCE: ____

CULVERT "B" 928+50

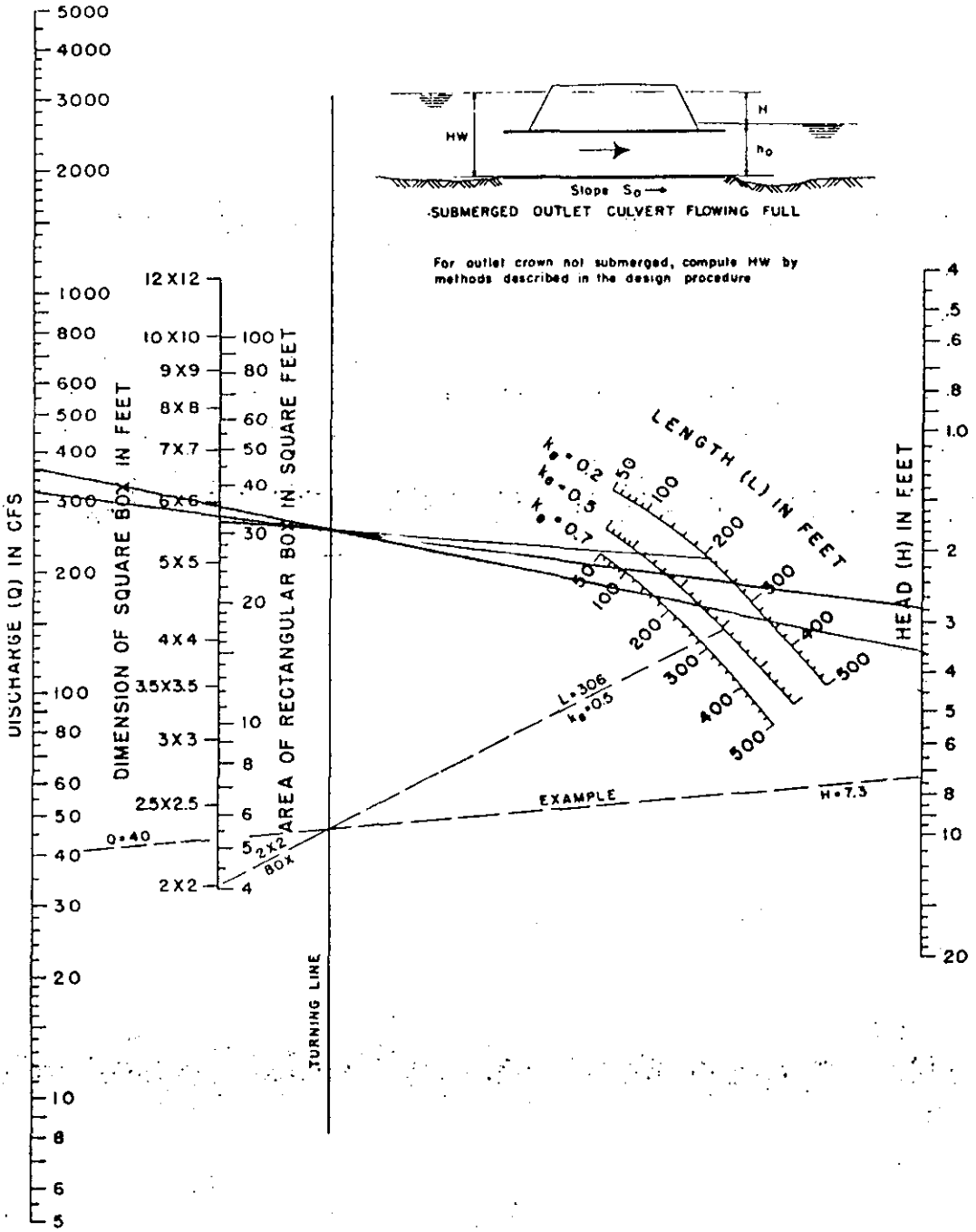
CHART 9



HEADWATER DEPTH FOR INLET CONTROL
RECTANGULAR BOX CULVERTS
FLARED WINGWALLS 18° TO 33.7° & 45°
WITH BEVELED EDGE AT TOP OF INLET

CULVERT #3
"B" 908150

CHART 15



HEAD FOR CONCRETE BOX CULVERTS FLOWING FULL n = 0.012

AU OF PUBLIC ROADS JAN. 1963

PROJECT: S.R. 163
NDOT P-059-93-11

STATION: "AB" 959+28 (-AA)
SHEET 1 OF 3

CULVERT DESIGN FORM

DESIGNER / DATE: AJZ / 5/17
REVIEWER / DATE: /

HYDROLOGICAL DATA

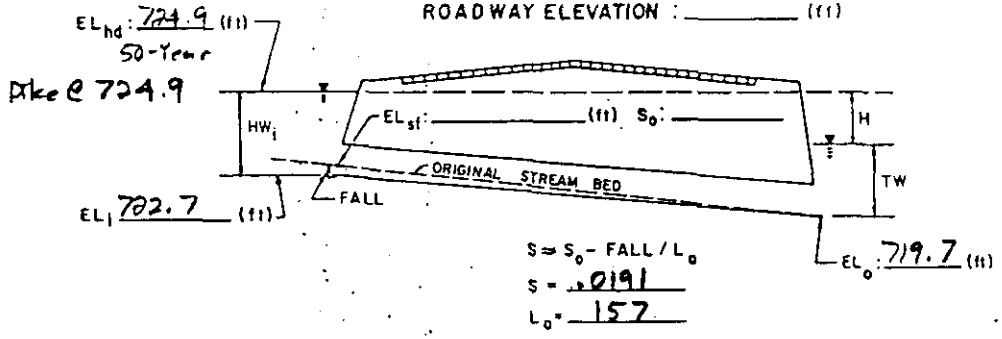
SEE ADD'L SHTS.

- [x] METHOD: HEC-1
- [ ] DRAINAGE AREA: ____ [ ] STREAM SLOPE: ____
- [ ] CHANNEL SHAPE: ____
- [ ] ROUTING: ____ [ ] OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
50	47	1' (Est.)
100	65	-

ROADWAY ELEVATION: ____ (ft)



S ≈ S_o - FALL / L_o
S = .0191
L_o = 157

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
5'x3' RCBC. w/ Headwall	47	47	.76	2.2		724.9	±1'	1.4	2.2	2.2	.2	.3	722	724.9	12.2	50-Yr Design

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

$Q_f = 245$
$Q_D/Q_f = .19$
$V_f = 16.3$
$V_D/V_f = .75$

SUBSCRIPT DEFINITIONS:

- a. APPROXIMATE
- f. CULVERT FACE
- hd. DESIGN HEADWATER
- hi. HEADWATER IN INLET CONTROL
- ho. HEADWATER IN OUTLET CONTROL
- i. INLET CONTROL SECTION
- o. OUTLET
- sf. STREAMBED AT CULVERT FACE
- tw. TAILWATER

COMMENTS / DISCUSSION:

For the 100 Year event, runoff in excess of 47cfs (18cfs) will overtop the dike and flow along the north side of "AB".

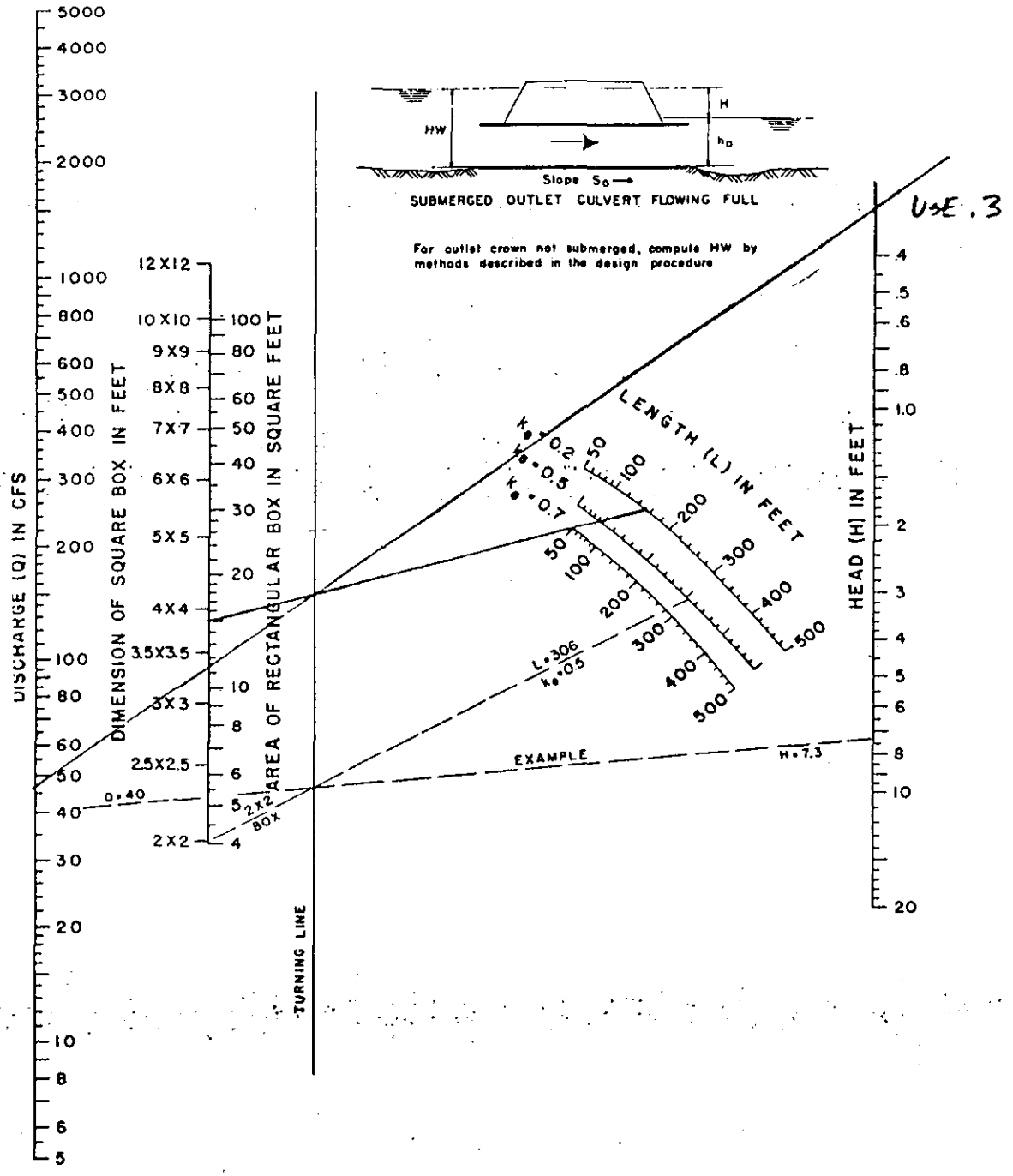
CULVERT BARREL SELECTED:

SIZE: ____
SHAPE: ____
MATERIAL: ____
ENTRANCE: ____

240

CULVERT 1 3/5
"A8" 959+28

CHART 15



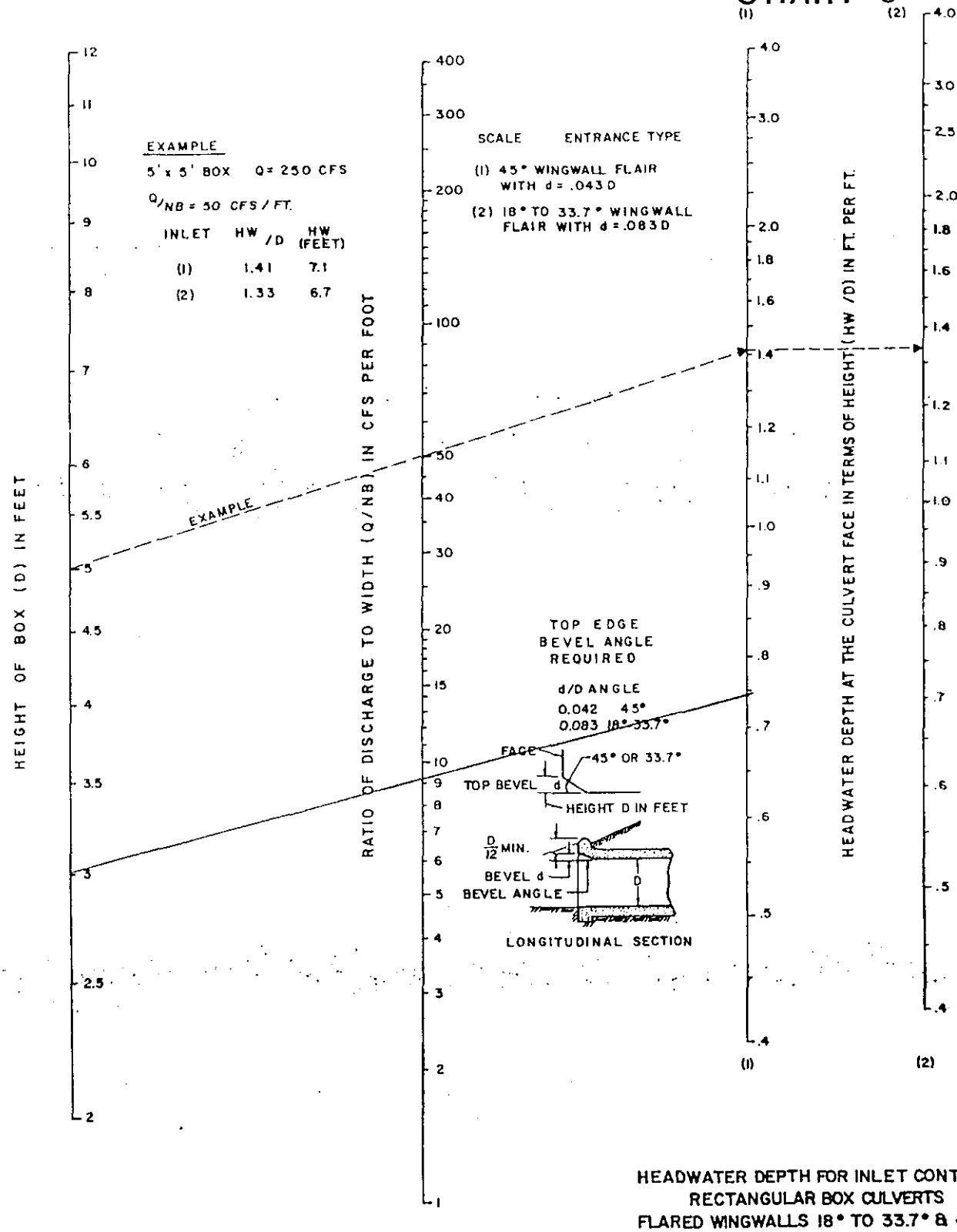
HEAD FOR CONCRETE BOX CULVERTS FLOWING FULL n = 0.012

AU OF PUBLIC ROADS JAN. 1963

CULVERT "T"
"A8" 959+28

-15

CHART 9



HEADWATER DEPTH FOR INLET CONTROL
RECTANGULAR BOX CULVERTS
FLARED WINGWALLS 18° TO 33.7° & 45°
WITH BEVELED EDGE AT TOP OF INLET

PROJECT: S.R. 163
NDOT P-059-93-11

STATION: "B" 978+00 (#6)
SHEET 1 OF 3

CULVERT DESIGN FORM
DESIGNER / DATE: AJR / 5/17
REVIEWER / DATE: /

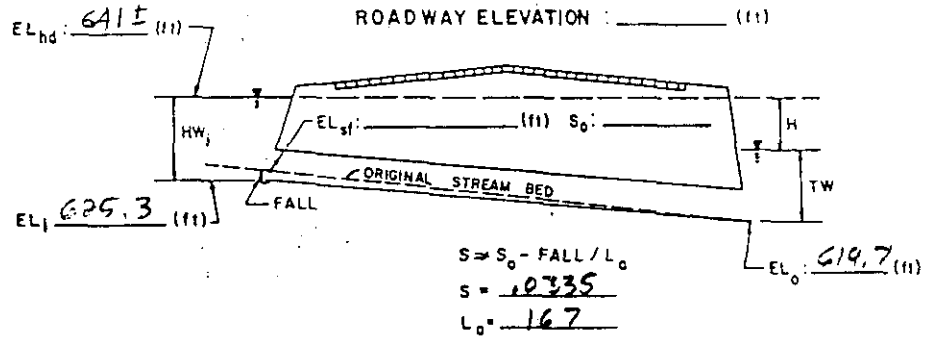
HYDROLOGICAL DATA

SEE ADD'L SHTS.

☒ METHOD: HEC-1
☐ DRAINAGE AREA: ____ ☐ STREAM SLOPE: ____
☐ CHANNEL SHAPE: ____
☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
50	17	1' (Eq.)
100	23	—



S ≈ S_o - FALL / L_o
S = .0335
L_o = 167

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
30" ØCMPW F.E.S.	17	17	.83	2.1		627.4	±1.0	1.4	2.0	2.0	.5	1.3	623.0	627.4	7.9	50-yr Design
" " " " "	23	23	1.03	2.6		627.9	±1.0	1.6	2.1	2.1	.5	2.4	624.2	627.9	8.7	100-yr check

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) HW_i/D = HW/D OR HW_i/D FROM DESIGN CHARTS

(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] v^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

$Q_f = 41 cfs$
$Q_D/Q_f = .41$
$V_f = 8.4 fps$
$V_D/V_f = .94$

SUBSCRIPT DEFINITIONS:

e. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

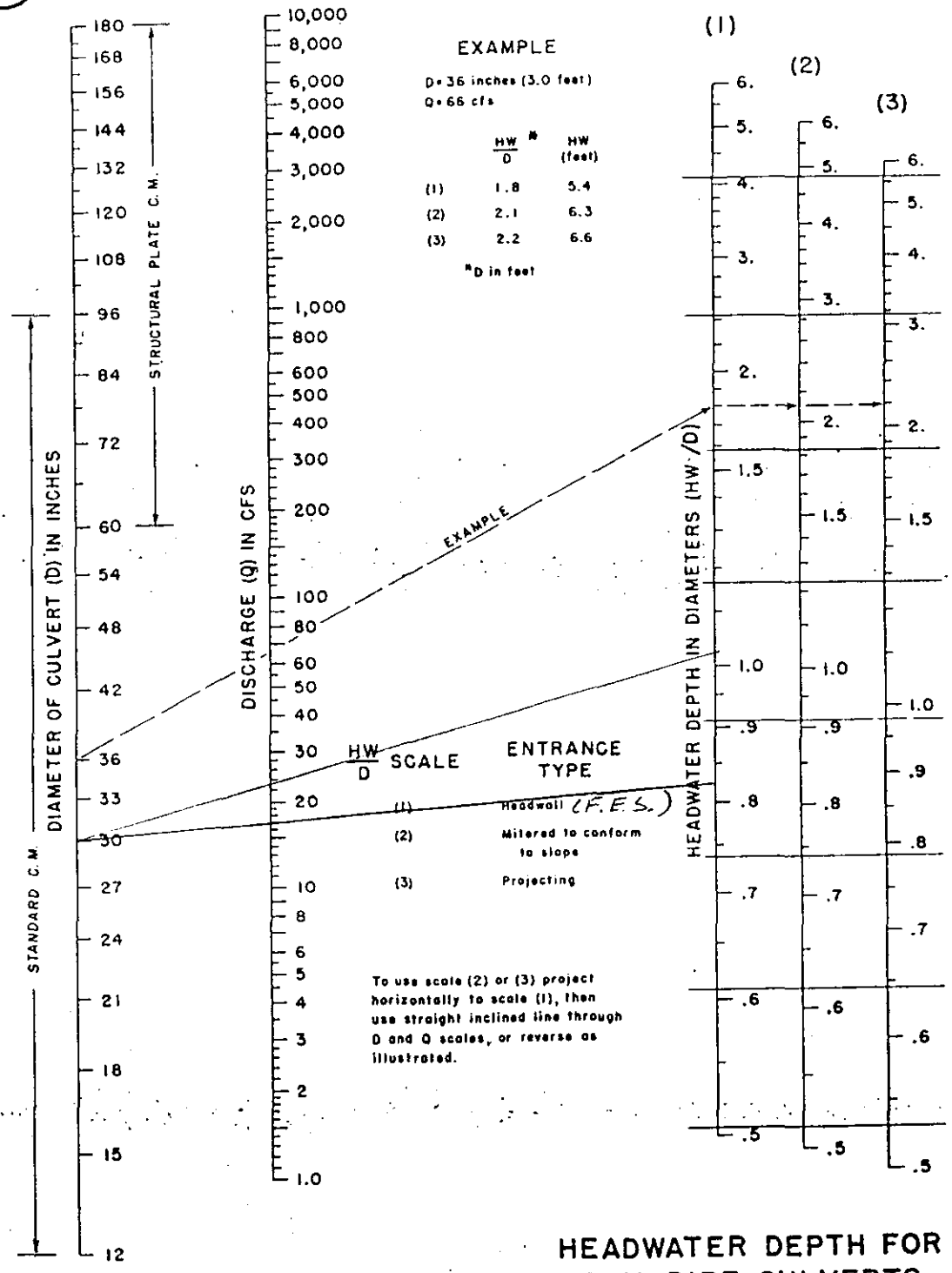
30" ø used instead of 24" ø to facilitate maintenance.

CULVERT BARREL SELECTED:

SIZE: ____
SHAPE: ____
MATERIAL: ____
ENTRANCE: ____

Culvert "B" 97+00 2/3

CHART 2



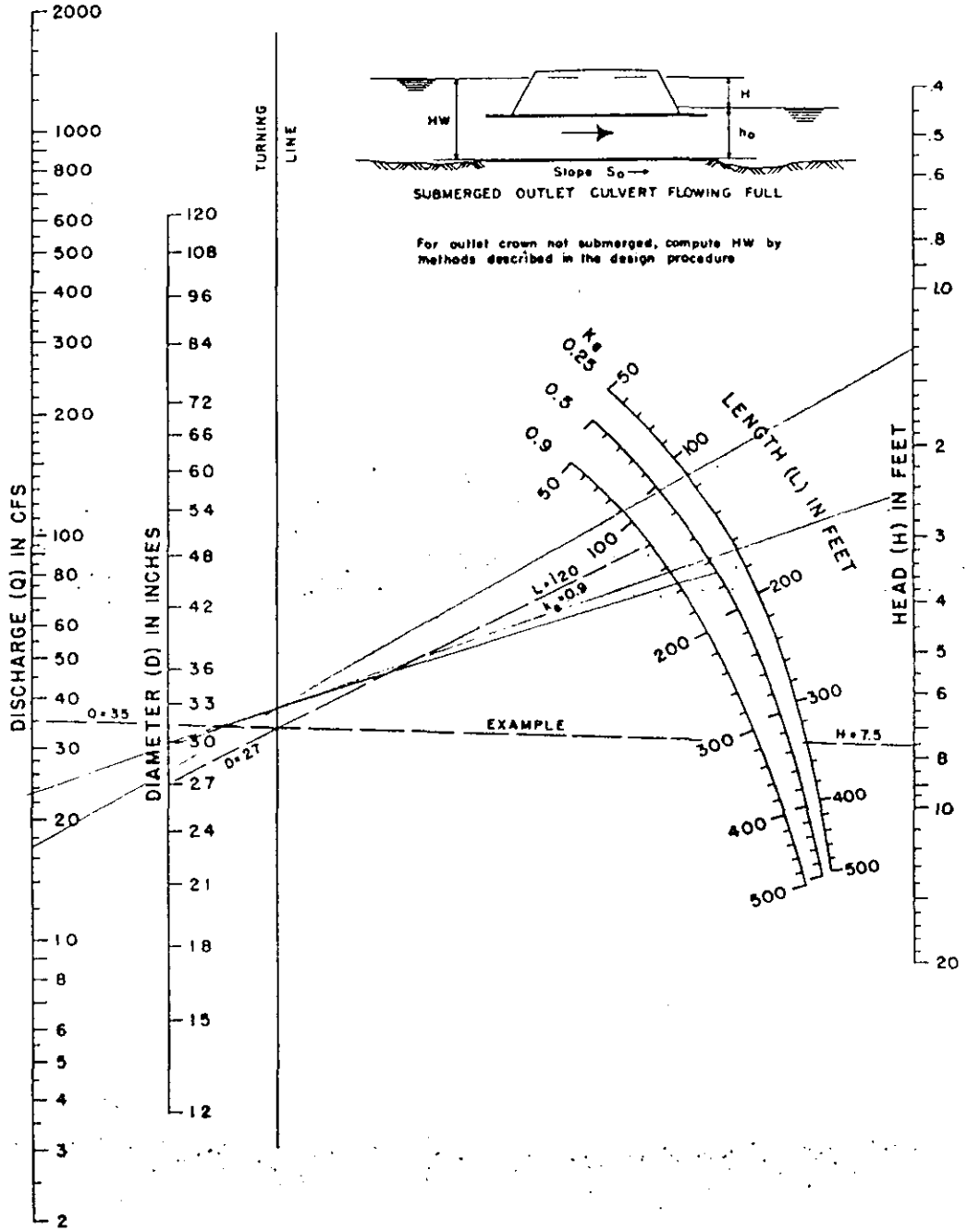
HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

Culvert #6
"B" 97+00

3/3

CHART 6



HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

BUREAU OF PUBLIC ROADS JAN. 1963

PROJECT: S.R. 163
NDOT P-059-93(11)

STATION: "A8" 986+58 (#7)
SHEET 1 OF 3

CULVERT DESIGN FORM
DESIGNER / DATE: AR / 5/17
REVIEWER / DATE: /

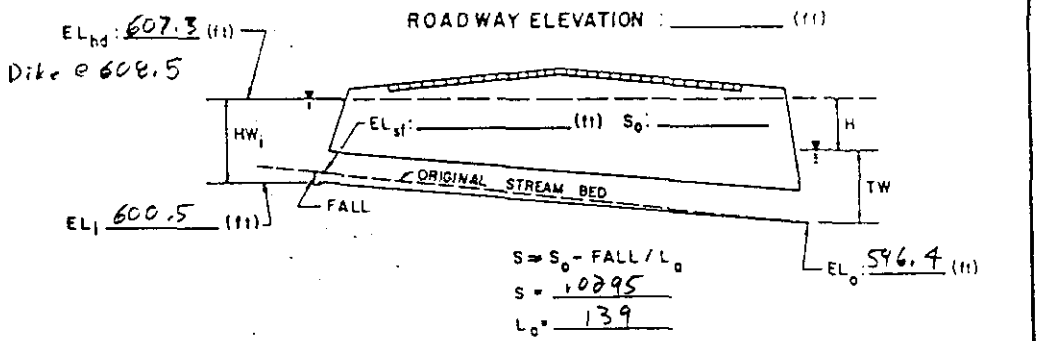
HYDROLOGICAL DATA

SEE ADD'L SHTS.

- [x] METHOD: HEC-1
- [ ] DRAINAGE AREA: ____ [ ] STREAM SLOPE: ____
- [ ] CHANNEL SHAPE: ____
- [ ] ROUTING: ____ [ ] OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
50	569	3' ±
100	843	



CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	INLET CONTROL HW_i	INLET CONTROL FALL (3)	INLET CONTROL EL_hi (4)	OUTLET CONTROL TW (5)	OUTLET CONTROL d_c	OUTLET CONTROL (d_c+D)/2	OUTLET CONTROL h_o (6)	OUTLET CONTROL k_e	OUTLET CONTROL H (7)	OUTLET CONTROL EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
12'x7' RCBC w/ Headwall	569	569	.97	6.8		607.3	3.0±	4.1	3.6	3.6	.2	1.0	601.0	607.3	20.7	50-Year Design
(w/o overtopping dike)	744	744	1.14	8.0		608.5	3.0±	4.8	5.9	5.9	.2	1.6	603.9	608.5	21.4	From drawdown Curve. D>D_n

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) HW_i/D = HW/D OR HW_i/D FROM DESIGN CHARTS

(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

$Q_f = 3032$
$Q_D/Q_f = .19$
$V_f = 36.1$
$V_D/V_f = .75$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

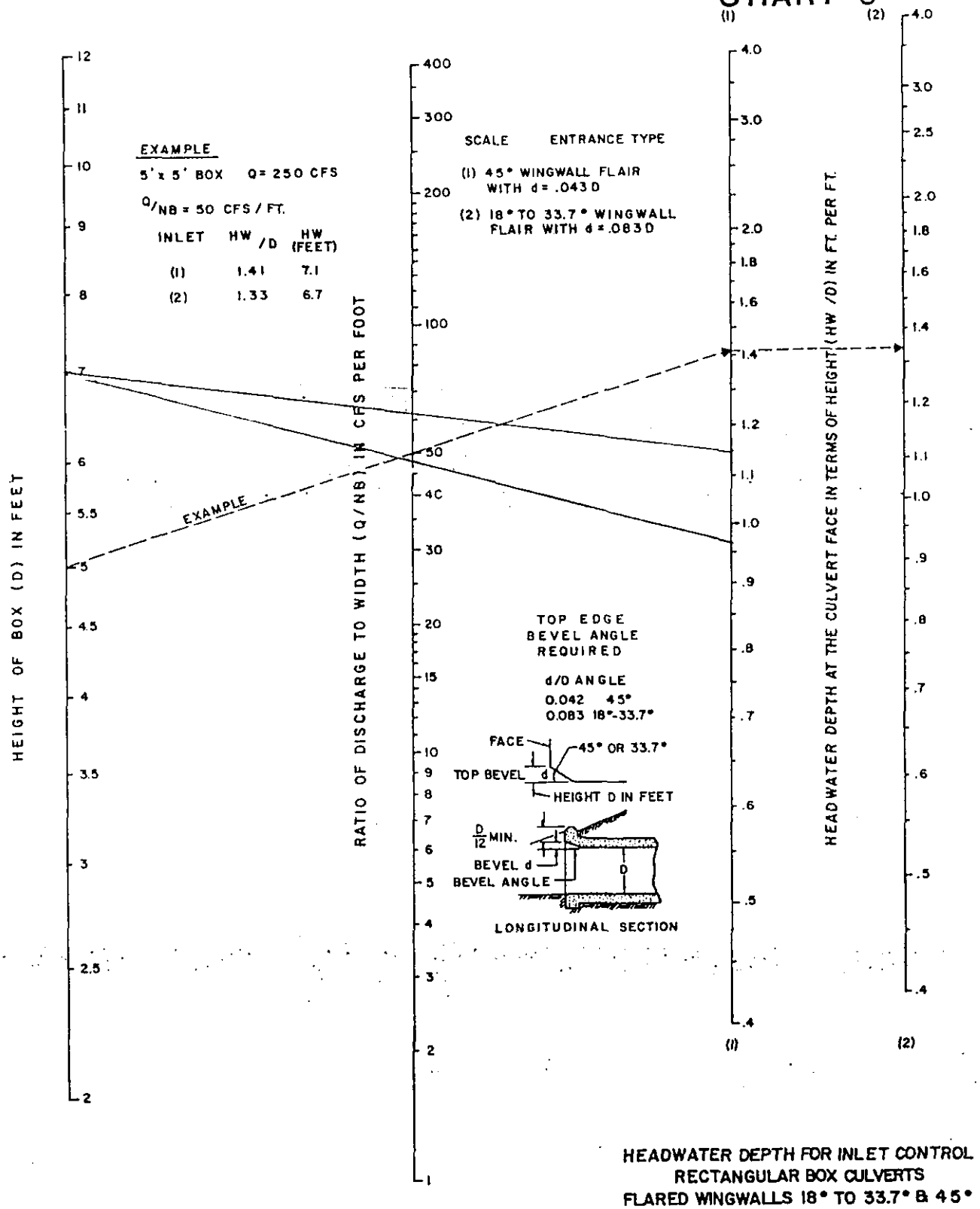
Outlet Velocity limited to less than V_D/V_f due to drawdown on short culvert length.
Culvert designed for 50-year event w/ min 1.0' freeboard.
For 100-year event, about 100 cfs will overtop dike & flow to culvert #8 (i.e. "C" 995+50) on north side of "A8"

CULVERT BARREL SELECTED:

SIZE: ____
SHAPE: ____
MATERIAL: ____ n ____
ENTRANCE: ____

Culvert #7 213
"AE" 986+58

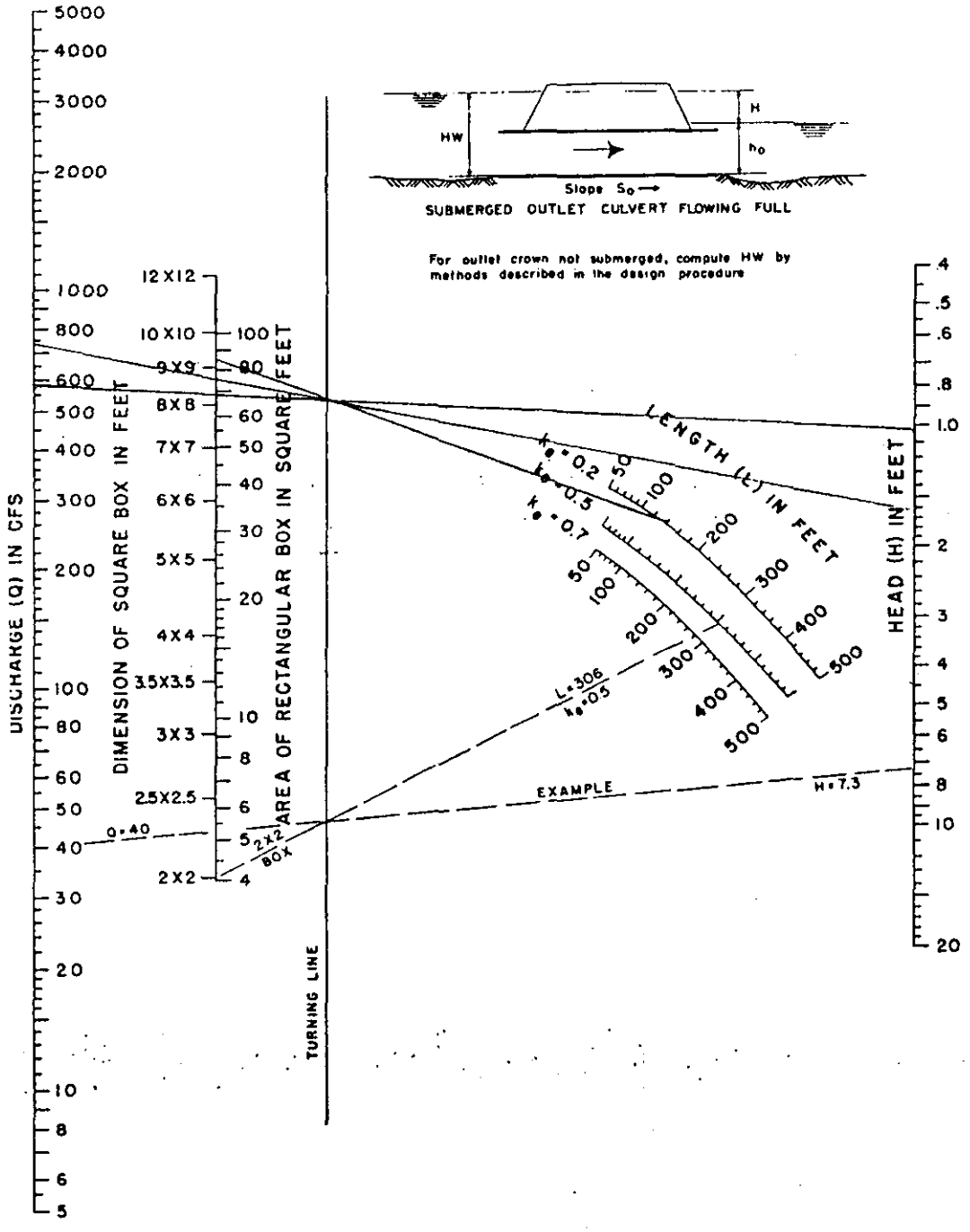
CHART 9



HEADWATER DEPTH FOR INLET CONTROL
RECTANGULAR BOX CULVERTS
FLARED WINGWALLS 18° TO 33.7° & 45°
WITH BEVELED EDGE AT TOP OF INLET

Culvert #7 3/3
"M" 986+58

CHART 15



HEAD FOR
CONCRETE BOX CULVERTS
FLOWING FULL
n = 0.012

AU OF PUBLIC ROADS JAN. 1963

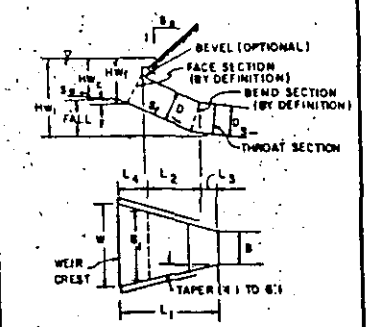
PROJECT: SR-163
NDOT P-059-93-11

STATION: "AE" 994+75
SHEET 1 OF 4

MITERED INLET DESIGN FORM

DESIGNER / DATE: AJC / 5/25
REVIEWER / DATE: ____ / ____

DESIGN DATA: N 1 ; B 10 ; D 3
Q 50yr = 574 cfs ; EL_{hi} 580.2 ft
EL. THROAT INVERT 567.2 ft EL. STREAM BED AT CREST 576.2 ft
FALL 9 ft ; TAPER 4 : (4:1 TO 6:1)
STREAM SLOPE, S_o — ft/ft ; BARREL SLOPE, S = .0479 ft/ft
SLOPE OF THE EMBANKMENT S_e = 2 : 1 ; S_f 3 : 1 (2:1 TO 3:1)
BARREL SHAPE AND MATERIALS: 10' x 3' RCBC
INLET EDGE DESCRIPTION: 6" R Bevel (Top Edge)



SLOPE-TAPERED INLET/MITERED FACE

COMMENTS
Provide Dike to Elevation 581.2

Q (cfs)	EL_{hi}	EL. THROAT INVERT	y (1)	EL. FACE INVERT (2)	HW_f (3)	HW_f/E (4)	Q/B_f (5)	MIN. B_f (6)	SELECTED B_f	MIN. L_3 (7)	L_4 (8)	L_2 (9)	CHECK L_2 (10)	ADJ. L_3 (11)	ADJ. TAPER (12)	L_1 (13)	EL. CREST INV.	HW_c (14)	MIN. W (15)	W (16)
574	580.2	567.2	.95	575.25	4.95	1.65	25	23.0	24.1	5.0	3.85	27.15	23.2	5.05	X	32.05	576.2	4.0	25.1	26.0

(1) $y = \left[\frac{(S_e \cdot S_f) - 1}{(S_e + S_f)(S_f^2 + 1)^{0.5}}\right] \cdot D$
(2) EL. FACE INVERT = EL. STREAM BED AT CREST - y
(3) HW_f = EL_{hi} - EL. FACE INVERT
(4) 1.1 D ≥ E ≥ D
(5) FROM DESIGN CHARTS
(6) MIN. $B_f = Q/(Q/B_f)$
(7) MIN. L_3 = 0.5 NB
(8) $L_4 = S_f y + D/S_f$
(9) L_2 = (EL. CREST INVERT - EL. THROAT INVERT) $S_f - L_4$
*** IF L_2 IS NEGATIVE DO NOT USE THIS INLET

(10) CHECK $L_2 = \left[\frac{B_f - NB}{2}\right]$ TAPER - L_3
(11) IF (10)>(9), ADJ. $L_3 = \left[\frac{B_f - NB}{2}\right]$ TAPER - L_2
(12) IF (9)>(10), ADJ. TAPER = $(L_2 + L_3) / \left[\frac{B - NB}{2}\right]$
(13) $L_1 = L_2 + L_3 + L_4$
(14) HW_c = EL_{hi} - EL. CREST INVERT
(15) MIN. W = $0.35 Q / (HW_c)^{1.5}$
(16) $W = NB + 2\left[\frac{L_1}{\text{TAPER}}\right]$
IF W<MIN. W, ADJUST TAPER

SELECTED DESIGN
B_f 24'-1"
L_1 32'-1"
L_2 23'-2"
L_3 5'-1"
L_4 3'-10"
BEVELS ANGLE 6"R.
b = — in; d = — in
TAPER 4 : 1
S_f 3 : 1

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CENTURY PARK
1771 EAST FLAMINGO ROAD–SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893–6266
FAX NO. (702) 893–6269

JOB NUMBER: 2016 SHEET 2 OF 4
JOB NAME: S.R. 163
CALC. BY: AJL DATE 5/25/93
CHKD. BY: _____ DATE __/__/__
REV. BY: _____ DATE __/__/__

SUBJECT: Sloping Mitered Inlet Design @ Culvert #8 "A8" 994+75

I. Inlet Control Check

Q = 574

Q/w = 57.4

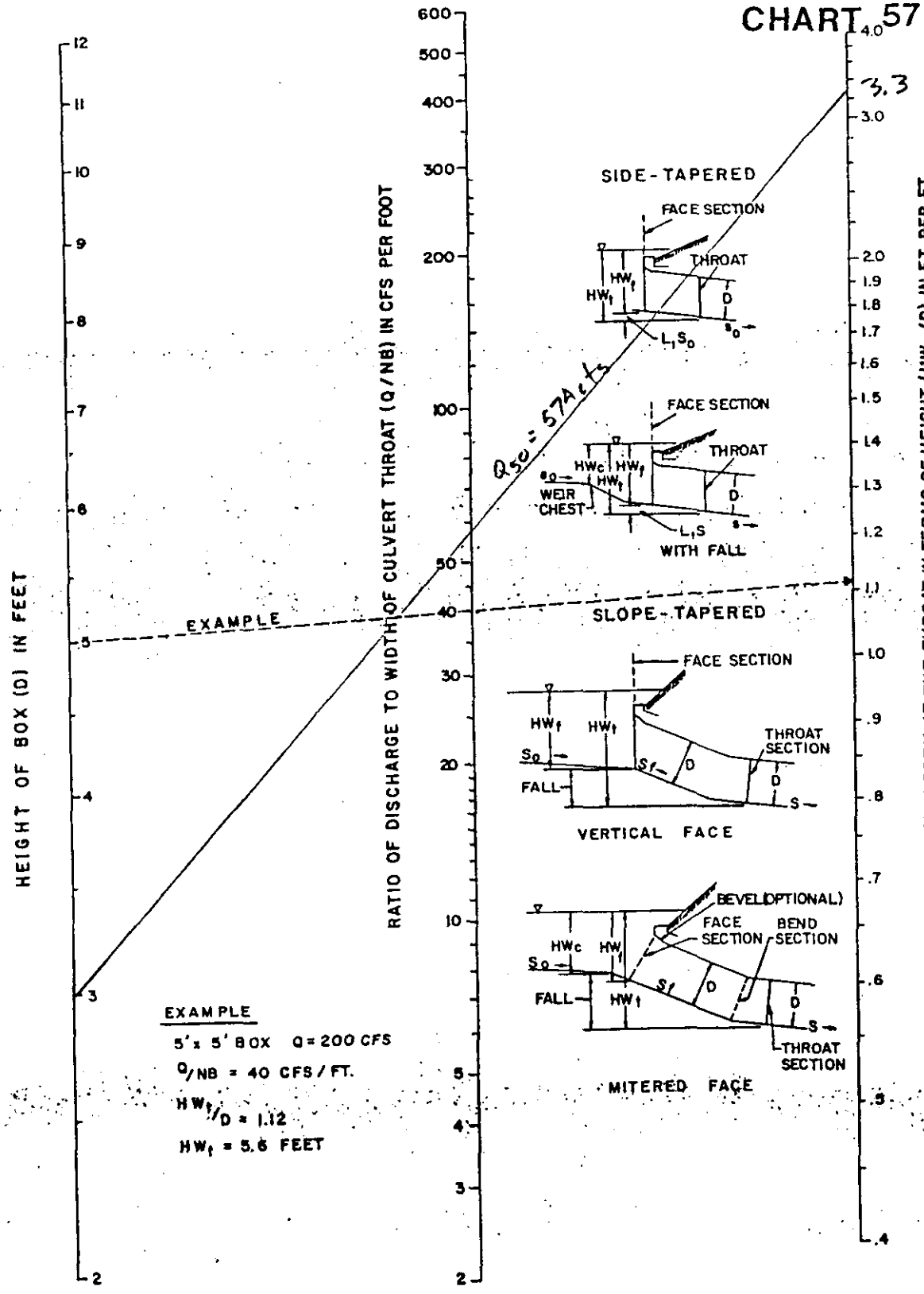
∴ From Chart 57, Hw/D = 3.3'

∴ Hw = 3.3 x 3 = 9.9'

Hw Elev = 567.2 + 9.9 = 577.1

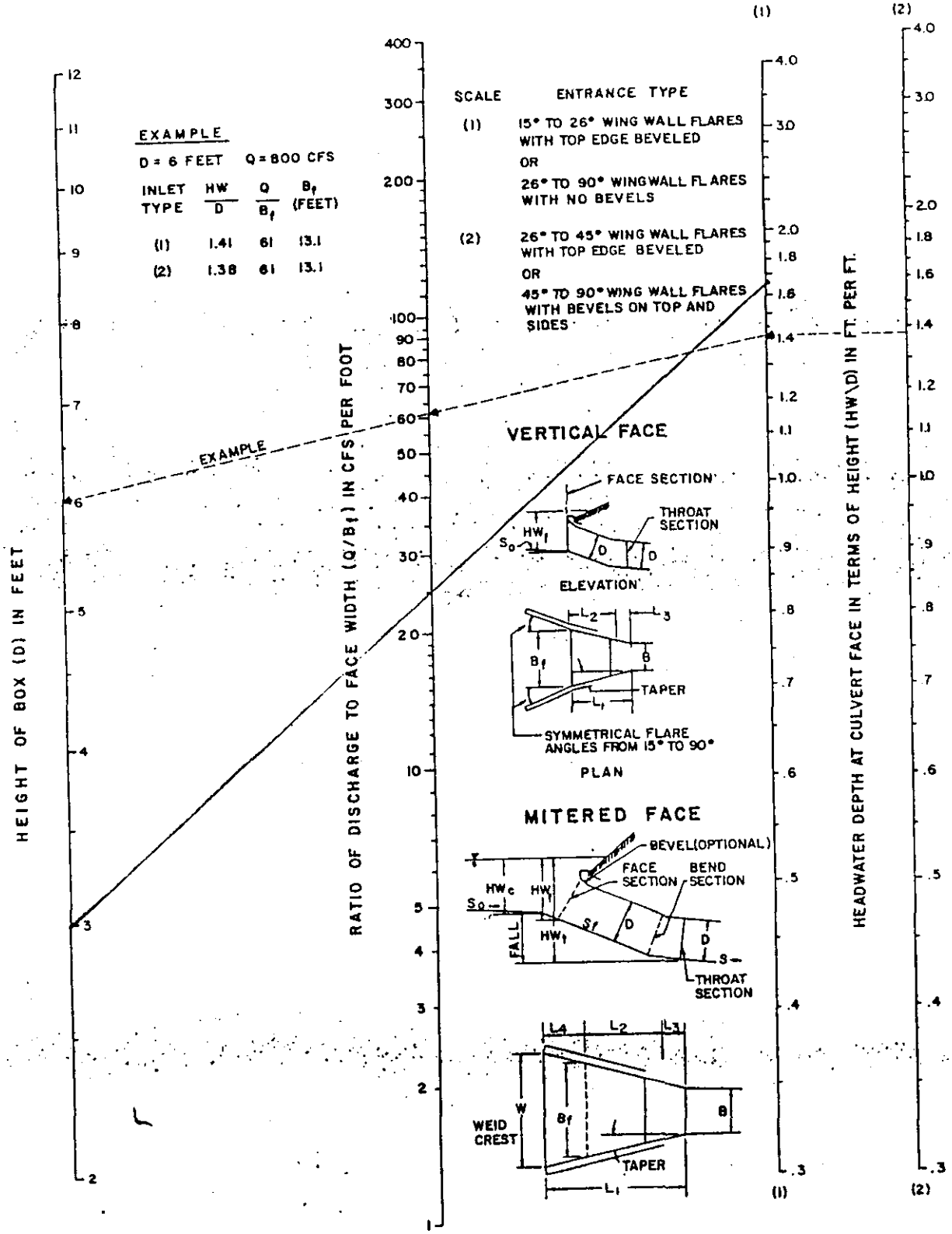
Hw Provided = 580.2 OK

CULVERT "B" 3/4
"A8" 994+75
CHART 57



THROAT CONTROL FOR BOX CULVERTS WITH TAPERED INLETS

CHART 59



FACE CONTROL FOR BOX CULVERTS WITH SLOPE TAPERED INLETS

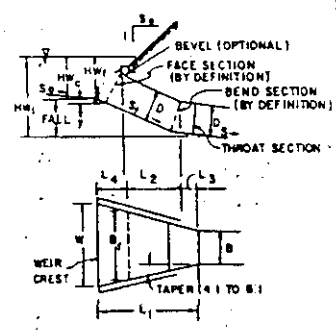
PROJECT: S.R. 163
NDOT P-059-93-11

STATION: "C" 999+79
SHEET 1 OF 1

MITERED INLET DESIGN FORM

DESIGNER / DATE: AJL / 5/17
REVIEWER / DATE: /

DESIGN DATA: N 1 ; B 6.5 ; D 6.5
Q 50-yr = 589 cfs ; EL_{hi} 554.8 ft (EL. = 554.8 @ STA 999+79)
EL. THROAT INVERT 543.0 ft EL. STREAM BED AT CREST 550.0 ft
FALL 7 ft ; TAPER 4:1 : (4:1 TO 6:1)
STREAM SLOPE, S_o — ft/ft ; BARREL SLOPE, S = .0202 ft/ft
SLOPE OF THE EMBANKMENT S_e = 2 : 1 ; S_f 3 : 1 (2:1 TO 3:1)
BARREL SHAPE AND MATERIAL: 78"Ø RCP (w/ Transition Section)
INLET EDGE DESCRIPTION: 6"R Bevel (Top Edge)



SLOPE-TAPERED INLET/MITERED FACE

COMMENTS
Use E = D
Throat control checked with chart 57 using 78" RCP throat.
- Set wingwalls @ 1.0' above crest @ crest end of wall
- Use 4' Bar to 78" Transition Section

Q (cfs)	EL_{hi}	EL. THROAT INVERT	y (1)	EL. FACE INVERT (2)	HW_f (3)	HW_f/E (4)	Q/B_f (5)	MIN. B_f (6)	SELECTED B_f	MIN. L_3 (7)	L_4 (8)	L_2 (9)	CHECK L_2 (10)	ADJ. L_3 (11)	ADJ. TAPER (12)	L_1 (13)	EL. CREST INV.	HW_c (14)	MIN. W (15)	W (16)
589	554.8	543.0	2.06	547.94	6.86	1.06	51	11.5	15.5	3.25	8.35	12.65	14.75	5.35	X	26.35	550.0	4.8	19.6	19.7

(1) $y = \left[\frac{(S_e \cdot S_f) - 1}{(S_e + S_f)(S_f^2+1)^{0.5}}\right] \cdot D$
(2) EL. FACE INVERT = EL. STREAM BED AT CREST - y
(3) $HW_f = EL_{hi}$ - EL. FACE INVERT
(4) 1.1 D ≥ E ≥ D
(5) FROM DESIGN CHARTS
(6) MIN. $B_f = Q/(Q/B_f)$
(7) MIN. L_3 = 0.5 NB
(8) $L_4 = S_f y + D/S_f$
(9) L_2 = (EL. CREST INVERT - EL. THROAT INVERT) $S_f - L_4$
*** IF L_2 IS NEGATIVE DO NOT USE THIS INLET

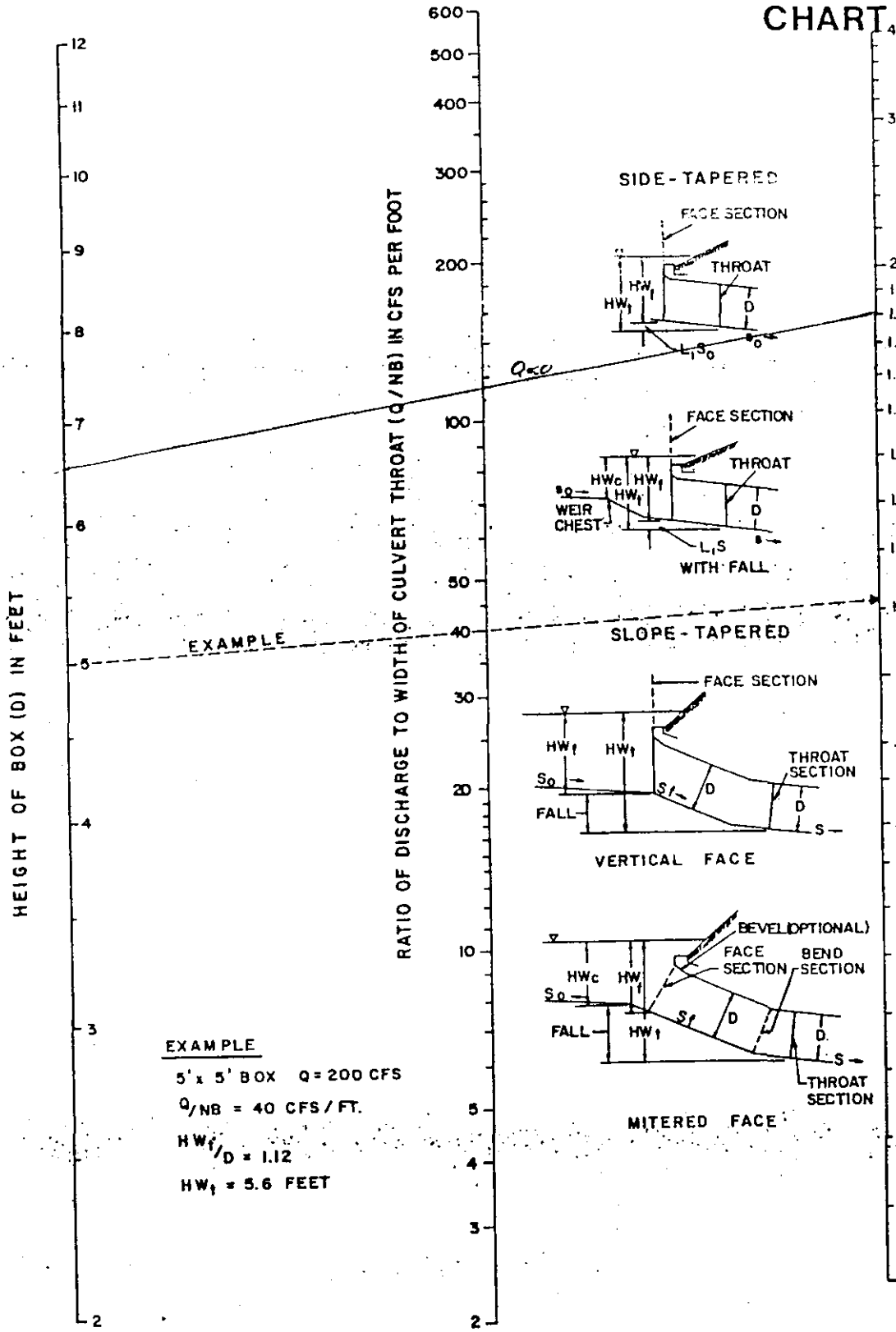
(10) CHECK $L_2 = \left[\frac{B_f - NB}{2}\right]$ TAPER - L_3
(11) IF (10)>(9), ADJ. $L_3 = \left[\frac{B_f - NB}{2}\right]$ TAPER - L_2
(12) IF (9)>(10), ADJ. TAPER = $(L_2 + L_3) / \left[\frac{B_f - NB}{2}\right]$
(13) $L_1 = L_2 + L_3 + L_4$
(14) HW_c = EL_{hi} - EL. CREST INVERT
(15) MIN. W = $0.35 Q / (HW_c)^{1.5}$
(16) $W = NB + 2\left[\frac{L_1}{TAPER}\right]$
IF W<MIN. W, ADJUST TAPER

SELECTED DESIGN
B_f 15'-6"
L_1 26'-4"
L_2 12'-8"
L_3 5'-4"
L_4 8'-4"
BEVELS ANGLE 6"R
b = — in; d = — in
TAPER 4 : 1
S_f 3 : 1

STORM SECTION ENTRANCE
STA "C" 999+29

2/4

CHART 57



EXAMPLE

5' x 5' BOX Q = 200 CFS

Q/NB = 40 CFS / FT.

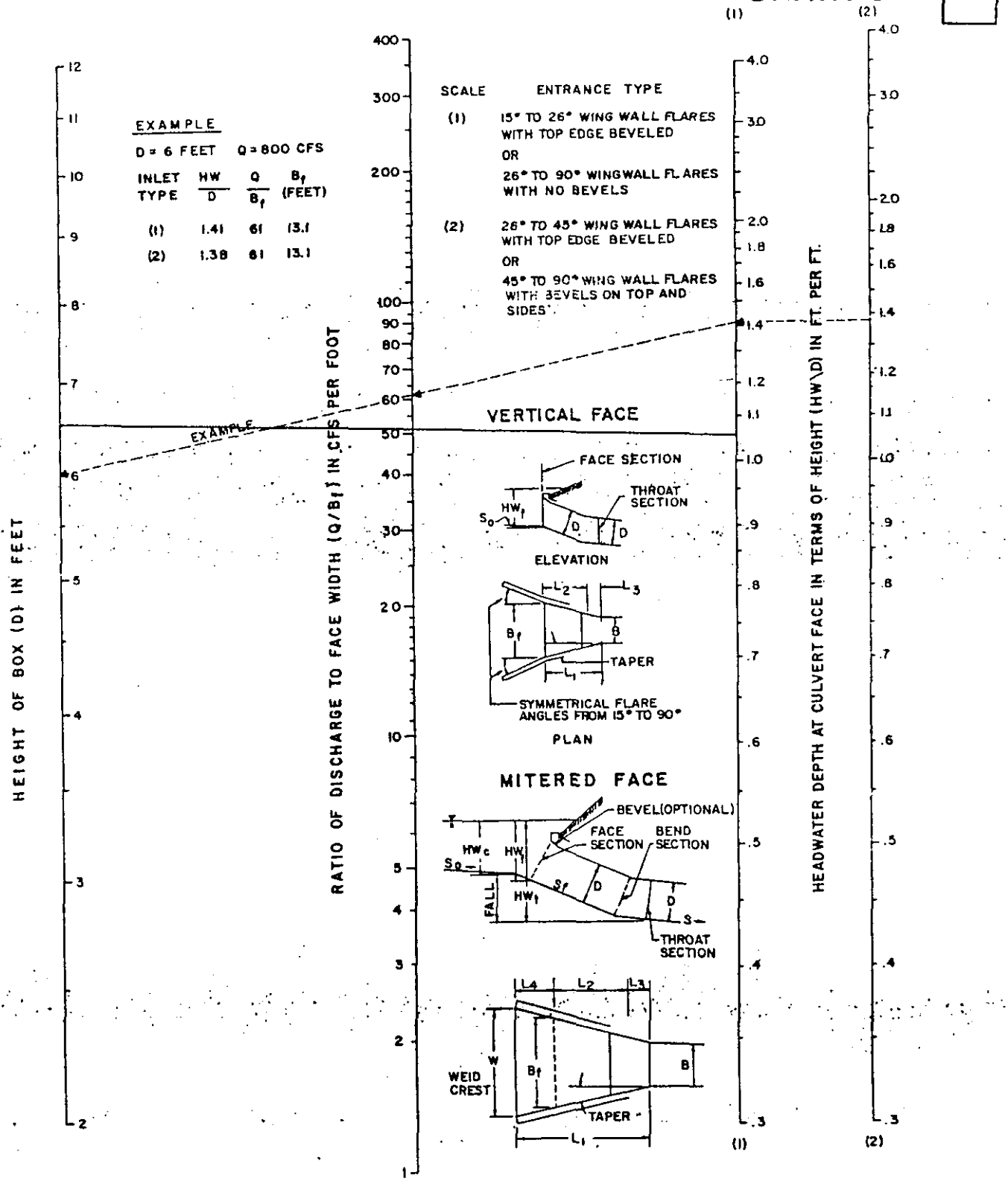
HW_f/D = 1.12

HW_f = 5.6 FEET

THROAT CONTROL FOR BOX CULVERTS WITH TAPERED INLETS

STORM SEWER ENTRANCE 5/4
STA "C" 999+29

CHART 59



FACE CONTROL FOR BOX CULVERTS WITH SLOPE TAPERED INLETS

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CENTURY PARK
1771 EAST FLAMINGO ROAD—SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893-6266
FAX NO. (702) 893-6269

JOB NUMBER: 2016 SHEET 4 OF 4
JOB NAME: S.R. 163
CALC. BY: AJL DATE 5/17/93
CHKD. BY: _____ DATE __/__/__
REV. BY: _____ DATE __/__/__

SUBJECT: Storm Sewer Sloping Mitered Inlet Design "L"999129

I. For Throat Control, use 78"ϕ RCP & convert to proper area for use in chart.

Area 78"ϕ = 33.18

Equivalent Box width = 33.18 / 6.5 = 5.1'

∴ Design cfs/ft = 589 / 5.1 = 115.4

From chart 57, HW/D = 1.81

∴ HW = 1.81 × 6.5 = 11.8'

Elev. HW = 11.8 + 543.0 = 554.8

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LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893–6266
FAX NO. (702) 893–6269

JOB NUMBER: 2016 SHEET 1 OF 5
JOB NAME: S.R. 163
CALC. BY: AAR DATE 5/17/93
CHKD. BY: _____ DATE __/__/__
REV. BY: _____ DATE __/__/__

SUBJECT: BAFFLED OUTLET DESIGN (IMPACT STILLING BASIN)

Ref: 1. "Hydraulic Design of Stilling Basin for Pipe or Channel Outlet", Research Report No. 24, U.S.B.R, Dept. of the Interior, Denver, Colorado, 1978.

2. "Hydraulic Design of Energy Dissipators for Culverts and Channels", HEC No. 14, FHWA, Dept. of Transportation, Washington, D.C., September 1983.

Design conditions:

$Q_{50} = 593$
$V_{(max)} = 25$fps

The HEC No. 14 limits the use of this basin to $Q \leq 400$ cfs. However, the U.S.BR. documents indicate that larger flows (and larger basins) can be used as long as: the basin width is computed using the standard design formulas; Froude No. ≤ 9; $V \leq 50$fps. Therefore, the USBR procedure is utilized for this design.

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LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893–6266
FAX NO. (702) 893–6269

JOB NUMBER: 2016 SHEET 2 OF 5
JOB NAME: S.R. 163
CALC. BY: AJL DATE 5/17/93
CHKD. BY: DATE __/__/__
REV. BY: DATE __/__/__

SUBJECT:

1. Compute inflow Froude Number, Ff_c

$Ff_c = V/\sqrt{g d}$

$d = \sqrt{A}$

A = Full flow area

$A = \pi (B)^2/4 = \pi (6.5)^2/4 = 33.18$ S.F.

$\therefore d = 5.76$ FT.

$V = Q/A = 593/33.18 = 17.87$ FPS

$\therefore Ff_c = 17.87/\sqrt{32.2(5.76)}$

$= 1.31$

$\therefore$ From Figure 8., w/D (min) $= 3.3$

$\therefore w = 3.3(5.76) = 19$ FT

Check normal max. design inflow parameters

$A_n = 26.1$ S.F.

$D_n = 4.77$ FT.

$V_n = 22.7$ FPS

$Ff_{rn} = 1.83$

$w/D_n = 4.1$

$w = 19.6$ FT

2. Suggested Width Range:

Minimum $w: Q = (w/1.46)^{2.5} \Rightarrow w = 18.8$

Intermediate $w: Q = (w/1.6)^{2.5} \Rightarrow w = 20.6$

Maximum $w: Q = (w/1.8)^{2.5} \Rightarrow w = 23.1$

3. $\therefore$ USE $w = 20'-0"$

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FAX NO. (702) 893-6269

JOB NUMBER: 2016 SHEET 3 OF 5
JOB NAME: S.R. 163
CALC. BY: AJL DATE 5/17/93
CHKD. BY: _____ DATE __/__/__
REV. BY: _____ DATE __/__/__

SUBJECT: _____

4. Select design dimensions:

a) Hydraulic dimensions:

H = .75W = 15'-0"
L = 1.33W = 26'-8"
a = .5W = 10'-0"
b = .375W = 7'-6"
c = .5W = 10'-0"
d = .167W = 3'-4"
e = .083W = 1'-8"

b) Structural dimensions: (To be determined by NDOT's structural designers)

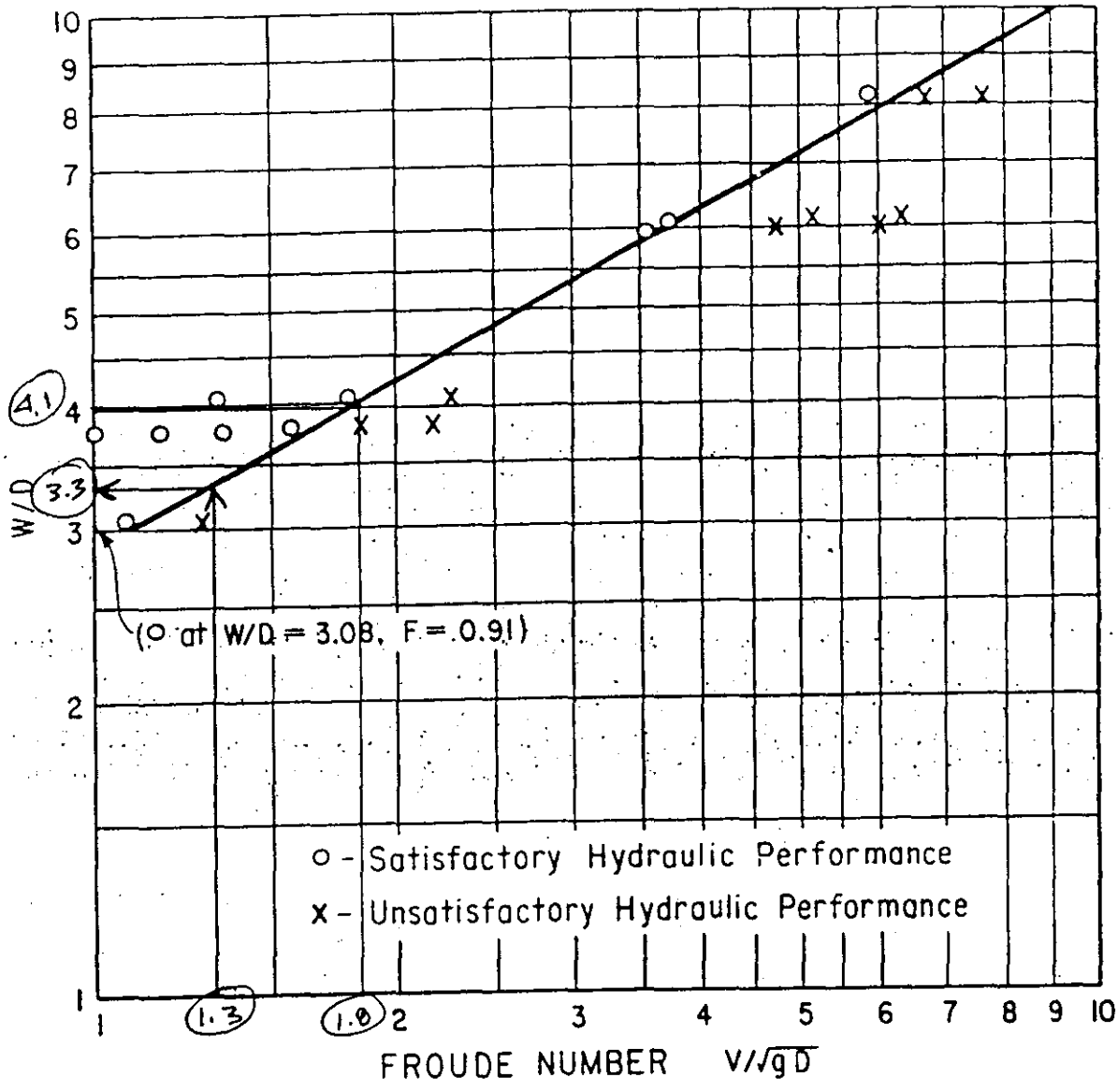
suggested parameters based on designs in literature:

t = .083W = 1'-8"
t_f = 1'-2"
t_w = 1'-2"
t_t = 0'-6"
t_{tw} = 0'-8"

f_a = 0'-3" (45°)
f_b = 0'-8" (45°)

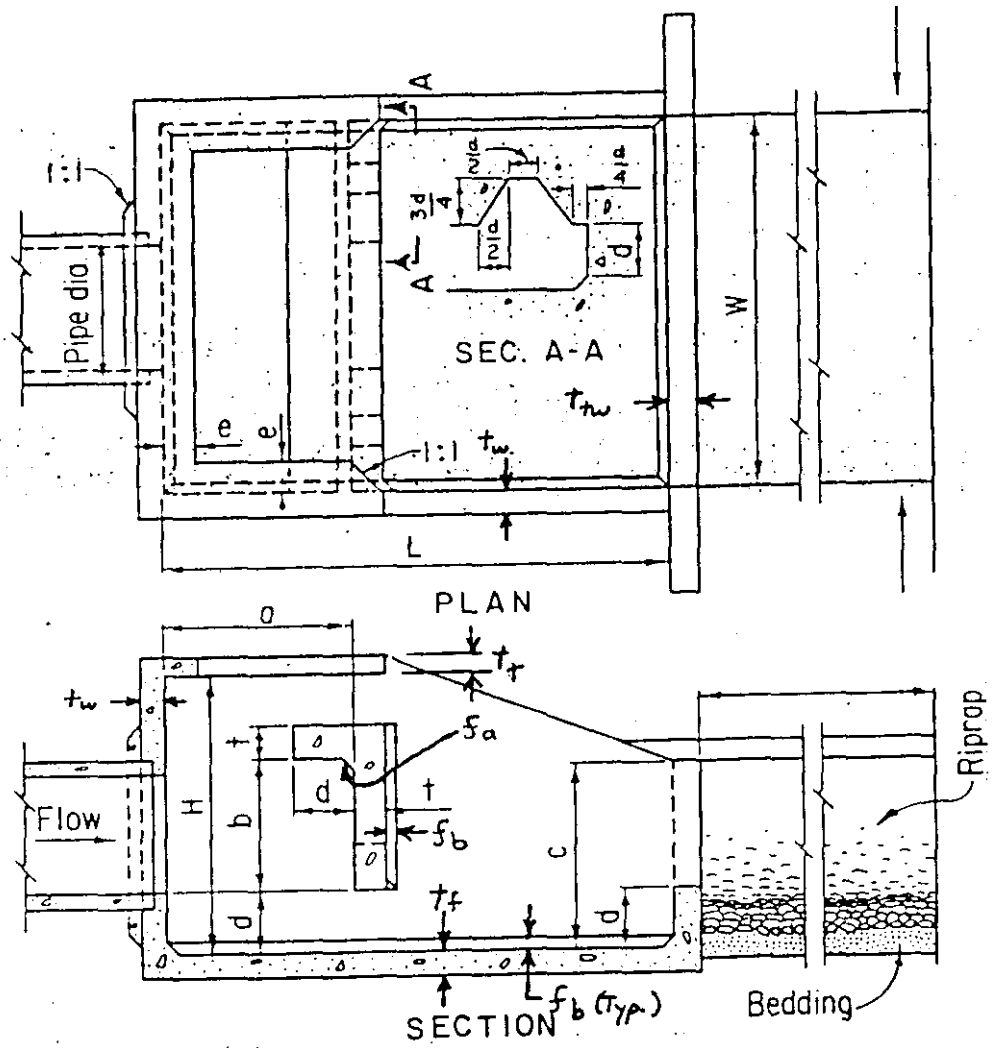
5. VENT PIPE

Add vent pipe to U/S intake structure or use grated manhole cover at U/S junction.



"W" is the inside width of the basin.
"D" represents the depth of flow entering the basin and is the square root of the flow area.
"V" is the velocity of the incoming flow.
The tailwater depth is uncontrolled.

Figure 8.–Design width of basin.

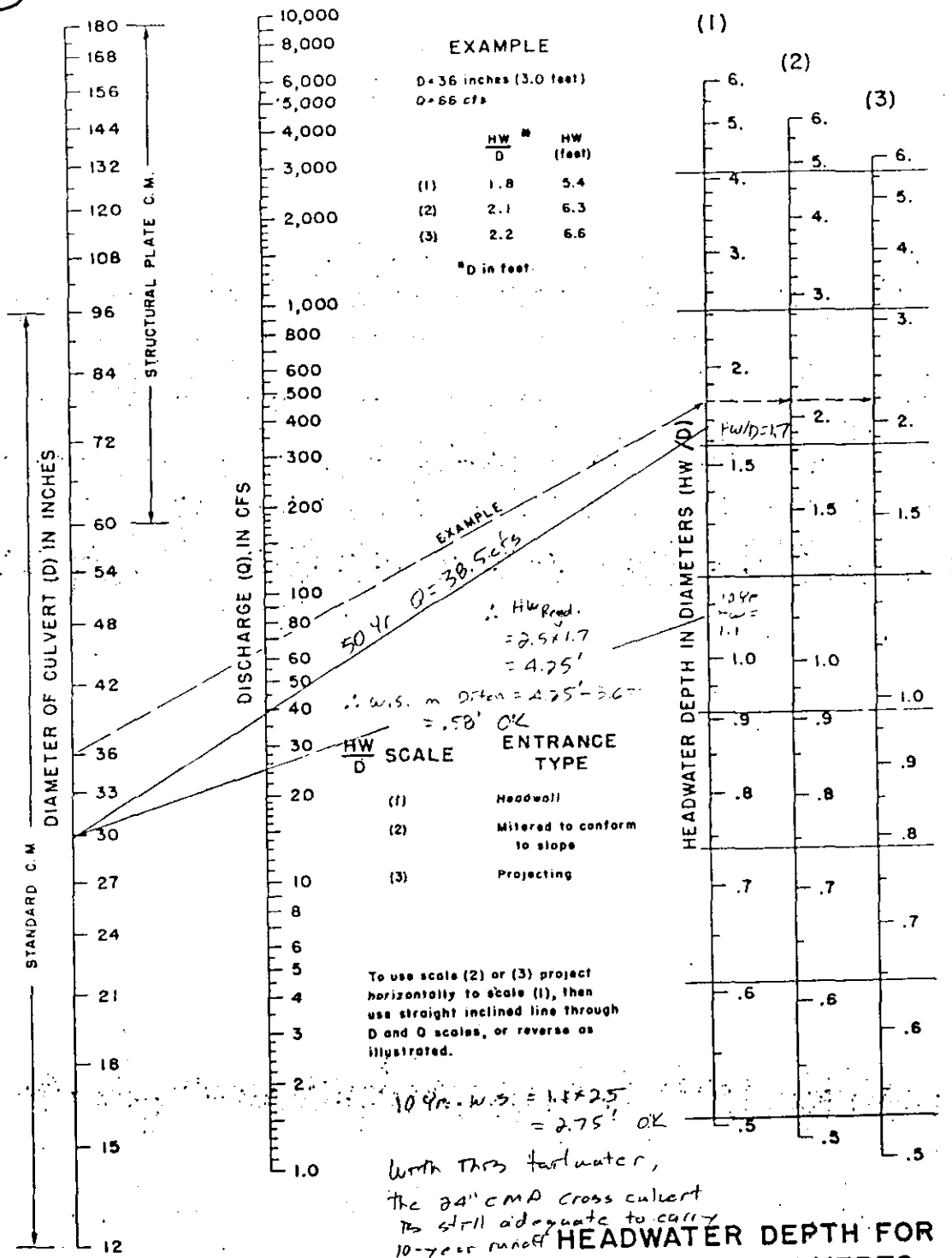


H = 3W/4	c = W/2
L = 4W/3	d = W/6
a = W/2	e = W/12
b = 3W/8	t = W/12 suggested minimum
	Riprap stone size diameter = W/20

Figure 1.–General design of the type VI impact stilling basin.

Check of On-site farm pond capacity @ sta 'F' 0+50-25± (30" CMP)

CHART 2



∴ $HW_{Read.}$ = 2.5 × 1.7 = 4.25'

∴ w.s. in Ditch = 4.25' − 3.67' = .58' OK

10 yr. HW = 1.1

10 yr. w.s. = 1.1 × 2.5 = 2.75' OK

With this tailwater, the 24" CMP cross culvert is still adequate to carry 10-year runoff from median and right ditch.

HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

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CENTURY PARK
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LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893–6266
FAX NO. (702) 893–6269

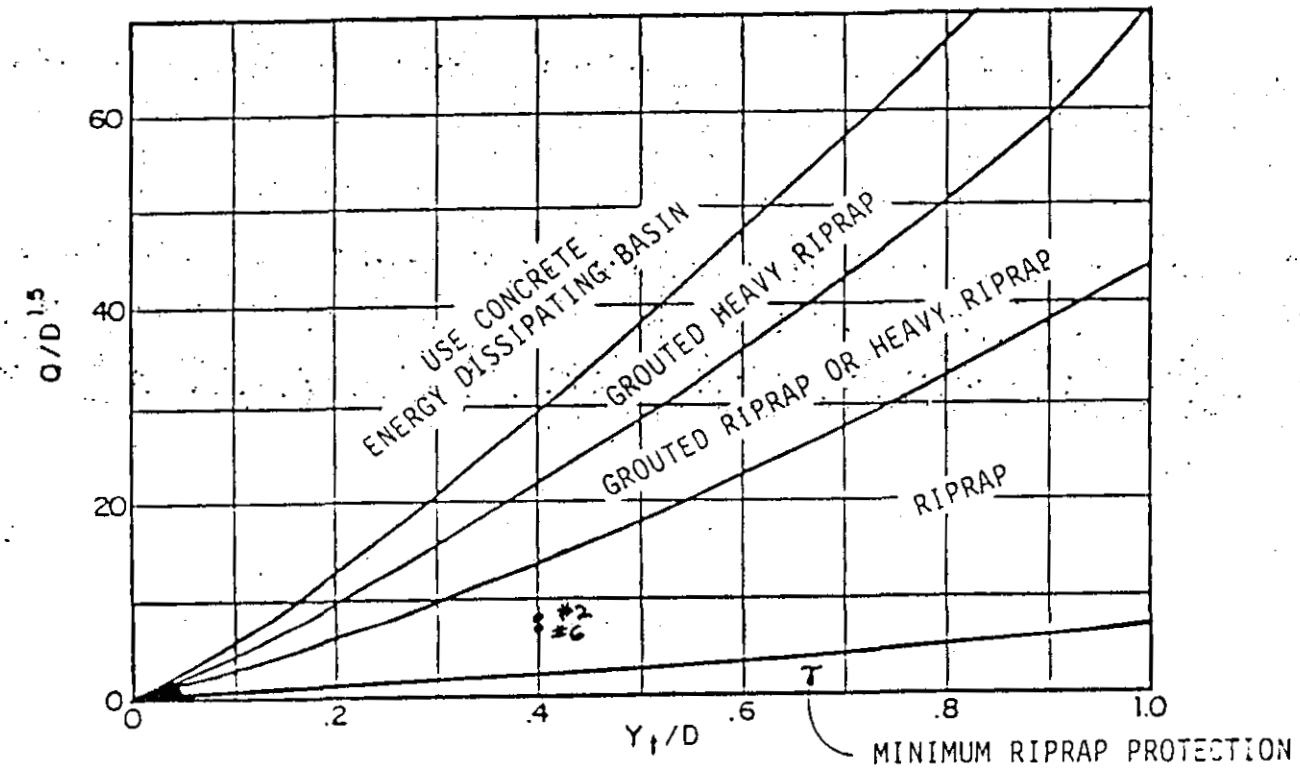
JOB NUMBER: 2016 SHEET 1 OF 8
JOB NAME: S.R. 163
CALC. BY: AJR DATE 6/6/93
CHKD. BY: _____ DATE __/__/__
REV. BY: _____ DATE __/__/__

SUBJECT: Riprap Sizing for Culvert Outlets

Culvert	Q_{100} (cfs)	D_{50} (Ho) (ft)	D_{50} (Actual) (ft)	$Y_f/D_{(Ho)}$	$Q/D^{1.5}$ or $Q/W H^{0.5}$	Figure 710/711
"B" 919+72	120	1.6	2.30	0.4	26.4	Riprap*
"B" 970+95	20	1.2	1.85	0.4	7.9	Riprap
"B" 970+50	317	1.7	2.85	0.4	23.5	Riprap*
"A" 959+28	47	0.8	1.90	0.4	6.8	Riprap
"B" 978+00	17	1.1	1.80	0.4	7.0	Riprap
"A" 986+58	529	2.3	4.65	0.4	22.0	Riprap*
"C" 995+80	574	2.2	2.60	0.4	35.6	Grouted/Heavy Riprap*

* For these culverts, outlet velocity exceeds Clark County Regional Flood control district criteria of 15fps maximum. Therefore, use Grouted Riprap for these areas.

RIPRAP EROSION PROTECTION AT CIRCULAR CONDUIT OUTLET



Notes:

1. Use H_a instead of H whenever culvert has supercritical flow in the barrel.
2. Minimum Riprap Protection: Use Riprap for a distance of 3H downstream for 18" to 36" equivalent round pipe size and 4D downstream for 42" and larger equivalent round pipe size.

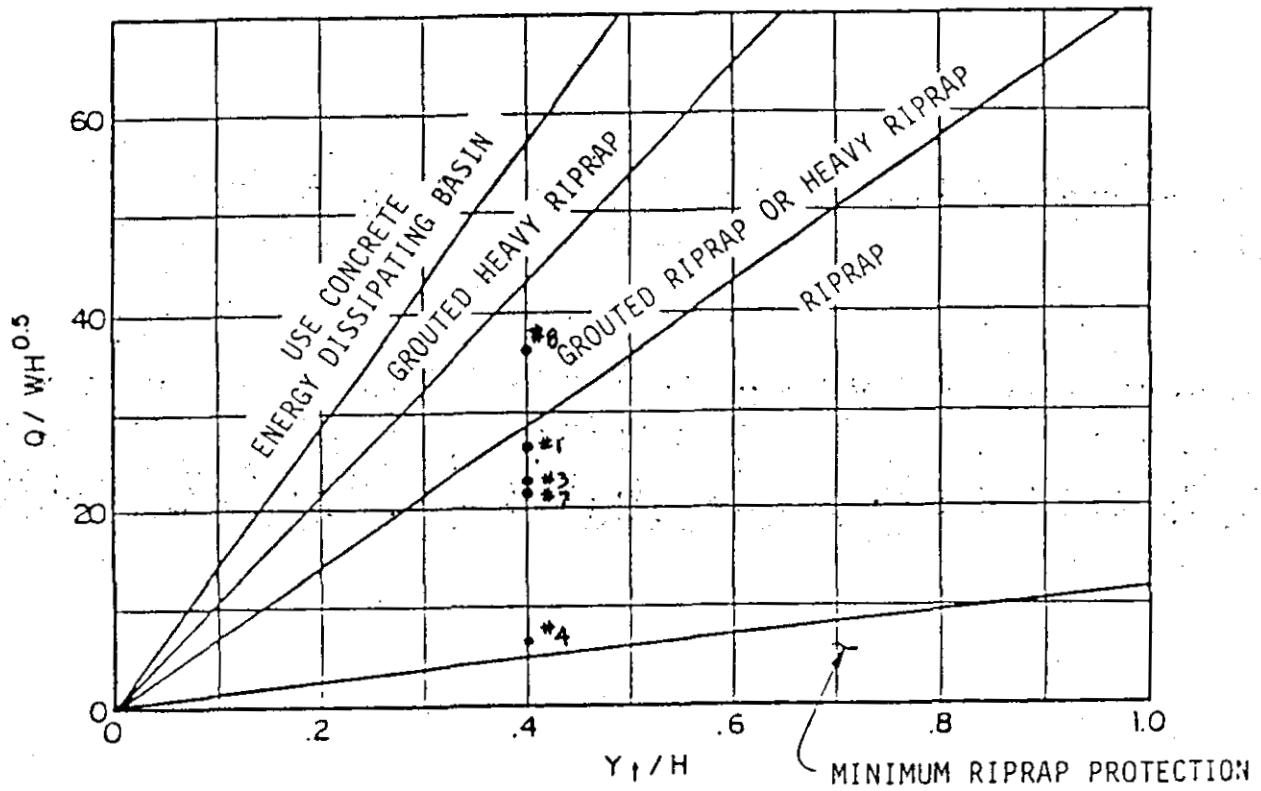
Revision	Date

WRC ENGINEERING

REFERENCE: USDCM, DRCOG, March 1969 (with modifications)

FIGURE 710

RIPRAP EROSION PROTECTION AT RECTANGULAR CONDUIT OUTLET



Notes:

1. Use H_a instead of H whenever culvert has supercritical flow in the barrel.
2. Minimum Riprap Protection: Use Riprap for a distance of 3H downstream for 18" to 36" equivalent round pipe size and 4D downstream for 42" and larger equivalent round pipe size.

Revision	Date

WRC ENGINEERING

REFERENCE: USDCM, DRCOG, March 1969 (with modifications)

FIGURE 7 1 1

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1771 EAST FLAMINGO ROAD–SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893–6266
FAX NO. (702) 893–6269

JOB NUMBER: 2016 SHEET 4 OF 8
JOB NAME: S.R. 163
CALC. BY: AGL DATE 6/6/93
CHKD. BY: ____ DATE __/__/__
REV. BY: ____ DATE __/__/__

SUBJECT: Extent of Riprap Protection downstream of culverts.

Culvert	1/2 tan θ	W.	Allowable V	A_R	L	L_{max}	Comment
"B" 914+72	3.5	5.0	3.75	32	53'	30'	(1)
"B" 920+95	6.7	2.5	3.75	5.3	13'	25'	(3)
"B" 928+50	1.9	0.0	3.75	8.5	80'	40'	(1)
"AB" 959+28	3.0	5.0	3.75	13	34'	30'	(4)
"B" 978+00	6.5	2.5	3.75	4.5	10'	25'	(3)
"AB" 986+58	2.7	12.0	3.75	152	146'	70'	(5)
"C" 995+80	3.0	10.0	3.75	153	179'	30'	(2)

(1) Use Grouted Riprap with Length = L_{max}

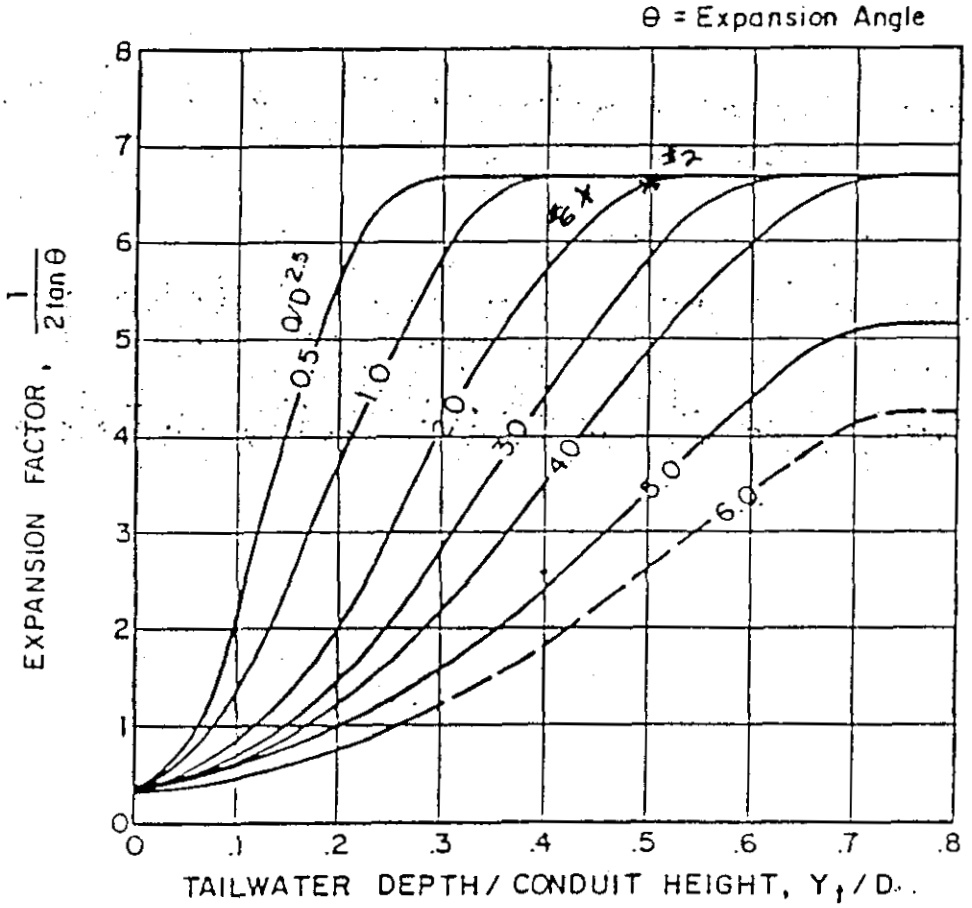
(2) Use Grouted Riprap with Length based on bend length in D16 channel

(3) Use Medium Riprap with Length = L

(4) Use Medium Riprap with Length = L_{max}.

(5) Use Grouted Riprap extending to ROW limits (60'± on 15° skew.)

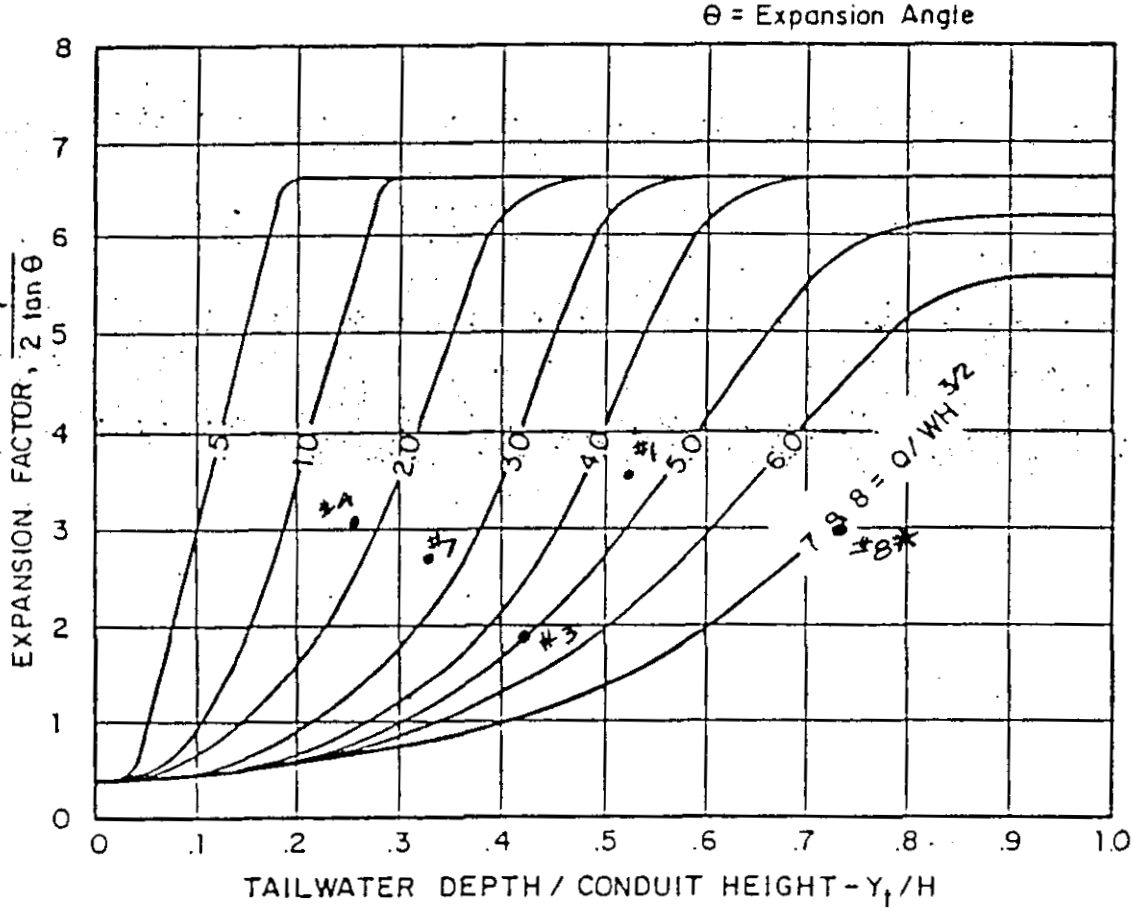
EXPANSION FACTOR FOR CIRCULAR CONDUITS



Revision	Date

WRC ENGINEERING	REFERENCE: USDCM, DRCOG, March 1969 (with modifications)	FIGURE 712

EXPANSION FACTOR RECTANGULAR CONDUITS



Assume $Y_t = D_n$ from culvert outlet.

Use D or H, not D_n or H_n

* $Q/WH^{3/2}$ for $\theta = 11$. ∴ Use the 7/8 line.

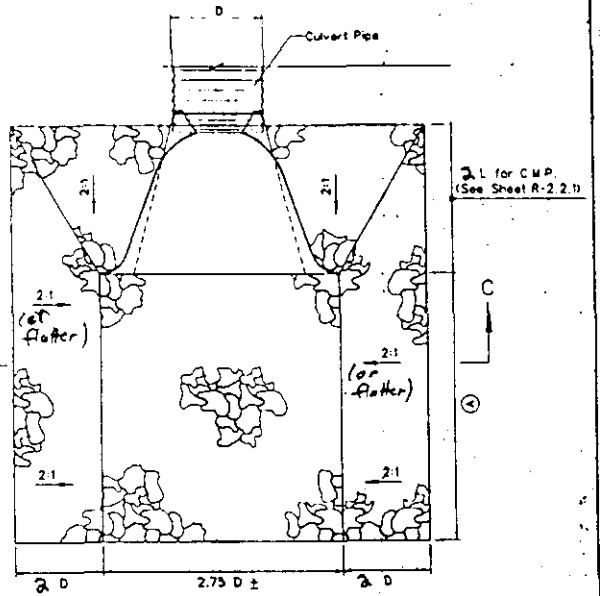
Revision	Date

WRC ENGINEERING

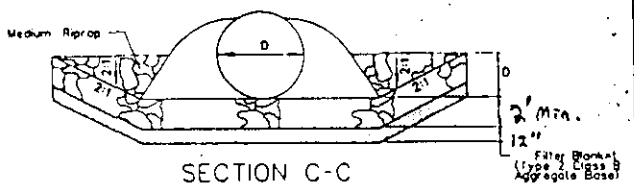
REFERENCE: USDCM, DRCOG, March 1969 (with modifications)

FIGURE 713

Use for culvert outlets at culverts: 18 48"DIA'S, LOW "A" = 10', "B" 978+00, "A" = 30', D = 5'
"AB" 951+26,



PLAN

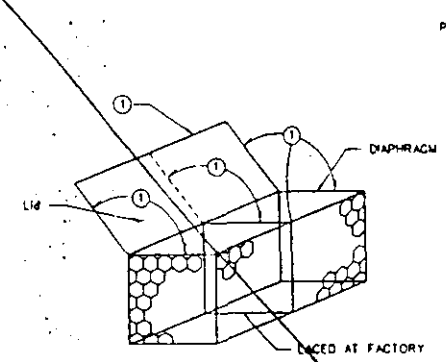


SECTION C-C

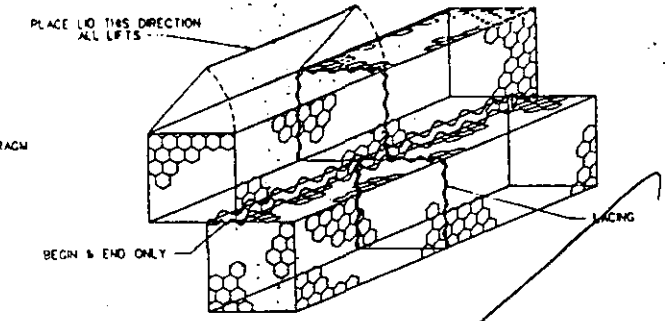
HYDRAULIC SECTION APPROVAL MUST BE OBTAINED PRIOR TO INCORPORATION INTO PLANS

MODIFIED ~~STANDARD~~ RIPRAP BASIN

NOTE:
① WHEN FULL, LACED TOGETHER

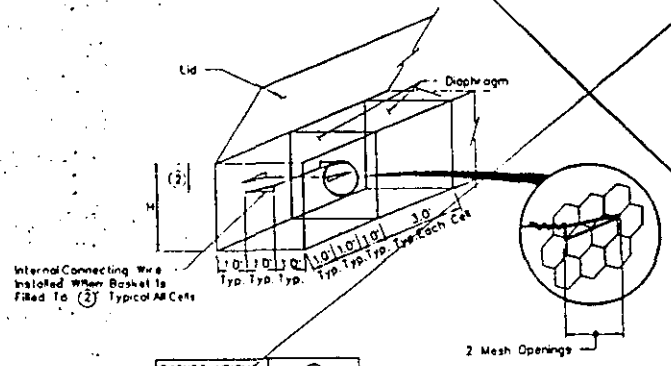


LACING: SINGLE BASKET



LACING: BASKET TO BASKET

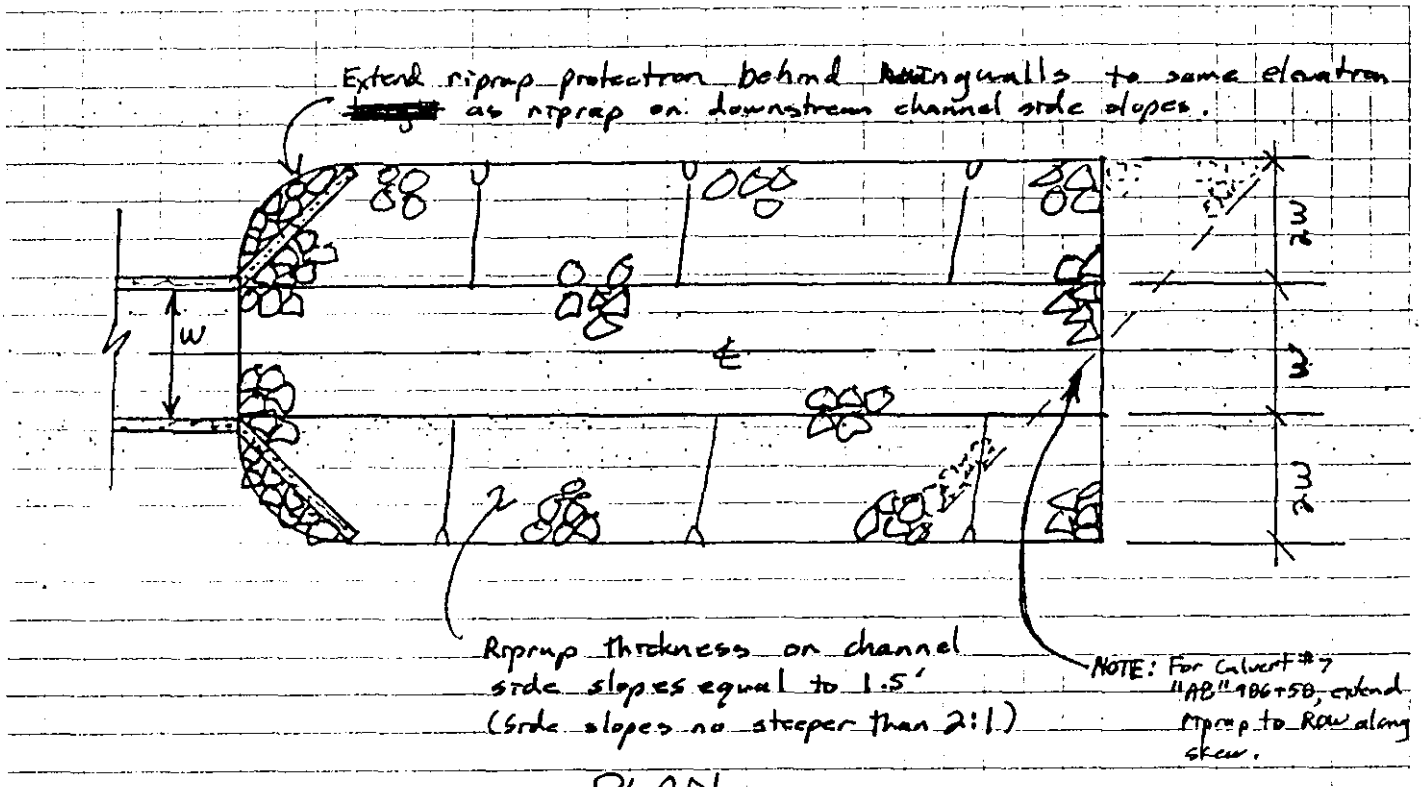
NOTE: OPTIONAL WIRE RING FASTENERS ALLOWED AS PER SPECIAL PROVISIONS.


Lid
Diaphragm
②
H
Internal Connecting Wire Installed When Basket Is Filled To ② Typical All Cells
1.0
Typ.
3.0
Typ. Typ. Typ.

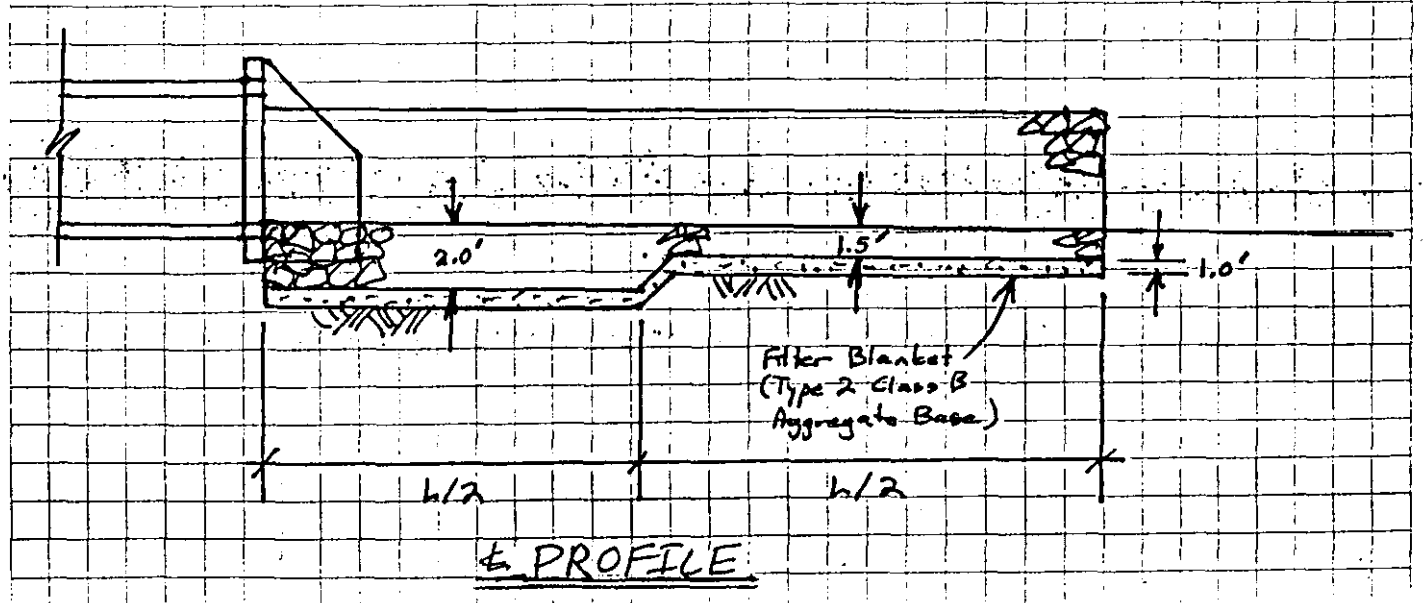
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FAX NO. (702) 893–6269

JOB NUMBER: 2016 SHEET 8 OF 8
JOB NAME: S.R. 163
CALC. BY: AJR DATE 6/6/93
CHKD. BY: DATE __/__/__
REV. BY: DATE __/__/__

SUBJECT: GROUTED RIPRAP BASIN



PLAN



℄ PROFILE

Note: 1. All riprap to be grouted to full depth of riprap lining.
2. Size of riprap shall be "Medium Riprap".

STORM SEWER HYDRAULIC CALCULATIONS

CONDUIT DATA						FLOW DATA							ENERGY LOSS DATA							ENERGY AND HYDRAULIC DATA					COMMENTS	
STATION FROM	STATION TO	SIZE / TYPE	INVERTS D/S ELEV.	INVERTS U/S ELEV.	LENGTH	A (FT^2)	L	Q (CFS)	V (FPS)	$H_v + V^2/2g$ (FT)	S_f (FT/FT)	AVE S_f (FT/FT)	PIPE H_f (FT)	TRANSITIONS H_f (FT)	H_j (FT)	H_m (FT)	H (FT)	R (FT)	TOTAL (FT)	PIPE U/S EGL ELEV	PIPE U/S HGL ELEV.	TRANSITION U/S EGL ELEV	TRANSITION U/S HGL ELEV.	PRESS FLOW?	OTHER
																				Enter Starting EGL and HGL Here →		41.40	37.24		Assume HGL = d_c = 6.24
																									$w H_v$ = 4.16
1000+ 55	1003+ 78.19	84" RCP	31.0	33.5	271	38.49	.00492	593	15.4	3.69	.0086	.0086	2.33			1.21				43.73	40.09	44.94	39.98		HGL > D_c ∴ Pressure flow calcs ok
1003+ 78.19	999+ 55.33	78" RCP	33.5	43.0	489	33.18	.00492	593	17.9	4.96	.0128	.0128	5.59							49.32	44.36				Pipe slope steeper than Sf ∴ Flow will approach Normal Depth
1003+ 78.19	1002+ 99.09	30" RCP	33.5	36.7	158	4.909	.00492	73	4.69	0.34	.0031	.0031	0.49							43.73	43.39				Use as Starting Point for 30" comp
														.07						44.22	43.88	44.29	43.95		Note: If the storm tracking 13.2mch that = The 50-year peak ~~flow hit~~ simultaneously, then the Type 7 Inlet at ~~dte~~ e 43.5 will be overtopped by a maximum of 23 cfs
																									* Non-pressure flow ∴ Inlet control will govern at internal inlet.

$S_f = \frac{Q H_v}{R^{1.33}}$ $\quad R = \frac{2(1a^2)}{2.24}$

R(78") = 1.625 R(84") = 1.750 R(30") = .625

Revision	Date

WRC ENGINEERING, INC.	REFERENCE: 2016	S.R. 163 - OUTFALL STORM SEWER	STANDARD FORM 6
AJL			

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JOB NAME: SR 163 - NDOT
CALC. BY: GPB DATE __/__/__
CHKD. BY: _____ DATE __/__/__
REV. BY: _____ DATE __/__/__

SUBJECT: INLETS, CULVERTS

	STATION	℄ ELEV	E.O. ELEV	TOP OF GRATE	UIE	LIE	S FT/FT	L F
"C"	799+50	1423.65	22.91	19.24	16.50	14.50	.016	1.
"A7"	811+00	1357.12	56.72	53.06	50.55	49.00	.009	1.
"A8"	826+00	1267.28	66.98	63.31	60.50	59.00	.015	1.
	848+66	1146.14	45.75	42.07	39.50	38.00	.025	1.

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JOB NUMBER: 2016 SHEET 1 OF 4
JOB NAME: S.R. 163
CALC. BY: AJL DATE 6/7/93
CHKD. BY: DATE __/__/__
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SUBJECT: Dropping Springs Canyon Wash Drike

I. Estimate extent of potential scour

Refs: - USBR "Computing Degradation and Local Scour", B. Pemberton, J. Lara, Denver, Colo. January 1984

- HEC-11 "Design of Riprap Revetment" USDOT, FHWA, McLean, Virginia, March, 1989.

Use reference equations to develop seperate estimates; compare estimates and select a representative scour depth for design. $Q_{100} = 4290$, Critical $W = 77$ ft

a. USBR page 32 (Eq. 24) (D_{50} from 0.5 to 0.7mm)

$$d_s = K(q)^{.24} \quad \text{w/ } K = 245 \text{ m-lbs}$$

where d_s = depth scour (ft)
q = unit discharge (ft^3/s / ft width)

$\therefore d_s = 245(4290/77)^{.24} = \boxed{6.4 \text{ ft.}}$ (Ref: notes based on field measurements)

b. USBR page 34 (Eq. 25)

Not applicable to this area of design.

c. USBR page 34 (Eq. 26)

$$d_m = 0.47(Q/f)^{1/3}$$

where d_m = mean depth (scour) in ft.
Q = design discharge (cfs)
$f = 1.76(D_m)^{1/2}$
D_m = mean grain size (mm)

From soils tests, $D_m \approx 2.2$mm

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SUBJECT: ____

$\therefore d_m = .47\ (4290/(1.76(2.2)^{1/2}))^{1/3}$

$= \boxed{5.5\ ft.}$

d. USBR page 34 (Eq. 27)

$$d_{fo} = q_f^{2/3}/F_{bo}^{1/3}$$

where d_{fo} = zero bed sed. transport depth (ft)
q_f = discharge per unit width (ft³/sec / ft. width)
F_{bo} = zero bed factor (ft/s²) from Figure 9.

From Figure 9 using bed material mean diameter of 2.2mm $\Rightarrow F_{bo} = 2.5$

$\therefore d_{fo} = (4290/77)^{2/3}/2.5^{1/3}$

$= \boxed{10.7\ ft.}$

Adjust by multiplying factor, z.

For equation 26, $d_s = z \cdot d_m$ w/ $z = .5$

$\therefore d_s = .5(5.5) = \underline{2.8'}$

For equation 27, $d_s = z\, d_{fo}$ w/ $z = .6$

$\therefore d_s = .6(10.7) = \underline{6.4'}$

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SUBJECT: ____

e. USBR page 37 (Eq. 31.)

Not applicable to this area of design

f. USBR page 38 (Eq. 32)

$$d_s = d_m \left(\frac{V_m}{V_c} - 1\right)$$

where d_s = scour depth (ft)
d_m = mean depth (ft)
V_m = mean velocity (fps)
V_c = competent velocity (fps)

$V_m = V_{normal} = 22.8$ fps
$d_m = d_{normal} = 2.25$ ft.
$V_c = 2.6$ fps (From Figure 12, page 41 w/ grain size = 2.2mm & Depth = 2.25ft.)

$$\therefore d_s = 2.25 \left(\frac{22.8}{2.6} - 1\right)$$

$$= \underline{17.5 \text{ ft}}$$

g. HEC-11 page (Eq. 5)

$d_s = 6.5 (D_{50})^{.11}$ where $D_{50} = .006$ ft (2.2mm)

$= 6.5 (.006)^{.11}$

$= \underline{11.4 \text{ ft}}$

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SUBJECT: _____

Summarize scour results (d_s)

a) D_s = 6.4 ft.
b) Not applicable
c) D_s = 2.0 ft.
d) D_s = 6.4 ft.
e) Not applicable
f) D_s = 17.5 ft.
g) D_s = 11.4 ft.

Averaging all D_s = 8.9 ft.
Averaging all but highest and lowest D_s = 8.1 ft.

Select 8.0 ft as depth for scour protection using Grouted Riprap. Provide additional non-grouted riprap at toe to launch into scour hole if scour exceeds 8.0 ft.

S.R. 163
DRIPPING SPRINGS CANYON WASH
DIKE HYDRAULIC CALCULATIONS
WITH 10 FOOT NPS ROAD

STA	Q (CFS)	S (FT./FT.)	n	BW–L (FT.)	BW–R (FT.)	SS–L (FT./FT.)	SS–R (FT./FT.)	A (SQ. FT.)	V (FPS)	D (FT.)	EGL (FT.)
78370	4290	0.0500	0.0250	9.0000	77.0000	3.0000	3.0000	398.3452	10.8	4.22	6.0210
78400	4290	0.0500	0.0250	18.0000	75.0000	3.0000	3.0000	406.3383	10.6	4.19	5.9208
78500	4290	0.0500	0.0250	40.0000	66.0000	3.0000	3.0000	424.6675	10.1	4.85	6.4346
78600	4290	0.0500	0.0250	104.0000	64.0000	3.0000	3.0000	483.1792	8.9	4.92	6.1441
78700	4290	0.0500	0.0250	142.0000	64.0000	3.0000	3.0000	511.0763	8.4	4.89	5.9841
78800	4290	0.0500	0.0250	192.0000	62.0000	3.0000	3.0000	545.7963	7.9	4.89	5.8493
78900	4290	0.0500	0.0250	228.0000	60.0000	3.0000	3.0000	565.0512	7.6	4.52	5.4151
79000	4290	0.0500	0.0250	297.0000	50.0000	3.0000	3.0000	596.9988	7.2	4.14	4.9418
79100	4290	0.0500	0.0250	375.0000	40.0000	3.0000	3.0000	630.3272	6.8	3.68	4.3993
79200	4290	0.0500	0.0250	424.0000	40.0000	3.0000	3.0000	653.0267	6.6	3.17	3.8401
79300	4290	0.0500	0.0250	472.0000	40.0000	3.0000	3.0000	669.8675	6.4	2.65	3.2869
79400	4290	0.0500	0.0250	510.0000	40.0000	3.0000	3.0000	686.3675	6.3	2.15	2.7566
79500	4290	0.0500	0.0250	557.0000	40.0000	3.0000	3.0000	702.6782	6.1	1.62	2.1988
79600	4290	0.0500	0.0250	595.0000	40.0000	3.0000	3.0000	718.3232	6.0	1.12	1.6738
79700	4290	0.0500	0.0250	613.0000	40.0000	3.0000	3.0000	725.2300	5.9	1.10	1.6433
79800	4290	0.0500	0.0250	653.0000	40.0000	3.0000	3.0000	741.1308	5.8	1.06	1.5803
79900	4290	0.0500	0.0250	693.0000	40.0000	3.0000	3.0000	746.4203	5.7	1.01	1.5229
80000	4290	0.0500	0.0250	743.0000	40.0000	3.0000	3.0000	765.2427	5.6	0.97	1.4580

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JOB NUMBER: 2016 SHEET 1 OF ____
JOB NAME: S.R. 163
CALC. BY: ATL DATE __/__/__
CHKD. BY: ____ DATE __/__/__
REV. BY: ____ DATE __/__/__

SUBJECT: Dripping Springs Canyon Wash Dike / Channel

1. Sta 783+70 to Sta 792+50

Channel slope as measured along "C" ℄

Elev. = 1958 @ 792+50
Elev. = 1998 @ 783+70

Δ Elev. = 40' Δ Sta = 880

Slope = 40 / 880 = 4.545% ✓

783+70 to 796+00

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JOB NUMBER: 2016 SHEET 2 OF ___
JOB NAME: S.R. 163
CALC. BY: AR DATE ___/___/___
CHKD. BY: ___ DATE ___/___/___
REV. BY: ___ DATE ___/___/___

SUBJECT: Dripping Springs Canyon Wash Drk / Channel

Alluvial Fan Width Measurements

Station	Width* (Ft.)	Width - Row to ℄ BW,
783+70		9
784+00	171	18
785+00	205	40
786+00	270	104
787+00	310	142
788+00	260	192
789+00	400	228
790+00	470	297
791+00	550	375
792+00	600	424
793+00	650	472
794+00	690	510
795+00	790	557
796+00	780	595
797+00	800	613
798+00	840	653
799+00	880	693
800+00	930	743 ~~730~~ Width - (Row + 30 + 17'½)
801+00	970	786 ~~772~~
802+00	1010	814
803+00	1050	855
804+00	1090	895

* ℄ S.R. 163 to Toe of Fan Bank

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JOB NAME: S.R. 163
CALC. BY: AJZ DATE __/__/__
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SUBJECT: Sta 783+70

Minimum Top of Dike Elev. = 98.00 + 4.22 + 1.0 = 106.22

	Elev.	Distance
E.O. =	106.45	
Dike Transition	106.45	2.0'
Sideslope 8.45@3:1	98.00	25.35'
Channel Bottom	98.00	77.0'
Sideslope 2.00@3:1	100.00	6.0'
Road	100.00	9.0'
Total		119.38'

ROW to ℄ = 162.5' − 37' − 5.5' 120.0'

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JOB NUMBER: 2016 SHEET 3 OF ____
JOB NAME: S.R. 163
CALC. BY: AGL DATE __/__/__
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REV. BY: ____ DATE __/__/__

SUBJECT: Sta 784+00

98 - 30(.045-45) = 96.64

Minimum Top of Dike Elev. = 96.64 + 4.19 + 4.0 = 104.83

	Elev.	Distance
B.O. =	104.87	
	Dike	5.0'
	104.92	
	Sideslope 8.19@3:1	24.57'
	96.73	
	Channel	75.0'
	96.73	
	Sideslope 2.0@3:1	6.0'
	98.73	
	Road	9.0'
	98.73	
	Total	119.57

Row to ℄ = 162' - 37' - 5.5' = 119.50'

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SUBJECT: Sta 785+00

09 100.9 ℄

Minimum Top of Dike Elev. = 92.28 + 4.85 + 4.0 = 101.13

	Elev.	Distance
E.O. = 99.58		
Sideslope 1.56' @ 3:1		4.68'
101.13		
Dike		12.0'
101.13		
Sideslope 8.85' @ 3:1		26.55'
92.28		
Channel		66.0'
92.28		
Sideslope 4.0' @ 3:1		12.0'
96.28		

Total = 171.23

ROW to ℄ = 164 - 37 - 5.5 = 121.50

Start Roadside Ditch W = 27'

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JOB NUMBER: 2016 SHEET 5 OF ____
JOB NAME: S.R. 163
CALC. BY: ASL DATE __/__/__
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REV. BY: ____ DATE __/__/__

SUBJECT: Sta 786+00

Minimum Top of Dike Elev. = 87.58 + 4.92 + 4.0 = 96.50

	Elev.	Distance
E.O. =	94.28	
	Sideslope 2.22' @ 3:1	6.66'
	96.50	
	Dike	12.0'
	96.50	
	Sideslope 8.97' @ 3:1	26.76'
	87.58	
	Channel	64.0'
	87.58	
	Sideslope 4.0' @ 3:1	12.0'
	91.58	
	Total	121.42'

ROW to ℄ = 166 - 37 - 5.5 = 123.50'

Ditch W = 2.08'

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SUBJECT: 787+00

Minimum Top of Dike Elev. = 83.00 + 1.89 + 1.00 = 91.89

	Elev.	Distance
E.O. = 88.98		
Sideslope	2.91' @ 3:1	8.73'
91.89		
Dike		12.0'
91.89		
Sideslope	8.89' @ 3:1	26.67'
83.00		
Channel		69.0'
83.00		
Sideslope	4.0' @ 3:1	12.0'
87.00		
	Total	123.40'

Row to ℄ = 168 - 37 - 5.5 = 125.50'

Ditch W = 2.10'

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SUBJECT: STA 788+00

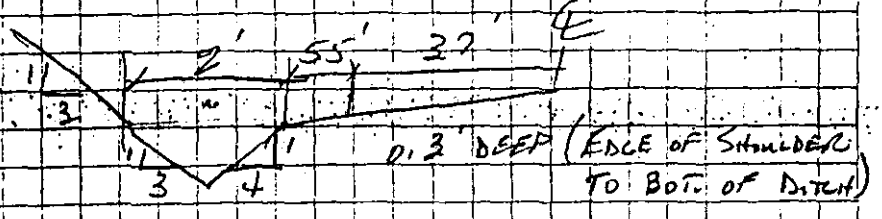
MIN TOP OF DIKE ELEV = 78.51 + 4.89 + 4.00 = 87.40

	ELEV.	DISTANCE
E.O. =	83.80	
SIDESLOPE 3.60 @ 3:1		10.80'
	87.40	
DIKE		12.00'
	87.40	
SIDESLOPE 8.89 @ 3:1		26.67'
	78.51	
CHANNEL		62.00'
	78.51	
SIDESLOPE 4.0' @ 3:1		12.00'
	82.51	
	TOTAL	123.47

ROW to ℄ = 168'

168 - 27 - 55 = 125.50'

125.50 - 123.47 = 2.03'



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SUBJECT: STA 789+00

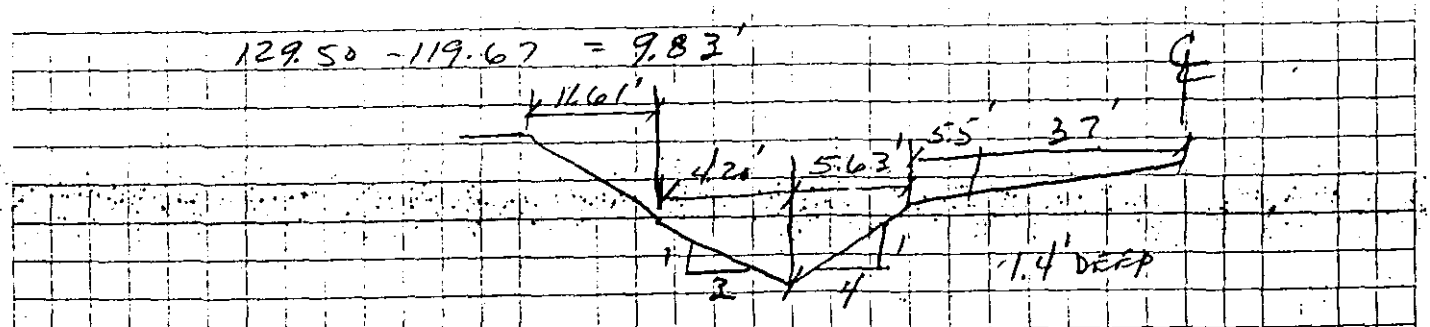
MIN. TOP OF DIKE ELEV = 73.86 + 4.52 + 4.00 = 82.38

	ELEV	DIST
E.O =	78.51	
SIDESLOPE .387 @ 3:1		11.61'
	82.38	
DIKE		12.00'
	82.38	
SIDESLOPE 8.52 @ 3:1		25.56'
	73.86	
CHANNEL		60.00'
	73.86	
SIDESLOPE 3.5 @ 3:1		10.50'
ROW	77.36	
TOTAL		119.67'

ROW to ℄ = 172

172 - 37 - 5.5 = 129.50'

129.50 - 119.67 = 9.83'



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CALC. BY: GPB DATE 6/7/93
CHKD. BY: ____ DATE __/__/__
REV. BY: ____ DATE __/__/__

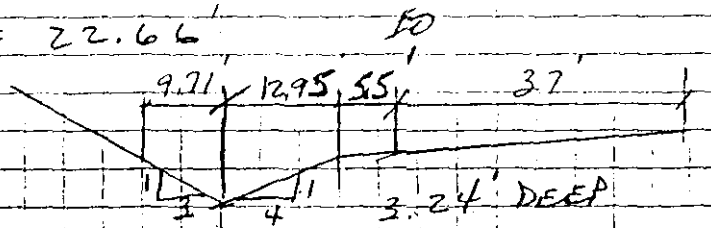
SUBJECT: STA 790 + 00

Mid. TOP OF DIKE ELEV. = 69.21 + 4.14 4.00 = 77.35

ELEV		DISTANCE
E.O. = 73.21		
	SIDESLOPE 4.14 @ 3:1	= 12.42'
77.35		
DIKE		12.00'
77.35		
SIDESLOPE	8.14' @ 3:1	24.42'
69.21		
CHANNEL		50.00'
69.21		
SIDESLOPE	3.00' @ 3:1	9.00'
72.21		
	TOTAL	= 107.84'

R.O.W. TO ℄ : 173 - 37 - 5.5 = 130.50'

130.50 - 107.84 = 22.66'



⟹ STA 790 + 56 : END 5.5' SHOULDER FOR BARRIER. TRANSITION TO BEGIN 6:1 FORESLOPE FROM E.O.

WRC NEVADA, INC.
CENTURY PARK
1771 EAST FLAMINGO ROAD–SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893–6266
FAX NO. (702) 893–6269

JOB NUMBER: 2016 SHEET 10 OF ____
JOB NAME: S.R. 163
CALC. BY: GPB DATE 6/7/93
CHKD. BY: ____ DATE __/__/__
REV. BY: ____ DATE __/__/__

SUBJECT: STA 791+00

82

MIN. TOP OF DIKE ELEV = 64.62 + 3.68 + 4.00 = 72.30

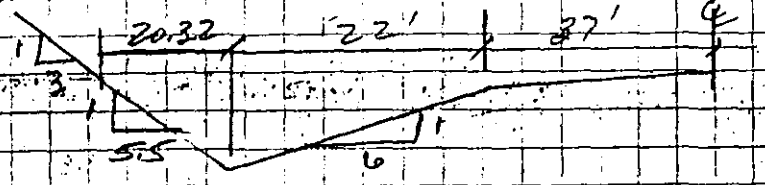
ELEV	DISTANCE
E.O. = 67.92	
SIDESLOPE 4.38' @ 3:1	13.14'
72.30	
DIKE	12.00'
72.30	
SIDESLOPE 7.68' @ 3:1	23.04'
64.62	
CHANNEL	40.00'
64.62	
SIDESLOPE 2.5' @ 3:1	7.50
67.12	
	TOTAL 95.68'

R.O.W. to ℄ = 165'

175 - 37' = 138'

DITCH WIDTH = 138 - 95.68 = 42.32'

22/6 = 3.67' = DEPTH OF DITCH



STA 791+48 - BEGIN STD SECTION W/6:1 SIDESLOPES ON DITCH

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JOB NUMBER: 2016 SHEET 11 OF ____
JOB NAME: SR 163
CALC. BY: GPB DATE 6/7/93
CHKD. BY: ____ DATE __/__/__
REV. BY: ____ DATE __/__/__

SUBJECT: STA 792+00 BEGIN 40' CHANNEL BOTTOM

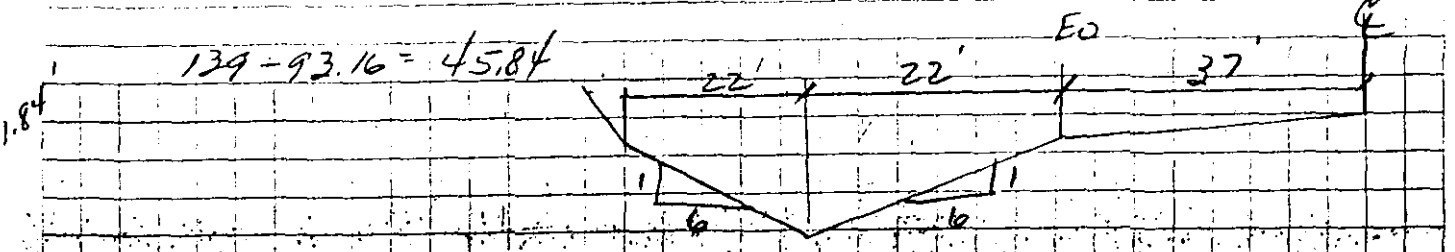
M.N. TOP OF DIKE ELEV = 60.00 + 3.17 + 4.00 = 67.17

ELEVATION	DISTANCE
E.O. = 62.62	
SIDESLOPE 4.55' @ 3:1	13.65'
67.17	
DIKE	12.00'
67.17	
∴ SIDESLOPE 7.17 @ 3:1	21.51
60.00	
CHANNEL	40.00'
60.00	
SIDESLOPE 2.0' @ 3:1	6.00'
62.00	
	TOTAL 93.16'

R.O.W. TO ℄ = 176'

176 - 37 = 139'

139 - 93.16 = 45.84'



WRC NEVADA, INC.
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LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893–6266
FAX NO. (702) 893–6269

JOB NUMBER: 2016 SHEET 12 OF ____
JOB NAME: S.R. 163
CALC. BY: GPB DATE 6/7/93
CHKD. BY: ____ DATE __/__/__
REV. BY: ____ DATE __/__/__

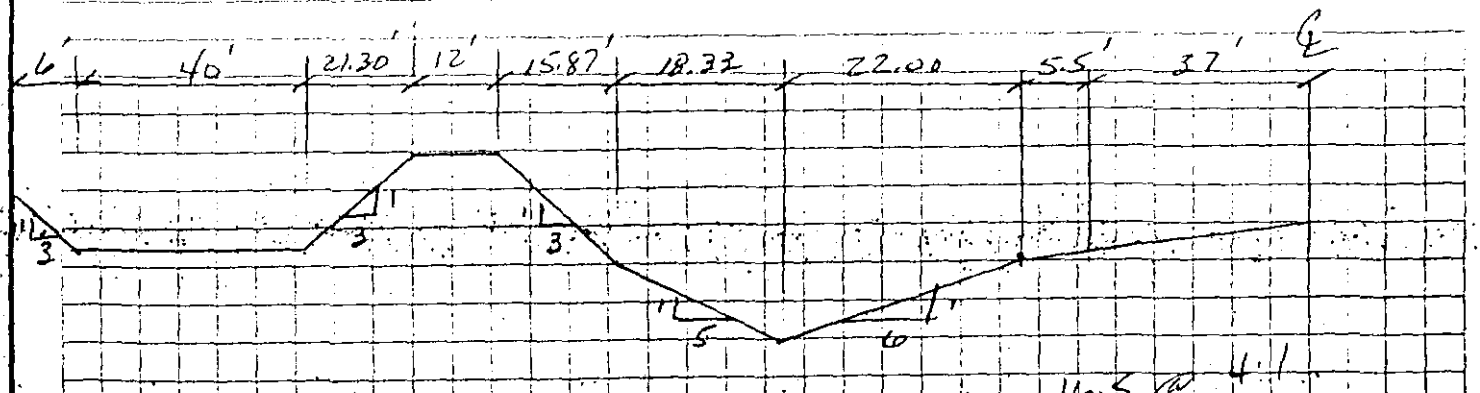
SUBJECT: STA 793+00

MIN TOP OF DIKE ELEV = 57.33 + 3.10 + 4.0 = 64.43

ELEV.	DISTANCE
E.O. = 57.33	
SIDESLOPE 5.29' @ 3:1	15.87'
62.62	
DIKE	12.00'
62.62	
SIDESLOPE 7.10 @ 3:1	21.30'
55.52	
CHANNEL	40.00'
55.52	
SIDESLOPE 20' @ 3:1	6.00'
	TOTAL = 95.17'

ROW to ℄ = 178'

178 - 37 - 5.5 = 135.50'



WRC NEVADA, INC.
CENTURY PARK
1771 EAST FLAMINGO ROAD–SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893–6266
FAX NO. (702) 893–6269

JOB NUMBER: 2016 SHEET 13 OF ____
JOB NAME: S.R. 163
CALC. BY: GPB DATE __/__/__
CHKD. BY: ____ DATE __/__/__
REV. BY: ____ DATE __/__/__

SUBJECT: ____

STATION	CHANNEL ELEV. (FT)	D_L (FT)	TOP OF DIKE EL. (FT)		DIST. (FT)
			$E_{CH}+D_L+4'$ FB (3'+1' SILT)		$(E_{TD}-E_{CH})$@3:1
783+70	1498.00	4.22	1506.22		24.66
784	1496.64	4.19	1504.83		24.57
785	1492.09	4.85	1500.94		26.55
786	1487.55	4.92	1496.47		26.76
787	1483.00	4.89	1491.89		26.67
788	1478.46	4.89	1487.35		26.67
789	1473.91	4.52	1482.43		25.56
790	1469.37	4.14	1477.51		24.32
791	1464.82	3.68	1472.50		23.04
792	1460.28	3.17	1467.45		21.51
793	1455.74		1462.14		19.20
794	1451.19		1456.84	S.L. INT.	16.95
795	1446.64		1451.53		14.67
796	1442.10	1.12	1446.22	$E_{CH}+D_L+3'$ (DAYLIGHT CH BOT.)	12.36
797	1436.56	1.10	1446.66		12.30
798	1431.02	1.06	1435.08		12.18
799	1425.49	1.01	1429.50		12.03
800	1419.95	0.97 (1.00)	1423.95		12.00
809	1370.11	1.00	1374.11		12.00

4.545% (CH. BOT.)

5.538%

WRC NEVADA, INC.
CENTURY PARK
1771 EAST FLAMINGO ROAD–SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893–6266
FAX NO. (702) 893–6269

JOB NUMBER: 2016 SHEET 14 OF ____
JOB NAME: S.R. 163
CALC. BY: GPB DATE __/__/__
CHKD. BY: ____ DATE __/__/__
REV. BY: ____ DATE __/__/__

SUBJECT: ____

STA	CH. ELEV (FT)	ΔL (FT)	TOP OF DIKE ELEV (FT)	DIST. (FT)
809+00	1370.11	1.00	1374.11	12.00
6.073%				
833+70	1220.10	1.00	1224.10	12.00
5.229%				
849	1140.10	1.00	1144.10	12.00

APPENDIX - C

DESIGN INFORMATION

WRC NEVADA, INC.
CENTURY PARK
1771 EAST FLAMINGO ROAD–SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893–6266
FAX NO. (702) 893–6269

JOB NUMBER: 2016 SHEET 1 OF 1
JOB NAME: S.R. 163
CALC. BY: AJL DATE 6/8/93
CHKD. BY: _____ DATE __/__/__
REV. BY: _____ DATE __/__/__

SUBJECT: Drke Alignment

Station	Offset from "C" ℄
	Transition Section
784+00	
785+00	53'
786+00	57'
787+00	59'
788+00	59'
789+00	60'
790+00	83'
791+00	93'

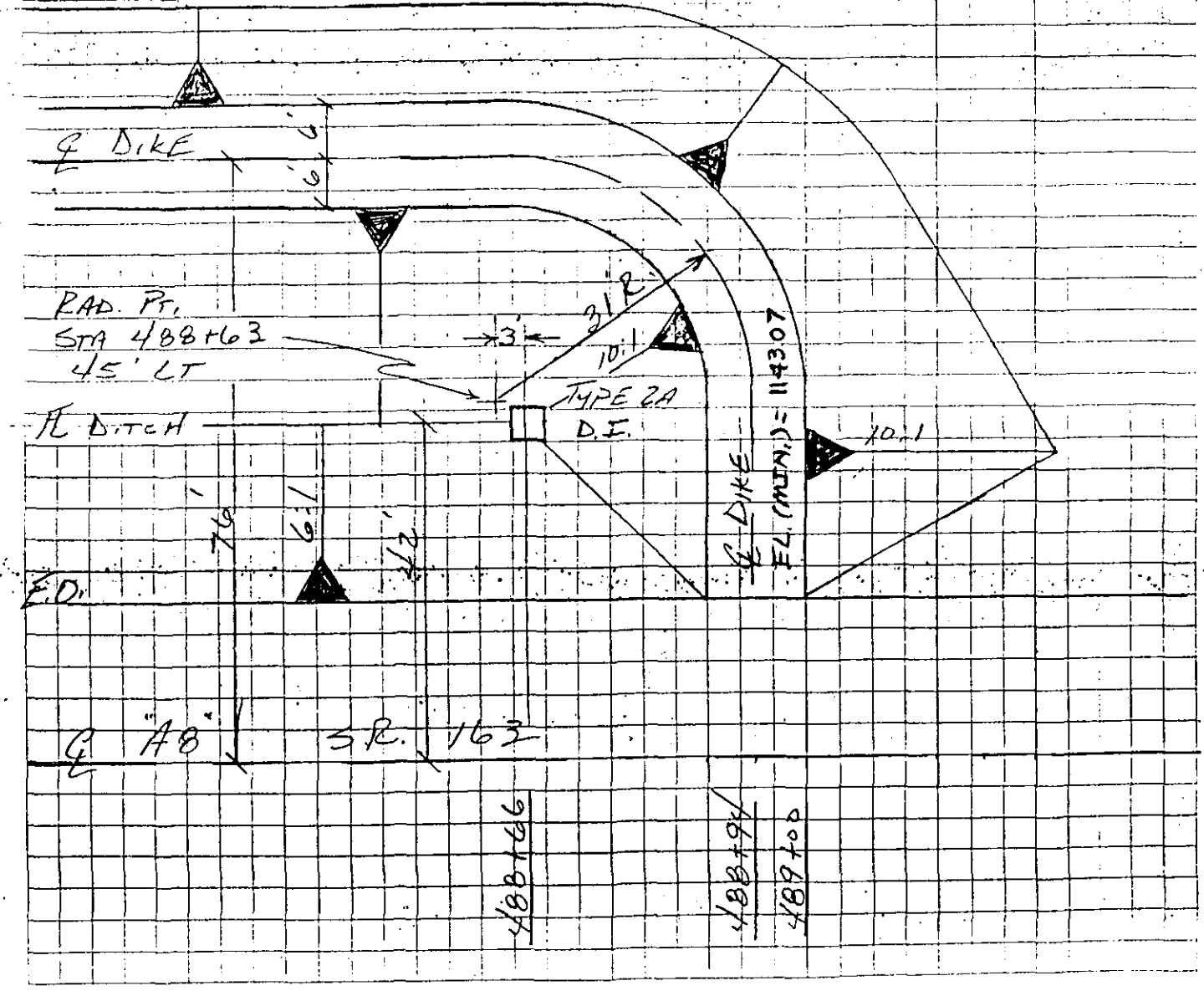
WRC ENGINEERING, INC.
1660 SOUTH ALBION STREET–SUITE 500
DENVER, COLORADO 80222
PHONE NO. (303) 757–8513
FAX NO. (303) 758–3208

JOB NUMBER: 2016 SHEET 15 OF
JOB NAME: SR 163
CALC. BY: GPB DATE __/__/__
CHKD. BY: DATE __/__/__
REV. BY: DATE __/__/__

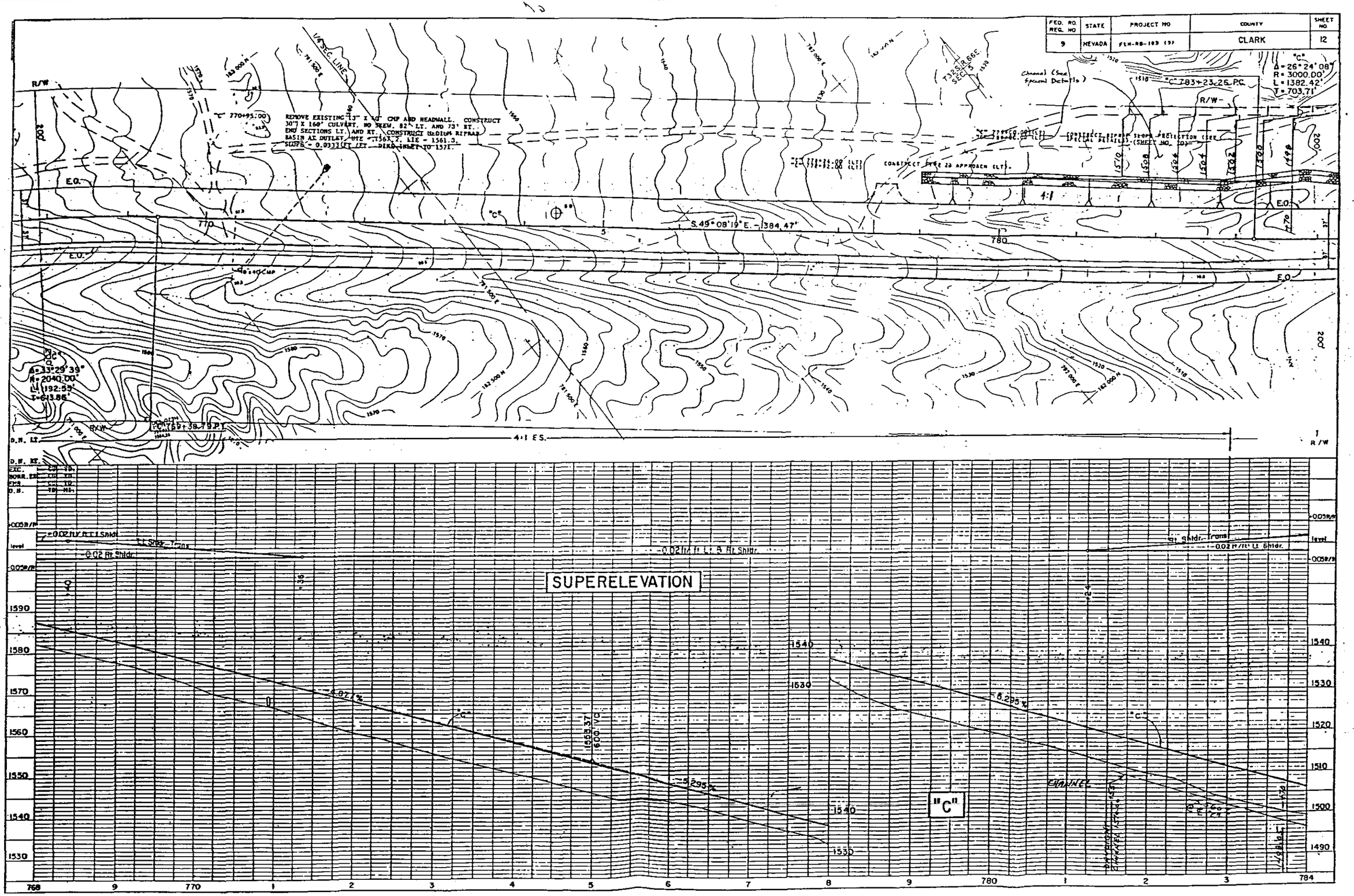
SUBJECT:

DIKE DETAIL

NTS



FED. RD. REG. NO	STATE	PROJECT NO	COUNTY	SHEET NO.
9	NEVADA	FLH-NB-103 (5)	CLARK	12



FED RD REG NO	STATE	PROJECT NO	COUNTY	SHEET NO
9	NEVADA	FLM-RB-183 (3)	CLARK	13

"C" 786+00.00' (LT.), CONSTRUCT DIKE LT. TIE INTO FILL SLOPE
"C" 789+00.00 (LT.) LT. OF "C" 786+00.00

"C" 783+23.26 P.C.

"C" 797+05.68 P.T.

T32S R66E SEC 5

"C"
Δ = 26° 24' 08"
R = 3000.00'
L = 1382.42'
T = 703.71'

Channel (See Special Details)

Dike (See Special Details)

145 Lt. "C" 789+00.00

S.49°08'19"E. 1384.47'

S.75°32'27"E. 294.32'

R/W

E.O.

D.H. LT.

D.H. RT.

EXC. CU YD
BORR. EXC. CU YD
EMB CU YD
O.M. SQ FT

+0.02 ft/ft Rt. Slope

-0.02 ft/ft Lt. Slope

SUPERELEVATION

Rt. Slope Transition

Lt. Slope Transition

Top of Dike (Slope Varies)

CHANNEL

"C"

783 4 5 6 7 8 9 790 1 2 3 4 5 6 7 8 799

FED RD REG. NO	STATE	PROJECT NO	COUNTY	SHEET NO.
9	NEVADA	(FLH-RR-163 (3)	CLARK	14

- MISC. PLANTMIX AREAS (5.0" DEPTH)

"A7" Δ=0°47'30" R=2500.00' L=34.54' T=17.27'

1/4 SEC. LINE

SEC. 5 / SEC. 4

T32S R66E

R/W

E.O.

"A7" 800+00.00 P.O.T. P.C.

"A" 800+34.54 P.T.

CONSTRUCT PAVED MEDIAN AND PLACE DIAGONAL

S65°32'27"E — 284.32' "C"

"A7" S.76°19'57"E — 1702.49'

"B" S.75°32'27"E — 5600.00'

Sta 799+58' Lt.
Construct 24" x 125' culvert and type 2A drop inlet, skew 24° Lt. ahead, with metal end sections.
1419.24 Top of Grate
U/E = 1416.50
L/E = 1414.50
Slope = 0.016 Ft/Ft

GENERAL DITCH NOTE: "A7/A8" 6:1 F.S. OR 6:1-3.7° DITCH, THEN 6:1 OR 1 1/2:1 B.S. EXCEPT AS NOTED.

Sta 811+06.42' Lt.
Construct 24" x 170' culvert and type 2A drop inlet, skew 12° Lt. ahead, with metal end sections.
1353.06 Top of Grate
U/E = 1350.55
L/E = 1347.00
Slope = 0.009 Ft/Ft

D.M. LT. / D.M. RT.

Match "A7" E.O. — 6:1 ~ 1° Ditch Trans. To 6:1 ~ 2.17° Ditch

EXC. / BORR. EXC. / EMB. / O.M.

Rt Shldr Trans. .092 Ft/Ft Lt & Rt

.005 Ft/Ft Lt Shldr

SUPERELEVATION

Top of Dike

-5.283%

"C"

D.M. LT. Trans. -30

Match "B" E.O. — 6:1 ~ 1° Ditch Transition To 6:1 Intersect

GENERAL DITCH NOTE: "B" 6:1 F.S. or 6:1-3.7' DITCH, THEN 6:1 B.S. EXCEPT AS NOTED.

-5.393%

-5.982%

Top of Dike

-6.077%

-2.744%

-3.982%

-5.982%

798 9 800 1 2 3 4 5 6 7 8 9 810 1 2 3 814

FED RD REG. NO	STATE	PROJECT NO	COUNTY	SHEET NO.
9	NEVADA	FLH-88-103 (3)	CLARK	15

T32S. R66E. SEC. 4

"A7" Δ=0°47'30" R=2500.00' L=34.54' T=17.27'

Dike (See special Details)

"A7" 817+71.67 P.T. — "A8" 817+71.41 P.O.T.

"A7" S.76°19'57"E. 1702.49'

"A8" S.75°32'27"E. 4828.59'

S.75°32'27"E. 6600.00'

Median Dike

STA 820+00, 42' Lt.
CONSTRUCT 24" x 108' CULVERT AND TYPE 2A DROP INLET, SKEW 35° Lt. AHEAD WITH METAL END SECTION
IE = 1263.31 TOP OF GRATE
UIE = 1220.50
LIE = 1219.00
SLOPE = 0.015 FT/FT

6:1 ~ 1st Ditch Trans. To 6:1 ~ 2.17' Ditch

6:1 ~ 2.17' Ditch

6:1 ~ 1st Ditch Trans. To 6:1 ~ Intersect

6:1 ~ Intersect

"A7" 817+71.67 P.T. — "A8" 817+71.41 P.O.T.

TOP OF DIKE

"A7" -5.98%- "A8" -5.98%- TOP OF DIKE

"B" -5.98%- "C"

EXC. BORR. EXC. EMB. O.B. 1350 1340 1330 1320 1300 1290 1280 1270 1260 1250 1240 1230

817 818 819 820 821 822 823 824 825 826 827 828 829

FED RD REG NO.	STATE	PROJECT NO	COUNTY	SHEET NO.
9	NEVADA	FLH-RS-163(5)	CLARK	16

LIMITS OF PLANTMIX BITUMINOUS GORE

CONSTRUCT MEEKER HIGHWAY APPROACH

"A8" 831+00.00 POT = N 2+70.74 POT

"A8" S75° 32' 27" E - 4828.59'

S75° 32' 27" E - 660.00'

N 2+14.17 PT

Limits of Paving N 0+00.00 PC

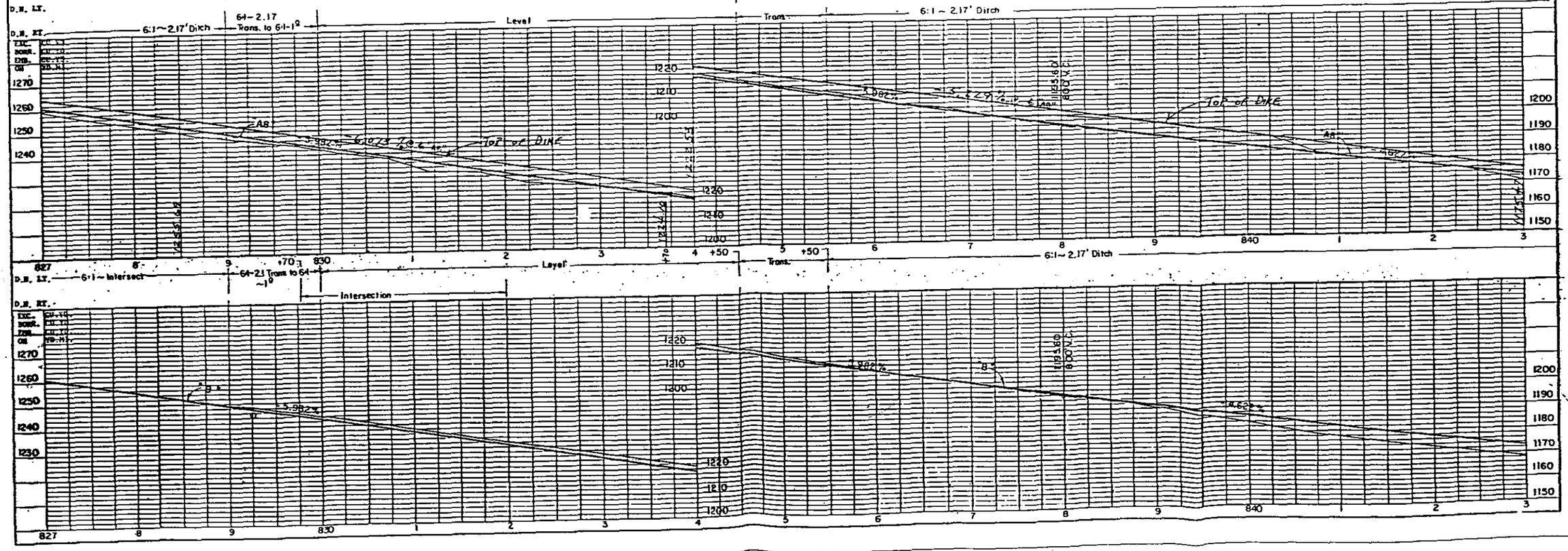
R = 900' L = 214.1757' T = 107.595'

E.O.

R/W

Dyke (See Special Detail)

TANGENT



FED. RD REG. NO.	STATE	PROJECT NO	COUNTY	SHEET NO.
9	NEVADA	FLH-RS-169(3)	CLARK	17

T32S R66E

SEC. 3

Dike (See Special Details)

R/W

E.O.

"A8"

"B"

850

S. 75°32'27"E. - 4828.59'

S. 75°32'27"E. - 5600.00'

Median Dike

Sta 8+68+66.42' Ahd
CONSTRUCT 24" x 60' CULVERT AND TYPE 2A DROP INLET, SKEW 75° LT. AHEAD WITH METAL END SECTION
U.E. = 1142.00 ± TOP of GRATE
U.I.E. = 1139.50
L.I.E. = 1136.00
SLOPE = 0.025 Ft/Ft.

6:1 ~ 2.17' Ditch

6:1 ~ Intersect

D.S. LT.

D.S. RT.

Sta 8+22.72 Ahd

Top of DIKE

"A8"

-9.622%

"B"

-9.622%

+44

842

858

END PROJECT FLH-RS-163(5)
"A8" 866+00.00 P.O.T.=
"TC1" 0+00.00 P.C.

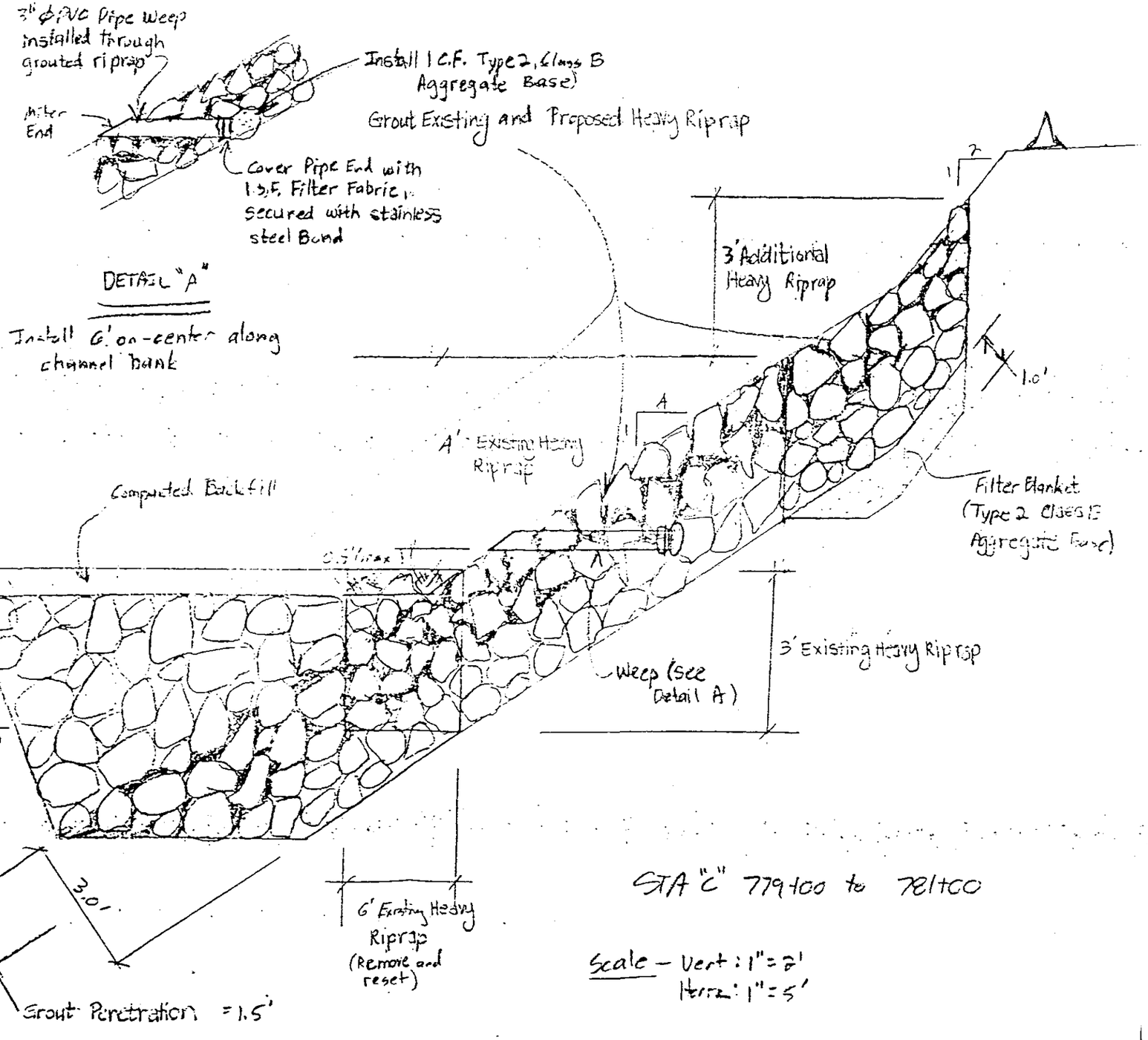
END PROJECT FLH-RS-163(5)
"B" 866+00.00 P.O.T.=
"TC2" 0+00.00 ∠

"A8"
S. 75°32'27"E.-4828.59'
"B"
S.75°32'27"E.-6600.00'
E.O.
Median Dike
"TC1"
"TC2"
MATCH LINE "A"

CONSTRUCT 24" X 32A" CULVERT AND TYPE 2A
R.I. 25' LEFT AND MEDIAN DIKES, 45 DEGREE
SKEW FT. AHEAD, WITH METAC END SECTION
1062.15 TOP OF GRATE, U.E.=1058.98, L.E.=
1056.25, SLOPE=0.006 FT./FT.

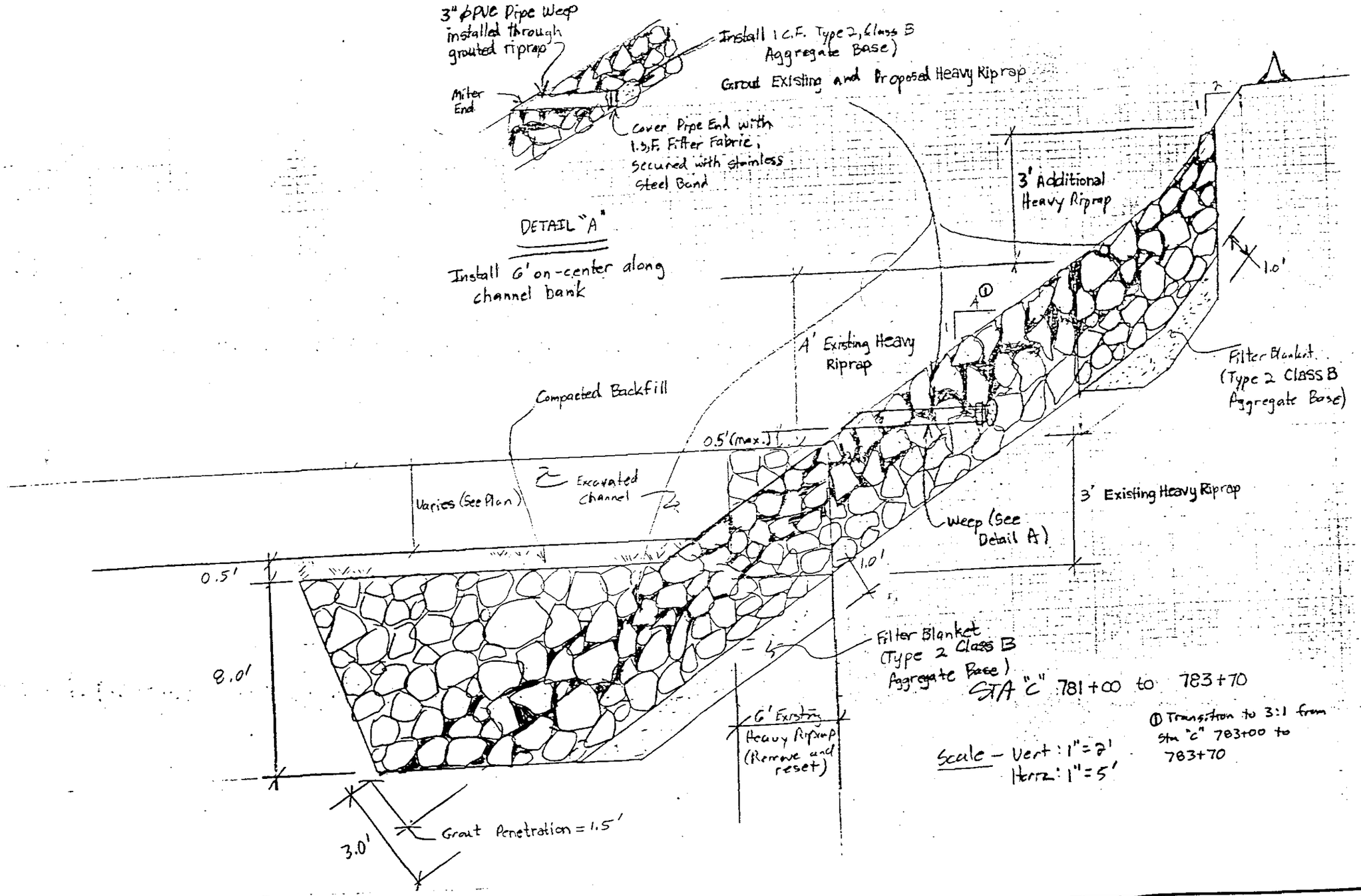
NOTE: GEOMETRICS AND PROFILES FOR "TC1" & "TC2" SEE SHEET NO. 19

D.N. LT.
D.N. RT.
EXC.
BORR. EX.
EVG.
6:1 2.17' Ditch
Median Dike
MATCH LINE "A"



2016 SEC-D-E.DWG (3/1) 06-11-93 JLW

WRC	SR 163 DRAINAGE DESIGN P-059-93-010	DRIPPING SPRINGS CANYON WASH DIKE	SHEET 1 OF 5	JOB NO. 2016



2016 SEC-D-E.DWG (3/2) 06-11-93 JLW

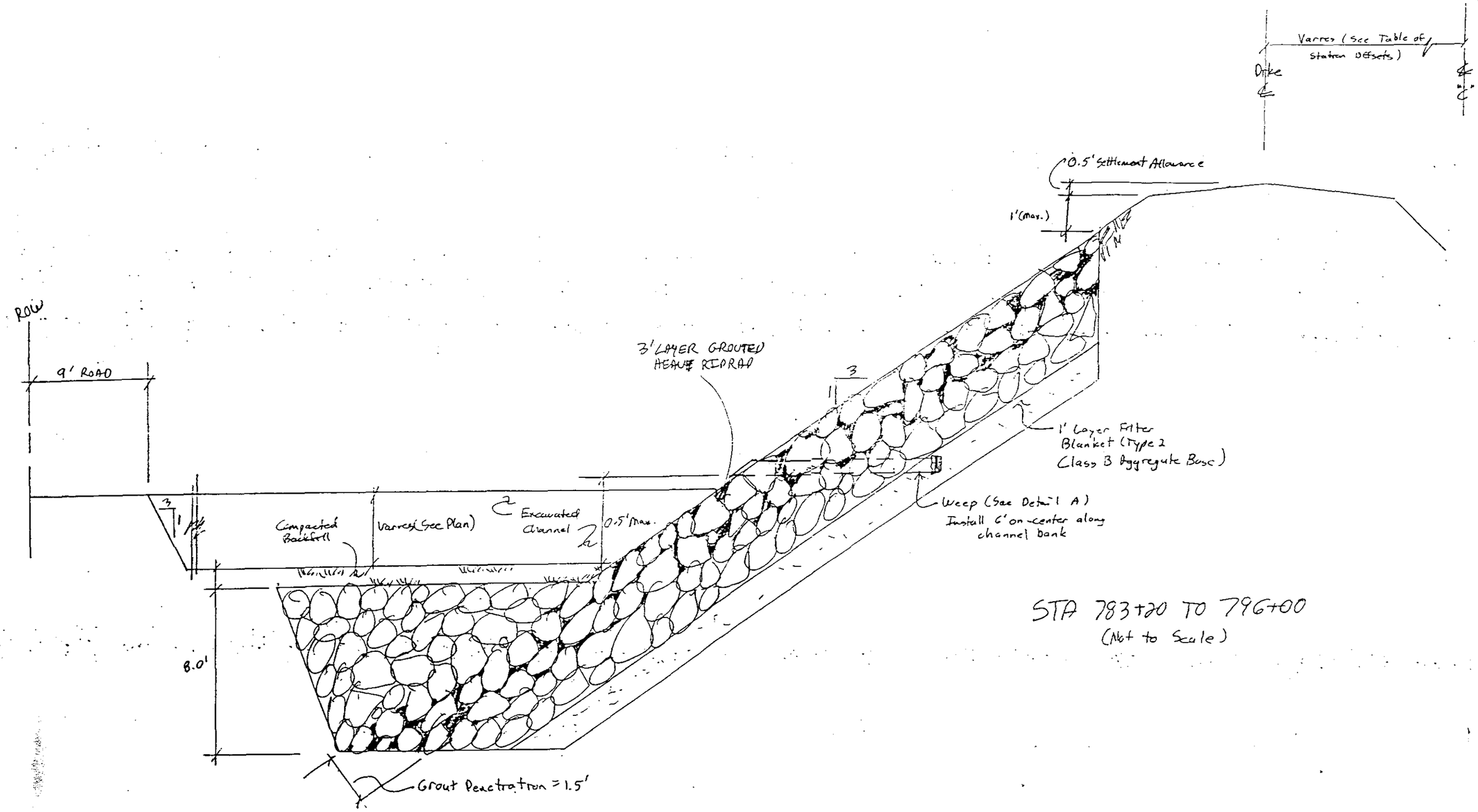
WRC

SR 163 DRAINAGE DESIGN
P-059-93-010

DRIPPING SPRINGS CANYON
WASH DIKE

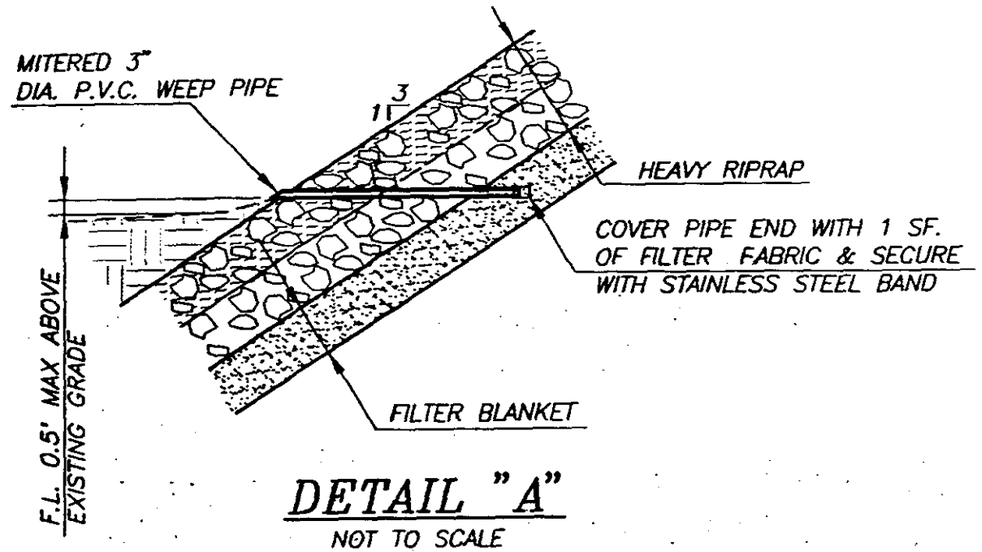
SHEET 2 OF 5

JOB NO. 2016



2016 SEC-D-E.DWG (3/3) 06-11-93 JLW

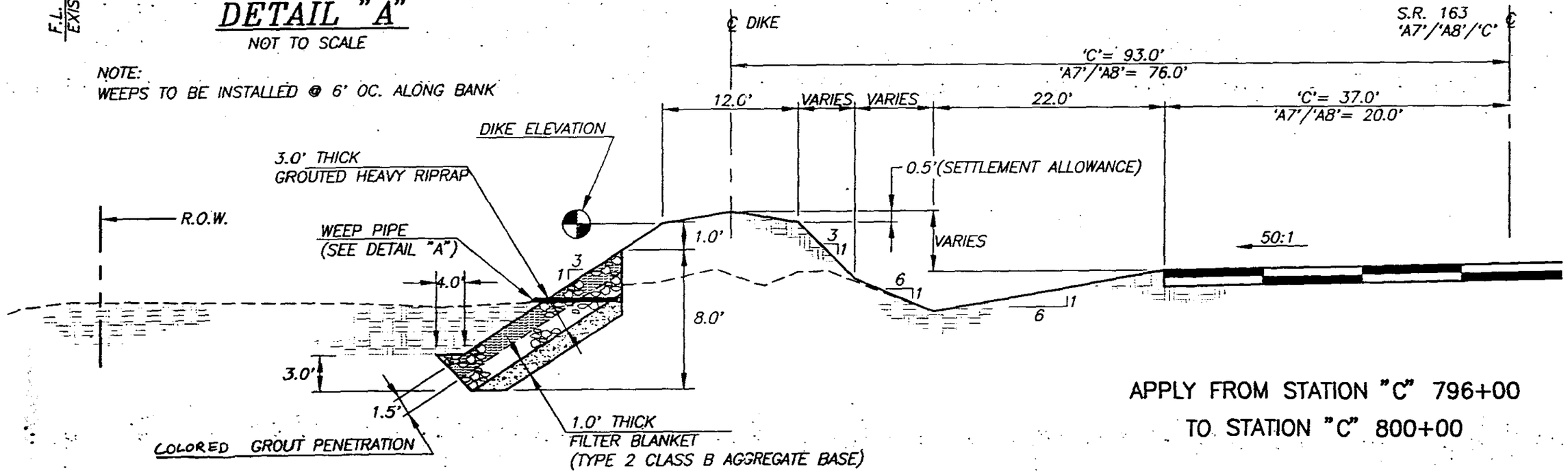
WRC	SR 163 DRAINAGE DESIGN P-059-93-010	DRIPPING SPRINGS CANYON WASH DIKE	SHEET 3 OF 5	JOB NO. 2016



DETAIL "A"

NOT TO SCALE

NOTE:
WEEPS TO BE INSTALLED @ 6' OC. ALONG BANK



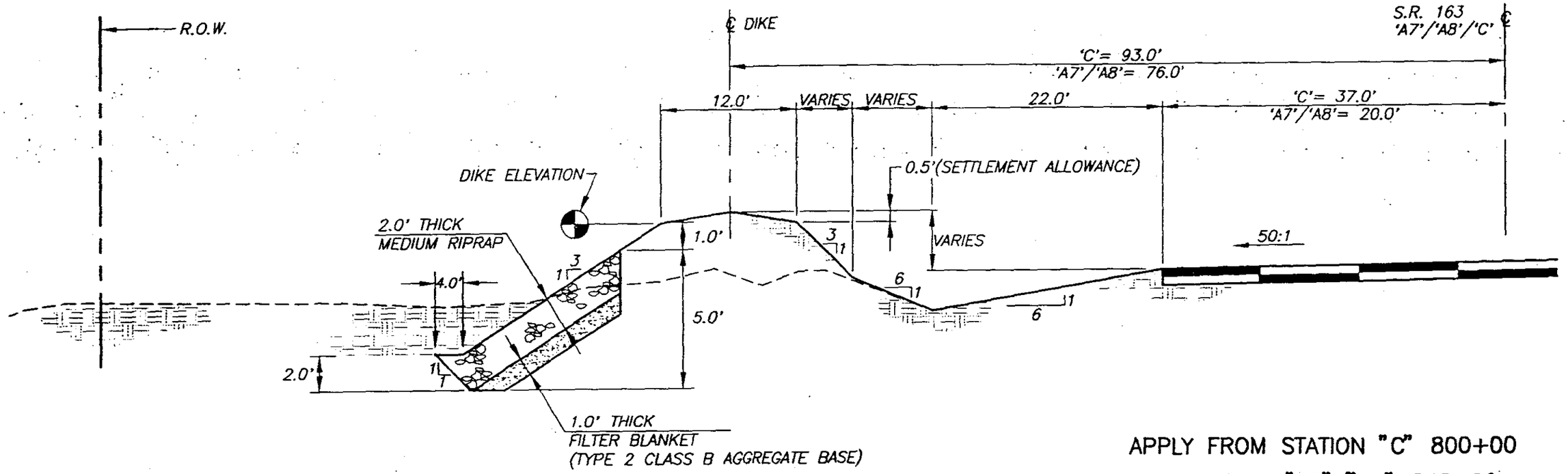
APPLY FROM STATION "C" 796+00
TO STATION "C" 800+00

TYPICAL CROSS SECTION 'D-D'

NOT TO SCALE

2016 SEC-D-E.DWG (3/4) 06-11-93 JLW

WRC	SR 163 DRAINAGE DESIGN P-059-93-010	DRIPPING SPRINGS CANYON WASH DIKE	SHEET 4 OF 5	JOB NO. 2016



APPLY FROM STATION "C" 800+00
TO STATION "A7"/"A8" 848+66

TYPICAL CROSS SECTION 'E–E'

NOT TO SCALE

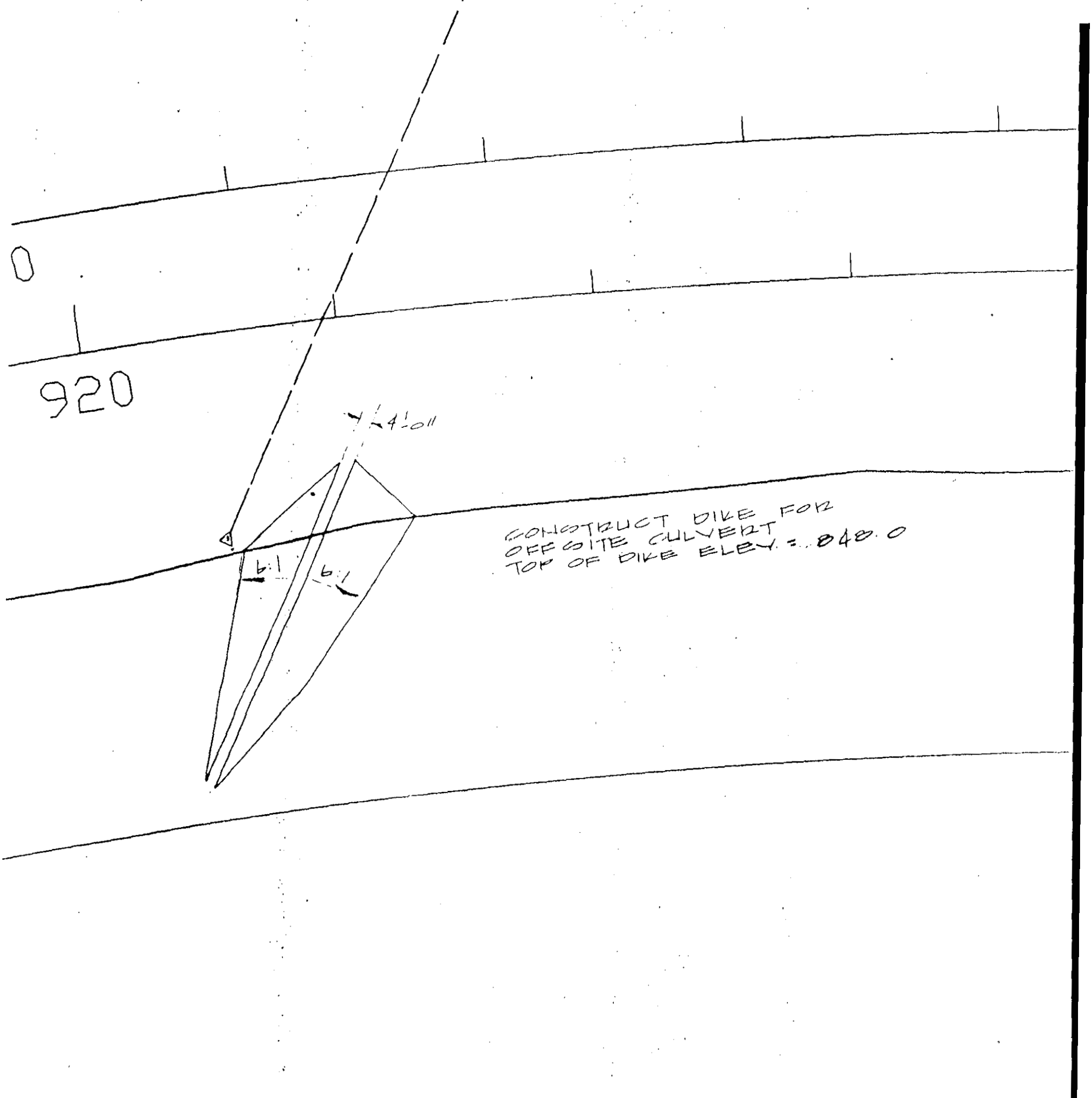
2016 SEC-D-E.DWG (3/5) 06-11-93 JLW

WRC	SR 163 DRAINAGE DESIGN P–059–93–010	DRIPPING SPRINGS CANYON WASH DIKE	SHEET 5 OF 5	JOB NO. 2016

STATION "B" 914+72
CONSTRUCT 5'x3' x 218' RCB CULVERT
15° DEGREE SKEW LT. AHEAD 153' LT.
ALONG SKEW & 65' RT. ALONG SKEW. TYPE 1
HEADWALL LT. & RT. INV = 865.71
INV = 862.0
SLOPE = .017 FT/FT.

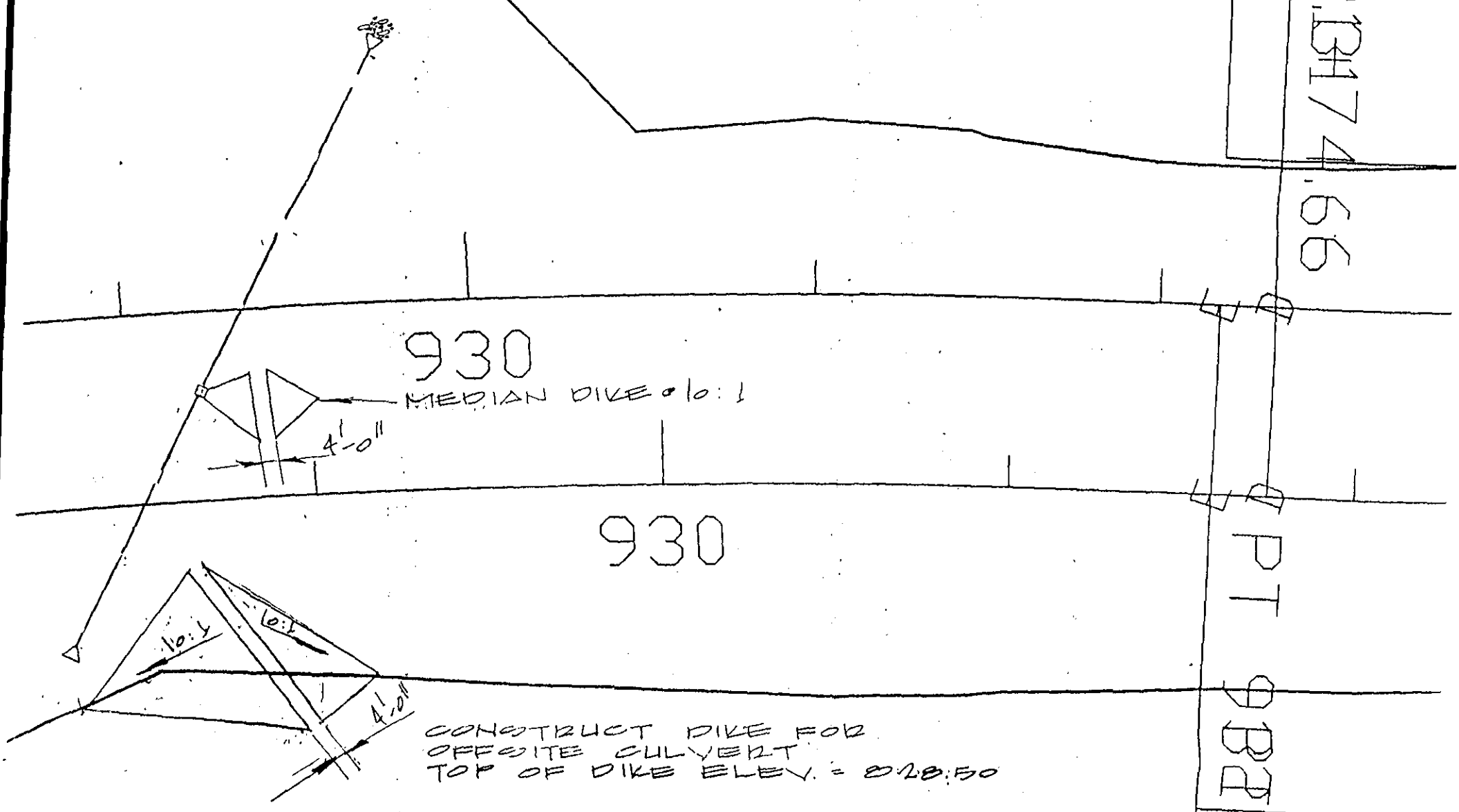
CONSTRUCT GROUTED RIP. RAP BASIN @ OUTLET
CONSTRUCT TYPE 3 RISER INLET OVER OFFSITE
CULVERT. TOP GRATE ELEV. = 873.8

STATION "B" 920+95
CONSTRUCT 30" x 292' CULVERT
30° DEGREE SKEW LT. AHEAD 916 LT
ALONG SKEW & 1+16 RT. ALONG SKEW
END SECTION LT. & RT. HIE = 844.1
HIE = 833.7
SLOPE = 0.0356 FT./FT.
CONSTRUCT MODIFIED RIP. RAP BASIN @ OUTLET.



STATION "B" 928+50
CONSTRUCT 8' x 4' x 216' RCB CULVERT
30° DEGREE SKEW LT. AHEAD 155' LT.
ALONG SKEW & 55' RT. ALONG SKEW
TYPE I HEADWALLS LT. & RT. INLET = 822.5
OUTLET = 813.5
SLOPE = 0.0081 FT./FT.

CONSTRUCT GROUTED RIP. RAP @ BASIN OUTLET
CONSTRUCT TYPE 3 RISER, INLET OVER OFFSITE CULVERT.
TOP GRATE ELEV. 826.6



CONSTRUCT DIKE FOR
OFFSITE CULVERT
TOP OF DIKE ELEV. = 828.50

PC 928+93.74
PT 932+58.56

To ALAN Co
From Doyle
Co
Dept.
Phone #
Fax #

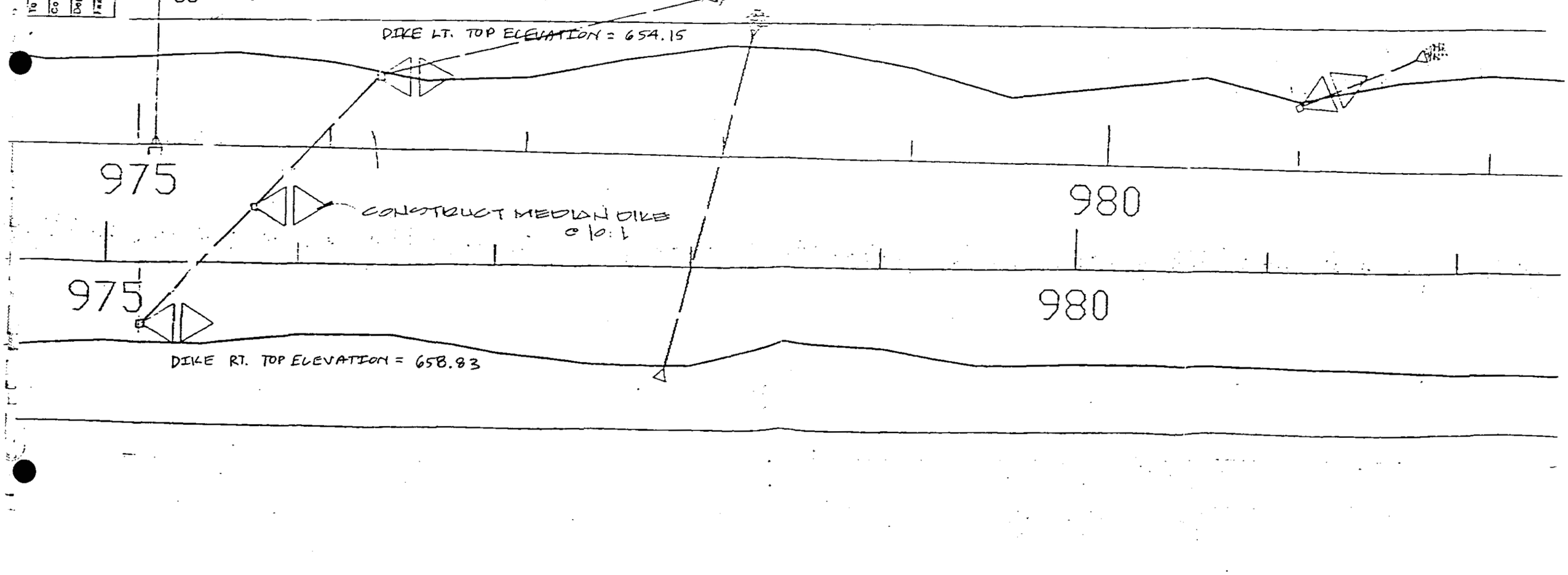
PI 975+08.78

STATION "B" 975+50
CONSTRUCT 24" x 163.36' CMP CULVERT
121.64' LT. ALONG SKEW, 41.72' RT. ALONG SKEW
CONSTRUCT TYPE 2A DI C RT. DITCH
CONSTRUCT TYPE 3 PIPE DROP INLET
C MEDIAN DITCH
CONSTRUCT TYPE 1 DI C LT. DITCH
45° DEGREE SKEW LT. AHEAD
TOP GRATE ELEV. LT. = 653.20
TOP GRATE ELEV. RT. = 657.88
TOP GRATE ELEV. MED. = 656.18
UIE = 644.71
LIE = 649.86
SLOPE = 0.0297 FT./FT.
CONSTRUCT 30" x 175' CMP CULVERT
UIE = 649.86
LIE = 620.00
SLOPE = 0.1706 FT./FT.
CONSTRUCT STANDARD RIP-RAP BASIN C OUTLET
78 DEGREE SKEW LT. AHEAD (30" CMP)

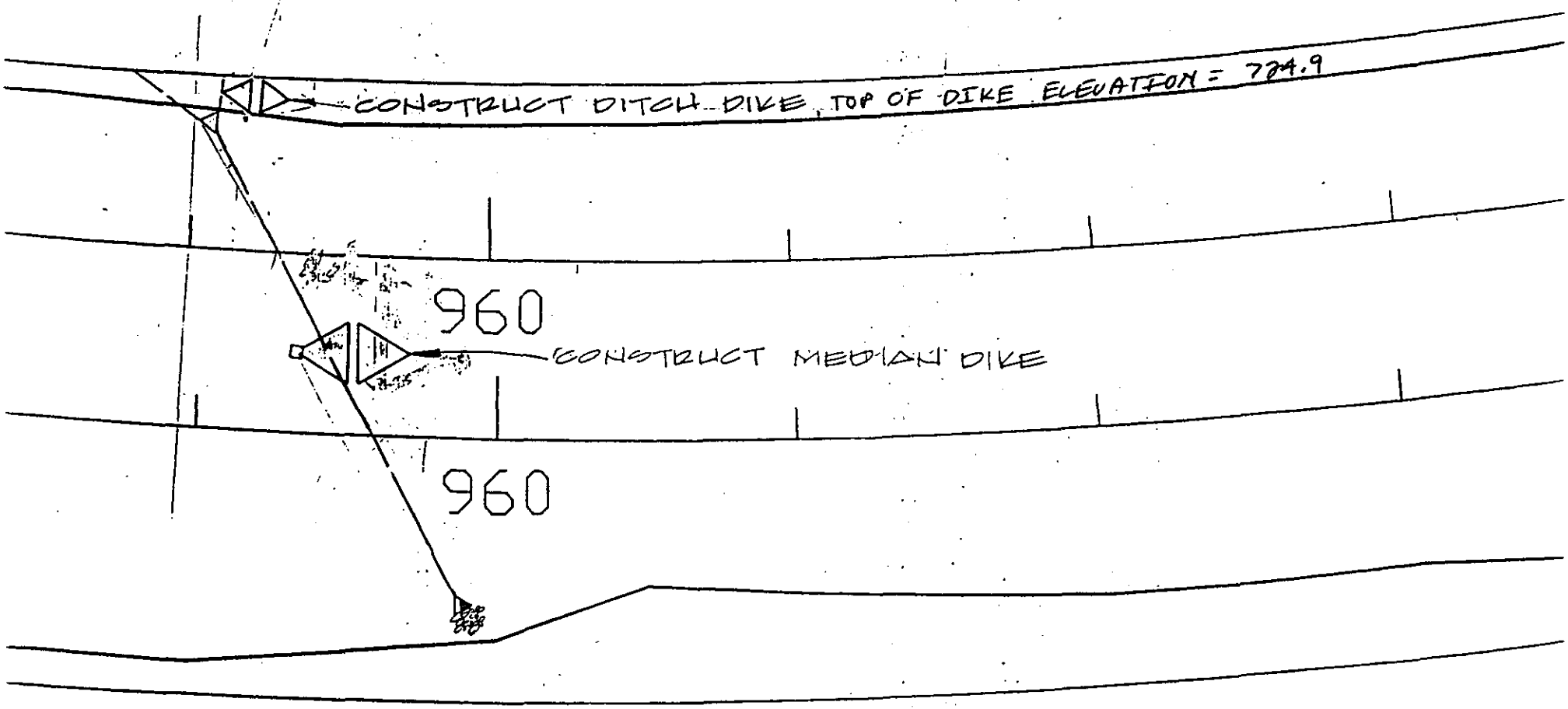
STATION "B" 977+00
CONSTRUCT 30" x 167' CMP CULVERT
23 DEGREE SKEW LT. AHEAD 115' LT.
ALONG SKEW & 52' RT. ALONG SKEW
END SECTION LT. & RT. UIE = 625.3
LIE = 619.7
SLOPE = 0.0335 FT./FT.
CONSTRUCT MODIFIED RIP-RAP. BASIN C OUTLET

STATIO
CONST
12" x 6

USE T
CONST



STATION - "A8" - 959 + 28
CONSTRUCT 5' x 3' x 157' RCB CULVERT
30° DEGREE SKEW RT. AHEAD 136' LT.
ALONG SKEW & 121' RT. ALONG SKEW
TYPE I HEADWALL LT. & RT. LIE = 722.7
LIE = 719.7
SLOPE = 0.0191 FT./FT.
CONSTRUCT MODIFIED RIP RAP @ BASIN OUTLET



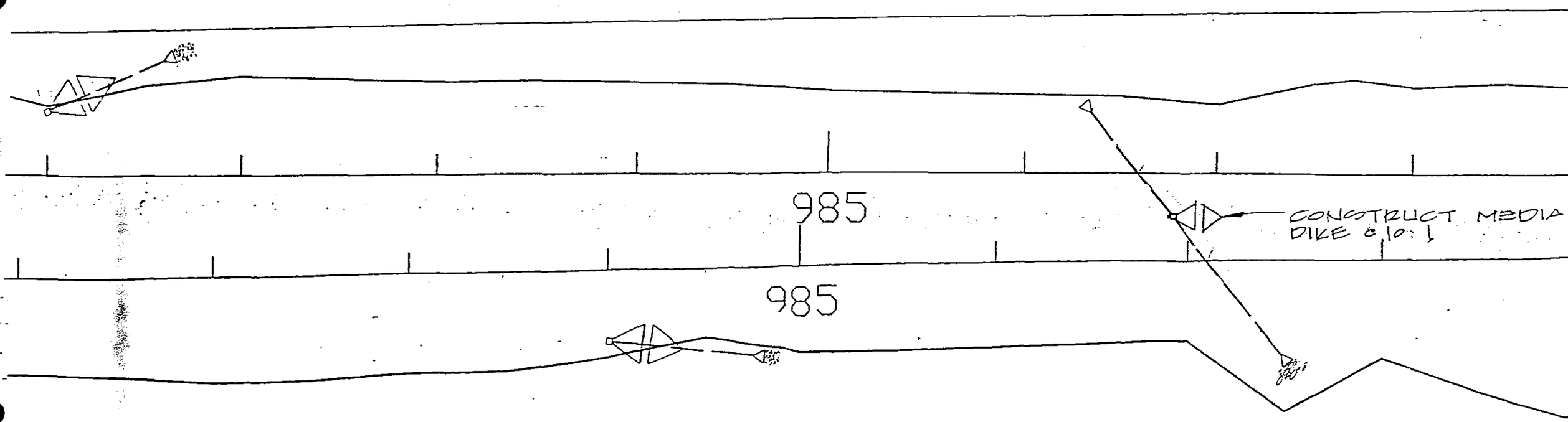
STATION "A8" 981+00
CONSTRUCT TYPE D EMBANKMENT PROTECTOR
12" x 60' CMP & DITCH DIKE 29.5' LT.
TOP OF GRATE ELEV. = 632.21
LIE = 607.0

USE TYPE 2A INLET GRATE
TOP OF DITCH DIKE ELEVATION = 633.16

STATION "A8" 986+58
CONSTRUCT 12' x 7' x 139' RCB CULVERT
45° SKEW RT. AHEAD 39' LT.
ALONG SKEW & 100' RT. ALONG SKEW
TYPE I HEADWALL LT. & RT. LIE = 600.5
LIE = 596.4
SLOPE = 0.0295

CONSTRUCT GROUTED RIP. RAP BASIN
CONSTRUCT TYPE 3 BICER INLET OVE
CULVERT.

TOP OF GRATE ELEV
= 608.68



STATION "B" 984+00
CONSTRUCT TYPE D EMBANKMENT PROTECTOR
12" x 70' CMP & DITCH DIKE 29.5' RT
TOP OF GRATE = 619.53
LIE = 600.00

OUTFALL CHANNEL/STORM SEWER SYSTEM

- Station "A8" 994+75, 72.00' LT to "A8" 994+97.69, 49.31 LT
  Construct mitered inlet
  See special detail
  UIE = 576.20
  LIE = 567.20

- Station "A8" 991+50.00 to "C" 995+60.00
  Construct Dike

Station	Top of Dike Elevation	Dike Centerline Offset
991+50.00	586.00	47.00' LT
993+20.00	581.20	47.00' LT
994+65.00	581.20	47.00' LT
995+60.00	581.20	98.00' LT

- Station "C" 995+80
  Construct 10'x3'x167' RCB culvert
  45° skew RT. ahead, 94' LT. along skew
  and 73' RT. along skew, Type I headwall RT.
  UIE = 567.20
  LIE = 559.20
  Slope = 0.0479 FT/FT

- Station "C" 996+31.62 to 999+29.00
  Construct riprap lined channel
  UIE = 559.20, LIE = 550.00, Slope = 0.030 FT/FT
  Construct 10' layer filter blanket under all heavy and grouted riprap (Type 2 Class B Aggregate Base)

STATION	CHANNEL CENTERLINE OFFSET	CHANNEL BOTTOM WIDTH	NOTES
"C" 996+31.62	51.62' RT	10.0'	Centerline: Δ = 45°, R=50'
"C" 996+66.97	67.00' RT	20.0'	
"C" 999+29.00	60.00' RT	20.0'	

STATION TO STATION	RIPRAP	RIPRAP THICKNESS	RIPRAP HEIGHT
"C" 996+31.62 TO 997+07.00	GROUTED HEAVY RIPRAP	3.0'	6.0'
"C" 997+07.00 TO 998+75.40	HEAVY RIPRAP	3.0'	3.5'
"C" 998+75.40 TO 999+29.00	GROUTED HEAVY RIPRAP	3.0'	6.0'

- Station "C" 999+10, 95' RT
  Construct riprap drop structure
  See special detail

- Station "C" 999+29 to 999+55.33, 60' RT
  Construct mitered inlet
  See special detail
  UIE = 550.00
  LIE = 543.00

- Station "C" 999+55.33, 60' RT to 1002+00, 80' RT
  Construct 78" Diameter RCP storm sewer, L=250'
  UIE = 543.00
  LIE = 537.59
  Slope = 0.0216

- Station "C" 1002+00, 80' RT to 1003+78.19, 80' RT
  Construct 78" Diameter RCP storm sewer, L = 189'
  UIE = 537.59
  LIE = 533.5
  Slope = 0.0216
  Construct Modified Type 4 Manhole at Station "C" 1002+00 with grated cover.

- Station "C" 1003+78.19, 80' RT to 1006+55, 80' RT
  Construct 84" Diameter RCP storm sewer, L = 271'
  UIE = 533.50
  LIE = 531.00
  Slope = 0.00923
  Construct Modified Type 4 Manhole at Station "C" 1003+78.2 with grated cover

- Station "C" 1006+55 to 1006+82.5, 80' RT
  Construct impact stilling basin
  See special detail
  UIE = 531.00
  LIE = 531.00
  Left Wingwall Left End Top Elevation = 536.67 (suggest Top of Footing Elev. = 529.67)
  Right Wingwall Right End Top Elevation = 531.17 (suggest Top of Footing Elev. = 527.67)

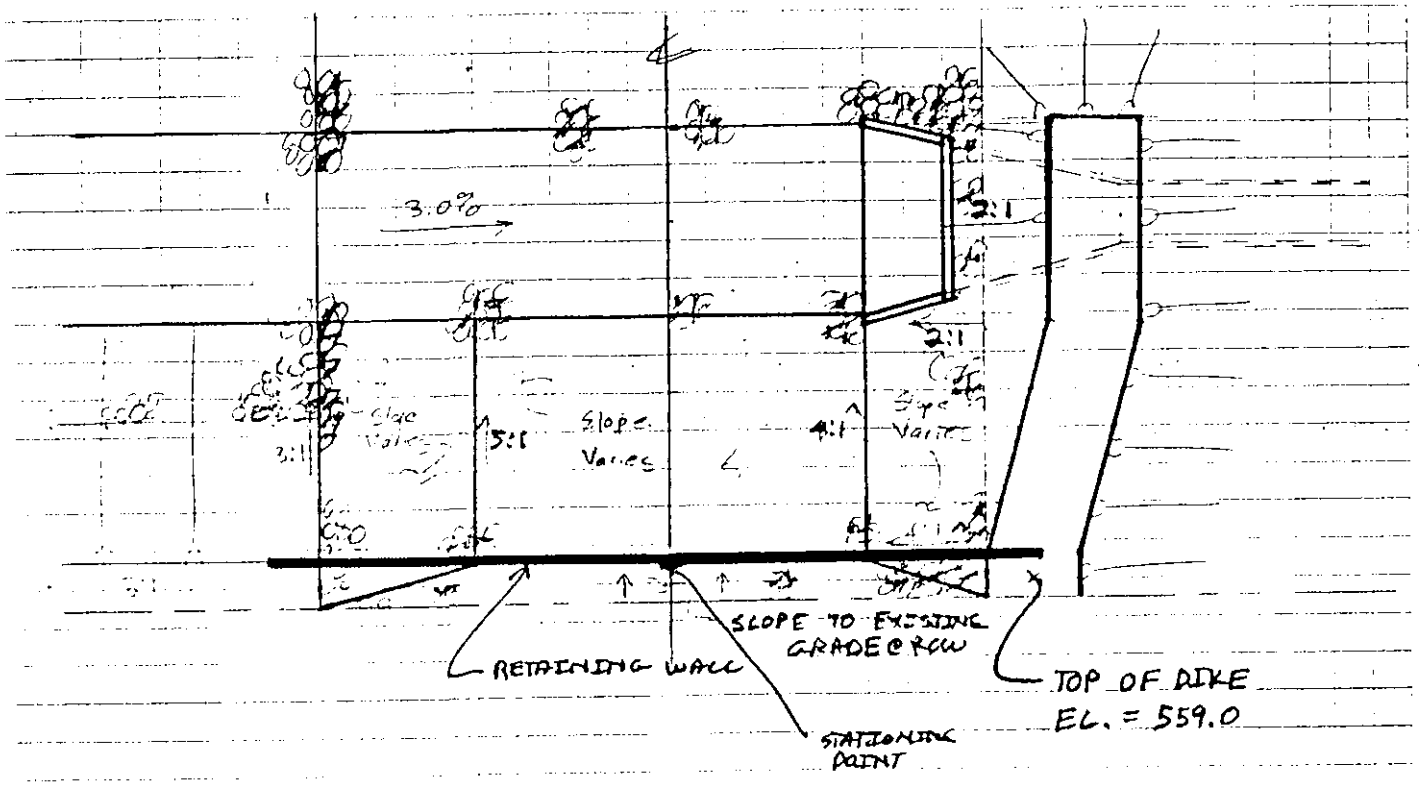
- Station "C" 1006+82.5, 80' RT, to 1008+50, 74' RT
  Construct 153' channel
  See special detail
  UIE = 530.2, BW = 20'
  LIE = 530.0, BW = 50'
  2.0' Medium riprap lining, Station "C" 1006+82.5 to 1007+08; extended riprap lining up left sideslope to maximum elev. = 536.2; no extension on right sideslope.
  Construct 1.0' layer filter blanket under medium riprap (Type 2 Class B Aggregate Base)

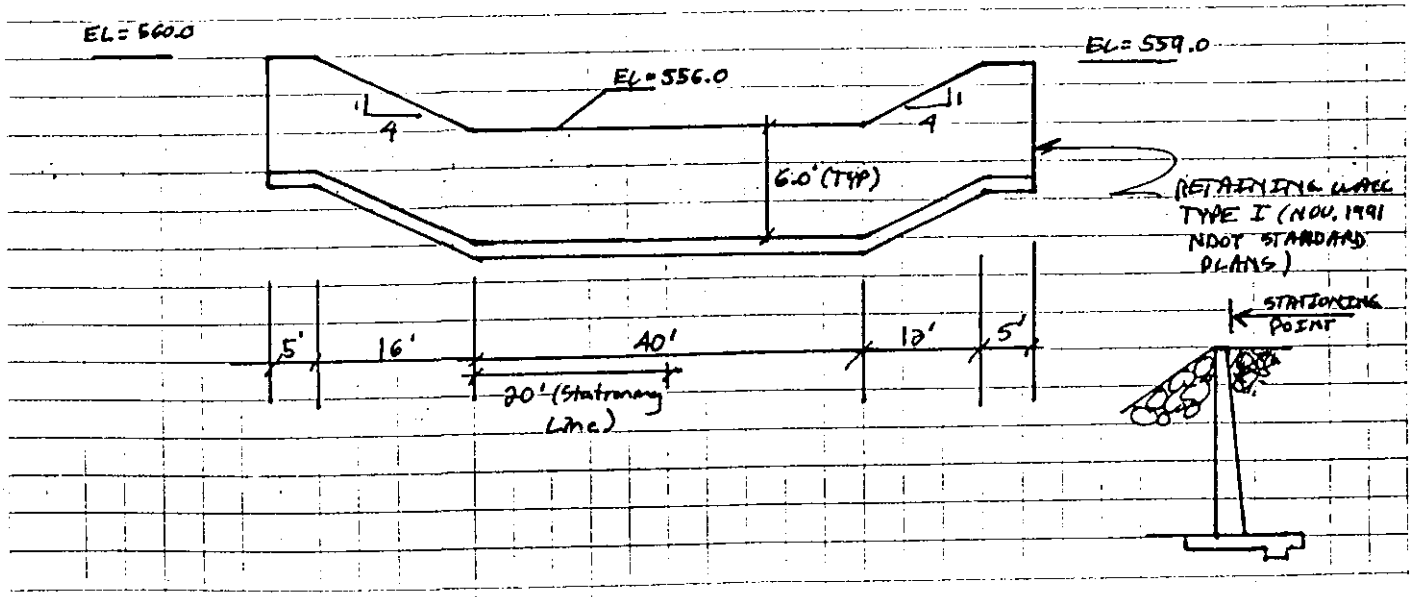
- Station "C" 1002+99.09, 57' LT, to 1003+78.19, 80' RT
  Construct 30" Diameter RCP storm sewer, L = 158'
  UIE = 536.70
  LIE = 533.50
  Slope = .0203
  Construct Type 7 Drop Inlet, Station "C" 1002+99.09, 57' LT
  Top Grate Elev. = 540.04
  Construct Dike for Type 7 Inlet, Dike Elev. = 543.5

WRC NEVADA, INC.
CENTURY PARK
1771 EAST FLAMINGO ROAD—SUITE 200A
LAS VEGAS, NEVADA 89119
PHONE NO. (702) 893--6266
FAX NO. (702) 893--6269

JOB NUMBER: 2016 SHEET 1 OF 1
JOB NAME: S.R. 163
CALC. BY: AJL DATE 6 / 21 / 93
CHKD. BY: DATE / /
REV. BY: DATE / /

SUBJECT: RIPRAP DROP STRUCTURE STA 999+10, 95' RT.





PRB 995+88.88

PC 997+43.13

994+75
72' LT.±
Inv. El.= 576.2

Slope Tapered Inlet

Top of Ditch =581.2

Slope Varies

Ditch ℄

10'x3' RCBC

995

995

995

1000

Slope Tapered Inlet

3:1

3:1

3:1

Drop Structure Crest (See Detail "A")

℄ e 67'

Rprap Lined Channel

PI 1000+53.49

HYDROLOGIC DATA

STATION	STRUCTURE LIST	DESIGN FLOOD		BASIC FLOOD Q (100)		FLOOD OF RECORD Q (R)		
		DISCHARGE IN C.F.S.	WATER SURFACE ELEVATION AT INLET	DISCHARGE IN C.F.S.	WATER SURFACE ELEVATION AT INLET *	DISCHARGE IN C.F.S.	WATER SURFACE ELEVATION AT INLET	DATE
"B" 914+72	5'x3' RCBC	120	870.2	168	871.5			
"B" 920+95	30" CMP	20	846.4	28	848.0			
"B" 928+50	8'x4' RCBC	317**	827.7	275	827.1			
"A8" 959+28	6'x3' RCBC	47	724.9	65	724.9			
"B" 978+00	30" CMP	17	627.4	23	627.9			
"A8" 986+58	12'x7' RCBC	569	607.3	843	608.5			
"C" 995+80	10'x3' RCBC	574	580.2	854	581.2			
"C" 999+55.33	78" RCP STORM SEWER	589	554.8	876	554.8			
"C" 1003+32	30" RCP STORM SEWER	23	543.5	32	543.5			

* Note: where Q100 overtops proposed dikes, the elevation shown herein is the top of dike elevation.

** Note: This culvert was designed to accomodate the 50-year flood event for the total area tributary to "B" 914+72, "B" 920+95, and "B" 928+50.

FED. ROAD PROJ. NO.	STATE	PROJECT	COUNTY
9	NEVADA		CLARK

570

560

1005

1003+98.

1003+51.60

30" RCP Storm Sewer

84" RCP STORM SEWER

78" RCP STORM SEWER

IMPACT STILLING BASIN

wingwall, L=18', 45° Skew

wingwall, L=24'

2:1

"C" ℄
Δ = 17° 36' 05"
R = 2002.0'
L = 615.02'
T = 309.95'

N 71° 47' 01" E

E.O.

R/W

Master

CONTRACT 2594

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	SPS-163(2) STP-PLH-163(6)	CLARK	1

INDEX OF SHEETS

SHEET NO.	DESCRIPTION
1	TITLE SHEET
1A	LOCATION SKETCH
2 - 2A	TYPICAL SECTIONS
3 - 31	SUMMARY AND ESTIMATE OF QUANTITIES
4 - 17	PLANS AND PROFILES
18 - 21	DETOURS, PLANS AND PROFILES
22 - 38	SPECIAL DETAILS
R1 - R5	RIGHT-OF-WAY PLANS
TC1 - TC5	TRAFFIC CONTROL PLANS - PHASE 1 - 3B
T1 - T3	SIGNALS AND LIGHTING SYSTEMS
TS1 - TS16	PERMANENT SIGN REMOVALS & SIGN LOCATIONS
ST-1	STRIPING DETAIL
H1	HYDROLOGIC DATA SHEET
SD1	STORM DRAIN SCHEDULE
S01 - S07	STRUCTURE LISTS

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

CONSTRUCTION PLANS

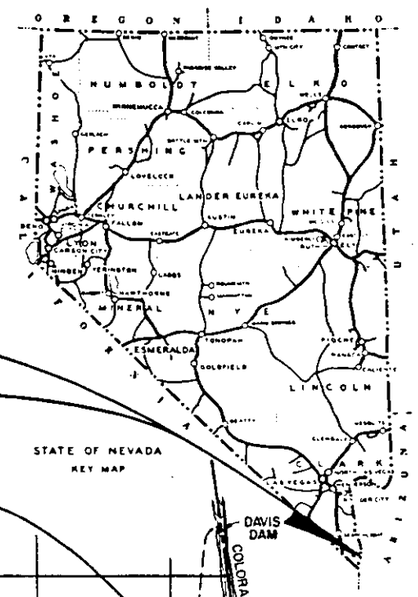
CLARK COUNTY

FROM JCT. US 95 VIA LAUGHLIN TO NEV. - ARIZ. STATE LINE

DESIGN DESIGNATIONS

ADT 1994	5000
ADT 2014	14000
DHV	1540
D	53%
T (DHV)	8%
V (MPH)	50 - 60

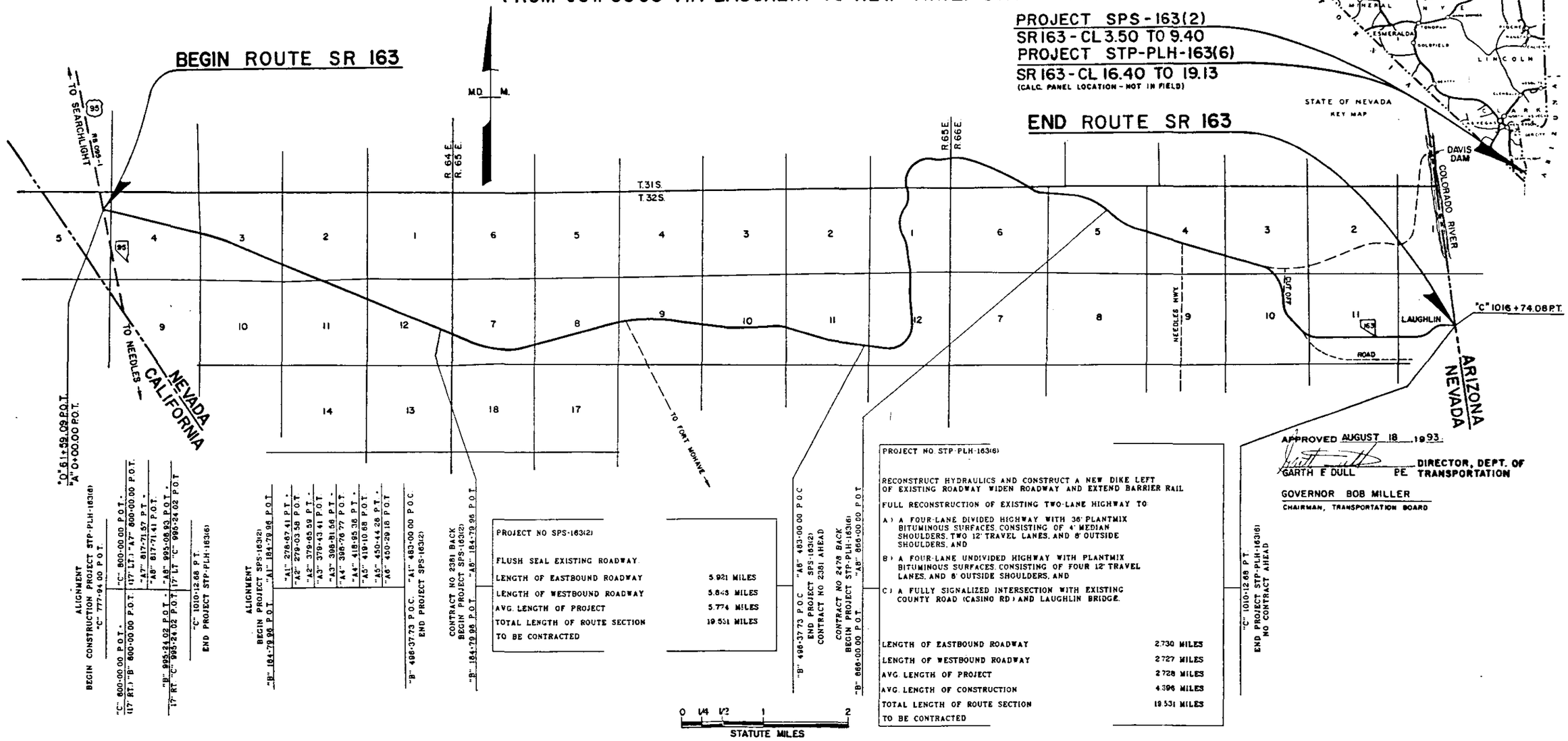
PROJECT SPS-163(2)
SR 163 - CL 3.50 TO 9.40
PROJECT STP-PLH-163(6)
SR 163 - CL 16.40 TO 19.13
(CALC. PANEL LOCATION - NOT IN FIELD)



STATE OF NEVADA
KEY MAP

BEGIN ROUTE SR 163

END ROUTE SR 163



ALIGNMENT
BEGIN CONSTRUCTION PROJECT STP-PLH-163(6)
"C" 777+94.00 P.O.T.

"C" 800+00.00 P.O.T. - "C" 800+00.00 P.O.T.
(17' LT.) "A7" 817+71.57 P.T. - (17' RT.) "B" 800+00.00 P.O.T.
"A7" 817+71.57 P.T. -
"A8" 817+71.41 P.O.T.
"B" 995+24.02 P.O.T. - "A8" 995+08.93 P.O.T. -
17' RT. "C" 995+24.02 P.O.T. 17' LT. "C" 995+24.02 P.O.T.
"C" 1010+12.68 P.T.
END PROJECT STP-PLH-163(6)

ALIGNMENT
BEGIN PROJECT SPS-163(2)
"B" 184+79.96 P.O.T. "A1" 184+79.96 P.O.T.
"A1" 278+67.41 P.T. -
"A2" 279+03.58 P.O.T.
"A2" 379+65.59 P.T. -
"A3" 379+43.41 P.O.T.
"A3" 398+81.58 P.T. -
"A4" 398+76.77 P.O.T.
"A4" 418+85.36 P.T. -
"A5" 419+10.68 P.O.T.
"A5" 450+44.26 P.T. -
"A6" 450+29.16 P.O.T.

"B" 498+37.73 P.O.C. "A1" 483+00.00 P.O.C
END PROJECT SPS-163(2)

CONTRACT NO 2381 BACK
BEGIN PROJECT SPS-163(2)
"B" 184+79.96 P.O.T. "A8" 184+79.96 P.O.T.

PROJECT NO SPS-163(2)	
FLUSH SEAL EXISTING ROADWAY	
LENGTH OF EASTBOUND ROADWAY	5.921 MILES
LENGTH OF WESTBOUND ROADWAY	5.648 MILES
AVG. LENGTH OF PROJECT	5.774 MILES
TOTAL LENGTH OF ROUTE SECTION TO BE CONTRACTED	19.551 MILES

"B" 498+37.73 P.O.C "A8" 483+00.00 P.O.C
END PROJECT SPS-163(2)
CONTRACT NO 2381 AHEAD

CONTRACT NO 2478 BACK
BEGIN PROJECT STP-PLH-163(6)
"B" 866+00.00 P.O.T. "A8" 866+00.00 P.O.T.

PROJECT NO STP-PLH-163(6)

RECONSTRUCT HYDRAULICS AND CONSTRUCT A NEW DIKE LEFT OF EXISTING ROADWAY WIDEN ROADWAY AND EXTEND BARRIER RAIL

FULL RECONSTRUCTION OF EXISTING TWO-LANE HIGHWAY TO

A) A FOUR-LANE DIVIDED HIGHWAY WITH 36' PLANTMIX BITUMINOUS SURFACES, CONSISTING OF 4' MEDIAN SHOULDERS, TWO 12' TRAVEL LANES, AND 8' OUTSIDE SHOULDERS, AND

B) A FOUR-LANE UNDIVIDED HIGHWAY WITH PLANTMIX BITUMINOUS SURFACES, CONSISTING OF FOUR 12' TRAVEL LANES, AND 8' OUTSIDE SHOULDERS, AND

C) A FULLY SIGNALIZED INTERSECTION WITH EXISTING COUNTY ROAD (CASINO RD.) AND LAUGHLIN BRIDGE.

LENGTH OF EASTBOUND ROADWAY	2.730 MILES
LENGTH OF WESTBOUND ROADWAY	2.727 MILES
AVG. LENGTH OF PROJECT	2.728 MILES
AVG. LENGTH OF CONSTRUCTION	4.396 MILES
TOTAL LENGTH OF ROUTE SECTION TO BE CONTRACTED	19.531 MILES

"C" 1010+12.68 P.T.
END PROJECT STP-PLH-163(6)
NO CONTRACT AHEAD

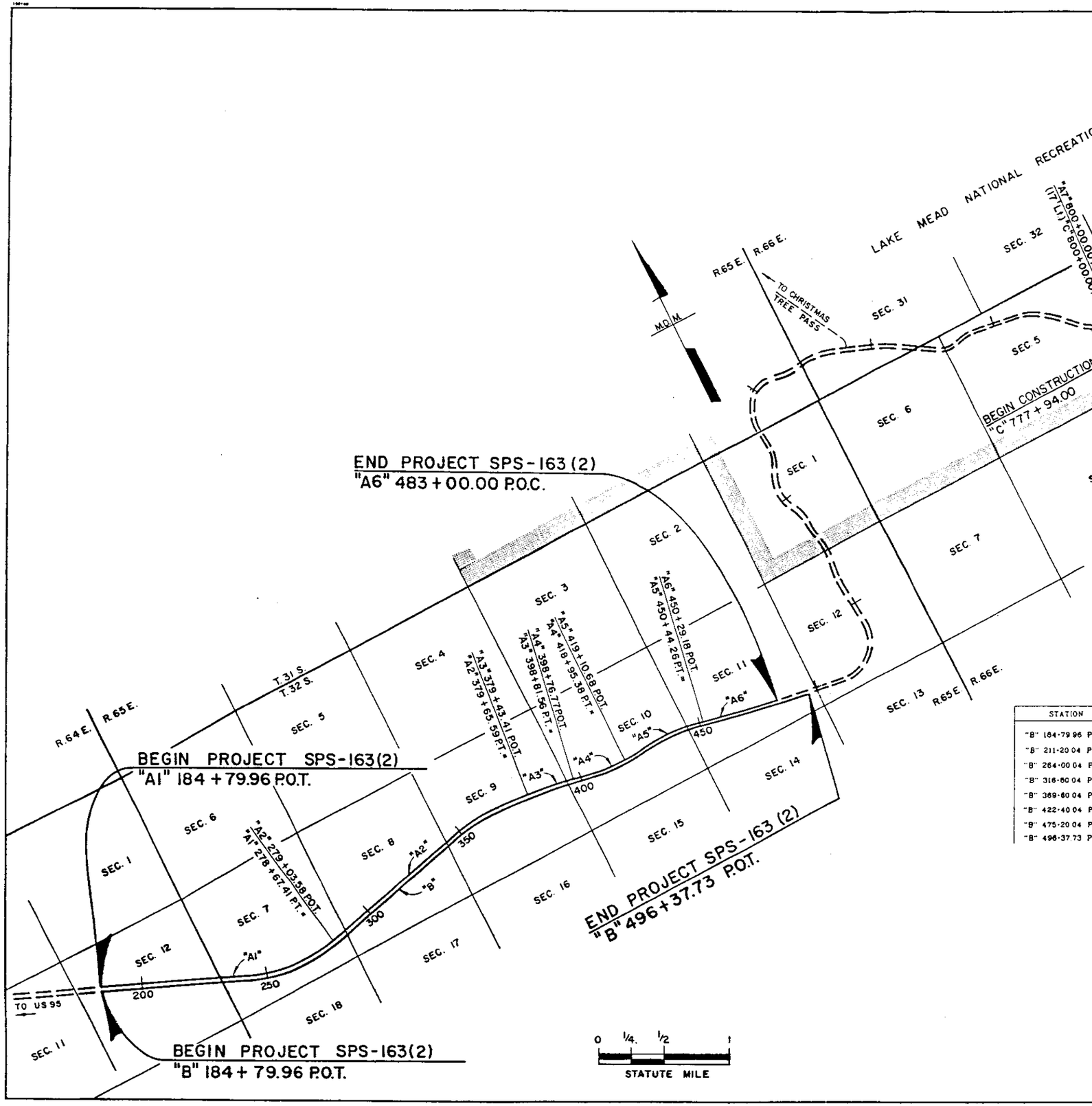
0 1/4 1/2 1 2
STATUTE MILES

APPROVED AUGUST 18, 1993.

GARTH F DULL, P.E. — DIRECTOR, DEPT. OF TRANSPORTATION

GOVERNOR BOB MILLER
CHAIRMAN, TRANSPORTATION BOARD

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	1A



MILEPOST TABULATION

STATION	MILEPOST	DESCRIPTION
"B" 184+79.96 P.O.T.	SR 163 CL 3.50	BEGIN PROJECT SPS-163(2)
"B" 211+20.04 P.O.T.	SR 163 CL 4.00	4.00
"B" 264+00.04 P.O.T.	SR 163 CL 5.00	5.00
"B" 316+80.04 P.O.T.	SR 163 CL 6.00	6.00
"B" 369+60.04 P.O.T.	SR 163 CL 7.00	7.00
"B" 422+40.04 P.O.T.	SR 163 CL 8.00	8.00
"B" 475+20.04 P.O.T.	SR 163 CL 9.00	9.00
"B" 496+37.73 P.O.C.	SR 163 CL 9.40	END PROJECT SPS-163(2)

MILEPOST TABULATION

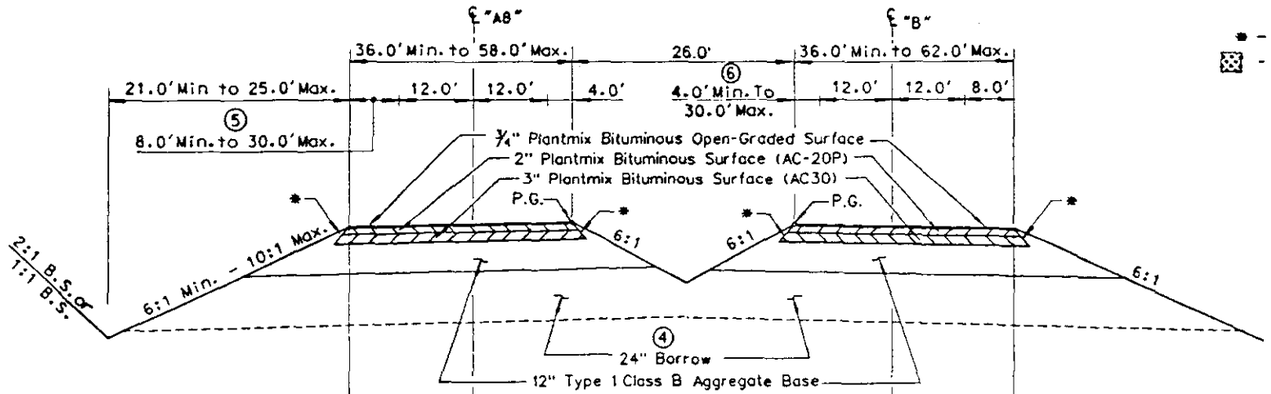
STATION	MILEPOST	DESCRIPTION
"C" 777+94.00 P.O.T.	SR 163 CL 14.73	BEGIN CONSTRUCTION
"C" 792+05.73 P.O.T.	SR 163 CL 15.00	15.00
"C" 800+00.00 P.O.T. = "B" 800+00.00 P.O.T.	SR 163 CL 15.15	15.15
"B" 844+65.73 P.O.T.	SR 163 CL 16.00	16.00
"B" 866+00.00 P.O.T.	SR 163 CL 16.40	BEGIN PROJECT STP-PLH-163(6)
"B" 887+65.73 P.O.T.	SR 163 CL 17.00	17.00
"B" 950+45.73 P.O.T.	SR 163 CL 18.00	18.00
"B" 995+24.02 P.O.T. = "C" 995+24.02 P.O.T.	SR 163 CL 18.85	18.85
"C" 1003+25.73 P.O.T.	SR 163 CL 19.00	19.00
"C" 1010+12.68 P.O.T.	SR 163 CL 19.13	END PROJECT STP-PLH-163(6)

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

LOCATION SKETCH

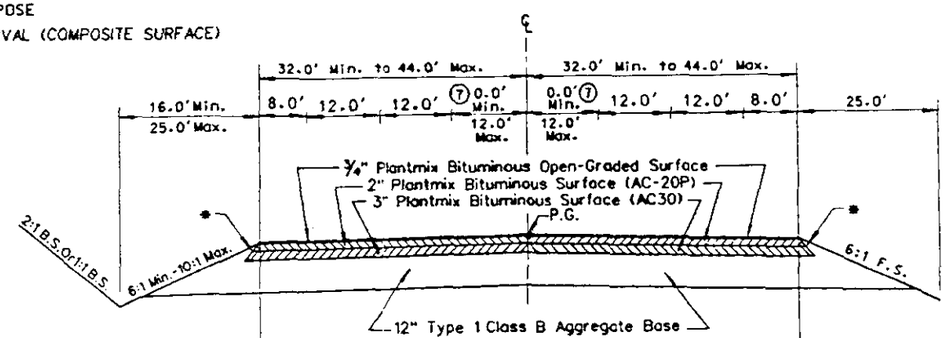
ROAD DESIGN DIVISION	
DESIGN ENGR	LARKIN
SENIOR DESIGN ENGR	MARTINOVICH
PHONE 687-5475	

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	2



* - ANGLE OF REPOSE

▨ - LIMITS OF REMOVAL (COMPOSITE SURFACE)

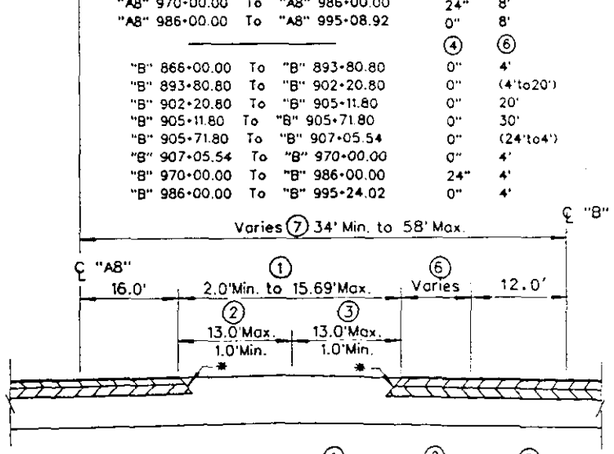


SECTION OF IMPROVEMENT

CONSTRUCTION TYPE CODE 1000

	④	⑤
"A8" 866+00.00 To "A8" 894+95.51	0"	8'
"A8" 894+95.51 To "A8" 900+95.51	0"	(8' to 16')
"A8" 900+95.51 To "A8" 902+15.82	0"	(16' to 30')
"A8" 902+15.82 To "A8" 905+23.37	0"	(8' to 10')
"A8" 905+23.37 To "A8" 909+08.50	0"	16'
"A8" 909+08.50 To "A8" 910+08.50	0"	(16' to 8')
"A8" 910+08.50 To "A8" 970+00.00	0"	8'
"A8" 970+00.00 To "A8" 986+00.00	24"	8'
"A8" 986+00.00 To "A8" 995+08.92	0"	8'

	④	⑥
"B" 866+00.00 To "B" 893+80.80	0"	4'
"B" 893+80.80 To "B" 902+20.80	0"	(4' to 20')
"B" 902+20.80 To "B" 905+11.80	0"	20'
"B" 905+11.80 To "B" 905+71.80	0"	30'
"B" 905+71.80 To "B" 907+05.54	0"	(24' to 4')
"B" 907+05.54 To "B" 970+00.00	0"	4'
"B" 970+00.00 To "B" 986+00.00	24"	4'
"B" 986+00.00 To "B" 995+24.02	0"	4'



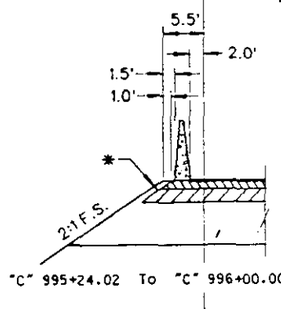
	①	②	③	⑦
"B" 899+22.00 To "B" 902+20.80	(15.69' to 10.00')	(10.00')	(5.69' to 0')	58'
"B" 902+20.80 To "B" 905+11.80	(10.00')	(10.00')	(0.0')	58'
"A8" 986+93.69 To "A8" 995+08.92	(15.23' to 2.0')	(7.62+to 1')	(7.62+to 1')	(47.23' to 34')

SECTION OF IMPROVEMENT

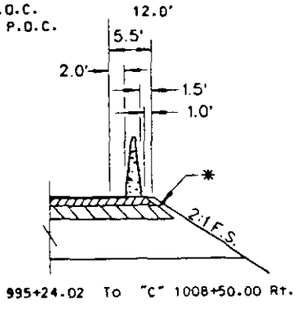
CONSTRUCTION TYPE CODE 1000

"C" 995+24.02 P.O.T. To "C" 997+43.13 P.O.T.
"C" 997+43.13 P.O.T. To "C" 1003+98.36 P.C.
"C" 1003+98.36 P.C. To "C" 1007+80.00 P.O.C.
"C" 1007+80.00 P.O.C. To "C" 1009+94.07 P.O.C.

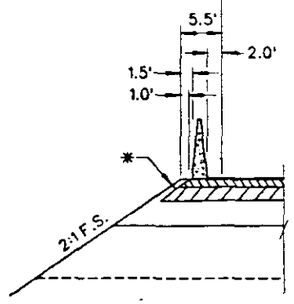
⑦ (5.0' to 0.0') 0.0' (0.0' to 12.0') 12.0'



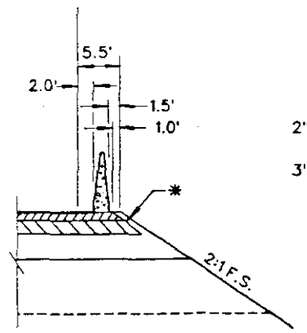
"C" 995+24.02 To "C" 996+00.00 Lt.



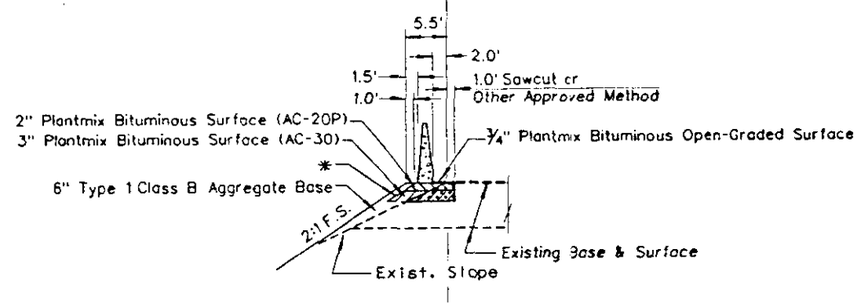
"C" 995+24.02 To "C" 1008+50.00 Rt.



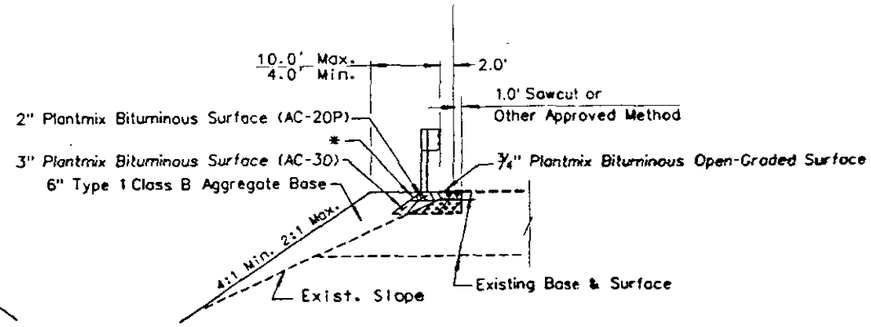
"A8" 958+50.00 To "A8" 995+08.92 Lt.



"B" 959+00.00 To "B" 995+24.02 Rt.



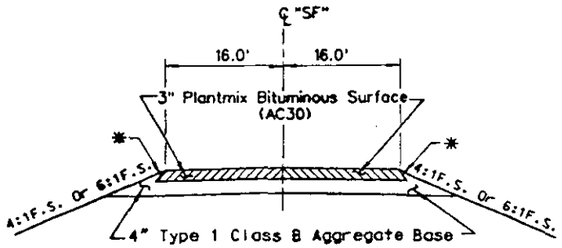
"C" 783+68.75 To "C" 791+00.00 P.T. Lt.



"C" 791+00.00 To "C" 791+37.50 P.T.

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6) SPS-163(6)	CLARK	2A

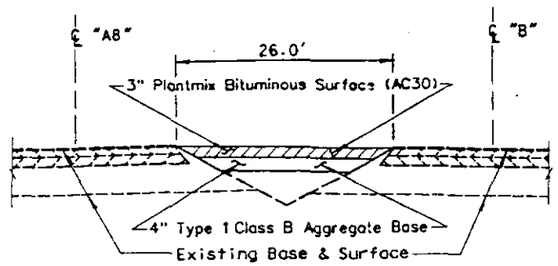
* - ANGLE OF REPOSE



SECTION OF IMPROVEMENT

(TEMPORARY DETOUR)

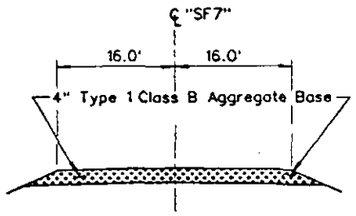
"SF1" 2+41.00 To "SF1" 9+19.80
"SF4" 1+00.00 To "SF4" 4+50.00



SECTION OF IMPROVEMENT

(TEMPORARY DETOUR)

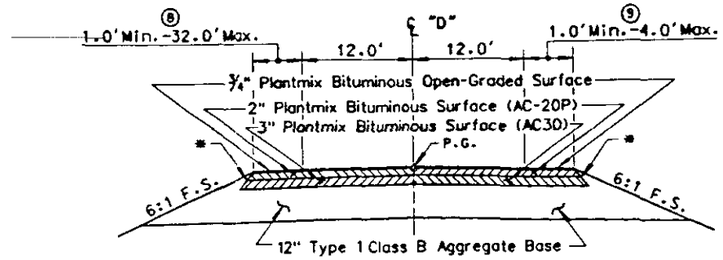
("SF2" & "SF3")
"A8" 892+91.78 To "A8" 895+44.40
("SF5" & "SF6")
"A8" 851+39.94 To "A8" 855+07.97



SECTION OF IMPROVEMENT

(TEMPORARY DETOUR)

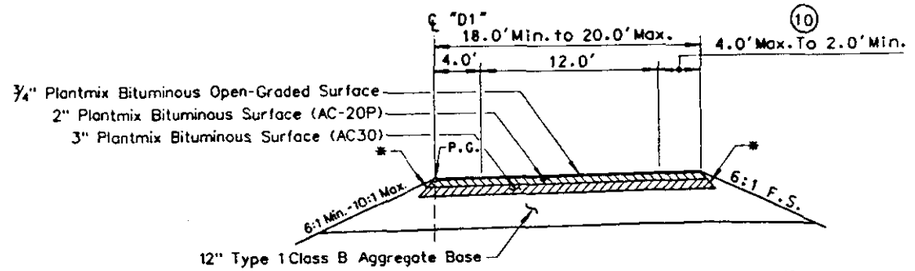
Note : Contractor Shall Be Responsible For Maintenance of Gravel Road.



SECTION OF IMPROVEMENT

CONSTRUCTION TYPE CODE 1000

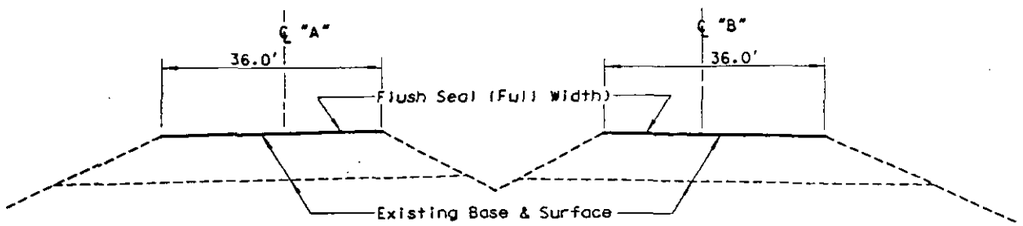
			⑧	⑨
"D" 0+28.00	To	"D" 2+01.68	(2.0'to 4.0')	4.0'
"D" 2+01.68	To	"D" 3+25.62	(32.0'to 4.0')	4.0'
"D" 3+25.62	To	"D" 5+73.11	4.0'	4.0'
"D" 5+73.11	To	"D" 6+73.11	(4.0'to 1.0')	(4.0'to 1.0')



SECTION OF IMPROVEMENT

CONSTRUCTION TYPE CODE 1000 ⑩

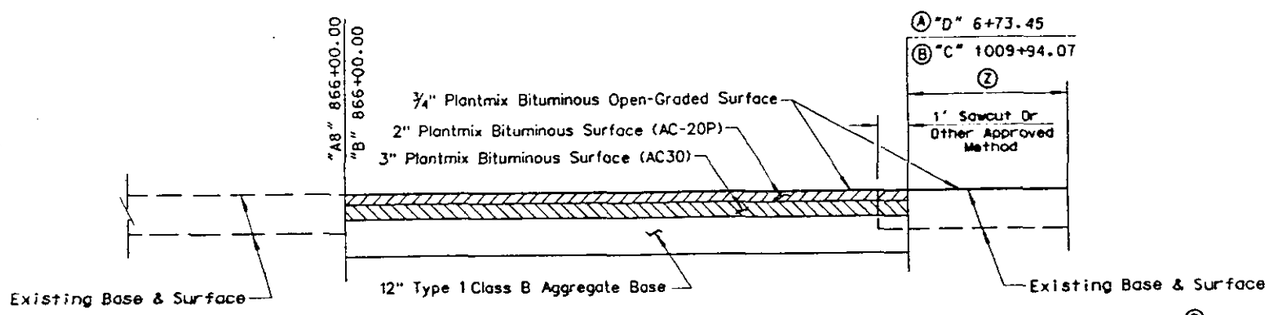
"D1" 1+21.13 To "D1" 4+83.60 (2.0'to 4.0')



SECTION OF IMPROVEMENT

CONSTRUCTION TYPE CODE F000

"A1" 184+79.96 P.O.T. To "A6" 483+00.00 P.O.C.
"B" 184+79.96 P.O.T. To "B" 496+37.73 P.O.T.



	Ⓩ
Ⓐ DAVIS DAM RD	50'
Ⓑ CASINO DRIVE	(Full Width Of Inter.)

LONGITUDINAL SECTION

SUMMARY OF SURFACING QUANTITIES

NOTE: QUANTITIES SHOWN IN THE SUMMARIES FOR BASE AND SURFACE MATERIALS ARE THEORETICAL AND USED FOR ESTIMATING PURPOSES ONLY. ACTUAL SPREADS SHALL BE VARIED AS REQUIRED TO OBTAIN THE DEPTH OF THE VARIOUS COURSES SHOWN ON THE TYPICAL SECTIONS.

ITEM	TONS/ STATION	STATION	TOTAL	UNIT
TYPE 1 CLASS B AGGREGATE BASE (Quantities include 8% by Weight for Moisture content.) (No Slope Allowance or Angle of Repose Included)				
12" DEPTH (WIDTH VARIES)				
"A8" LINE				
"A8" 866+00.00 TO "A8" 894+95.51 (36' WIDE)	289.3	28.96	8378	TON
"A8" 894+95.51 TO "A8" 900+95.51 (40' AVE WIDTH)	321.4	6.00	1929	TON
"A8" 900+95.51 TO "A8" 902+15.82 (51' AVE WIDTH)	409.8	1.20	492	TON
"A8" 902+15.82 TO "A8" 905+23.37 (37' AVE WIDTH)	297.3	3.08	916	TON
"A8" 905+23.37 TO "A8" 909+08.50 (44' WIDE)	353.6	3.85	1361	TON
"A8" 909+08.50 TO "A8" 910+08.50 (40' AVE WIDTH)	321.4	1.00	321	TON
"A8" 910+08.50 TO "A8" 958+50.00 (36' WIDE)	289.3	48.42	14008	TON
"A8" 958+50.00 TO "A8" 995+08.92 (40.5' WIDE)	325.5	36.59	11909	TON
"B" LINE				
"B" 866+00.00 TO "B" 893+80.80 (36' WIDE)	289.3	27.81	8045	TON
"B" 893+80.80 TO "B" 902+20.80 (42' AVE WIDTH)	337.5	8.40	2835	TON
"B" 902+20.80 TO "B" 905+11.80 (48' WIDE)	385.7	2.91	1122	TON
"B" 905+11.80 TO "B" 905+71.80 (58' WIDE)	466.1	0.60	280	TON
"B" 905+71.80 TO "B" 907+05.54 (46' AVE WIDTH)	369.7	1.34	495	TON
"B" 907+05.54 TO "B" 958+18.75 (36' WIDE)	289.3	51.13	14792	TON
"B" 958+18.75 TO "B" 959+00.00 (38' WIDE)	305.4	0.81	247	TON
"B" 959+00.00 TO "B" 995+24.01 (40.5' WIDE)	325.5	36.24	11796	TON
"C" LINE				
"C" 995+24.02 TO "C" 996+00.00 (81.27' AVE WIDTH)	653.1	0.76	496	TON
"C" 996+00.00 TO "C" 996+81.25 (75.18' AVE WIDTH)	604.2	0.81	489	TON
"C" 996+81.25 TO "C" 997+31.25 (70.16' AVE WIDTH)	563.8	0.50	282	TON
"C" 997+31.25 TO "C" 997+43.13 (68.75' AVE WIDTH)	552.5	0.12	66	TON
"C" 997+43.13 TO "C" 1003+98.36 (68.50 AVE WIDTH)	550.5	6.55	3606	TON
"C" 1003+98.36 TO "C" 1007+80.00 (80.50' AVE WIDTH)	646.9	3.82	2471	TON
"C" 1007+80.00 TO "C" 1008+50.00 (92.50' AVE WIDTH)	743.3	0.70	520	TON
"C" 1008+50.00 TO "C" 1009+31.25 (90' WIDE)	723.2	0.81	586	TON
"C" 1009+31.25 TO "C" 1009+94.07 (88' WIDE)	707.2	0.63	446	TON
"D" LINE				
"D" 0+28.00 TO "D" 2+01.68 (31' AVE WIDTH)	249.1	1.74	433	TON
"D" 2+01.68 TO "D" 3+25.62 (46' AVE WIDTH)	369.7	1.24	458	TON
"D" 3+25.62 TO "D" 5+73.11 (32'WIDE)	257.2	2.47	635	TON
"D" 5+73.11 TO "D" 6+73.11 (29' AVE WIDTH)	233.0	1.00	233	TON
"D1" LINE				
"D1" 1+21.13 TO "D1" 4+83.60 (19' AVE WIDTH)	152.7	3.62	553	TON
MISC AREAS (Includes Slope Allowance)	N/A	N/A	192	TON
6" DEPTH (WIDTH VARIES)				
"C" 783+68.75 TO "C" 791+00.00 (AVG. WIDTH 6.5')	12.0	7.31	88	TON
"C" 791+00.00 TO "C" 791+37.50 (AVG. WIDTH 9.0')	52.6	0.38	20	TON
"C" 791+37.50 TO "C" 791+87.50 (AVG. WIDTH 5.0')	50.1	0.50	25	TON
4" DEPTH (WIDTH VARIES) (Includes Slope Allowance)				
"SF1"	N/A	N/A	647	TON
"SF2" ("SF3")	N/A	N/A	477	TON
"SF4"	N/A	N/A	419	TON
"SF5" ("SF6")	N/A	N/A	477	TON
"SF7"	N/A	N/A	344	TON

FED. RD. REG. NO.	STATE	PROJECT NO.
1	NEVADA	STP-PLH-163(6)

COUNTY	SHEET NO.
CLARK	3

ITEM	TONS/ STATION	STATION	TOTAL	UNIT
SLOPE ALLOWANCE (17" DEPTH)				
Slope Allowance (slope varies)				
Includes Widening for Guardrail and Barrier Rail				
"A8" LINE (LEFT SIDE ONLY)				
"A8" 866+00.00 TO "A8" 931+45.21 (6:1)	48.1	65.45	3147	TON
"A8" 931+45.21 TO "A8" 932+08.51 (6:1 to 10:1)	57.1	0.63	36	TON
"A8" 932+08.51 TO "A8" 958+22.50 (10:1)	125.8	26.14	3289	TON
"A8" 958+22.50 TO "A8" 958+50.00 (10:1 to 2:1)	96.4	0.28	27	TON
"A8" 958+50.00 TO "A8" 955+08.02 (2:1)	26.8	36.59	982	TON
"A8" LINE (RIGHT SIDE ONLY)				
"A8" 866+00.00 TO "A8" 899+00.00 (6:1 FS)	53.5	33	1765	TON
"A8" 899+00.00 TO "A8" 899+22.00	168.2	0.22	37	TON
(transition 6:1 FS to 2:1 BS)				
"A8" 899+22.00 TO "A8" 905+11.80 (2:1 BS)	110.2	5.99	660	TON
"A8" 905+11.80 TO "A8" 905+71.80 (EXCEPTION)	0.0	0.6	0	
"A8" 905+71.80 TO "A8" 986+80.69 (6:1 FS)	56.9	71.08	4047	TON
"A8" 986+80.69 TO "A8" 986+89.69	55.6	0.09	5	TON
(transition 6:1 FS to 2:1 BS)				
"A8" 986+89.69 TO "A8" 995+08.92 (2:1 BS)	34.7	8.19	284	TON
"B" LINE (LEFT SIDE ONLY)				
"B" 866+00.00 TO "B" 899+00.00 (6:1)	44.8	33	1477	TON
"B" 899+00.00 TO "B" 899+22.00	18.2	0.22	4	TON
(transition 6:1 to 50:1)				
"B" 899+22.00 TO 902+20.80 (50:1)	0.0	2.98	0	TON
"B" 902+20.80 TO "B" 905+71.80 (EXCEPTION)	0.0	3.51	0	TON
"B" 905+71.80 TO "B" 986+96.00 (6:1)	50.0	81.24	4058	TON
"B" 986+96.00 TO "B" 987+05.00	22.2	0.09	2	TON
(transition 6:1 to 50:1)				
"B" 987+05.00 TO "B" 995+24.01 (50:1)	28.9	8.19	237	TON
"B" LINE (RIGHT SIDE ONLY)				
"B" 866+00.00 TO "B" 958+18.75 (6:1)	50.4	92.19	4647	TON
"B" 958+18.75 TO "B" 959+00.00	107.4	0.81	87	TON
(transition 6:1 to 2:1)				
"B" 959+00.00 TO "B" 995+24.01 (2:1)	33.4	36.24	1209	TON
"C" LINE (LEFT SIDE ONLY)				
"C" 995+24.02 TO "C" 996+00.00 (2:1)	26.5	0.76	20	TON
"C" 996+00.00 TO "C" 996+81.25 (2:1)	103.1	0.81	84	TON
"C" 996+81.25 TO "C" 997+31.25	110.4	0.50	55	TON
(transition 2:1 to 6:1)				
"C" 997+31.25 TO "C" 1007+00.00 (6:1)	53.5	9.69	518	TON
"C" 1007+00.00 TO "C" 1007+80.00	76.4	0.80	61	TON
(transition 6:1 to 10:1)				
"C" 1007+80.00 TO "C" 1009+94.07 (10:1)	99.4	2.14	213	TON
"C" LINE (RIGHT SIDE ONLY)				
"C" 995+24.02 TO "C" 1008+50.00 (2:1)	26.7	13.26	354	TON
"C" 1008+50.00 TO "C" 1009+31.25	103.1	0.81	84	TON
(transition 2:1 to 6:1)				
"C" 1009+31.25 TO "C" 1009+81.25 (6:1)	110.4	0.50	55	TON
"C" 1009+81.25 TO "C" 1009+94.07 (6:1)	46.2	0.13	6	TON
"D" LINE (LEFT SIDE ONLY)				
"D" 0+28.00 TO "D" 6+73.11 (6:1)	53.5	6.45	345	TON
"D" LINE (RIGHT SIDE ONLY)				
"D" 0+28.00 TO "D" 6+73.11 (6:1)	53.5	6.45	345	TON
"D1" LINE (LEFT SIDE ONLY)				
"D1" 1+21.13 TO "D1" 4+83.60 (6:1)	53.6	3.62	194	TON
"D" LINE (RIGHT SIDE ONLY)				
"D1" 1+21.13 TO "D1" 4+83.75 (6:1)	38.7	3.62	140	TON
TOTAL			121.363	TON
USE TOTAL			121.365	TON

FED.RD. REG.NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
1	NEVADA	STP-PLH-163(6)	CLARK	3A

ITEM	TONS/ STATION	STATION	TOTAL	UNIT
PLANTMIX BITUMINOUS SURFACE				
(Quantities Include Slope Allowance)				
(Quantities Include Allowance for Super Elevations)				
5" DEPTH (WIDTH VARIES)				
"A8" LINE				
"A8" 866+00.00 TO "A8" 894+95.51 (36' WIDE)	114.2	28.96	3307	TON
"A8" 894+95.51 TO "A8" 900+95.51 (40' AVE WIDTH)	126.6	6.00	760	TON
"A8" 900+95.51 TO "A8" 902+15.82 (51' AVE WIDTH)	160.7	1.20	193	TON
"A8" 902+15.82 TO "A8" 905+23.37 (37' AVE WIDTH)	117.3	3.08	361	TON
"A8" 905+23.37 TO "A8" 909+08.50 (44' WIDE)	139.0	3.85	535	TON
"A8" 909+08.50 TO "A8" 910+08.50 (40' AVE WIDTH)	126.6	1.00	127	TON
"A8" 910+08.50 TO "A8" 958+50.00 (36' WIDE)	114.3	48.42	5534	TON
"A8" 958+50.00 TO "A8" 995+08.92 (40.5' WIDE)	128.3	36.59	4694	TON
"B" LINE				
"B" 866+00.00 TO "B" 893+80.80 (36' WIDE)	114.5	27.81	3184	TON
"B" 893+80.80 TO "B" 902+20.80 (42' AVE WIDTH)	131.7	8.40	1106	TON
"B" 902+20.80 TO "B" 905+11.80 (48' WIDE)	150.2	2.91	437	TON
"B" 905+11.80 TO "B" 905+71.80 (58' WIDE)	181.7	0.60	109	TON
"B" 905+71.80 TO "B" 907+05.54 (46' AVE WIDTH)	145.5	1.34	195	TON
"B" 907+05.54 TO "B" 957+68.75 (36' WIDE)	114.3	50.63	5787	TON
"B" 957+68.75 TO "B" 958+18.75 (36' WIDE)	114.0	0.50	57	TON
"B" 958+18.75 TO "B" 959+00.00 (38' WIDE)	119.8	0.81	97	TON
"B" 959+00.00 TO "B" 995+24.01 (40.5' WIDE)	128.4	36.24	4653	TON
"C" LINE				
"C" 995+24.02 TO "C" 996+00.00 (81.27' AVE WIDTH)	254.7	0.76	194	TON
"C" 996+00.00 TO "C" 996+81.25 (75.18' AVE WIDTH)	235.8	0.81	191	TON
"C" 996+81.25 TO "C" 997+31.25 (70.16' AVE WIDTH)	220.2	0.50	110	TON
"C" 997+31.25 TO "C" 997+43.13 (68.75' AVE WIDTH)	215.8	0.12	26	TON
"C" 997+43.13 TO "C" 1003+98.36 (68.50 AVE WIDTH)	215.1	6.55	1409	TON
"C" 1003+98.36 TO "C" 1007+80.00 (80.5' AVE WIDTH)	252.3	3.82	964	TON
"C" 1007+80.00 TO "C" 1008+50.00 (92.50' AVE WIDTH)	289.5	0.70	203	TON
"C" 1008+50.00 TO "C" 1009+31.25 (90' WIDE)	281.7	0.81	228	TON
"C" 1009+31.25 TO "C" 1009+94.07 (88' WIDE)	275.5	0.63	174	TON
"D" LINE				
"D" 0+28.00 TO "D" 2+01.68 (31' AVE WIDTH)	99.2	1.74	173	TON
"D" 2+01.68 TO "D" 3+25.62 (46' AVE WIDTH)	145.7	1.24	181	TON
"D" 3+25.62 TO "D" 5+73.11 (32'WIDE)	102.3	2.47	253	TON
"D" 5+73.11 TO "D" 6+73.11 (29' AVE WIDTH)	93.0	1.00	93	TON
"D1" LINE				
"D1" 1+21.13 TO "D1" 4+83.60 (19' AVE WIDTH)	61.7	3.62	223	TON
MISC AREAS	N/A	N/A	76	TON
5" DEPTH (WIDTH VARIES)				
(Includes Slope Allowance)				
"C" 783+68.75 TO "C" 791+00.00 (WIDTH 5.5')	18.4	7.31	135	TON
"C" 791+00.00 TO "C" 791+37.50 (WIDTH 3.0')	10.6	0.38	4	TON
3" DEPTH (WIDTH VARIES)				
(Includes Slope Allowance)				
SF1	N/A	N/A	407	TON
SF2 (SF3)	N/A	N/A	419	TON
SF4	N/A	N/A	247	TON
SF5 (SF6)	N/A	N/A	419	TON
TOTAL			37,265	TON
USE TOTAL			37,265	TON

FED.RD. REG.NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
1	NEVADA	STP-PLH-163(6)	CLARK	38

EARTHWORK QUANTITIES

STATIONS	ROADWAY EXCAVATION	ROADWAY W/ 10% SHRINKAGE	EMBANKMENT	CUMULATIVE
STAGE 1 **				
"A8" 929+00.00 to "A8" 995+08.92	119,503	108,639	55,601	
"B" 953+75.00 to "B" 995+24.02	75,692	68,811	27,773	
"C" 995+24.02 to "C" 1009+94.07	32,764	29,785	2,102	
DIKES	---	---	1,370	
"SF1"	2,855	2,595	---	
"SF7"	87	79	1,164	
Sub-Total	230,901	209,909	88,010	121,899
STAGE 2 ** "C" 783+68.75 to "C" 791+37.50	106	96	63	
"A8" 893+50.00 to "A8" 929+00.00	119	108	139,573	
"B" 889+00.00 to "B" 953+75.00	8,137	7,397	66,717	
"D" 0+28.00 to "D" 6+73.11	946	860	6,060	
"D1" 1+30.00 to "D1" 6+16.86	252	229	2,682	
"SF2" ("SF3")	---	---	477	
"SF5" ("SF6")	---	---	477	
"SF4"	---	---	160	
DIKES	---	---	1,807	
Sub-Total	9,560	8,690	218,016	-87,427
STAGE 3A ** "A8" 866+00.00 to "A8" 893+50.00	11,464	10,422	6,367	
Sub-Total	11,464	10,422	6,367	-83,372
STAGE 3B ** "B" 866+00.00 to "B" 889+00.00	5,346	4,860	2,671	
Sub-Total	5,346	4,860	2,671	

	ROADWAY EXCAVATION	BORROW EMBANKMENT
Total	257,271 Cu. Yd.	-83,372 Cu. Yd.
Use Total	257,280 Cu. Yd.	-83,380 Cu. Yd. ***

** Staging quantities include the following cubic yards of top soil salvage quantities. See general earthwork notes for placement areas.

STAGE 1	14,770 Cu. Yd.
STAGE 2	20,242 Cu. Yd.
STAGE 3A	3,818 Cu. Yd.
STAGE 3B	3,564 Cu. Yd.

*** Because of staging Stage 3B excess excavation quantities are not included. Additional material generated by roadway excavation in Stage 3B may be used on back sides of dikes, to flatten slopes or other areas as directed by engineer.

GENERAL EARTHWORK NOTES

1. Earthwork stages are based on traffic control stages.
2. Detour "SF7" (4" gravel) shall be maintained by contractor during the length of time it is used for traffic.
3. Surplus soil from stage 1 shall be brought forward to stage 2 areas.
4. Top 6" of original ground is to be stockpiled for placement along fill slopes, dikes, and areas of roadway removal. There is no additional payment for stockpiling. For placement use equipment hours.
5. There is a 2' undercut area between Sta. "A8" 970+00 to "A8" 986+00 and and Sta. "B" 970+00 to "B" 986+00. All soil obtained from cuts in this area cannot be used within 2' of structural section.
6. Roadway excavation for "A8" 866+00 to "A8" 893+30 and "B" 866+00 to "B" 889+00 includes removal of TC1 and TC2.
7. Portions of stage 2 and 3A may be constructed during stage 1.

FED.RD. REG.NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
8	NEVADA	STP-PLH-163(8)	CLARK	3C

THEORETICAL APPLICATION OF SURFACING MATERIALS

Project No. STP-PLH-163(6)

Plantmix Bituminous Open-Graded Surface (Aggregate And Asphalt)	85.00	Lbs. Per Sq. Yd.
Asphalt Cement, Grade AC20P (Open-Graded Surface)	8.50	Percent
Asphalt Cement, Grade AC20P (Plantmix Surface)	7.00	Percent
Asphalt Cement, Grade AC30 (Plantmix Surface)	6.50	Percent
Liquid Asphalt, Type MC-70 (Prime Coat)	0.375	Gal. Per Sq. Yd.
Emulsified Asphalt, Type SS-1h (Diluted) (Tack Coat) (Used under Open-Graded Surface)	0.07	Gal. Per Sq. Yd.
Emulsified Asphalt, Type SS-1h (Diluted) (Tack Coat) (Used between New Plantmix Courses)	0.05	Gal. Per Sq. Yd.
Emulsified Asphalt, Type SS-1h (Diluted) (Seal Coat) (Used over Detours)	0.10	Gal. Per Sq. Yd.
Mineral Filler	1.50	Percent
Sand Blotter (Detours)	10.00	Lbs. Per Sq. Yd.
Specific Gravity Used	2.65	

Project No. SPS-163(2)

Sand Blotter	2.5	Lbs. Per Sq. Yd.
Asphalt Rejuvenating Agent (ERA-C) (Flush Seal)	0.075	Gal. Per Sq. Yd.

GENERAL NOTES

1. Depth of base and surfacing is compacted thickness.
2. All existing guideposts to be removed by State Forces.
3. Location of underground utilities as shown on plans is approximate only. It shall be the responsibility of the contractor to contact the utility company for the exact location and depth of the utility.
4. Construction signs, permanent signs and barricades shall conform to the requirements of the M.U.T.C.D., 1988 Edition and the Nevada Supplement thereto.
5. All highway signs inappropriate to the traffic control are to be covered as directed by the engineer with no direct payment. Some permanent signs will be installed during construction as directed by the Engineer.
6. For single lane traffic control not shown refer to Work Zone Traffic Control Handbook, 1985 Edition and the M.U.T.C.D., 1988 Edition. The truck crossing signs shall be removed, laid down or covered when haul operations are not being performed.
7. Vegetation and wildlife along SR 163 shall be avoided as outlined in Special Provisions.
8. The contractor shall be responsible to apply all temporary lane striping prior to allowing traffic on traveled way. The State will apply permanent striping using State furnished equipment and materials.
9. Ditches to be warped to drainage structure inlets and outlets. No direct payment.
10. Reference and Right of Way monuments to be placed at the direction of the Engineer.
11. Permanent pavement marking film (Type 1) width varies and shall be used for the final application of crosswalk and stop bars as shown on the striping detail.
12. Removal of plantmix from detours SF2 and SF6 shall be hauled off-site.
13. Stations "A8" and "B" 970+00.00 to 986+00.00 requires a 2' undercut and all material removed in this area cannot be used within 2 feet of structural section.
14. See Special Provisions for times for the installation of open grade and temporary pavement markings at the intersection of Casino Drive and SR 163.
15. All areas of existing roadway excavation shall be re-graded to a natural condition and seeded as outlined in the Special Provisions.
16. All topsoil to be removed shall be stockpiled for placement on areas of roadway excavation, fill slopes, dikes etc. as directed by engineer.
17. Channel excavation for Sta. "C" 779+00 to Sta. "A7" 848+00 include cost of berm and removal and resetting of existing riprap.

FED. RD. REG. NO.	STATE	PROJECT NO.	SHEET NO.
9	NEVADA	STP-PLH-163(6)	30
		CLARK	COUNTY

SUMMARY OF CONSTRUCTION SIGNS AND BARRICADES

NOTE: QUANTITIES SHOWN ARE APPOXIMATE AND ARE SUBJECT TO INCREASE OR DECREASE ADDITIONAL SIGNS. NOT LISED. MAY BE REQUIRED AS DIRECTED BY THE ENGINEER

SIGN NO.	AND MESSAGE	PANEL SIZE	NO. OF SIGNS	SQ. FT. EACH	TOTAL SQ. FT.
G20-1	Road Construction next 3 Miles	60" X 36"	3	15	45
G20-2	End Construction	60" X 24"	7	10	70
M4-10L	Detour Arrow Sign (Left)	48" X 48"	2	16	70
M4-10R	Detour Arrow Sign (Right)	48" X 48"	1	16	16
R11-2	Road Closed	48" X 30"	8	10	80
R2-1	Speed Limit 45 MPH	48" X 36"	4	12	48
R2-5a	Reduced Speed Ahead	48" X 36"	3	12	36
R4-1	Do Not Pass	48" X 36"	9	16	144
R4-7a	Keep Right	48" X 36"	1	12	12
W1-2L	Curve (Left)	48" X 48"	4	16	64
W1-2R	Curve (Right)	48" X 48"	5	16	80
W13-1	Advisory Speed Plate (35 MPH)	18" X 18"	9	2.25	20
W20-1	Road Construction Ahead	48" X 48"	4	16	64
W20-2	Detour Ahead	48" X 48"	4	16	64
W20-5L	Left Lane Closed Ahead	48" X 48"	3	16	48
W20-5R	Right Lane Closed Ahead	48" X 48"	1	16	16
W4-2L	Pavement Width Transition (Left)	48" X 48"	3	16	48
W4-2R	Pavement Width Transition (Right)	48" X 48"	1	16	16
W6-3	Two Way Traffic	48" X 48"	6	16	96
W8-1	Bump	48" X 48"	6	16	96
W8-6	Truck Crossing	48" X 48"	6	16	96

1191 Total
1191 Use Total

RENT TRAFFIC CONES (EACH)	RENT TEMPORARY IMPACT ATTENUATOR (EACH)
100	4

RENT TRAFFIC DRUMS (EACH)	RENT TRAFFIC BARRICADES (TYPE 111B) (EACH)
225	20

RENT ARROW BOARD (TYPE C) (EACH)	RENT PORTABLE PRECAST CONCRETE BARRIER RAIL (LINEAR FEET)
2	1200

RENT BARRICADE WARNING LIGHTS (TYPE A) (EACH)
78

SUMMARY OF GUIDEPOSTS

TEXT	TOTAL	UNIT
TYPE 1	300	EACH
TYPE 2	15	EACH
TYPE 3	2	EACH
	317	Total
	317	Use Total

SUMMARY OF OBJECT MARKERS AND REFERENCE MONUMENTS

TEXT	TOTAL	UNIT
REFERENCE MONUMENT	27	EACH
RIGHT OF WAY	28	EACH

FED.RD. REG.NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
1	NEVADA	STP-PLH-1631(6)	CLARK	3E

DEPTH CHECK SHEET

SAMP. NO.	STATION	REF. TO CL	BASE DEPTH	OIL DEPTH	DEPTH DRILLED	REMARKS
1	87+00	6" Right	8"	5½"		
		"B" Line				
2	927+00	13' Right	8"	3"		
		"A" Line				
3	950+00	On CL	7"	3"		
		"B" Line				
4	100+80	On CL	7"	6"		
		"C" Line				

ESTIMATE OF QUANTITIES
Quantities Shown are Approximate Only and are Subject to Increase or Decrease
TO BE CONTRACTED

ITEM NO.	TOTAL	UNIT	ITEM
110 0100	3,200	HOUR	TRAINING (4 TRAINEES)
201 0110	LS	---	CLEARING AND GRUBBING
202 0829	38	LINFT	REMOVE AND RESET GUARDRAIL
202 1500	741	LINFT	REMOVAL OF CULVERT PIPE
202 3103	12,340	CUYD	REMOVAL OF COMPOSITE SURFACE
202 4600	7	EACH	REMOVAL OF HEADWALL
202 6601	11,390	LINFT	REMOVAL OF PAINTED TRAFFIC LINE
203 0100	257,280	CUYD	ROADWAY EXCAVATION
203 0300	35,580	CUYD	CHANNEL EXCAVATION
203 0501	83,380	CUYD	BORROW EMBANKMENT
203 0800	10	STA	V-TYPE DITCHES
205 0100	133,300	YDMI	OVERHAUL
206 0100	19,930	CUYD	STRUCTURE EXCAVATION
207 0200	10,791	CUYD	GRANULAR BACKFILL
212 0260	25,870	SQYD	ROCK COLORING
302 0100	121,363	TON	TYPE 1 CLASS B AGGREGATE BASE
401 0100	650	TON	MINERAL FILLER
402 4021	37,265	TON	PLANTMIX BITUMINOUS SURFACE AGGREGATE (TYPE 2)(COARSE)
402 4210	1,430	TON	ASPHALT CEMENT, GRADE AC-20 (POLYMERIZED)
402 4300	1,530	TON	ASPHALT CEMENT, GRADE AC-30
402 5000	270	SQYD	PLANTMIXING MISCELLANEOUS AREAS
403 2500	5,470	TON	PLANTMIX BITUMINOUS OPEN-GRADED SURFACE AGGREGATE (1/2-INCH)
403 3000	5.17	MILE	SCORE SHOULDER (OPEN-GRADED)
405 5430	70	TON	EMULSIFIED ASPHALT, TYPE SS-1H (DILUTED)
406 3100	200	TON	LIQUID ASPHALT, TYPE MC-70
406 8000	349	TON	SAND BLOTTER
407 8130	80	TON	ASPHALT REJUVENATING AGENT (DILUTED)
502 0101	225	CUYD	CLASS A CONCRETE (MINOR)
502 0610	9,420	LINFT	CONCRETE BARRIER RAIL (TYPE A)
502 3100	509	CUYD	CLASS A CONCRETE, MODIFIED (MAJOR)
505 0100	175,000	POUND	REINFORCING STEEL
600 0240	714	LINFT	24-INCH CULVERT PIPE
600 0300	634	LINFT	30-INCH CULVERT PIPE
600 1240	5	EACH	24-INCH END SECTION
600 1300	4	EACH	30-INCH END SECTION
603 0053	13	LINFT	24-INCH REINFORCED CONCRETE PIPE, CLASS III
603 0073	158	LINFT	30-INCH REINFORCED CONCRETE PIPE, CLASS III
603 0213	439	LINFT	78-INCH REINFORCED CONCRETE PIPE, CLASS III
603 0243	271	LINFT	84-INCH REINFORCED CONCRETE PIPE, CLASS III
608 0050	2	EACH	EMBANKMENT PROTECTOR, TYPE 5
608 0150	6	EACH	ANCHOR ASSEMBLY (12-INCH)
608 0320	130	LINFT	12-INCH DOWNDRAIN PIPE
608 0340	2	EACH	12-INCH METAL END SECTION (DOWNDRAIN)
609 0200	1,838	POUND	STRUCTURAL STEEL GRATES
609 0485	2	EACH	48-INCH PRECAST REINFORCED CONCRETE MANHOLE, TYPE 4 (MODIFIED)
609 8132	3,770	LINFT	3-INCH POLYVINYL CHLORIDE PIPE (SDR-21)
610 0110	260	CUYD	LIGHT RIPRAP
610 0120	7,370	CUYD	MEDIUM RIPRAP
610 0200	12,245	CUYD	HEAVY RIPRAP
610 0300	1,380	CUYD	GROUTED RIPRAP
610 0900	4,940	CUYD	FILTER BLANKET

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	SPS-163(2) STP-PLH-163(6)	CLARK	3G

ESTIMATE OF QUANTITIES (Continued)

ITEM NO.	TOTAL	UNIT	ITEM
618 0200	75	LINFT	GALVANIZED GUARDRAIL
618 0201	94	LINFT	GALVANIZED GUARDRAIL (TRIPLE CORRUGATION)
618 9600	3	EACH	BREAKAWAY CABLE TERMINAL
618 9701	3	EACH	GUARDRAIL- BARRIER RAIL CONNECTION (TRIPLE CORRUGATION)
619 0502	317	EACH	GUIDE POSTS (FLEXIBLE)
620 0100	28	EACH	RIGHT OF WAY MARKERS
621 0100	27	EACH	REFERENCE MONUMENTS
623 0115	930	LINFT	1-1/2-INCH CONDUIT
623 0120	80	LINFT	2-INCH CONDUIT
623 0130	825	LINFT	3-INCH CONDUIT
623 1002	50	LINFT	NO. 2 CONDUCTOR
623 1006	40	LINFT	NO. 6 CONDUCTOR
623 1008	700	LINFT	NO. 8 CONDUCTOR
623 1010	1,800	LINFT	NO. 10 CONDUCTOR
623 1014	1,450	LINFT	NO. 14 CONDUCTOR
623 1110	150	LINFT	10 CONDUCTOR NO. 14 CABLE
623 1115	830	LINFT	15 CONDUCTOR NO. 14 CABLE
623 1120	180	LINFT	20 CONDUCTOR NO. 14 CABLE
623 2035	5	EACH	NO. 3-1/2 PULL BOX
623 2050	9	EACH	NO. 5 PULL BOX
623 2070	1	EACH	NO. 7 PULL BOX
623 3104	5	EACH	SODIUM VAPOR LUMINAIRE, 400 WATT
623 3602	4	EACH	ILLUMINATED STREET NAME SIGN, DOUBLE FACE (6-FOOT)
623 4011	2	EACH	STEEL POLE, TYPE 1A
623 4071	1	EACH	STEEL POLE, TYPE 7 WITH SAFETY BASE
623 4350	4	EACH	STEEL POLE, TYPE 35
623 4352	1	EACH	STEEL POLE, TYPE 35A
623 6203	2	EACH	SIGNAL HEAD (12-INCH) 1W3C, POST TOP
623 6206	2	EACH	SIGNAL HEAD (12-INCH) 1W3C, BRACKET
623 6208	3	EACH	SIGNAL HEAD (12-INCH) 2W3C, BRACKET
623 6211	12	EACH	SIGNAL HEAD (12-INCH) 1W3C, MAST ARM
623 6501	2	EACH	PEDESTRIAN SIGNAL HEAD 1W
623 6502	3	EACH	PEDESTRIAN SIGNAL HEAD 2W
623 7000	18	EACH	LOOP DETECTOR (6-FOOT X 6-FOOT)
623 7002	12	EACH	LOOP DETECTOR (B)
623 7006	14	EACH	LOOP DETECTOR AMPLIFIER CHANNELS (NEW CABINET)
623 7100	2,950	LINFT	LEAD-IN CABLE FOR LOOP DETECTORS
623 7500	1	EACH	TRAFFIC ACTUATED CONTROLLER
623 8750	1	EACH	UNDERGROUND ELECTRICAL SERVICE
624 0200	5,000	HOUR	FLAGGER
624 0500	120	HOUR	RENT EQUIPMENT (MOTOR GRADER)
624 0540	120	HOUR	RENT EQUIPMENT (LOADER)
624 0550	120	HOUR	RENT EQUIPMENT (DUMP TRUCK)
624 0600	120	HOUR	RENT EQUIPMENT (BACKHOE)
625 0110	1,191	SQFT	RENT CONSTRUCTION SIGNS
625 0114	100	EACH	RENT TRAFFIC CONES
625 0117	78	EACH	RENT BARRICADE WARNING LIGHTS (TYPE A)
625 0122	20	EACH	RENT CONSTRUCTION BARRICADES (TYPE IIIB)
625 0123	1,200	LINFT	RENT PORTABLE PRECAST CONCRETE BARRIER RAIL
625 0303	2	EACH	RENT ARROW BOARD (TYPE C)
625 0416	225	EACH	RENT TRAFFIC DRUMS

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	SPS-163(2) STP-PLH-163(6)	CLARK	3H

ESTIMATE OF QUANTITIES (Continued)

ITEM NO.	TOTAL	UNIT	ITEM
625 1000	4	EACH	RENT TEMPORARY IMPACT ATTENUATOR
627 0110	586	SQFT	PERMANENT SIGNS (GROUND MOUNTED) (METAL SUPPORTS)
627 0140	396	SQFT	PERMANENT SIGNS, REMOVE
627 0145	40	SQFT	PERMANENT SIGNS, RESET
628 0100	LS	---	MOBILIZATION
633 0100	2,637	EACH	NON-REFLECTIVE PAVEMENT MARKERS
633 0200	904	EACH	REFLECTIVE PAVEMENT MARKERS
634 2112	400	LINFT	PERMANENT PAVEMENT MARKING FILM (TYPE 1) (12-INCH)
636 1000	4.20	MILE	TEMPORARY PAINTED STRIPING (BROKEN WHITE)
636 1001	0.27	MILE	TEMPORARY PAINTED STRIPING (BROKEN YELLOW)
636 1002	0.50	MILE	TEMPORARY PAINTED STRIPING (8-INCH SOLID WHITE)
636 1003	2.90	MILE	TEMPORARY PAINTED STRIPING (DOUBLE SOLID YELLOW)
636 1006	10	MILE	TEMPORARY PAINTED STRIPING (SOLID WHITE)
636 1007	4.80	MILE	TEMPORARY PAINTED STRIPING (SOLID YELLOW)
636 1012	881	LINFT	TEMPORARY PAINTED STRIPING (12-INCH SOLID WHITE)
637 0001	FA	---	TEMPORARY POLLUTION CONTROL
637 0100	10	TON	DUST PALLIATIVE

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	SPS-163(2) STP-PLH-163(6)	CLARK	31

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	SPS-163(2) STP-PLH-163(6)	CLARK	4

BEARING SOURCE IS NEVADA STATE PLANE COORDINATES (NAD29) EAST ZONE USING A DATUM ADJUSTING FACTOR OF 1.000148022

COORDINATE EQUATION @ 381+49.66 $\frac{139479.0610}{790816.3162} = \frac{139459.1896}{790717.7782}$

BEARING SOURCE IS NEVADA STATE PLANE COORDINATES (NAD29) EAST ZONE USING A DATUM ADJUSTMENT FACTOR OF 1.000023401

– LIMITS OF REMOVAL

– REMOVE & RESET RIPRAP

For Section A-A, B-B, See Sht. 22
For Section C-C, D-D, See Sht. 23

BEGIN PROJECT SPS-163(2)
"A1" 184+89.16 P.O.T.

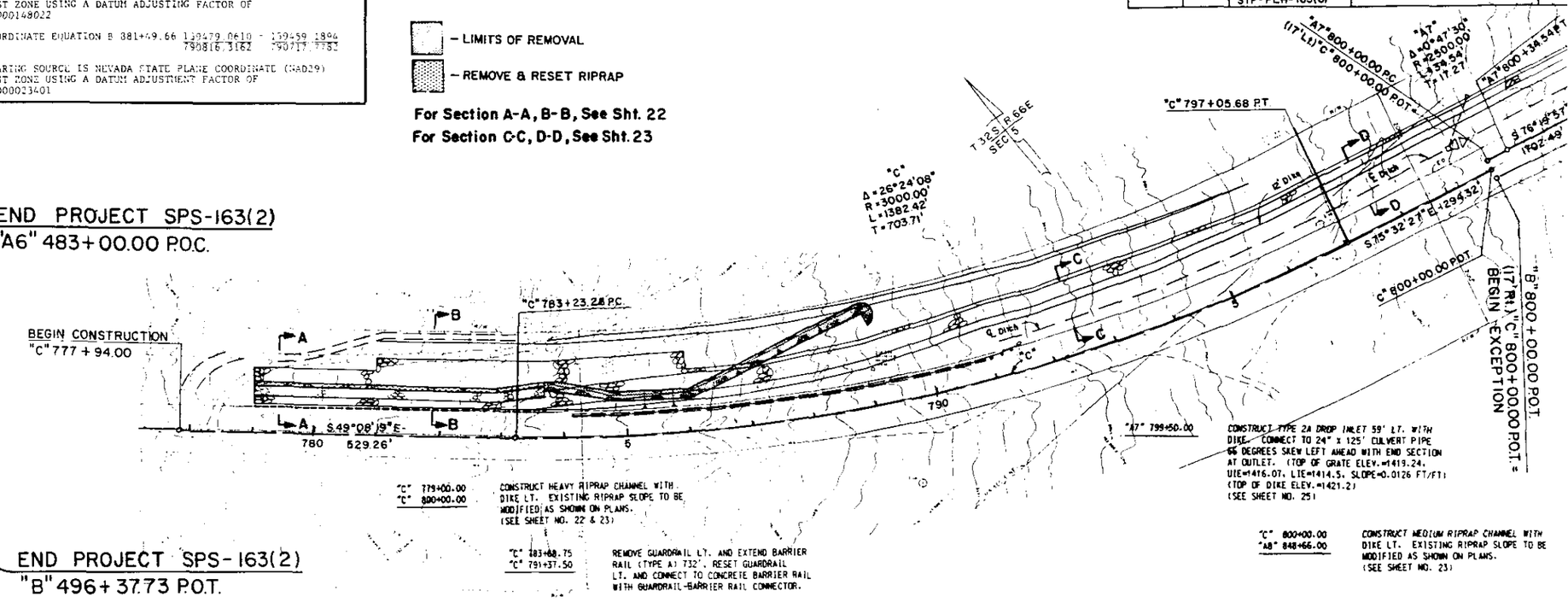
END PROJECT SPS-163(2)
"A6" 483+00.00 P.O.C.

"A1" 278+67.41 P.T. =
"A2" 279+03.58 P.O.T.
"A2" 379+65.59 P.T. =
"A3" 379+43.41 P.O.T.
"A3" 398+81.56 P.T. =
"A4" 398+76.77 P.O.T.
"A4" 418+95.38 P.O.T. =
"A5" 419+10.68 P.O.T.
"A5" 450+44.26 P.O.T. =
"A6" 450+29.18 P.O.T.

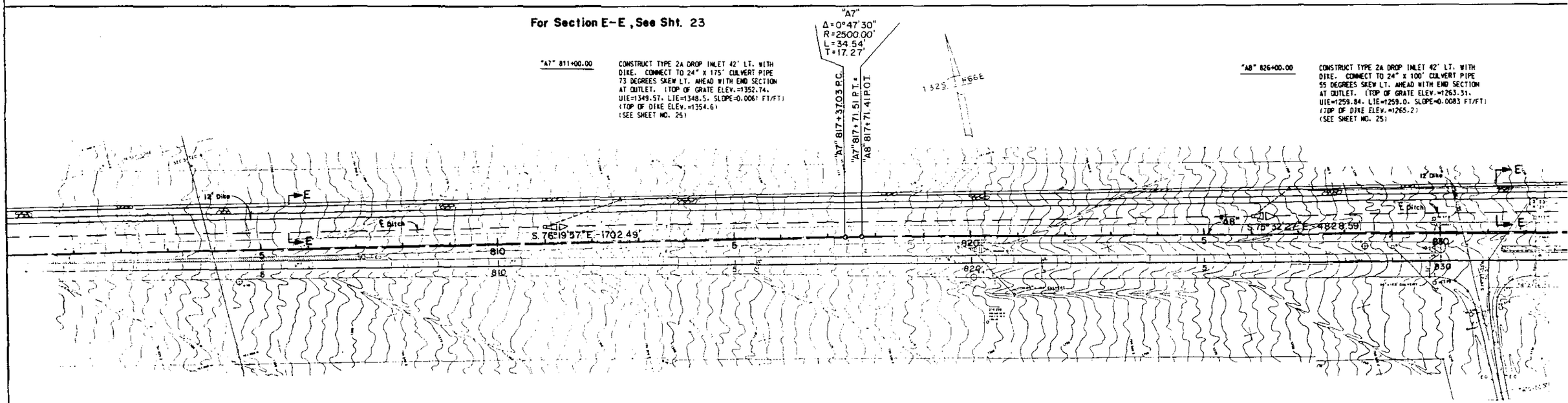
185
185
399
399
450
450

BEGIN PROJECT SPS-163(2)
"B" 184+79.96 P.O.T.

END PROJECT SPS-163(2)
"B" 496+37.73 P.O.T.



For Section E-E, See Sht. 23



FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	5

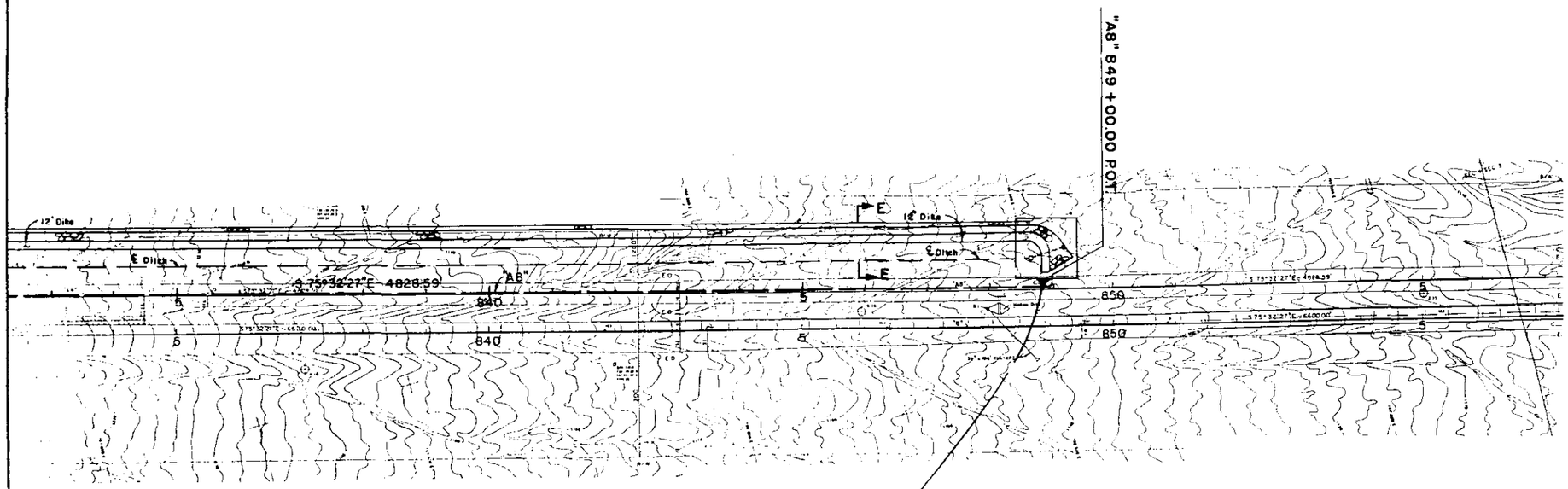
▨ - LIMITS OF REMOVAL (COMPOSITE SURFACE)

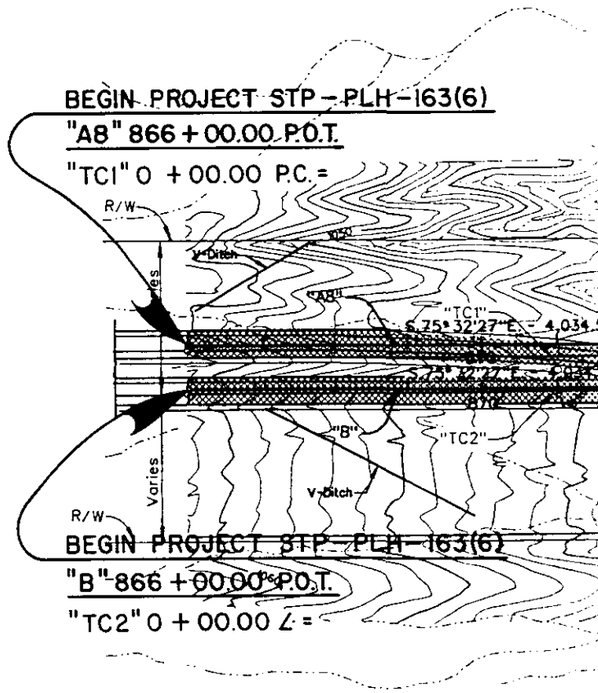
T.32S. R.66E.

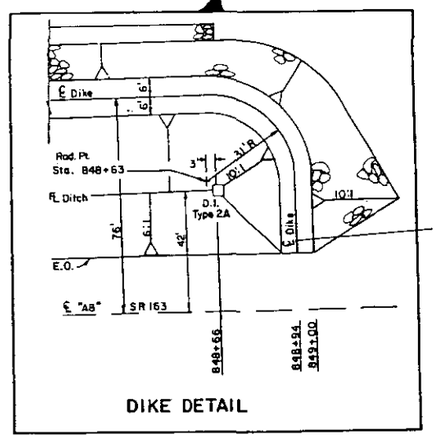
"A8" 848+66.00 — CONSTRUCT TYPE 2A DROP INLET 42' LT. CONNECT TO 24" x 60' CULVERT PIPE 71 DEGREES SKEW LT. AHEAD WITH END SECTION AT OUTLET. (TOP OF GRATE ELEV.=1142.06. UIE=1138.89. LIE=1138.0. SLOPE=0.0148 FT/FT)

"A8" 866+00.00 / "A8" 867+64.54 — CONSTRUCT 190' V-DITCH (2' MIN. DEPTH) FROM 45' LT. STA. "A8" 866+00 TO 140' LT. STA. "A8" 867+64.54 (UIE=1059.4. LIE=1051.0. SLOPE=0.0442 FT./FT.)

"B" 867+00.00 / "B" 869+51.15 — CONSTRUCT 290' V-DITCH (2' MIN. DEPTH) FROM 45' RT. STA. "B"867+00 TO 190' RT. STA. "B" 869+51.15 (UIE=1054.1. LIE=1047.0. SLOPE=0.0245 FT./FT.)







DIKE DETAIL

For Section E-E See Sht. 23

"A8" 866+00.00 — INSTALL LOOP DETECTORS IN TRAVEL LANES, CONNECT TO NO. 5 PULL BOX IN MEDIAN

"B" 866+00.00 — INSTALL LOOP DETECTORS IN TRAVEL LANES, CONNECT TO NO. 5 PULL BOX IN MEDIAN

SEC. 3
SEC. 10

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	6

- LIMITS OF ROADWAY REMOVAL

"A8" 899+00.00

INSTALL 24" x 85' CULVERT PIPE WITH END SECTION LT. CONNECT TO TYPE 2A D.I. 25' RT. CONSTRUCT MEDIAN DIKE. (TOP OF GRATE=934.01, UIE=930.84, LIE=928.0, SLOPE=0.0334 FT./FT.) CONSTRUCT STANDARD MEDIUM RIPRAP BASIN AT OUTLET. (SEE SHEET NO. 25)

"DI"
Δ=58° 54' 21"
R=600.00'
L=616.86'
T=338.81'

T.32S. R.66E.

"TC1" 10+81.22 P.T.
"TC2" 10+79.19 ∠ -
"X" 876+55.24 P.O.T.

"DI" (28' Lt.) "A8" 900+95.51 P.O.T.
"DI" 0+00.00 R.C.

R/W

E.O.

"A8"

S.75° 32' 27"E. - 4,034.51'

Detour "SF2"

"B"
Detour "SF4"

V-Ditch

Detour "SF1"

"DI"

SEC. 3
SEC. 10

1/4 Sec. Line

"B" 889+00.00
"B" 890+64.54

CONSTRUCT 190' V-DITCH (2' MIN. DEPTH) FROM 45' RT. STA. "B" 889+00 TO 140' RT. STA. "B" 890+64.54 (UIE=968.1, LIE=961.0, SLOPE=0.0374 FT./FT.)

"B" 897+50.00
"B" 899+83.83

CONSTRUCT 270' V-DITCH (2' MIN. DEPTH) FROM 45' RT. STA. "B" 897+50 TO 180' RT. STA. "B" 899+83.83 (UIE=936.2, LIE=925.0, SLOPE=0.0415 FT./FT.)

FED. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-1631(6)	CLARK	7

- Limits of Plantmix Misc Area
- Limits of Removal(Composite Surface)

"CO" 0+95 ± REMOVE EXISTING 24" x 30' CULVERT PIPE AND HEADWALLS LT. AND RT.

"CO" 4+48 ± REMOVE EXISTING 30" x 78' CULVERT PIPE AND HEADWALL LT.

"CO" 6+20 ± REMOVE EXISTING 18" x 46' CULVERT PIPE AND HEADWALL LT.

"CO" 8+42 ± REMOVE EXISTING 24" x 75' CULVERT PIPE AND HEADWALL LT.

"CO" 8+55 ± REMOVE EXISTING 24" x 30' CULVERT PIPE AND HEADWALL LT.

"CO" 10+90 ± REMOVE EXISTING 24" x 88' CULVERT PIPE AND HEADWALL LT.

"CO" 14+15 ± PLUG AND ABANDON EXISTING CULVERT PIPE (NO DIRECT PAYMENT)

"CO" 15+91 ± PLUG AND ABANDON EXISTING CULVERT PIPE (NO DIRECT PAYMENT)

"CO" 18+31 ± REMOVE EXISTING 24" x 80' CULVERT PIPE

"CO" 21+95 ± REMOVE EXISTING 24" x 40' CULVERT PIPE

L=325' R 66E

"A8"
Δ=28° 32'54"
R=1,764'
L=869.97'
T=444.21'

"B"
Δ=28° 32'54"
R=1,804'
L=898.87'
T=458.97'

"X" 924+97.09 P.O.T.
"CO" 0+25.40 P.O.T.=

Detour "SF2"

"X" 918+43.29 P.O.C.
"D" 06+73.11 P.T.=

13' Lt. +73.11
13' Rt. +73.11
16' Lt. +73.11
16' Rt. +73.11
E.O.

"D"
Δ=31° 10'47"
R=600'
L=326.51'
T=167.41'

(16' Lt.) "D" 3+25.62 P.O.C. =
"D1" 06+16.86 P.T.

"D1"
Δ=58° 54'21"
R=600'
L=616.86'
T=338.81'

"D1"

"D1" 0+00.00 P.C.
(28' Lt.) "A8" 905+95.51 P.O.T. =

S.75° 32'27"E. - 4,034.51'

"A8" 905+36.80 P.O.T. =

"A8" 906+34.51 P.C.
"B" 905+34.51 P.C.
"D1" 0+00.00 P.C.
"A8" 905+36.80 P.O.T. =

28' Lt. +08.50
20' Lt. +08.50
50' R

Detour "SF1"

"A8" 932+17.21 P.T.
"A8" 932+33.31 P.C.
"B" 931+58.56 P.T.
"B" 931+74.66 P.C.

S.17° 36'04"E. - 16.10'

Culvert Dike No. 1
Culvert Dike No. 2
Culvert Dike No. 3

R/W

"A8"
Δ=57° 56'23"
R=2,554'
L=2,582.70'
T=1,413.95'

"B"
Δ=57° 56'23"
R=2,496'
L=2,524.05'
T=1,381.84'

E.O.
E.O.
E.O.
R/W
V-Ditch
R/W

"B" 914+72.00 CONSTRUCT 5' x 3' x 219' RCB 15 DEGREE SKEW LT. AHEAD (199' LT. ALONG SKEW AND 65' RT. ALONG SKEW) CONSTRUCT TYPE 1 HEADWALLS LT. AND RT. CONSTRUCT GROUTED RIPRAP BASIN AT OUTLET (INE=865.71, LHE=862.0, SLOPE=0.01' FT./FT.) CONSTRUCT MEDIAN DIKE AND TYPE 3 RISER INLET OVER CULVERT (TOP OF GRATE=873.8, H=6.0) CONSTRUCT DIKE AT INLET (TOP OF DIKE=871.5) (SEE SHEET NO 24 & 25)

"B" 920+95.00 INSTALL 30" x 292' CULVERT PIPE 30 DEGREE SKEW LT AHEAD (196' LT ALONG SKEW AND 96' RT. ALONG SKEW) INSTALL END SECTIONS LT. AND RT. CONSTRUCT MODIFIED MEDIUM RIPRAP BASIN AT OUTLET (INE=844.1, LHE=833.7, SLOPE=0.038 FT./FT.) CONSTRUCT DIKE AT INLET (TOP OF DIKE=848.0) (SEE SHEET NO 25)

"B" 928+50.00 CONSTRUCT 8' x 4' x 210' RCB 30 DEGREE SKEW LT AHEAD (155' LT ALONG SKEW AND 55' RT. ALONG SKEW) CONSTRUCT TYPE 1 HEADWALLS LT. AND RT. CONSTRUCT GROUTED RIPRAP BASIN AT OUTLET (INE=821.5, LHE=813.5 SLOPE=0.038 FT./FT.) CONSTRUCT MEDIAN DIKE AND TYPE 3 RISER INLET (H=3.76) OVER CULVERT (TOP OF GRATE=826.6) CONSTRUCT DIKE AT INLET (TOP OF DIKE=828.5) (SEE SHEET NO 24 & 25)

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-1631(6)	CLARK	8

▨ - LIMITS OF REMOVAL OF COMPOSITE SURFACE

"A8"
Δ=57°56'23"
R=2,554'
L=2,582.70'
T=1,413.95'

"A8" 959+28.00

CONSTRUCT 5' X 3' X 157' RCB, 30 DEGREE SKEW, RT. AHEAD (36' LT. ALONG SKEW) AND 121' RT. ALONG SKEW); CONSTRUCT TYPE 1 HEADWALLS LT. AND RT.; CONSTRUCT MODIFIED MEDIUM RIPRAP BASIN AT OUTLET (IE=722.7 LIE=719.7, SLOPE=0.019 FT./FT.); CONSTRUCT DIKE AT INLET (TOP OF DIKE=724.9) (SEE SHEET NO 25)

"A8" 950+50.00
"C" 996+00.00

INSTALL CONCRETE BARRIER RAIL (TYPE A) LT.

"A8" 964+00.00
"A8" 976+32.00

CONSTRUCT SPECIAL RIPRAP LINED CHANNEL 315' LT (SEE SHEET NO 24)

"A8"
Δ=28°32'54"
R=1,764'
L=869.97'
T=444.21'

"B"
Δ=28°32'54"
R=1,804'
L=898.87'
T=458.97'

"A8" 959+40.00

CONSTRUCT TYPE 1A RIPRAP INLET APRON, CONNECT TO 5' X 3' RCB WITH 24" X 5' CURVED PIPE (UPPER END AT L=5+25.4, 722+44.8, 720.32, LOWER END AT L=5+25.4, RIM=724.32, INVERT=719.32, 24" X 5' REDUCER, 4 HOURS CONSTRUCTION MEASURED (SEE SHEET NO 25)

"A8"
Δ=44°26'49"
R=2,446'
L=1,897.47'
T=999.36'

"B"
Δ=44°26'49"
R=2,504'
L=1,942.47'
T=1,023.06'

"A8" 932+17.21 P.T.
S.17°36'04"E. - 16.10'
"A8" 932+33.31 P.C.

"A8" 941+03.28 P.T.

"A8" 946+86.64 P.C.

S.46°08'58"E. - 783.36'

"B" 940+73.52 P.T.

"B" 948+56.88 P.C.

"B" 958+18.75
"B" 959+00.00

INSTALL GALVANIZED GUARDRAIL RT. WITH G.G.T. (W-II) TRANSITION BARRIER RAIL WITH GUARDRAIL-BARRIER RAIL CONNECTION

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-9LH-163(6)	CLARK	9

"A8" 964+00.00
"A8" 976+32.00 CONSTRUCT SPECIAL RIPRAP LINED CHANNEL 29.5'LT. (SEE SHEET NO 25)

"A8" 976+00.00 INSTALL LOOP DETECTORS IN TRAVEL LANES, CONNECT TO NO. 5 PULL BOX IN MEDIAN

"A8" 981+00.00 INSTALL TYPE 5 EMBANKMENT PROTECTOR WITH MODIFIED GRATE 29.5'LT. WITH 60' DOWN DRAIN. CONSTRUCT STANDARD MEDIUM RIPRAP BASIN AT OUTLET. CONSTRUCT DIKE IN DITCH 33'LT. (TOP OF GRATE=632.21, TOP OF DIKE=633.16) (SEE SHEET NO. 25)

"A8" 986+58.00 CONSTRUCT 12'W x 7'H x 139'RCB 45 DEGREE SKEW RT. AHEAD (139'LT. ALONG SKEW AND 100'RT. ALONG SKEW). CONSTRUCT TYPE 1 HEADWALLS LT. AND RT. CONSTRUCT GROUTED RIPRAP BASIN AT OUTLET. (UIE=600.5, LIE=596.4, SLOPE=0.03 FT./FT.) CONSTRUCT DIKE AT INLET. INSTALL TYPE 3 RISER INLET WITH MEDIAN DIKE (H=2.83 OVER PIPE IN MEDIAN. (TOP OF DIKE ELEV =581.2, TOP OF GRATE ELEV =608.5) (SEE SHEET NOS. 24 & 75)

"C" 995+80.00 CONSTRUCT 10'W x 3'H x 167'RCB CULVERT 45 SKEW RT. AHEAD (94'LT. ALONG SKEW AND 73'RT. ALONG SKEW)(UIE=567.2, LIE=559.2) CONSTRUCT SPECIAL SLOPING TAPERED INLET LT. CONSTRUCT TYPE 1 HEADWALL RT. OUTLET TO GROUTED RIPRAP CHANNEL. (SEE SHEET NO 26)

"A8" 995+50.00
"C" 995+60.00 CONSTRUCT CULVERT DIKE FROM 47'LT TO 98'LT. (SEE SHEET NO. 25)

"C" 996+00.00
"C" 996+81.25 INSTALL GALVANIZED GUARDRAIL LT. WITH B.C.T. (Nm4). CONNECT TO BARRIER RAIL WITH GUARDRAIL-BARRIER RAIL CONNECTOR.

T.32S. - R.61E.

SEC. 11 - SEC. 12

"A8"
Δ=44°26'49"
R=2,446'
L=1,897.47'
T=999.36'

"B"
Δ=44°26'49"
R=2,504'
L=1,942.47'
T=1,023.06'

"C"
Δ=17°37'12"
R=2,002.50'
L=615.82'
T=310.36'

"A8" 967+84.11 P.T.
"A8" 975+08.78 ∠ = 00°25'44" Rt.
"A8" 993+08.94 ∠ = 00°25'44" Lt.
"A8" 995+08.94 P.O.T. (17' Lt.) =
"C" 995+24.02 P.O.T.
"C" 995+24.02 P.O.T.
"C" 997+43.13 P.C.
"B" 967+99.35 P.T.
"B" 995+24.01 P.O.T. (17' Rt.) =
"C" 995+24.02 P.O.T.

R/W
E.O.
N.89°24'13"E. - 2,724.66'
N.89°24'13"E. - 200.00'
= N. 89°49'57"E. - 1300.16'
970
980
990
5
SS
Culvert Dike No.4
Raw Water Line
N.89°24'15"E - 219'
3134'Lt. @1.25
3132'Lt. @0.00
4057'Lt. @0.00

"B" 976+36.66 CONSTRUCT TYPE 7 DROP INLET (86.7'LT.) WITH DIKE AT BASE OF RIPRAP LINED CHANNEL. CONNECT TO 24" X 164' CULVERT PIPE LT. AND 30" X 175' CMP AHEAD. (TOP OF GRATE ELEV.= 653.20, TOP OF DIKE ELEV.=654.15) (SEE SHEET NO. 25)

"B" 976+10.00 INSTALL LOOP DETECTORS IN TRAVEL LANES, CONNECT TO NO. 5 PULL BOX IN MEDIAN.

"B" 976+36.66
"B" 977+81.00 INSTALL 30" X 175' CULVERT CMP, PROJECT, WITH STANDARD MEDIUM RIPRAP BASIN AT OUTLET. CONNECT TO TYPE 7 DROP INLET "B" 976+36.66 (UIE=648.86, LIE=648.0, SLOPE=0.1706)

"B" 975+20.50 CONSTRUCT TYPE 2A DROP INLET WITH DIKE 29.5'RT. CONNECT TO 24" X 164' CULVERT PIPE (TOP OF GRATE ELEV.=657.88, TOP OF DIKE ELEV.=658.83) (SEE SHEET NO 25)

"B" 978+00.00 INSTALL 30" x 167' CULVERT PIPE 45 DEGREE SKEW LT. AHEAD (115'LT. ALONG SKEW AND 52' RT. ALONG SKEW). INSTALL MODIFIED END SECTIONS LT. AND RT. CONSTRUCT MEDIUM RIPRAP BASIN AT OUTLET. (UIE=625.3, LIE=619.7, SLOPE=0.034 FT./FT.) (SEE SHEET NO. 25)

"B" 959+00.00
"C" 1008+50.00 INSTALL CONCRETE BARRIER RAIL (TYPE A) RT.

"B" 984+00.00 INSTALL TYPE 5 EMBANKMENT PROTECTOR WITH MODIFIED GRATE 29.5'RT. WITH 60' DOWN DRAIN. CONSTRUCT STANDARD MEDIUM RIPRAP BASIN AT OUTLET. CONSTRUCT DIKE IN DITCH 29.5'RT. (TOP OF GRATE=619.5', TOP OF DIKE=620.48) (SEE SHEET NO. 25)

"B" 975+50.00 INSTALL 24" X 164' CULVERT PIPE 45 DEGREE SKEW (123'LT. AHEAD ALONG SKEW AND 42'RT. ALONG SKEW) CONSTRUCT TYPE 3 PIPE RISER INLET (H=3.57) WITH MEDIAN DIKE 29'LT. (TOP OF GRATE=656.18) (UIE=654.71, LIE=649.86, SLOPE=0.03 FT./FT.) CONNECT TO DROP INLETS LT. AND RT. (SEE SHEET NO 25)

"C" 996+31.62
"C" 997+07.00 CONSTRUCT GROUTED HEAVY RIPRAP LINED CHANNEL (SLOPE=0.30 FT./FT.) (SEE SHEET NO 30)

FED. REG. NO.	STATE			
9	NEVADA	STP-PLH-163(6)	CLARK	10

- LIMITS OF PLANTMIX MISC. AREAS

"C" 1002+99.09
"C" 1003+78.19

CONSTRUCT TYPE 7 DROP INLET 57' LT. OF "C" 1002+99.09. (TOP OF GRATE=640.04) CONNECT TO MODIFIED TYPE 4 MANHOLE AT 80' RT. STA. "C" 1003+78.10 WITH 30" RCP STORM DRAIN. (IUIE=536.70, LIE=533.50, SLOPE=0.020) CONSTRUCT DIKE FOR INLET (TOP OF DIKE=543.5) (SEE SHEET NO. SD1 & 7 29)

PARK BOUNDARY

"C" 997+43.13 P.C.

"C"
Δ=17° 37'12"
R=2,002.50'
L=615.82'
T=310.36'

"C" 1003+58.95 P.T.

"C" 1009+60.87 LT. MISCELLANEOUS PLANTMIX AREA
"C" 1010+16.13 LT.

TO DAVIS DAM

PARK BOUNDARY

T. 32 S.
SEC. 2
R 66 E

END PROJECT RS-163(1)
"C" 1010+12.68 P.T.

Limits of Open-Grade

R/W

E.O.

N.89° 24'13"E. - 219.11'

"C"

N.71° 47'01"E. - 39.41'

E.O.

1000

M.H.

M.H.

E.O.

5

1010

R/W

E.O.

60' R

44' Lt.
1009+60.82

88.52' Lt.
1010+15.13

44' Rt.
1009+09.38

44.18' Rt.
1009+31.25

46.03' Rt.
1009+30.48

134.06' Rt.
1009+64.93

56' R

R/W

48.5' Rt.
1008+00.00

43.67' Rt.
1008+50.00

46.17' Rt.
1008+50.00

TO ARIZONA

Limits of Open-Grade

SS

"C" 1003+98.36 P.C.

Δ=17° 36'15"
R=1,997.50'
L=614.31'
T=309.60'

Limits of Open-Grade

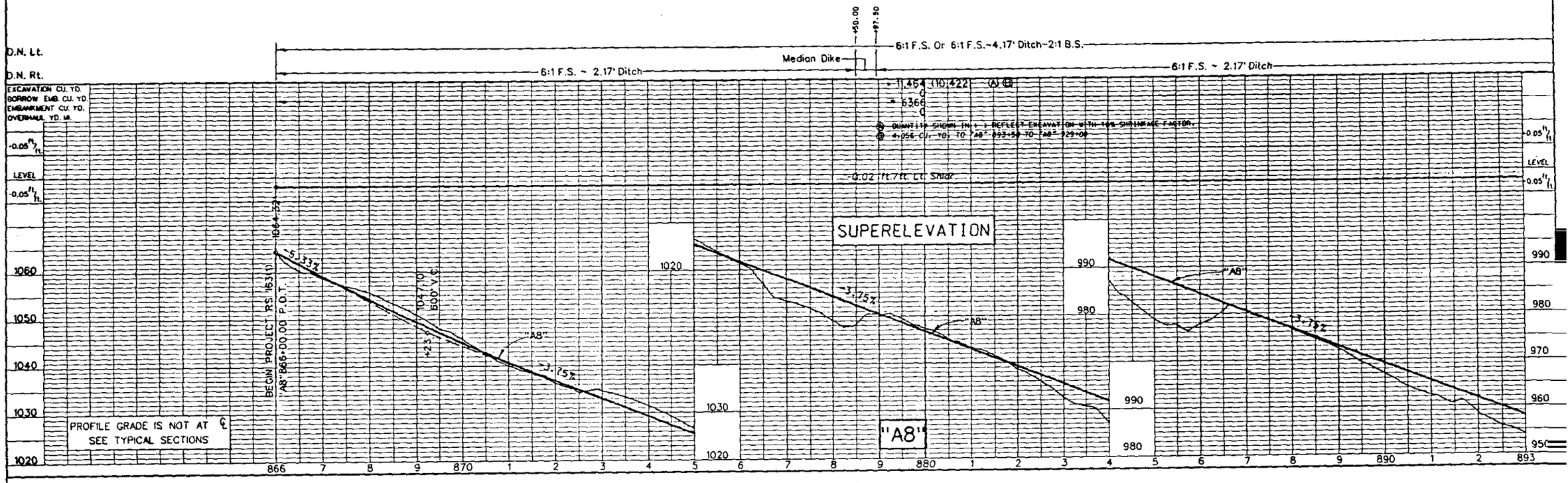
TO LAUGHLIN

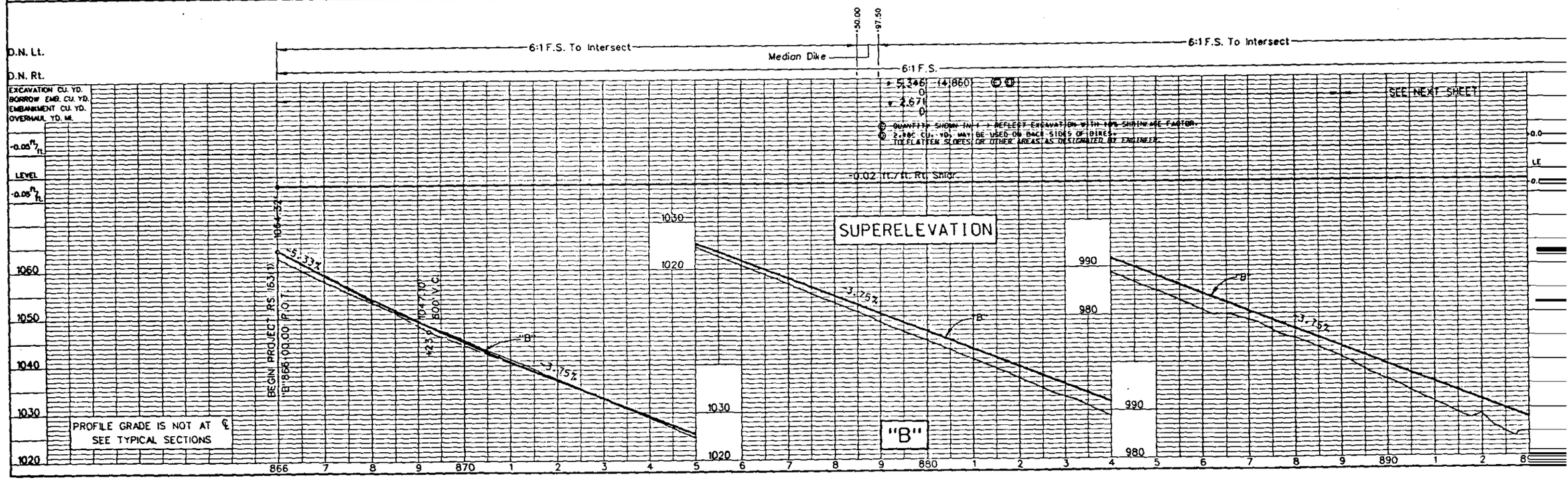
"C" 996+31.62 "C" 997+07.00	CONSTRUCT GROUTED HEAVY RIPRAP LINED CHANNEL (SLOPE=0.030 FT./FT.) (SEE SHEET NO. 27)
"C" 997+07.00 "C" 998+75.40	CONSTRUCT HEAVY RIPRAP LINED CHANNEL (SLOPE=0.030 FT./FT.) (SEE SHEET NO. 30)
"C" 998+75.40 "C" 999+29.00	CONSTRUCT GROUTED HEAVY RIPRAP LINED CHANNEL (SLOPE=0.030 FT./FT.) (SEE SHEET NO. 30)
"C" 999+10.00	CONSTRUCT GROUTED RIPRAP DROP STRUCTURE 95' RT. (SEE SHEET NO. 30)
"C" 999+29.00 "C" 999+55.33	CONSTRUCT METERED INLET 60' RT. FOR 78" RCP AT END OF RIPRAP CHANNEL (IUIE=550.0, LIE=543.0) (SEE SHEET NO. SD1 & 27)
"C" 999+55.33 "C" 1002+00.00	INSTALL 78" RCP STORM DRAIN FROM 60' RT. CONSTRUCT MODIFIED TYPE 4 MANHOLE 80' RT. WITH GRATE COVER. (IUIE=537.59, LIE=537.59) H=21.21) (SEE SHEET NO. SD1 & 28)
"C" 1002+00.00	TO 80' RT. (IUIE=543.0, LIE=537.59, SLOPE=0.0216) CONNECT TO MODIFIED TYPE 4 MANHOLE AT "C" 1002+00.70 (SEE SHEET NO. SD1 & 28)
"C" 1002+00.00 "C" 1003+78.19	INSTALL 78" RCP STORM DRAIN 80' RT. (IUIE=537.59, LIE=533.5, SLOPE=0.0216) CONNECT TO MODIFIED TYPE 4 MANHOLES AT EACH END. (SEE SHEET NO. SD1, 28 & 29)
"C" 1003+78.19	CONSTRUCT MODIFIED TYPE 4 MANHOLE 80' RT. WITH GRATE COVER. (IUIE=533.5, LIE=533.5) (H=20.7) (SEE SHEET NO. SD1 &28)
"C" 1003+78.19 "C" 1006+55.00	INSTALL 84" RCP STORM DRAIN 80' RT. (IUIE=533.5, LIE=527.0, SLOPE=0.0092) CONNECT TO MODIFIED TYPE 4 MANHOLE AT "C" 1003+78.19 (SEE SHEET NO. SD1 & 28)

"C" 1009+09.38 RT. MISCELLANEOUS PLANTMIX AREA
"C" 1009+64.93 RT.

"C" 1008+50.00 "C" 1009+31.25	INSTALL GALVANIZED CHAIN LINK RAIL WITH BASE PLATE (TYP.) CONNECT TO BARRIER RAIL WITH GUARDRAIL-BARRIER RAIL CONNECTOR.
"C" 1006+55.00 "C" 1006+82.50	CONSTRUCT IMPACT STILLING BASIN 80' RT. (IUIE=531.0, LIE=527.0) (SEE SHEET NOS. 31-34)
"C" 1006+82.50 "C" 1008+30.00	CONSTRUCT MEDIUM RIPRAP CHANNEL FROM 80' RT. TO 74' RT. (IUIE=530.2, BW 20', LIE=530.0, BW=50') (SEE SHT. NO. 30)

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	NO.
9	NEVADA	STP-PLH-1634(3)	CLARK	11





floppy Harkin71303-1 sht11 dgn

FED. HD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLM-163(6)	CLARK	12

6:1 F.S.~2.17' Ditch | +80.80 | 6:1 F.S. Or 6:1 F.S.~4.17' Ditch~2:1 B.S. | +22.00 Median Dike | +20.80 | +11.89 +23.33 +63.17 +71.80 Exception | 6:1 F.S. Or 6:1 F.S.~4.17' Ditch~2:1 B.S. | +47.50 Median Dike | 6:1 F.S. ~ 2.17' Ditch

D.N. Lt.

D.N. Rt. — 6:1 F.S. ~ 2.17' Ditch To 1.34' Ditch | 50:1 B.S. To Daylight | 6:1 F.S. ~ 2.17' Ditch

EXCAVATION CU. YD.
BORROW EMB. CU. YD.
EMBANKMENT CU. YD.
OVERHAUL YD. MI.

SEE PRECEDING SHEET

119 (108) Ⓒ
60,386
139,572
79,762
Ⓒ Ⓓ Ⓔ
Ⓒ QUANTITY SHOWN IN (-) REFLECT EXCAVATION WITH 10% SHRINKAGE FACTOR.
Ⓓ 62,758 CU. YD. FROM "AB" 929+00 TO "AB" 995+08.92
Ⓔ 4,056 CU. YDS. FROM "AB" 866+00 TO "AB" 893+50

+50 | +86.51 | +105.51

-0.05 ft/ft | LEVEL | -0.05 ft/ft

-0.02 ft./ft. L.t. Shldr. | Trans. Lt. Shldr. | -0.03 ft./ft. Lt. Shldr.

960 950 940 930 920 910

920 910

"AB" -3.75% | -3.75% "AB" | -3.28% "AB"

SUPERELEVATION

880 870

880 870

868.03'
1000' V.C.

PROFILE GRADE IS NOT AT ℄
SEE TYPICAL SECTIONS

"A8"

892 3 4 5 6 7 8 9 900 1 2 3 4 5 6 7 8 9 910 1 2 3 4 5 6 7 8 9 920 1 2 3 924

-0.05 ft/ft | LEVEL | -0.05 ft/ft | 880 870 860 850 840 83

6:1 F.S.To Intersect | +80.80 | 6:1 F.S. To Intersect | Median Dike | +22.00 | 50:1 B.S. To Daylight | +20.80 | Warp To Intersect "AB" E.O. | +11.80 | +71.80 Exception | 6:1 F.S. To Intersect | +72.00 Median Dike | +19.50 | 6:1 F.S. To Intersect

D.N. Lt.

D.N. Rt. — 6:1 F.S.

EXCAVATION CU. YD.
BORROW EMB. CU. YD.
EMBANKMENT CU. YD.
OVERHAUL YD. MI.

8,243 (7,493) Ⓒ Ⓓ Ⓔ
15,332
69,701 Ⓕ Ⓖ Ⓗ
53,529
Ⓒ QUANTITY SHOWN IN (-) REFLECT EXCAVATION WITH 10% SHRINKAGE FACTOR.
Ⓓ INCLUDES 4,807 CU. YD. FOR DIKES
Ⓔ INCLUDES 106 (96) CU. YD. EXCAVATION FOR STA. "C" 783+68 TO "C" 191+37
Ⓕ INCLUDES 1,114 CU. YD. FOR DETOUR "SF-1" "SF-4" & "SF-5"
Ⓖ 46,877 CU. YD. FROM "B" 953+75 TO "B" 995+24.02
Ⓗ INCLUDES 63 CU. YD. EMBANKMENT FOR STA. "C" 783+68 TO "C" 191+37

+86.51 | +105.51 | +34.37

-0.02 ft./ft. Rt. Shldr. | Trans. Rt. Shldr. | -0.03 ft./ft. Rt. Shldr.

960 950 940 930 920 910

920 910

-3.75% "B" | -3.75% "B" | -3.82% "B" | -3.28%

SUPERELEVATION

880 870

880 870

868.03'
1024' V.C.

+34.37 | 907.77' | NO. V.C. | +15.24 | 868.03'

PROFILE GRADE IS NOT AT ℄
SEE TYPICAL SECTIONS

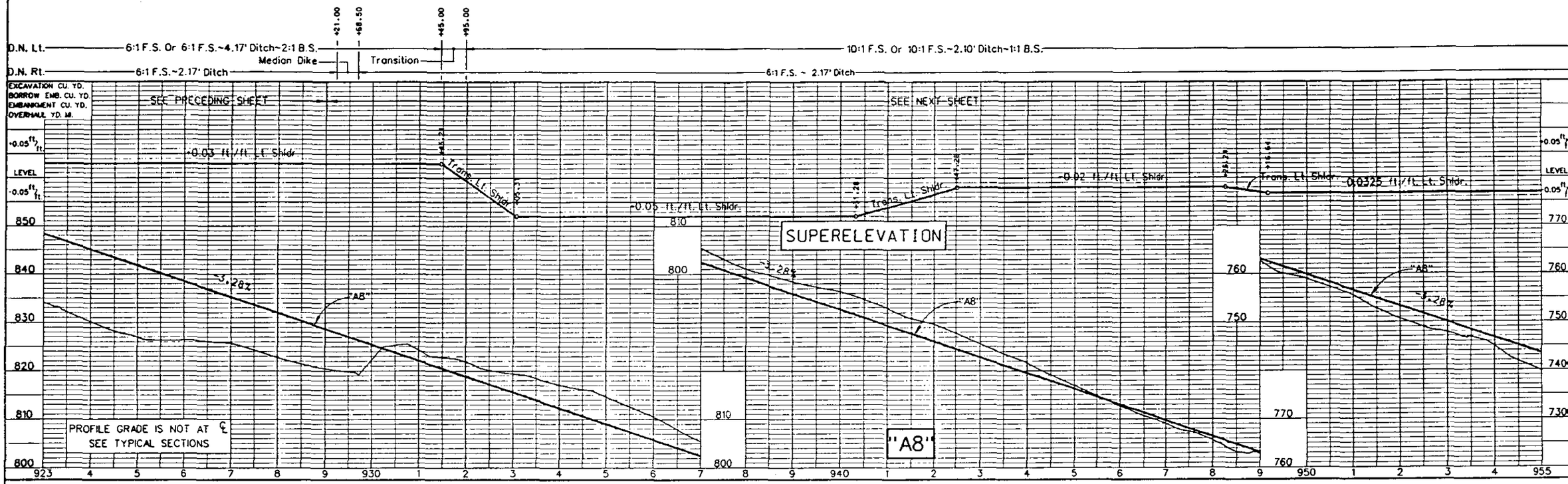
"B"

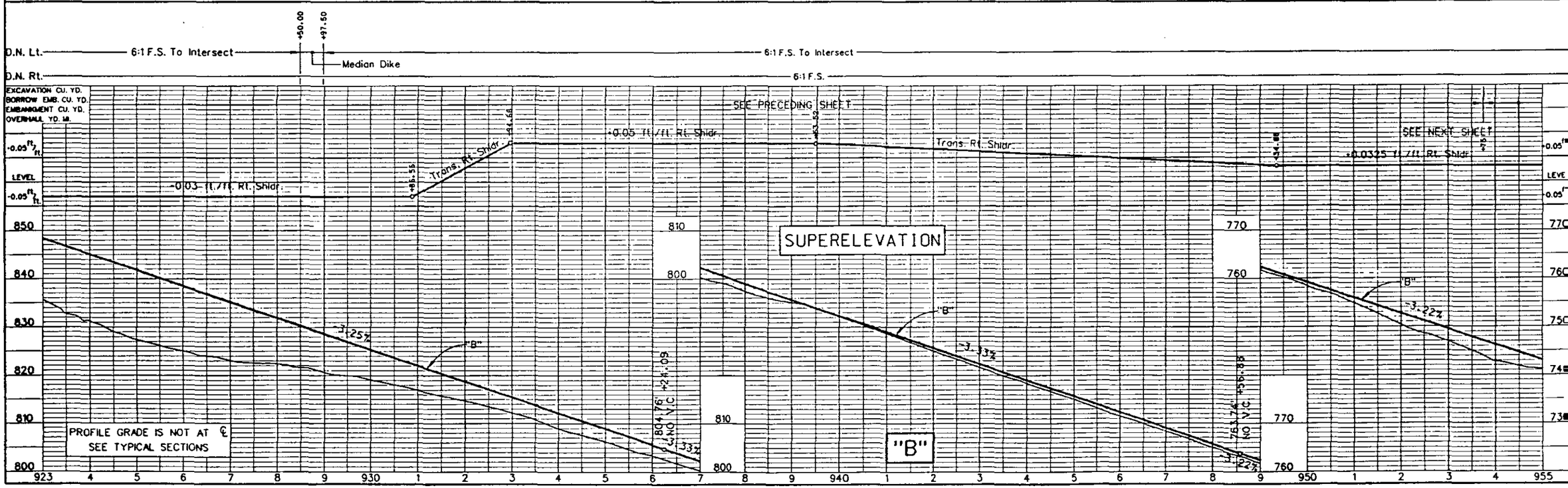
892 3 4 5 6 7 8 9 900 1 2 3 4 5 6 7 8 9 910 1 2 3 4 5 6 7 8 9 920 1 2 3 92

-0.05 | LEVEL | -0.0 | 8

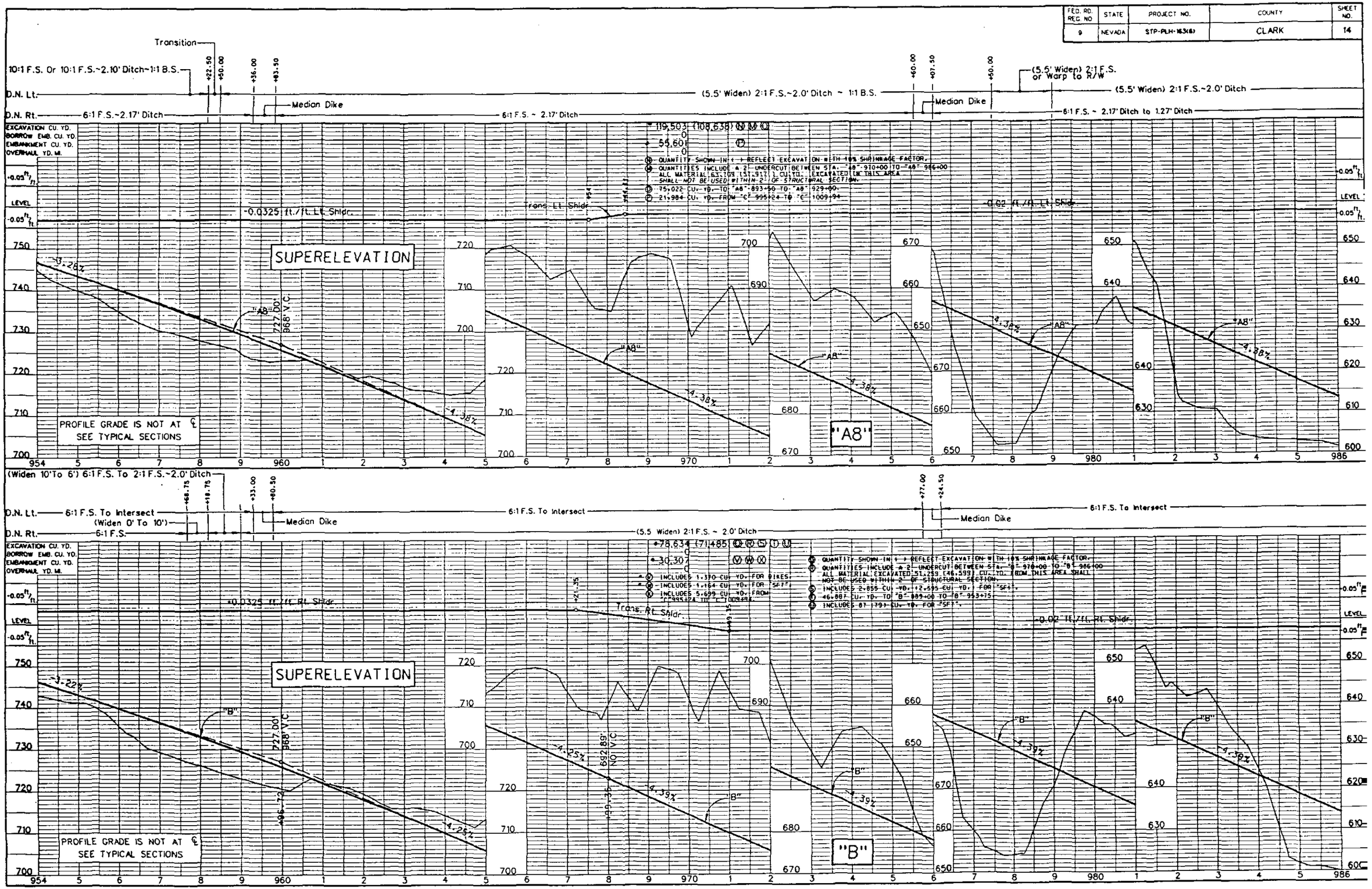
floppy tlarkin71303-1 sht12 dgn

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	13



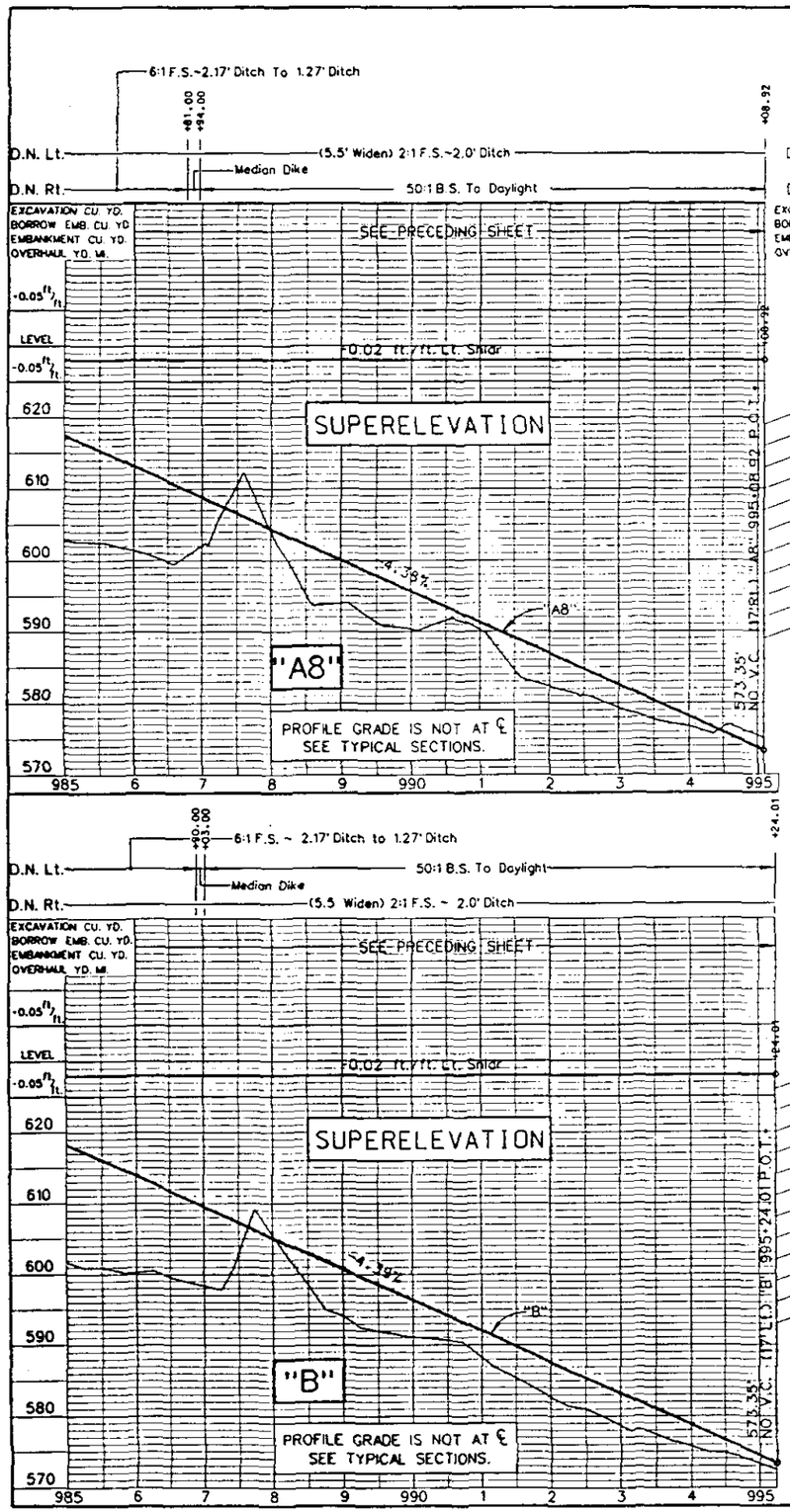


FED. RD. REG. NO	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	14

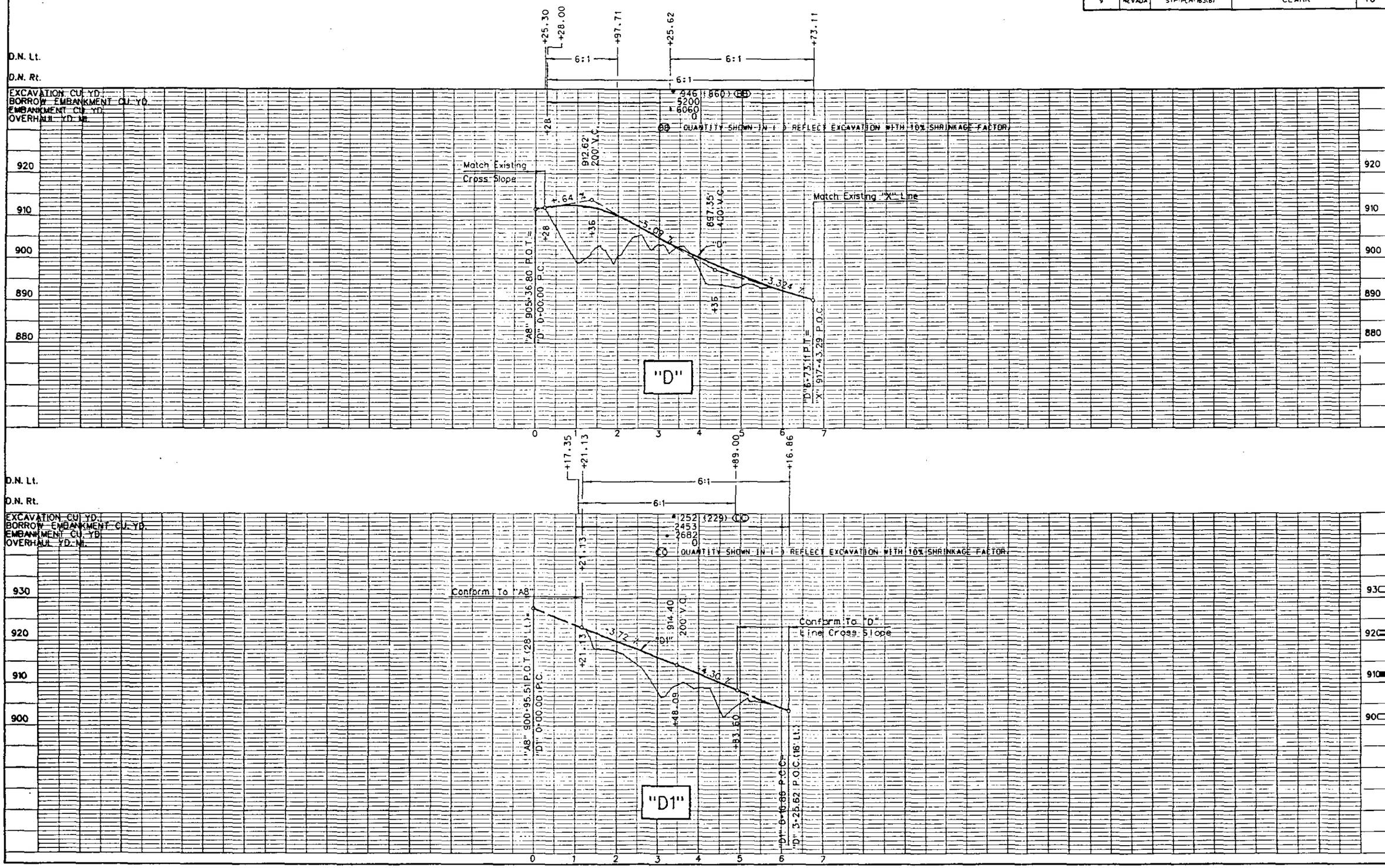


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FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	15



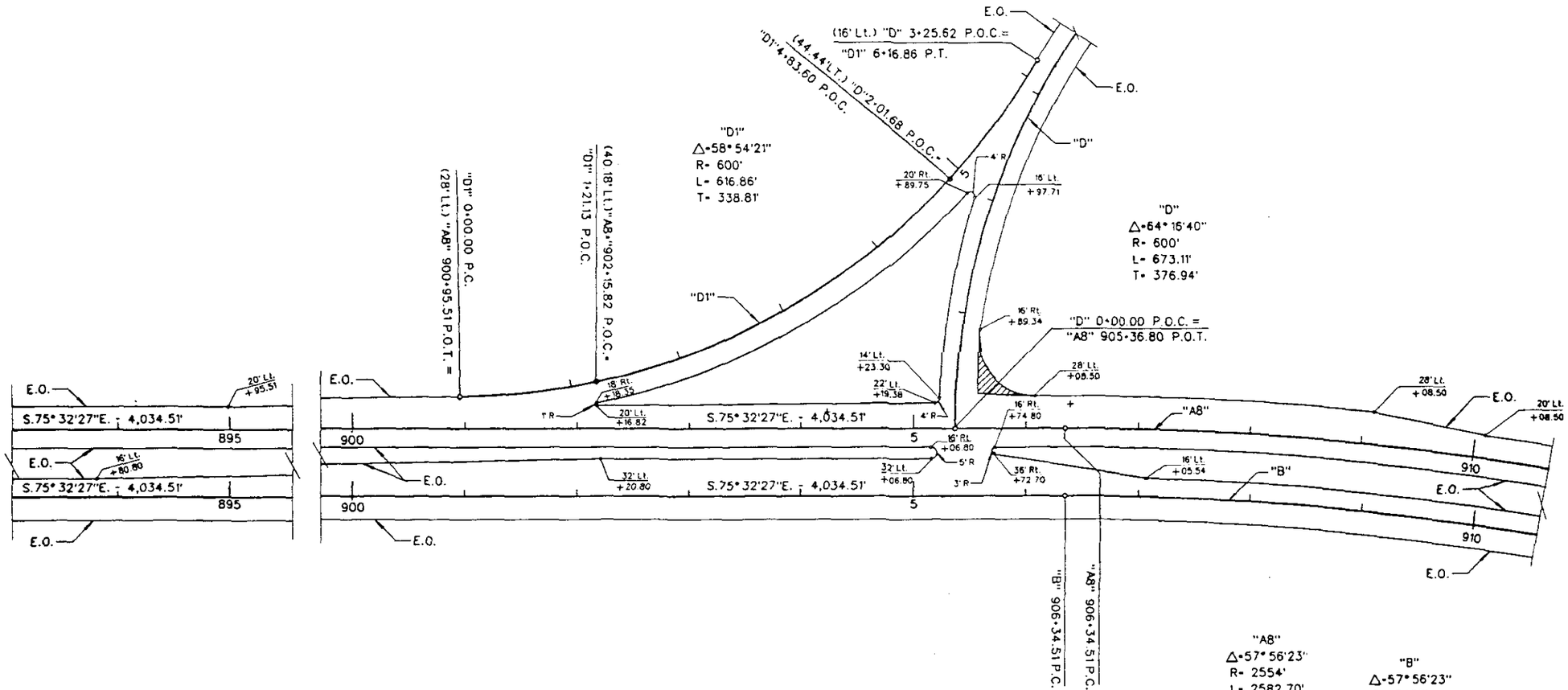
FED. RD REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	16



floppy tlarkin71303-1 sht16.dgn 8

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-1631(6)	CLARK	17

▨ - Limits of Miscellaneous Plantmix



"A8"
Δ=57°56'23"
R= 2554'
L= 2582.70'
T= 1413.95'

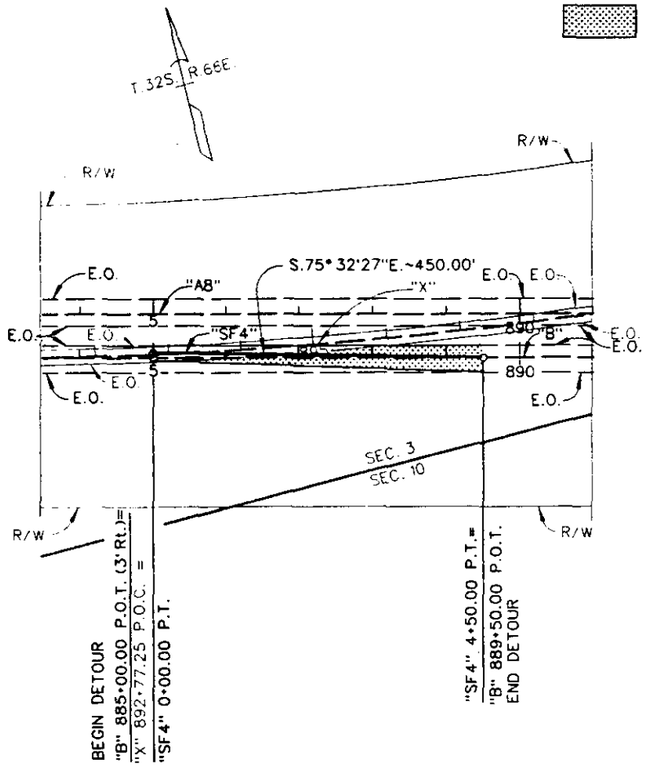
"B"
Δ=57°56'23"
R= 2496'
L= 2524.05'
T= 1381.84'

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

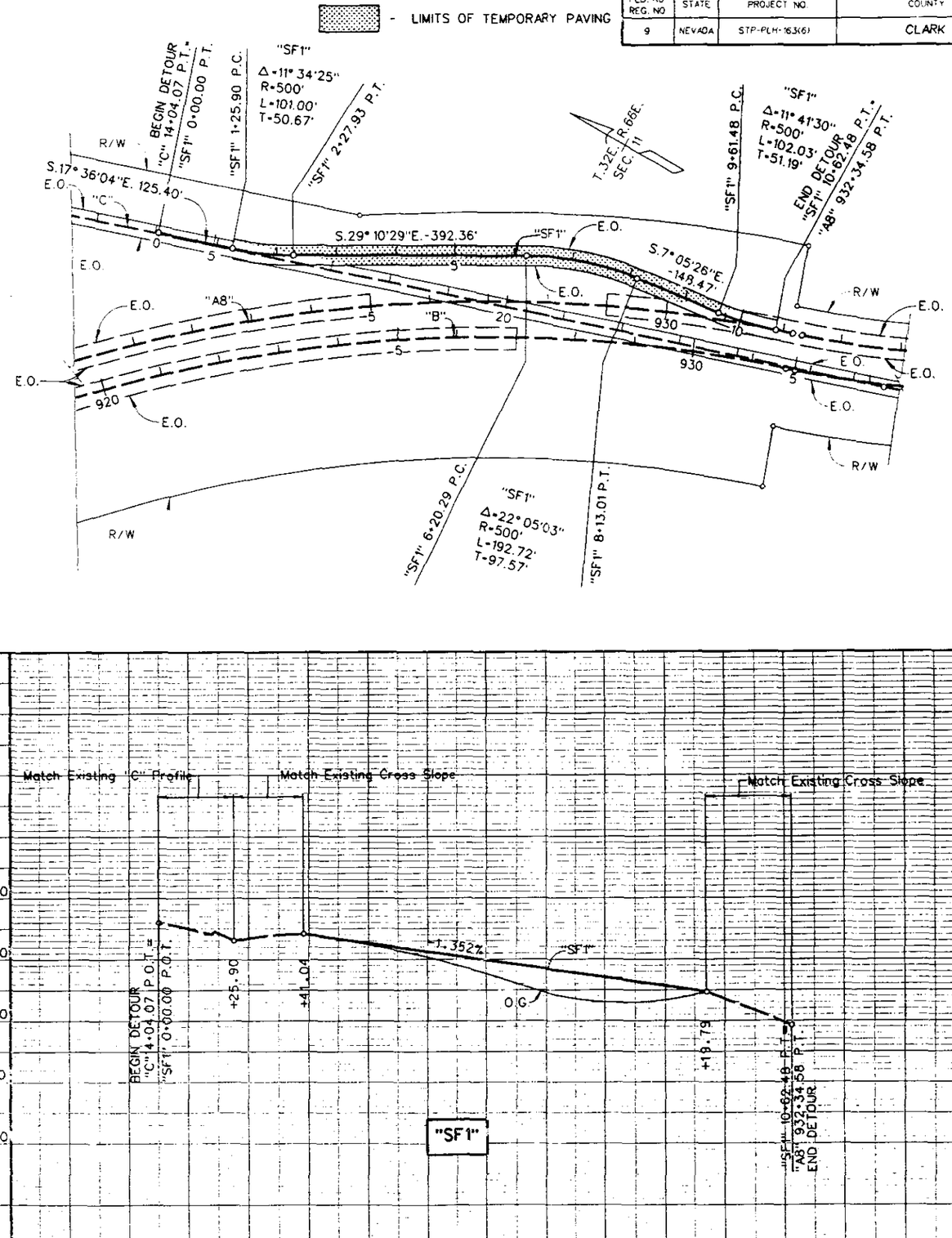
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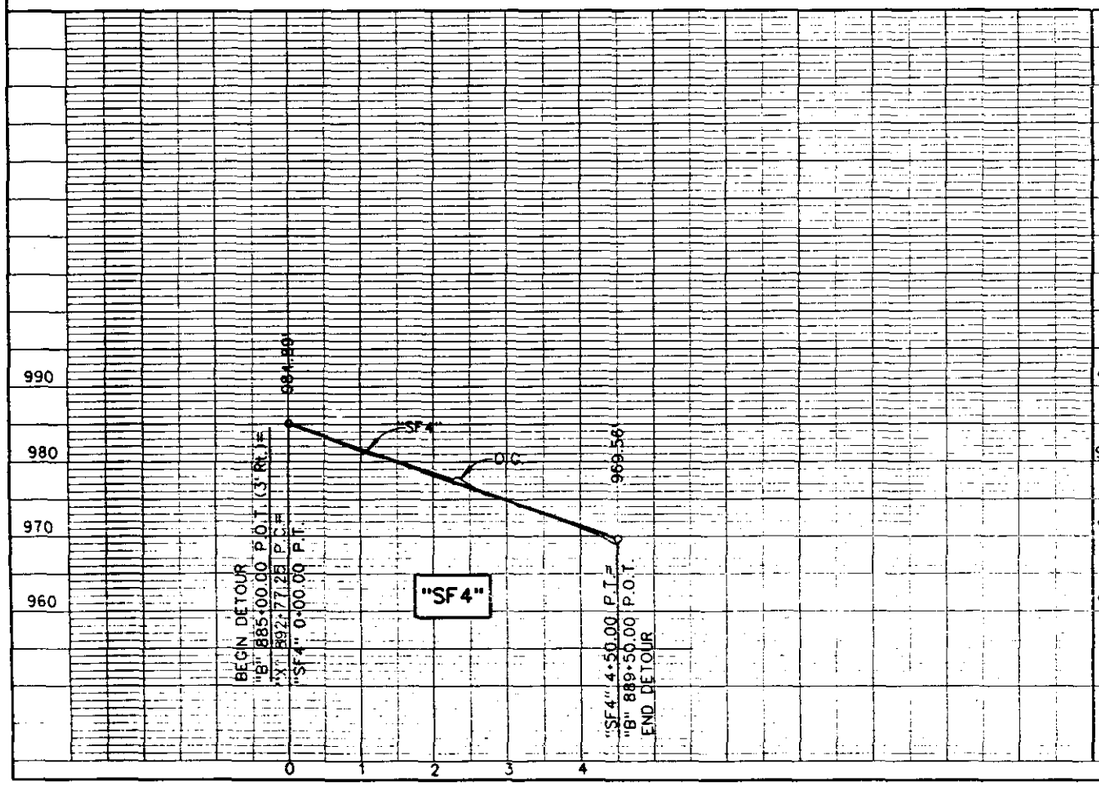
FED. RD REG. NO	STATE	PROJECT NO.	COUNTY	SHEET NO
9	NEVADA	STP-PLH-163(6)	CLARK	18

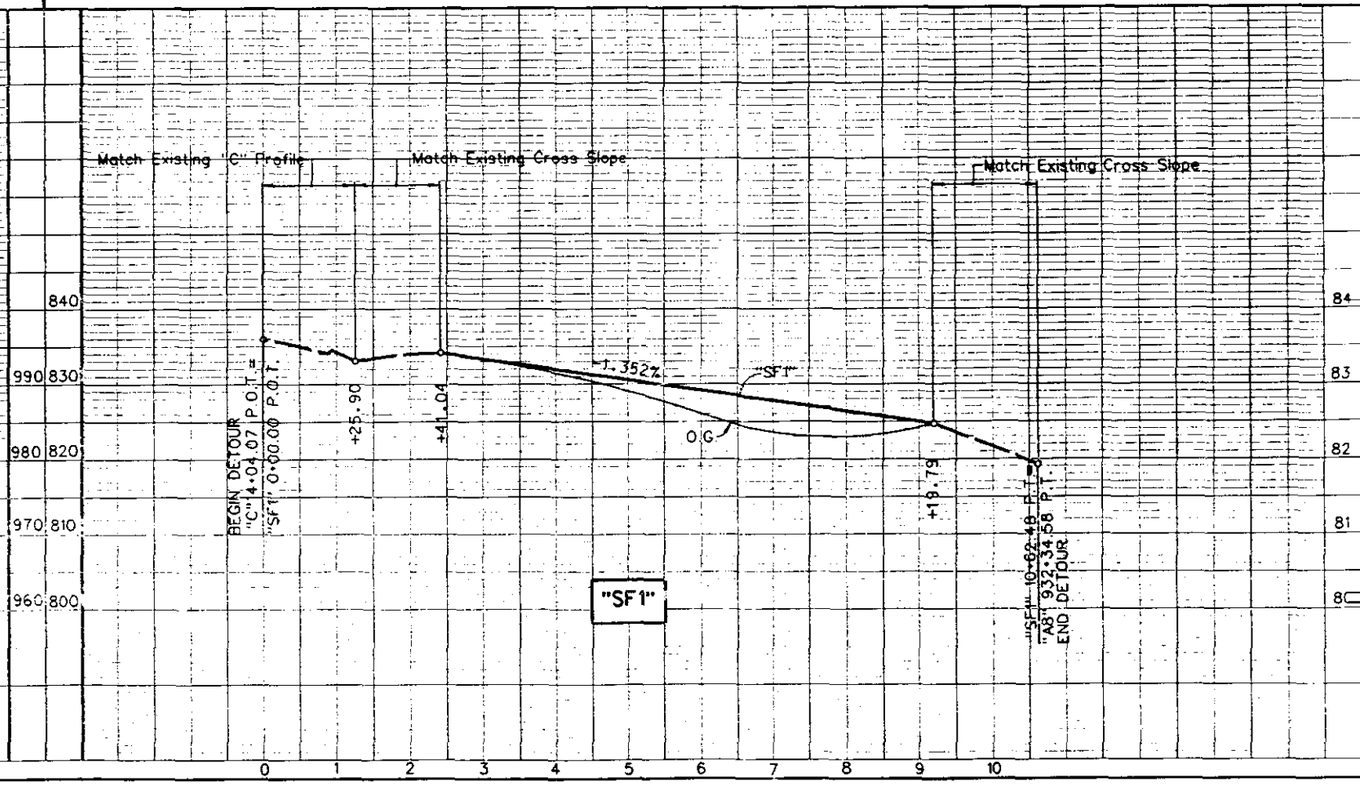
▨ - LIMITS OF TEMPORARY PAVING



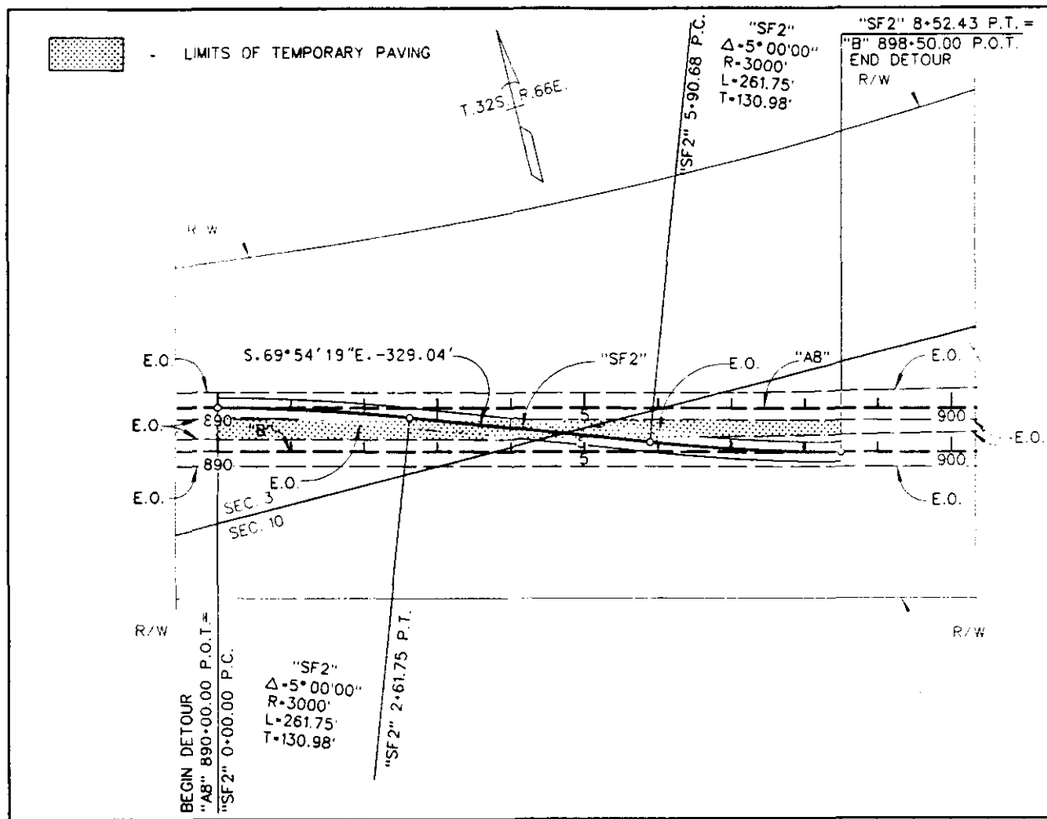
▨ - LIMITS OF TEMPORARY PAVING

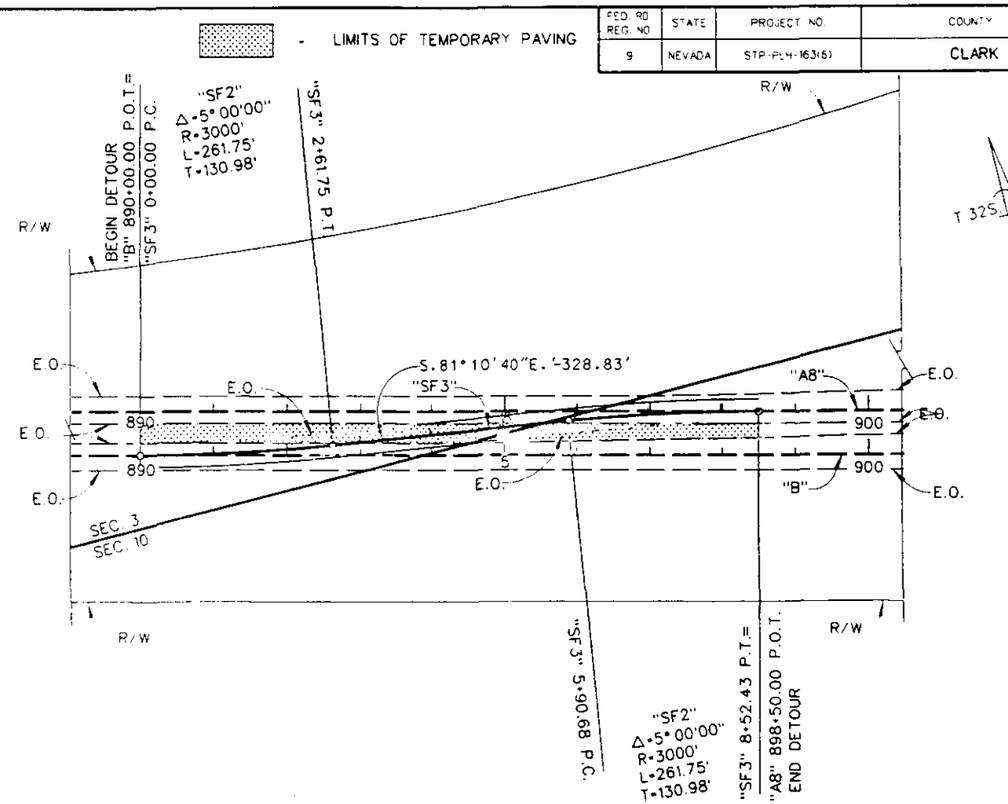


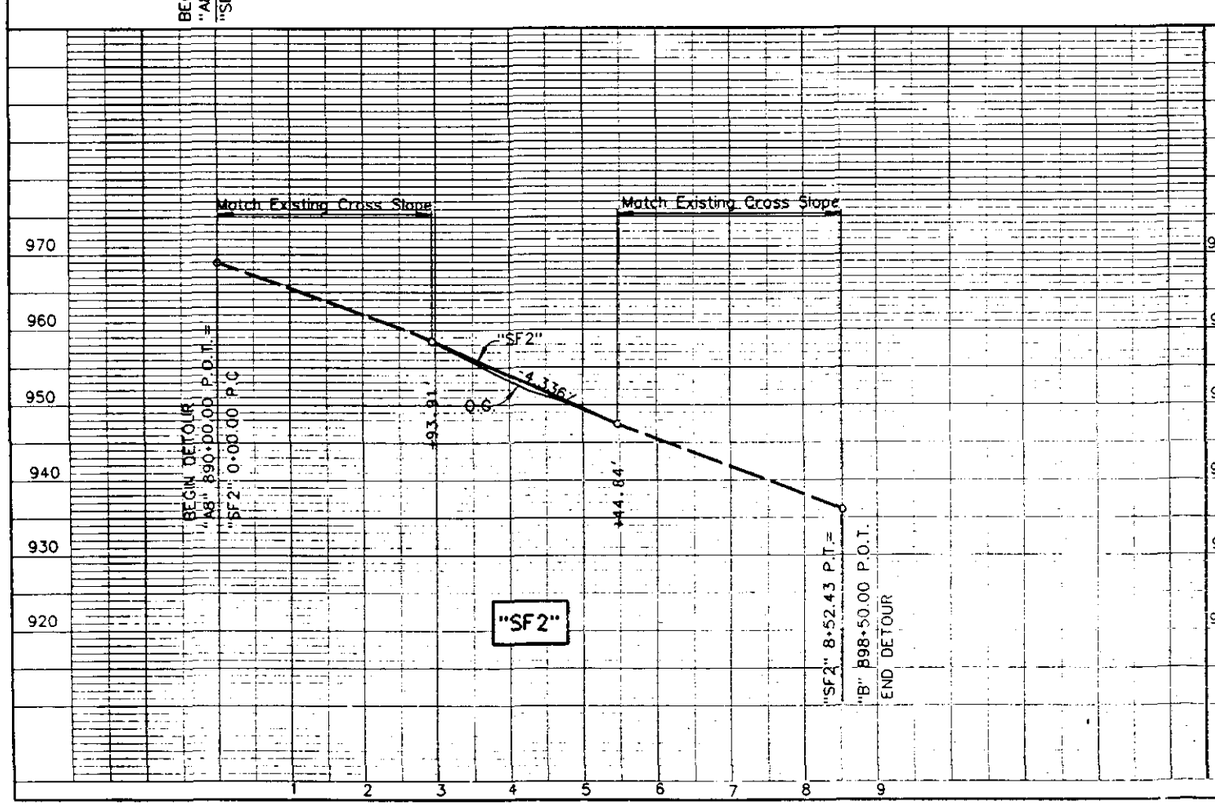


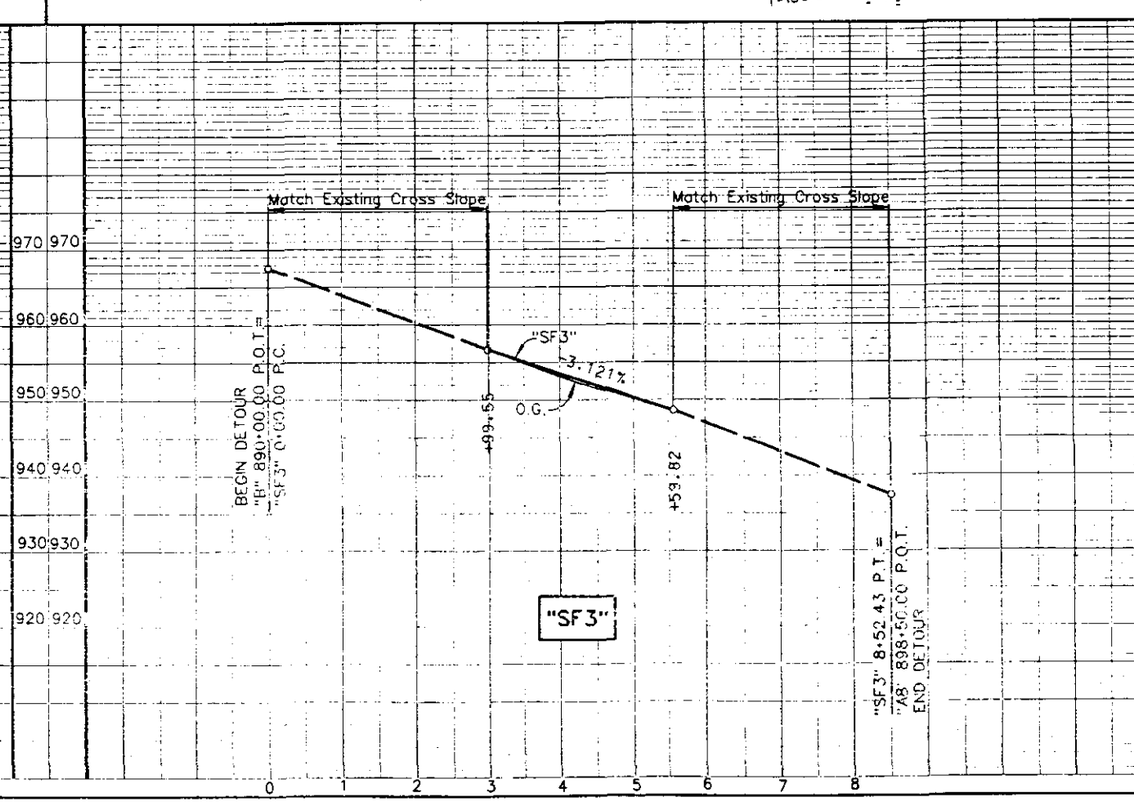


FED. RD REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-(PLH-163(6))	CLARK	19

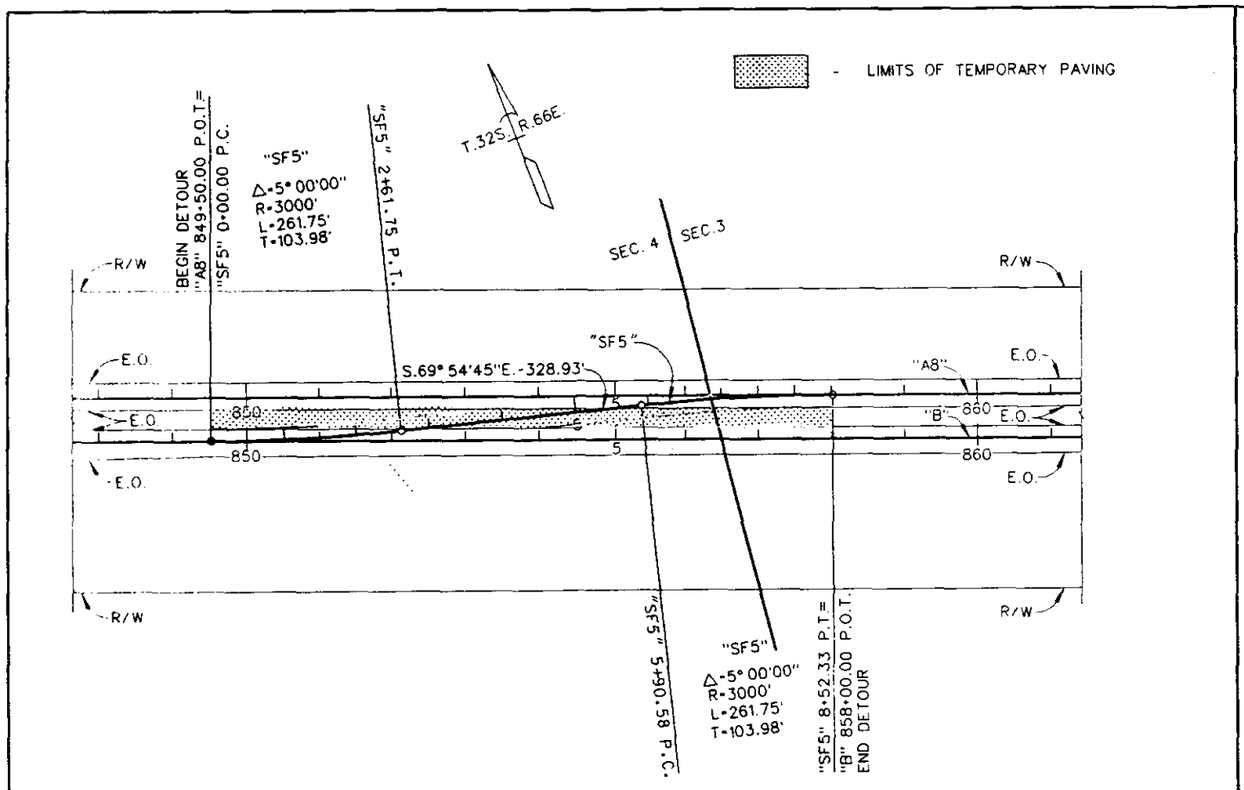


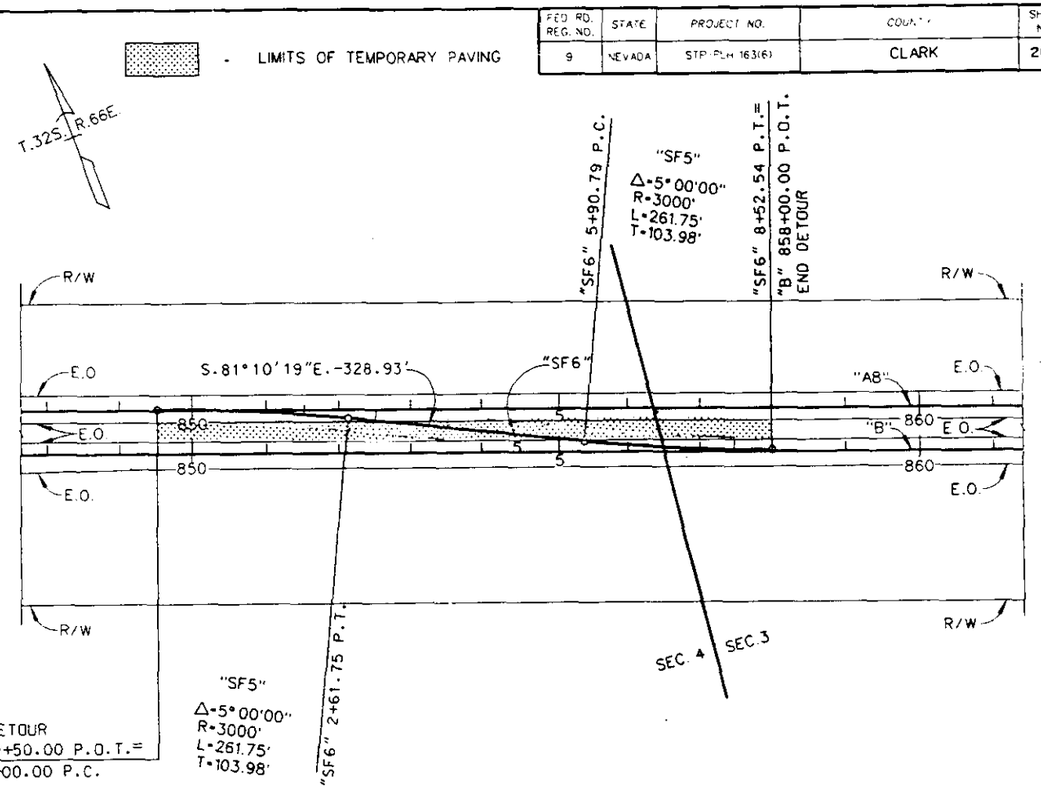


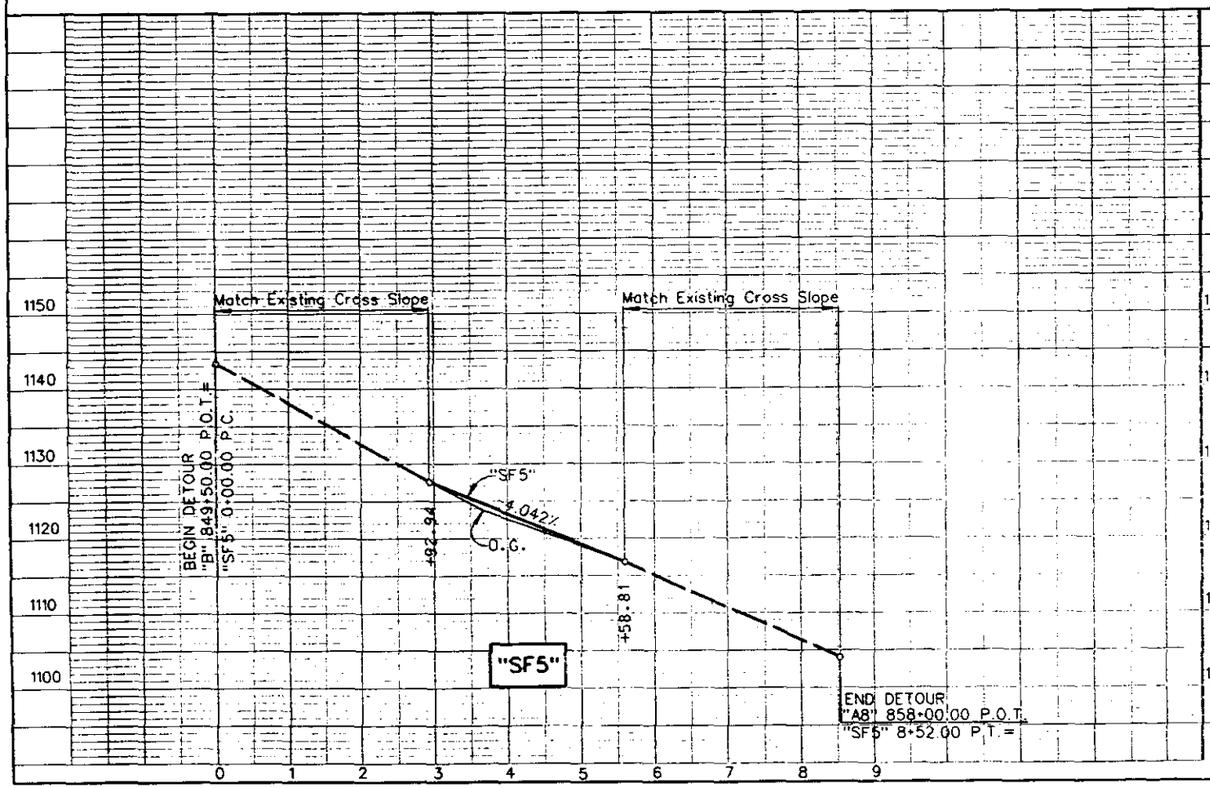


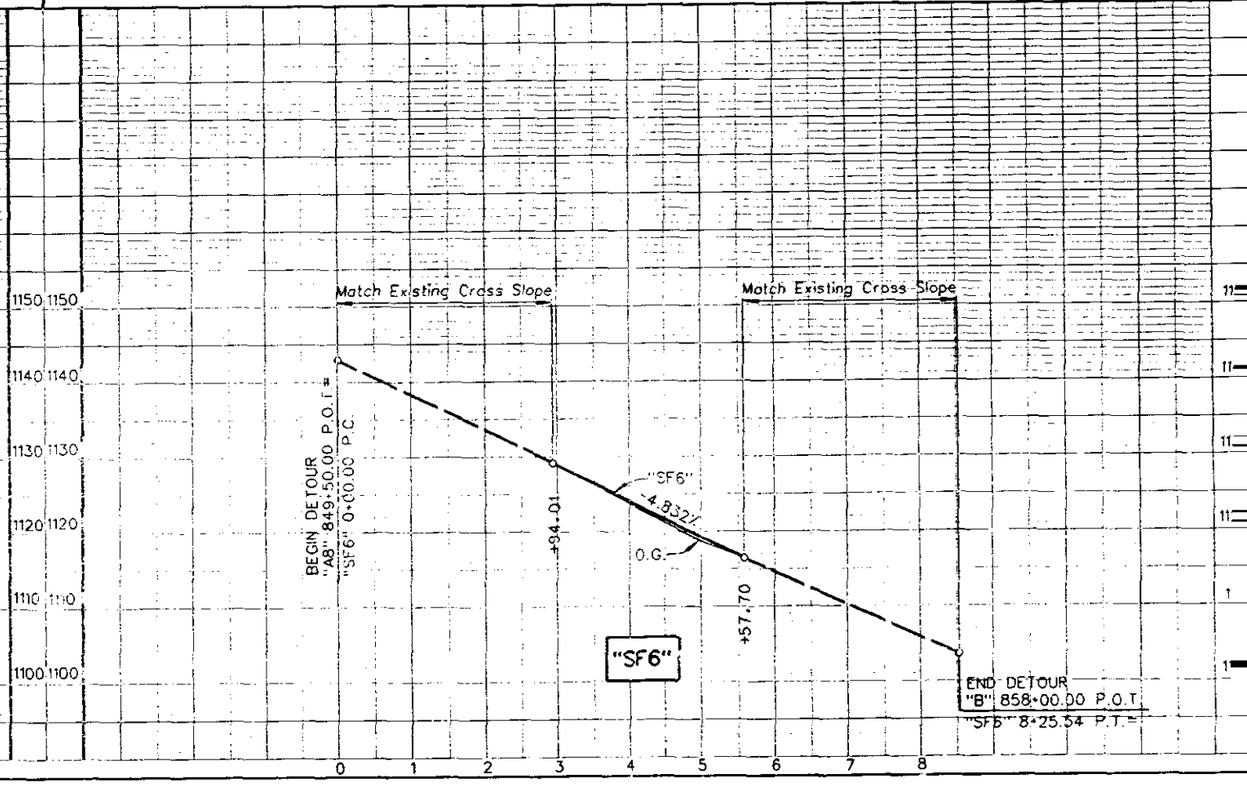


FED RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO
9	NEVADA	STP-PLH 163(6)	CLARK	20



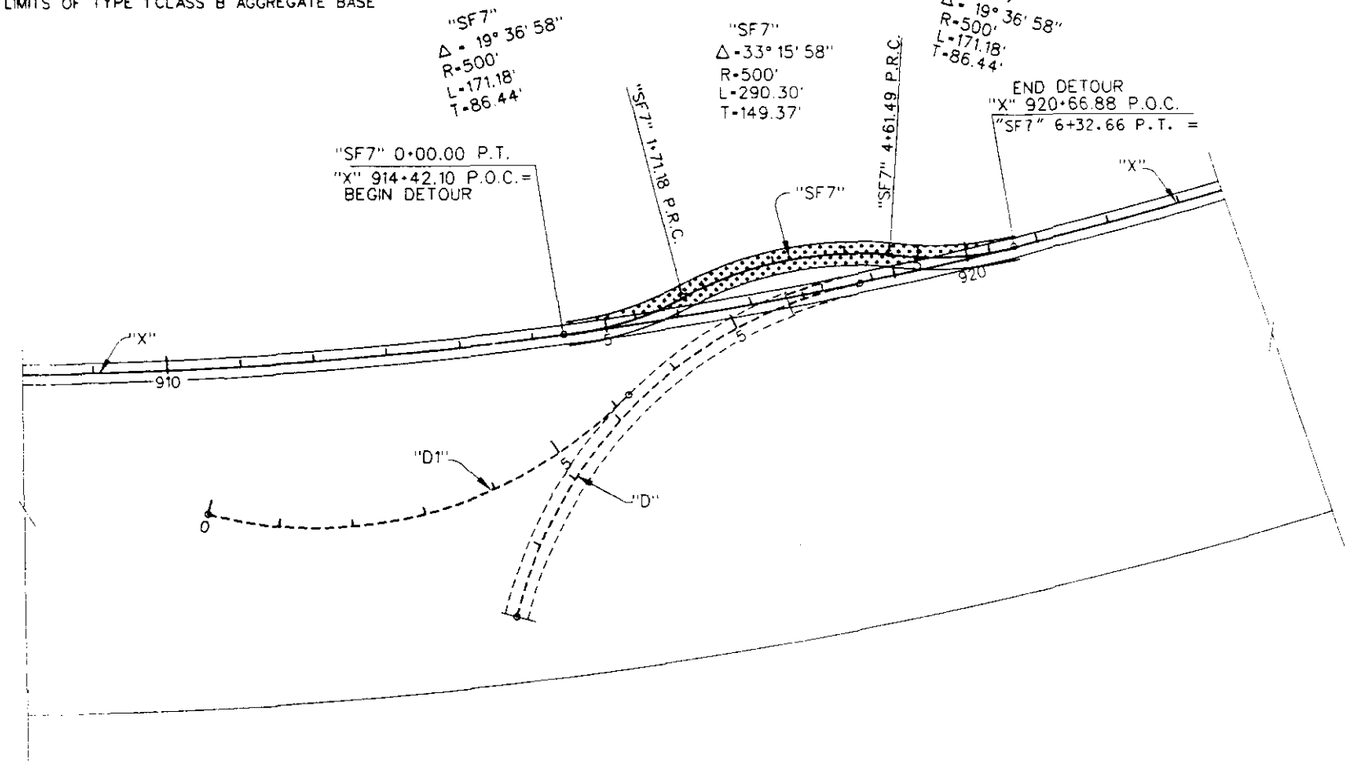


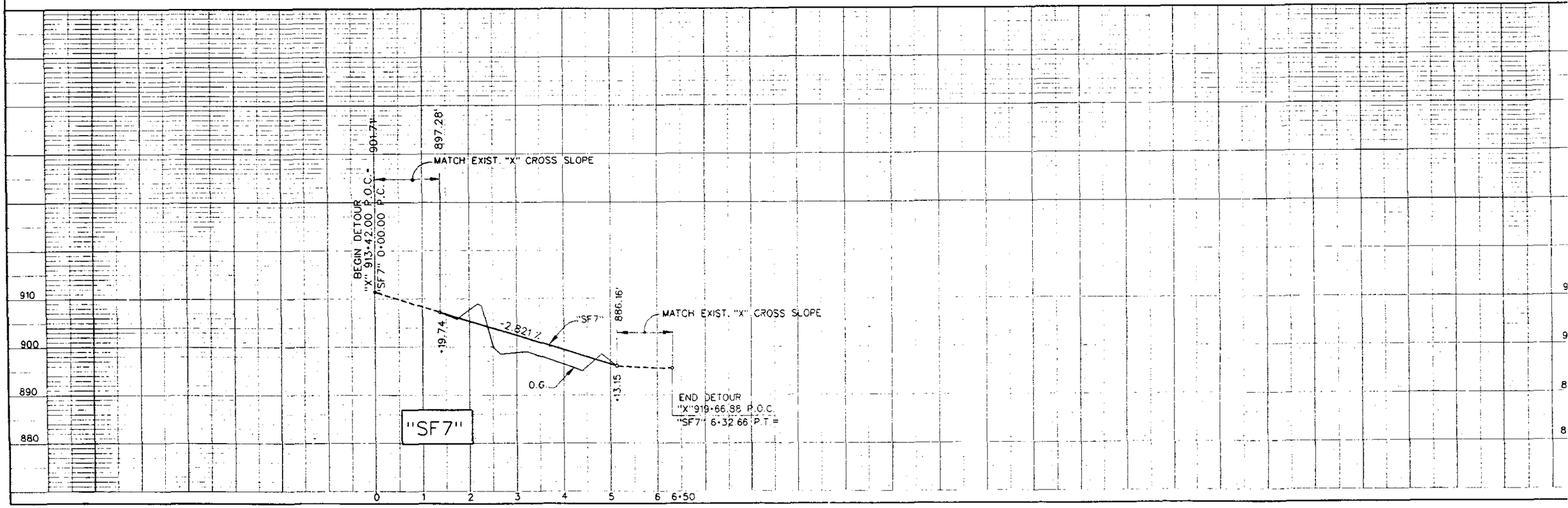




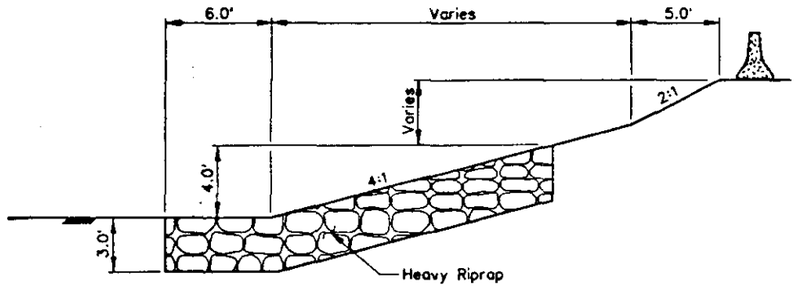
FED RD REG. NO.	STATE	PROJECT NO	COUNTY	SHEET NO
9	NEVADA	STP-PLH 163(6)	CLARK	21

- LIMITS OF TYPE 1 CLASS B AGGREGATE BASE



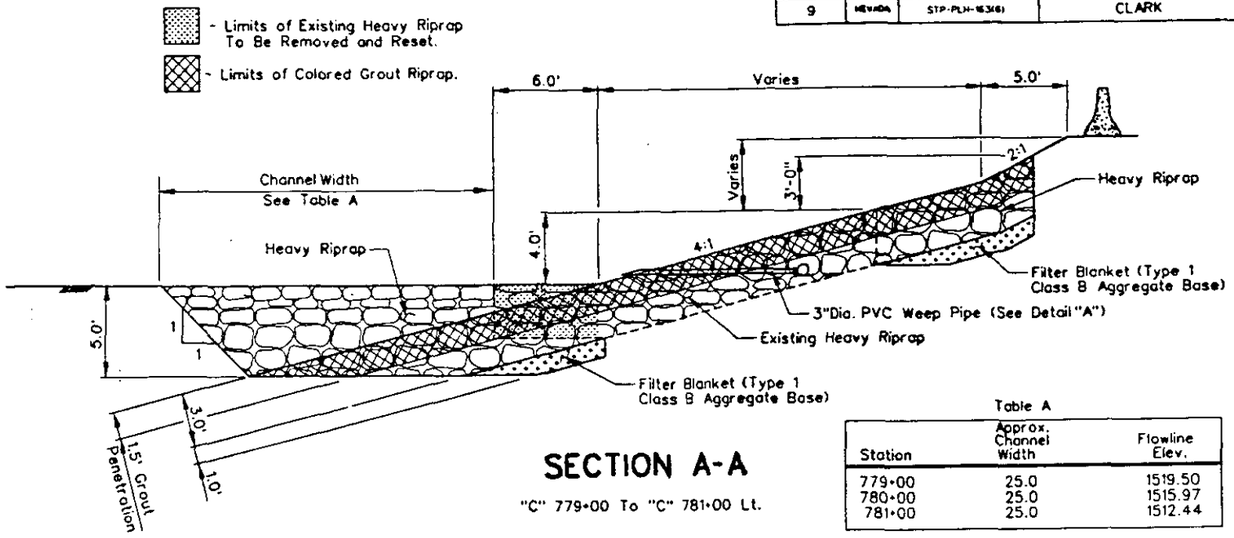


T.I.D. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-1536(6)	CLARK	22



AS CONSTRUCTED

"C" 779+00 To "C" 783+68.75 Lt.

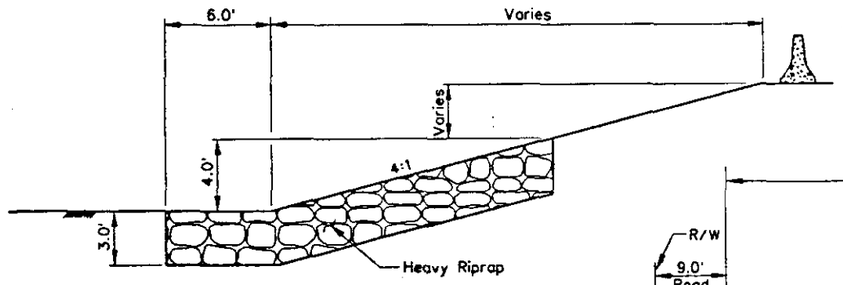


SECTION A-A

"C" 779+00 To "C" 781+00 Lt.

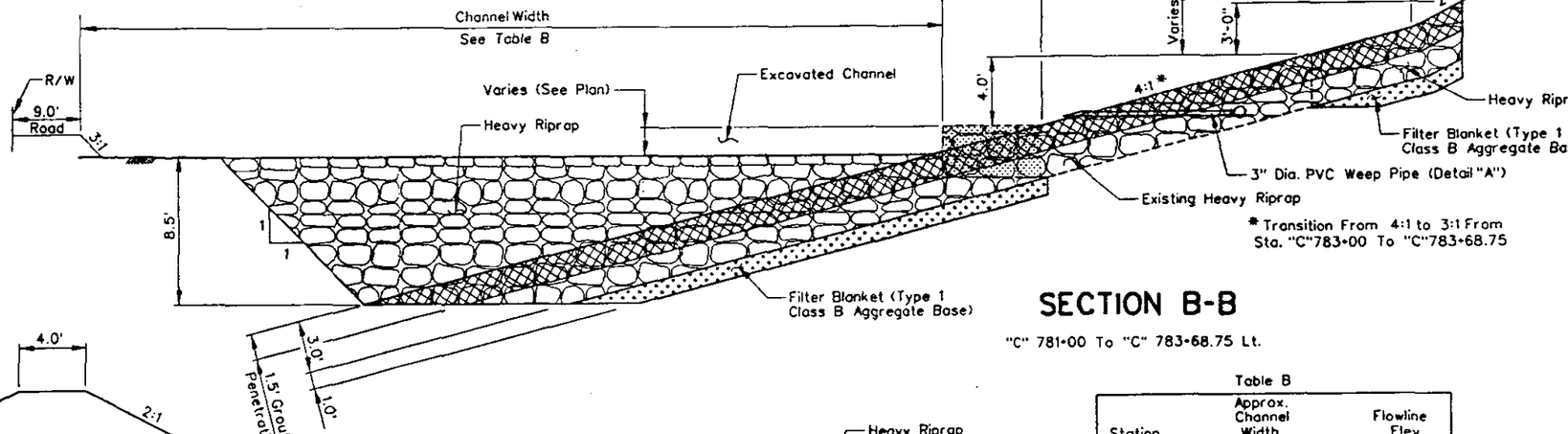
Table A

Station	Approx. Channel Width	Flowline Elev.
779+00	25.0	1519.50
780+00	25.0	1515.97
781+00	25.0	1512.44



AS CONSTRUCTED

"C" 783+68.75 To "C" 786+00 Lt.



* Transition From 4:1 to 3:1 From Sta. "C"783+00 To "C"783+68.75

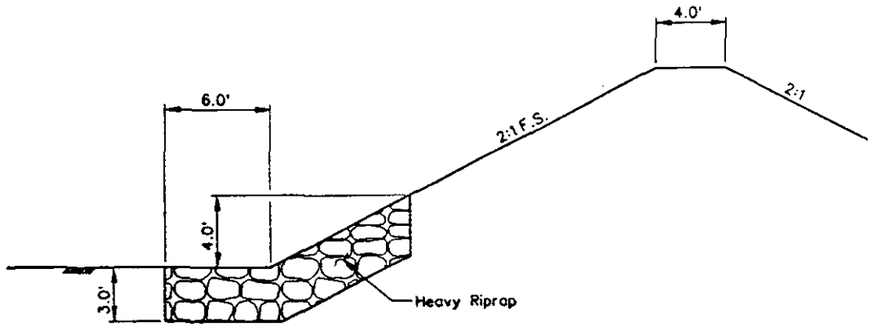
SECTION B-B

"C" 781+00 To "C" 783+68.75 Lt.

Table B

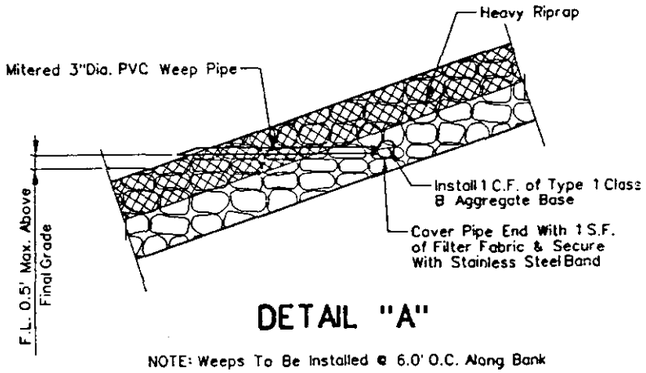
Station	Approx. Channel Width	Flowline Elev.
781+00	25.0	1512.44
718+55	42.5	1510.00
782+00	42.5	1507.50
783+00	42.5	1501.94
783+70	77.0	1498.05

Note: Permeon to be Applied to All Exposed Riprap. See General Notes.



AS CONSTRUCTED

"C" 786+00 To "C" 789+00 Lt.



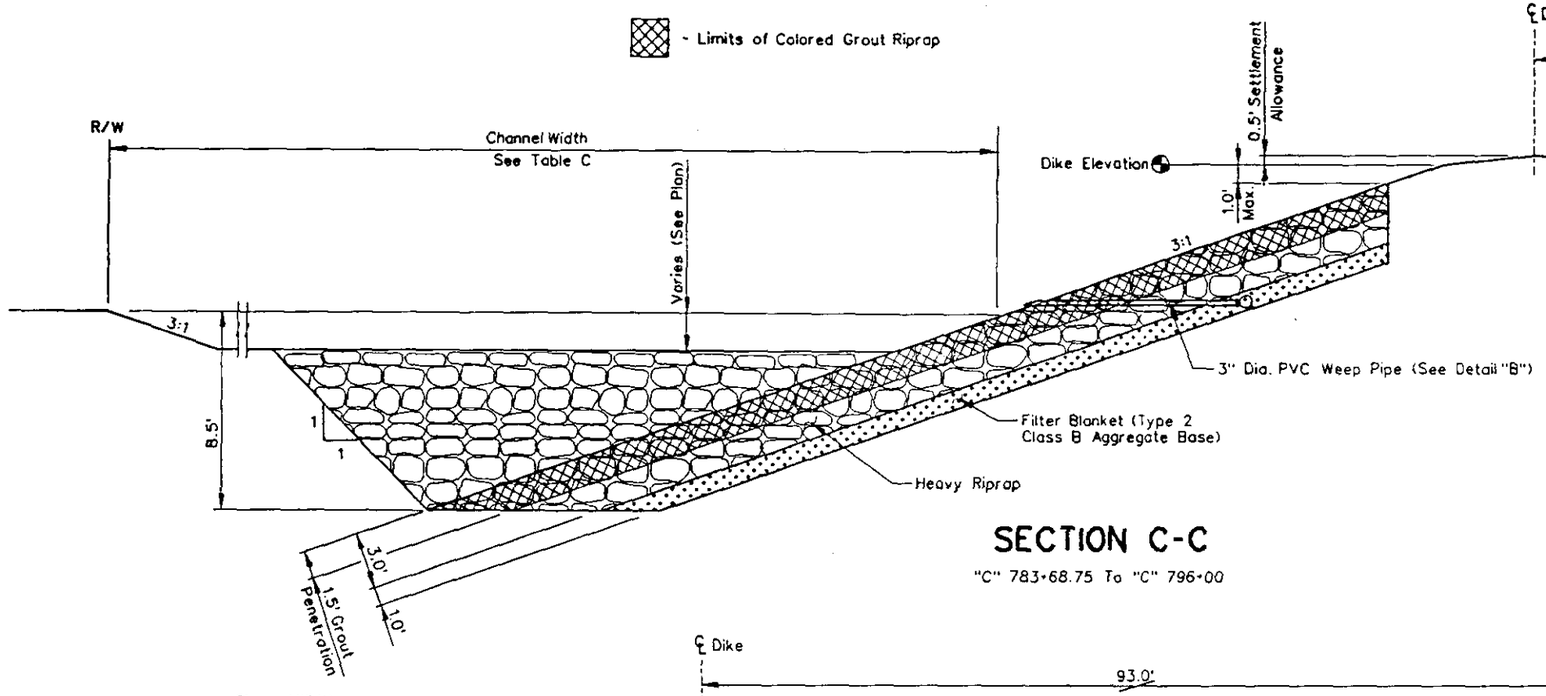
DETAIL "A"

NOTE: Weeps To Be Installed @ 6.0' O.C. Along Bank

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

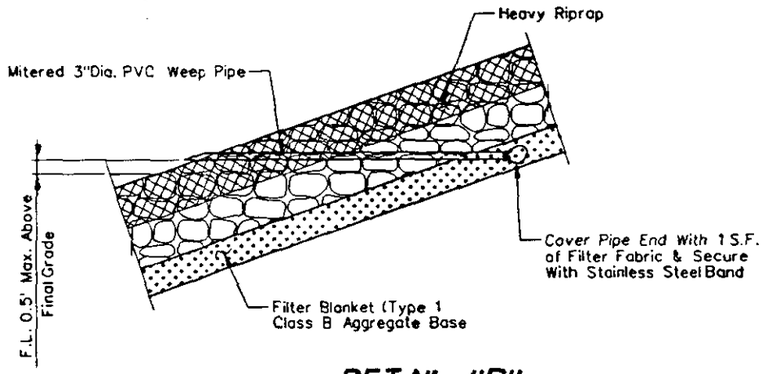
SPECIAL DETAILS

FED. ROAD REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-1631(6)	CLARK	23



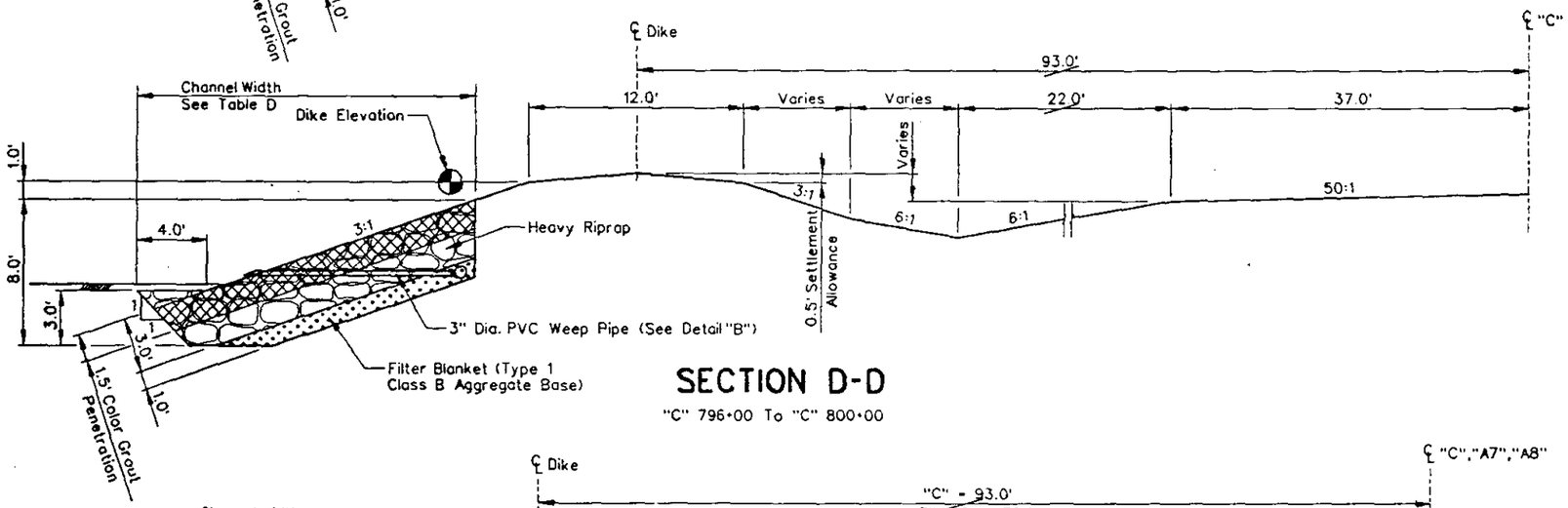
SECTION C-C

"C" 783+68.75 To "C" 796+00



DETAIL "B"

NOTE: Weeps To Be Installed @ 6.0' O.C. Along Bank



SECTION D-D

"C" 796+00 To "C" 800+00

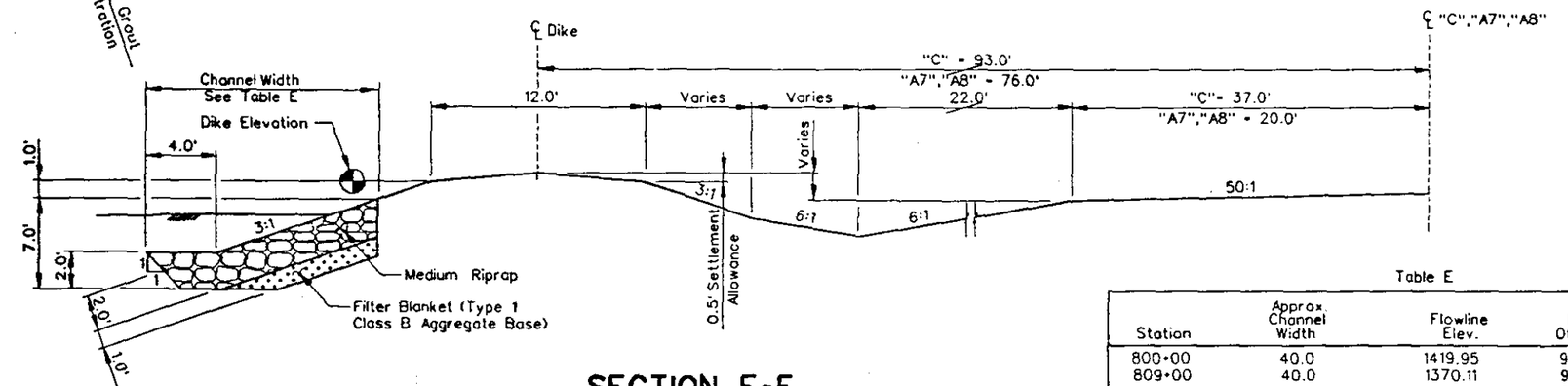
Table C

Station	Approx. Channel Width	Flowline Elev.	Dike Offset	Top of Dike Elev.
783+70	77.0	1498.05	43.5	1506.22
784+00	75.0	1496.64	43.5	1504.83
785+00	66.0	1492.09	53.5	1500.94
786+00	64.0	1487.55	57.2	1496.47
787+00	64.0	1483.00	59.3	1491.89
788+00	62.0	1478.46	61.3	1487.35
789+00	60.0	1473.91	69.9	1482.43
790+00	50.0	1469.37	83.6	1477.51
791+00	40.0	1464.82	93.0	1472.50
792+00	40.0	1460.28	93.0	1467.45
793+00	40.0	1455.74	93.0	1462.14
794+00	40.0	1451.19	93.0	1456.84
795+00	40.0	1446.64	93.0	1451.53
796+00	40.0	1442.10	93.0	1446.22

Table D

Station	Approx. Channel Width	Flowline Elev.	Dike Offset	Top of Dike Elev.
796+00	40.0	1442.10	93.0	1446.22
797+00	40.0	1436.56	93.0	1440.66
798+00	40.0	1431.02	93.0	1435.08
799+00	40.0	1425.49	93.0	1429.50
800+00	40.0	1419.95	93.0	1423.95

Note: Permeon To Be Applied To All Exposed Riprap. See General Notes.



SECTION E-E

"C" 800+00.00 To "A7","A8" 848+66.00

Table E

Station	Approx. Channel Width	Flowline Elev.	Dike Offset	Top of Dike Elev.
800+00	40.0	1419.95	93.0	1423.95
809+00	40.0	1370.11	93.0	1374.11
833+70	40.0	1220.10	93.0	1224.10
849+00	40.0	1140.10	93.0	1144.10

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

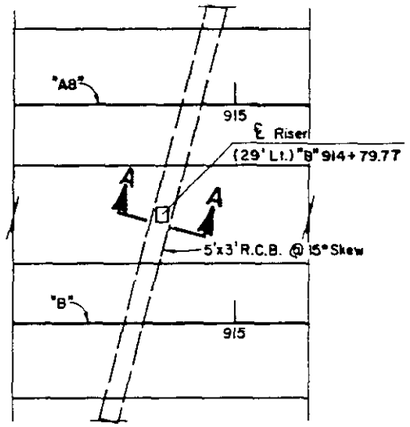
SPECIAL DETAILS

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA		CLARK	24

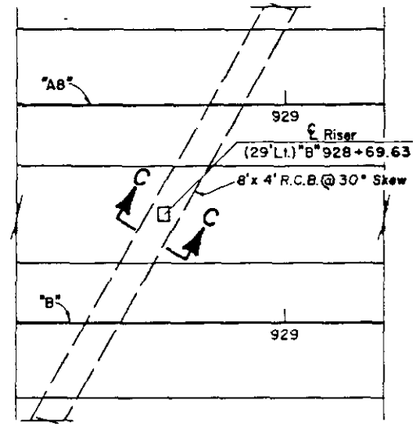
* - INSET LIP RING WIDTH TO CONFORM TO PIPE WALL THICKNESS.

FIELD CUT BARS WHERE NECESSARY TO ALLOW FOR 2" MINIMUM CLEARANCE FOR R.C.P.

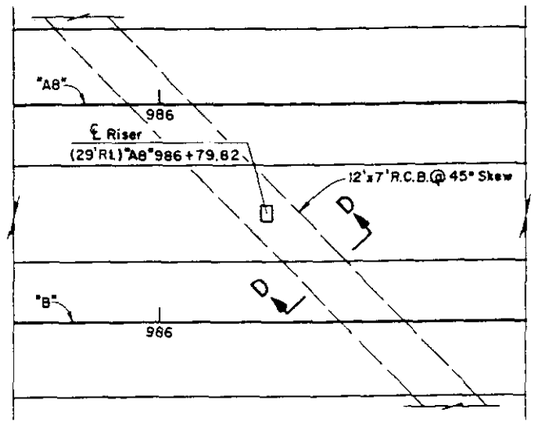
FOR REINFORCING AND DETAILS NOT SHOWN SEE STATE OF NEVADA STANDARD PLANS FOR ROAD AND BRIDGE CONSTRUCTION, FEBRUARY 1993. SHEET NO. R-20.1.2(502) & R-4.1.2(609)



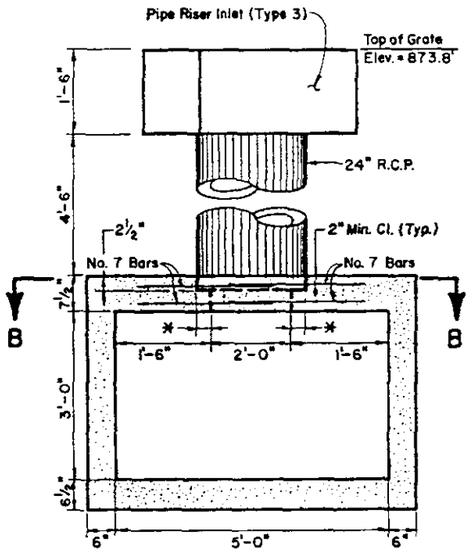
PLAN



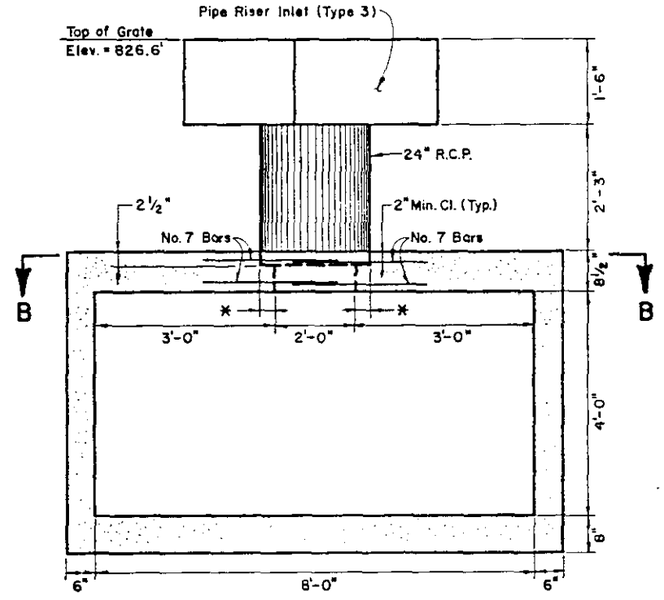
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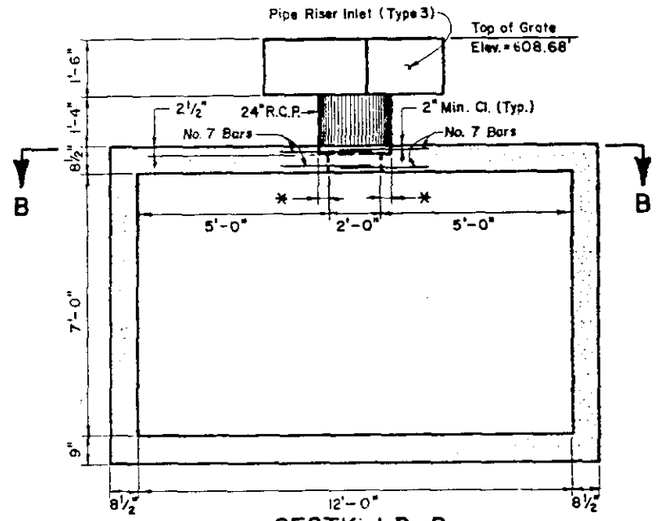
PLAN



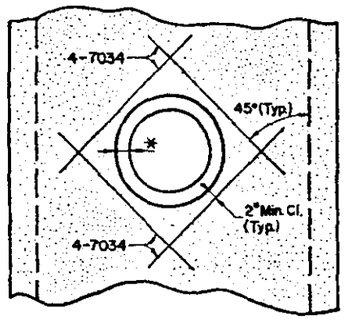
SECTION A-A



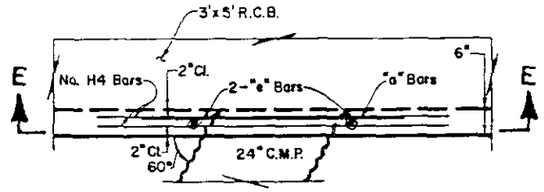
SECTION C-C



SECTION D-D



SECTION B-B



PLAN

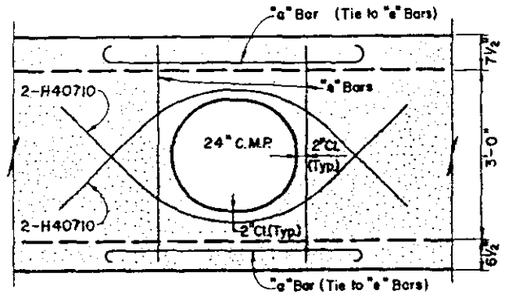
C.M.P. to R.C.B. Connection "A8" 959+45.00 (29' Rt.)

FIELD CUT BARS WHERE NECESSARY TO ALLOW FOR 2" MINIMUM CLEARANCE FOR C.M.P.

FOR REINFORCING AND DETAILS NOT SHOWN SEE STATE OF NEVADA STANDARD PLANS FOR ROAD AND BRIDGE CONSTRUCTION, FEBRUARY 1993. SHEET NO. R-20.1.2(502)



H40710

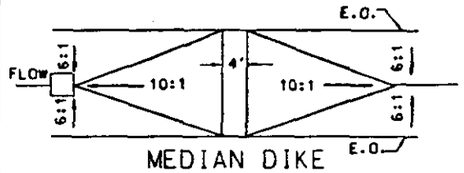


SECTION E-E

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

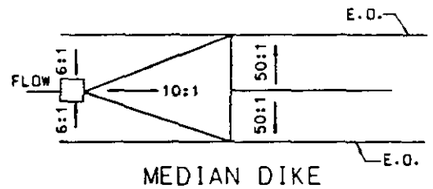
SPECIAL DETAILS

FED. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	25



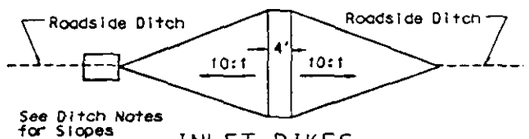
MEDIAN DIKE

"A8" 878+50.00 TO "A8"878+97.50.00
"B" 914+72.00 TO "B" 915+19.50.00
"B" 928+50.00 TO "B" 928+97.50.00
"A8" 959+40.00 TO "A8"959+87.50.00
"B"975+77.00 TO "B"976+24.50



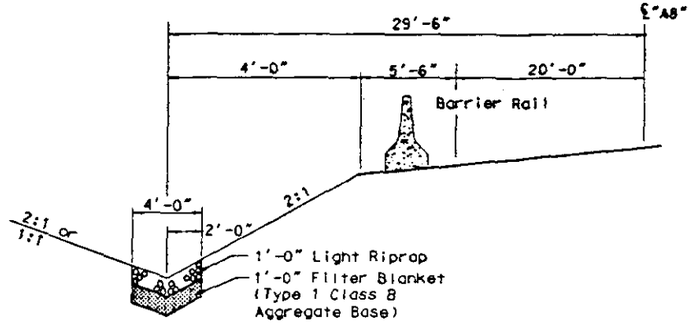
MEDIAN DIKE

"A8" 899+00.00 to "A8"899+22.00



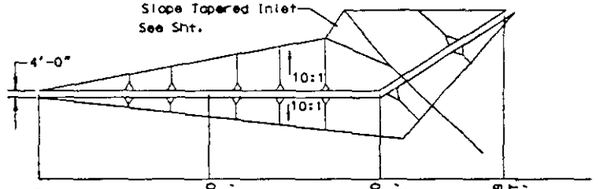
INLET DIKES

"A7"799+50.00 LT.
"A7"811+00.00 LT.
"A8"826+00.00 LT.
"A8"976+36.66 RT.
"A8"981+00.00 LT.
"B" 984+00.00 RT.
"C" 1003+02.99 LT.
"B" 975+20.50 RT.

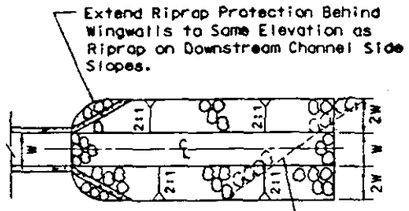


SPECIAL RIPRAP LINED CHANNEL

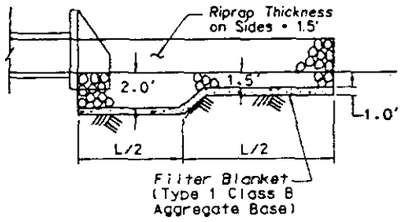
"A8" 964+00.00 to "A8" 976+32.00



CULVERT DIKE NO.4



PLAN



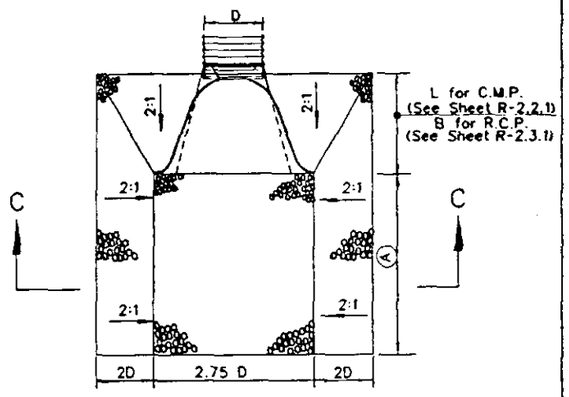
℄ PROFILE

Note: 1. All Riprap To Be Grouted To Full Depth of Riprap Lining.
2. Size of Riprap Shall Be "Medium Riprap".

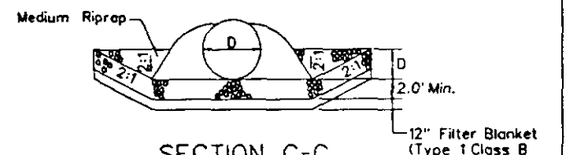
GROUTED RIPRAP BASIN

STATION	W	L
"B"914+72	5'	30'
"B"928+50	8'	40'
"A8"986+58 *	12'	70'

* EXTEND TO R/W ALONG SKEW



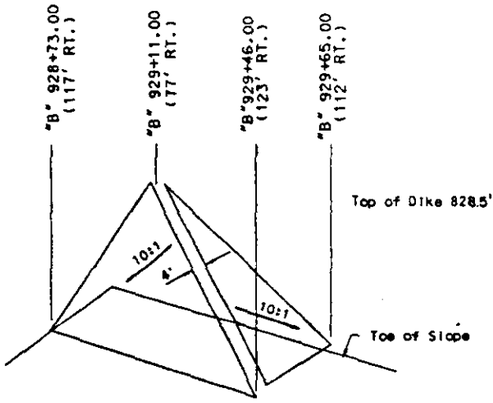
PLAN



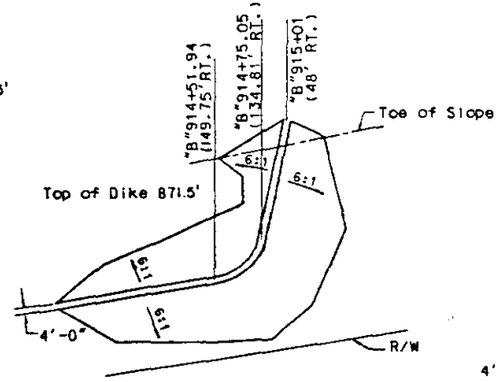
SECTION C-C

MODIFIED RIPRAP BASIN

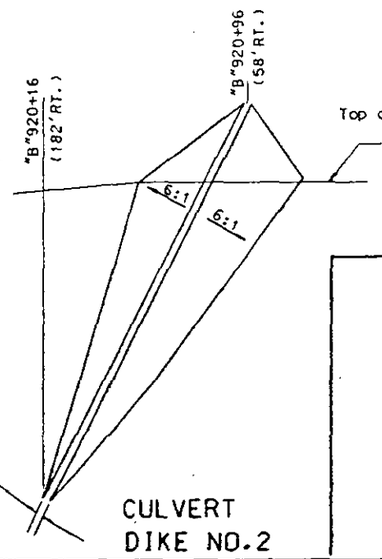
Ⓐ	
"B" 920+95.00	13'
"B" 978+00.00	10'
"B" 959+28.00	30'



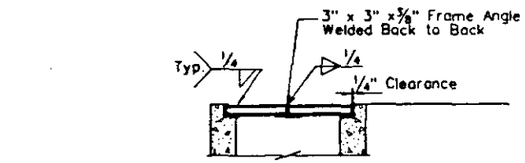
CULVERT DIKE NO. 3



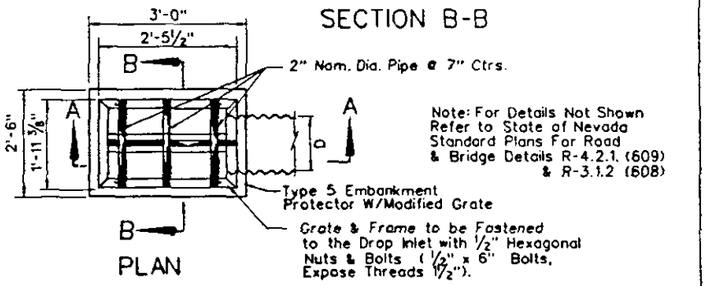
CULVERT DIKE NO. 1



CULVERT DIKE NO.2

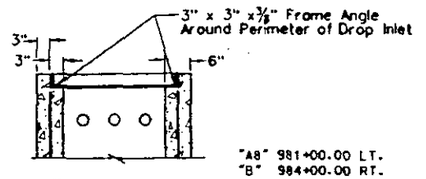


SECTION B-B



Note: For Details Not Shown Refer to State of Nevada Standard Plans For Road & Bridge Details R-4.2.1. (609) & R-3.1.2 (608)

PLAN



"A8" 981+00.00 LT.
"B" 984+00.00 RT.

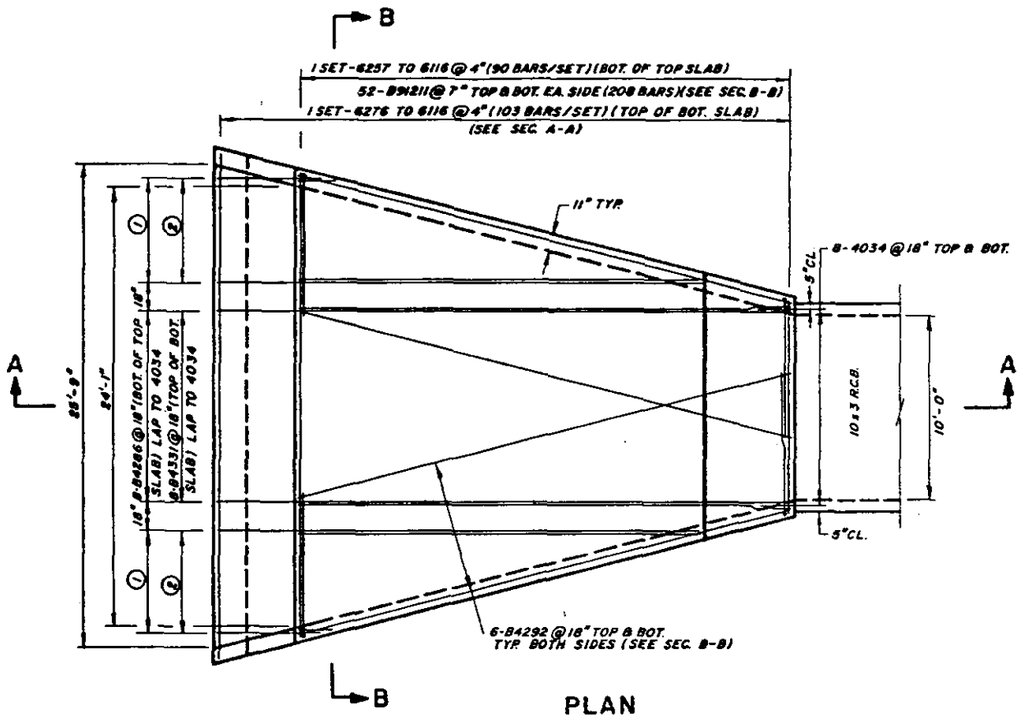
SECTION A-A

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

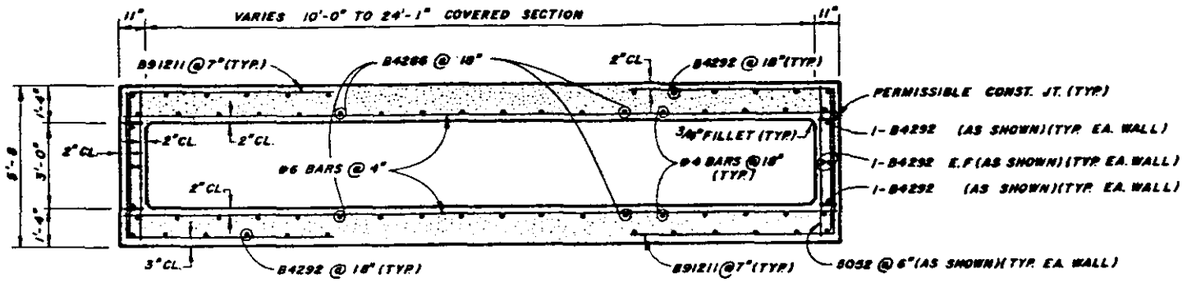
SPECIAL DETAILS

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA		CLARK	26

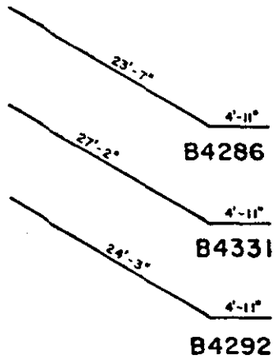
① 1 SET - 4235 TO 4014 @ 18" (5 BARS/SET) (BOT. OF TOP SLAB)
② 1 SET - 4280 TO 4046 @ 18" (5 BARS/SET) (TOP OF BOT SLAB)

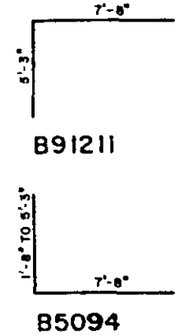


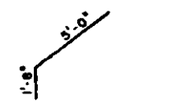
PLAN

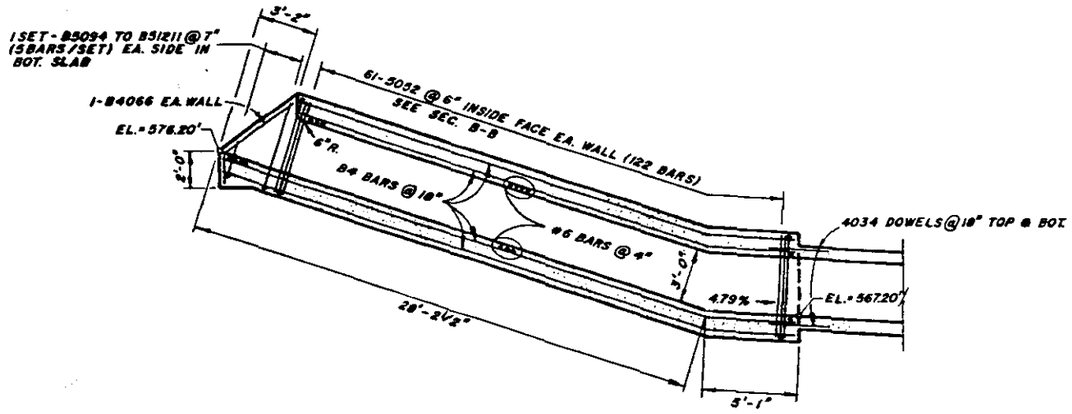


SECTION B-B









SECTION A-A

QUANTITIES

ITEM NUMBER	DESCRIPTION	UNIT	QUANTITY
206 0100	STRUCTURE EXCAVATION	CU. YD.	136.00
207 0200	GRANULAR BACKFILL	CU. YD.	18.00
502 3100	CLASS A CONCRETE, MODIFIED (MAJOR)	CU. YD.	91.00
505 0100	REINFORCING STEEL	POUND	16,621.00

NOTE

SEE SHEET 20.1.1(502) OF THE STANDARD PLANS FOR ROAD AND BRIDGE CONSTRUCTION, FEBRUARY 1993 FOR NOTES AND DETAILS NOT SHOWN.

STRUCTURAL DESIGN DIVISION	
CHIEF BRIDGE ENGR.	
PRINCIPAL BRIDGE ENGR.	McINNIS
PHONE 5542	

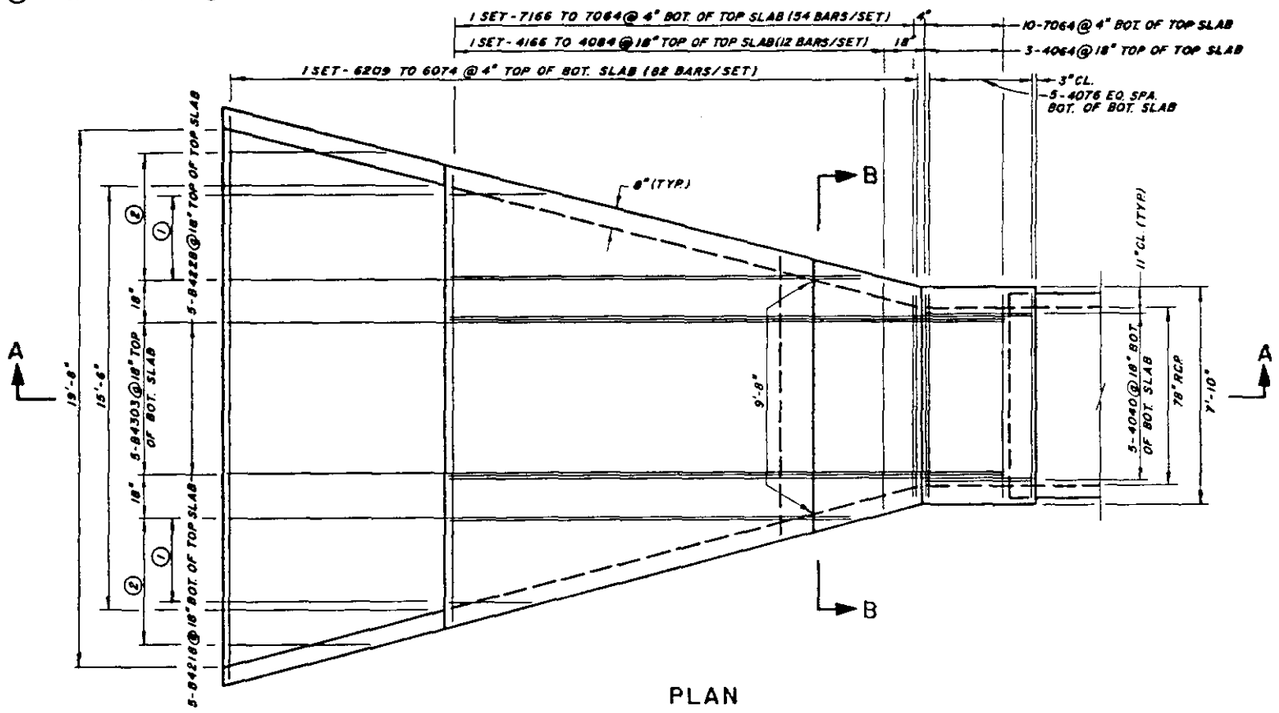
STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

SPECIAL DETAILS

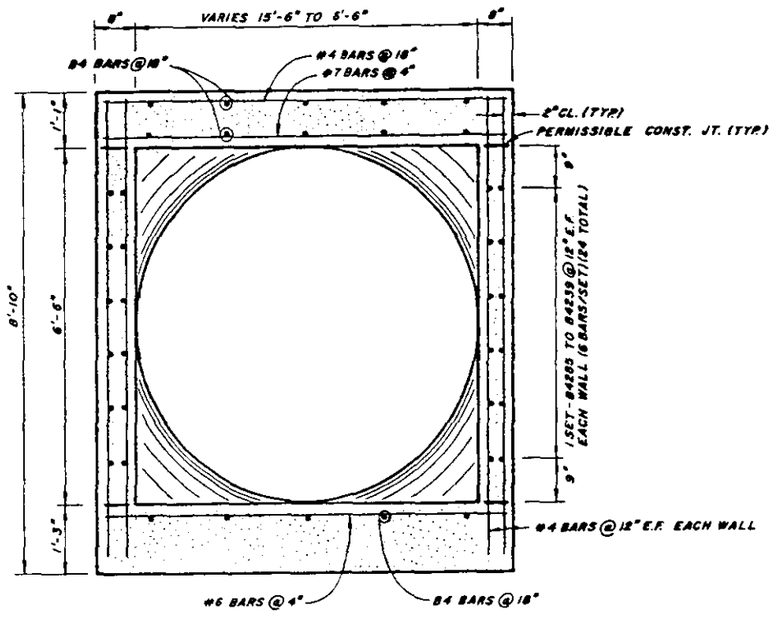
(SLOPE TAPERED INLET @ "A8"994+75)

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA		CLARK	27

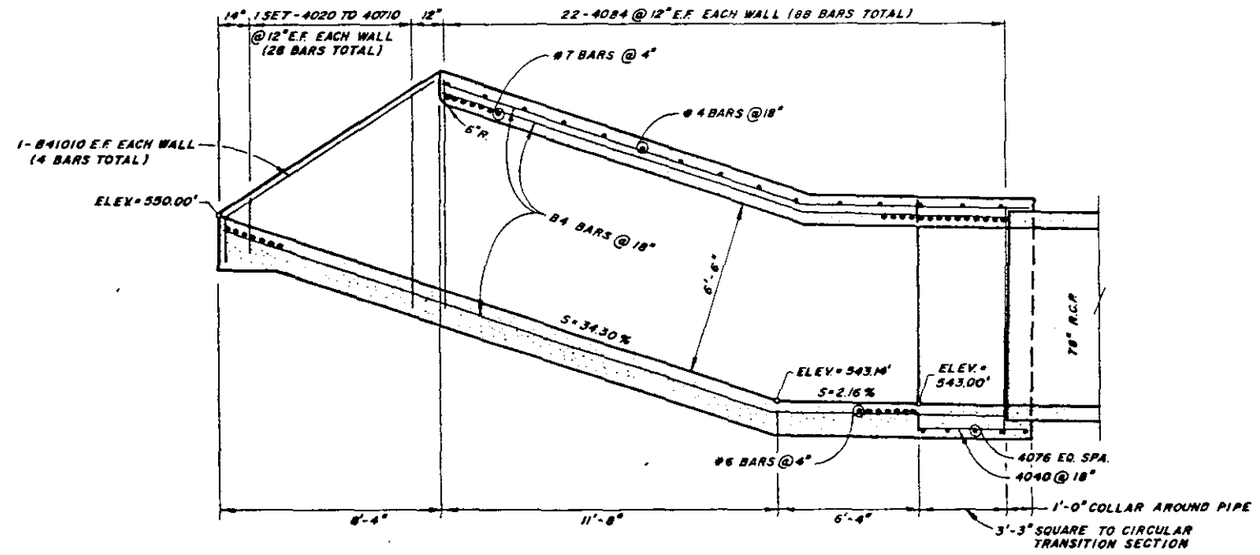
(1) 1 SET - 4149 TO 4039 @ 18" TOP & BOT. OF TOP SLAB
(2) 1 SET - 4236 TO 4046 @ 18" TOP OF BOT. SLAB



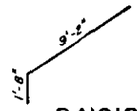
PLAN



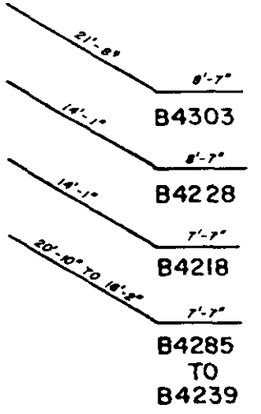
SECTION B-B



SECTION A-A



B41010



QUANTITIES

ITEM NUMBER	DESCRIPTION	UNIT	QUANTITY
206 0100	STRUCTURE EXCAVATION	CU. YD.	94.00
207 0200	GRANULAR BACKFILL	CU. YD.	17.00
502 3100	CLASS A CONCRETE, MODIFIED (MAJOR)	CU. YD.	47.00
505 0100	REINFORCING STEEL	POUND	4,501.00

NOTE

SEE SHEET 28.1.1(502) OF THE STANDARD PLANS FOR ROAD AND BRIDGE CONSTRUCTION, FEBRUARY 1993 FOR NOTES AND DETAILS NOT SHOWN.

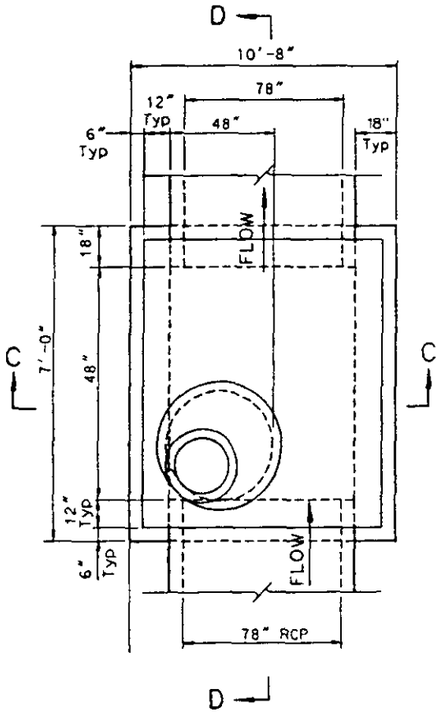
STRUCTURAL DESIGN DIVISION	
DESIGN ENGINEER, CIVIL	
PRINCIPAL ENGINEER, CIVIL	McINNIS
PHONE 5542	

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

SPECIAL DETAILS

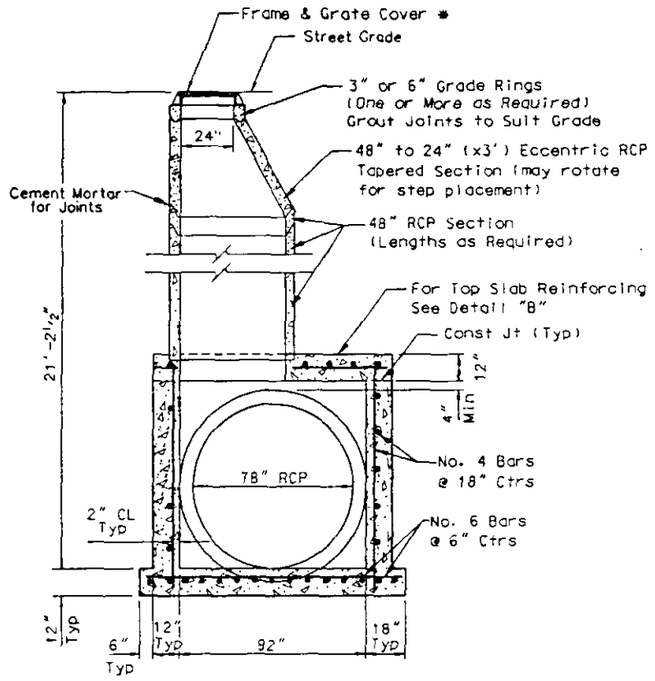
SLOPE TAPERED INLET @ "C" 999+29

FED. REG. NO.	RD. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9		NEVADA	STP-PLM-1631(6)	CLARK	28

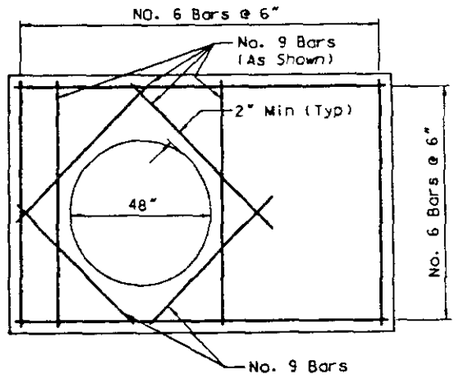


PLAN

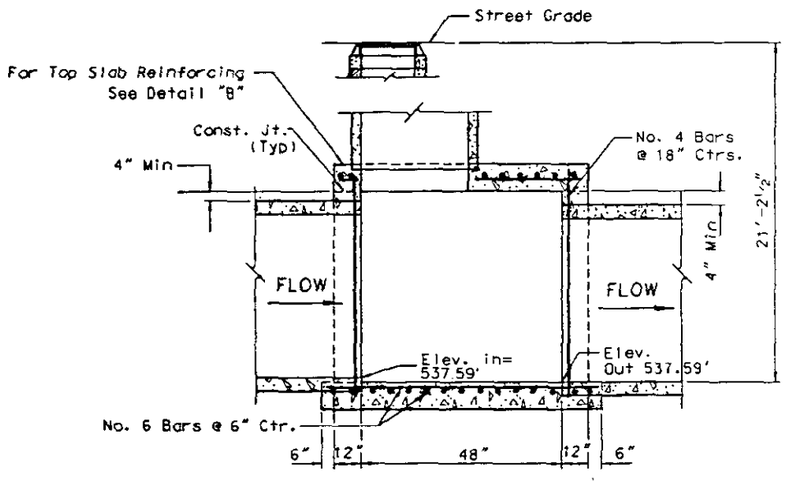
* NEENAH TYPE A OR EQUAL



SECTION C-C



DETAIL "B"
(TOP SLAB REINFORCING)



SECTION B-B

GENERAL NOTES:

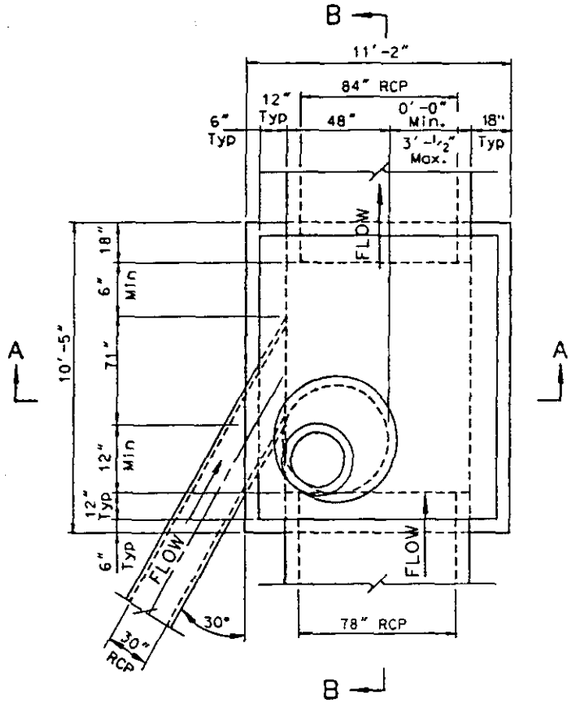
1) ALL CONCRETE SHALL BE CLASS A.
2) MANHOLE STEPS SHALL CONFORM TO ASTM STANDARD SPECIFICATION C-478 WITH MAXIMUM SPACING OF 16" AND 4" CLEAR DISTANCE FROM THE MANHOLE WALL. THE STEP MUST BE A 10" MINIMUM WIDTH.
3) MANHOLE COVER SHALL BEAR ENTITY IDENTIFICATION AND SYSTEM FUNCTION (IF APPLICABLE).

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

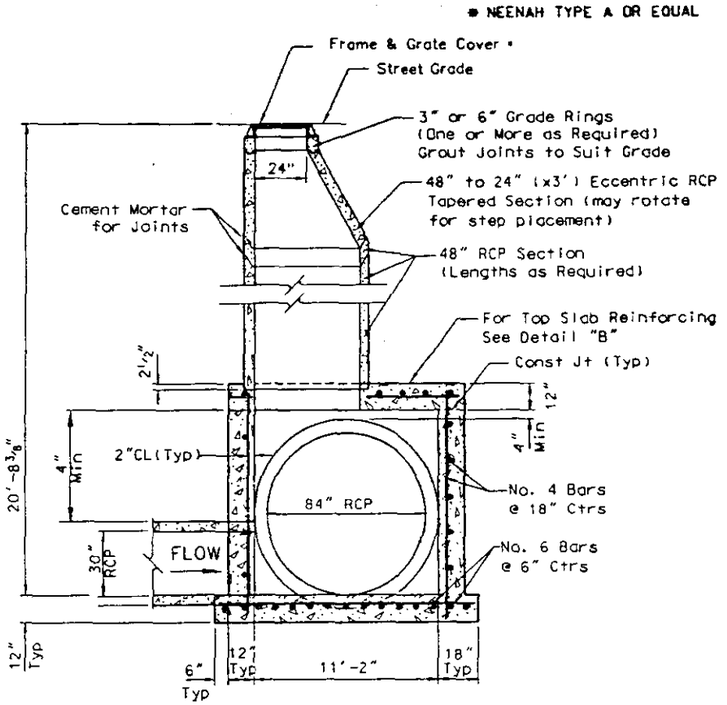
MODIFIED TYPE 4 MANHOLE

STA. "C" 1002+00.00

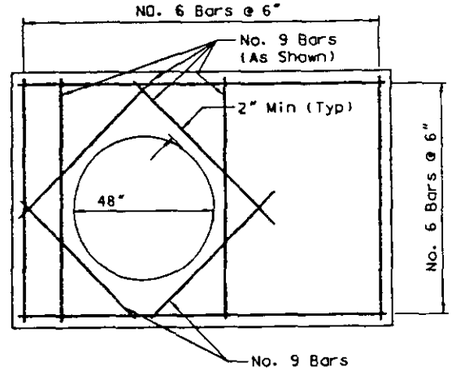
FED. REC. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA		CLARK	29



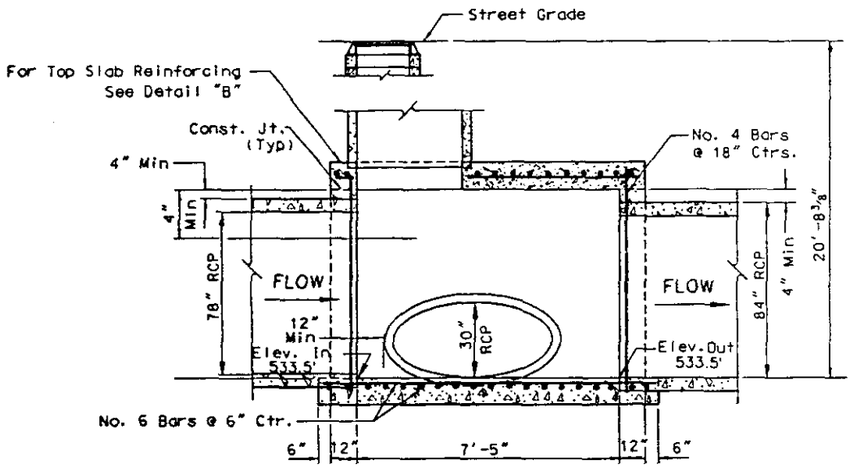
PLAN



SECTION A-A



DETAIL "B"
(TOP SLAB REINFORCING)



SECTION B-B

GENERAL NOTES:

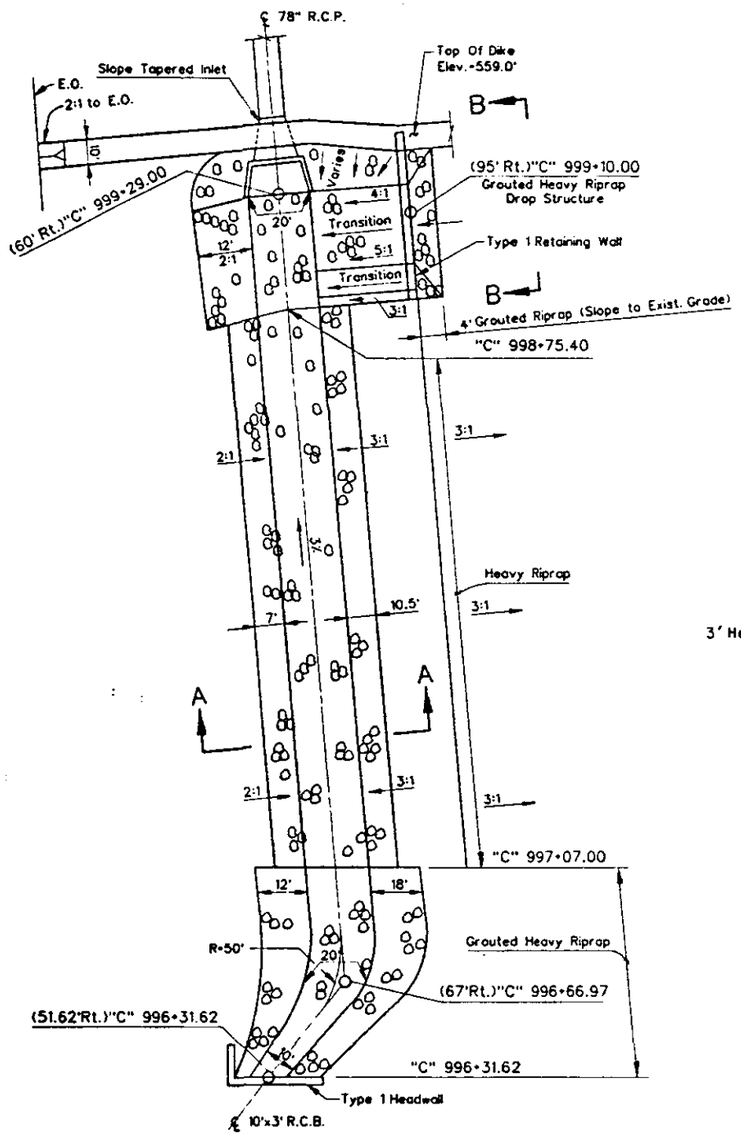
1) ALL CONCRETE SHALL BE CLASS A.
2) MANHOLE STEPS SHALL CONFORM TO ASTM STANDARD SPECIFICATION C-478 WITH MAXIMUM SPACING OF 16" AND 4" CLEAR DISTANCE FROM THE MANHOLE WALL. THE STEP MUST BE A 10" MINIMUM WIDTH.
3) MANHOLE COVER SHALL BEAR ENTITY IDENTIFICATION AND SYSTEM FUNCTION (IF APPLICABLE).

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

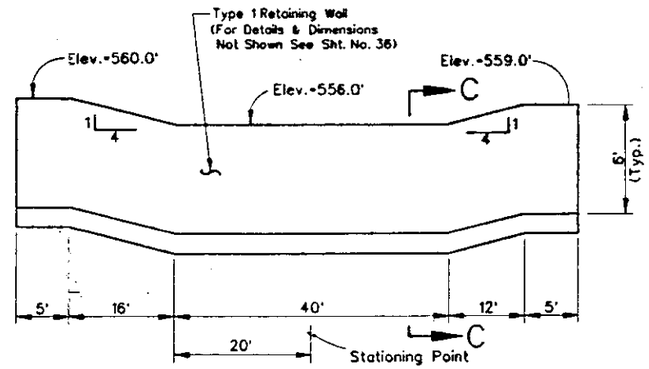
MODIFIED TYPE 4 MANHOLE

STA. "C" 1003+78.20

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	30

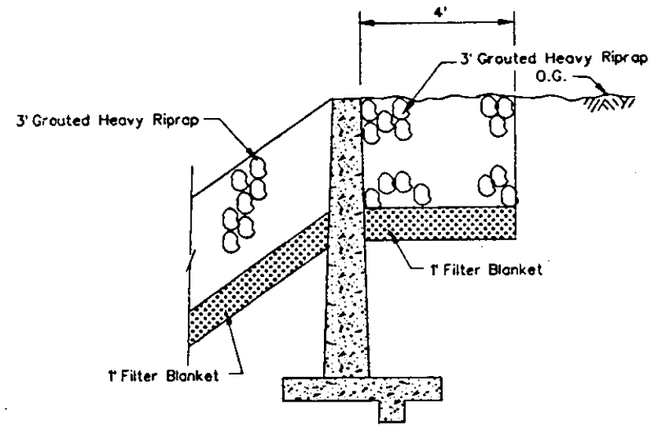


SPECIAL HEAVY RIPRAP
LINED CHANNEL

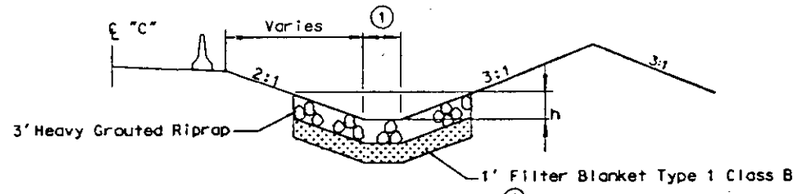


VIEW B-B

NOTE: Riprap Not Shown
For Clarity



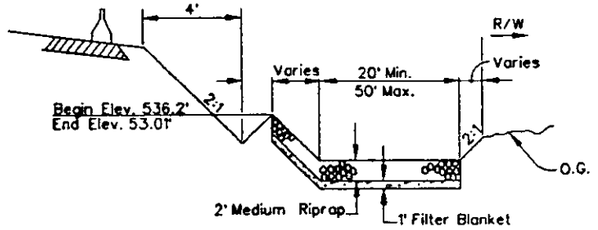
SECTION C-C



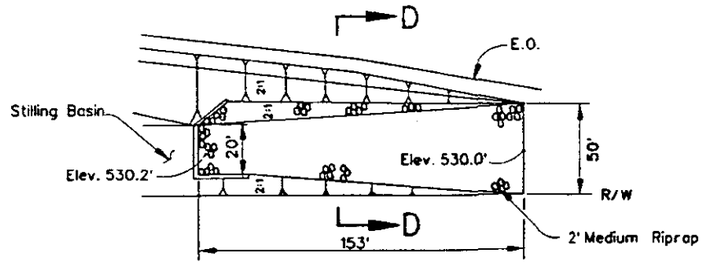
"C"996+31.62	to	"C"996+66.97	10' To 20'	h= 6'-0"
"C"996+66.97	to	"C"997+07.00	20'	h= 6'-0"
* "C"997+07.00	to	"C"998+75.40	20'	h= 3'-6"
"C"998+75.40	to	"C"999+29.00	20'	h= 6'-0"

● Heavy Riprap Only

SECTION A-A



SECTION D-D

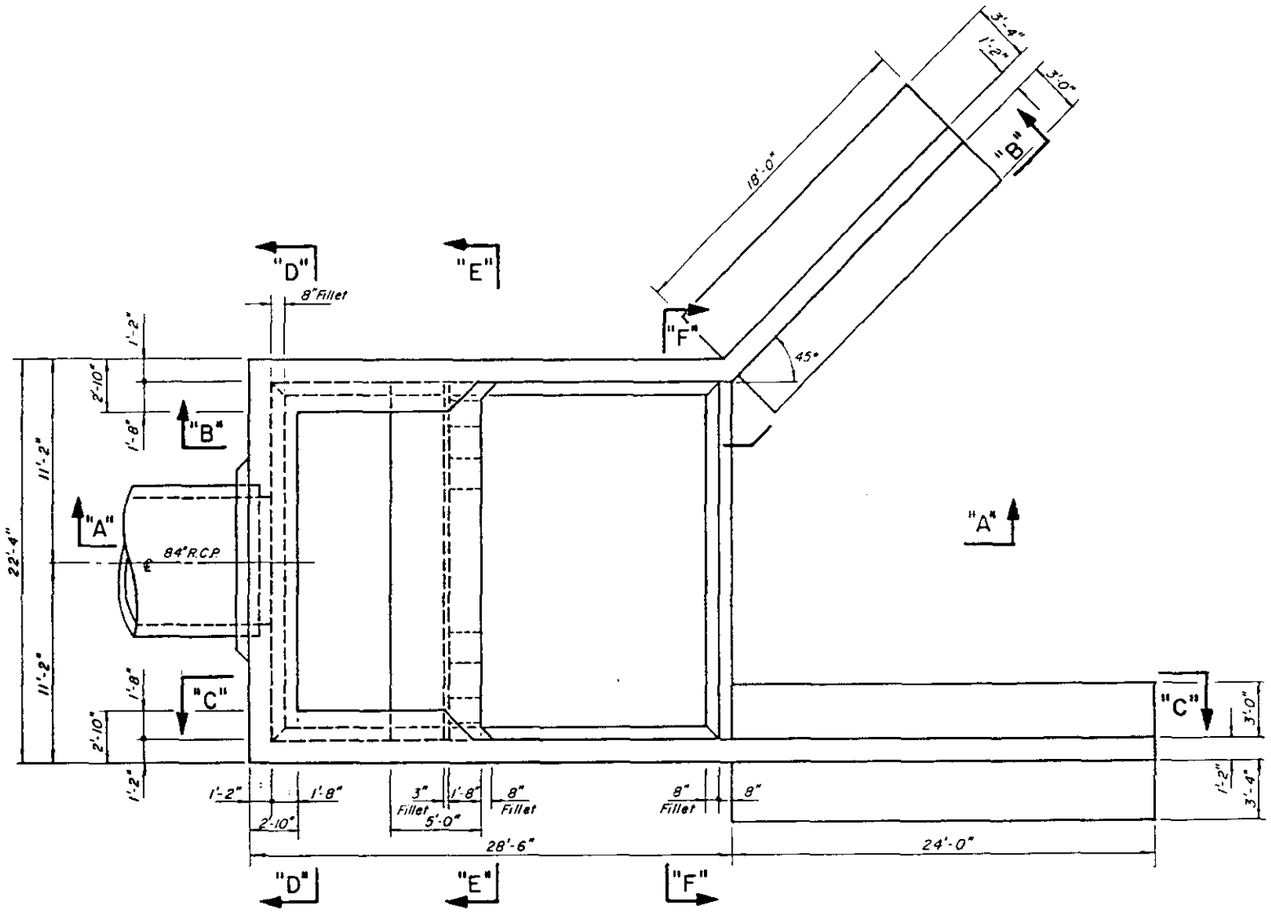


MEDIUM RIPRAP CHANNEL
"C"1006+82.50 TO "C"1008+50.00

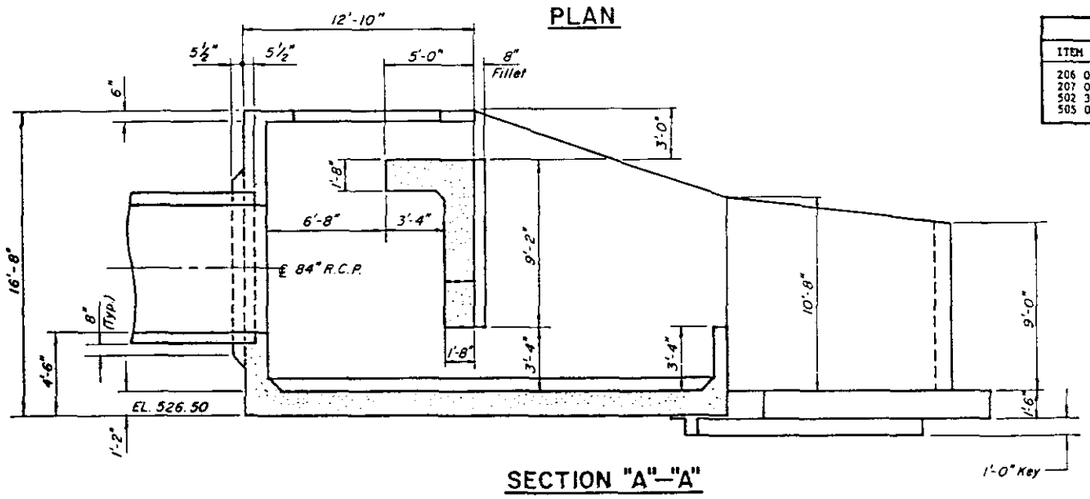
STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

SPECIAL DETAILS

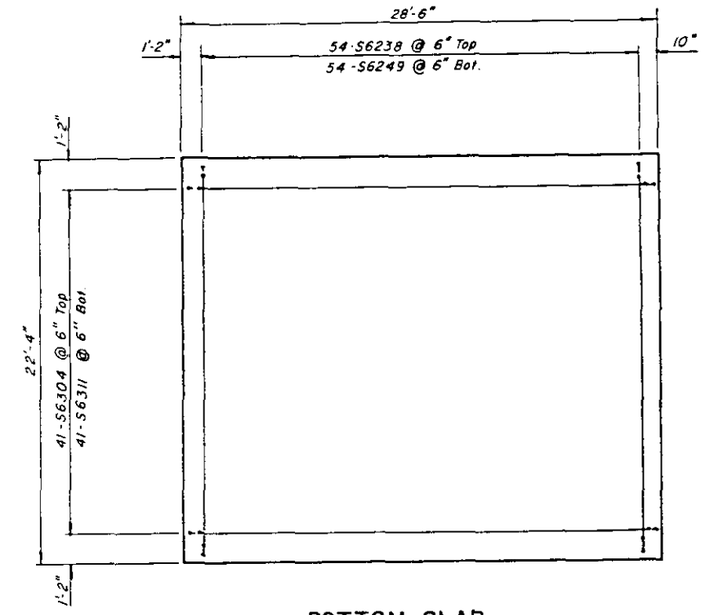
FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	31



PLAN



SECTION "A"—"A"



BOTTOM SLAB

QUANTITIES

ITEM NO.	DESCRIPTION	UNIT	QUANTITY
206 0100	STRUCTURE EXCAVATION	CU. YD.	790
207 0200	GRANULAR BACKFILL	CU. YD.	143
502 3100	CLASS A CONCRETE, MOD. (MAJOR)	CU.YD.	126
505 0100	REINFORCING STEEL	POUND	23,533

- GENERAL NOTES -

1) DESIGN SPECIFICATIONS: AASHTO "STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, FIFTEENTH EDITION-1992". WORKING STRESS DESIGN METHOD USED.

2) CONSTRUCTION SPECIFICATIONS: STATE OF NEVADA DEPARTMENT OF TRANSPORTATION "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, NOVEMBER 1986" EXCEPT AS NOTED BELOW AND IN THE SPECIAL PROVISIONS FOR THIS CONTRACT.

3) CONCRETE: CONCRETE SHALL BE CLASS A, MODIFIED (MAJOR) WITH AN ULTIMATE COMPRESSIVE STRENGTH OF F'c = 4000 PSI AT 28 DAYS.

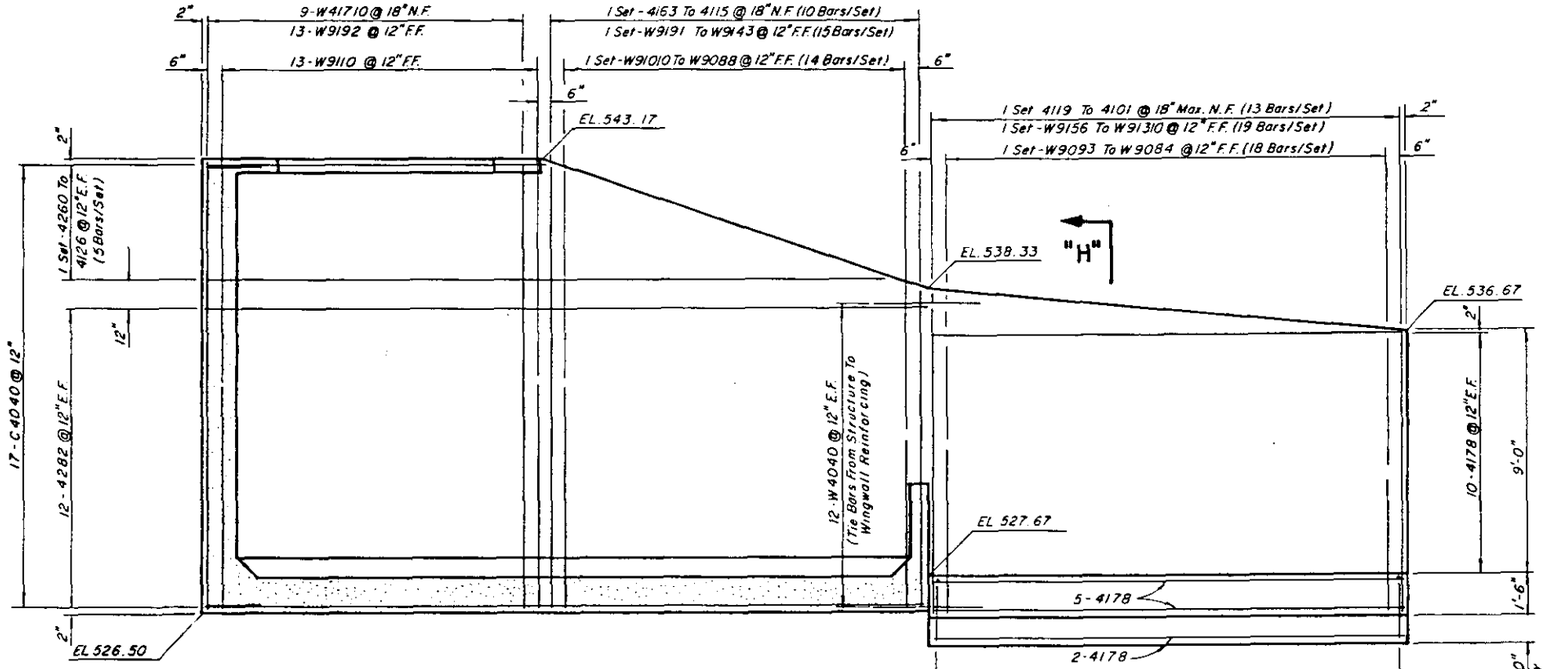
4) REINFORCING STEEL: ALL REINFORCING STEEL TO BE AASHTO M31 GRADE 60. DIMENSIONS RELATING TO BAR SPACING ARE CENTER TO CENTER. BENDING DIMENSIONS ARE FROM OUT TO OUT OF THE BARS. BAR SIZES THREE (3) TO NINE (9) ARE INDICATED BY THE FIRST NUMBER OF THE MARK, TEN (10) OR LARGER BY THE FIRST TWO NUMBERS. THE LENGTH OF BAR SIZES FOUR (4) AND FIVE (5), WHEN CONSIDERED AS BARS TO CONTROL TEMPERATURE, SHRINKAGE, AND DISTRIBUTION STRESSES BY THE BRIDGE ENGINEER, MAY BE ADJUSTED BY THE CONTRACTOR UPON CONCURRENCE AND APPROVAL OF THE BRIDGE ENGINEER.

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

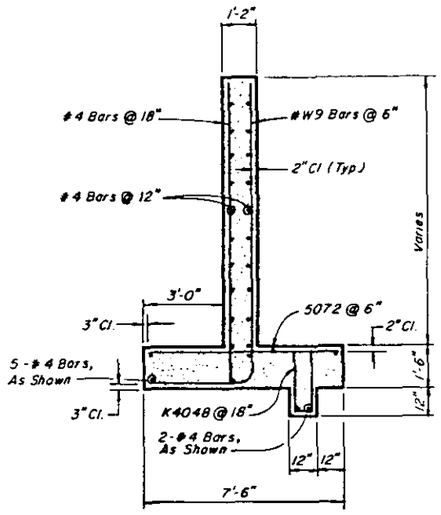
LAUGHLIN STILLING BASIN DETAILS

STRUCTURAL DESIGN DIVISION	
SENIOR BRIDGE ENGR.	CALL
PRINCIPAL BRIDGE ENGR.	McINNIS
PHONE 687-5542	

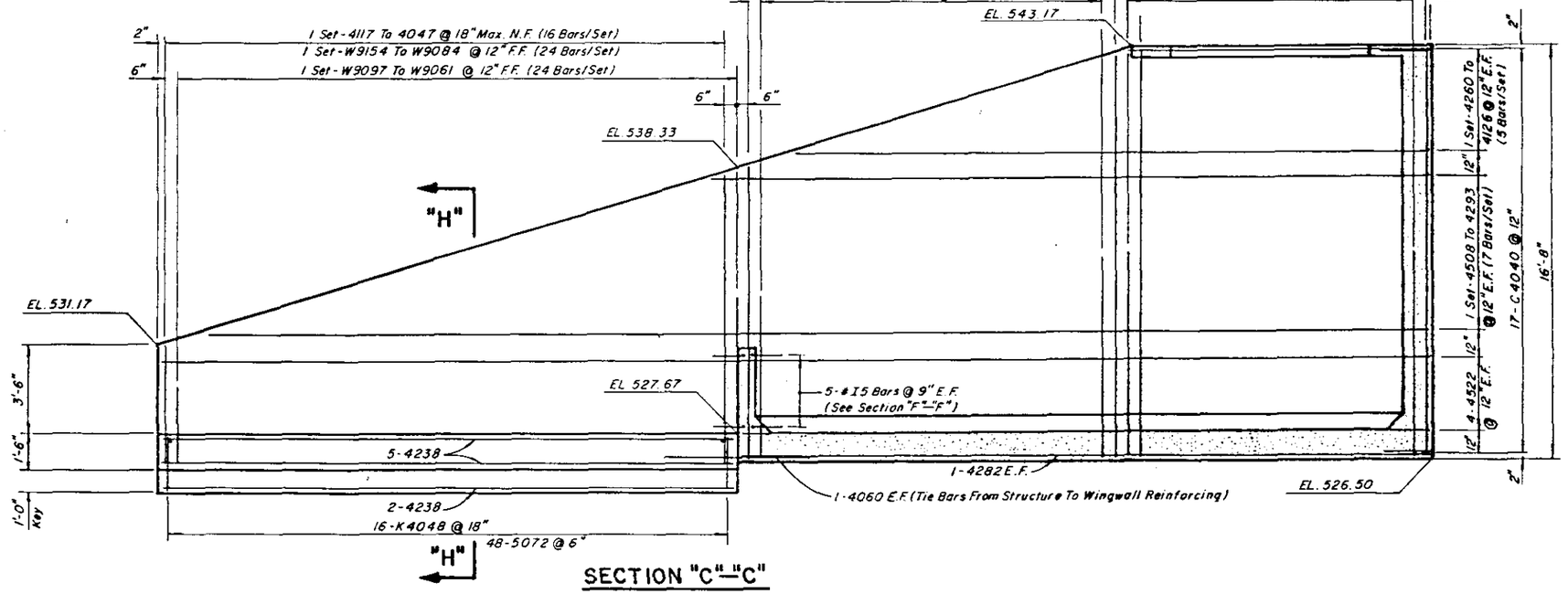
FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	32



SECTION "B"–"B"



SECTION "H"–"H"

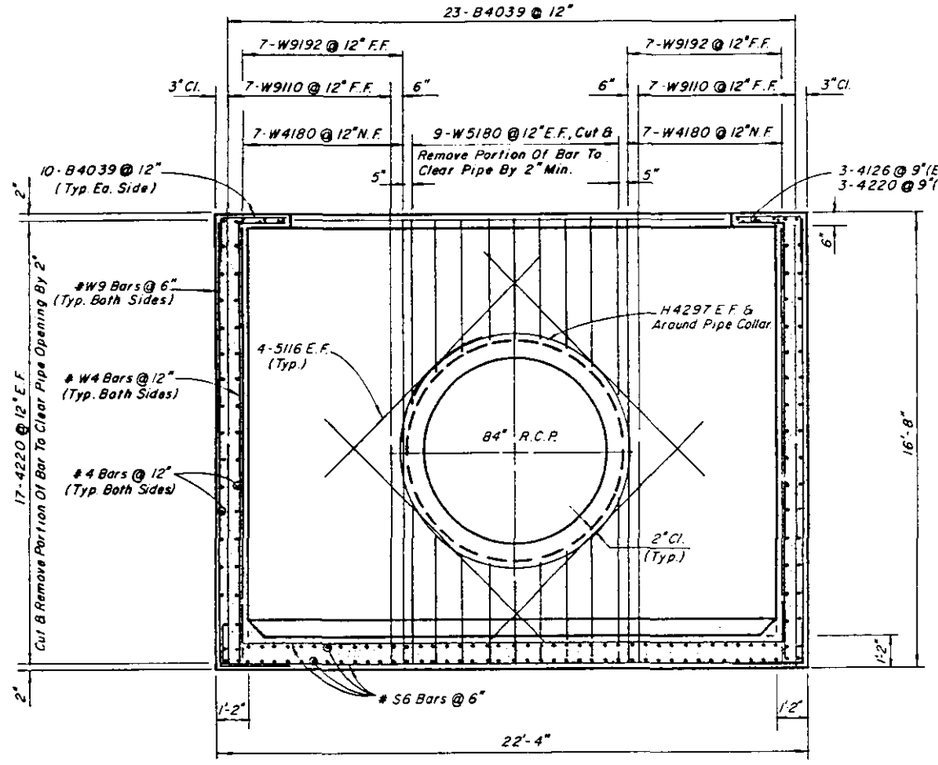


SECTION "C"–"C"

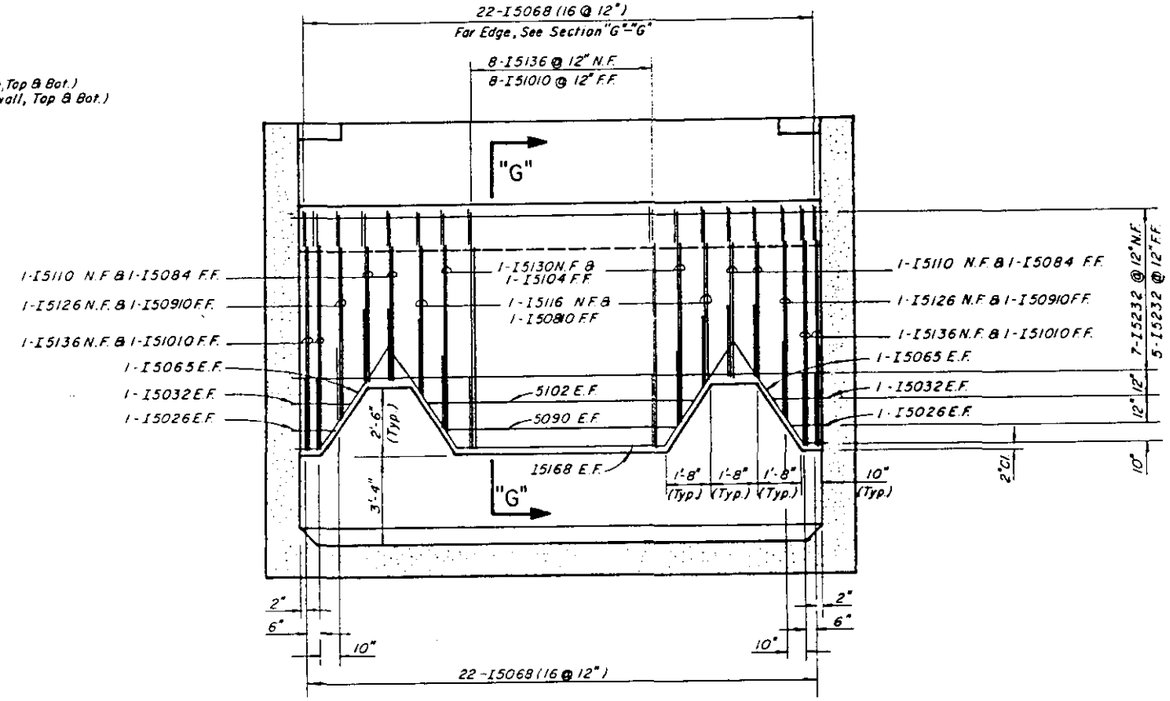
STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

LAUGHLIN STILLING BASIN SECTIONS

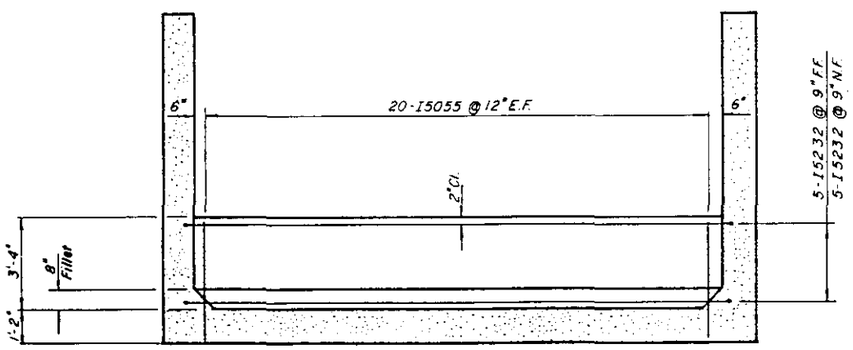
FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-183(6)	CLARK	33



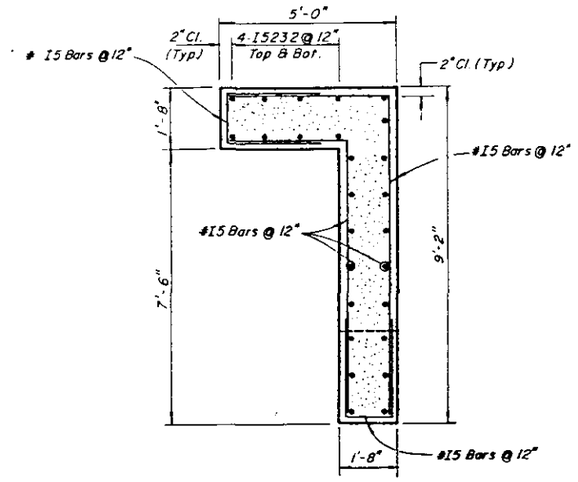
SECTION "D"—"D"



SECTION "E"—"E"



SECTION "F"—"F"

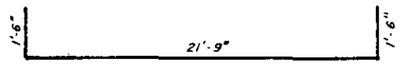


SECTION "G"—"G"

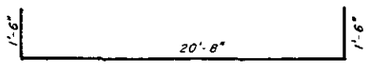
STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

LAUGHLIN STILLING BASIN SECTIONS

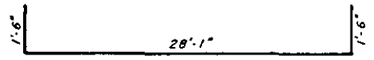
FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-1631(6)	CLARK	34



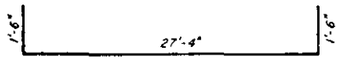
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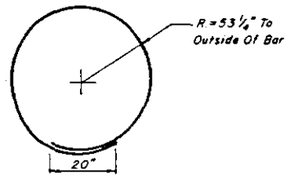
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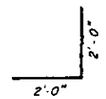
S6311



S6304



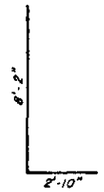
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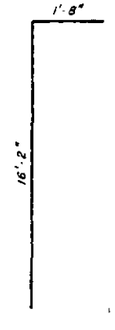
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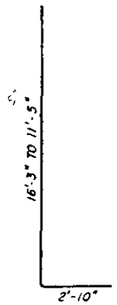
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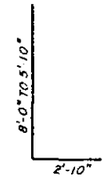
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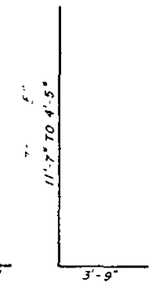
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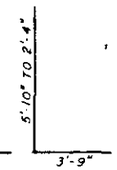
W9191 TO W9143



W91010 TO W9088



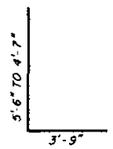
W9154 TO W9084



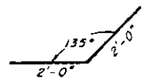
W9097 TO W9061



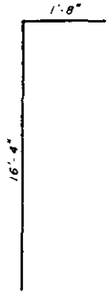
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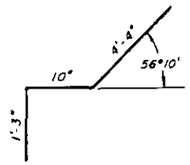
W9093 TO W9084



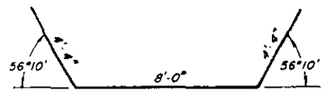
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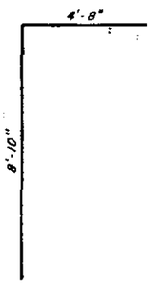
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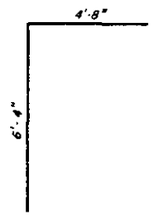
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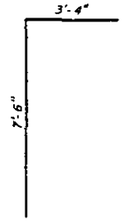
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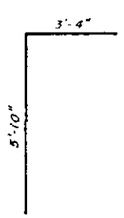
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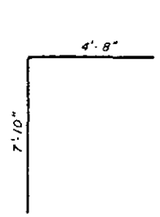
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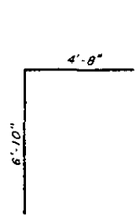
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I5084



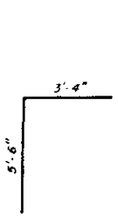
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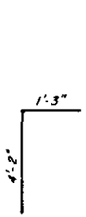
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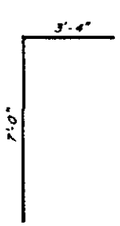
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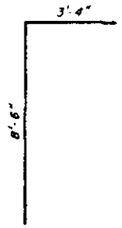
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I5055



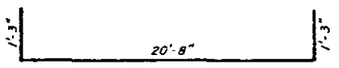
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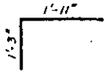
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I5068



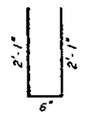
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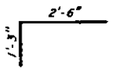
I5032



I5026



K4048



B4039

MARK	SIZE	LENGTH	NO.	WEIGHT
[illegible]				

SUB-TOTAL

REINFORCING STEEL	22,812.90 LBS.
CONCRETE CLASS A	126.00 C.Y.

BRIDGE TOTAL

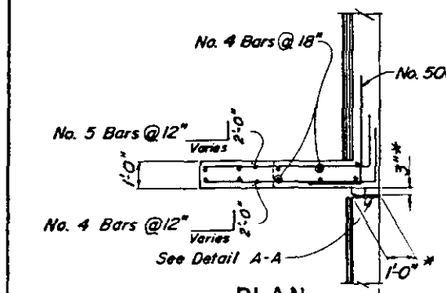
REINFORCING STEEL	22,812.90 LBS.
CONCRETE CLASS A	126.00 C.Y.

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

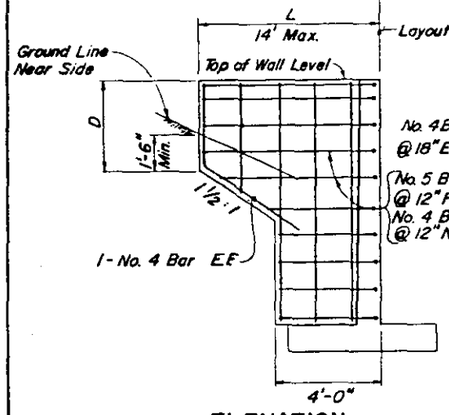
LAUGHLIN STILLING BASIN
BAR BENDING

FED. RD REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	35

* OMIT WHEN DETAIL A-A IS NOT REQUIRED



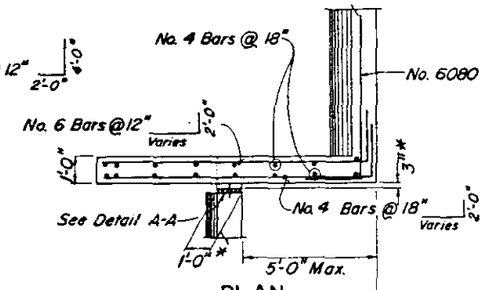
PLAN



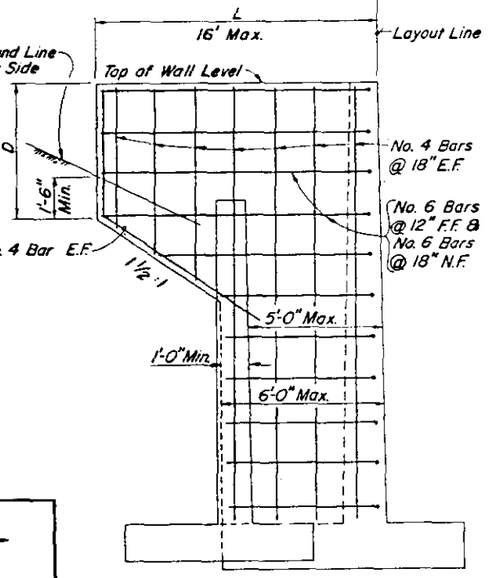
ELEVATION

RETURN WALL TYPE "A"

Use Where H=8' or Less



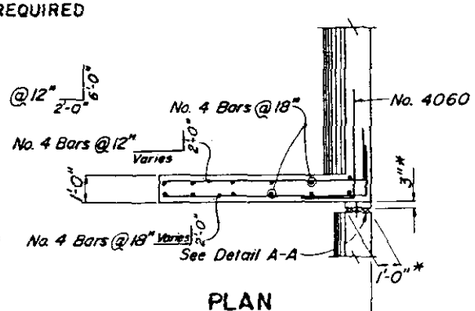
PLAN



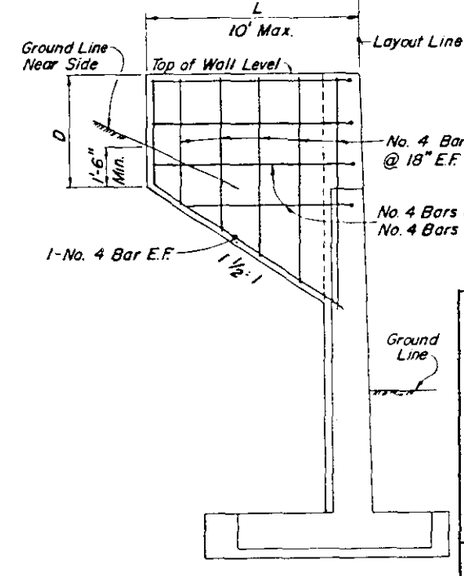
ELEVATION

RETURN WALL TYPE "B"

Use Where H=10' or More On Offset Wall



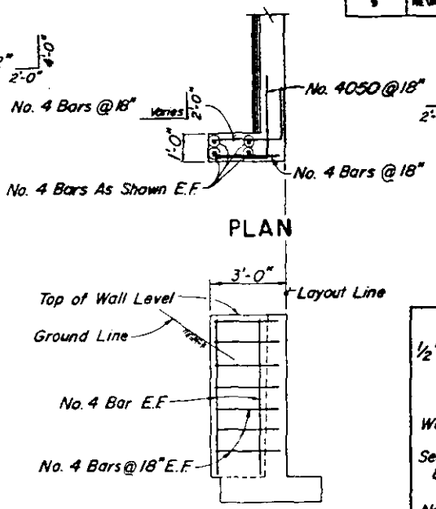
PLAN



ELEVATION

RETURN WALL TYPE "C"

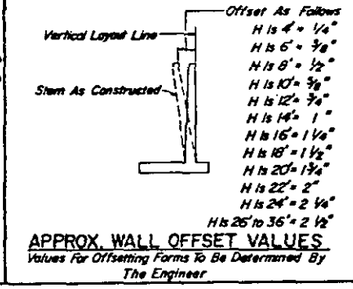
Use Where H=10' or More On Straight Wall



ELEVATION

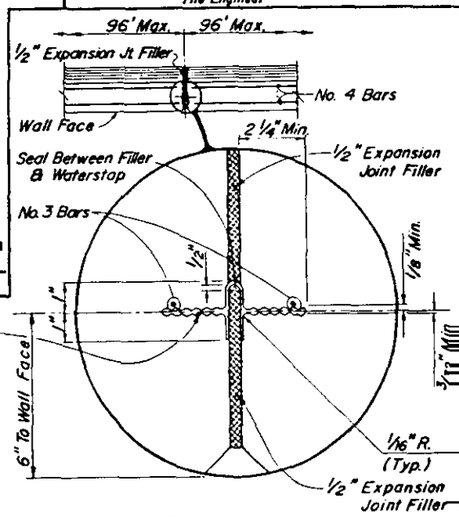
RETURN WALL TYPE "D"

Use Where H=6' or Less



APPROX. WALL OFFSET VALUES

Values For Offsetting Forms To Be Determined By The Engineer



DETAIL A-A

Waterstop To Have 5 or More Pairs Of Raised Ribs To Provide 01 Square Inch Min. Rib Cross-Section Area On Each Half Of The Waterstop. Height Of Ribs To Be 3/32" Min.

Note:
Holes Will Be Permitted In The Outer ½" Of The Web For Wires, Rings, Etc. Tie Web To No. 3 Reinforcing Bars @ 12" Maximum Intervals To Support The Waterstop In Proper Position During Concrete Placement. Alternative Detail May Be Submitted For Approval Of The Engineer.

CONTRACTION JOINT

NOTES:

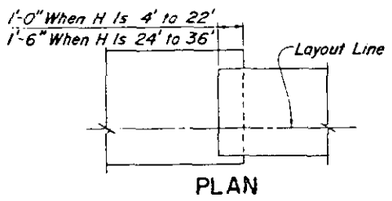
Design Conditions:

Design H May Be Exceeded By 6" Before Going To The Next Size. Special Footing Design Is Required Where Foundation Material Is Incapable Of Supporting Toe Pressure Loads Listed In Table.
Return Wall Not Required Unless Shown Elsewhere.

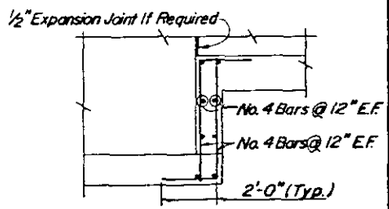
Design Data:

fc = 1300 psi fc' = 3250 psi fs = 24,000 psi n = 10 earth = 120 pcf
2' Surcharge:
Equivalent Fluid Pressure = { 36 pcf. Max. For Determination Of Toe Pressure. 27 pcf. Min. For Determination Of Heel Pressure.

Earth Pressures For 2:1 Unlimited Slope, 1½:1 Slope, And 1½:1 Unlimited Slope, Determined From Rankine's Formula With Ø = 33°-42'.

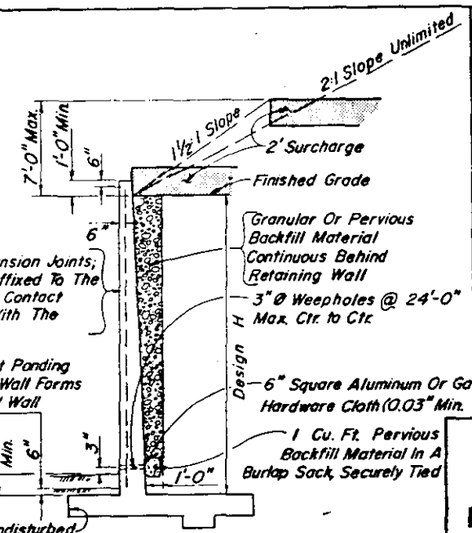


PLAN



ELEVATION

FOOTING STEP



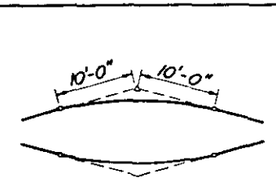
Waterstop Required At All Expansion Joints; However, A Geotextile Fabric Affixed To The Backfill Side Of The Wall With Contact Adhesive May Be Substituted With The Approval Of The Engineer.

Backfill Sufficiently To Prevent Ponding To Be Done After Removal Of Wall Forms And Before Backfilling Behind Wall

Place Concrete In Toe Against Undisturbed Material, Except As Permitted By The Engineer

DESIGN AND DRAINAGE

SURCHARGE LIMITS SHOWN Apply To Retaining Wall TYPE 1



20' VC AT TOP OF WALL SLOPE CHANGE

WHERE SHOWN ON THE PLANS

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

RETAINING WALL DETAILS TYPES 1, 2 & 3 SPECIAL DETAILS

FED. RD REG NO	STATE	PROJECT NO.	COUNTY	SHEET NO
9	NEVADA	STP-PLH-163(5)	CLARK	36

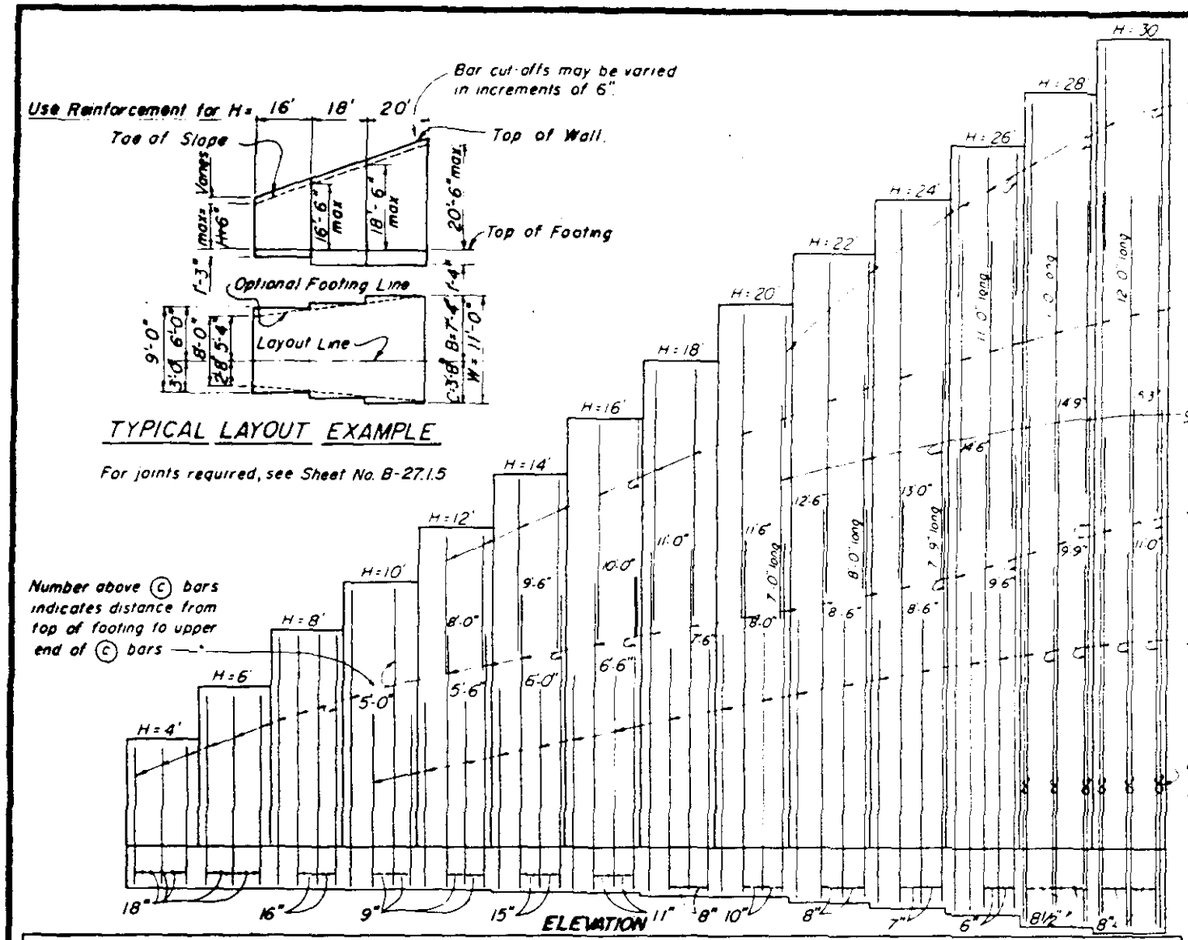
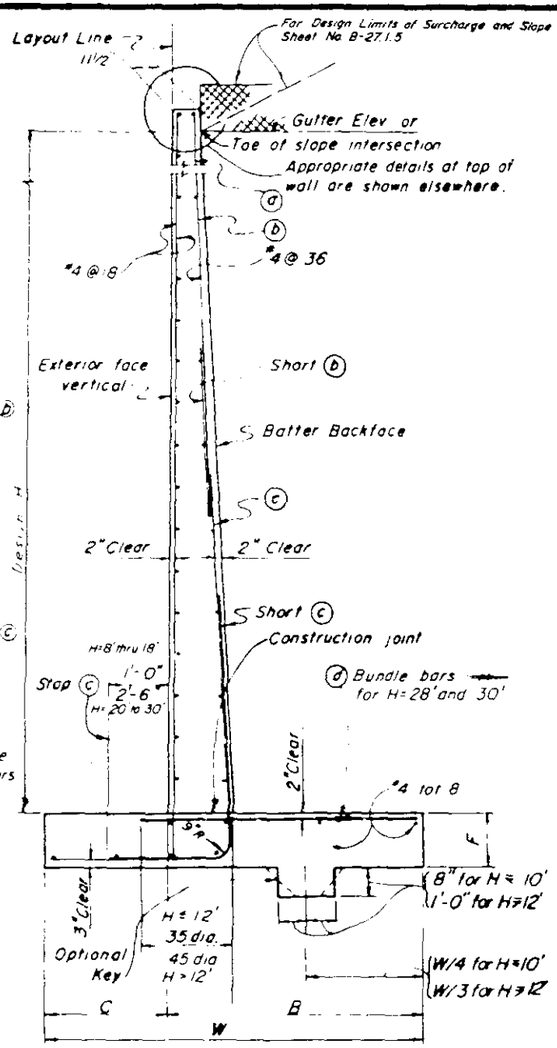


TABLE OF REINFORCING STEEL DIMENSIONS AND DATA

Design H		4'	6'	8'	10'	12'	14'	16'	18'	20'	22'	24'	26'	28'	30'
W		3'-2"	4'-2"	5'-2"	6'-2"	7'-2"	8'-0"	9'-0"	10'-0"	11'-0"	12'-0"	13'-3"	14'-3"	15'-3"	16'-9"
C		1'-0"	1'-4"	1'-8"	2'-0"	2'-4"	2'-8"	3'-0"	3'-4"	3'-8"	4'-0"	4'-5"	4'-9"	5'-1"	5'-5"
B		2'-2"	2'-10"	3'-6"	4'-2"	4'-10"	5'-4"	6'-0"	6'-8"	7'-4"	8'-0"	8'-10"	9'-6"	10'-2"	11'-4"
F Spread Ftg.		1'-2"	1'-2"	1'-2"	1'-2"	1'-2"	1'-3"	1'-3"	1'-4"	1'-4"	1'-6"	1'-8"	1'-11"	2'-2"	2'-4"
Batter		1/2:12	1/2:12	1/2:12	1/2:12	1/2:12	1/2:12	1/2:12	1/2:12	1/2:12	1/2:12	5/8:12	3/4:12	3/4:12	7/8:12
(a)	bars									#5@20	#5@32	#5@28	#5@12	#6@17	#6@16
(b)	bars					#4@18	#6@30	#6@22	#6@16	#8@20	#8@15	#8@14	#8@12	#8@8½	#8@8
(c)	bars	#5@18	#5@18	#5@16	#5@9	#6@9	#9@15	#9@11	#9@8	#10@10	#11@8	#11@7	#11@6	#10@8½	#10@8½
(d)	bars	#5@18	#5@18	#4@16	#4@9	#5@9	#8@15	#8@11	#9@8	#10@10	#10@8	#10@7	#10@6	#9@8½	#9@8½
Total (c)	bars	6-#6	6-#6	6-#6	10-#7	10-#7	10-#7	10-#7	6-#7	6-#7	6-#7	4-#7	4-#7	4-#7	4-#7
Total (f)	bars				4-#7	4-#7	4-#7	4-#7	4-#7	4-#7	4-#7	2-#7	2-#7	2-#7	2-#7
2' Level surcharge	Tons Ft k/st	1.6	1.9	2.2	2.5	2.8	3.3	3.5	4.0	4.3	4.6	4.9	5.3	5.7	6.2
2:1 unlimited slope	Tons Ft k/st	1.1	1.5	2.0	2.3	2.7	3.3	3.6	4.2	4.7	5.5	5.9	6.5	7.1	7.5
1½:1 limited slope	Tons Ft k/st	1.3	1.7	2.1	2.5	2.9	3.4	3.8	4.3	4.8	5.4	5.8	6.5	7.2	7.5
Spread Footing	Steel lbs/ft	18	22	28	37	51	80	105	153	192	248	307	409	449	507
	Conc cf/ft.	8.9	12.5	16.3	20.2	25.4	30.1	34.6	40.1	45.0	52.1	63.3	77.0	88.1	104.8



SPREAD FOOTING SECTION

NOTES

For details not shown and drainage notes see sheet No 35

Quantities do not include the wall portion above "Gutter Elevation" and are for design purposes only

For pile footing Design H=4' use same footing dimensions as Design H=6

QUANTITIES

ITEM NUMBER	DESCRIPTION	UNIT	QUANTITY
206 0100	STRUCTURE EXCAVATION	CU. YD.	165.00
207 0200	GRANULAR BACKFILL	CU. YD.	70.00
502 3100	CLASS A CONCRETE, MODIFIED (MAJOR)	CU. YD.	37.00
505 0100	REINFORCING STEEL	POUND	1,735.00

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

RETAINING WALL TYPE I H=4' to 30' SPECIAL DEAILS

Fed. Rd. Proj. No.	State	Project No.	E.A. No.	County	Sheet No.
9	Nevada			CLARK	R1

PARCEL NO. PREFIX: S-163-CL-

LAKE MEAD NATIONAL RECREATION AREA

BEGIN ACQUISITION
"B1" 891+49.66 P.C.=
"B" 891+49.66 P.O.T.

1/4 SECTION LINE

T.32S., R.66E., M.D.M.

"B"
Δ=35°35'00"
R=6000'
L=3726.28'

1/16 SECTION LINE

"B" 891+49.66 PC

1/16 SECTION LINE

R/W

TO DAVIS DAM

"B" EXISTING ℄ SR-163

"B" PROPOSED ℄

S.75°32'27"E.

PREVIOUSLY ACQUIRED
CC 022416

TO US-93

TO BULLHEAD CITY, AZ.

Δ=23°02'06"
R=6200'
L=2492.63'
T.B. S.75°32'27"E.

NATIONAL PARK SERVICE
016.741

N.75°32'27"W. - 2361.88'

1/16 SECTION LINE

1/4 SECTION LINE

1/16 SECTION LINE

COUNTY OF CLARK

Revision Dates _____ _____
_____ _____ _____

STATE OF NEVADA
Dept. of Transportation R/W: Division

Date: OCTOBER, 1991

R/W Plans

Approved _____
Supervisor, R/W Engineering

PARCEL NO. PREFIX: S-163-CL-

Fed. Rd. Reg. No.	State	Project No.	E.A. No.	County	Sheet No.
9	Nevada			CLARK	R2.

"B" Δ=35°35'00" R=6000' L=3726.28'

"B" EXISTING ℄ SR-163 "B" 0+00.00 P.O.C. "B" 43+29.20 P.C.C. "B" 49+72.12 P.C.C.

PREVIOUSLY ACQUIRED CC-022-4.18

"B" Δ=64°16'40" R=600' L=673.12'

TIE: S 41°02'49" E - 1159.26'

"B" Δ=11°45'58" R=500' L=102.66' T.B.=S 43°11'23" W

295.06' LT. "B" 915+69.91 P.O.C.

200.00' LT. "B" 915+34.07 P.O.C.

54.00' LT. "B" 914+14.12 P.O.C.

"0" 0+00.00 P.C.

"B" Δ=2°02'06" R=5400' L=192.62' T.B.=S 75°59'27" E

S 75°32'27" E

TO U.S. 93

N 75°32'27" W - 2361.88'

R/W

1/16 SECTION LINE

"B" PROPOSED ℄

NATIONAL PARK SERVICE
016.741

LAKE MEAD NATIONAL RECREATION AREA

"B" 915+11.54 P.C.

P/L

COUNTY OF CLARK

TO HOOVER DAM

PREVIOUSLY ACQUIRED NEV 04480

R/W

EXISTING COUNTY ROAD

T 32 S., R 66 E., M.D.M.

Δ=15°20'14" R=2700' L=722.75' T.B.=S 32°56'18" E.

Δ=42°05'10" R=2700' L=1983.26' T.B.=S 75°01'28" E.

Δ=36°00'41" R=2300' L=1445.59' T.B.=N 39°34'46" W

"B" Δ=5°27'55.23" R=2500' L=238.10'

P.O.B.=200.00' LT. "B" 933+70.42 P.O.C.

S 89°30'44" W - 1492.07'

BUREAU OF RECLAMATION
017.516

TO BULLHEAD CITY, AZ.

Δ=21°55'42" R=2300' L=880.26' T.B.=N 17°36'04" W.

STATE OF NEVADA
Dept. of Transportation R/W Division

Date: OCTOBER, 1991

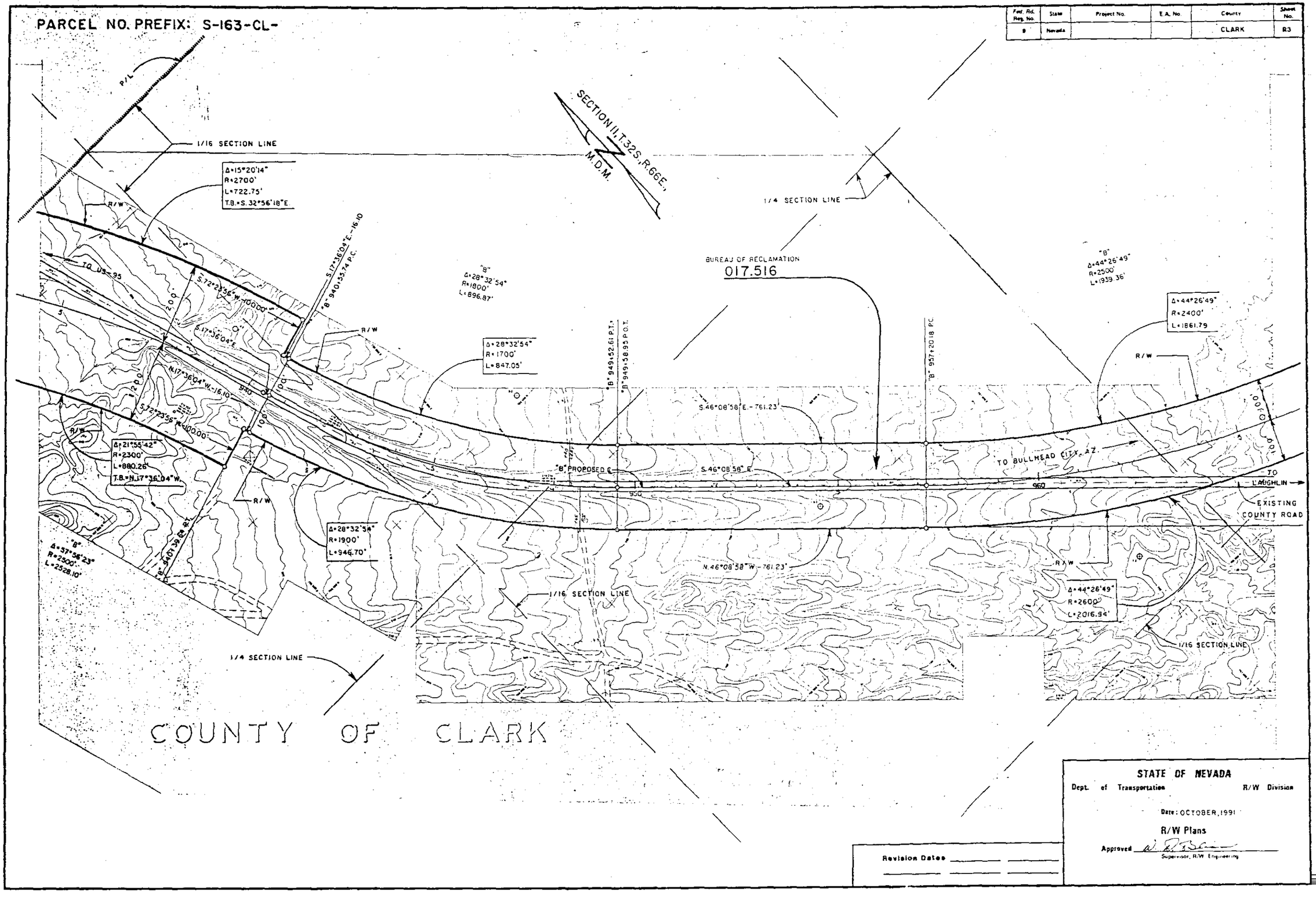
R/W Plans

Approved _____
Supervisor, R/W Engineering

Revision Dates _____

Fed. Rd. Reg. No.	State	Project No.	E.A. No.	County	Sheet No.
9	Nevada			CLARK	R3

PARCEL NO. PREFIX: S-163-CL-



STATE OF NEVADA
Dept. of Transportation R/W Division

Date: OCTOBER, 1991

R/W Plans

Approved _____
Supervisor, R/W Engineering

Revision Dates _____

PARCEL NO. PREFIX: S-163-CL-

Fed. Rd. Reg. No.	State	Project No.	E.A. No.	County	Sheet No.
9	Nevada			CLARK	R4

T.32S., R.66E., M.D.M.

LOT 13

LOT 14

1/4 SECTION LINE

"B" Δ=44°26'49" R=2500' L=1939.36'

BUREAU OF RECLAMATION 017.516

Δ=44°26'49" R=2400' L=1861.79'

100'

R/W

TO US-95

970'

1/16 SECTION LINE

"B" 9761+59.54 P.T.

N.89°24'13"E.-1385.05'

CLARK COUNTY 018.616

99.97' LT. "B" 990+44.59 P.O.T.

PERPETUATE LOT CORNER

N.89°24'13"E.-882.87'

N 12

S.2°01'00"E.-200.03'

"B" PROPOSED

N.89°24'13"E.

990'

VARIES

100'

TO BULLHEAD CITY, AZ.

Δ=44°26'49" R=2600' L=2016.94'

EXISTING COUNTY ROAD

S.89°24'13"W.-1390.00'

P.O.B.-100.00' RT. "B" 990+43.54 P.O.T.

S.89°24'13"W.-1569.57'

TIE N.2°01'00"W.-1114.50' FROM THE E. COR. SECTION 11, T.32S., R.66E., M.D.M.

200'

TO LAUGHLIN

COUNTY OF CLARK

STATE OF NEVADA
Dept. of Transportation R/W Division

Date: OCTOBER, 1991

R/W Plans

Approved _____
Supervisor, R/W Engineering

Revision Dates

PARCEL NO. PREFIX: S-163-CL-

Fed. Rd. Reg. No.	State	Project No.	E.A. No.	County	Sheet No.
9	Nevada			CLARK	R5

LAKE MEAD NATIONAL RECREATION AREA

LOT 13

LOT 12

LOT 33

LOT 32

LOT 31

LOT 28

SECTION 12, T.32S., R.66E., M.D.M.

NEVADA — ARIZONA

COLORADO RIVER

510 MSL CONTOUR LINE

P/L

"B" 1018+88.65 P.T.

N.89°24'16"E. - 183.69'

TO DAVIS DAM

N.89°24'16"E. - 478.67'

S.0°08'56"E. - 2000.01'

100.00' LT "B" 1025+51.21 P.O.T.

S.0°02'38"W. - 2000.01'

Δ=17°37'15"
R=2100'
L=645.84'

N.71°47'01"E. - 40.45'

"B" 1012+73.57 P.C.

Δ=17°38'38"
R=1900'
L=585.09'
T.B.=N.63°25'39"E.

100.00' LT "B" 1012+35.07 P.O.C.

P.O.B. = 99.69' LT "B" 1006+17.33 P.O.T.

99.97' LT "B" 999+27.45 P.O.T.

PERPETUAL LOT CORNER

N.89°24'13"E. - 882.87'

R/W

P/L

TO US - 95

"B" PROPOSED ℄

N.89°25'39"E. - 689.88'

N.89°24'43"E.

S.89°25'39"W. - 192.02'

NATIONAL PARK SERVICE
018.951

TO BULLHEAD CITY, AZ.

N.89°24'16"E. - 1058.17'

S.89°24'16"W. - 182.32'

S.89°24'16"W. - 478.00'

CLARK COUNTY
018.616

N.71°47'01"E.

S.71°47'01"W. - 39.41'

TIE: N.63°31'40"E. - 3250.03' FROM THE SW CORNER SECTION 12, T.32S., R.66E., M.D.M.

S.89°24'13"W. - 1569.57'

Δ=17°37'12"
R=2100'
L=645.81'

"B" 1012+73.57 P.C.

Δ=17°37'15"
R=1900'
L=584.33'
T.B.=S.89°24'16"W.

Δ=17°37'15"
R=2100'
L=645.06'

P.O.B.=100.00' RT. "B" 1020+70.97 P.O.T.

CLARK COUNTY
019.188 P.E.

10000' RT. "B" 1025+48.97 P.O.T.

END ACQUISITION
"B" 1025+50.09 P.O.T.

℄ CASINO DRIVE

TO LAUGHLIN

M.D.M.

G&SRB&M.

COUNTY OF CLARK

TIE: N.48°56'15"E. - 2024.42' FROM THE SW CORNER SECTION 12, T.32S., R.66E., M.D.M.

LOT 14

LOT 15

LOT 16

STATE OF NEVADA
Dept. of Transportation — R/W Division

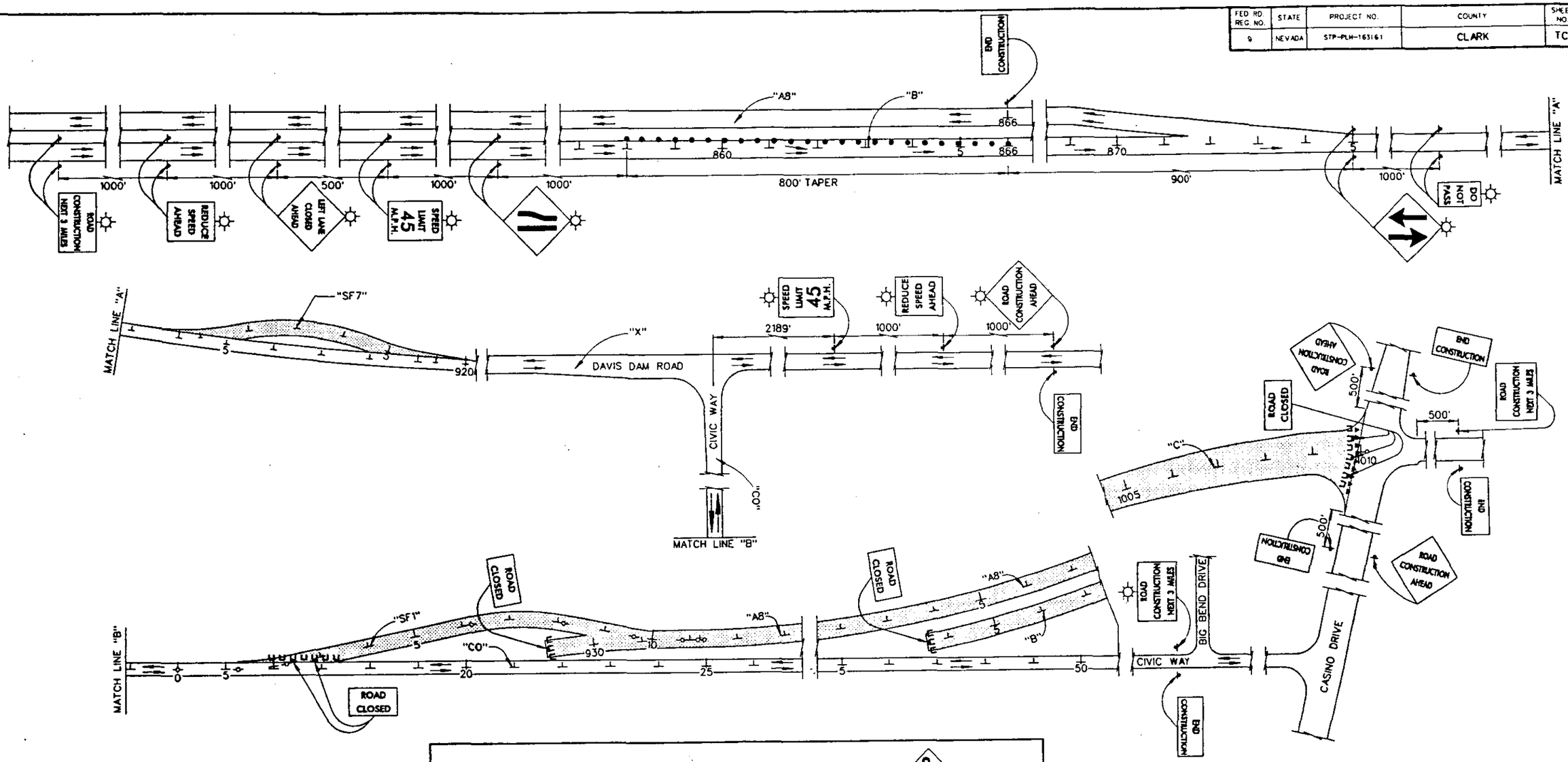
Date: OCTOBER, 1991

R/W Plans

Approved _____
Supervisor, R/W Engineering

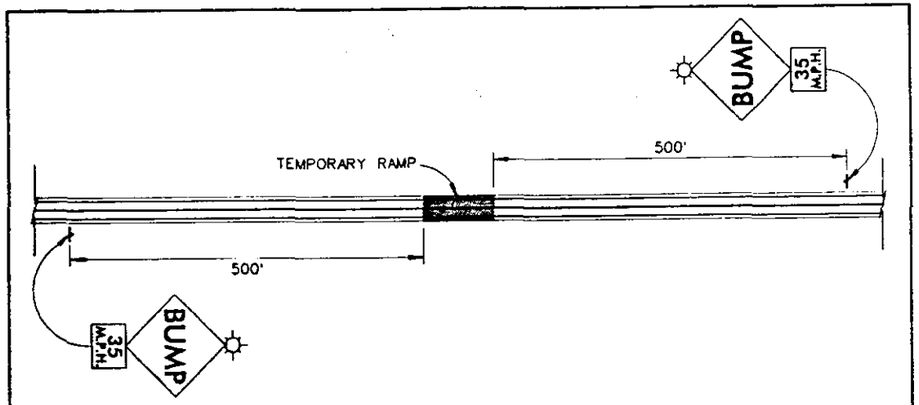
Revision Dates

FED RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	TC1



-LEGEND-

- ●-TRAFFIC DRUMS @ 35' SPACING
- ▲-TRAFFIC CONES @ 10' SPACING
- ⊐-TYPE III B BARRICADES
- ✲-TYPE A WARNING LIGHTS
- ▨-WORK AREA

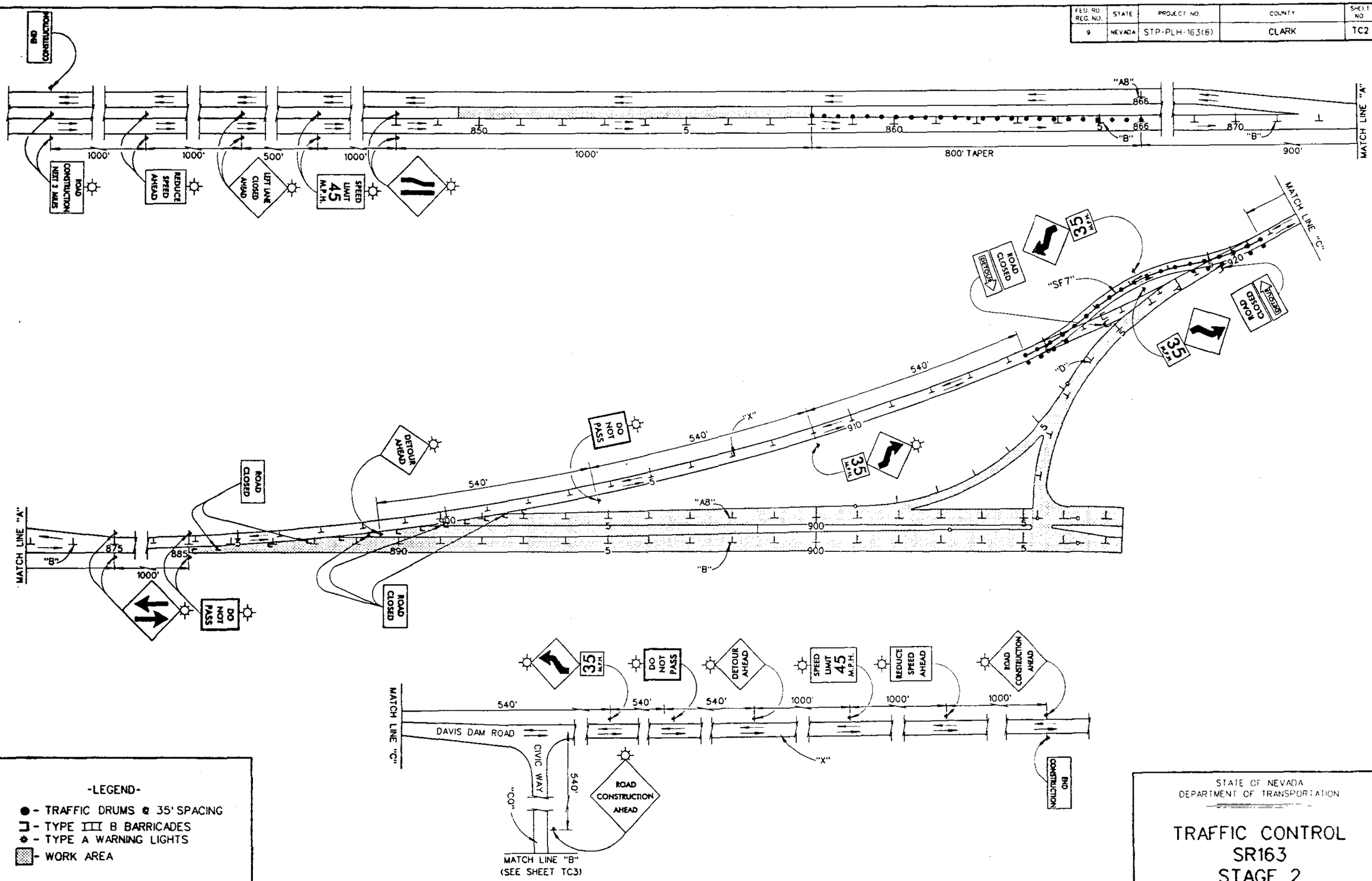


TYPICAL SIGNING AT TEMPORARY RAMPS

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

TRAFFIC CONTROL
SR163
STAGE 1

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	TC2



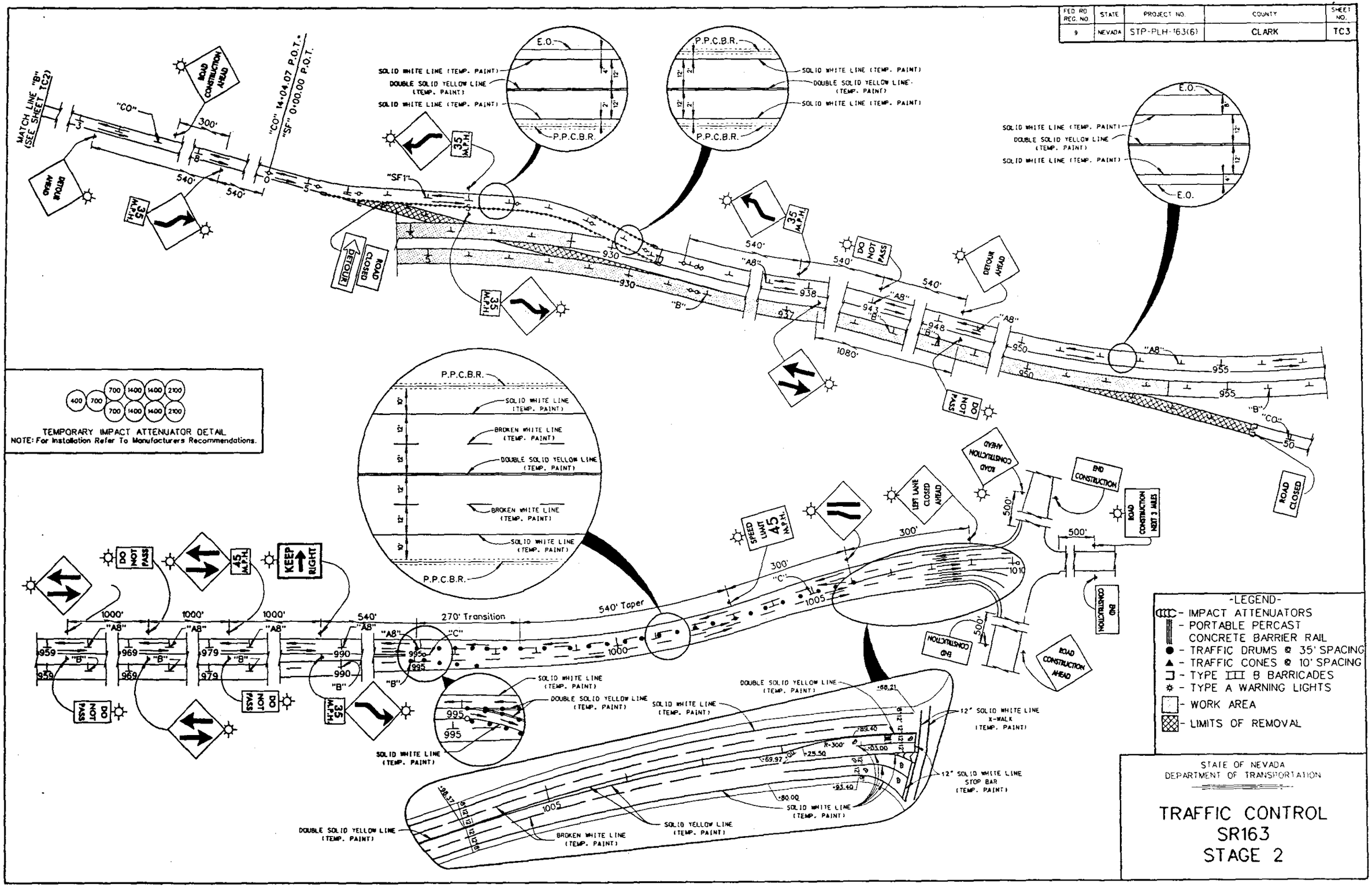
-LEGEND-

- ● - TRAFFIC DRUMS @ 35' SPACING
- ⊔ - TYPE III B BARRICADES
- ✱ - TYPE A WARNING LIGHTS
- ▨ - WORK AREA

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

TRAFFIC CONTROL
SR163
STAGE 2

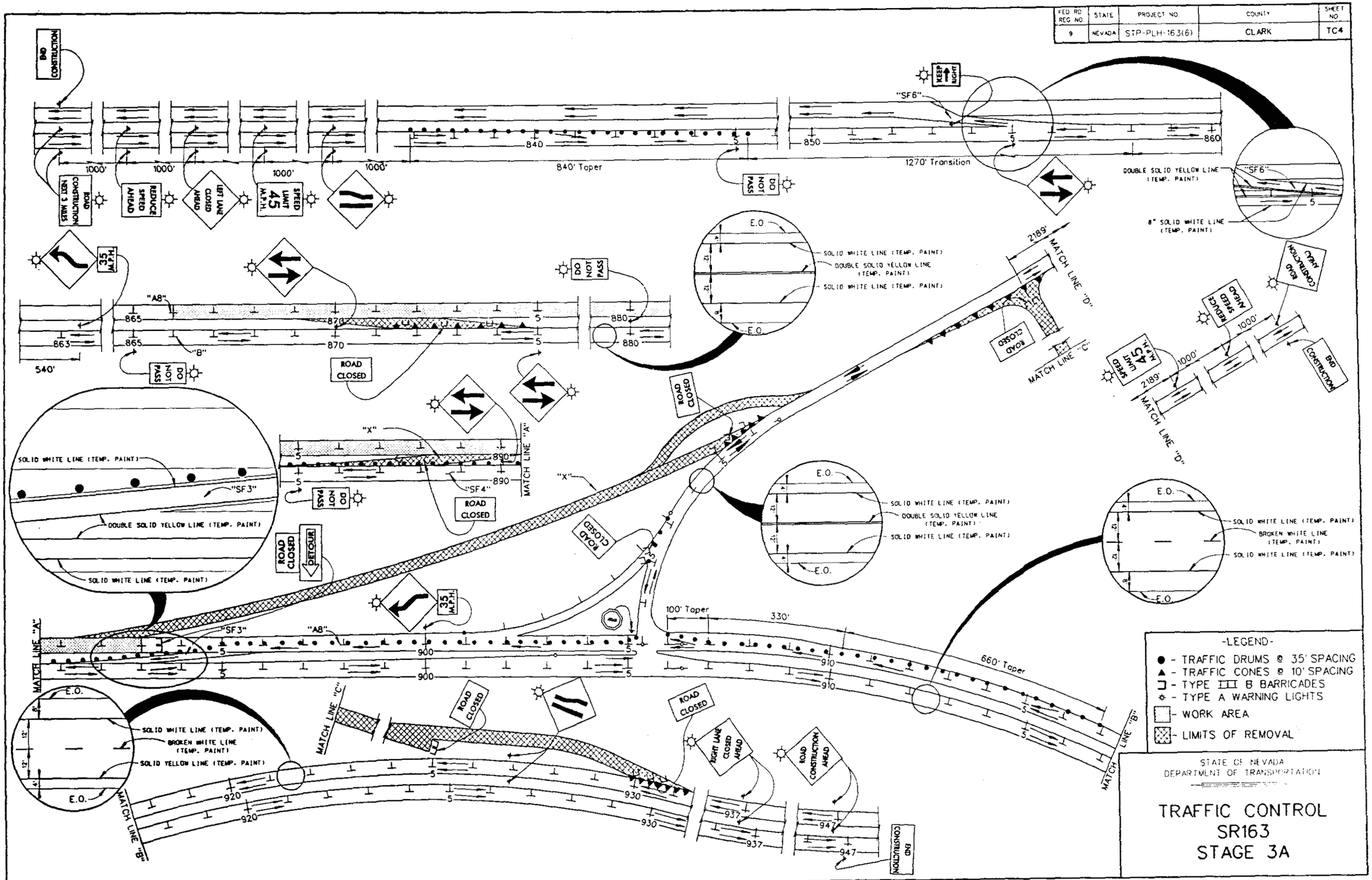
FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	TC3



STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

TRAFFIC CONTROL
SR163
STAGE 2

FED RD REG NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	TC4



-LEGEND-

- ● - TRAFFIC DRUMS @ 35' SPACING
- ▲ - TRAFFIC CONES @ 10' SPACING
- ⊐ - TYPE III B BARRICADES
- ☼ - TYPE A WARNING LIGHTS
- □ - WORK AREA
- ▨ - LIMITS OF REMOVAL

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

TRAFFIC CONTROL
SR163
STAGE 3A

FED. RD. PROJ. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	TC5

END CONSTRUCTION

1000' 1000' 1000' 1000' 1000'

CONSTRUCTION NEXT 3 MILES ROAD

REDUCE SPEED AHEAD

RIGHT LANE CLOSED AHEAD

SPEED LIMIT 45 M.P.H.

840' TAPER

840 5 850 5

35 M.P.H.

420' Transition

"SF5"

DETOUR ROAD CLOSED

E.O. 8' 12' 12' 4' E.O.

SOLID WHITE LINE (TEMP. PAINT)

DOUBLE SOLID YELLOW LINE (TEMP. PAINT)

SOLID WHITE LINE (TEMP. PAINT)

DO NOT PASS

858 858 865 865 870 870 880 880 890 890

MATCH LINE "A"

DO NOT PASS

DO NOT PASS

35 M.P.H.

"SF2"

8" SOLID WHITE LINE (TEMP. PAINT)

DOUBLE SOLID YELLOW LINE (TEMP. PAINT)

"SF2"

"A8"

5 900 5 900

KEEP RIGHT

SOLID WHITE LINE (TEMP. PAINT)

BROKEN WHITE LINE (TEMP. PAINT)

SOLID YELLOW LINE (TEMP. PAINT)

E.O. 8' 12' 12' 4' 26' 4' 12' 12' 8' E.O.

SOLID YELLOW LINE (TEMP. PAINT)

BROKEN WHITE LINE (TEMP. PAINT)

SOLID WHITE LINE (TEMP. PAINT)

MATCH LINE "B"

Taper

920 920 930 930 940 940 950 950

LEFT LANE CLOSED AHEAD

ROAD CONSTRUCTION AHEAD

END CONSTRUCTION

ROAD CONSTRUCTION AHEAD

REDUCE SPEED AHEAD

SPEED LIMIT 45 M.P.H.

1000' 1000'

2243'

END CONSTRUCTION

5 5

SOLID WHITE LINE (TEMP. PAINT)

DOUBLE SOLID YELLOW LINE (TEMP. PAINT)

"SF5"

SOLID WHITE LINE (TEMP. PAINT)

E.O. 4' 12' 4' E.O.

SOLID WHITE LINE (TEMP. PAINT)

12" SOLID WHITE LINE (STOP BAR) (TEMP. PAINT)

8" SOLID WHITE LINE (TEMP. PAINT)

5 910 910

840' Taper

MATCH LINE "B"

-LEGEND-

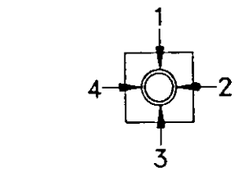
- ● - TRAFFIC DRUMS @ 35' SPACING
- ▲ - TRAFFIC CONES @ 10' SPACING
- ⊐ - TYPE III B BARRICADES
- ✲ - TYPE A WARNING LIGHTS
- □ - WORK AREA

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

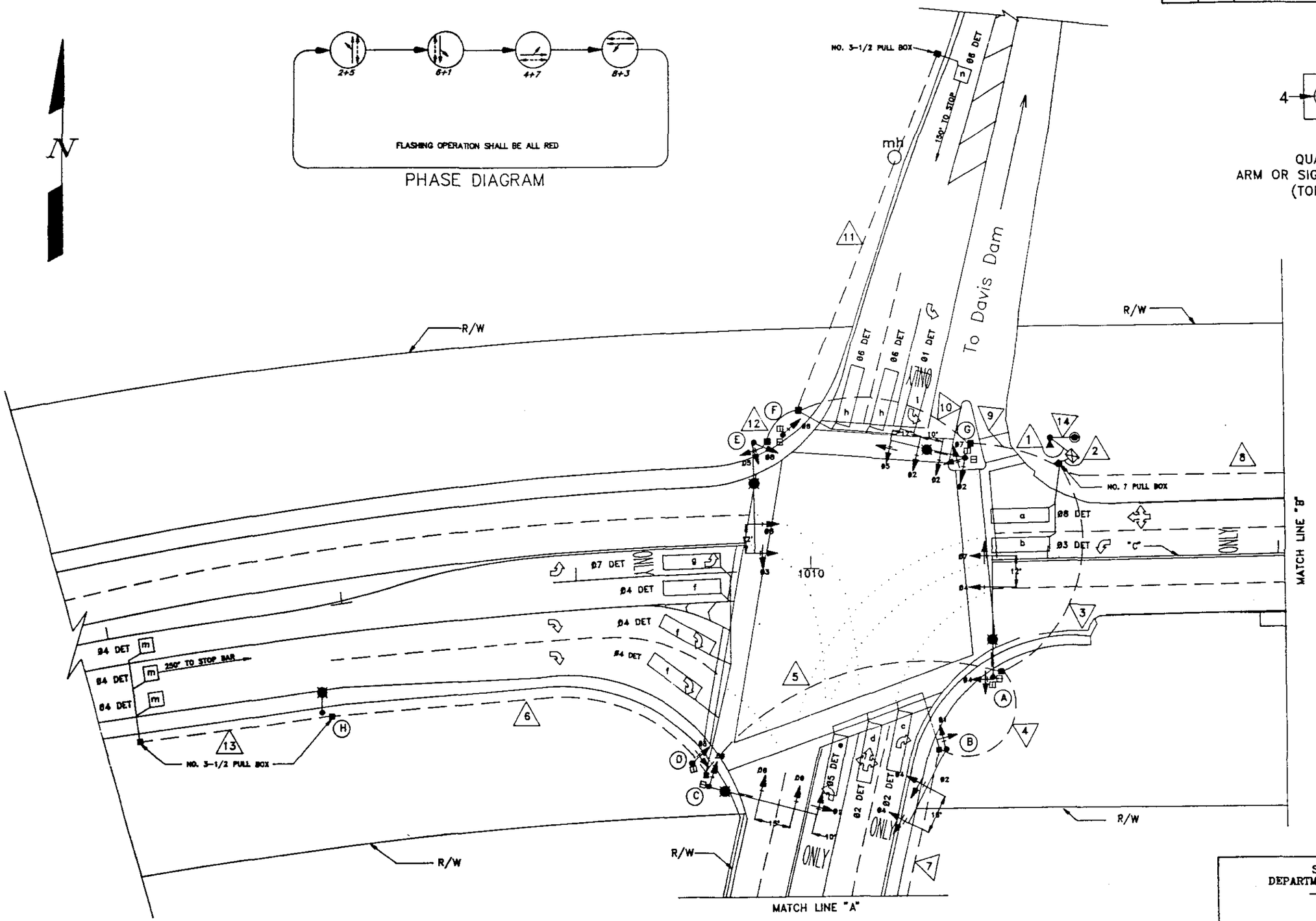
TRAFFIC CONTROL
SR163
STAGE 3B

FED. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO
9	NEVADA	STP-PLH-163 (6)	CLARK	T1

PHASE DIAGRAM



QUADRANT
ARM OR SIGNAL LOCATION
(TOP VIEW)

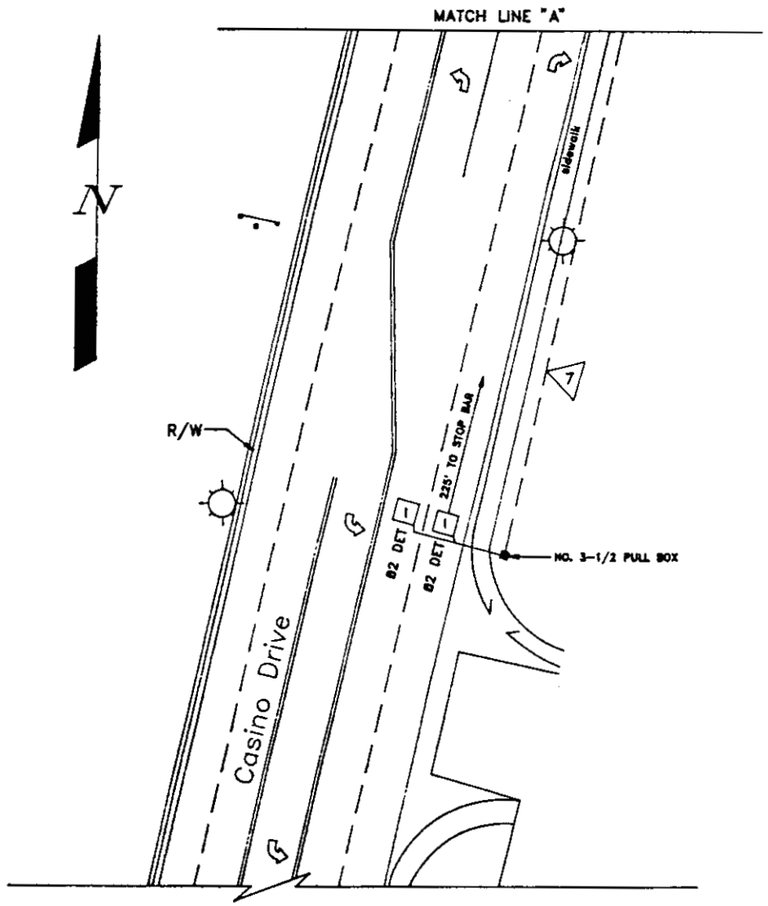


STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

NEW TRAFFIC SIGNAL SYSTEM FOR SR 163 AND CASINO DRIVE

TRAFFIC DESIGN DIVISION	
DESIGN ENGR	WAYNE C. NASH
SENIOR DESIGN ENGR	PHIL CHRISTOPHERSON
PHONE 687-3581	

FED. ROAD REG. NO	STATE	PROJECT NO.	COUNTY	SHEET NO
9	NEVADA	STP-PLH-163 (6)	CLARK	T2



GENERAL NOTES:

ELECTRICAL SERVICE NOTES:

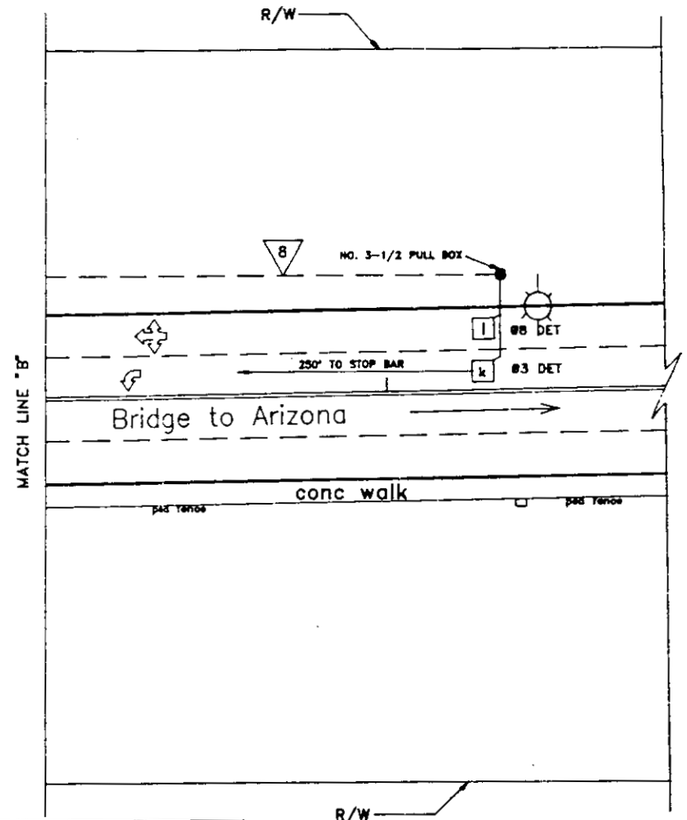
1. SERVICE PEDESTAL SHALL BE A 125 AMP, 120/140 VOLT 60 HZ SINGLE PHASE, UNDERGROUND FED SINGLE METER SERVICE PEDESTAL LABELED CLARK COUNTY. THE PEDESTAL SHALL HAVE PROVISIONS FOR A MINIMUM OF 16 CIRCUITS SUPPLIED WITH THE FOLLOWING CIRCUIT BREAKERS:
   a. ONE 60 AMP, 120 VOLT, SINGLE POLE BREAKER FOR SIGNALS.
   b. ONE 40 AMP, 120 VOLT, SINGLE POLE BREAKER FOR INTERSECTION LIGHTING.
   c. ONE SPARE 40 AMP, 240 VOLT TWO POLE BREAKER FOR FUTURE NEEDS.
   d. ONE SPARE 15 AMP, 120 VOLT SINGLE POLE BREAKER FOR FUTURE NEEDS.
2. ALL INSTALLATIONS SHALL MEET UTILITY COMPANY'S REQUIREMENTS.
3. COST OF CONDUIT AND CONDUCTORS SHALL BE PAID FOR BY RESPECTIVE BID ITEMS. ALL OTHER COSTS FOR SERVICE INSTALLATION SHALL BE INCLUDED IN UNIT PRICE BID FOR "UNDERGROUND ELECTRICAL SERVICE", EACH.

POLE NOTES:

1. LUMINARIES SHALL BE 120 VOLT, 400 WATT HIGH PRESSURE SODIUM 90 DEGREE CUTOFF WITH TYPE III DISTRIBUTION AND REGULATOR BALLAST AND INTEGRAL CONTROLS (GE #M4ACOSIM2GMC32 OR APPROVED EQUIVALENT).
2. ALL PEDESTRIAN HEADS SHALL BE INTERNATIONAL SYMBOLS.
3. IT WILL BE THE CONTRACTORS RESPONSIBILITY TO ASCERTAIN THE LOCATION OF ALL POLES ARE NOT IN CONFLICT WITH ANY UTILITIES.
4. ALL PULL BOXES WILL BE NO. 5 UNLESS OTHERWISE NOTED.
5. POLES A,C,E, AND G WILL REQUIRE INTERNALLY ILLUMINATED STREET NAME SIGNS PER CLARK COUNTY REQUIREMENTS. POLES A AND E WILL BE SIGNED, "CASINO DRIVE", POLES C AND G WILL BE SIGNED, "SR 163". ALL SIGNS WILL BE IN UPPER CASE.
6. POLE LOCATION MAY BE ADJUSTED AS DIRECTED BY THE ENGINEER.

CONTROLLER CABINET NOTES:

1. THE CONTROLLER WILL BE HOUSED IN THE TYPE "R" CABINET AS DESCRIBED IN THE STANDARD DRAWING SHEET T-30.1.5 .

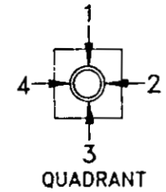


POLE SCHEDULE

No.	STATION	POLE TYPE	SIGNAL ARM QUANTITY	SIGNAL ARM LENGTH	LUM. ARM QUANTITY	LUM. ARM LENGTH	SIGNALS VEH. TYPE	VEH. MOUNT	VEH. QUAD.	SIG. PED. MOUNT	PED. QUAD.	PED. BUTTON QUAD.	PED. BUTTON ARROW
A	45'+ RIGHT "C" 1010+75+	35-A	1	50	1	15	1W3C 1W3C 1W3C	M-2 M-2 B-1	1 1	WS-2	3	1 4	RIGHT LEFT
B	75'+ RIGHT "C" 1010+65±	35	3.5	35	1	15	1W3C 2W3C 1W3C	M-2 B-2 M-2	3.5 1 3.5				
C	85'± RIGHT "C" 1009+50±	35	2.5	45	2	15	1W3C 1W3C 1W3C 1W3C	M-2 M-2 M-2 B-1	2.5 2.5 2.5 2	WS-1	3	1	LEFT
D	75'± RIGHT "C" 1009+43±	1A					1W3C	T-1	2	WS-1	3	2	RIGHT
E	60'± LEFT "C" 1009+75±	35	3	45	3	15	1W3C 1W3C 2W3C	M-2 M-2 B-2A	3 3 1				
F	60'± LEFT "C" 1009+85±	1A					1W3C	T-1		WS-2	4	3 2	RIGHT LEFT
G	45'± LEFT "C" 1009+85±	35	4	35	4	15	1W3C 1W3C 1W3C 2W3C	M-2 M-2 M-2 B-2A	4 4 4 2	WS-2	2	3 4	LEFT RIGHT
H	45'± RIGHT "C" 1007+85±	7			1	15							

CONDUIT-CABLE SCHEDULE

RUN NO.	FROM	TO	CONDUIT SIZE	SIGNAL CABLE	DET. LEADS	LIGHTING CIRCUIT	GROUNDWIRE	SERVICE
1	METERED SERVICE	CONTROLLER CABINET	1-1/2"				(1) #6	(2) #6
2	CONTROLLER CABINET	PULLBOX FOR CONTROLLER	(3)-3"	15 15 15 15 10 20 20	a,b,c,d,e,f, g,h,i,j,k,l, m,n	(2) #10	(1) #8	
3	PULLBOX FOR CONTROLLER	PULLBOX FOR POLE A	(2)-3"	20 15 15 15	c,d,e,f, g,i,m	(2) #10	(1) #8	
4	PULLBOX FOR POLE A	PULLBOX FOR POLE B	2"	15	i		(1) #8	
5	PULLBOX FOR POLE A	PULLBOX FOR POLE C&D	(2)-3"	15 15	f,g,m	(2) #10	(1) #8	
6	PULLBOX FOR POLE C	PULLBOX FOR POLE H	1-1/2"		m	(2) #10	(1) #8	
7	PULLBOX FOR POLE B	PULLBOX FOR DETECTORS	1-1/2"		i			
8	PULLBOX FOR CONTROLER	PULLBOX FOR DETECTORS	1-1/2"		j,k			
9	PULLBOX FOR CONTROLER	PULLBOX FOR POLE G	(2)-3"	10 15 20	h,i,n	(2) #10	(1) #8	
10	PULLBOX FOR POLE G	PULLBOX FOR POLE F	(2)-3"	10 15	h,i,n	(2) #10	(1) #8	
11	PULLBOX FOR POLE F	PULLBOX FOR DETECTORS	1-1/2"		n			
12	PULLBOX FOR POLE F	PULLBOX FOR POLE E	2"	15		(2) #10	(1) #8	
13	PULLBOX FOR POLE H	PULLBOX FOR DETECTORS	1-1/2"		m			
14	POWER SOURCE	METERED SERVICE	2"					AS REQUIRED BY NEVADA POWER



QUADRANT
ARM OR SIGNAL LOCATION
(TOP VIEW)

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

NEW TRAFFIC SIGNAL SYSTEM FOR SR 163 AND CASINO DRIVE

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO
9	NEVADA	STP-PLH-163 (6)	CLARK	T3

STRUCTURE LIST

PEDESTRIAN SIGNAL HEAD, 1W 623 6501	SIGNAL HEAD (12-INCH) 1W3C, MAST ARM 623 6211	SIGNAL HEAD (12-INCH) 2W3C, BRACKET 623 6213	SIGNAL HEAD (12-INCH) 1W3C, BRACKET 623 6206	SIGNAL HEAD (12-INCH) 1W3C, POST TOP 623 6203	STEEL POLE, TYPE 35A 623 4352	STEEL POLE, TYPE 35 623 4350	STEEL POLE, TYPE 7 WITH SAFETY BASE 623 4071	STEEL POLE, TYPE 1A 623 4011	ILLUMINATED STREET NAME SIGN, DOUBLE FACE (6-FOOT) 623 3602	SODIUM VAPOR LUMINAIRE, 400 WATT 623 3104	NO. 7 PULL BOX 623 2070	NO. 5 PULL BOX 623 2050	NO. 3-1/2 PULL BOX 623 2035	20 CONDUCTOR NO. 14 CABLE 623 1120	15 CONDUCTOR NO. 14 CABLE 623 1115	10 CONDUCTOR NO. 14 CABLE 623 1110	NO. 14 CONDUCTOR 623 1014	NO. 10 CONDUCTOR 623 1010	NO. 8 CONDUCTOR 623 1008	NO. 6 CONDUCTOR 623 1006	NO. 2 CONDUCTOR 623 1002	3-INCH CONDUIT 623 0130	2-INCH CONDUIT 623 0120	1-1/2-INCH CONDUIT 623 0115	DESCRIPTION	SHEET NO
2	12	3	2	2	1	4	1	2	4	5	1	6	5	180	825	150	1450	1800	700	40	50	825	80	930	NEW SIGNAL SYSTEM FOR CASINO DR. & SR 163	T1 AND T2
2	12	3	2	2	1	4	1	2	4	5	1	6	5	180	830	150	1450	1800	700	40	50	830	80	930	TOTAL		

UNDERGROUND ELECTRICAL SERVICE 623 8750	TRAFFIC ACTUATED CONTROLLER 623 7500	LEAD-IN CABLE FOR LOOP DETECTORS 623 7100	LOOP DETECTOR AMPLIFIER CHANNELS (NEW CABINET) 623 7006	LOOP DETECTOR (6-FOOT X 25-FOOT) 623 7002	LOOP DETECTOR (6-FOOT X 6-FOOT) 623 7000	PEDESTRIAN SIGNAL HEAD, 2W 623 6502	DESCRIPTION	SHEET NO
1	1	2950	14	12	8	3	NEW SIGNAL SYSTEM FOR CASINO DR. & SR 163	T1 AND T2
1	1	2950	14	12	8	3	TOTAL	

GENERAL NOTES CONTINUED

CONDUIT / CONDUCTOR SCHEDULE:

1. ALL SIGNAL CABLE SHALL CONFORM TO I.M.S.A. SPECIFICATION #20-1.
2. ALL LOOP DETECTOR CABLE SHALL CONFORM TO I.M.S.A. SPECIFICATION #19-2 OR #20-2.
3. (20) = 20 CONDUCTOR
   (15) = 15 CONDUCTOR
   (10) = 10 CONDUCTOR
4. CONDUIT RUNS AS SHOWN ARE FOR CLARITY OF RUNS ONLY. ALL CONDUIT RUNS, EITHER SINGLE OR MULTIPLE, SHALL RUN CORNER TO CORNER. MULTIPLE RUNS NOT TERMINATING IN THE SAME PULL BOX SHALL PASS UNDER THE PULL BOX USING 90 DEGREE SWEEP ELS AND CONTINUE TO THE NEXT CORNER OR TERMINATION POINT. ALL MULTIPLE CONDUIT RUNS SHALL BE PLACED IN THE SAME TRENCH WHENEVER POSSIBLE.

LOOP DETECTOR NOTES:

1. EACH LOWER CASE LETTER REPRESENTS A SEPERATE SINGLE CHANNEL AND LOOPS WILL USE TYPE 1 LOOP AMPLIFIERS EXCEPT LOOPS, "j","k", "l","m", & "n" WHICH REQUIRE TYPE III LOOP AMPLIFIERS.
2. ALL LOOPS SHALL BE CABLE ENCLOSED IN VINYL TUBING. (CABLE-IN-DUCT SYSTEM).
3. LOCATE ALL LOOPS AT INTERSECTION 2 FOOT IN ADVANCE OF STOP BAR.

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

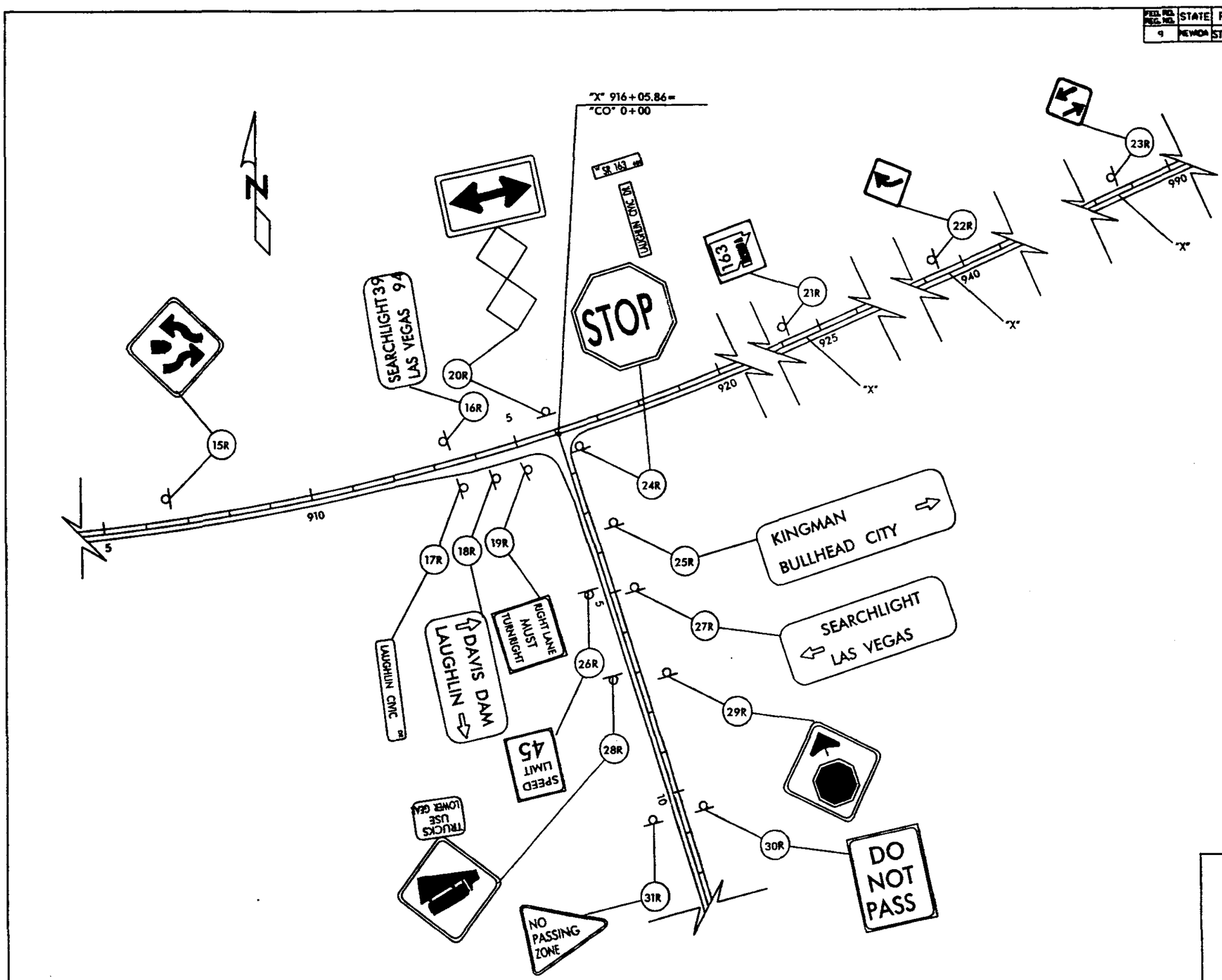
NEW TRAFFIC SIGNAL SYSTEM FOR SR 163 AND CASINO DRIVE

FED. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	TS-1

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

SIGN REMOVALS

FED. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	TS-2

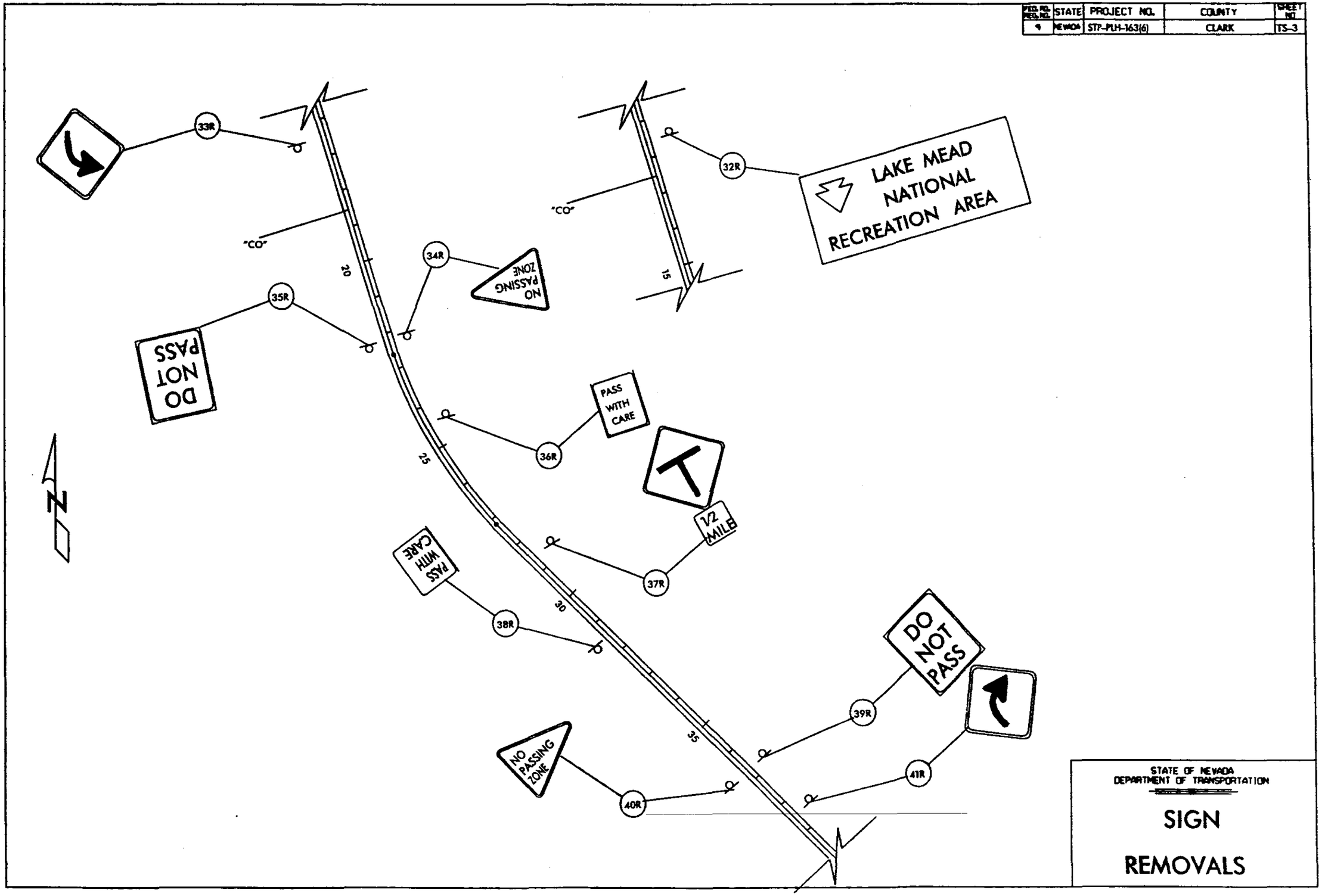


STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

SIGN REMOVALS

PLAN2

FED. RD. PROJ. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	TS-3

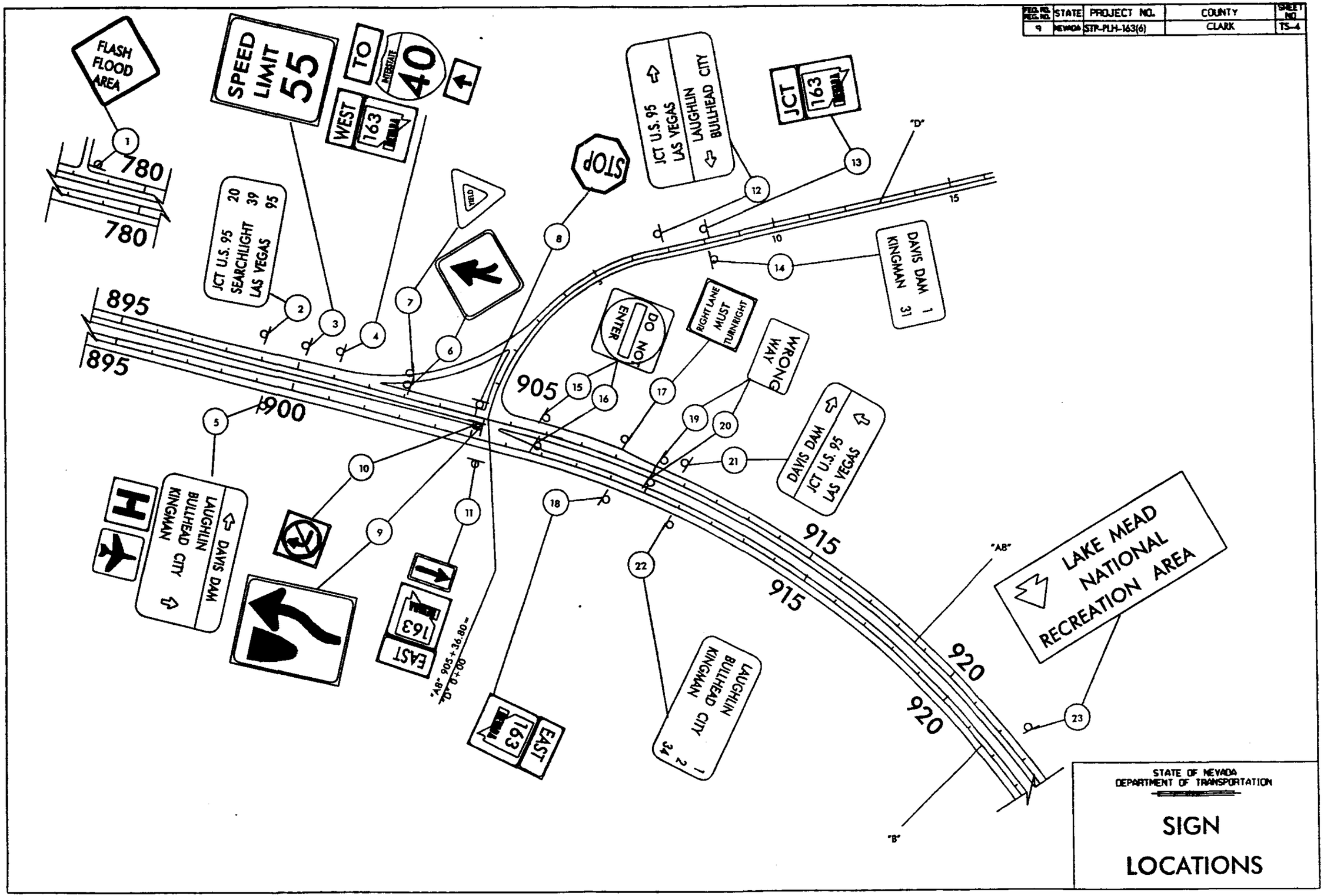


STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

SIGN REMOVALS

PLAN3

FED. AID PROJ. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	TS-4

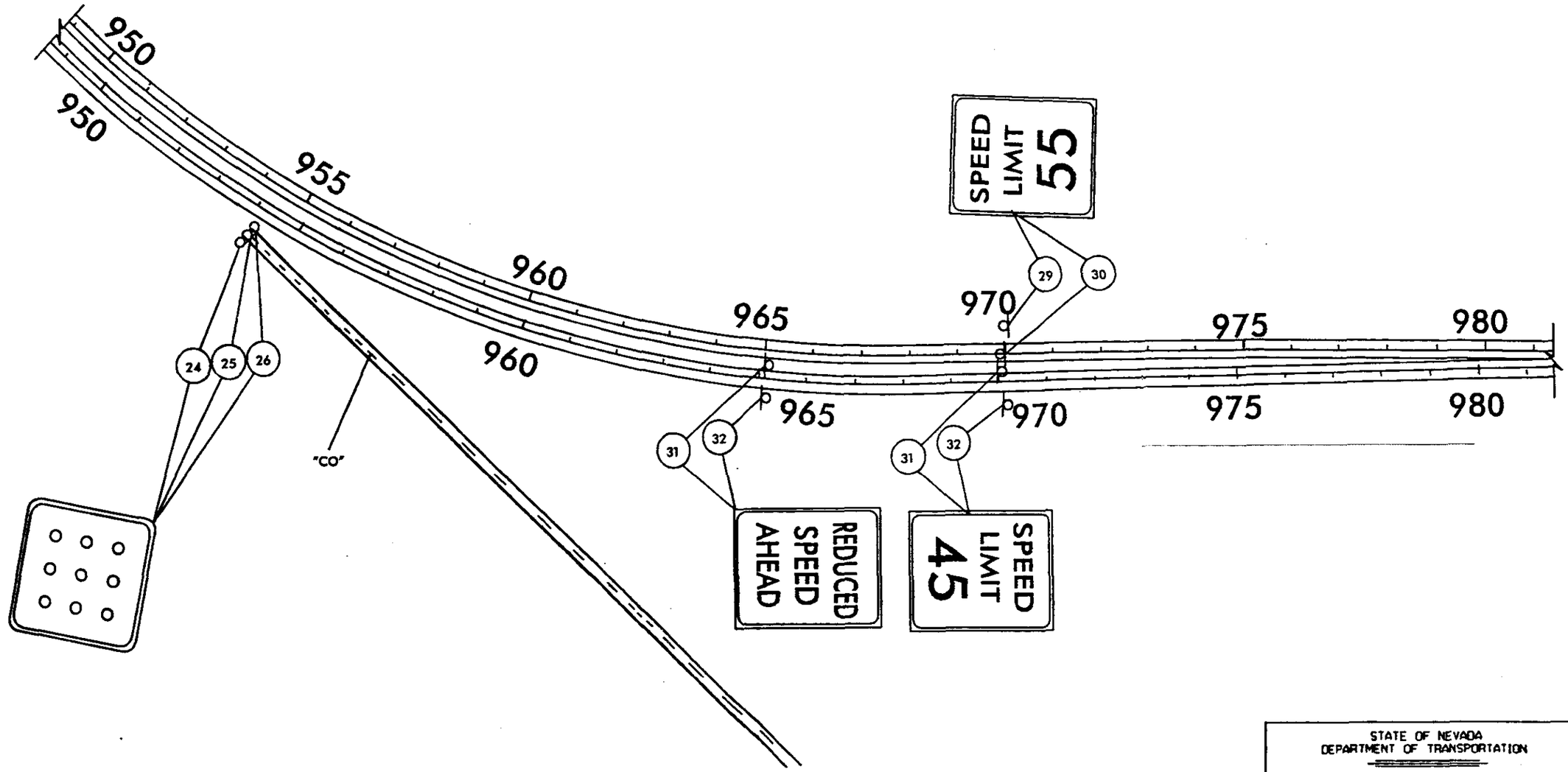


STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

SIGN LOCATIONS

PLAN4

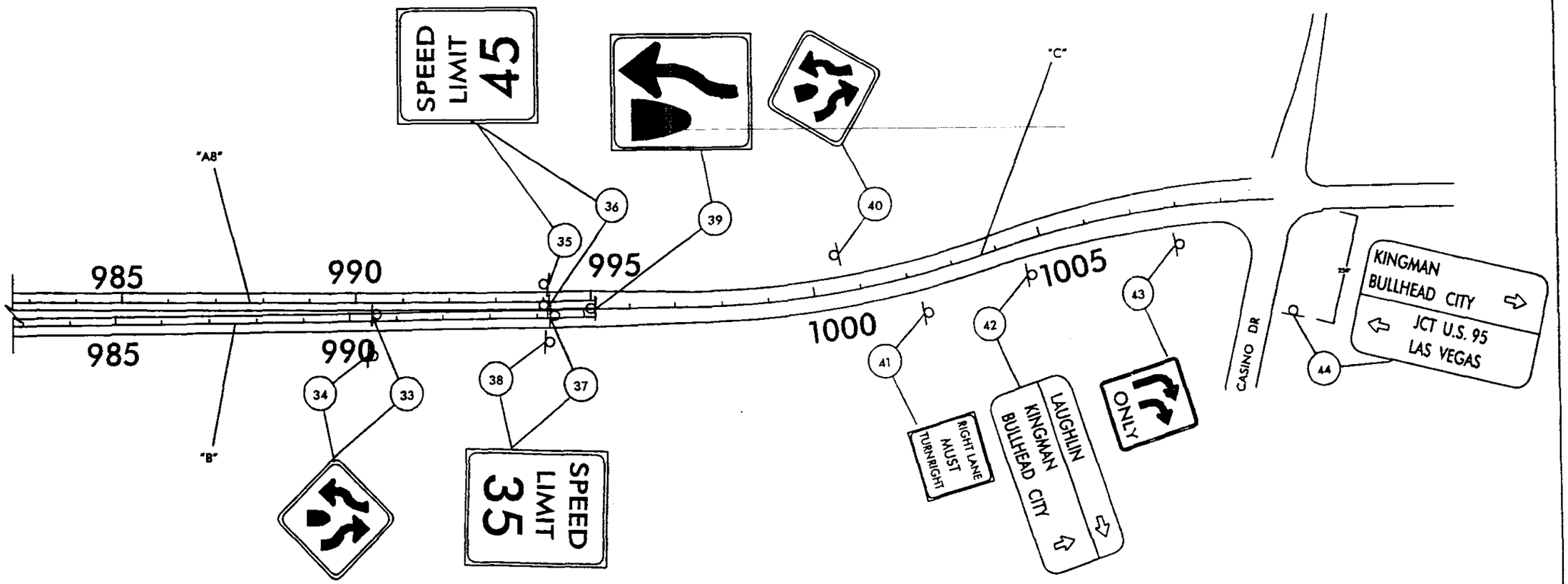
FED. ROAD REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	TS-5



STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

SIGN LOCATIONS

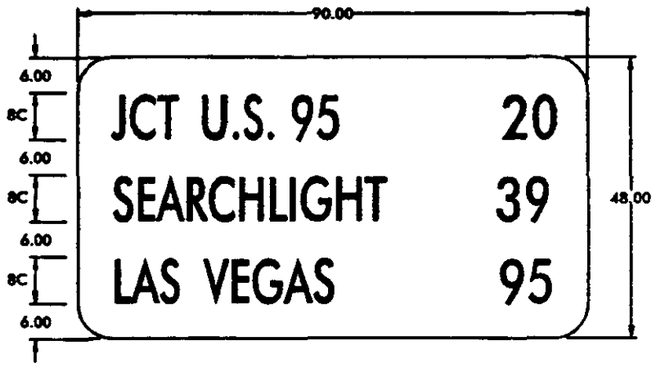
FED. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	TS-6



STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

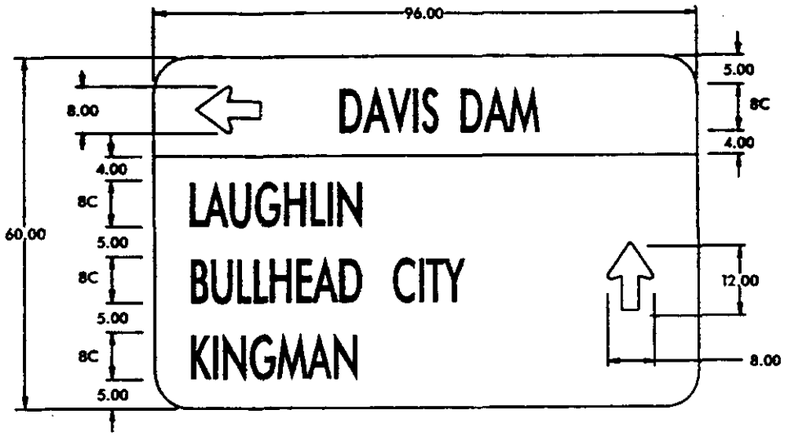
SIGN LOCATIONS

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	TS-7



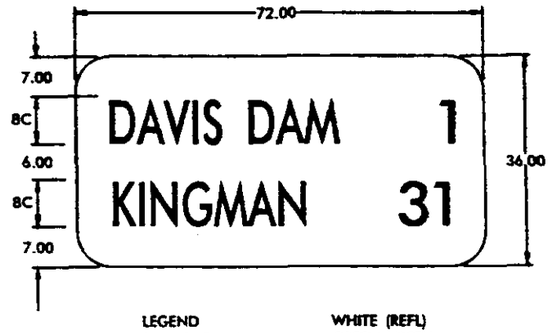
LEGEND	WHITE (REFL)
BACKGROUND	GREEN (REFL)
CORNER RADIUS	6.00
BORDER	1.00

(2)



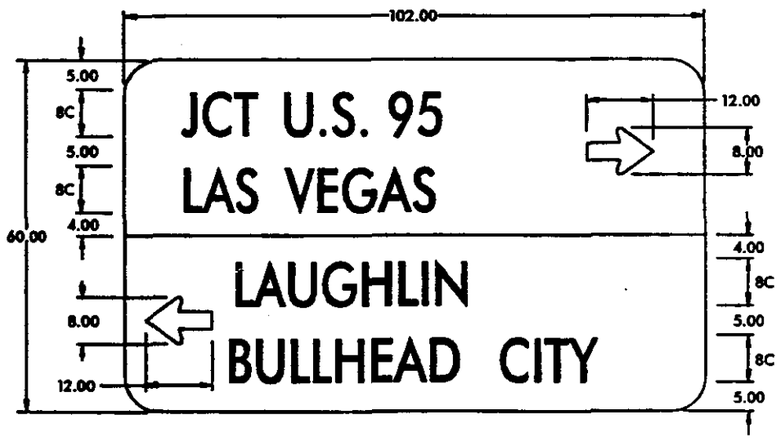
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BACKGROUND	GREEN (REFL)
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BORDER	1.00

(5)



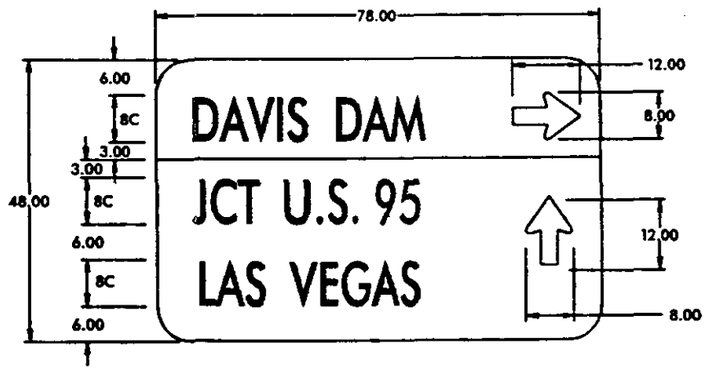
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BACKGROUND	GREEN (REFL)
CORNER RADIUS	6.00
BORDER	1.00

(14)



LEGEND	WHITE (REFL)
BACKGROUND	GREEN (REFL)
CORNER RADIUS	6.00
BORDER	1.00

(12)



LEGEND	WHITE (REFL)
BACKGROUND	GREEN (REFL)
CORNER RADIUS	6.00
BORDER	1.00

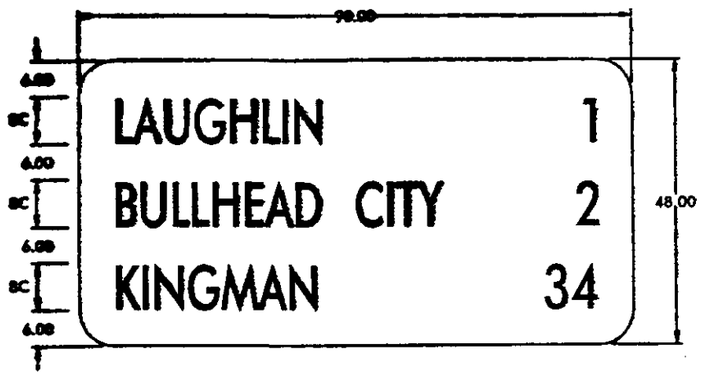
(21)

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

SIGN DETAILS

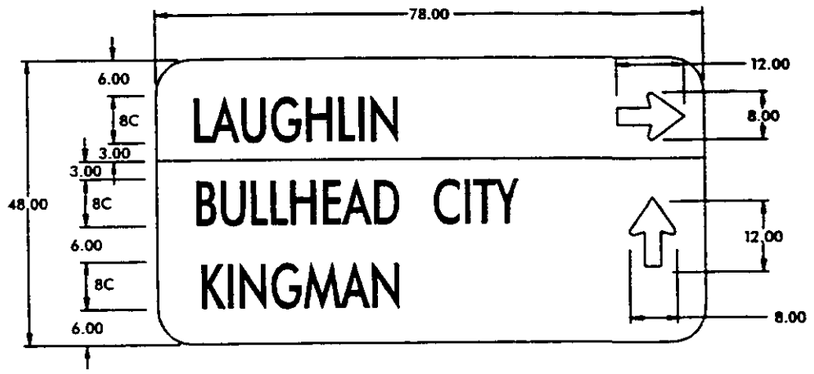
LASIGN

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	TS-8



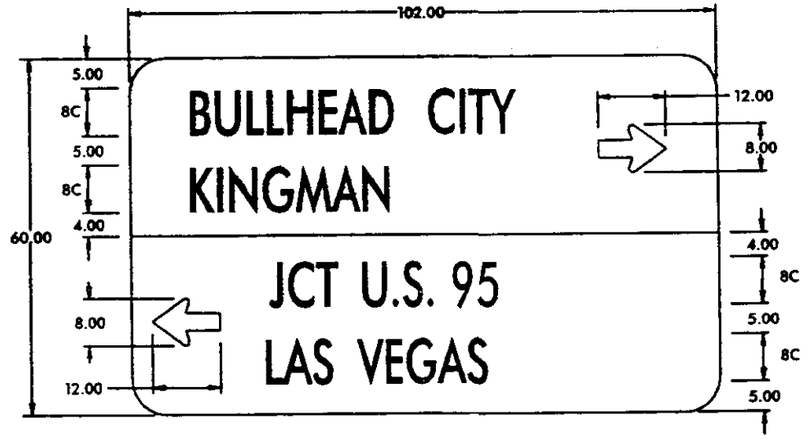
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BACKGROUND	GREEN (REFL)
CORNER RADIUS	6.00
BORDER	1.00

(22)



LEGEND	WHITE (REFL)
BACKGROUND	GREEN (REFL)
CORNER RADIUS	6.00
BORDER	1.00

(42)



LEGEND	WHITE (REFL)
BACKGROUND	GREEN (REFL)
CORNER RADIUS	6.00
BORDER	1.00

(44)

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

SIGN DETAILS

LASIGN

ITEM NO.	ITEM	TOTAL	USE TOTAL	UNIT
627-0110	PERMANENT SIGNS (GROUND MOUNTED) (METAL SUPPORTS)	586.04	587.00	SQ. FT.
627-0140	PERMANENT SIGNS, REMOVE	395.49	396.00	SQ. FT.
627-0145	PERMANENT SIGNS, RESET	40.00	40.00	SQ. FT.

SIGN GENERAL NOTES

1. Sign numbers on sign summary are taken from the Manual on Uniform Traffic Control Devices (1988) and Standard Highway Signs – Nevada Supplement.
2. Posts lengths pertain to the type of post as shown on the sign summary. If the Contractor chooses one of the other types shown in our Standard Plans, the Contractor must furnish a sign summary depicting the appropriate post and corresponding post length. This sign summary must be approved by the Traffic Engineering Division prior to the fabrication of these alternate posts.
3. Installation numbers with an R signify removal.
4. All sign removals shall be stockpiled for pickup by State Forces.
5. Distance from edge of travel way to near edge of sign shall be *minimum as shown on* Standard Sheet T–31.1.1., Rev.13
6. Post lengths for all ground mounted signs are calculated to the nearest inch. All single post lengths are based on the use of a sign island. see Standard Sheet T–31.1.1, Rev.13
7. Breakaway bases shall be used on all double posts supports.
8. All Reset sign panels shall be installed on new supports unless otherwise noted.
9. Type III Reflective Sheeting shall be used on all installations.
10. All interstate route markers shall be white on red and blue and be cut out in shape whether used on a green guide sign or used independently. All supplemental plates such as arrows, cardinal direction, etc., used with these markers shall be white on blue.
11. *All U.S. or Nevada route markers shall* be black on white with black background and be square or rectangular in shape when used independently.When used on a green guide sign the marker shall be cut out in shape w/o background. All supplemental plates such as arrows, cardinal directions, etc., shall be black on white.

FED.AID REV.NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-1636(6)	CLARK	TS-9

BIDNOTE

FED. RD. PROJ. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-1631(6)	CLARK	TS-10

SIGN SUMMARY

REMARKS	POST				MESSAGE	SIGN AREA	PANEL SIZE	SIGN NO.	LOC	STATION	INST NO.
	LENGTH		NO.	TYPE & SIZE							
	OUTER	INNER									
					LEFT LANE ENDS	9.00	36X36		LT	"B" 833+00	1R
					LEFT LANE ENDS	9.00	36X36		RT	"B" 833+00	2R
					PASS WITH CARE	12.00	36X48		LT	"A8" 848+00	3R
					PAVEMENT WIDTH TRANSITION	9.00	36X36		LT	"B" 848+00	4R
					PAVEMENT WIDTH TRANSITION	9.00	36X36		RT	"B" 848+00	5R
					WRONG WAY	6.00	36X24		LT	"A8" 862+00	6R
					WRONG WAY	6.00	36X24		RT	"A8" 862+00	7R
					KEEP 30 DEG ARROW RIGHT	12.00	36X48		RT	"TC1" 3+40	8R
					DO NOT ENTER	9.00	36X36		RT	"X" 876+57	9R
					CURVE LEFT	6.25	30X30		RT	"X" 879+10	10R
					LAUGHLIN TURN OFF 1/2 MILE	19.25	66X42		RT	"X" 884+38	11R
					DO NOT PASS	12.00	36X48		RT	"X" 886+57	12R
BACK TO BACK MOUNTING					TWO WAY TRAFFIC	9.00	36X36		RT	"X" 886+57	13R
					NO PASSING ZONE	5.56	48X48X36				
					REVERSE CURVE	9.00	36X36		LT	"X" 896+62	14R
					BEGIN DIVIDED HIGHWAY	9.00	36X36		LT	"X" 906+62	15R

SUM01

FED. ROAD PROJ. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	TS-11

SIGN SUMMARY

REMARKS	POST				MESSAGE	SIGN AREA	PANEL SIZE	SIGN NO.	LOC	STATION	INST NO.
	LENGTH		NO.	TYPE & SIZE							
	OUTER	INNER									
					SEARCHLIGHT 39	9.00	54X24		LT	"X" 913+41	16R
					LAS VEGAS 94						
					LAUGHLIN CIVIC DR	3.00	48X9		RT	"X" 913+41	17R
					90 DEG ARROW DAVIS DAM	12.50	60X30		RT	"X" 914+15	18R
					LAUGHLIN 0 DEG ARROW						
					MANDATORY TURN (RIGHT)	6.25	30X30		RT	"X" 914+85	19R
					2 DIRECTION ARROW	8.00	48X24		LT	"X" 916+06	20R
					TYPE 1 OBJECT MARKER	2.25	18X18				
					TYPE 1 OBJECT MARKER	2.25	18X18				
					CURVE RIGHT	6.25	30X30		LT	"X" 924+13	21R
					TWO WAY TRAFFIC	9.00	36X36		LT	"X" 939+37	22R
					NEVADA SR 163	4.00	24X24		LT	"X" 988+57	23R
					STOP	16.00	48X48		LT	"CO" 0+15	24R
					LAUGHLIN CIVIC DRIVE	1.50	36X6				
					W SR163 600	1.00	24X6				
					KINGMAN, BULLHEAD CITY	20.00	96X30		LT	"CO" 2+54	25R
					RT ARROW						
					SPEED LIMIT 45	5.00	30X24		RT	"CO" 3+76	26R
					LT ARROW	17.50	87X30		LT	"CO" 4+25	27R
					SEARCHLIGHT, LAS VEGAS						

SUM02

FED. ROAD PROJ. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PUH-1631(6)	CLARK	TS-10

SIGN SUMMARY

REMARKS	POST LENGTH OUTER	POST LENGTH INNER	POST NO.	POST TYPE & SIZE	MESSAGE	SIGN AREA	PANEL SIZE	SIGN NO.	LOC	STATION	INST NO.
					LEFT LANE ENDS	9.00	36X36		LT	"B" 833+00	1R
					LEFT LANE ENDS	9.00	36X36		RT	"B" 833+00	2R
					PASS WITH CARE	12.00	36X48		LT	"A8" 848+00	3R
					PAVEMENT WIDTH TRANSITION	9.00	36X36		LT	"B" 848+00	4R
					PAVEMENT WIDTH TRANSITION	9.00	36X36		RT	"B" 848+00	5R
					WRONG WAY	6.00	36X24		LT	"A8" 862+00	6R
					WRONG WAY	6.00	36X24		RT	"A8" 862+00	7R
					KEEP 30 DEG ARROW RIGHT	12.00	36X48		RT	"TC1" 3+40	8R
					DO NOT ENTER	9.00	36X36		RT	"X" 876+57	9R
					CURVE LEFT	6.25	30X30		RT	"X" 879+10	10R
					LAUGHLIN TURN OFF 1/2 MILE	19.25	66X42		RT	"X" 884+38	11R
					DO NOT PASS	12.00	36X48		RT	"X" 886+57	12R
BACK TO BACK MOUNTING					TWO WAY TRAFFIC NO PASSING ZONE	9.00 5.56	36X36 48X48X36		RT	"X" 886+57	13R
					REVERSE CURVE	9.00	36X36		LT	"X" 896+62	14R
					BEGIN DIVIDED HIGHWAY	9.00	36X36		LT	"X" 906+62	15R

SUM01

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-1636(6)	CLARK	TS-12

SIGN SUMMARY

REMARKS	POST				MESSAGE	SIGN AREA	PANEL SIZE	SIGN NO.	LOC	STATION	INST NO.
	LENGTH		NO.	TYPE & SIZE							
	OUTER	INNER									
					HILL (SYMBOL)	6.25	30X30		RT	"CO" 5+93	28R
					TRUCKS USE LOWER GEAR	3.00	24X18				
					STOP AHEAD (SYMBOL)	9.00	36X36		LT	"CO" 6+33	29R
					DO NOT PASS	5.00	24X30		LT	"CO" 9+65	30R
					NO PASSING ZONE	5.56	48X48X36		RT	"CO" 9+65	31R
RESET PANEL TO INSTALLATION 23					LAKE MEAD NATIONAL RECREATION AREA	40.00	120X48		RT	"CO" 11+54	32R
					CURVE LEFT	6.25	30X30		RT	"CO" 16+54	33R
					NO PASSING ZONE	5.56	48X48X36		LT	"CO" 22+50	34R
					DO NOT PASS	5.00	24X30		RT	"CO" 22+50	35R
					PASS WITH CARE	5.00	24X30		LT	"CO" 24+59	36R
					T-SYMBOL	6.25	30X30		LT	"CO" 28+22	37R
					1/2 MILE	2.25	18X18				
					PASS WITH CARE	5.00	24X30		RT	"CO" 31+62	38R
					DO NOT PASS	5.00	24X30		LT	"CO" 36+72	39R
					NO PASSING ZONE	5.56	48X48X36		RT	"CO" 36+72	40R
					CURVE RIGHT	6.25	30X30		LT	"CO" 38+71	41R

FED. AID PROJ. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	TS-13

SIGN SUMMARY

REMARKS	POST LENGTH OUTER	POST LENGTH INNER	POST NO.	POST TYPE & SIZE	MESSAGE	SIGN AREA	PANEL SIZE	SIGN NO.	LOC	STATION	INST NO.
		12'-7"	1	2 1/2" SQ 12 GA	FLASH FLOOD AREA	9.00	36X36	NFF-1	LT	"C" 778+50	1
		11'-4"	1	3" DIA RND MTL	ICT U.S. 95 20	30.00	90X48	SPCL	LT	"A8" 899+00	2
					SEARCHLIGHT 39						
					LAS VEGAS 95						
		12'-4"	1	2 1/2" SQ 12 GA	SPEED LIMIT 55	12.00	36X48	R2-1	LT	"A8" 900+00	3
		11'-7"	1	2 1/2" SQ 10 GA	CARDINAL DIR-WEST	3.13	30X15	M3-4	LT	"A8" 901+00	4
					NEVADA ST ROUTE 163	4.00	24X24	M1-5SI			
					TO MARKER	2.00	24X12	M4-5			
					INTERSTATE 40	4.00	24X24	M1-1			
					UP ARROW	2.19	21X15	M6-3			
		10'-4"	1	3" DIA RND MTL	LT ARROW DAVIS DAM	40.00	96X60	SPCL	RT	"B" 899+40	5
					LAUGHLIN						
					BULLHEAD CITY RT ARROW						
					KINGMAN						
					HOSPITAL (SYMBOL)	4.00	24X24	D9-2			
					AIRPORT (SYMBOL)	4.00	24X24	1-5			
		12'-7"	1	2 1/2" SQ 12 GA	MERGE	16.00	48X48	W4-1	LT	"A8" 902+50	6
		10'-11"	1	2 1/2" SQ 12 GA	YIELD	3.90	36X36X36	R1-2	LT	"D1" 1+50	7
		10'-10"	1	2 1/2" SQ 12 GA	STOP	6.25	30X30	R1-1	RT	"D" 0+25	8
		12'-4"	1	2 1/2" SQ 12 GA	KEEP RIGHT (SYMBOL)	12.00	36X48	W3-3	RT	"A8" 905+10	9
		11'-4"	1	2 1/2" SQ 12 GA	NO RIGHT TURN (SYMBOL)	6.25	36X36	R3-1	RT	"A8" 905+00	10

FED. RD. PROJ. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	TS-14

SIGN SUMMARY

REMARKS	POST LENGTH OUTER	POST LENGTH INNER	POST NO.	POST TYPE & SIZE	MESSAGE	SIGN AREA	PANEL SIZE	SIGN NO.	LOC	STATION	INST NO.
		13'-6"	1	2 1/2" SQ 10 GA	CARDINAL DIR-EAST	2.19	21X15	M3-2	RT	"A8" 905+30	11
					NEVADA SR 163	4.00	24X24	M1-5SI			
					LARGE ARROW	8.00	48X24	W1-6			
		12'-4"	1	3" DIA RND MTL	ICT U.S. 95 RT ARROW	42.50	102X60	SPCL	LT	"D" 7+00	12
					LAS VEGAS						
					LAUGHLIN						
					LT ARROW BULLHEAD CITY						
		11'-6"	1	2 1/2" SQ 12 GA	JUNCTION MARKER	2.19	21X15	M2-1	LT	"D" 8+00	13
					NEVADA SR 163	4.00	24X24	M1-5SI			
		10'-4"	1	3" DIA RND MTL	DAVIS DAM 1	18.00	72X36	SPCL	RT	"D" 8+00	14
					KINGMAN 31						
		11'-4"	1	2 1/2" SQ 12 GA	DO NOT ENTER	9.00	36X36	R5-1	LT	"A8" 907+00	15
		11'-4"	1	2 1/2" SQ 12 GA	DO NOT ENTER	9.00	36X36	R5-1	RT	"A8" 907+00	16
		10'-10"	1	2 1/2" SQ 12 GA	MANDATORY TURN (RIGHT)	6.25	30X30	R3-7R	LT	"A8" 909+00	17
		11'-6"	1	2 1/2" SQ 12 GA	CARDINAL DIR-EAST	2.19	21X15	M3-2	RT	"B" 909+00	18
					NEVADA SR 163	4.00	24X24	M1-5SI			
		10'-4"	1	2 1/2" SQ 12 GA	WRONG WAY	6.00	36X24	R5-1A	LT	"A8" 910+00	19
		10'-4"	1	2 1/2" SQ 12 GA	WRONG WAY	6.00	36X24	R5-1A	RT	"A8" 910+00	20
		11'-4"	1	3" DIA RND MTL	DAVIS DAM RT ARROW	26.00	78X48	SPCL	LT	"A8" 910+50	21
					ICT U.S. 95 UP ARROW						
					LAS VEGAS						

FED. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	TS-15

SIGN SUMMARY

REMARKS	POST LENGTH OUTER	POST LENGTH INNER	POST NO.	POST TYPE & SIZE	MESSAGE	SIGN AREA	PANEL SIZE	SIGN NO.	LOC	STATION	INST NO.
		11'-4"	1	3" DIA RND MTL	LAUGHLIN 1	30.00	90X48	SPCL	RT	"B" 911+00	22
					BULLHEAD CITY 2						
					KINGMAN 34						
RESET PANEL FROM 31R	10'-4"	10'-4"	2	3" DIA RND MTL	LAKE MEAD NATIONAL	40.00	120X48	RESET	LT	"A8" 922+50	23
					RECREATION AREA						
4 FT MOUNTING HEIGHT		7'-6"	1	2 1/2" SQ 12 GA	T1 OBJECT MARKER (RED)	2.25	18X18	OM-1	LT		24
4 FT MOUNTING HEIGHT		7'-6"	1	2 1/2" SQ 12 GA	T1 OBJECT MARKER (RED)	2.25	18X18	OM-1	CL		25
4 FT MOUNTING HEIGHT		7'-6"	1	2 1/2" SQ 12 GA	T1 OBJECT MARKER (RED)	2.25	18X18	OM-1	RT		26
		12'-4"	1	2 1/2" SQ 12 GA	REDUCED SPEED AHEAD	12.00	36X48	R2-5A	LT	"B" 965+00	27
		12'-4"	1	2 1/2" SQ 12 GA	REDUCED SPEED AHEAD	12.00	36X48	R2-5A	RT	"B" 965+00	28
		12'-4"	1	2 1/2" SQ 12 GA	SPEED LIMIT 55	12.00	36X48	R2-1	LT	"A8" 970+00	29
		12'-4"	1	2 1/2" SQ 12 GA	SPEED LIMIT 55	12.00	36X48	R2-1	RT	"A8" 970+00	30
		12'-4"	1	2 1/2" SQ 12 GA	SPEED LIMIT 45	12.00	36X48	R2-1	LT	"B" 970+00	31
		12'-4"	1	2 1/2" SQ 12 GA	SPEED LIMIT 45	12.00	36X48	R2-1	RT	"B" 970+00	32
		12'-7"	1	2 1/2" SQ 12 GA	END DIVIDED HIGHWAY	9.00	36X36	W6-2	LT	"B" 990+24	33
		12'-7"	1	2 1/2" SQ 12 GA	END DIVIDED HIGHWAY	9.00	36X36	W6-2	RT	"B" 990+24	34
		12'-4"	1	2 1/2" SQ 12 GA	SPEED LIMIT 45	12.00	36X48	R2-1	LT	"A8" 995+00	35

FED. ROAD PROJ. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-1636(6)	CLARK	TS-16

SIGN SUMMARY

REMARKS	POST LENGTH OUTER	POST LENGTH INNER	POST NO.	POST TYPE & SIZE	MESSAGE	SIGN AREA	PANEL SIZE	SIGN NO.	LOC	STATION	INST NO.
		12'-4"	1	2 1/2" SQ 12 GA	SPEED LIMIT 45	12.00	36X48	R2-1	RT	"A8" 995+00	36
		12'-4"	1	2 1/2" SQ 12 GA	SPEED LIMIT 35	12.00	36X48	R2-1	LT	"A8" 995+00	37
		12'-4"	1	2 1/2" SQ 12 GA	SPEED LIMIT 35	12.00	36X48	R2-1	RT	"A8" 995+00	38
		12'-4"	1	2 1/2" SQ 12 GA	KEEP RIGHT (SYMBOL)	12.00	36X48	R4-7	LT	"C" 995+00	39
		12'-7"	1	2 1/2" SQ 12 GA	BEGIN DIVIDED HIGHWAY	9.00	36X36	W6-1	LT	"C" 1000+00	40
		10-10"	1	2 1/2" SQ 12 GA	MANDATORY TURN (RIGHT)	6.25	30X30	R3-7R	RT	"C" 1002+00	41
		11'-4"	1	3" DIA RND MTL	LAUGHLIN RT ARROW KINGMAN UP ARROW BULLHEAD CITY	26.00	78X48	SPCL	RT	"C" 1004+50	42
		11'-4"	1	2 1/2" SQ 12 GA	RIGHT TURN ARROWS-ONLY	7.50	30X36	NRT-2	RT	"C" 1008+00	43
		12'-4"	1	3" DIA RND MTL	KINGMAN RT ARROW BULLHEAD CITY LT ARROW ICT US 95 LAS VEGAS	42.50	102X60	SPCL	RT		44

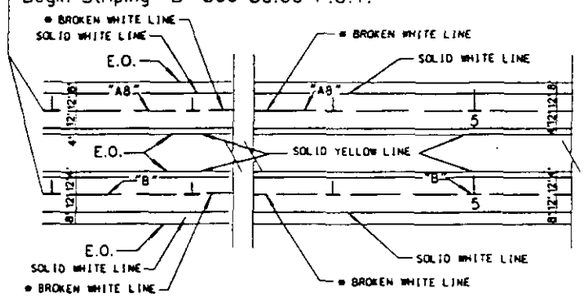
FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-1631(6)	CLARK	ST1

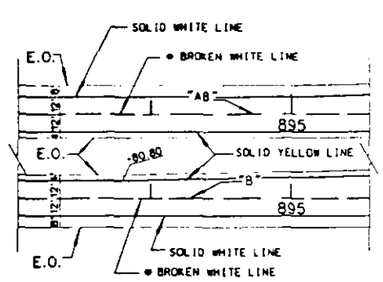
Begin Striping "A8" 866+00.00 P.O.T.

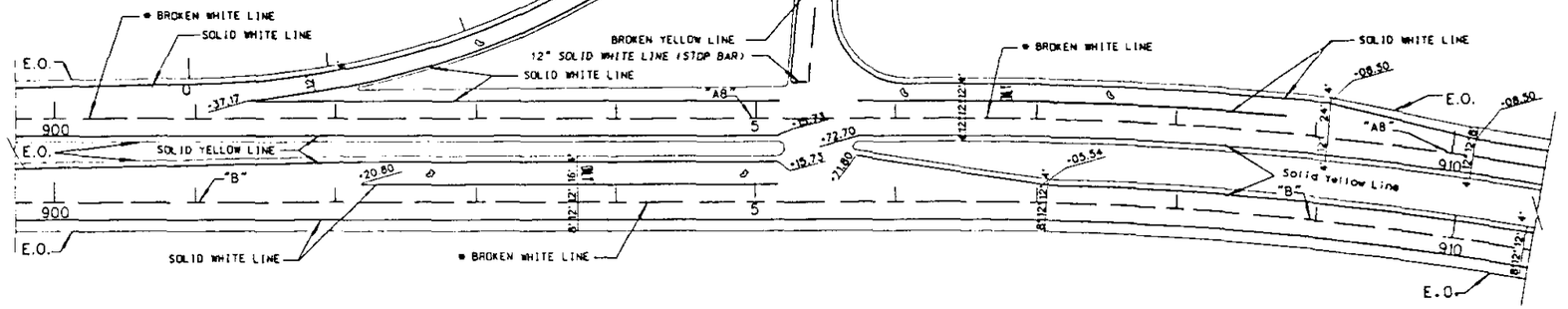
Begin Striping "B" 866+00.00 P.O.T.

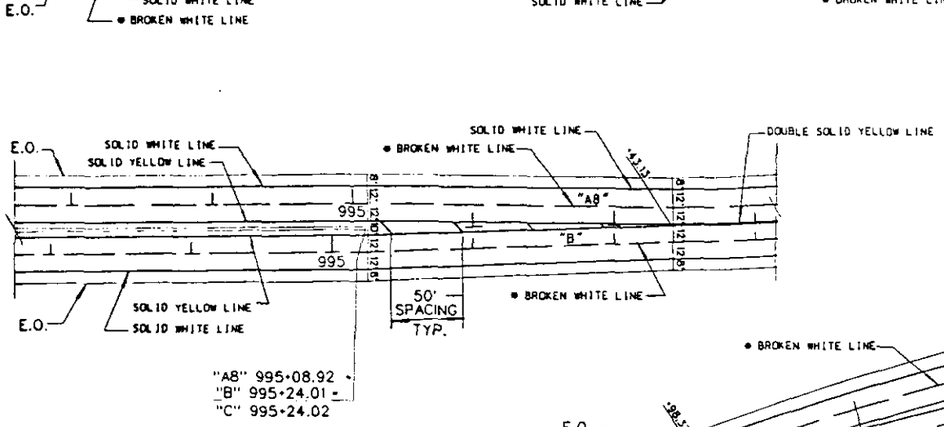
* - PERMANENT PAVEMENT MARKERS

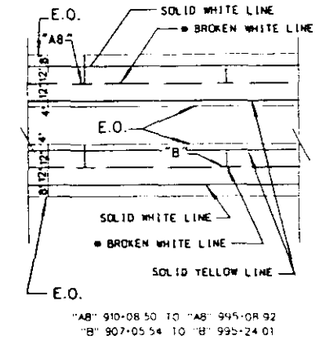
** >>>> - 25' SPACING (TYP.)



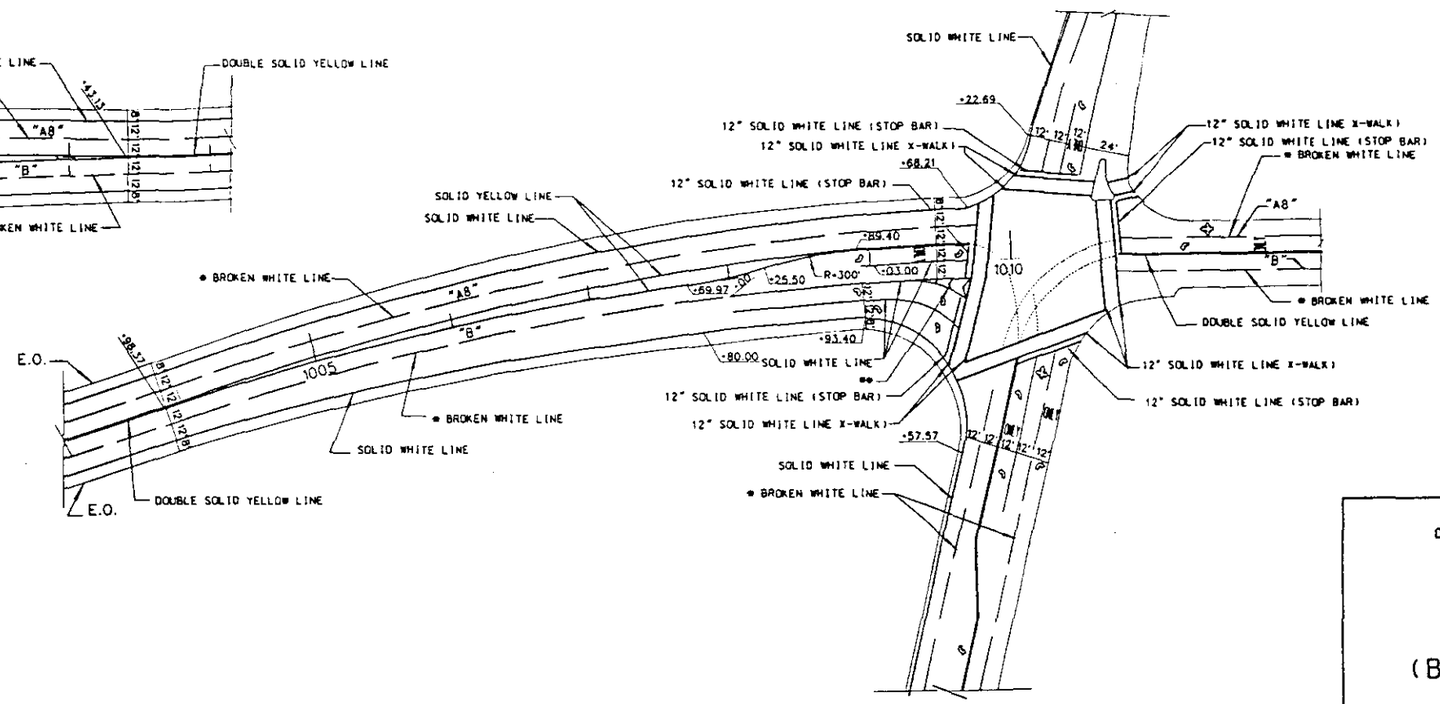








"A8" 910+08.50 TO "A8" 995+08.92
"B" 907+05.54 TO "B" 995+24.01



STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

PERMANENT STRIPING
(BY STATE FORCES)

HYDROLOGIC DATA

STATION	STRUCTURE LIST	DESIGN FLOOD Q(50)		BASIC FLOOD Q(100)		FLOOD OF RECORD Q (R)		
		DISCHARGE IN C.F.S.	WATER SURFACE ELEVATION AT INLET	DISCHARGE IN C.F.S.	WATER SURFACE ELEVATION AT INLET	DISCHARGE IN C.F.S.	WATER SURFACE ELEVATION AT INLET	DATE
"B" 914+72	5' X 3' RCBC	120	870.2	168	871.5	- - -	- - -	- - -
"B" 920+95	30" CMP	20	846.4	28	848.0	- - -	- - -	- - -
"B" 928+50	8' X 4' RCBC	317	827.7	275	827.1	- - -	- - -	- - -
"A8" 959+28	5' X 3' RCBC	47	724.9	65	724.9	- - -	- - -	- - -
"B" 978+00	30'CMP	17	627.4	23	627.9	- - -	- - -	- - -
"A8" 986+58	12' X 7' RCBC	569	607.3	843	608.5			
"C" 995+80	10' X 3' RCBC	574	580.2	854	581.2			
"C" 999+55.33	78" RCP STORM SEWER	589	554.8	876	554.8			
"C" 1003+32	30" RCP STORM SEWER	23	543.5	32	543.5			

- Note: Where Q_{100} overtops proposed dikes, the elevation shown herein is the top of dike elevation.
- ** Note: This culvert was designed to accomodate the 50-year flood event for the total area tributary to "B" 914+72, "B" 920+95 and "B" 928+50.

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-1636()	CLARK	H1

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	SD1

STORM DRAIN SCHEDULE

SHEET NO.	STRUCTURE - LINE NO.	LOCATION STA.	LOCATION OFFSET	STRUCTURE TYPE TYPE 7 D.I.	STRUCTURE TYPE TYPE 4 MANHOLE (MODIFIED)	ELEVATION GRATE, RIM OR COVER	ELEVATION INVERT IN	ELEVATION INVERT OUT	LINE, SIZE AND LENGTH SLOPE FT./FT.	603 0073 30" CLASS III	603 0213 78" CLASS II	603 0243 84" CLASS III	REMARKS	QUANTITIES STRUCTURE EXCAVATION 206 0100	GRANULAR BACKFILL 207 0200	CLASS A CONCRETE (MINOR) 502 0101	REINFORCING STEEL 505 0100	STRUCTURAL STEEL GRATE 609 0200	48" PRECAST REINFORCED CONCRETE MAN-HOLE TYPE 4 609 0465
		"C"																	
		999+29.00					550.0	543.0					CONSTRUCT SPECIAL MITERED INLET	94	24	54	3783		
		999+55.33	60' rt.																
									0.0216	250			Q(50)=589 cfs *	3228	1782				
		1002+00.00	60' rt.		1	558.8	537.59	537.59					h=21.21	222	190				1
									0.0216	189			Q(50)=593 cfs *	3228	1782				
		1003+78.19	80' rt.		1	564.2	533.5	533.5					h=20.7	217	188				1
									0.00923		271		Q(50)=593 cfs *	3372	1224				
		1006+55.00	80' rt.				---	531.0											
													*(SEE SHEETS NOS. 10, 27-29)						
		1002+99.00	57' lt.	1		540.04	536.7	---					CONSTRUCT DIKE AT INLET	219	83	1.41	68	117	
									0.0203	158			TOP OF DIKE ELEV.=543.5 Q=23 CFS.						
		1003+78.19	80' rt.				---	533.5											
								TOTALS	158	439	271			10580	5251	55.41	3851	117	2

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	S-01

STRUCTURE LIST

LOOP DETECTOR (6-FOOT X 6-FOOT) 623 7000	NO. 5 PULL BOX 623 2050	GUARDRAIL-BARRIER RAIL CONNECTION (TRIPLE CORR.) 618 9701	BREAKAWAY CABLE TERMINAL 618 9600	GALVANIZED GUARDRAIL (TRIPLE CORR.) 618 0201	GALVANIZED GUARDRAIL 618 0200	FILTER BLANKET 610 0900	GROUTED RIPRAP 610 0300	HEAVY RIPRAP 610 0200	MEDIUM RIPRAP 610 0120	LIGHT RIPRAP 610 0110	3-INCH POLYVINYL CHLORIDE PIPE (SDR-21) 609 8132	STRUCTURAL STEEL GRATE 609 0200	12-INCH METAL END SECTION (DOWNDRAIN) 608 0340	12-INCH DOWNDRAIN PIPE 608 0320	ANCHOR ASSEMBLY 608 0150	EMBANKMENT PROTECTOR (TYPE 5) 608 0050	24-INCH REINFORCED CONCRETE PIPE CLASS III 603 0053	30-INCH END SECTION 600 1300	24-INCH END SECTION 600 1240	30-INCH CULVERT PIPE 600 0300	24-INCH CULVERT PIPE 600 0240	REINFORCING STEEL 505 0100	CLASS A CONCRETE (MAJOR MODIFIED) 502 3100	CONCRETE BARRIER RAIL (TYPE A) 502 0610	CLASS A CONCRETE (MINOR) 502 0101	PLANTMIX MISCELLANEOUS AREAS 402 5000	ROCK COLORING 212 0260	GRANULAR BACKFILL 207 0200	STRUCTURE EXCAVATION 206 0100	V-TYPE DITCH 203 0800	CHANNEL EXCAVATION 203 0300	REMOVAL OF HEADWALL 202 4600	REMOVAL OF COMPOSITE SURFACES 202 3103	REMOVAL OF CULVERT PIPE 202 1500	REMOVE AND RESET GUARDRAIL 202 0829	DESCRIPTION	TO STATION STATION
																																					BARRIER RAIL AND GUARDRAIL	
																																					REMOVE GUARDRAIL LT. AND EXTEND BARRIER RAIL (TYPE A) 732'. RESET GUARDRAIL LT. AND CONNECT TO CONCRETE BARRIER RAIL WITH GUARDRAIL-BARRIER RAIL CONNECTOR.	"C" 783+68.75 to "C" 791+37.50
																								732		233									37		
																																					INSTALL CONCRETE BARRIER RAIL (TYPE A) LT.	"A8" 958+50.00 to "C" 996+00.00
																								373		118											
																																					INSTALL GALVANIZED GUARDRAIL LT. WITH B.C.T. (W=4). CONNECT TO BARRIER RAIL WITH GUARDRAIL-BARRIER RAIL CONNECTOR.	"C" 996+00.00 to "C" 996+81.25
		1	1	31.25	25																																
																																					INSTALL GALVANIZED GUARDRAIL RT. WITH B.C.T. (W=4). CONNECT TO BARRIER RAIL WITH GUARDRAIL-BARRIER RAIL CONNECTOR.	"B" 958+18.75 to "B" 959+00.00
		1	1	31.25	25																																
																																					INSTALL CONCRETE BARRIER RAIL (TYPE A) RT.	"B" 959+00.00 to "C" 1008+50.00
																								4350		1575											
																																					INSTALL GALVANIZED GUARDRAIL RT. WITH B.C.T. (W=4). CONNECT TO BARRIER RAIL WITH GUARDRAIL-BARRIER RAIL CONNECTOR.	"C" 1008+50.00 to "C" 1009+31.25
		1	1	31.25	25																																
																																					DRAINAGE	
																																					REMOVE EXISTING 24" X 90' CULVERT PIPE AND HEADWALLS LT. AND RT.	"CO" 0+95 +-
																																			2	90	
																																					REMOVE EXISTING 30" X 78' CULVERT PIPE AND HEADWALL LT.	"CO" 4+48 +-
																																			1	78	
																																					REMOVE EXISTING 18" X 160' CULVERT PIPE AND HEADWALL LT.	"CO" 6+20 +-
																																			1	160	
																																					REMOVE EXISTING 24" X 75' CULVERT PIPE AND HEADWALL LT.	"CO" 8+42 +-
																																			1	75	
																																					REMOVE EXISTING 18" X 80' CULVERT PIPE AND HEADWALL LT.	"CO" 8+55 +-
																																			1	80	
																																					REMOVE EXISTING 24" X 88' CULVERT PIPE AND HEADWALL LT.	"CO" 10+90 +-
																																			1	88	
																																					PLUG AND ABANDON EXISTING CULVERT PIPE (NO DIRECT PAYMENT).	"CO" 14+15 +-
																																					PLUG AND ABANDON EXISTING CULVERT PIPE (NO DIRECT PAYMENT).	"CO" 15+91 +-
																																				80	REMOVE EXISTING 36" X 80' CULVERT PIPE.	"CO" 18+91 +-

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	S-02

STRUCTURE LIST

LOOP DETECTOR 16-FOOT X 6-FOOT) 623 7000	NO. 5 PULL BOX 623 2050	GUARDRAIL-BARRIER RAIL CONNECTION (TRIPLE CORR.) 618 9701	BREAKAWAY CABLE TERMINAL 618 9600	GALVANIZED GUARDRAIL (TRIPLE CORR.) 618 0201	GALVANIZED GUARDRAIL 618 0200	FILTER BLANKET 610 0900	GROUTED RIPRAP 610 0300	HEAVY RIPRAP 610 0200	MEDIUM RIPRAP 610 0120	LIGHT RIPRAP 610 0110	3-INCH POLYVINYL CHLORIDE PIPE (SDR-21) 609 8132	STRUCTURAL STEEL GRATE 609 0200	12-INCH METAL END SECTION (DOWNDRAIN) 608 0340	12-INCH DOWNDRAIN PIPE 608 0320	ANCHOR ASSEMBLY 608 0150	EMBANKMENT PROTECTOR (TYPE 5) 608 0050	24-INCH REINFORCED CONCRETE PIPE CLASS III 603 0053	30-INCH END SECTION 600 1300	24-INCH END SECTION 600 1240	30-INCH CULVERT PIPE 600 0300	24-INCH CULVERT PIPE 600 0240	REINFORCING STEEL 505 0100	CLASS A CONCRETE (MAJOR MODIFIED) 502 3100	CONCRETE BARRIER RAIL (TYPE A) 502 0610	CLASS A CONCRETE (MINOR) 502 0101	PLANTMIX MISCELLANEOUS AREAS 402 5000	ROCK COLORING 212 0260	GRANULAR BACKFILL 207 0200	STRUCTURE EXCAVATION 206 0100	V-TYPE DITCH 203 0800	CHANNEL EXCAVATION 203 0300	REMOVAL OF HEADWALL 202 4600	REMOVAL OF COMPOSITE SURFACES 202 3103	REMOVAL OF CULVERT PIPE 202 1500	REMOVE AND RESET GUARDRAIL 202 0829	DESCRIPTION	TO STATION STATION
																																			90		REMOVE EXISTING 36" X 90' CULVERT PIPE.	"CO" 21+95 +-
																																						CONSTRUCT HEAVY RIPRAP CHANNEL WITH DIKE LT. EXISTING RIPRAP SLOPE TO BE MODIFIED AS SHOWN ON PLANS. (SEE SHEET NO. 22 & 23)	"C" 779+00.00 "C" 800+00.00
						2068		11428		377																	1104				12442						CONSTRUCT MEDIUM RIPRAP CHANNEL WITH DIKE LT. EXISTING RIPRAP SLOPE TO BE MODIFIED AS SHOWN ON PLANS. (SEE SHEET NO. 23)	"C" 800+00.00 "A8" 848+66.00
						1294			6779																		6671				7059						
																																						CONSTRUCT TYPE 2A DROP INLET 59' LT. WITH DIKE. CONNECT TO 24" X 125' CULVERT PIPE 66 DEGREES SKEW LEFT AHEAD WITH END SECTION AT OUTLET. (TOP OF GRATE ELEV.=1419.24, UIE=1416.07, LIE=1414.5, SLOPE=0.0126 FT/FT) (TOP OF DIKE ELEV.=1421.2) (SEE SHEET NO. 25)	"A7" 799+50.00
												1.33								1	125	44		.8		50	75												
																																							CONSTRUCT TYPE 2A DROP INLET 42' LT. WITH DIKE. CONNECT TO 24" X 175' CULVERT PIPE 73 DEGREES SKEW LT. AHEAD WITH END SECTION AT OUTLET. (TOP OF GRATE ELEV.=1352.74, UIE=1349.57, LIE=1348.5, SLOPE=0.0061 FT/FT) (TOP OF DIKE ELEV.=1354.6) (SEE SHEET NO. 25)	"A7" 811+00.00
												1.33								1	175	44		.8		82	103												
																																							CONSTRUCT TYPE 2A DROP INLET 42' LT. WITH DIKE. CONNECT TO 24" X 100' CULVERT PIPE 55 DEGREES SKEW LT. AHEAD WITH END SECTION AT OUTLET. (TOP OF GRATE ELEV.=1263.31, UIE=1259.84, LIE=1259.0, SLOPE=0.0083 FT/FT) (TOP OF DIKE ELEV.=1265.2) (SEE SHEET NO. 25)	"A8" 826+00.00
												1.33								1	100	44		.8		49	62												
																																							CONSTRUCT TYPE 2A DROP INLET 42' LT. CONNECT TO 24" X 60' CULVERT PIPE 71 DEGREES SKEW LT. AHEAD WITH END SECTION AT OUTLET. (TOP OF GRATE ELEV.=1142.06, UIE=1138.89, LIE=1138.0, SLOPE=0.0148 FT/FT)	"A8" 848+66.00
												1.33								1	60	44		.8		31	39												
																																							CONSTRUCT 190' V-DITCH (2' MIN. DEPTH) FROM 45' LT. STA. "A8" 866+00 TO 140' LT. STA. "A8" 867+64.54 (UIE=1059.4, LIE=1051.0, SLOPE=0.0442 FT./FT.) (SEE SHEET NO. 5)	"A8" 866+00.00 "A8" 867+64.54
																																				1.9			
																																						CONSTRUCT 290' V-DITCH (2' MIN. DEPTH) FROM 45' RT. STA. "B"867+00 TO 190' RT. STA. "B" 869+51.15 (UIE=1054.1, LIE=1047.0, SLOPE=0.0245 FT./FT.) (SEE SHEET NO. 5)	"B" 867+00.00 "B" 869+51.15
																																				2.9			

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	S-03

STRUCTURE LIST

LOOP DETECTOR (6-FOOT X 6-FOOT) 623 7000	NO. 5 PULL BOX 623 2050	GUARDRAIL-BARRIER RAIL CONNECTION (TRIPLE CORR.) 618 9701	BREAKAWAY CABLE TERMINAL 618 9600	GALVANIZED GUARDRAIL (TRIPLE CORR.) 618 0201	GALVANIZED GUARDRAIL 618 0200	FILTER BLANKET 610 0900	GROUTED RIPRAP 610 0300	HEAVY RIPRAP 610 0200	MEDIUM RIPRAP 610 0120	LIGHT RIPRAP 610 0110	3-INCH POLYVINYL CHLORIDE PIPE (SDR-21) 609 8132	STRUCTURAL STEEL GRATE 609 0200	12-INCH METAL END SECTION (DOWNDRAIN) 608 0340	12-INCH DOWNDRAIN PIPE 608 0320	ANCHOR ASSEMBLY 608 0150	EMBANKMENT PROTECTOR (TYPE 5) 608 0050	24-INCH REINFORCED CONCRETE PIPE CLASS III 603 0053	30-INCH END SECTION 600 1300	24-INCH END SECTION 600 1240	30-INCH CULVERT PIPE 600 0300	24-INCH CULVERT PIPE 600 0240	REINFORCING STEEL 505 0100	CLASS A CONCRETE (MAJOR MODIFIED) 502 3100	CONCRETE BARRIER RAIL (TYPE A) 502 0610	CLASS A CONCRETE (MINOR) 502 0101	PLANTMIX MISCELLANEOUS AREAS 402 5000	ROCK COLORING 212 0260	GRANULAR BACKFILL 207 0200	STRUCTURE EXCAVATION 206 0100	V-TYPE DITCH 203 0800	CHANNEL EXCAVATION 203 0300	REMOVAL OF HEADWALL 202 4600	REMOVAL OF COMPOSITE SURFACES 202 3103	REMOVAL OF CULVERT PIPE 202 1500	REMOVE AND RESET GUARDRAIL 202 0829	DESCRIPTION	TO STATION STATION

FED. ROAD PROJ. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	S-04

STRUCTURE LIST

LOOP DETECTOR (6-FOOT X 6-FOOT) 623 7000	NO. 5 PULL BOX 623 2050	GUARDRAIL-BARRIER RAIL CONNECTION (TRIPLE CORR.) 618 9701	BREAKAWAY CABLE TERMINAL 618 9600	GALVANIZED GUARDRAIL (TRIPLE CORR.) 618 0201	GALVANIZED GUARDRAIL 618 0200	FILTER BLANKET 610 0900	GROUTED RIPRAP 610 0300	HEAVY RIPRAP 610 0200	MEDIUM RIPRAP 610 0120	LIGHT RIPRAP 610 0110	3-INCH POLYVINYL CHLORIDE PIPE (SDR-21) 609 8132	STRUCTURAL STEEL GRATE 609 0200	12-INCH METAL END SECTION (DOWNDRAIN) 608 0340	12-INCH DOWNDRAIN PIPE 608 0320	ANCHOR ASSEMBLY 608 0150	EMBANKMENT PROTECTOR (TYPE 5) 608 0050	24-INCH REINFORCED CONCRETE PIPE CLASS III 603 0053	30-INCH END SECTION 600 1300	24-INCH END SECTION 600 1240	30-INCH CULVERT PIPE 600 0300	24-INCH CULVERT PIPE 600 0240	REINFORCING STEEL 505 0100	CLASS A CONCRETE (MAJOR MODIFIED) 502 3100	CONCRETE BARRIER RAIL (TYPE A) 502 0610	CLASS A CONCRETE (MINOR) 502 0101	PLANTMIX MISCELLANEOUS AREAS 402 5000	ROCK COLORING 212 0260	GRANULAR BACKFILL 207 0200	STRUCTURE EXCAVATION 206 0100	V-TYPE DITCH 203 0800	CHANNEL EXCAVATION 203 0300	REMOVAL OF HEADWALL 202 4600	REMOVAL OF COMPOSITE SURFACES 202 3103	REMOVAL OF CULVERT PIPE 202 1500	REMOVE AND RESET GUARDRAIL 202 0829	DESCRIPTION	TO STATION STATION
																																					CONSTRUCT 5' X 3' X 157' RCB 30 DEGREE SKEW RT. AHEAD (36' LT. ALONG SKEW AND 121' RT. ALONG SKEW). CONSTRUCT TYPE 1 HEADWALLS LT. AND RT. CONSTRUCT MODIFIED MEDIUM RIPRAP BASIN AT OUTLET. (UIE=722.7 LIE=719.7. SLOPE=0.019 FT./FT.) CONSTRUCT DIKE AT INLET (TOP OF DIKE=724.9) (SEE SHEET NO. 25)	"A8" 959+28.00
																																					CONSTRUCT TYPE 2A DROP INLET 29' RT. CONNECT TO 5' X 3' RCB WITH 24" X 5' CULVERT PIPE. (TOP OF GRATE=725.83, UIE= 722.66, LIE=722.22, SLOPE=0.088 FT./FT.) RESHAPE SLOPE AT INLET (USE EQUIPEMENT HOURS) CONSTRUCT MEDIAN DIKE. (SEE SHEET NO. 25)	"A8" 959+40.00
																																						CONSTRUCT SPECIAL RIPRAP LINED CHANNEL 31.5' LT. (SEE SHEET NO. 25)	"A8" 964+00.00 "A8" 976+32.00
																																						CONSTRUCT TYPE 2A DROP INLET WITH DIKE 29.5' RT. CONNECT TO 24" X 163' CULVERT PIPE TOP OF GRATE ELEV.=657.88, TOP OF DIKE ELEV.=658.83) (SEE SHEET NO. 25)	"B" 975+20.50
																																						INSTALL 24" X 164' CULVERT PIPE 45 DEGREE SKEW (122' LT. AHEAD ALONG SKEW AND 42' RT. ALONG SKEW) CONSTRUCT TYPE 3 PIPE RISER INLET H=3.57) WITH MEDIAN DIKE 29' LT. (TOP OF GRATE=656.18) (UIE=654.71, LIE=649.86, SLOPE=0.03 FT./FT.) CONNECT TO DROP INLETS LT. AND RT. (SEE SHEET NOS. 24 & 25)	"B" 975+50.00
																																						CONSTRUCT TYPE 7 DROP INLET (86.7' LT.) WITH DIKE AT BASE OF RIPRAP LINED CHANNEL. CONNECT TO 24" X 164' CULVERT PIPE LT. AND 30" X 175' CMP AHEAD. (TOP OF GRATE ELEV.= 653.20, TOP OF DIKE ELEV.=654.15) (SEE SHEET NO. 25)	"B" 976+36.66
																																						INSTALL 30" X 175' CULVERT PIPE 86.7' LT. WITH STANDARD MEDIUM RIPRAP BASIN AT OUTLET CONNECT TO TYPE 7 DROP INLET AT "A8" 976+39.10 (UIE=649.86, LIE=620.0. SLOPE=0.1706)	"B" 976+36.66 "B" 977+81.00
																																						INSTALL 30" X 167' CULVERT PIPE 23 DEGREE SKEW LT. AHEAD (115' LT. ALONG SKEW AND 52' RT. ALONG SKEW). INSTALL MODIFIED END SECTIONS LT. AND RT. CONSTRUCT MEDIUM RIPRA BASIN AT OUTLET. (UIE=625.3, LIE=619.7, SLOPE=0.034 FT./FT.) (SEE SHEET NO. 25)	"B" 978+00.00

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	S-05

STRUCTURE LIST

LOOP DETECTOR (6-FOOT X 6-FOOT) 623 7000	NO. 5 PULL BOX 623 2050	GUARDRAIL-BARRIER RAIL CONNECTION (TRIPLE CORR.) 618 9701	BREAKAWAY CABLE TERMINAL 618 9600	GALVANIZED GUARDRAIL(TRIPLE CORR.) 618 0201	GALVANIZED GUARDRAIL 618 0200	FILTER BLANKET 610 0900	GROUTED RIPRAP 610 0300	HEAVY RIPRAP 610 0200	MEDIUM RIPRAP 610 0120	LIGHT RIPRAP 610 0110	3-INCH POLYVINYL CHLORIDE PIPE (SDR-21) 609 8132	STRUCTURAL STEEL GRATE 609 0200	12-INCH METAL END SECTION (DOWNDRAIN) 608 0340	12-INCH DOWNDRAIN PIPE 608 0320	ANCHOR ASSEMBLY 608 0150	EMBANKMENT PROTECTOR (TYPE 5) 608 0050	24-INCH REINFORCED CONCRETE PIPE CLASS III 603 0053	30-INCH END SECTION 600 1300	24-INCH END SECTION 600 1240	30-INCH CULVERT PIPE 600 0300	24-INCH CULVERT PIPE 600 0240	REINFORCING STEEL 505 0100	CLASS A CONCRETE (MAJOR MODIFIED) 502 3100	CONCRETE BARRIER RAIL (TYPE A) 502 0610	CLASS A CONCRETE (MINOR) 502 0101	PLANTMIX MISCELLANEOUS AREAS 402 5000	ROCK COLORING 212 0260	GRANULAR BACKFILL 207 0200	STRUCTURE EXCAVATION 206 0100	V-TYPE DITCH 203 0800	CHANNEL EXCAVATION 203 0300	REMOVAL OF HEADWALL 202 4600	REMOVAL OF COMPOSITE SURFACES 202 3103	REMOVAL OF CULVERT PIPE 202 1500	REMOVE AND RESET GUARDRAIL 202 0829	DESCRIPTION	TO STATION STATION
																																					INSTALL TYPE 5 EMBANKMENT PROTECTOR WITH	"A8" 981+00.00
																																					MODIFIED GRATE 29.5' LT. WITH 60' DOWN	
																																						DRAIN. CONSTRUCT STANDARD MEDIUM RIPRAP	
																																						BASIN AT OUTLET. CONSTRUCT DIKE IN DITCH	
																																						33' LT. (TOP OF GRATE=632.21. TOP OF	
									2				1	60	3	1																					DIKE=633.16) (SEE SHEET NO. 25)	
																																						INSTALL TYPE 5 EMBANKMENT PROTECTOR WITH	"B" 984+00.00
																																						MODIFIED GRATE 29.5' RT. WITH 70' DOWN	
																																						DRAIN. CONSTRUCT STANDARD MEDIUM RIPRAP	
																																						BASIN AT OUTLET. CONSTRUCT DIKE IN DITCH	
																																						33.5' RT. (TOP OF GRATE=619.53. TOP OF	
									3				1	70	3	1																					DIKE=620.48) (SEE SHEET NO. 25)	
																																						CONSTRUCT 12' X 7' X 139' RCB 45 DEGREE	"A8" 986+58.00
																																						SKEW RT. AHEAD (39' LT. ALONG SKEW AND	
																																						100' RT. ALONG SKEW). CONSTRUCT TYPE 1	
																																						HEADWALLS LT. AND RT. CONSTRUCT GROUTED	
																																						RIPRAP BASIN AT OUTLET (UIE=600.5,	
																																						LIE=596.4. SLOPE=0.03 FT./FT.)	
																																						CONSTRUCT DIKE AT INLET. INSTALL TYPE	
																																						3 RISER INLET WITH MEDIAN DIKE (H=2.83	
																																						OVER PIPE IN MEDIAN. (TOP OF DIKE ELEV.	
																																						=581.2. TOP OF GRATE ELEV.=608.5)	
																																						(SEE SHEET NOS. 24 & 25)	
																																						CONSTRUCT CULVERT DIKE FROM 47' LT. TO	"A8" 991+50.00
																																						98' LT. (SEE SHEET NO. 25)	"C" 995+60.00
																																						CONSTRUCT 10' X 3' X 167' RCB CULVERT	"C" 995+80.00
																																						45 SKEW RT. AHEAD (94' LT. ALONG SKEW	
																																						AND 73' RT. ALONG SKEW) (UIE=567.2,	
																																						LIE=559.2) CONSTRUCT SPECIAL SLOPING	
																																						TAPERED INLET LT. CONSTRUCT TYPE 1	
																																						HEADWALL RT. OUTLETS TO RIPRAP CHANNEL.	
																																						(SEE SHEET NO. 26)	
																																						CONSTRUCT GROUTED HEAVY RIPRAP LINED	"C" 996+31.62
																																						CHANNEL (SLOPE=0.030 FT./FT.)	"C" 997+07.00
																																						(SEE SHEET NO. 28)	
																																						CONSTRUCT HEAVY RIPRAP LINED CHANNEL	"C" 997+07.00
																																						(SLOPE=0.030 FT./FT.) (SEE SHEET NO. 28)	"C" 998+75.40
																																						CONSTRUCT GROUTED HEAVY RIPRAP LINED	"C" 998+75.40
																																						CHANNEL (SLOPE=0.030 FT./FT.)	"C" 999+29.00
																																						(SEE SHEET NO. 28)	
																																						CONSTRUCT GROUTED RIPRAP DROP STRUCTURE	"C" 999+10.00
																																						95' RT. (SEE SHEET NO. 28)	

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	S-06

STRUCTURE LIST

LOOP DETECTOR (6-FOOT X 6-FOOT) 623 7000	NO. 5 PULL BOX 623 2050	GUARDRAIL-BARRIER RAIL CONNECTION (TRIPLE CORR.) 618 9701	BREAKAWAY CABLE TERMINAL 618 9600	GALVANIZED GUARDRAIL (TRIPLE CORR.) 618 0201	GALVANIZED GUARDRAIL 618 0200	FILTER BLANKET 610 0900	GROUTED RIPRAP 610 0300	HEAVY RIPRAP 610 0200	MEDIUM RIPRAP 610 0120	LIGHT RIPRAP 610 0110	3-INCH POLYVINYL CHLORIDE PIPE (SDR-21) 609 8132	STRUCTURAL STEEL GRATE 609 0200	12-INCH METAL END SECTION (DOWNDRAIN) 608 0340	12-INCH DOWNDRAIN PIPE 608 0320	ANCHOR ASSEMBLY 608 0150	EMBANKMENT PROTECTOR (TYPE 5) 608 0050	24-INCH REINFORCED CONCRETE PIPE CLASS III 603 0053	30-INCH END SECTION 600 1300	24-INCH END SECTION 600 1240	30-INCH CULVERT PIPE 600 0300	24-INCH CULVERT PIPE 600 0240	REINFORCING STEEL 505 0100	CLASS A CONCRETE (MAJOR MODIFIED) 502 3100	CONCRETE BARRIER RAIL (TYPE A) 502 0610	CLASS A CONCRETE (MINOR) 502 0101	PLANTMIX MISCELLANEOUS AREAS 402 5000	ROCK COLORING 212 0260	GRANULAR BACKFILL 207 0200	STRUCTURE EXCAVATION 206 0100	V-TYPE DITCH 203 0800	CHANNEL EXCAVATION 203 0300	REMOVAL OF HEADWALL 202 4600	REMOVAL OF COMPOSITE SURFACES 202 3103	REMOVAL OF CULVERT PIPE 202 1500	REMOVE AND RESET GUARDRAIL 202 0829	DESCRIPTION	TO STATION STATION
																																				CONSTRUCT IMPACT STILLING BASIN 80' RT.	"C" 1006+55.00
																																				(UIE=531.0, LIE=531.0)	"C" 1006+82.50
																							0281			126			133	790						(SEE SHEET NOS. 31-36)	
																																				CONSTRUCT MEDIUM RIPRAP CHANNEL FROM	"C" 1006+82.50
																																				80' RT. TO 74' RT. (UIE=530.2, BW=20',	"C" 1008+50.00
									490																			730				270					LIE=530.0, BW=50')	
																																				LOOP DETECTORS	
																																				INSTALL LOOP DETECTORS IN TRAVEL LANES.	"A8" 866+00.00
																																				CONNECT TO NO. 5 PULL BOX IN MEDIAN.	
																																				INSTALL LOOP DETECTORS IN TRAVEL LANES.	"B" 866+00.00
																																					CONNECT TO NO. 5 PULL BOX IN MEDIAN.	
																																				INSTALL LOOP DETECTORS IN TRAVEL LANES.	"D" 6+50.00
																																					CONNECT TO NO. 5 PULL BOX 20' RT.	
																																				INSTALL LOOP DETECTORS IN TRAVEL LANES.	"A8" 976+00.00
																																					CONNECT TO NO. 5 PULL BOX IN MEDIAN.	
																																				INSTALL LOOP DETECTORS IN TRAVEL LANES.	"B" 976+10.00
																																					CONNECT TO NO. 5 PULL BOX IN MEDIAN.	
																																				INSTALL LOOP DETECTORS IN TRAVEL LANES.	
																																					50' WEST OF LAUGHLIN BRIDGE. CONNECT	
																																					TO NO. 5 PULL BOX 50' LT.	
																																				PLANTMIX MISCELLANEOUS AREAS	
																																				MISCELLANEOUS PLANTMIX AREA	"D" 0+89.34 RT.
																																					"A8" 907+08.50 LT.
																																				MISCELLANEOUS PLANTMIX AREA	"C" 1009+09.38 RT.
																																					"C" 1009+64.91 RT.
																																				MISCELLANEOUS PLANTMIX AREA	"C" 1009+60.87 LT.
																																					"C" 1010+16.13 LT.
																																				REMOVAL OF COMPOSITE SURFACES	
																																				REMOVE COMPOSITE SURFACE DURING TRAFFIC	"TC1" 0+00.00
																																					CONTROL STAGE 3A	"TC1" 10+81.22
																																				REMOVE COMPOSITE SURFACE DURING TRAFFIC	"TC2" 0+00.00
																																					CONTROL STAGES 3A AND 3B.	"X" 924+97.09
																																				REMOVE COMPOSITE SURFACE DURING TRAFFIC	"CO" 0+38.40
																																					CONTROL STAGES 2 AND 3A	"CO" 49+20.00

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	STP-PLH-163(6)	CLARK	S-07

STRUCTURE LIST

DESCRIPTION	TO STATION STATION	LOOP DETECTOR (6-FOOT X 6-FOOT) 623 7000	NO. 5 PULL BOX 623 2050	GUARDRAIL-BARRIER RAIL CONNECTION (TRIPLE CORR.) 618 9701	BREAKAWAY CABLE TERMINAL 618 9600	GALVANIZED GUARDRAIL (TRIPLE CORR.) 618 0201	GALVANIZED GUARDRAIL 618 0200	FILTER BLANKET 610 0900	GROUTED RIPRAP 610 0300	HEAVY RIPRAP 610 0200	MEDIUM RIPRAP 610 0120	LIGHT RIPRAP 610 0110	3-INCH POLYVINYL CHLORIDE PIPE (SDR-21) 609 8132	STRUCTURAL STEEL GRATE 609 0200	12-INCH METAL END SECTION (DOWNDRAIN) 608 0340	12-INCH DOWNDRAIN PIPE 608 0320	ANCHOR ASSEMBLY 608 0150	EMBANKMENT PROTECTOR (TYPE 5) 608 0050	24-INCH REINFORCED CONCRETE PIPE CLASS III 603 0053	30-INCH END SECTION 600 1300	24-INCH END SECTION 600 1240	30-INCH CULVERT PIPE 600 0300	24-INCH CULVERT PIPE 600 0240	REINFORCING STEEL 505 0100	CLASS A CONCRETE (MAJOR MODIFIED) 502 3100	CONCRETE BARRIER RAIL (TYPE A) 502 0610	CLASS A CONCRETE (MINOR) 502 0101	PLANTMIX MISCELLANEOUS AREAS 402 5000	ROCK COLORING 212 0260	GRANULAR BACKFILL 207 0200	STRUCTURE EXCAVATION 206 0100	V-TYPE DITCH 203 0800	CHANNEL EXCAVATION 203 0300	REMOVAL OF HEADWALL 202 4600	REMOVAL OF COMPOSITE SURFACES 202 3103	REMOVAL OF CULVERT PIPE 202 1500	REMOVE AND RESET GUARDRAIL 202 0829
REMOVE COMPOSITE SURFACE LEFT AS DEPICTED	"C" 783+68.75																																				
ON TYPICALS. WIDEN FOR BARRIER RAIL AND	"C" 791+37.50																																				
GUARDRAIL.																																	106			
REMOVE COMPOSITE SURFACE DURING TRAFFIC	"SF1" 2+27.93																																				
CONTROL STAGE 3A	"SF1" 9+61.48																																460				
REMOVE COMPOSITE SURFACE AFTER COMPLETION	"A8" 890+00.00 RT																																				
OF TRAFFIC CONTROL STAGE 3B	"A8" 898+50.00 RT																																346				
REMOVE COMPOSITE SURFACE DURING TRAFFIC	"SF4" 0+00.00																																				
CONTROL STAGE 3B	"SF4" 4+50.00																																282				
REMOVE COMPOSITE SURFACE AFTER COMPLETION	"A8" 949+50.00 RT																																				
OF TRAFFIC CONTROL STAGE 3B	"A8" 858+00.00 RT																																349				
REMOVE COMPOSITE SURFACE DURING TRAFFIC	"SF7" 1+19.74																																				
CONTROL STAGE 3A	"SF7" 5+13.15																																155				
TOTAL		14	4	3	3	93.7	75	4931	1371	2245	7364	256	3770	1721	2	130	6	2	13	4	5	634	714	2702.008	941	151.7	2.4	25872	5534	934	9.4	25571	7	12337	741	37.1
USE-TOTAL		14	4	3	3	94	75	4940	1380	2245	7370	260	3770	1721	2	130	6	2	13	4	5	634	714	2702	509	942	170	270	25870	5540	935	10	25580	7	12340	741	38

CONSTRUCTION ITEMS

1. CONSTRUCT A.C. PAVING
2. CONSTRUCT "L" TYPE CURB & GUTTER PER DETAIL 2 ON SHEET C33
3. CONSTRUCT 5' SIDEWALK PER DETAIL B ON SHEET C33
4. ADJUST EXISTING SEWER MANHOLE TO PROPOSED FINISH GRADE
5. ADJUST EXISTING ELECTRICAL MANHOLE TO PROPOSED FINISH GRADE BY OTHERS
6. ADJUST EXISTING TELEPHONE MANHOLE TO PROPOSED FINISH GRADE
7. ADJUST EXISTING WATER VALVE TO PROPOSED FINISH GRADE PER DETAIL 4 ON SHEET C34
8. CONSTRUCT WHEELCHAIR RAMP PER DETAIL 1 ON SHEET C34

REMOVAL ITEMS

- E REMOVE EXISTING ASPHALT PAVING
- B REMOVE AND RELOCATE TRAFFIC SIGN- SEE TRAFFIC SIGNING AND STRIPING SHEETS

CULVERTS

STATION	TYPE	LENGTH	SLOPE	SKEW	REMARKS
479+67.27	(6) 10'x 5' RCBs	140 LF (67' LT., 73' RT.)	0.0077 FT/FT	30 DEGREES	TYPE I HEADWALLS LT. AND RT. RIPRAP BASIN LT.& RT., SEE DETAIL, SHEET SD2, SD13.

UNDEVELOPED

CONSTRUCT CUT-OFF WALL AT BACK OF SIDEWALK/EDGE OF AC PER DETAIL 3/34 STA. 460+00 TO 539+03.22

STREETLIGHTS SHOWN FOR INFORMATIONAL PURPOSES ONLY. REFER TO TRAFFIC SHEETS FOR DETAILS.

ADJUST EXISTING ROAD TO GRADE, ELEVATION TO REMAIN 8.5' (977.5) ABOVE CULVERT INVERT GRADE TO MATCH EXISTING

CONSTRUCT AC TRANSITION

MATCHLINE STA. 473+00.00 SEE SHEET C19

MATCHLINE STA. 485+00.00 SEE SHEET C21

STA. 484+04.47 ℄ 40' COMM. DRIVW'Y

STA. 480+28.50 END C&G, SW 978.54 TC

SEE GRADING PLAN, SHEET SD10.

STA. 482+86.85 NEEDLES HWY.

STA. 10+00.00 DESERT ROAD

STA. 482+31.43 SECTION LINE

16 SECTION LINE 21

BLM

MOHAVE GENERATING PLANT PROPERTY

MOHAVE GENERATING PLANT PROPERTY (CAUTION! HIGH VOLTAGE OVERHEAD LINES)

TELEPHONE LINES TO BE ADJUSTED BY OTHERS

DESERT ROAD (SEE PROFILE, SHEET C29)

S 1/4 SEC 16

APPROXIMATE GRADING LIMITS

EX. GAS TO BE EXTENDED BY OTHERS

CONSTRUCT (6) 10'X 5' RCBs, SEE PROFILE, SHEET SD1

4" GAS LINE TO BE RELOCATED BY SOUTHWEST GAS

℄ CURVE DATA
Δ = 05°51'21"
R = 2000.00'
L = 204.41'
T = 102.29'

N 00°19'19" W

N 05°32'02" E

S 89°53'23" E

313 LF ROAD SECTION PER DETAIL 18/32

287 LF ROAD SECTION PER DETAIL 19/32

78 LF PER DETAIL 20/32

50.5 LF PER DETAIL 6/31

11.5 LF PER DETAIL 6/31

168.05 LF ROAD SECTION PER DETAIL 21/32

176.79 LF INTERSECTION

115.12 LF ROAD SECTION PER DETAIL 21/32

CURVE TABLE (TO EDGE OF PAVEMENT)

CURVE	RADIUS	LENGTH	TANGENT	DELTA
C1	60.00'	88.57'	54.57'	84°34'32"
C2	60.00'	99.93'	65.97'	95°23'28"

NEEDLES HIGHWAY
SCALE: 1"=40'

Avoid cutting underground utility lines. It's costly.

Call before you Dig
1-800-227-2600

SUPERELEVATION

STA. 475+55.00 BEGIN TRANSITION TO SUPERELEVATION

STA. 478+99.00 BEGIN FULL SUPERELEVATION

STA. 479+31.00 END FULL SUPERELEVATION

STA. 482+75.00 END TRANSITION FROM SUPERELEVATION

LT. EDGE OF AC TRANSITION

RT. EDGE OF AC

2%

-2%

STA. 480+28.50 END C, G, AND SW 978.30 TC

800' VC
PVI STA = 480+00
PVI ELEV = 981.00
A.D. = 2.43
K = 329.74

700' VC
PVI STA = 470+50
PVI ELEV = 944.38
A.D. = 2.15
K = 326.30

EVC STA = 474+00 EVC ELEV = 967.34

EVC STA = 474+00 EVC ELEV = 957.87

BVC STA = 476+00 BVC ELEV = 964.58

EVC STA = 484+00 EVC ELEV = 986.71

S = +3.85%

S = +3.83%

S = +1.43%

WEST TOP OF CURB

℄

PROPOSED FINISHED GRADE AT ℄

APPROXIMATE EXISTING GRADE AT PROPOSED ℄

STA. 479+65 (6) 10'x5' RCB's 968.56 INV @ ℄

PROPOSED FINISHED GRADE ELEVATION AT ℄, TYP.

953.86 FG | 957.87 FG | 961.73 FG | 965.58 FG | 969.28 FG | 972.68 FG | 975.78 FG | 978.56 FG | 981.06 FG | 983.25 FG | 985.13 FG | 986.71 FG | 988.14 FG

473+00 | 474+00 | 475+00 | 476+00 | 477+00 | 478+00 | 479+00 | 480+00 | 481+00 | 482+00 | 483+00 | 484+00 | 485+00

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APPROVAL

Scale
HORIZONTAL : 1" = 40'
VERTICAL : 1" = 10'
Job No. 7120.436

Church Engineering
A Division of PBSJ POST, BUCKLEY, SCHUH & JERNIGAN
ENGINEERING · PLANNING · SURVEYING · CONSTRUCTION SERVICES
6600 West Charleston Blvd. Suite 140 Las Vegas, Nevada 89102 Telephone: 702/876-6244 Fax: 702/878-7758

Seal

Designed by : WEH Date : 09/03/93
Drawn by : MDS Date : 09/03/93
Checked by : VRH Date : 09/03/93
File No. : 436 Dwg No. : 436-20

Clark County Department of Public Works

NEEDLES HIGHWAY STREET IMPROVEMENTS
PLAN & PROFILE STA. 473+00 TO STA. 485+00

SID #91 SHEET C20

436-20 Wed Feb 23 13:32:05 1994 Church Engineering - Bob Mc

℄ CURVE DATA

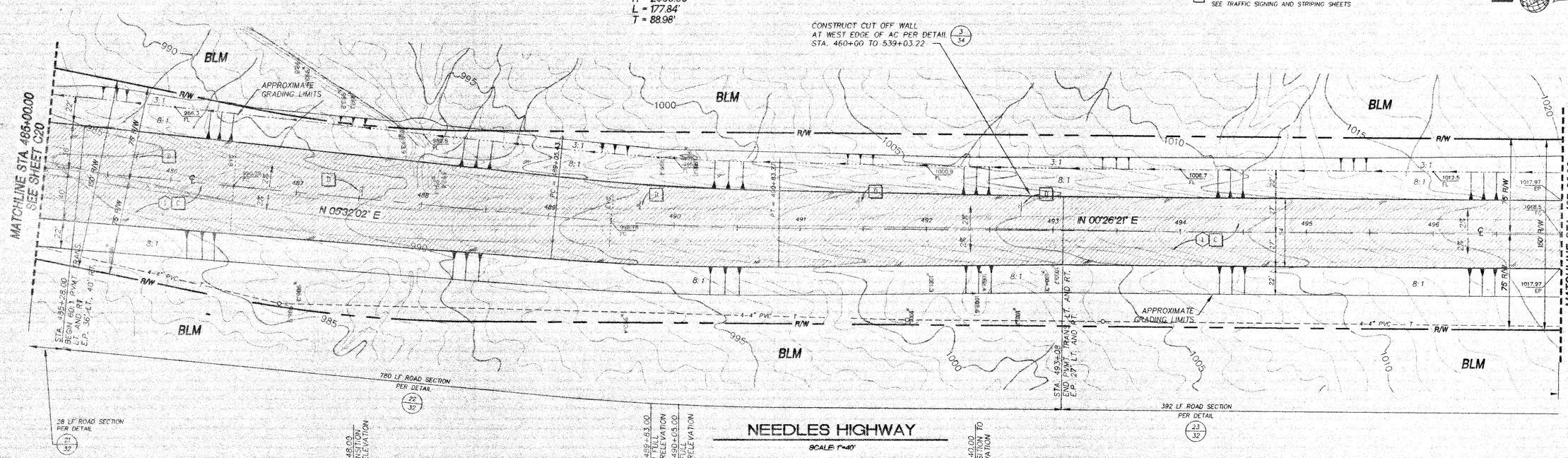
Δ = 05°05'41"
R = 2000.00'
L = 177.84'
T = 88.98'

CONSTRUCTION ITEMS

1 CONSTRUCT A.C. PAVING

REMOVAL ITEMS

C REMOVE EXISTING ASPHALT PAVING
D REMOVE AND RELOCATE TRAFFIC SIGN– SEE TRAFFIC SIGNING AND STRIPING SHEETS

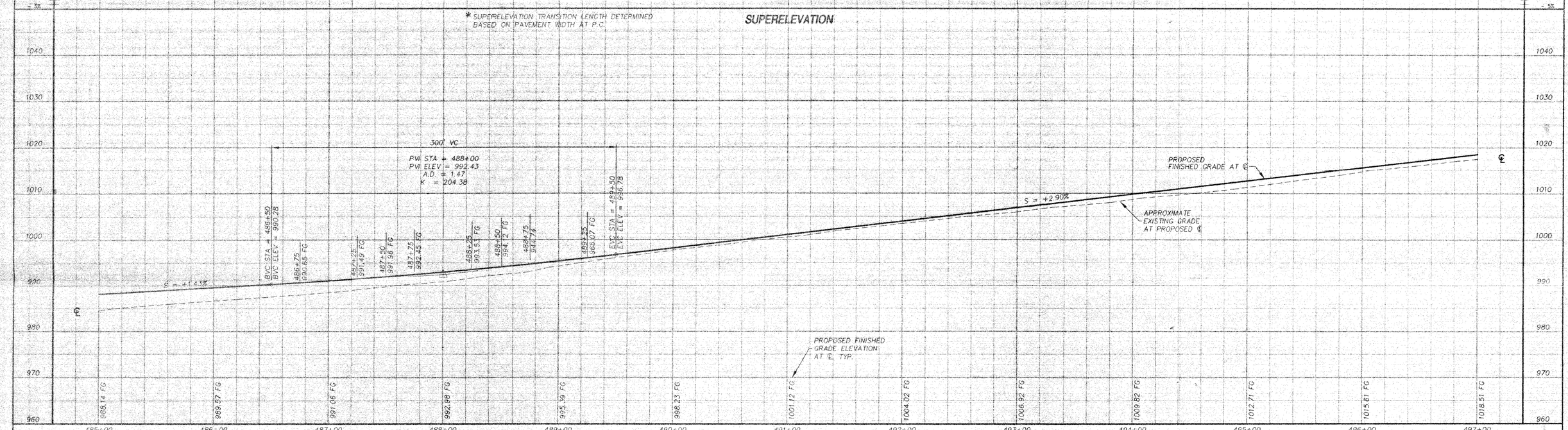


Avoid cutting underground utility lines. It's costly.

Call before you Dig
1-800-227-2600

* SUPERELEVATION TRANSITION LENGTH DETERMINED BASED ON PAVEMENT WIDTH AT P.C.

SUPERELEVATION



REVISIONS				
REV.	DESCRIPTION	BY	DATE	APPROVAL

Scale
HORIZONTAL : 1" = 40'
VERTICAL : 1" = 10'
Job No. 7120.436

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A Division of PBSJ POST, BUCKLEY, SCHUH & JERNIGAN
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Las Vegas, Nevada 89102
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Seal

Designed by : WEH Date : 09/03/93
Drawn by : MDS Date : 09/03/93
Checked by : VRH Date : 09/03/93
File No. : 436IMP Dwg No. : 436-21

Clark County Department of Public Works

NEEDLES HIGHWAY STREET IMPROVEMENTS
PLAN & PROFILE STA. 485+00 TO STA. 497+00

SID #91 SHEET C21

436-21 Wed FEB 23 11:51:20 1994 Church Engineering Group

Avoid digging underground utility lines. It's costly.

Call before you Dig

1-800-227-2600

EXISTING FLOOD WALL

PROPOSED FLOODWALL SEE SHEET 1 OF 1

APPROXIMATE GRADING LIMITS

AREA OF EXCAVATION

℄ CURVE DATA
Δ = 8°53'39"
R = 1500.00'
L = 2143.98'
T = 1301.50'

AREA OF FILL (100% FROM BACK OF S.W. TO EX. GRADE)

REFER TO DETAIL 1 ON SHEET SD14

CONCRETE APRON

UNDEVELOPED

NEEDLES HIGHWAY

BAY SANDS ACCESS ROAD (PRIVATE)

CONSTRUCT EARTH BERM STA. 405+00 TO STA. 429+50 REFER TO DETAIL ON THIS SHEET

R/W

IR/W

RIP RAP BASIN D50 = 11" 120'

PROPOSED BOX CULVERTS

217 LF 24" RCP S= 0.0312 FT/FT

188 LF 24" RCP S= 0.0312 FT/FT

36 LF 18" RCP S= 0.0312 FT/FT

STA. 426+30.50 CONSTRUCT 48" M.H. 36" R.C.

STA. 426+37.32 CONSTRUCT TYPE 30 C.I. DROP INLET FOUR (4) GRATES

STA. 426+42.09 CONSTRUCT 48" M.H. 36" R.C.

STA. 426+47.32 CONSTRUCT TYPE 30 C.I. DROP INLET FOUR (4) GRATES

20" HP GAS

4" PE GAS

24" RCP

18" RCP

27"W

3:1

2:1 SLOPES

NATIVE MATERIAL COMPACTED TO 90% HEAVY RIP RAP

EARTH BERM
STA. 405+00 TO STA. 429+50 N.T.S.

STORM DRAIN
STA. 402+20 TO STA. 4406+37.32 N.T.S.

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APPROVAL

Scale
HORIZONTAL : 1" = 40'
VERTICAL :

Job No. 7120.436

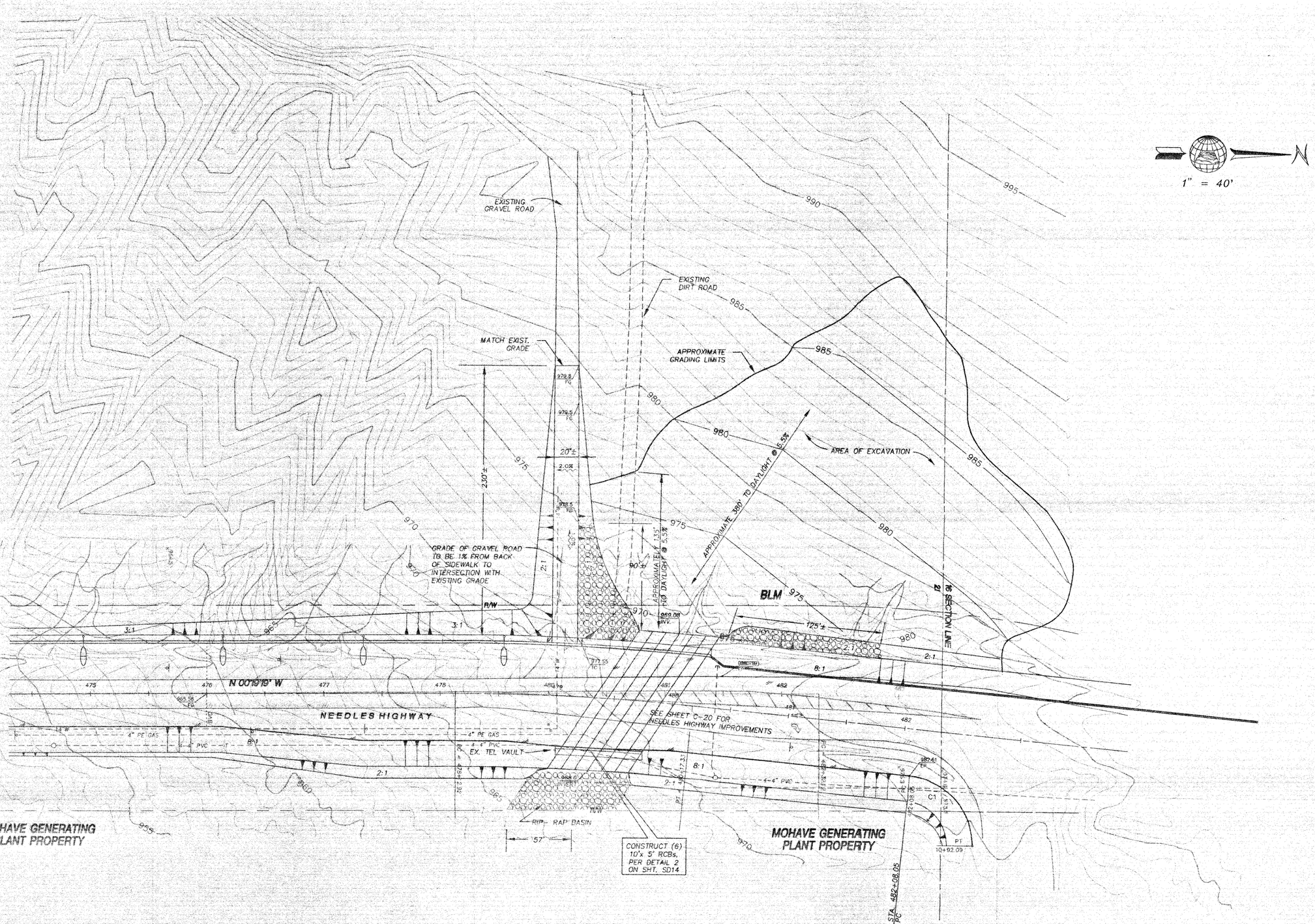
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Designed by : WEH Date : 09/03/93
Drawn by : MDS Date : 09/03/93
Checked by : VRH Date : 09/03/93
File No. : 436IMP Dwg No. : 436-SD9

Clark County Department of Public Works

NEEDLES HIGHWAY STREET IMPROVEMENTS
HIKO WASH GRADING PLAN
SID #91 SHEET SD9



1" = 40'

REVISIONS

REV.	DESCRIPTION	BY	DATE	APPROVAL

Scale

HORIZONTAL : 1" = 40'

VERTICAL :

Job No. 7120.436

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Sent

Designed by : WEH Date : 09/03/93

Drawn by : MDS Date : 09/03/93

Checked by : VRH Date : 09/03/93

File No. : 436IMP Dwg No. : 436-SD10

Clark County Department of Public Works

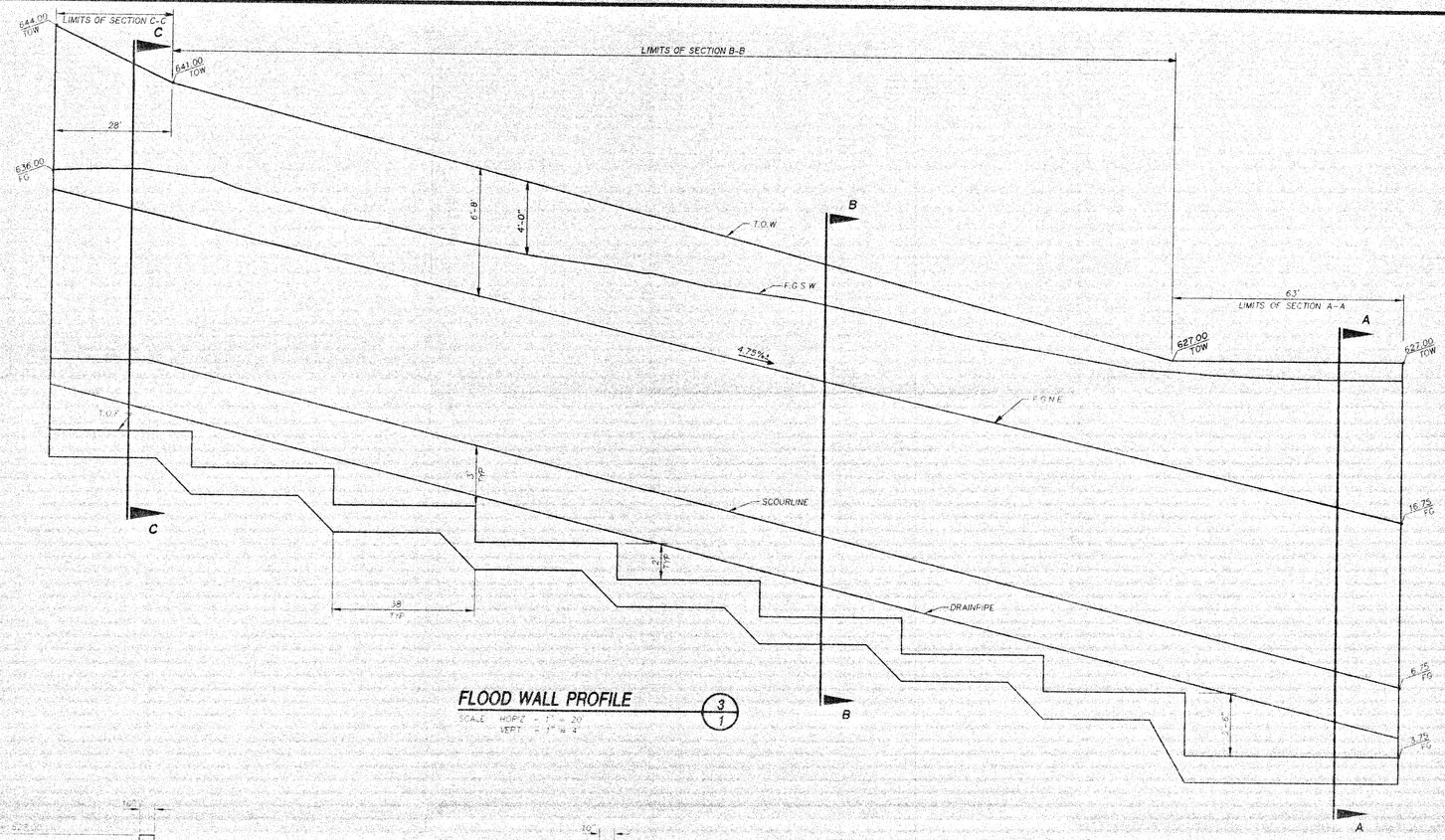
NEEDLES HIGHWAY STREET IMPROVEMENTS

DESERT ROAD CULVERT GRADING PLAN

SID #91

SHEET SD10

C:\MICRO~1\436-SD10.TXT Thu Feb 24 07:48:03 1994 Church Engineering



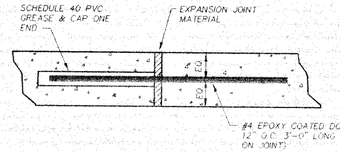
FLOOD WALL PROFILE

3/1

SCALE: HORIZ. = 1" = 20'
VERT. = 1" = 4'

GENERAL NOTES:

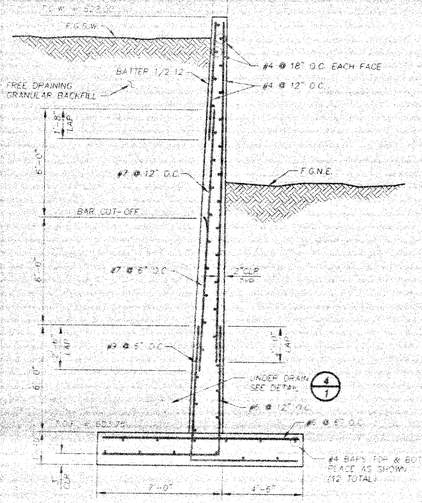
1. DESIGN SPECIFICATIONS: ACI 318-89 BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE.
2. CONSTRUCTION SPECIFICATIONS: NEVADA DEPARTMENT OF TRANSPORTATION "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION."
3. LIVE LOAD: STANDARD HS20-44
4. CONCRETE: ALL CONCRETE SHALL BE CLASS AA MODIFIED WITH A MINIMUM COMPRESSIVE STRENGTH F'C=4000 PSI @ 28 DAYS. ALL EXPOSED EDGES OF CONCRETE SHALL BE CHAMFERED 3/4". CEMENT FOR ALL CONCRETE SHALL BE TYPE V, HIGH SULFATE RESISTANT.
5. REINFORCING STEEL: ALL REINFORCING STEEL TO BE ASTM A615 GRADE 60. THE MINIMUM CLEARANCE, MEASURED FROM THE FACE OF THE CONCRETE TO THE SURFACE OF ANY REINFORCING BAR SHALL BE 2", EXCEPT WHERE OTHERWISE NOTED.
6. FOUNDATION LOADS: MAXIMUM NET DESIGN BEARING = 12000 PSF FOR FLOOD WALL FOOTINGS, PER THE PROJECT SOILS REPORT BY CONVERSE CONSULTANTS SOUTHWEST, INC. PROJECT NO. 92-33326-01 DATED SEPT. 04, 1992.
7. FOR DETAILS NOT SHOWN, SEE STATE OF NEVADA "STANDARD PLANS FOR ROAD AND BRIDGE CONSTRUCTION," 1993 EDITION UNLESS OTHERWISE NOTED.
8. UTILITIES: THE CONTRACTOR SHALL COORDINATE HIS ACTIVITIES WITH THE VARIOUS UTILITY COMPANIES TO ASSURE THAT ALL CONFLICTS ARE RESOLVED.



DOWELED EXPANSION JOINT

1/1

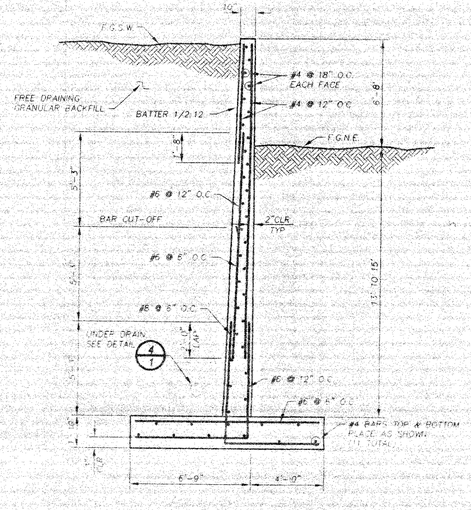
SCALE: NO SCALE



SECTION A-A

7/1

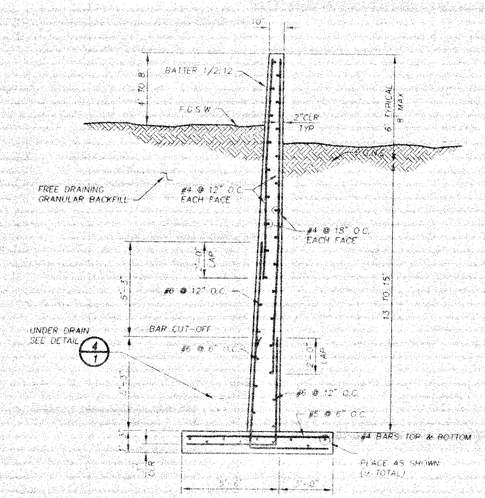
SCALE: 1/4" = 1'



SECTION B-B

6/1

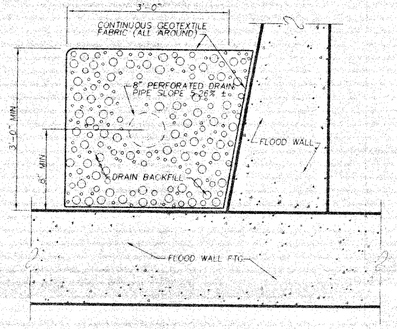
SCALE: 1/4" = 1'



SECTION C-C

5/1

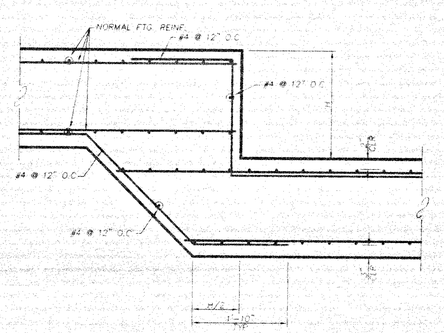
SCALE: 1/4" = 1'



UNDERDRAIN DETAIL

4/1

SCALE: NO SCALE



FOOTING STEP

2/1

SCALE: NO SCALE

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APPROVAL

Scale
HORIZONTAL : AS SHOWN
VERTICAL :
Job No. 7120.436

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Telephone: 702/878-6244
Fax: 702/878-7758

Seal
DOUGLAS M. MOTT
No. 7174
CIVIL
2-24-94

Designed by: PLK Date: 10/11/93
Drawn by: AAS Date: 10/11/93
Checked by: PA Date: 10/11/93
File No. 436IMP Dwg No. 436-S1

Clark County
Department of Public Works

NEEDLES HIGHWAY STREET IMPROVEMENTS
STRUCTRAL DETAILS

SID #91

SHEET 1 OF 1