Design Hydraulic Study

Bridge 49C-337, Main Street, Cambria over Santa Rosa Creek

San Luis Obispo County

Prepared for:

TY Lin International
10365 Old Placerville Road, Suite 250
Sacramento, CA 95827

Prepared by:

Pacific Hydrologic Incorporated
1050 West Street
Redding, CA 96001

Norman S. Braithwaite, P.E.

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Executive Summary

Purpose:	Replace existing deficient bridge
Funding Program:	HBRR
Design Flood:	Standard Design Flood (15,400-cfs Q50)
Clearance for Drift:	3-feet
Design Exception:	None required for hydraulic conditions

Recommendations:

Min. Soffit Elevation –	70.97-feet NAVD-88 (to meet the recommendations of Caltrans and FHWA)
Abutment Scour –	Abutments should be designed considering or protected against potential scour to an elevation of 35.6-feet, NAVD-88 at Abutment 1 and 37.6-feet, NAVD-88 at Abutment 2.
Abutment Protection –	Strongly recommended in front of abutments to reduce the potential for long term abutment damage resulting from bank erosion during infrequent flood events. Protection should be placed on all disturbed banks to an elevation 2-feet above the water surface elevation of the most probable 100-year flood and in a manner that does not reduce the channel area.

Note regarding estimates of potential scour: Potential scour has been estimated using empirical equations presented in FHWA HEC-18. These equations do not consider geotechnical conditions and therefore assume all substrate is capable of being eroded. The potential scour estimates identified in this report may be inappropriate if a geotechnical investigation identifies material resistant to erosion at higher elevations.

Preferred Bridge Characteristics:

Soffit Elevation –	71.03-ft, NAVD-88 (3.06-ft above Q50, 0.78-ft above Q100)
Overtopping Flood –	78.96-ft, >25000-cfs, >200-year flood
Impact on Flood Risk –	1.41-foot reduction in water surface elevation during bridge design base flood (from existing condition with no drift assumption) 1.15-foot reduction in water surface elevation during FEMA Base Flood (from existing condition with no drift assumption) Possible reduced risk of flood damage to structures
Impact on Channel –	None expected

Design Hydraulic Study
Main Street, Cambria over Santa Rosa Creek

INTRODUCTION

Background: This bridge hydraulic analysis has been prepared to meet the requirements of 23 CFR §650.115 and §650.117 dealing with bridges, structures, and hydraulics. Although potentially useful for other purposes, this analysis has not been prepared for any other purpose. Reuse of information contained in this report for purposes other than those for which this analysis and report are intended is not endorsed or encouraged by the author and is at the sole risk of the entity reusing information herein contained. Estimates of peak flows for frequent flood peaks (5-year or more frequent), if shown in this report, should not be considered accurate unless an overtopping flood of 5-year or more frequent recurrence is identified.

Analyses to meet the specific requirements of FEMA, the State of California Reclamation Board, low flow environmental or construction concerns and for other purposes may be provided as additional services.

Design Standards: Hydraulic design of the preferred bridge is based on standards recommended by Caltrans (Reference 1). Exceptions to these design standards are recommended only if meeting the standard is found to be impractical or unreasonably costly for the proposed project and the exception does not result in an increased risk of damage during floods. Local design standards that have been provided in writing prior to the preparation of the hydraulic analysis have also been considered.

Funding: HBRR

Existing Bridge:
Year Constructed – 1922
Length – 90-feet (nominal)
Skew – Approximately 30-degrees (approach), 0-degrees (departure)
Clear Width – 21.3-feet
Total Width – 23.9-feet
Lanes – 2
Speed Limit – 35-mph
Load Limit – none
Other limiting factors – road horizontal and vertical alignment
Structure – 2 span RC “T” girder on vertical RC pier wall and abutments
Deficiency – Structure (condition, function)
Photos 1-4, pages 13-14.

Significance:	Vital Route – yes Bus Route – yes Road Classification – Urban Minor Collector Present ADT – 3509 (2007) Trucks or Commercial Vehicles – 2% Description of Service – Business route, alternate to SR-1 Length of Detour – 3-miles on roads of equal or greater level of service Description of Road – Winding, rolling
Proposed Bridge:	Length – 150-feet (nominal) Skew – Approximately 30-degrees Clear Width – 34.2-feet Total Width – 37.0-feet Lanes – 2 Speed Limit – 35-mph Load Limit – none Structure – Single span CIP/PS box girder supported on vertical RC abutment walls Traffic During Construction – maintained on existing bridge General Plan – Figure 1, page 16.

DESCRIPTION OF BASIN

Geographic Location:	Above Main Street, Santa Rosa Creek drains a portion of the western slopes of the Santa Lucia Mountains in the coastal range.
Receiving Waters:	Pacific Ocean
Characteristics:	Area of basin – 44.7-square miles (approximate) Shape – Oblate triangular, apex upstream Highest elevation – 2320-feet on Black Mountain Lowest elevation – 700-feet near bridge Elevation index – 0.7 Average annual precipitation (basin wide) – 30-inches Aspect – West
Land use:	Small farms, small ranches, rural residential, limited suburban residential and commercial near the City of Cambria.
Vegetation:	Coastal grasses and chaparral
Geologic:	Topographic features indicate modest potential for significant landslides capable of causing channel instability and risk to bridge integrity.
Basin:	Figure 2, page 17.

DESCRIPTION OF STREAM AND SITE

Stream Channel: In the vicinity of Main Street, Santa Rosa Creek is a medium to large stream with a well defined, incised, meandering channel. Streambed materials consist of silt, sand, gravel and a few cobbles. Santa Rosa Creek is shown in Photos 5 and 6 on page 15.

Stream Banks: The banks of Santa Rosa Creek consist of silty, sandy loam covered with grass, shrubs, willow and sparse native trees.

Existing Bridge: The existing bridge is a two span reinforced concrete "T" girder structure supported on a vertical reinforced concrete pier and abutments. Santa Rosa Creek approaches the existing bridge at a skew of approximately 30-degrees and departs the existing bridge approximately perpendicular to the bridge. Significant bank erosion at abutments and local pier scour are reported as continuing problems.

Site Topography: Figure 3, page 18.

HYDROLOGIC ANALYSIS

Hydrologic Stability: Peak flow during infrequent floods may have increased over time as a result of channel enlargement and loss of overbank storage routing.

Flood History: The flood of March 10, 1995 resulted in considerable damage to structures in the town of Cambria downstream of Main Street. Water surface elevations in the area where damages were experienced were due to conditions in the vicinity of the damage and not near the Main Street bridge. The peak flow of this flood was estimated to be 11,900-cfs based on a stage reading of 17.07-feet at San Luis Obispo stream gage 21 (located immediately upstream of the bridge). The flood was conveyed under the soffit of the existing bridge with a water surface elevation estimated to be 63.52-feet NAVD-88 in 1995. For present channel conditions the water surface elevation of a similar flood will be higher.

Number of Methods: Seven methods were investigated for estimating potential infrequent flood peak flows in Santa Rosa Creek at Main Street. These have included four adjustments of known flood frequency statistics at a proximate streamgages (translation), direct application of the USGS Central Coast equation, application of the San Luis Obispo County "Small Basins" methodology, and consideration of hydrology conducted for the FEMA FIS.

Translation Analysis: Approach – Translation analysis consists of estimating the infrequent flood peak flows by comparison with statistics at gaged stream or river basins. After identification of potentially representative gaged basins,

flood frequency relationships for the gaged basins are determined by plotting annual flood peaks and computing the normal probability Log-Pearson Type III curve fit (reference 7). If the Log-Pearson type III curve fit reasonably represents the plotted data for the less frequent floods, it is considered representative of the gaged basin and used as a basis of comparison. If not, a line of best visual fit may be used as a basis of comparison.

After identifying flood-frequency relationships for the gaged basins, candidate flood frequency relationships representing the stream or river at the proposed project site are estimated by adjusting the gaged basin flood frequency relationship to account for differences in characteristics between the gaged basin and the basin above the proposed project. The adjustments are made using the area, elevation and precipitation exponents of the appropriate USGS region equation (reference 8).

Basin Characteristics – Characteristics of Santa Rosa Creek above Main Street and of gaged basins found to be potentially representative of the basin above the proposed project and having records of adequate length to reasonably identify infrequent flood peak flows are identified in Table 1.

TABLE 1
Stream and Gaged Basin Characteristics

Basin Description	USGS Gage Number	Area (sq mi)	Average Annual Precip (in)	Elevation Index	Years of Record
Santa Rosa Creek at Main St	n/a	44.7	30	0.7	n/a
Santa Rosa Creek at Main St	21 (SLO Co)	44.7	30	0.7	13
Santa Rosa Ck near Cambria	11142200	12.5	27	1.0	16
A. de la Cruz nr San Simeon	11142500	41.2	31	0.4	29
Santa Rita Ck nr Templeton	11147070	18.2	31	1.2	27
Jack Creek near Templeton	11147000	25.3	34	1.3	29

Gaged basin flood frequency curves – Plotted flood frequency data and curves for the gaged basins used in this analysis are shown in Appendix A.

Regional Equations: Approach – The USGS has published a set of regional equations for estimating infrequent flood peak flows in ungaged natural streams and rivers (not affected by lakes, reservoirs, substantial development or substantial reclamation projects) throughout most of California (reference 8). These equations are useful for planning level and rough preliminary estimates of infrequent flood peak flows and corroboration of flood frequency estimates using more detailed procedures. Flood peak flows estimated by these equations should only be relied upon for design if confidence in other methodologies is low and if verified by other methodologies. The empirical equations estimate flood peak flows from

basin characteristics including area, elevation index and precipitation. Use of the area, elevation index and precipitation factor exponents of the regional equation for adjustment of flood characteristics from representative long term gaged basins (described in Regional Analysis above) is generally considered to provide a more reliable estimate of infrequent flood peak flows for the ungaged basin.

SLO "Small Basins": Using peak flow data from numerous small basins, San Luis Obispo County has prepared a graphical method of estimating peak flows from ungaged basins for the most probable 25, 50, and 100-year floods. The method is most appropriate for estimating floods from basins draining steep rocky areas such as the foothills of the Santa Lucia Range.

Previous Studies: The Federal Emergency Management Agency (FEMA) has published a Flood Insurance Study (FIS) for properties along Santa Rosa Creek in the town of Cambria. The peak flows estimated for infrequent floods studied by FEMA have been included for consideration by this study.

Flood Peak Flows: Candidate flood frequency relationship – All candidate flood frequency curves derived from regional analysis for the proposed project site are plotted and shown in Appendix A. Estimated 50- and 100-year flood peak flows from all methods investigated are summarized in Table 2.

TABLE 2
Estimated 50- and 100-year Flood Peak Flows

Estimated from	50-Year (cfs)	100-Year (cfs)
Santa Rosa Creek at Main Street[1]	14100	17600
Arroyo de la Cruz near San Simeon	26800	32400
Santa Rita Creek near Templeton	17300	19100
Jack Creek near Templeton	14900	17200
USGS Central Coast Equations	9280	11400
SLO County “Peak Discharges”	15400	19800
FEMA FIS	12500	18000

Notes: 1) Extended using area adjusted flood peak flow data from USGS streamgage 11142200, “Santa Rosa Creek near Cambria” for a 29-year consolidated length of record.

Selected flood frequency relationship – The flood frequency relationship estimated using the San Luis Obispo “Small Basins” methodology has been selected for hydraulic evaluation and design of the preferred bridge. This relationship was selected because it has been based a broad base of local data representative of the Santa Rosa Creek basin and because of the general agreement with the estimate from Santa Rosa Creek streamgage records. The estimates from statistics at gaged streams have not been selected because of the somewhat limited duration of all potentially representative streamgage records and the modest disparity between these

estimates. The estimate from the USGS Central Coast Equation was not selected because the equation is intended to provide a rough estimate of flood peak flows emanating from the central coast when local data are unavailable. The estimate from FEMA has not been selected for bridge hydraulic evaluation or design because of the disparity between the FEMA flood frequency curve and most others (relatively low estimate of the peak flow during the most probable 50-year flood) and potential changes to infrequent flood hydrology related to loss of flood routing associated with channel enlargement. The backwater models for existing and preferred bridge conditions were, however, run with the FEMA Base Flood to identify the preferred bridge impacts on the FEMA Base Flood and the potential need for a FEMA map revision. The selected flood frequency relationship is shown in Figure 4 on page 19.

Flood of Record: March 10, 1995; peak flow estimated to be 11,900-cfs by San Luis Obispo County at SLO County streamgage 21.

HYDRAULIC ANALYSIS

Backwater Model: Backwater program – The Corps of Engineers' HEC-RAS version 3.1.2 backwater program (reference 3) has been selected for modeling hydraulic characteristics representing existing conditions, preliminary bridge configurations and the proposed bridge. This program has been selected because of its long history of use (derived from HEC-2), wide acceptance and great flexibility for evaluating bridge configurations.

Cross-section data – Stream cross-sections and Manning's roughness coefficients upstream and downstream of the proposed project have been assumed constant for all models. Cross-sections used in the backwater models were from a recent ground survey. Locations of cross-sections used in the backwater model are shown in Figure 5 on page 20. Cross-sections have been adjusted for skew as appropriate.

Elevation Datum – NAVD-88 (Subtract 2.72 for NGVD-29)

Manning's Roughness Coefficients – Mannings Roughness Coefficients for the channel and overbanks were estimated by observation and comparison with similar channels identified in Roughness Characteristics of Natural Channels (reference 6) and as described in Urban Surface Water Management (reference 10). Manning's roughness coefficients ranging from 0.032 to 0.036 were used to represent the channel and from 0.060 to 0.080 were used to represent the stream banks.

Contraction and Expansion Coefficients – Contraction and expansion coefficients of 0.1 and 0.3 respectively were used to represent the natural channel. These were raised to 0.3 and 0.5 respectively in the vicinity of the bridge.

Downstream starting water surface elevation assumption – The normal depth method in HEC-RAS was selected for estimating the downstream water surface elevation. A slope of 0.002, estimated from the slope of the stream channel, was used as the starting slope. Three surveyed, one derived (from detailed site topography), and three interpolated cross-sections were used to isolate the effects of downstream starting water surface elevation assumption from water surface elevations at the bridge site.

Interpolated cross-sections – Automatically interpolated cross-sections were inserted where necessary to improve model performance. These cross-sections were checked to insure no significant interpolation error.

Preliminary Bridges: Backwater models were prepared to represent two similar candidate bridge configurations. Results from these models were provided to project staff in the form of memoranda. Using information provided in these memoranda and considering additional factors not related to hydraulic conditions, a bridge configuration was selected as the preferred bridge for final hydraulic design.

Existing Bridge: Purpose – The existing condition backwater model has been prepared to identify and document existing hydraulic conditions and to serve as a basis of comparison with which to evaluate preliminary and proposed bridge configurations.

Channel roughness coefficient at bridge – 0.032 up, 0.036 down
Overbank roughness coefficient at bridge – 0.080 left, 0.060 right
Contraction coefficient – 0.3 (at bridge)
Expansion coefficient – 0.5 (at bridge)
Bridge modeling method – Pressure and weir.
Drift assumption – 7-foot effective pier width (2 x actual pier width)
Modeled bridge cross-section – Figure 6, page 21.

Model results – Existing hydraulic conditions are summarized in Table 3. Existing condition flood profiles and a stage discharge curve with and without the drift assumption at cross-section 1470 are shown in Figures 7 through 10 on pages 22 and 25.

TABLE 3
Existing Hydraulic Conditions (with drift except as noted)

Flood	Flow (cfs)	Recurrence (years)	W.S. Elevation[1] (feet, NAVD-88)	Avg. Channel Velocity[2] (fps)
Standard Design	15400	50	69.31	12.7
Base Flood	19800	100	71.80	14.7
Base Flood (no drift)	19800	100	71.67	14.0
Flood of Record[3]	11900	25	66.52	11.1
Overtopping Flood	23000±	150±	74.5	>15
FEMA Base (no drift)	18000	100[4]	70.53	13.1

Notes: 1) Computed at cross-section 1470 located approximately 65-feet upstream of the upstream face of the existing bridge.
2) "Bridge opening" velocity in contracted section under bridge.
3) Based on backwater model. Channel changes prevent relying on prior high water.
4) FEMA estimate

Preferred Bridge: The preferred bridge backwater model has been prepared to identify hydraulic requirements and impacts of the preferred bridge. This backwater model was prepared by adding data representing the preferred bridge to a copy of the existing condition backwater model.

Channel roughness coefficient at bridge – 0.032 up, 0.036 down
Overbank roughness coefficient at bridge – 0.080 left, 0.060 right
Contraction coefficient – 0.3 (at bridge)
Expansion coefficient – 0.5 (at bridge)
Bridge modeling method – Pressure and weir.
Drift assumption – none (clear span)
Modeled bridge cross-section – Figure 11, page 26.

Model results – Preferred bridge hydraulic conditions are summarized in Table 4. Proposed bridge flood profiles and a stage discharge curve at cross-section 1470 are shown in Figures 12 and 13 on pages 27 and 28.

TABLE 4
Preferred Bridge Hydraulic Conditions

Flood	Flow (cfs)	Recurrence (years)	W.S. Elevation[1] (feet, NAVD-88)	Avg. Channel Velocity[2] (fps)
Standard Design	15400	50	67.97	9.4
Base	19800	100	70.25	10.4
Flood of Record[3]	11900	25	65.59	11.7
Overtopping Flood	>25000	>200	78.96	>15
FEMA Base	18000	40	69.38	11.2

Notes: 1) Computed at cross-section 1470 located approximately 65-feet upstream of the upstream face of the existing bridge.
2) Average channel velocity approaching bridge.
3) Based on backwater model. Channel changes prevent relying on prior high water.

SCOUR AND EROSION

Channel Stability: Santa Rosa Creek appears to be in an active process of channel enlargement. Considerable evidence of bank erosion is also present along Santa Rosa Creek near Main Street. Bank materials consist of silty, sandy loam and are very easily eroded when exposed to high water velocities. Continuing deepening of 1.5 to 4-feet can be reasonably expected in the Santa Rosa Creek channel over the expected life of the replacement bridge.

Construction of the preferred bridge is not expected to redirect flows or affect sediment transport to a significant degree and therefore is not expected to affect long term channel stability (or in this case, instability). In the vicinity of Main Street, both channel and bank erosion can be expected as continuing stream processes unrelated to the bridge project.

Abutment Local: Potential scour has been estimated using the Froehlich Equation in FHWA HEC-18 (reference 4). The scour computations are shown in Appendix C.

Contraction Local: Potential contraction scour has been estimated using an equal conveyance area assumption. The scour computation is shown in Appendix C.

Total Scour: Total potential scour and potential scour elevations at abutments are summarized in Table 5.

TABLE 5
Total Potential Scour (feet)

Location	Ground Elev.[1]	Degradation	Contraction Scour	Local Scour	Total Scour	Scour Elev.
Abutment 1	48	4.0	1.0	7.4	12.4	35.6
Abutment 2	48	4.0	1.0	5.4	10.4	37.6

Notes: 1) Considering high potential for thalweg migration

OTHER CONSIDERATIONS:

Drift: There is a significant potential for large volumes of small to medium sized drift (branches to small tree trunks) to be present in Santa Rosa Creek. Accumulation of drift has been reported as a problem on the pier of the existing bridge. Being a clear span structure with a higher soffit elevation, accumulation of drift is expected to be less of a problem for the preferred bridge.

Geologic Hazard: Topographic and geologic conditions indicate a potential for transient aggradation in the Santa Rosa Creek channel after upstream fires or landslides. During such events the water surface elevations of floods may be higher than expected for the peak flow of water. This is due to a reduced effective channel size as sediment is transported downstream. While it is unlikely that water surface elevations will exceed the overtopping flood elevation for the preferred bridge during such events, it is possible for lesser floods to have water surface elevations exceeding the elevations estimated for the most probable 100-year flood.

Flood Risk: Upstream of the bridge, construction of the preferred bridge will affect a reduction in the water surface elevation of the most probable 100-year flood (Base Flood). This reduction is estimated to be 1.41-feet for the bridge base flood (19,800-cfs) and 1.15-foot for the FEMA Base Flood. This reduction in water surface elevations may reduce the risk of damage to structures in the floodplain during the most probable 100-year flood.

Downstream of the bridge project, construction of the preferred bridge is not expected to affect water surface elevations during floods. The preferred bridge is not expected to redirect flow or change the magnitude of downstream flows. The reduction in water surface elevation of the most probable 100-year flood upstream of the project does not represent a significant loss of flood routing.

If the preferred bridge is to be constructed through a flood season, the potential flood and erosion risks of all anticipated combinations of encroachments by the existing bridge, the preferred bridge, and temporary

construction facilities should be investigated. Evaluation of construction period flood and erosion risks has not been investigated as part of this study. Should a construction period flood risk evaluation be determined necessary, the evaluation can be provided as additional services.

FEMA: The preferred bridge is located in an area having flood risk mapped by FEMA using detailed study methods. As such, projects must show that they do not increase the risk of damage to structures (by avoiding increased water surface elevations or by mitigation) and must correct published FEMA documents if the project affects a change (increase or decrease) in the flood profile or floodplain. Replacement of the existing bridge with the preferred bridge is expected to affect a significant reduction in the elevation differential across the bridge during the FEMA Base Flood. Base Flood water surface elevations estimated by this study, however, are significantly lower than estimated by FEMA except immediately downstream of the bridge. The lower base flood elevations are most likely due to channel enlargement. Upstream of the bridge they match reasonably closely after construction of the preferred bridge. The higher downstream water surface elevations are most likely due to higher thalweg elevations at the present time (sediment slug). The current condition stream thalweg and Base Flood profiles are plotted against the FEMA thalweg and Base Flood profiles on Figure 14, Page 29.

Given the changes to the Santa Rosa Creek channel over time (channel enlargement, vegetation changes), the entire floodplain of Santa Rosa Creek in the vicinity of Main Street is different than that mapped by FEMA. While a FEMA Conditional Letter of Map Revision (CLOMR) is not believed necessary prior to construction of the preferred bridge (the preferred bridge does not increase the risk of damage to structures during the FEMA Base Flood), a FEMA Letter of Map Revision (LOMR) may be necessary to reflect changes to the FEMA Base Flood profile or floodplain associated with the preferred bridge after construction of the bridge. The need for a LOMR after construction of the preferred bridge will have to be determined by the FEMA Community Official at San Luis Obispo County.

A FEMA reference mark (RM-34) is identified as a rod in the center of Main Street approximately 90-feet from the bridge. If disturbed or removed, this reference mark should be replaced with a new reference mark and FEMA should be notified.

CONCLUSIONS AND RECOMMENDATIONS

Design Flood: Standard Design Flood (15,400-cfs Q50)

Clearance for Drift: 3-feet

Design Exception: None required for hydraulic conditions

Recommendations:

Min. Soffit Elevation – 70.97-feet NAVD-88 (to meet the recommendations of Caltrans and FHWA)

Abutment Scour Elevation – Abutments should be designed considering or protected against potential scour to an elevation of 35.6-feet NAVD-88 at Abutment 1 and 37.6-feet NAVD-88 at Abutment 2.

Abutment Protection – Strongly recommended in front of abutments to reduce the potential for long term abutment damage resulting from bank erosion during infrequent flood events. Protection should be placed on all disturbed banks to an elevation 2-feet above the water surface elevation of the most probable 100-year flood and in a manner that does not reduce the channel area.

Note regarding estimates of potential scour: Potential scour has been estimated using empirical equations presented in FHWA HEC-18. These equations do not consider geotechnical conditions and therefore assume all substrate is capable of being eroded. The potential scour estimates identified in this report may be inappropriate if a geotechnical investigation identifies material resistant to erosion at higher elevations.

Preferred Bridge Characteristics:

Soffit Elevation – 71.03-ft NAVD-88 (3.6-ft above Q50, 0.78-ft above Q100)

Overtopping Flood – 78.96-ft, >25000-cfs, >200-year flood

Impact on Flood Risk – 1.41-foot reduction in water surface elevation during bridge design base flood (from existing condition with no drift assumption)
1.15-foot reduction in water surface elevation during FEMA Base Flood (from existing condition with no drift assumption)
Possible reduced risk of flood damage to structures

Impact on Channel – None expected

Photo 1: Looking downstream (southwest) at bridge 49C-337,
Main Street, Cambria over Santa Rosa Creek

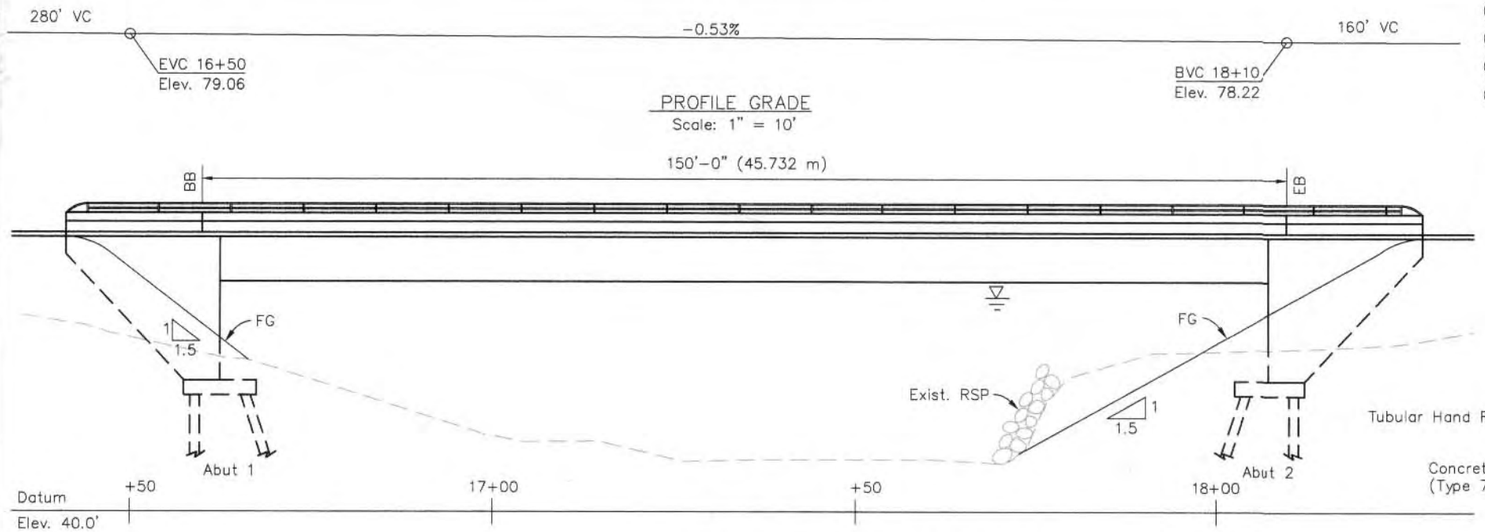
Photo 2: Looking upstream (northeast) at bridge 49C-337,
Main Street, Cambria over Santa Rosa Creek

Photo 3: Looking northwest across bridge 49C-337,
Main Street, Cambria over Santa Rosa Creek

Photo 4: Looking southeast across bridge 49C-337,
Main Street, Cambria over Santa Rosa Creek

Photo 5: Looking downstream (southwest) at Santa Rosa Creek
from bridge 49C-337, Main Street, Cambria

Photo 6: Looking upstream (northeast) at Santa Rosa Creek
from bridge 49C-337, Main Street, Cambria



1. Paint "Br. No. 49C-***" and year completed
2. Paint "Main Street Bridge"
3. Metal Beam Guard Railing
4. Approach Slab Type EQ10

CURVE DATA				
CURVE	R	Δ	L	T
C2	600'	57°02'36"	597.36'	572.99'

DIST	COUNTY	ROUTE	POST MILE TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
05	SLO	CR			

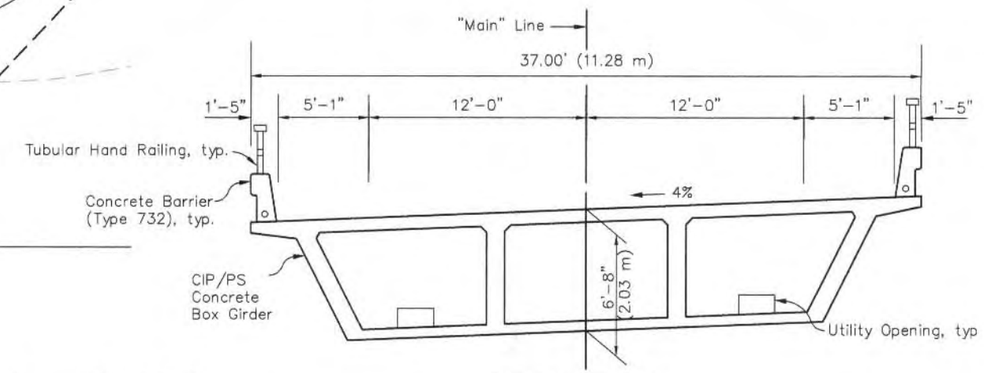
Progress Print

REGISTERED ENGINEER - CIVIL

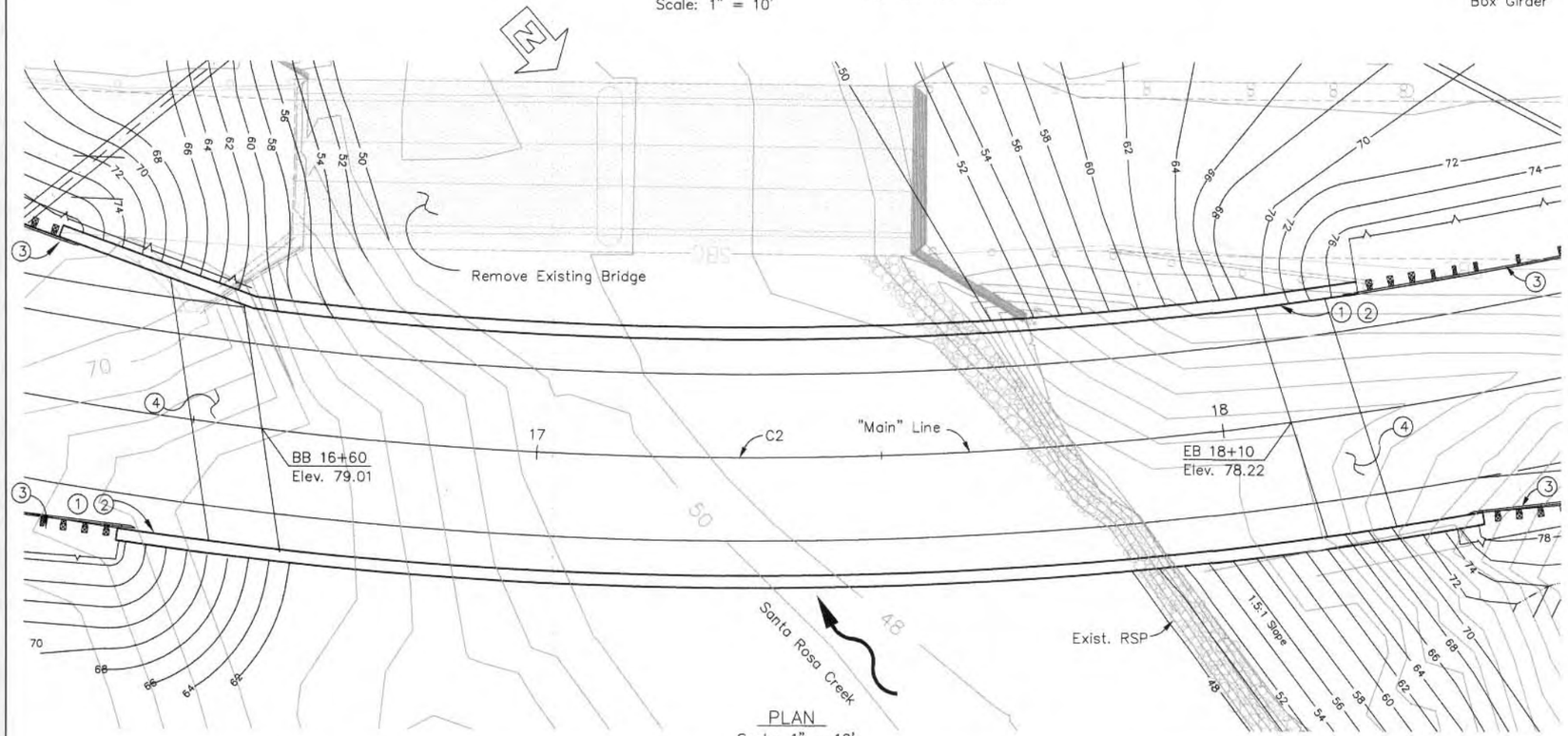
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Md. Wahiduzzaman No. C49838 Exp. 9/30/04 CIVIL STATE OF CALIFORNIA

DESIGN CONSULTANT:
BENGAL ENGINEERING
250 BIG SUR DRIVE
GOLETA, CA 93117



TYPICAL SECTION
Scale: 1/4" = 1'



PLAN
Scale: 1" = 10'

NOTES

1. For Design Notes see "Deck Contours" Sheet
2. The contractor shall verify all controlling field dimensions before ordering or fabricating any materials.
3. For Pile Data Table, see "DECK CONTOURS" sheet.
4. Utilities not shown, See civil plans for utility locations.
5. See Road Plans for Lane layout.
6. See "Typical Section" Sheet for utility openings.

Section identification

Standard plan sheet No.
Detail number

STANDARD PLANS, DUAL UNITS, DATED JULY, 2002

A10-A,B	ABBREVIATIONS AND SYMBOLS
A62-A	EXCAVATION AND BACKFILL MISCELANEOUS DETAILS
A62-C	LIMITS OF PAYMENT FOR EXCAVATION AND BACKFILL-BRIDGE
A77K	GUARD RAIL CONNECTION TO BRIDGE SIDEWALK AND CURBS
B0-1	BRIDGE DETAILS
B0-3	BRIDGE DETAILS
B0-5	BRIDGE DETAILS
B0-13	BRIDGE DETAILS
B2-5	PILE DETAILS-CLASS 45 & CLASS 70
B6-21	JOINT SEALS (MAXIMUM MOVEMENT RATING =2")
B7-1	BOX GIRDER DETAILS
B11-55	CONCRETE BARRIER TYPE 732
B13-2	SLOPE PROTECTION DETAIL NO. 2

Figure 1

DESIGN OVERSIGHT	DESIGN	BY MDW	CHECKED XX	LOAD FACTOR DESIGN	LIVE LOADING: HS20-44 AND ALTERNATIVE AND PERMIT DESIGN LOAD	PREPARED FOR THE COUNTY OF SAN LUIS OBISPO DEPARTMENT OF PUBLIC WORKS	BRIDGE NO. 49C-NEW — MAIN ST. BRIDGE OVER SANTA ROSA CR. (REPL.)
SIGNOFF DATE	DETAILS	BY	CHECKED	LAYOUT	BY MDW / CHECKED	Md. Wahiduzzaman PROJECT ENGINEER	POST MILE * — GENERAL PLAN
	QUANTITIES	BY	CHECKED	SPECIFICATIONS	BY / PLANS AND SPECS COMPARED	CU EA	

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 3

DISREGARD PRINTS BEARING EARLIER REVISION DATES → 3/1 3/30 4/06

REVISION DATES (PRELIMINARY STAGE ONLY) SHEET 1 OF 1

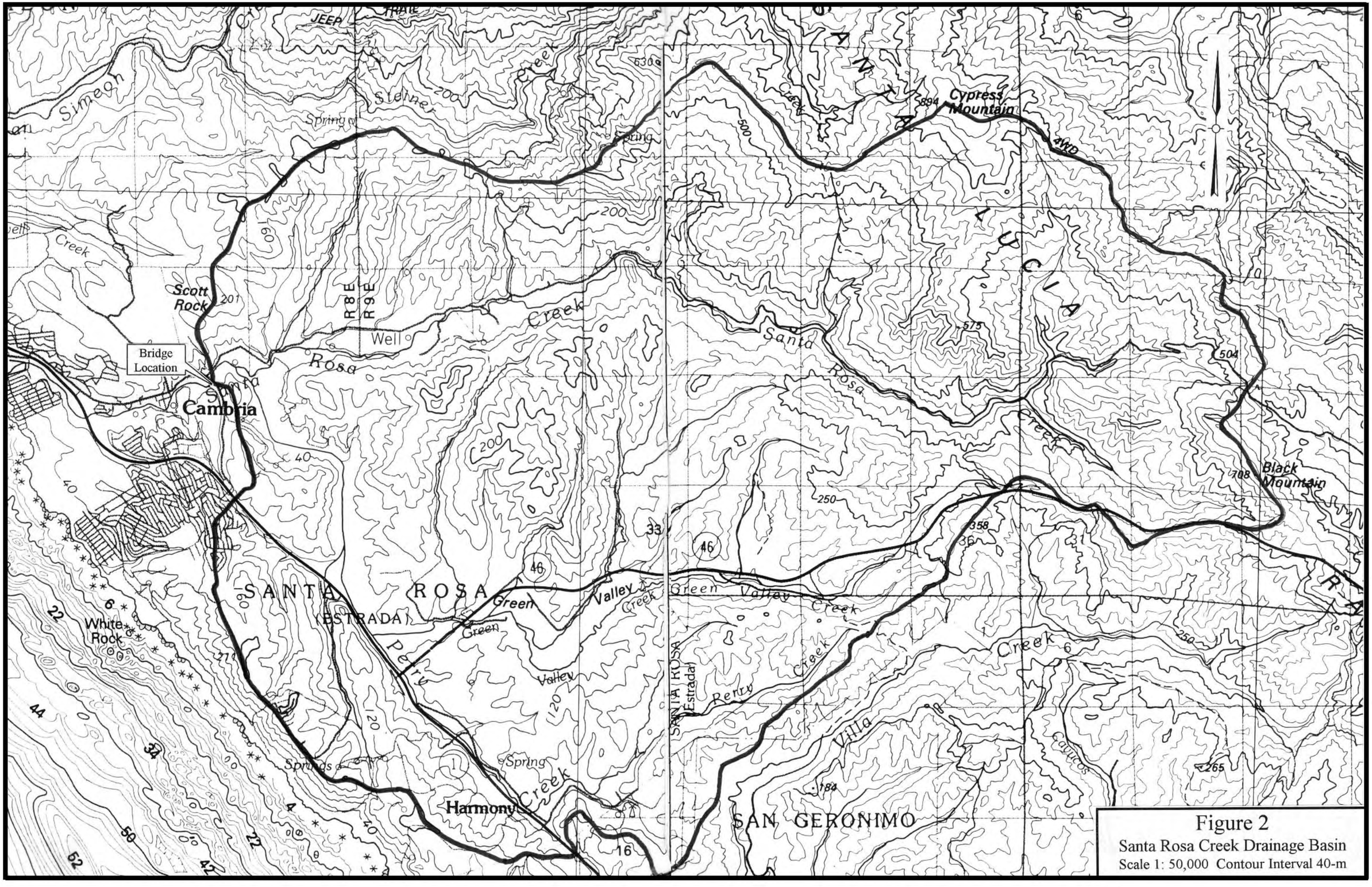


Figure 2
Santa Rosa Creek Drainage Basin
Scale 1: 50,000 Contour Interval 40-m

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
05	SLO		PM xx to xx		

REGISTERED ENGINEER – CIVIL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER S. Onishuk No. C48052 Exp. 12/31/05 CIVIL STATE OF CALIFORNIA

PRIME CONSULTANT:
TY LIN INTERNATIONAL
10365 Old Placerville Rd.
Suite 200
Sacramento, CA 95827

DESIGN CONSULTANT:
BENGAL ENGINEERING
250 Big Sur Drive Goleta,
CA 93117

The State of California & The County of SLO, & their officers or agents shall not be responsible for the accuracy or completeness of electronic copies of the plan sheet.

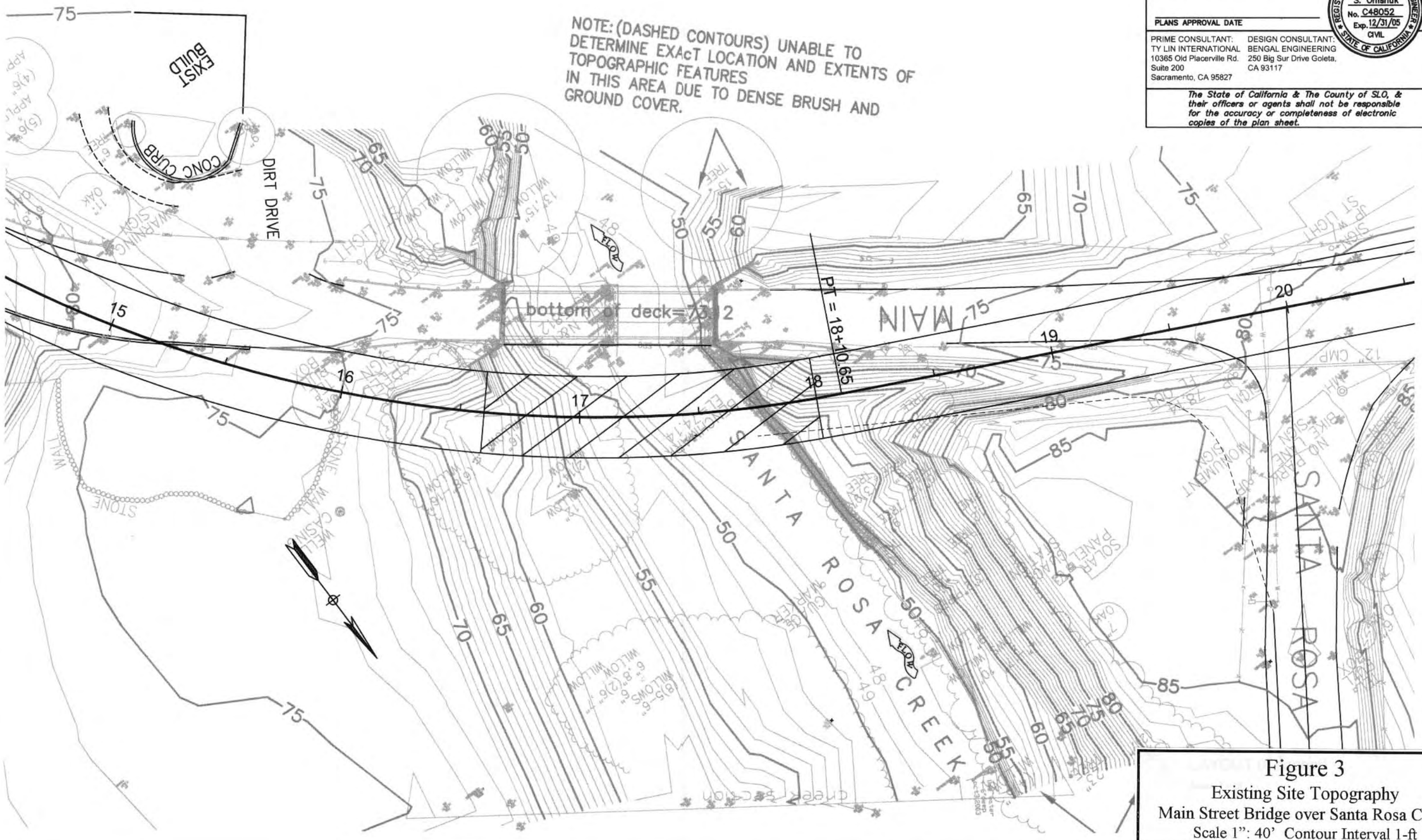


Figure 3
Existing Site Topography
Main Street Bridge over Santa Rosa Creek
Scale 1": 40' Contour Interval 1-ft

DATE	DATE REVISED:	REVISED BY:

CALCULATED/DESIGNED BY
CHECKED BY

PROJECT ENGINEER
Md. Wahiduzzaman

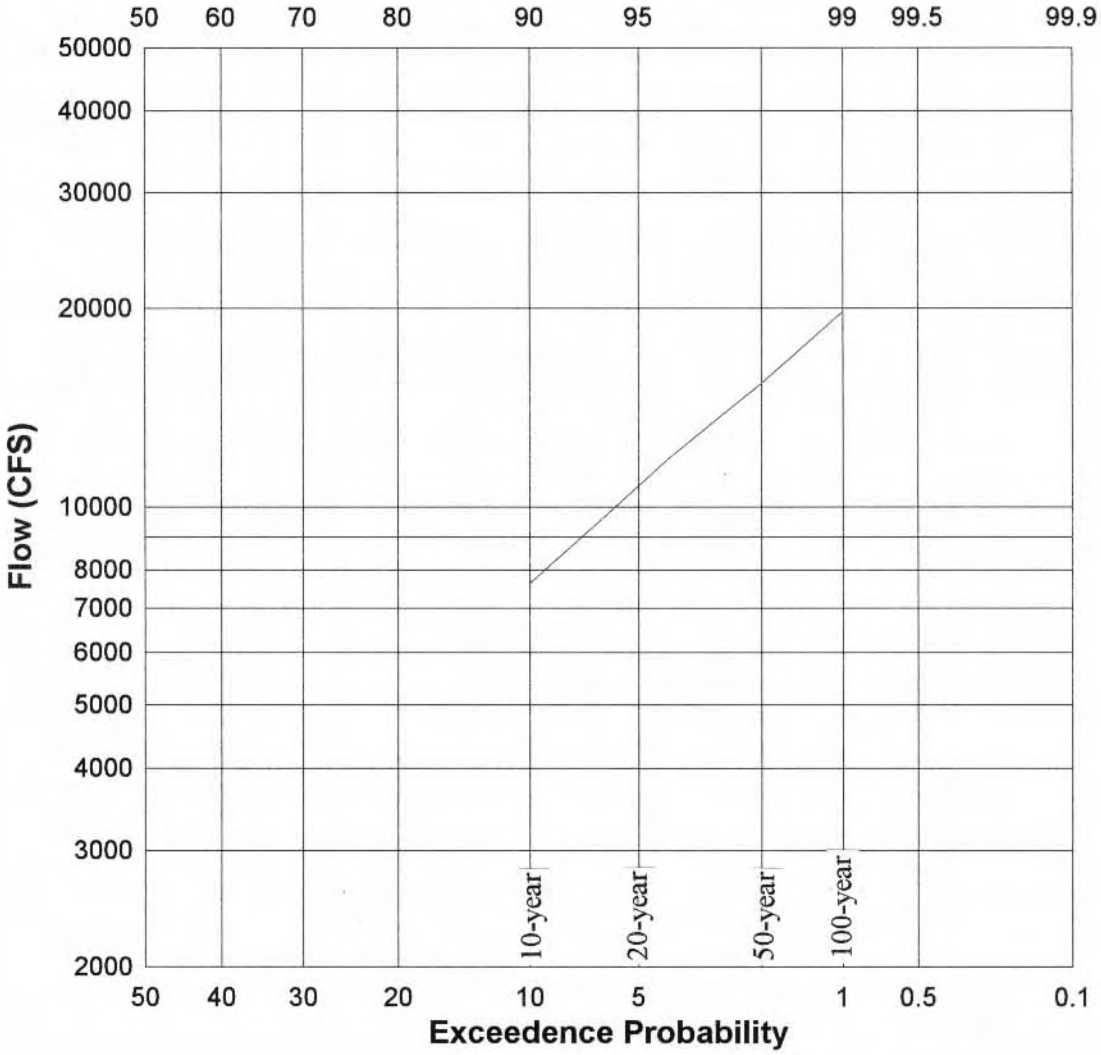
SAN LUIS OBISPO COUNTY, CALIFORNIA
Ray Uder, PE, Project Manager

FOR REDUCE PLANS ORIGINAL SCALE IS IN MILLIMETERS 0 1 2 3

USER NAME:
DWG FILE:

Figure 4

Flood Frequency Curve
Santa Rosa Creek at Main Street, Cambria



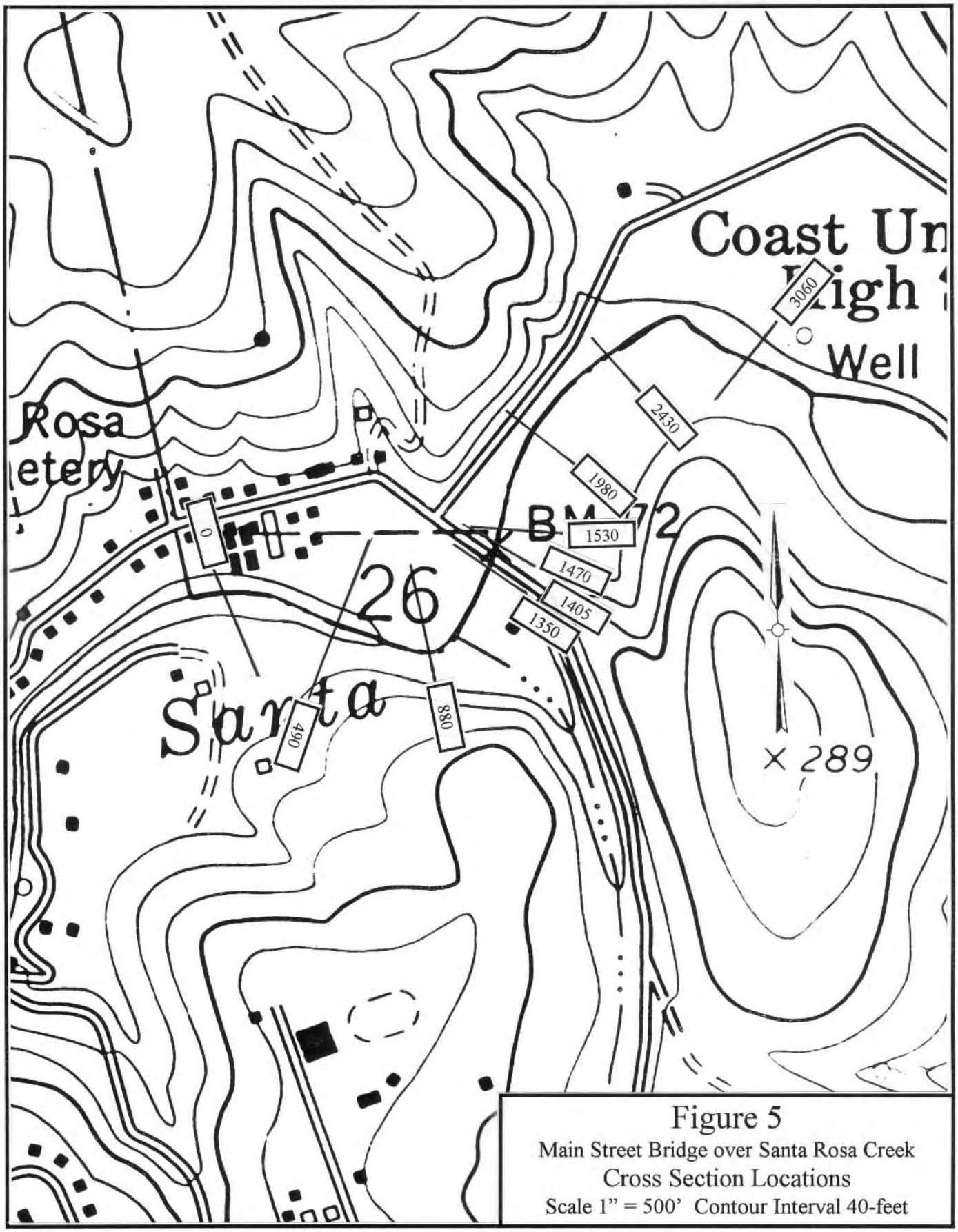


Figure 5
Main Street Bridge over Santa Rosa Creek
Cross Section Locations
Scale 1" = 500' Contour Interval 40-feet

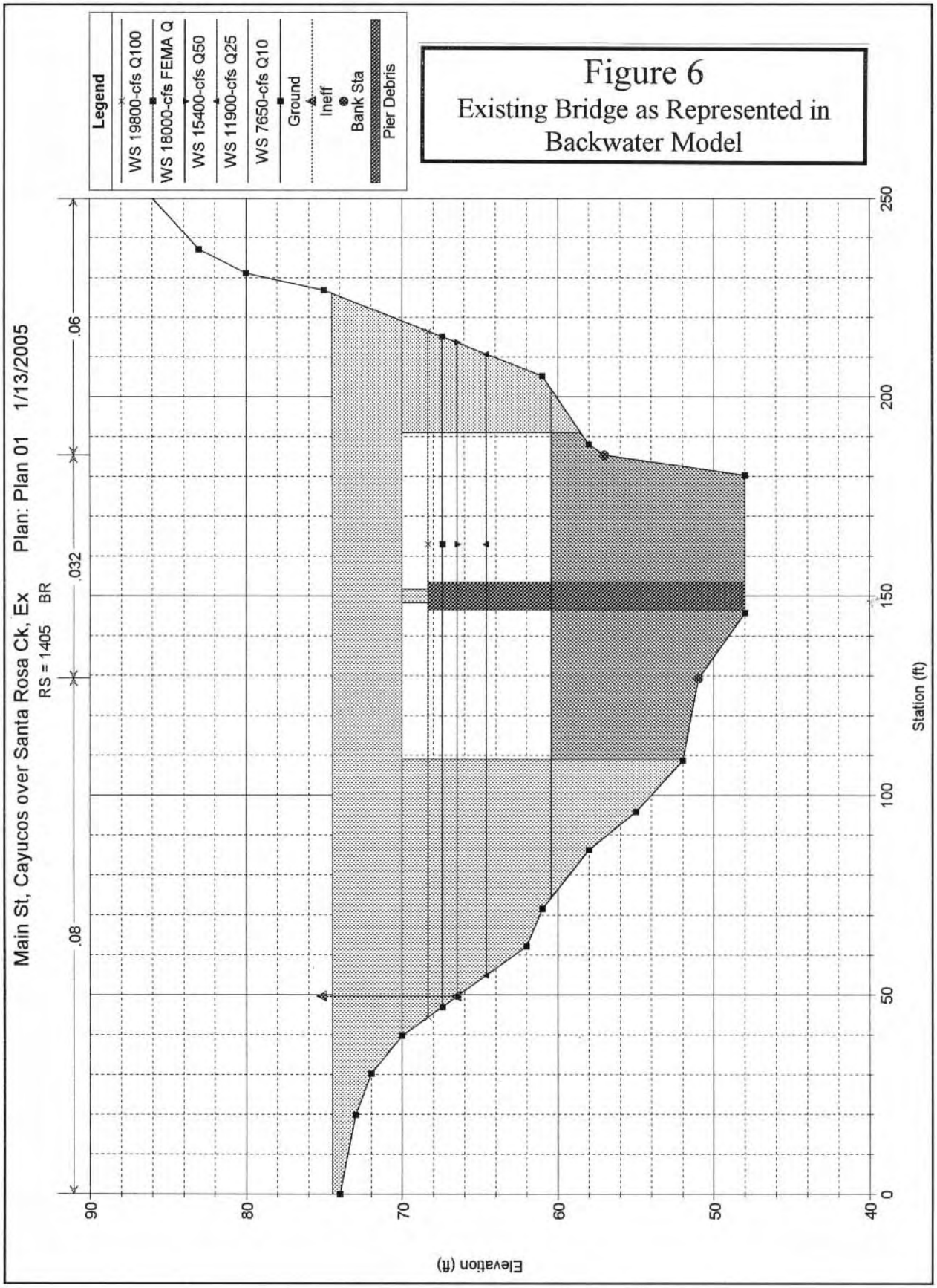


Figure 6
Existing Bridge as Represented in Backwater Model

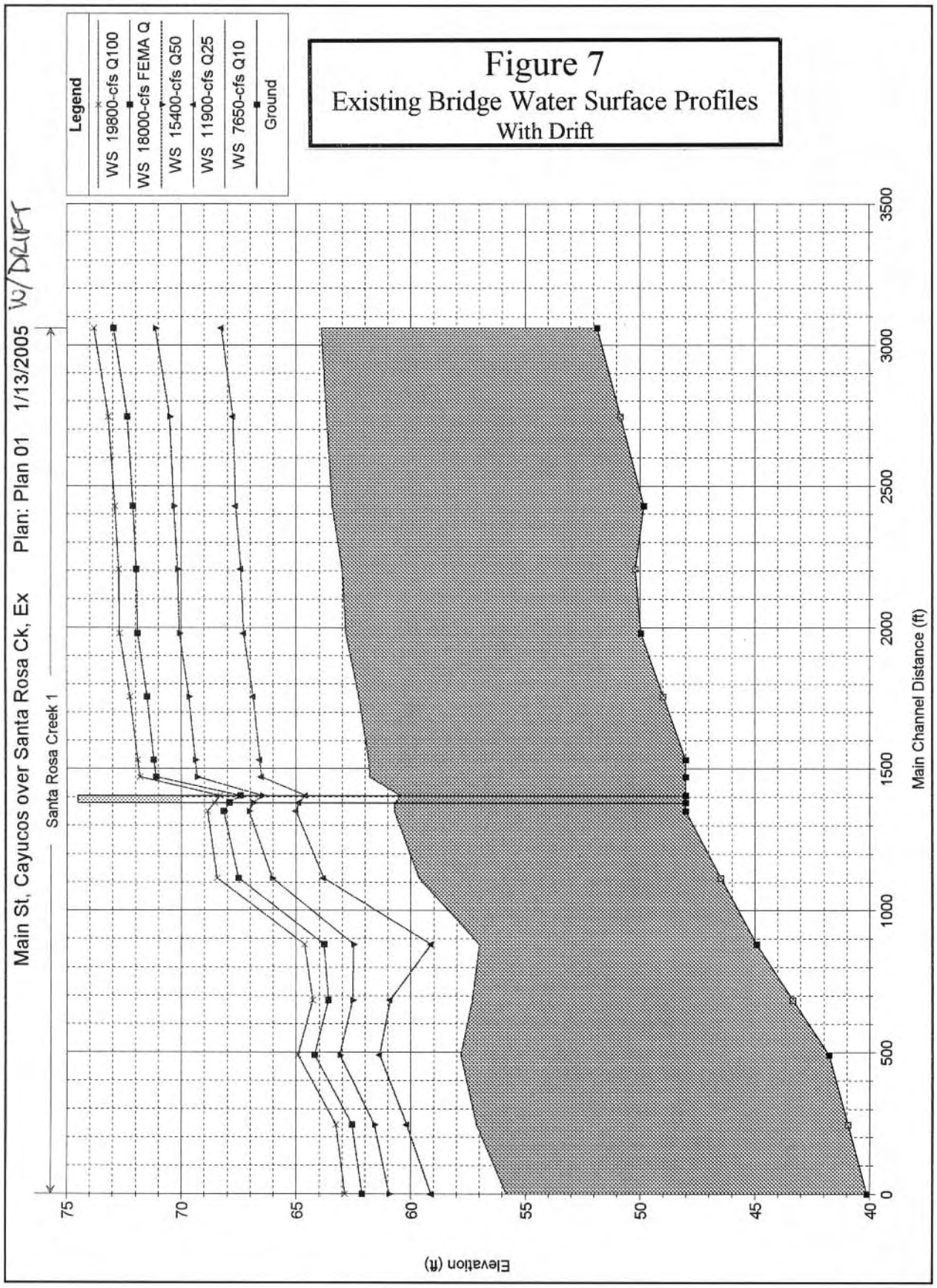
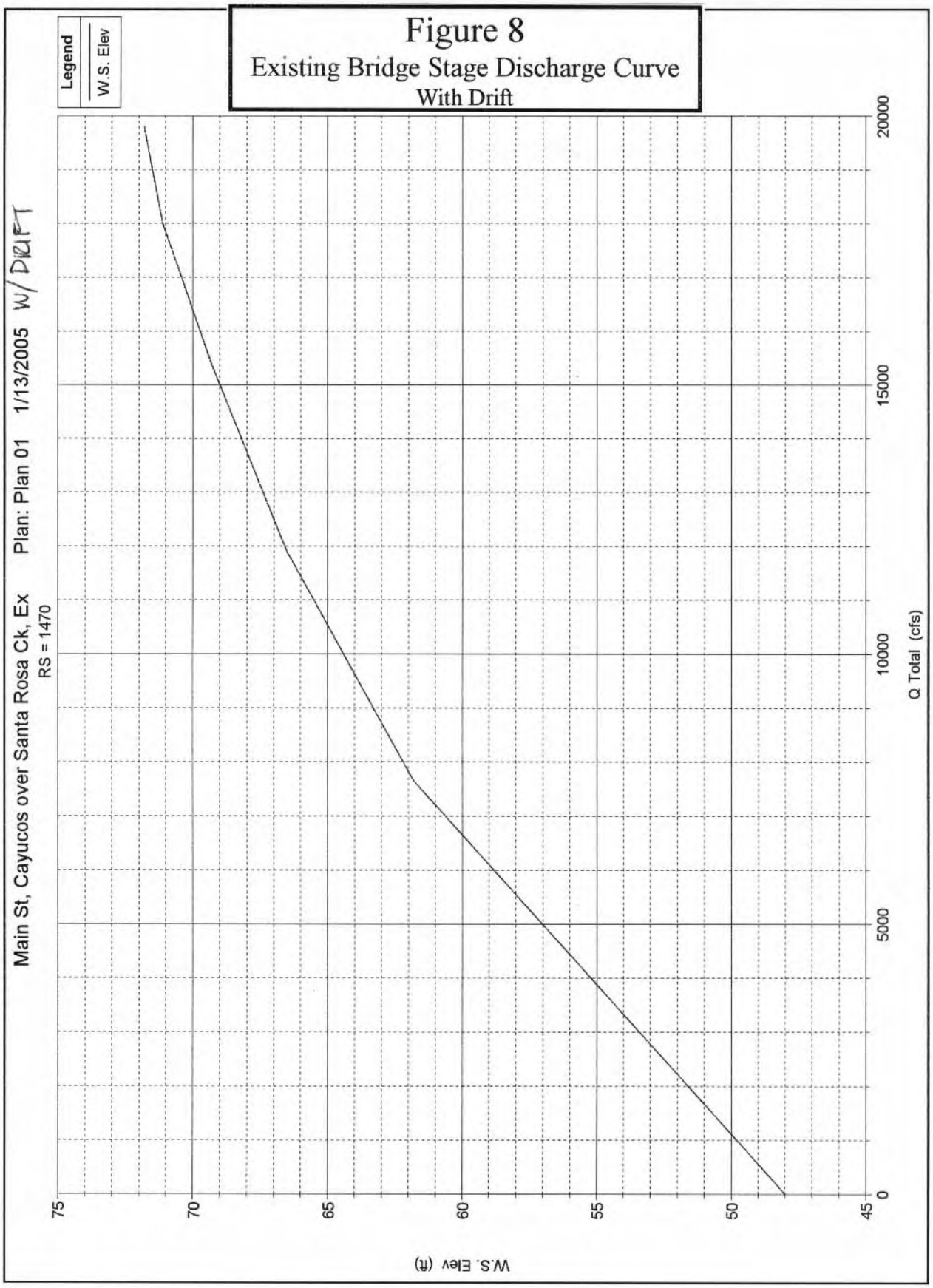


Figure 7
Existing Bridge Water Surface Profiles
With Drift

Figure 8
Existing Bridge Stage Discharge Curve
With Drift



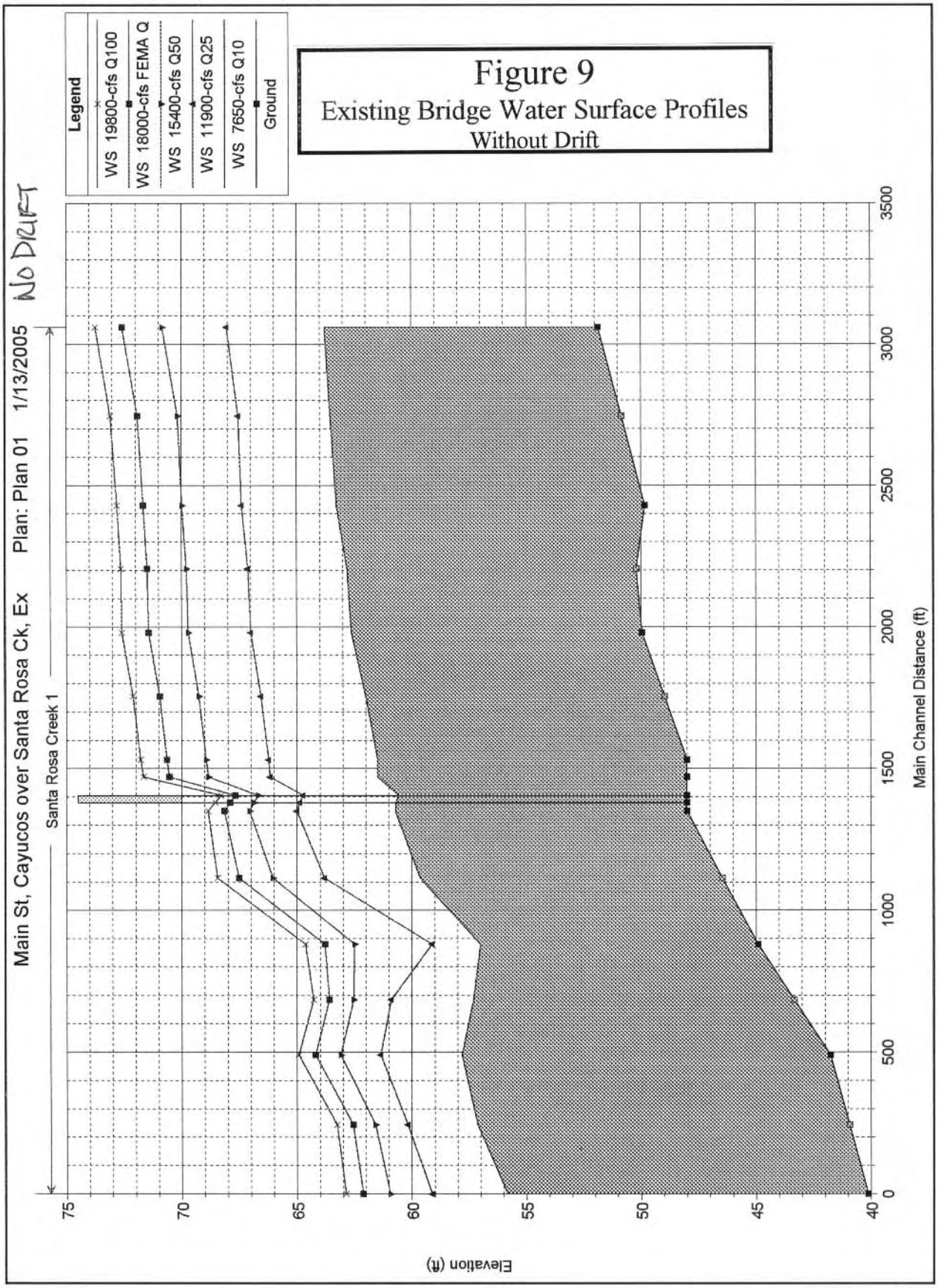
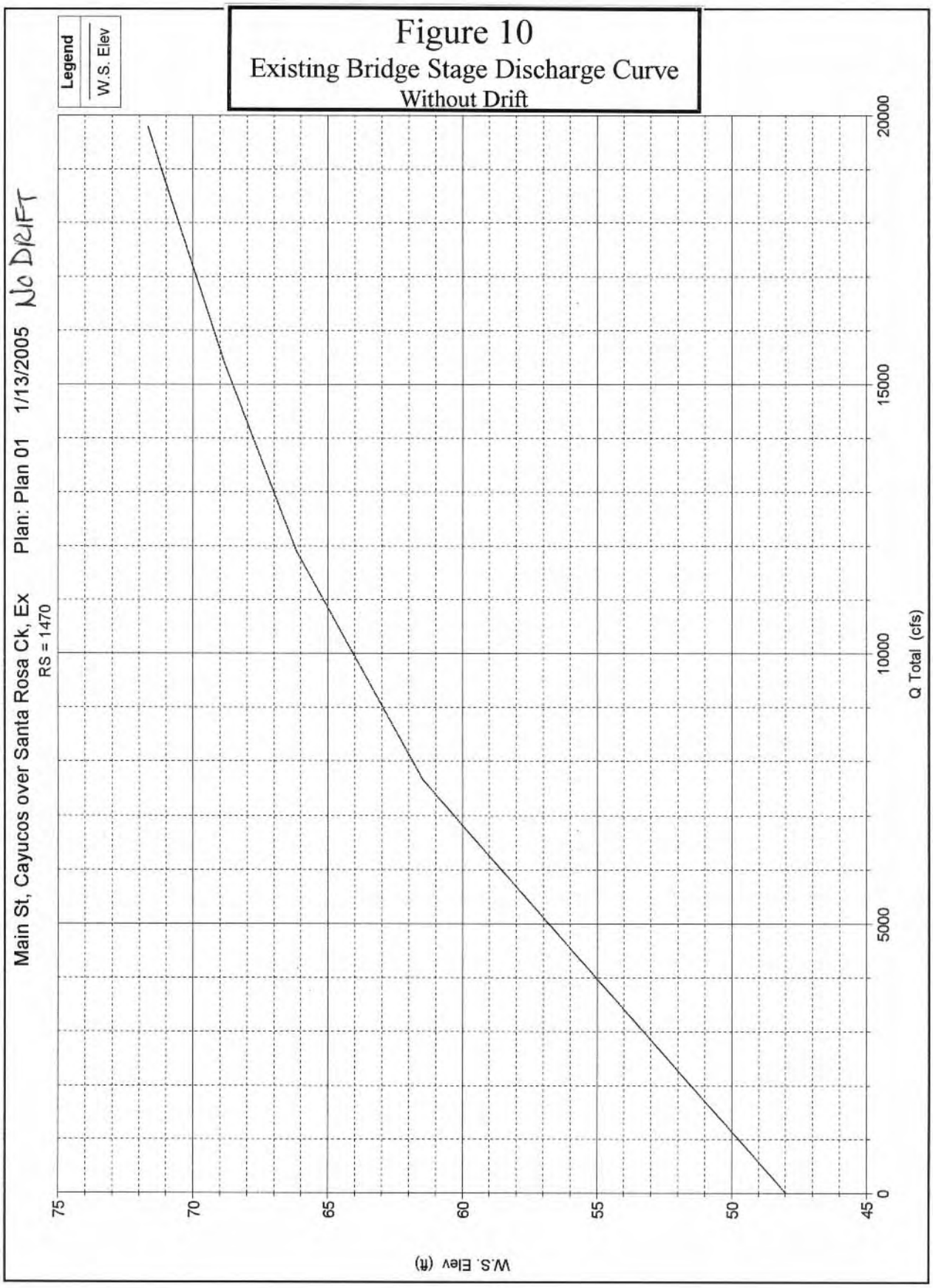


Figure 9
Existing Bridge Water Surface Profiles
Without Drift

Figure 10
Existing Bridge Stage Discharge Curve
Without Drift



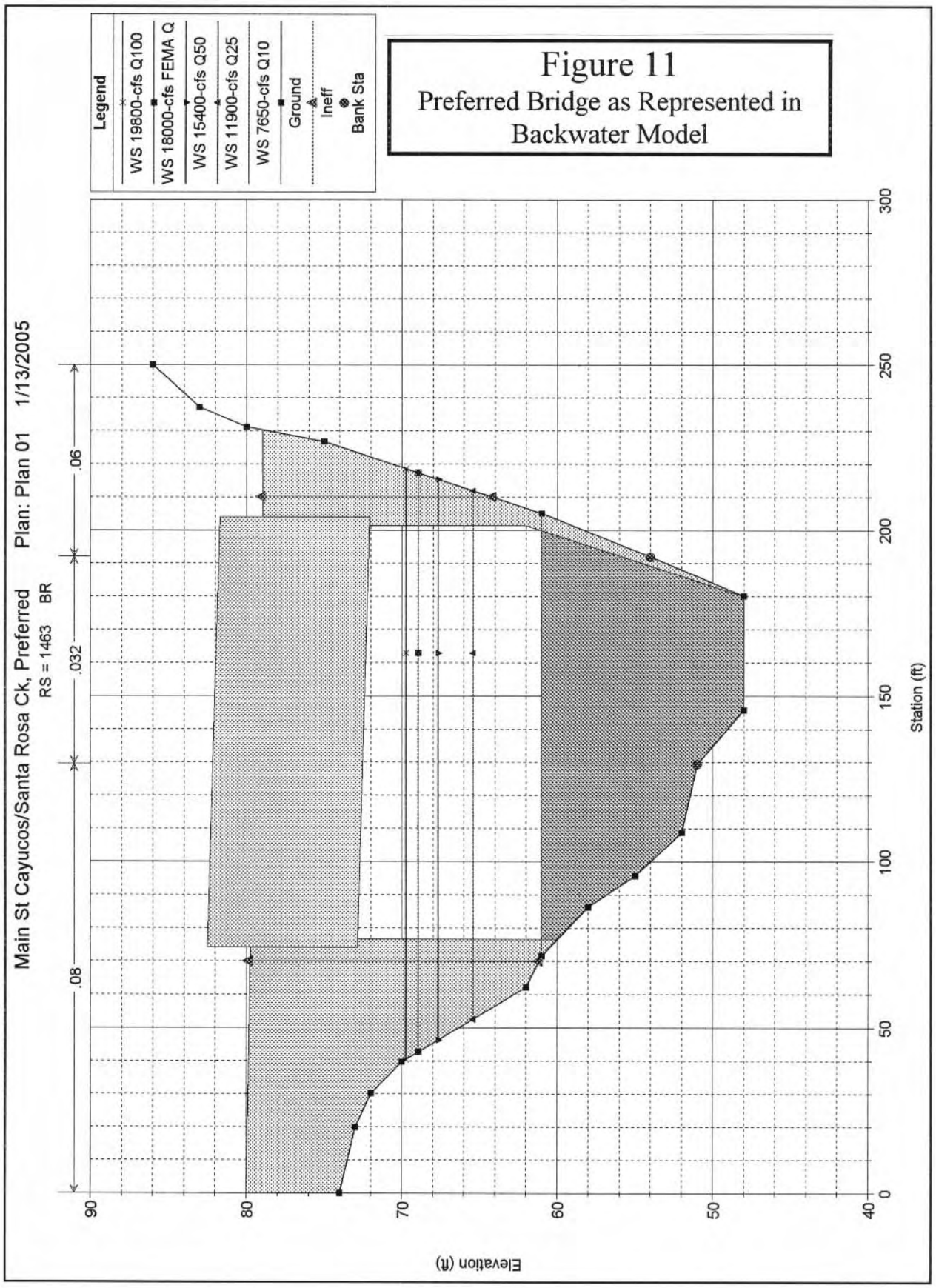


Figure 11
Preferred Bridge as Represented in Backwater Model

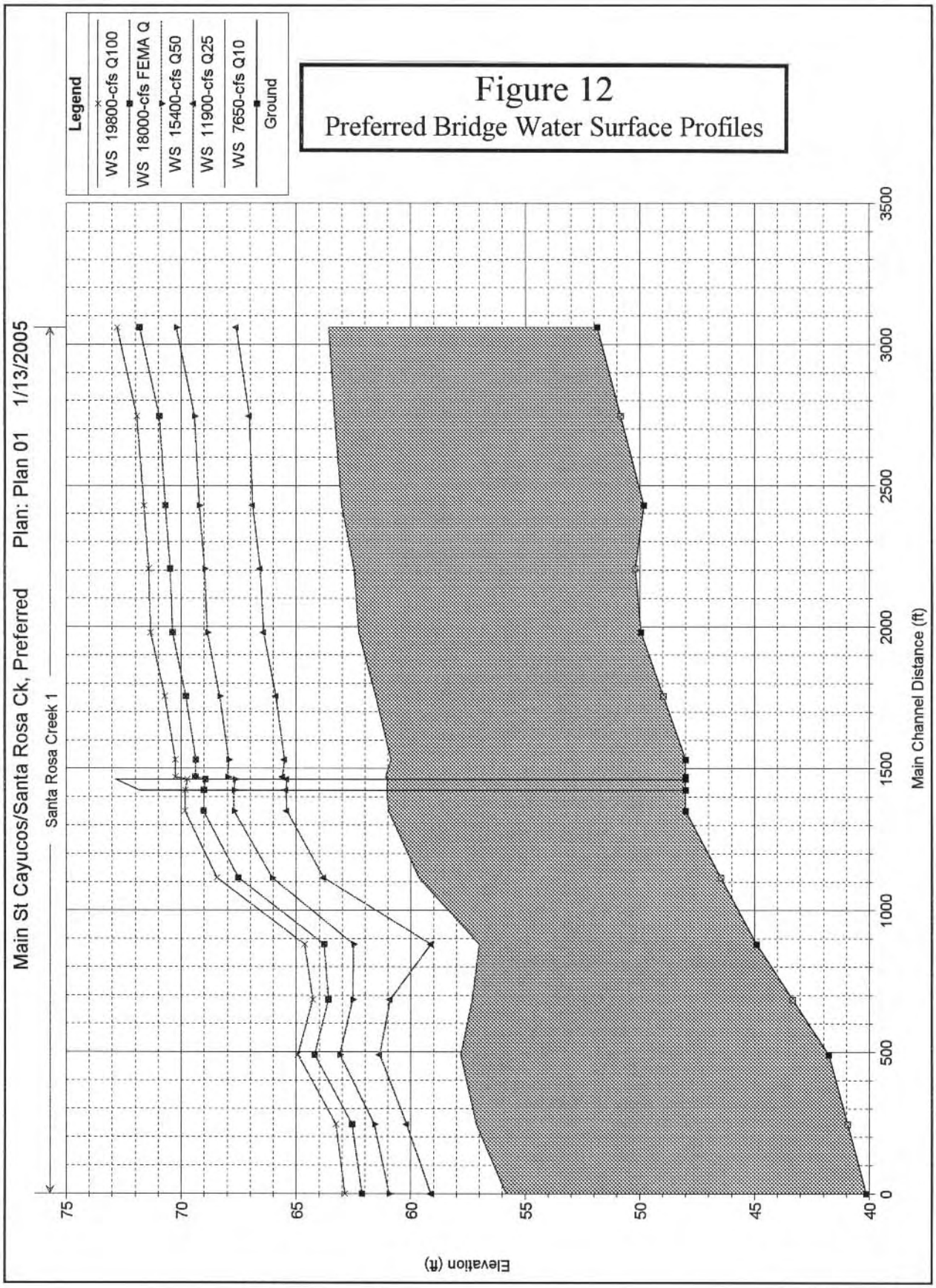


Figure 12
Preferred Bridge Water Surface Profiles

Figure 13
Preferred Bridge Stage Discharge Curve

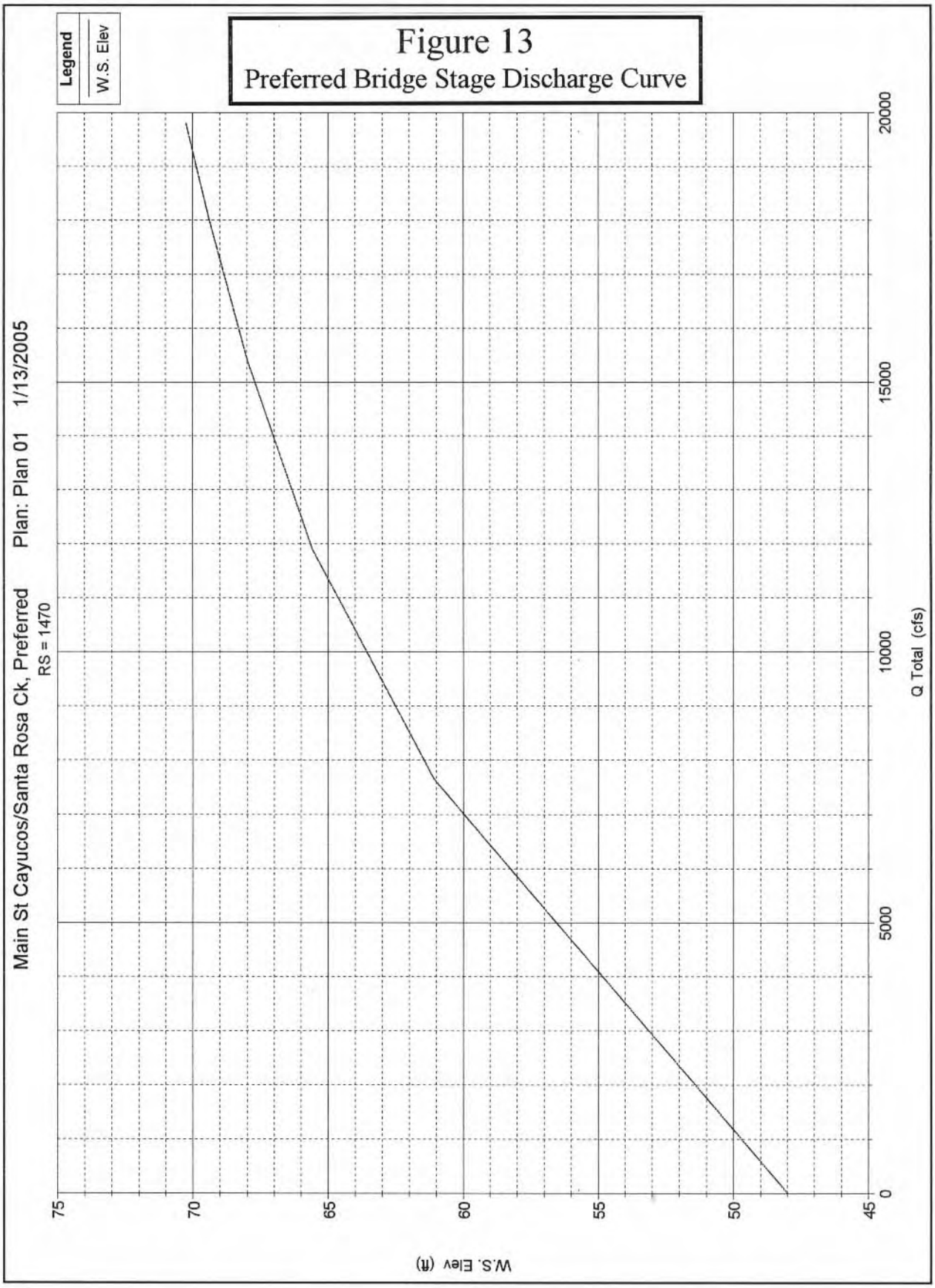
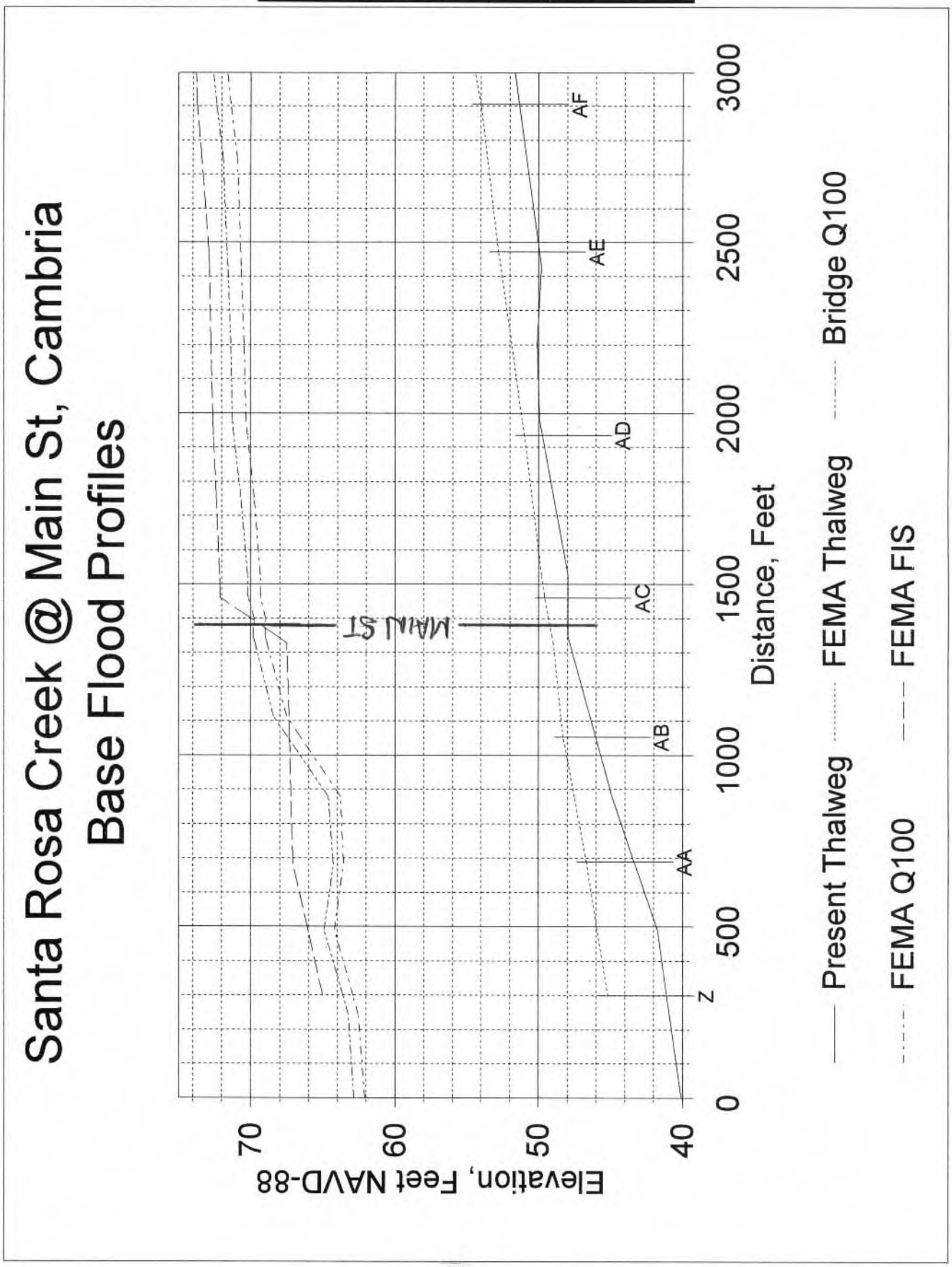


Figure 14

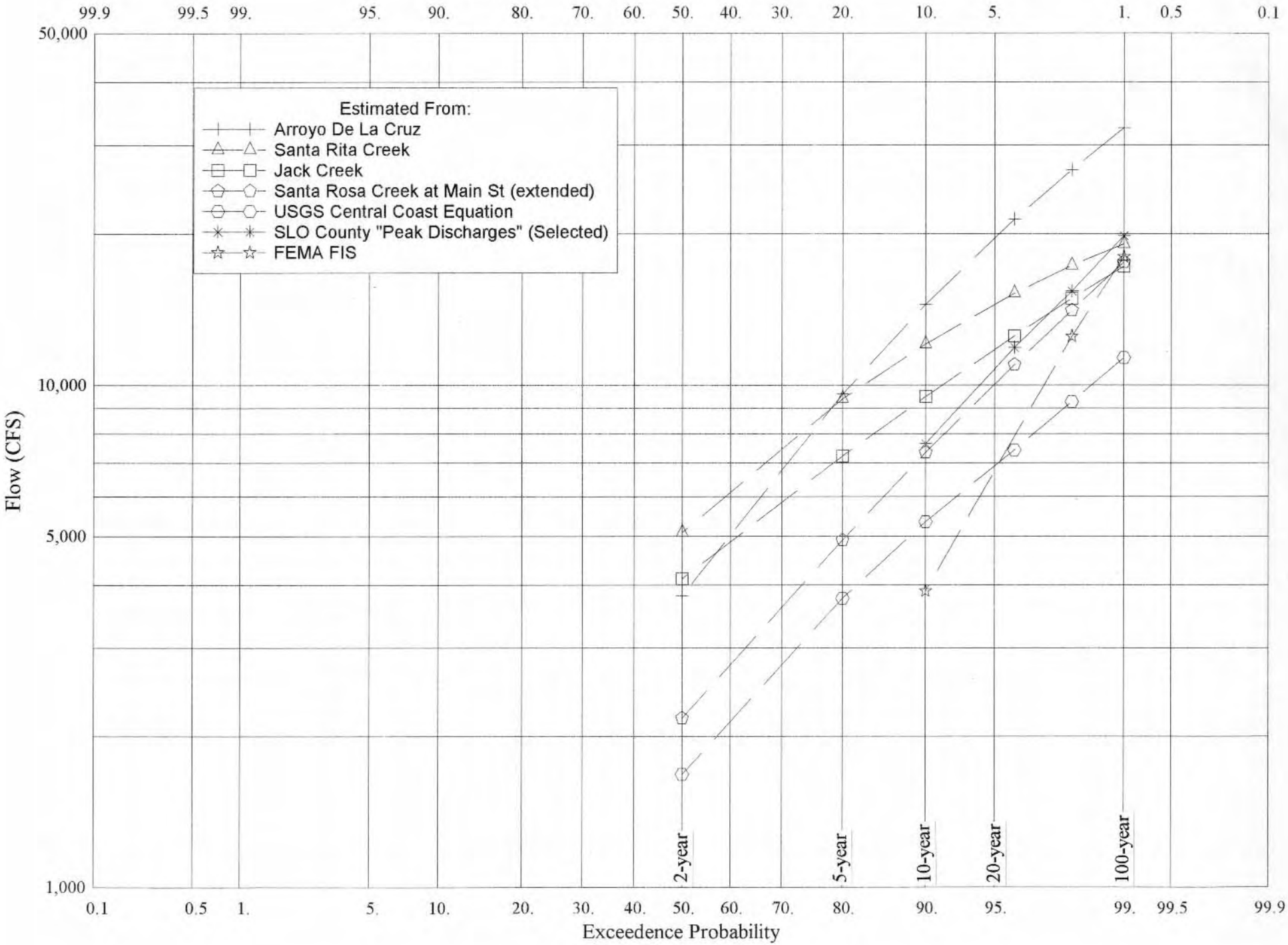

Santa Rosa Creek @ Main St, Cambria
Base Flood Profiles
Elevation, Feet NAVD-88
70
60
50
40
0
500
1000
1500
2000
2500
3000
Distance, Feet
Z
AA
AB
AC
AD
AE
AF
MAIN ST
Present Thalweg
FEMA Thalweg
Bridge Q100
FEMA Q100
FEMA FIS

APPENDIX A

Additional Hydrologic Figures

Candidate Flood Frequency Curves

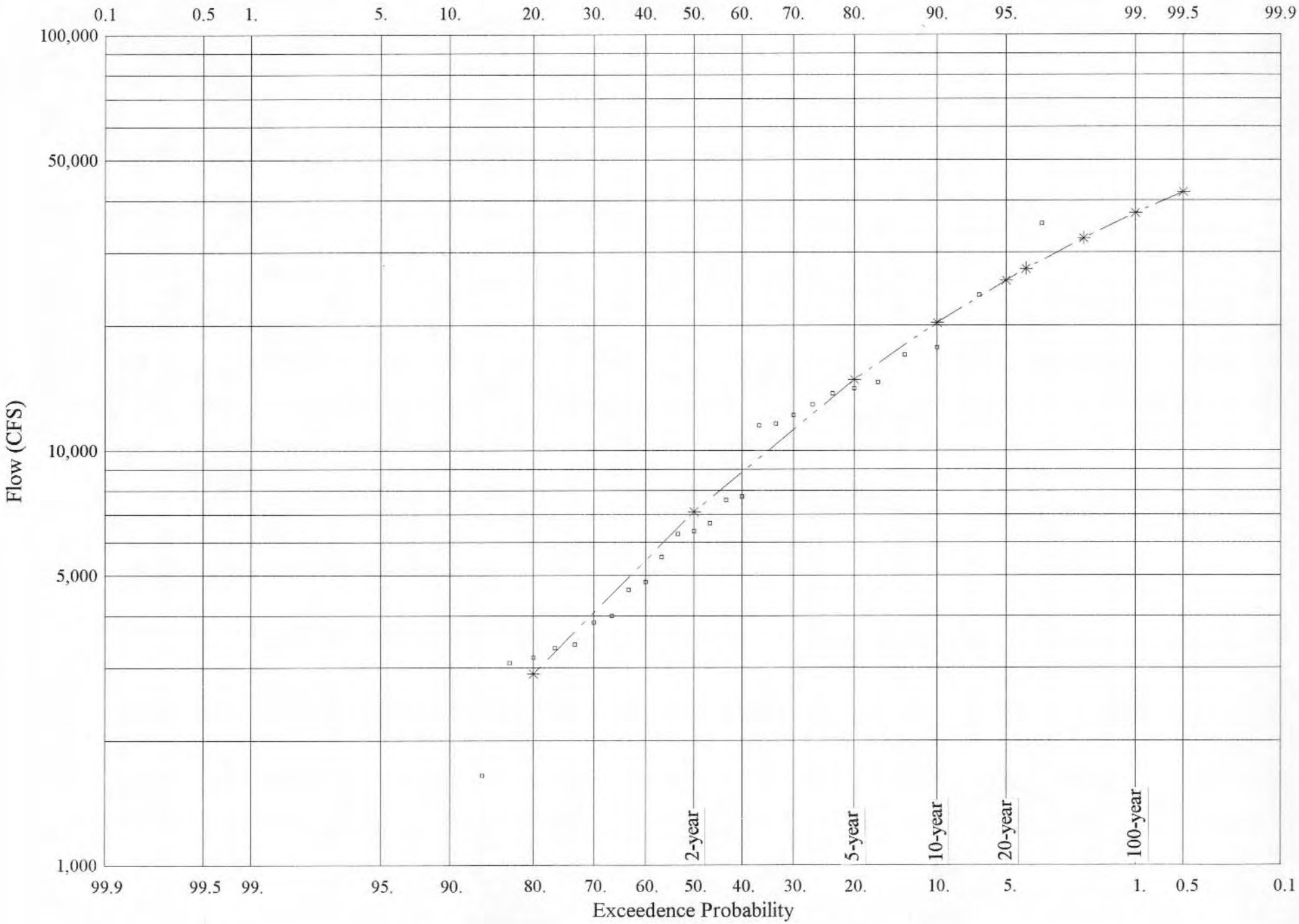
Santa Rosa Creek at Main Street, Cambria



Arroyo De La Cruz near San Simeon

USGS Streamgage 11142500, 29-years, 41.2 sq-mi, 31-in, EI=0.4

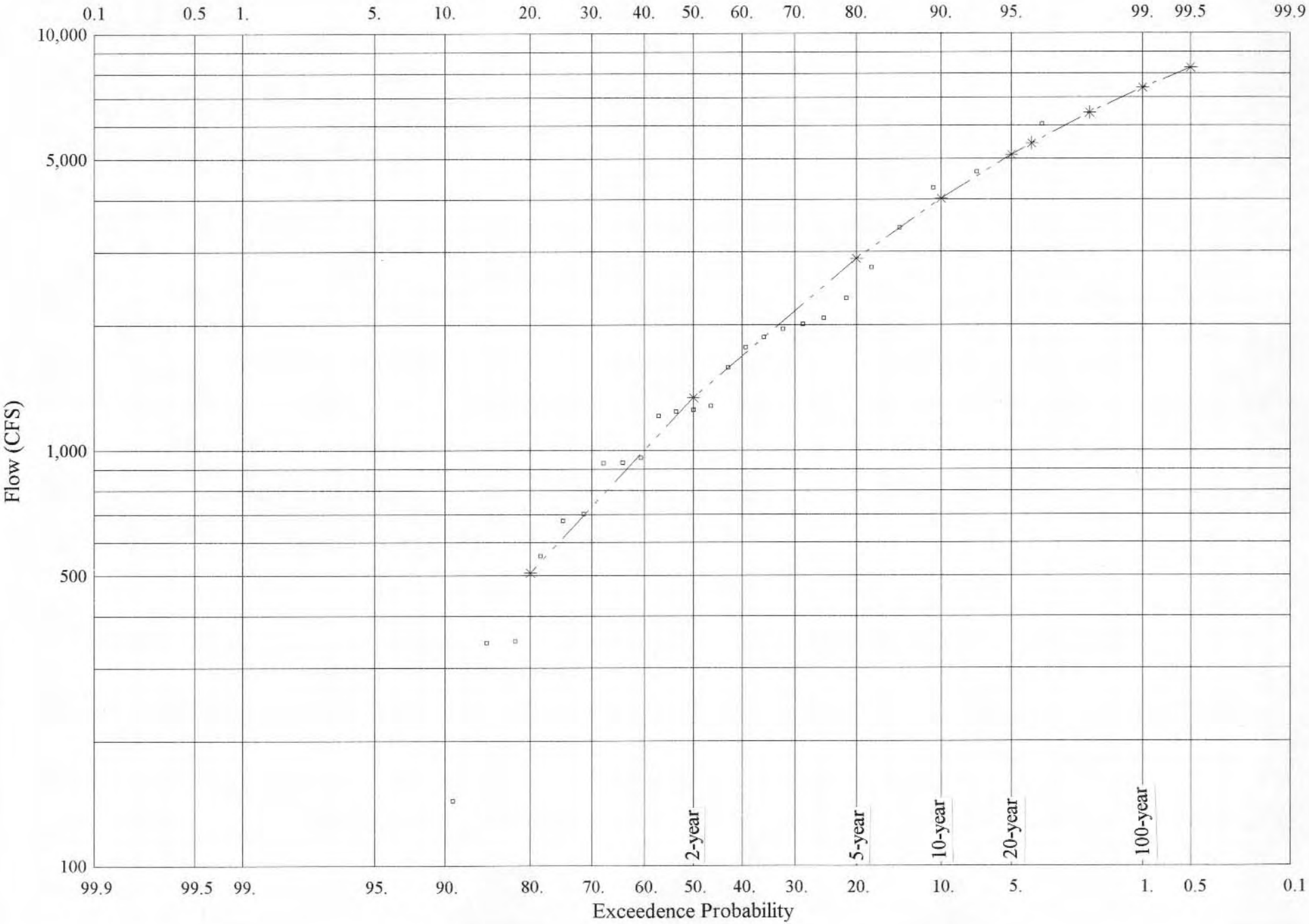
Discontinued



Santa Rita Creek near Templeton

USGS Streamgage 11147070, 27-years, 18.2 sq-mi, 31-in, EI=1.2

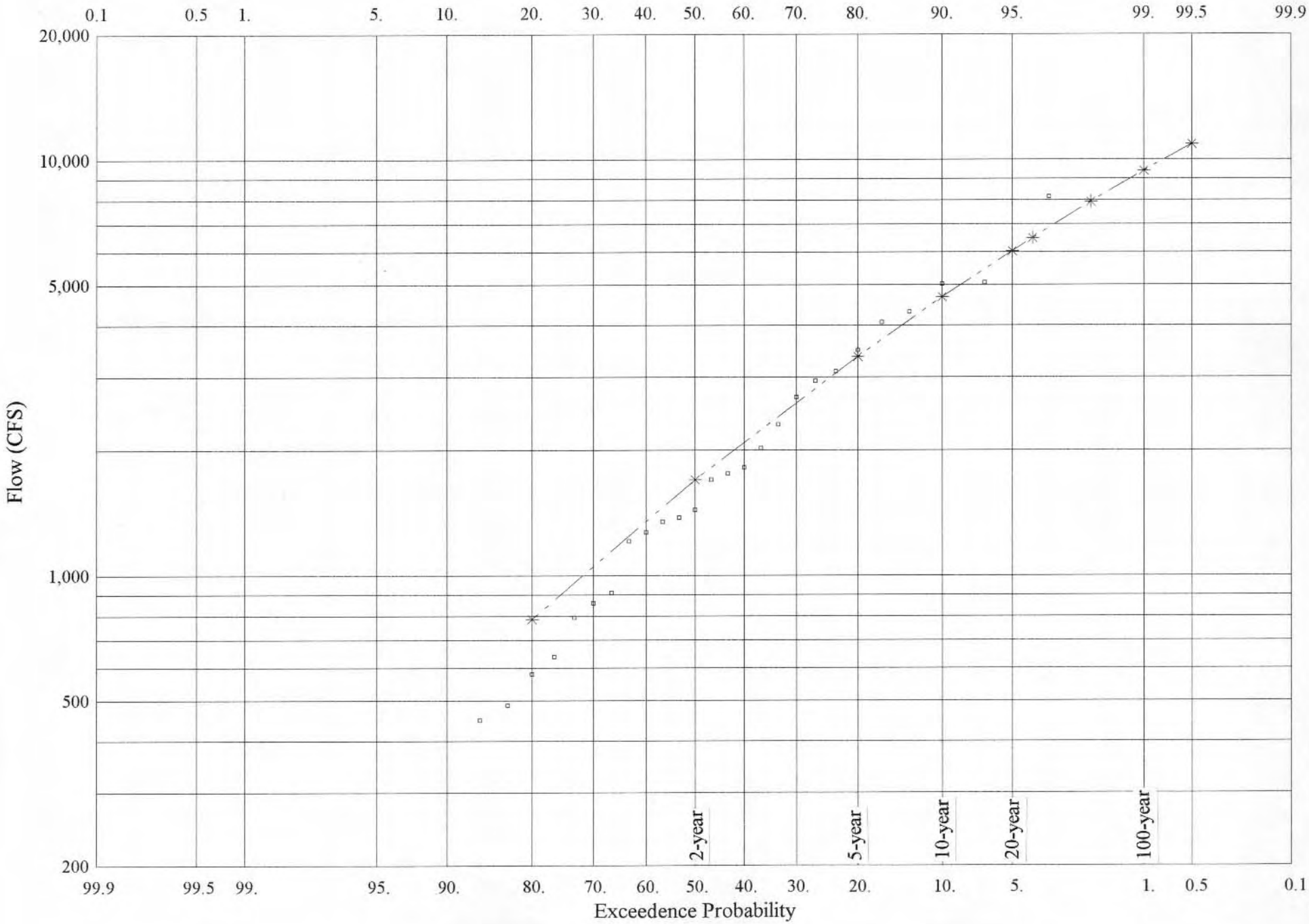
Discontinued



Jack Creek near Templeton

USGS Streamgage 11147000, 29-years, 25.3 sq-mi, 34-in, EI=1.3

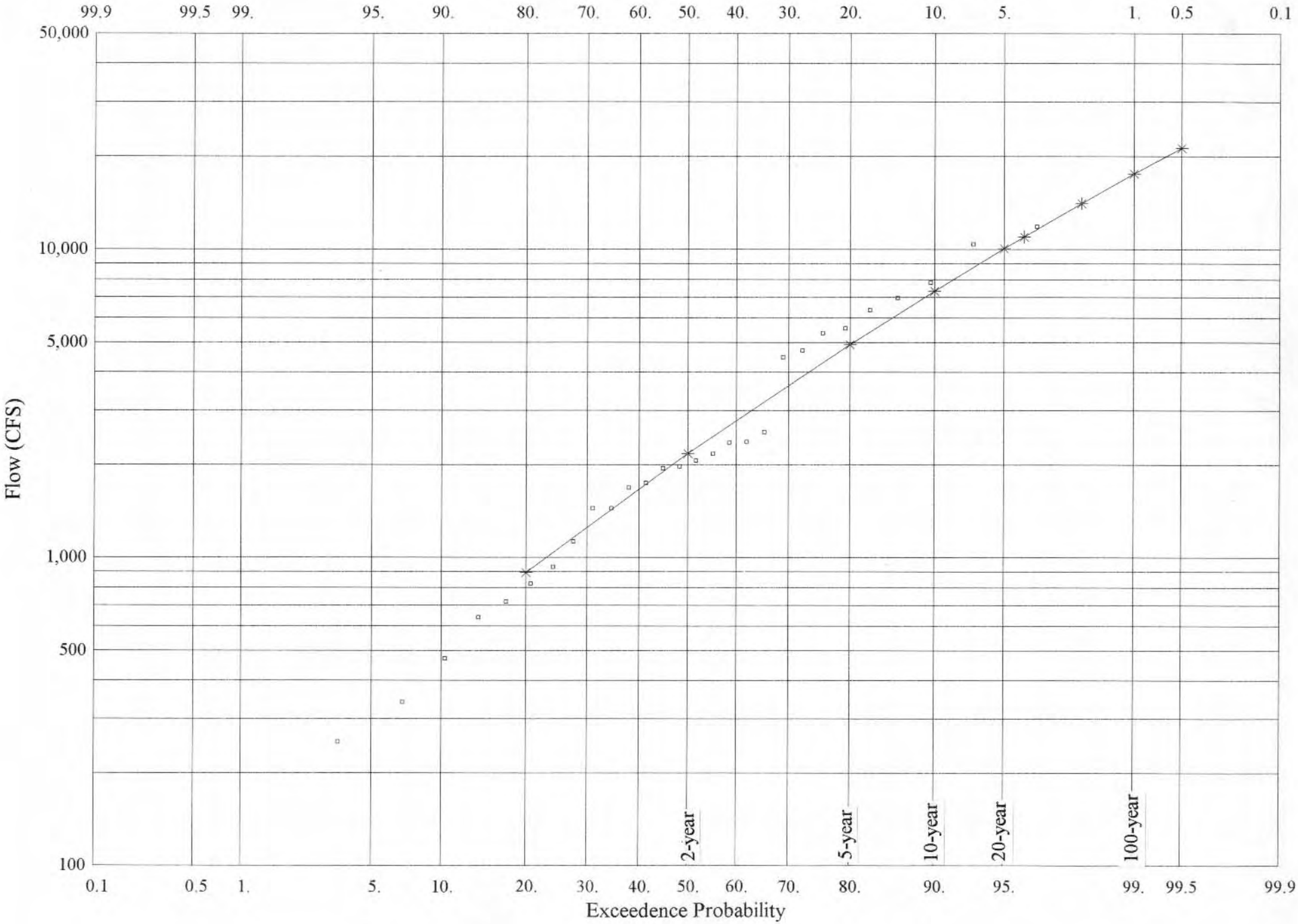
Discontinued



Santa Rosa Creek at Main Street, Cambria (Extended by Santa Rosa Ck nr Cambria)

SLO County Streamgage 21, 13-years, 44.7 sq-mi, 30-in, EI=0.4 (operating)

USGS Streamgage 11142200, 16-years, 12.5 sq-mi (discontinued)



APPENDIX B

Additional Hydraulic Information

HEC-RAS Plan: Plan 01 River: Santa Rosa Creek Reach: 1 EXISTING CONDITION W/DRIFT 1/2

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	3060	7650-cfs Q10	7650.00	51.87	63.91		66.25	0.004137	13.89	899.39	174.96	0.73
1	3060	11900-cfs Q25	11900.00	51.87	68.26		69.80	0.002124	12.40	1783.82	223.39	0.56
1	3060	15400-cfs Q50	15400.00	51.87	71.14		72.43	0.001556	11.90	2444.66	235.53	0.49
1	3060	19800-cfs Q100	19800.00	51.87	73.83		75.11	0.001361	12.19	3092.80	246.86	0.47
1	3060	18000-cfs FEMA Q	18000.00	51.87	72.97		74.20	0.001363	11.86	2881.79	243.23	0.47
1	2745.*	7650-cfs Q10	7650.00	50.85	63.68		65.05	0.002160	10.44	1037.33	144.18	0.55
1	2745.*	11900-cfs Q25	11900.00	50.85	67.77		69.19	0.001606	11.05	1719.96	185.88	0.49
1	2745.*	15400-cfs Q50	15400.00	50.85	70.52		71.96	0.001382	11.43	2276.60	217.48	0.47
1	2745.*	19800-cfs Q100	19800.00	50.85	73.19		74.68	0.001259	11.95	2875.13	231.69	0.46
1	2745.*	18000-cfs FEMA Q	18000.00	50.85	72.36		73.78	0.001239	11.54	2686.34	227.30	0.45
1	2430	7650-cfs Q10	7650.00	49.82	63.43		64.38	0.001446	8.58	1208.16	142.67	0.45
1	2430	11900-cfs Q25	11900.00	49.82	67.63		68.67	0.001093	9.20	1832.94	159.34	0.41
1	2430	15400-cfs Q50	15400.00	49.82	70.33		71.51	0.001029	9.94	2291.88	180.66	0.41
1	2430	19800-cfs Q100	19800.00	49.82	72.90		74.29	0.001043	10.92	2781.37	200.92	0.42
1	2430	18000-cfs FEMA Q	18000.00	49.82	72.12		73.39	0.000995	10.40	2626.86	194.75	0.41
1	2205.*	7650-cfs Q10	7650.00	50.21	63.00		64.04	0.001407	8.62	1131.14	151.61	0.45
1	2205.*	11900-cfs Q25	11900.00	50.21	67.40		68.44	0.000963	8.88	1853.79	176.51	0.40
1	2205.*	15400-cfs Q50	15400.00	50.21	70.17		71.28	0.000859	9.35	2360.96	189.54	0.38
1	2205.*	19800-cfs Q100	19800.00	50.21	72.75		74.05	0.000871	10.28	2876.14	212.27	0.40
1	2205.*	18000-cfs FEMA Q	18000.00	50.21	71.97		73.16	0.000829	9.78	2714.45	204.94	0.38
1	1980	7650-cfs Q10	7650.00	49.95	62.82		63.72	0.001134	7.84	1169.95	155.14	0.41
1	1980	11900-cfs Q25	11900.00	49.95	67.29		68.20	0.000795	8.18	1943.23	189.12	0.36
1	1980	15400-cfs Q50	15400.00	49.95	70.09		71.06	0.000712	8.62	2496.06	205.99	0.35
1	1980	19800-cfs Q100	19800.00	49.95	72.70		73.82	0.000708	9.37	3054.32	221.72	0.36
1	1980	18000-cfs FEMA Q	18000.00	49.95	71.92		72.94	0.000677	8.94	2882.49	217.00	0.35
1	1755.*	7650-cfs Q10	7650.00	48.97	62.26		63.41	0.001403	9.03	1140.37	155.92	0.46
1	1755.*	11900-cfs Q25	11900.00	48.97	66.88		67.99	0.000963	9.27	1926.08	184.30	0.40
1	1755.*	15400-cfs Q50	15400.00	48.97	69.68		70.87	0.000878	9.80	2466.28	201.94	0.39
1	1755.*	19800-cfs Q100	19800.00	48.97	72.25		73.62	0.000890	10.71	3005.27	217.53	0.40
1	1755.*	18000-cfs FEMA Q	18000.00	48.97	71.50		72.75	0.000844	10.19	2844.35	213.41	0.39
1	1530	7650-cfs Q10	7650.00	48.00	61.83		63.05	0.001700	10.01	1271.19	160.52	0.49
1	1530	11900-cfs Q25	11900.00	48.00	66.59		67.75	0.001160	10.19	2095.67	185.15	0.43
1	1530	15400-cfs Q50	15400.00	48.00	69.39		70.64	0.001078	10.83	2633.33	198.83	0.42
1	1530	19800-cfs Q100	19800.00	48.00	71.92		73.38	0.001120	11.93	3150.75	211.33	0.44
1	1530	18000-cfs FEMA Q	18000.00	48.00	71.20		72.53	0.001050	11.31	3001.53	207.72	0.42
1	1470	7650-cfs Q10	7650.00	48.00	61.80	56.87	62.92	0.001432	9.10	1184.61	142.51	0.45
1	1470	11900-cfs Q25	11900.00	48.00	66.52	59.36	67.68	0.001049	9.58	1910.93	164.28	0.40
1	1470	15400-cfs Q50	15400.00	48.00	69.31	61.01	70.57	0.000980	10.21	2375.16	176.39	0.40
1	1470	19800-cfs Q100	19800.00	48.00	71.80	63.55	73.31	0.001030	11.31	2799.58	190.73	0.42
1	1470	18000-cfs FEMA Q	18000.00	48.00	71.10	62.82	72.46	0.000961	10.70	2679.92	186.34	0.40
1	1405		Bridge									
1	1350	7650-cfs Q10	7650.00	48.00	60.72	56.09	61.87	0.001692	8.98	997.13	102.49	0.45
1	1350	11900-cfs Q25	11900.00	48.00	65.00	58.50	66.40	0.001423	10.06	1398.95	233.49	0.44
1	1350	15400-cfs Q50	15400.00	48.00	67.06	60.20	68.87	0.001580	11.47	1592.36	253.67	0.47
1	1350	19800-cfs Q100	19800.00	48.00	68.86	62.09	71.31	0.001891	13.35	1761.92	266.51	0.52
1	1350	18000-cfs FEMA Q	18000.00	48.00	68.16	61.34	70.35	0.001766	12.60	1696.07	261.52	0.50
1	1115.*	7650-cfs Q10	7650.00	46.46	59.63	55.72	61.26	0.002343	10.70	863.14	88.36	0.53
1	1115.*	11900-cfs Q25	11900.00	46.46	63.81	58.45	65.83	0.002044	12.11	1376.07	160.90	0.52
1	1115.*	15400-cfs Q50	15400.00	46.46	66.05	60.40	68.32	0.002035	13.15	1773.45	195.53	0.53
1	1115.*	19800-cfs Q100	19800.00	46.46	68.44	63.96	70.84	0.001951	13.94	2261.23	254.51	0.53
1	1115.*	18000-cfs FEMA Q	18000.00	46.46	67.52	60.40	69.86	0.001980	13.63	2069.13	228.76	0.53
1	880	7650-cfs Q10	7650.00	44.91	57.00		60.29	0.005555	15.09	602.40	69.72	0.79
1	880	11900-cfs Q25	11900.00	44.91	59.12	57.72	64.65	0.007514	19.66	769.48	95.44	0.94
1	880	15400-cfs Q50	15400.00	44.91	62.50	62.50	67.35	0.005210	19.01	1191.34	149.70	0.82
1	880	19800-cfs Q100	19800.00	44.91	64.63	64.63	69.87	0.005090	20.34	1530.51	169.12	0.82
1	880	18000-cfs FEMA Q	18000.00	44.91	63.78	63.78	68.89	0.005153	19.85	1390.91	161.41	0.82
1	685.*	7650-cfs Q10	7650.00	43.34	57.32		59.08	0.002814	11.42	950.48	141.09	0.57
1	685.*	11900-cfs Q25	11900.00	43.34	60.89		62.80	0.002391	12.45	1490.33	160.96	0.55
1	685.*	15400-cfs Q50	15400.00	43.34	62.53		64.92	0.002705	14.13	1763.57	175.90	0.59
1	685.*	19800-cfs Q100	19800.00	43.34	64.29		67.18	0.002999	15.84	2083.48	188.45	0.63
1	685.*	18000-cfs FEMA Q	18000.00	43.34	63.60		66.29	0.002889	15.18	1954.67	183.50	0.62
1	490	7650-cfs Q10	7650.00	41.77	57.82		58.42	0.001003	7.29	1656.88	162.73	0.34
1	490	11900-cfs Q25	11900.00	41.77	61.35		62.17	0.001065	8.71	2301.86	194.77	0.36
1	490	15400-cfs Q50	15400.00	41.77	63.10		64.18	0.001254	10.06	2655.18	211.78	0.40
1	490	19800-cfs Q100	19800.00	41.77	64.93		66.33	0.001475	11.59	3063.27	233.11	0.44
1	490	18000-cfs FEMA Q	18000.00	41.77	64.21		65.48	0.001391	11.00	2897.69	224.70	0.43

HEC-RAS Plan: Plan 01 River: Santa Rosa Creek Reach: 1 (Continued) EXISTING CONDITION W/DRIFT 2/2

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	245.*	7650-cfs Q10	7650.00	40.94	57.12		58.11	0.001255	9.15	1290.44	137.07	0.41
1	245.*	11900-cfs Q25	11900.00	40.94	60.18		61.78	0.001622	11.77	1806.54	205.41	0.49
1	245.*	15400-cfs Q50	15400.00	40.94	61.58		63.70	0.001993	13.70	2116.84	239.51	0.55
1	245.*	19800-cfs Q100	19800.00	40.94	63.26		65.79	0.002246	15.37	2542.56	267.50	0.59
1	245.*	18000-cfs FEMA Q	18000.00	40.94	62.57		64.96	0.002169	14.77	2362.33	256.84	0.57
1	0	7650-cfs Q10	7650.00	40.12	55.83	51.79	57.71	0.002001	12.56	986.55	188.98	0.57
1	0	11900-cfs Q25	11900.00	40.12	59.11	55.36	61.29	0.002004	14.32	1733.41	250.58	0.59
1	0	15400-cfs Q50	15400.00	40.12	60.94	59.04	63.20	0.002002	15.24	2214.00	275.39	0.60
1	0	19800-cfs Q100	19800.00	40.12	62.88	60.70	65.22	0.002000	16.19	2770.40	298.88	0.61
1	0	18000-cfs FEMA Q	18000.00	40.12	62.12	60.08	64.43	0.002001	15.82	2547.84	289.77	0.60

HEC-RAS Plan: Plan 01 River: Santa Rosa Creek Reach: 1 EXISTING CONDITION, NO DRIFT 1/2

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	3060	7650-cfs Q10	7650.00	51.87	63.78		66.22	0.004373	14.17	875.91	172.37	0.75
1	3060	11900-cfs Q25	11900.00	51.87	68.03		69.68	0.002286	12.74	1733.14	222.43	0.58
1	3060	15400-cfs Q50	15400.00	51.87	70.84		72.22	0.001684	12.24	2373.64	234.26	0.51
1	3060	19800-cfs Q100	19800.00	51.87	73.74		75.04	0.001387	12.27	3071.28	246.50	0.47
1	3060	18000-cfs FEMA Q	18000.00	51.87	72.58		73.91	0.001491	12.25	2788.19	241.61	0.49
1	2745.*	7650-cfs Q10	7650.00	50.85	63.54		64.96	0.002269	10.61	1017.03	142.98	0.56
1	2745.*	11900-cfs Q25	11900.00	50.85	67.53		69.02	0.001713	11.29	1674.38	183.23	0.51
1	2745.*	15400-cfs Q50	15400.00	50.85	70.16		71.71	0.001506	11.77	2199.21	215.11	0.49
1	2745.*	19800-cfs Q100	19800.00	50.85	73.08		74.60	0.001286	12.03	2851.70	231.15	0.47
1	2745.*	18000-cfs FEMA Q	18000.00	50.85	71.91		73.44	0.001368	11.94	2584.55	224.90	0.48
1	2430	7650-cfs Q10	7650.00	49.82	63.27		64.25	0.001527	8.73	1184.98	142.25	0.46
1	2430	11900-cfs Q25	11900.00	49.82	67.38		68.46	0.001157	9.37	1793.08	157.35	0.42
1	2430	15400-cfs Q50	15400.00	49.82	69.97		71.22	0.001107	10.17	2227.56	177.83	0.42
1	2430	19800-cfs Q100	19800.00	49.82	72.79		74.21	0.001063	10.99	2760.50	200.10	0.43
1	2430	18000-cfs FEMA Q	18000.00	49.82	71.66		73.01	0.001085	10.70	2538.19	191.12	0.43
1	2205.*	7650-cfs Q10	7650.00	50.21	62.80		63.90	0.001507	8.81	1101.00	150.47	0.47
1	2205.*	11900-cfs Q25	11900.00	50.21	67.12		68.21	0.001032	9.09	1804.46	175.07	0.41
1	2205.*	15400-cfs Q50	15400.00	50.21	69.79		70.97	0.000931	9.60	2289.39	187.75	0.40
1	2205.*	19800-cfs Q100	19800.00	50.21	72.64		73.96	0.000888	10.34	2853.34	211.25	0.40
1	2205.*	18000-cfs FEMA Q	18000.00	50.21	71.50		72.76	0.000906	10.06	2618.01	200.44	0.40
1	1980	7650-cfs Q10	7650.00	49.95	62.62		63.54	0.001200	7.98	1138.91	150.05	0.42
1	1980	11900-cfs Q25	11900.00	49.95	67.00		67.96	0.000854	8.37	1888.37	187.36	0.37
1	1980	15400-cfs Q50	15400.00	49.95	69.70		70.73	0.000772	8.85	2416.25	203.64	0.36
1	1980	19800-cfs Q100	19800.00	49.95	72.59		73.72	0.000723	9.44	3029.93	221.05	0.36
1	1980	18000-cfs FEMA Q	18000.00	49.95	71.43		72.53	0.000744	9.22	2777.02	214.05	0.36
1	1755.*	7650-cfs Q10	7650.00	48.97	61.99		63.21	0.001531	9.30	1098.19	154.23	0.47
1	1755.*	11900-cfs Q25	11900.00	48.97	66.56		67.73	0.001040	9.51	1866.64	182.29	0.41
1	1755.*	15400-cfs Q50	15400.00	48.97	69.25		70.52	0.000958	10.09	2380.66	199.25	0.41
1	1755.*	19800-cfs Q100	19800.00	48.97	72.13		73.52	0.000909	10.79	2979.22	216.80	0.40
1	1755.*	18000-cfs FEMA Q	18000.00	48.97	70.97		72.31	0.000932	10.54	2731.48	210.05	0.41
1	1530	7650-cfs Q10	7650.00	48.00	61.49		62.82	0.001892	10.38	1217.37	158.73	0.51
1	1530	11900-cfs Q25	11900.00	48.00	66.24		67.47	0.001258	10.47	2030.78	183.43	0.44
1	1530	15400-cfs Q50	15400.00	48.00	68.94		70.27	0.001180	11.16	2543.27	196.61	0.44
1	1530	19800-cfs Q100	19800.00	48.00	71.79		73.28	0.001145	12.02	3123.80	210.69	0.44
1	1530	18000-cfs FEMA Q	18000.00	48.00	70.64		72.07	0.001163	11.70	2884.89	204.92	0.44
1	1470	7650-cfs Q10	7650.00	48.00	61.48	56.87	62.67	0.001569	9.37	1138.87	138.93	0.46
1	1470	11900-cfs Q25	11900.00	48.00	66.16	59.36	67.39	0.001135	9.84	1853.10	162.75	0.42
1	1470	15400-cfs Q50	15400.00	48.00	68.85	61.01	70.20	0.001072	10.53	2297.59	174.39	0.41
1	1470	19800-cfs Q100	19800.00	48.00	71.67	63.55	73.20	0.001053	11.39	2776.97	189.90	0.42
1	1470	18000-cfs FEMA Q	18000.00	48.00	70.53	62.82	72.00	0.001064	11.07	2582.32	182.74	0.42
1	1405		Bridge									
1	1350	7650-cfs Q10	7650.00	48.00	60.72	56.09	61.87	0.001692	8.98	997.13	102.49	0.45
1	1350	11900-cfs Q25	11900.00	48.00	65.00	58.50	66.40	0.001423	10.06	1398.95	233.49	0.44
1	1350	15400-cfs Q50	15400.00	48.00	67.06	60.20	68.87	0.001580	11.47	1592.36	253.67	0.47
1	1350	19800-cfs Q100	19800.00	48.00	68.86	62.09	71.31	0.001891	13.35	1761.92	266.51	0.52
1	1350	18000-cfs FEMA Q	18000.00	48.00	68.16	61.34	70.35	0.001766	12.60	1696.07	261.52	0.50
1	1115.*	7650-cfs Q10	7650.00	46.46	59.63	55.72	61.26	0.002343	10.70	863.14	88.36	0.53
1	1115.*	11900-cfs Q25	11900.00	46.46	63.81	58.45	65.83	0.002044	12.11	1376.07	160.90	0.52
1	1115.*	15400-cfs Q50	15400.00	46.46	66.05	60.40	68.32	0.002035	13.15	1773.45	195.53	0.53
1	1115.*	19800-cfs Q100	19800.00	46.46	68.44	63.96	70.84	0.001951	13.94	2261.23	254.51	0.53
1	1115.*	18000-cfs FEMA Q	18000.00	46.46	67.52	60.40	69.86	0.001980	13.63	2069.13	228.76	0.53
1	880	7650-cfs Q10	7650.00	44.91	57.00		60.29	0.005555	15.09	602.40	69.72	0.79
1	880	11900-cfs Q25	11900.00	44.91	59.12	57.72	64.65	0.007514	19.66	769.48	95.44	0.94
1	880	15400-cfs Q50	15400.00	44.91	62.50	62.50	67.35	0.005210	19.01	1191.34	149.70	0.82
1	880	19800-cfs Q100	19800.00	44.91	64.63	64.63	69.87	0.005090	20.34	1530.51	169.12	0.82
1	880	18000-cfs FEMA Q	18000.00	44.91	63.78	63.78	68.89	0.005153	19.85	1390.91	161.41	0.82
1	685.*	7650-cfs Q10	7650.00	43.34	57.32		59.08	0.002814	11.42	950.48	141.09	0.57
1	685.*	11900-cfs Q25	11900.00	43.34	60.89		62.80	0.002391	12.45	1490.33	160.96	0.55
1	685.*	15400-cfs Q50	15400.00	43.34	62.53		64.92	0.002705	14.13	1763.57	175.90	0.59
1	685.*	19800-cfs Q100	19800.00	43.34	64.29		67.18	0.002999	15.84	2083.48	188.45	0.63
1	685.*	18000-cfs FEMA Q	18000.00	43.34	63.60		66.29	0.002889	15.18	1954.67	183.50	0.62
1	490	7650-cfs Q10	7650.00	41.77	57.82		58.42	0.001003	7.29	1656.88	162.73	0.34
1	490	11900-cfs Q25	11900.00	41.77	61.35		62.17	0.001065	8.71	2301.86	194.77	0.36
1	490	15400-cfs Q50	15400.00	41.77	63.10		64.18	0.001254	10.06	2655.18	211.78	0.40
1	490	19800-cfs Q100	19800.00	41.77	64.93		66.33	0.001475	11.59	3063.27	233.11	0.44
1	490	18000-cfs FEMA Q	18000.00	41.77	64.21		65.48	0.001391	11.00	2897.69	224.70	0.43

HEC-RAS Plan: Plan 01 River: Santa Rosa Creek Reach: 1 (Continued) EXISTING CONDITION, NO DRIFT 2/2

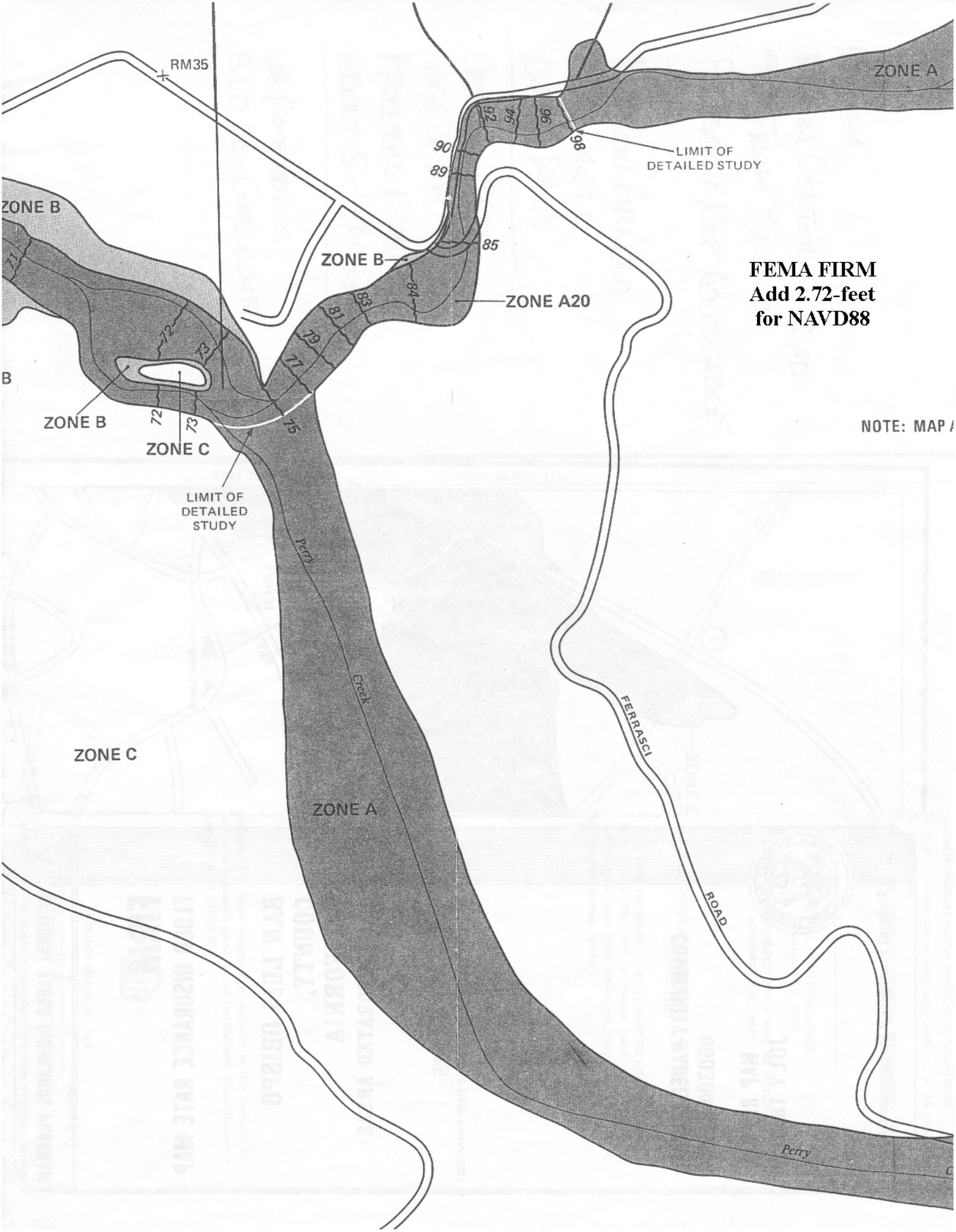
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	245.*	7650-cfs Q10	7650.00	40.94	57.12		58.11	0.001255	9.15	1290.44	137.07	0.41
1	245.*	11900-cfs Q25	11900.00	40.94	60.18		61.78	0.001622	11.77	1806.54	205.41	0.49
1	245.*	15400-cfs Q50	15400.00	40.94	61.58		63.70	0.001993	13.70	2116.84	239.51	0.55
1	245.*	19800-cfs Q100	19800.00	40.94	63.26		65.79	0.002246	15.37	2542.56	267.50	0.59
1	245.*	18000-cfs FEMA Q	18000.00	40.94	62.57		64.96	0.002169	14.77	2362.33	256.84	0.57
1	0	7650-cfs Q10	7650.00	40.12	55.83	51.79	57.71	0.002001	12.56	986.55	188.98	0.57
1	0	11900-cfs Q25	11900.00	40.12	59.11	55.36	61.29	0.002004	14.32	1733.41	250.58	0.59
1	0	15400-cfs Q50	15400.00	40.12	60.94	59.04	63.20	0.002002	15.24	2214.00	275.39	0.60
1	0	19800-cfs Q100	19800.00	40.12	62.88	60.70	65.22	0.002000	16.19	2770.40	298.88	0.61
1	0	18000-cfs FEMA Q	18000.00	40.12	62.12	60.08	64.43	0.002001	15.82	2547.84	289.77	0.60

HEC-RAS Plan: Plan 01 River: Santa Rosa Creek Reach: 1 PREFERRED BRIDGE 1/2

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	3060	7650-cfs Q10	7650.00	51.87	63.57		66.20	0.004761	14.60	841.16	168.41	0.78
1	3060	11900-cfs Q25	11900.00	51.87	67.60		69.46	0.002644	13.44	1636.11	220.59	0.62
1	3060	15400-cfs Q50	15400.00	51.87	70.20		71.79	0.001999	13.02	2225.22	231.57	0.55
1	3060	19800-cfs Q100	19800.00	51.87	72.79		74.33	0.001719	13.24	2838.23	242.48	0.52
1	3060	18000-cfs FEMA Q	18000.00	51.87	71.80		73.34	0.001800	13.10	2600.78	238.31	0.53
1	2745.*	7650-cfs Q10	7650.00	50.85	63.32		64.82	0.002448	10.88	986.29	141.16	0.58
1	2745.*	11900-cfs Q25	11900.00	50.85	67.04		68.69	0.001958	11.81	1586.13	179.22	0.54
1	2745.*	15400-cfs Q50	15400.00	50.85	69.43		71.19	0.001788	12.47	2044.84	206.15	0.53
1	2745.*	19800-cfs Q100	19800.00	50.85	71.93		73.78	0.001648	13.11	2589.24	225.01	0.52
1	2745.*	18000-cfs FEMA Q	18000.00	50.85	70.95		72.77	0.001703	12.88	2371.52	219.79	0.53
1	2430	7650-cfs Q10	7650.00	49.82	63.02		64.06	0.001665	8.98	1149.32	141.60	0.48
1	2430	11900-cfs Q25	11900.00	49.82	66.89		68.05	0.001297	9.70	1716.65	153.47	0.44
1	2430	15400-cfs Q50	15400.00	49.82	69.22		70.60	0.001293	10.68	2096.30	171.90	0.46
1	2430	19800-cfs Q100	19800.00	49.82	71.61		73.26	0.001325	11.80	2529.48	190.76	0.47
1	2430	18000-cfs FEMA Q	18000.00	49.82	70.68		72.22	0.001311	11.36	2355.76	183.43	0.46
1	2205.*	7650-cfs Q10	7650.00	50.21	62.48		63.67	0.001684	9.14	1053.35	148.66	0.49
1	2205.*	11900-cfs Q25	11900.00	50.21	66.56		67.76	0.001191	9.52	1706.83	171.86	0.44
1	2205.*	15400-cfs Q50	15400.00	50.21	68.99		70.32	0.001110	10.17	2139.84	183.97	0.43
1	2205.*	19800-cfs Q100	19800.00	50.21	71.41		72.95	0.001115	11.13	2600.36	199.61	0.44
1	2205.*	18000-cfs FEMA Q	18000.00	50.21	70.48		71.92	0.001101	10.71	2419.12	190.97	0.44
1	1980	7650-cfs Q10	7650.00	49.95	62.28		63.27	0.001340	8.26	1089.82	138.26	0.44
1	1980	11900-cfs Q25	11900.00	49.95	66.41		67.48	0.000990	8.79	1778.97	183.81	0.40
1	1980	15400-cfs Q50	15400.00	49.95	68.87		70.04	0.000924	9.39	2249.00	198.63	0.39
1	1980	19800-cfs Q100	19800.00	49.95	71.32		72.67	0.000919	10.21	2753.88	213.39	0.40
1	1980	18000-cfs FEMA Q	18000.00	49.95	70.37		71.65	0.000918	9.88	2554.14	207.68	0.40
1	1755.*	7650-cfs Q10	7650.00	48.97	61.53		62.89	0.001787	9.78	1027.13	150.91	0.51
1	1755.*	11900-cfs Q25	11900.00	48.97	65.89		67.20	0.001224	10.03	1745.77	178.18	0.44
1	1755.*	15400-cfs Q50	15400.00	48.97	68.32		69.78	0.001166	10.77	2197.95	193.38	0.44
1	1755.*	19800-cfs Q100	19800.00	48.97	70.71		72.40	0.001185	11.78	2677.70	208.43	0.46
1	1755.*	18000-cfs FEMA Q	18000.00	48.97	69.79		71.38	0.001174	11.38	2488.18	202.62	0.45
1	1530	7650-cfs Q10	7650.00	48.00	60.86		62.41	0.002331	11.13	1118.40	155.39	0.57
1	1530	11900-cfs Q25	11900.00	48.00	65.50		66.89	0.001501	11.11	1895.73	179.80	0.48
1	1530	15400-cfs Q50	15400.00	48.00	67.92		69.48	0.001452	11.97	2346.69	191.66	0.48
1	1530	19800-cfs Q100	19800.00	48.00	70.26		72.09	0.001510	13.18	2807.53	203.07	0.50
1	1530	18000-cfs FEMA Q	18000.00	48.00	69.36		71.08	0.001482	12.69	2627.13	198.68	0.49
1	1470	7650-cfs Q10	7650.00	48.00	61.08	56.46	62.16	0.001355	8.86	1170.10	134.58	0.45
1	1470	11900-cfs Q25	11900.00	48.00	65.59	58.77	66.74	0.001005	9.42	1794.34	160.25	0.41
1	1470	15400-cfs Q50	15400.00	48.00	67.97	60.53	69.35	0.001022	10.39	2129.01	170.59	0.42
1	1470	19800-cfs Q100	19800.00	48.00	70.25	62.65	71.97	0.001112	11.68	2448.98	180.99	0.45
1	1470	18000-cfs FEMA Q	18000.00	48.00	69.38	61.95	70.95	0.001072	11.16	2326.27	176.69	0.44
1	1463		Bridge									
1	1350	7650-cfs Q10	7650.00	48.00	60.96	55.65	61.87	0.001312	7.96	1152.82	120.72	0.40
1	1350	11900-cfs Q25	11900.00	48.00	65.40	57.95	66.45	0.001044	8.71	1738.18	241.84	0.38
1	1350	15400-cfs Q50	15400.00	48.00	67.70	59.61	68.96	0.001076	9.64	2060.22	258.27	0.39
1	1350	19800-cfs Q100	19800.00	48.00	69.85	61.49	71.43	0.001193	10.90	2359.72	273.53	0.42
1	1350	18000-cfs FEMA Q	18000.00	48.00	69.03	60.74	70.48	0.001142	10.39	2246.00	267.73	0.41
1	1115.*	7650-cfs Q10	7650.00	46.46	59.63	55.72	61.26	0.002343	10.70	863.14	88.36	0.53
1	1115.*	11900-cfs Q25	11900.00	46.46	63.81	58.45	65.83	0.002044	12.11	1376.07	160.90	0.52
1	1115.*	15400-cfs Q50	15400.00	46.46	66.05	60.40	68.32	0.002035	13.15	1773.45	195.53	0.53
1	1115.*	19800-cfs Q100	19800.00	46.46	68.44	63.96	70.84	0.001951	13.94	2261.23	254.51	0.53
1	1115.*	18000-cfs FEMA Q	18000.00	46.46	67.52	60.40	69.86	0.001980	13.63	2069.13	228.76	0.53
1	880	7650-cfs Q10	7650.00	44.91	57.00		60.29	0.005555	15.09	602.40	69.72	0.79
1	880	11900-cfs Q25	11900.00	44.91	59.12	57.72	64.65	0.007514	19.66	769.48	95.44	0.94
1	880	15400-cfs Q50	15400.00	44.91	62.50	62.50	67.35	0.005210	19.01	1191.34	149.70	0.82
1	880	19800-cfs Q100	19800.00	44.91	64.63	64.63	69.87	0.005090	20.34	1530.51	169.12	0.82
1	880	18000-cfs FEMA Q	18000.00	44.91	63.78	63.78	68.89	0.005153	19.85	1390.91	161.41	0.82
1	685.*	7650-cfs Q10	7650.00	43.34	57.32		59.08	0.002814	11.42	950.48	141.09	0.57
1	685.*	11900-cfs Q25	11900.00	43.34	60.89		62.80	0.002391	12.45	1490.33	160.96	0.55
1	685.*	15400-cfs Q50	15400.00	43.34	62.53		64.92	0.002705	14.13	1763.57	175.90	0.59
1	685.*	19800-cfs Q100	19800.00	43.34	64.29		67.18	0.002999	15.84	2083.48	188.45	0.63
1	685.*	18000-cfs FEMA Q	18000.00	43.34	63.60		66.29	0.002889	15.18	1954.67	183.50	0.62
1	490	7650-cfs Q10	7650.00	41.77	57.82		58.42	0.001003	7.29	1656.88	162.73	0.34
1	490	11900-cfs Q25	11900.00	41.77	61.35		62.17	0.001065	8.71	2301.86	194.77	0.36
1	490	15400-cfs Q50	15400.00	41.77	63.10		64.18	0.001254	10.06	2655.18	211.78	0.40
1	490	19800-cfs Q100	19800.00	41.77	64.93		66.33	0.001475	11.59	3063.27	233.11	0.44
1	490	18000-cfs FEMA Q	18000.00	41.77	64.21		65.48	0.001391	11.00	2897.69	224.70	0.43

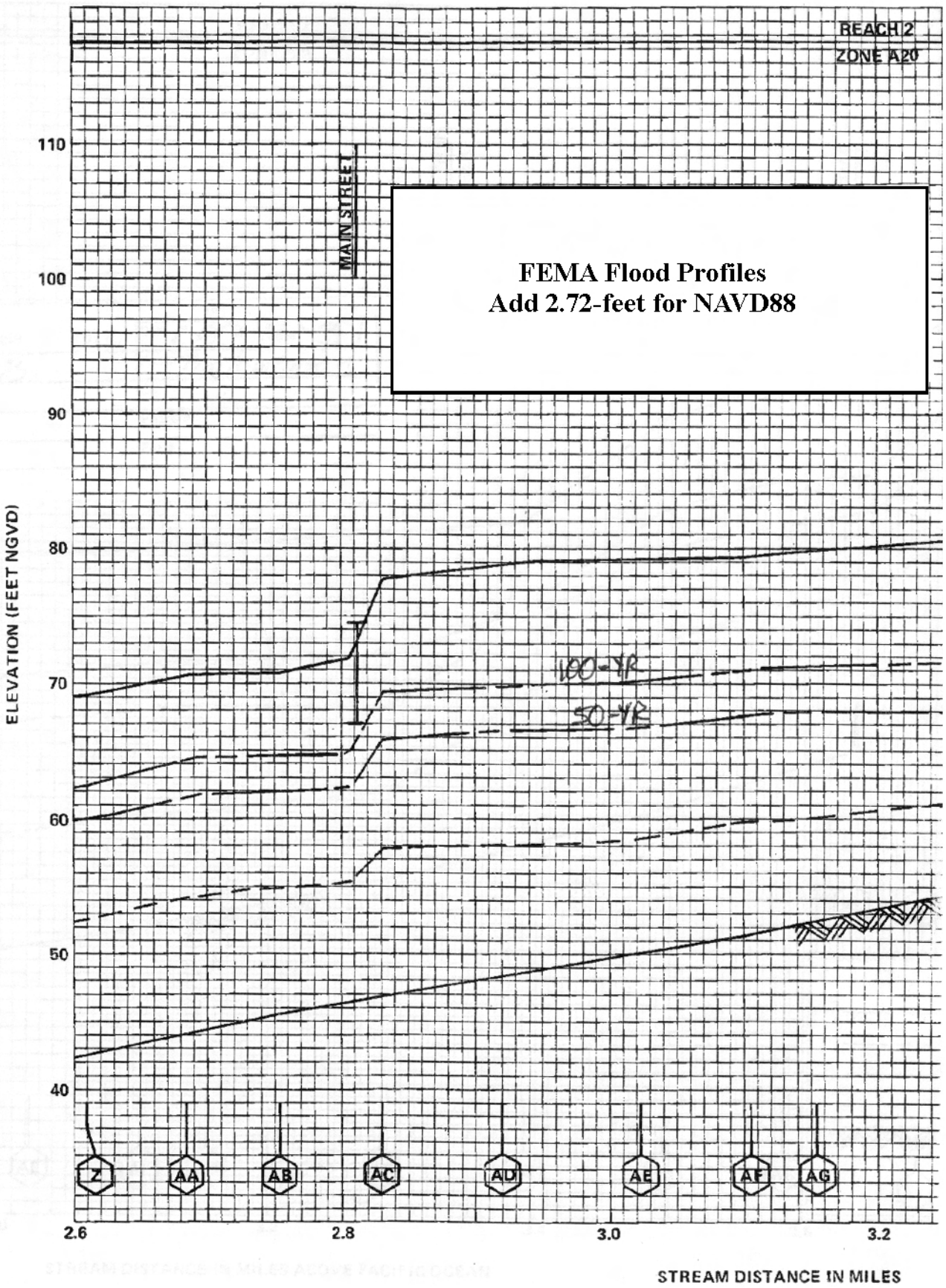
HEC-RAS Plan: Plan 01 River: Santa Rosa Creek Reach: 1 (Continued) PREFERRED BRIDGE 2/2

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	245.*	7650-cfs Q10	7650.00	40.94	57.12		58.11	0.001255	9.15	1290.44	137.07	0.41
1	245.*	11900-cfs Q25	11900.00	40.94	60.18		61.78	0.001622	11.77	1806.54	205.41	0.49
1	245.*	15400-cfs Q50	15400.00	40.94	61.58		63.70	0.001993	13.70	2116.84	239.51	0.55
1	245.*	19800-cfs Q100	19800.00	40.94	63.26		65.79	0.002246	15.37	2542.56	267.50	0.59
1	245.*	18000-cfs FEMA Q	18000.00	40.94	62.57		64.96	0.002169	14.77	2362.33	256.84	0.57
1	0	7650-cfs Q10	7650.00	40.12	55.83	51.79	57.71	0.002001	12.56	986.55	188.98	0.57
1	0	11900-cfs Q25	11900.00	40.12	59.11	55.36	61.29	0.002004	14.32	1733.41	250.58	0.59
1	0	15400-cfs Q50	15400.00	40.12	60.94	59.04	63.20	0.002002	15.24	2214.00	275.39	0.60
1	0	19800-cfs Q100	19800.00	40.12	62.88	60.70	65.22	0.002000	16.19	2770.40	298.88	0.61
1	0	18000-cfs FEMA Q	18000.00	40.12	62.12	60.08	64.43	0.002001	15.82	2547.84	289.77	0.60



FEMA FIRM
Add 2.72-feet
for NAVD88

NOTE: MAP A

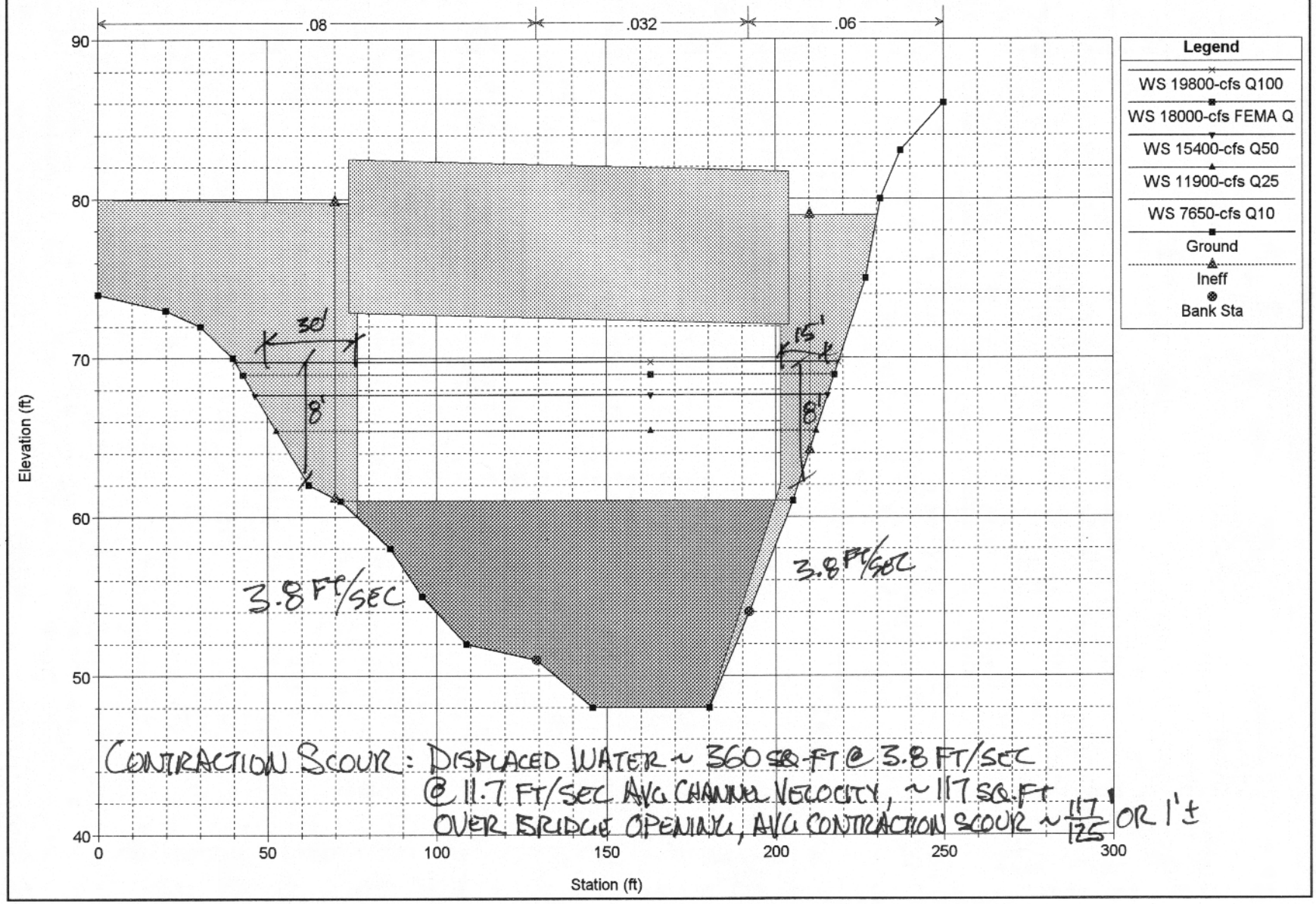

REACH 2
ZONE A20
MAIN STREET
FEMA Flood Profiles
Add 2.72-feet for NAVD88
100-YR
50-YR
ELEVATION (FEET NGVD)
110
100
90
80
70
60
50
40
Z
AA
AB
AC
AD
AE
AF
AG
2.6
2.8
3.0
3.2
STREAM DISTANCE IN MILES

APPENDIX C

Scour Calculations

Main St Cayucos/Santa Rosa Ck, Preferred Plan: Plan 01 1/13/2005

RS = 1463 BR



CONTRACTION SCOUR: DISPLACED WATER ~ 360 SQ.FT @ 3.8 FT/SEC
@ 11.7 FT/SEC AVG CHANNEL VELOCITY, ~ 117 SQ.FT
OVER BRIDGE OPENING, AVG CONTRACTION SCOUR ~ $\frac{117}{125}$ OR 1'±

Plan: Plan 01 Santa Rosa Creek 1 RS: 1470 Profile: 19800-cfs Q100

E.G. Elev (ft)	71.97	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.72	Wt. n-Val.	0.080	0.032	0.060
W.S. Elev (ft)	70.25	Reach Len. (ft)	7.00	7.00	7.00
Crit W.S. (ft)	62.65	Flow Area (sq ft)	908.04	1334.92	206.02
E.G. Slope (ft/ft)	0.001112	Area (sq ft)	1071.53	1334.92	234.31
Q Total (cfs)	19800.00	Flow (cfs)	3419.09	15596.26	784.65
Top Width (ft)	180.99	Top Width (ft)	90.87	62.68	27.44
Vel Total (ft/s)	8.08	Avg. Vel. (ft/s)	3.77	11.68	3.81
Max Chl Dpth (ft)	22.25	Hydr. Depth (ft)	15.28	21.30	11.38
Conv. Total (cfs)	593887.4	Conv. (cfs)	102553.3	467799.1	23535.0
Length Wtd. (ft)	7.00	Wetted Per. (ft)	60.56	64.39	20.80
Min Ch El (ft)	48.00	Shear (lb/sq ft)	1.04	1.44	0.69
Alpha	1.69	Stream Power (lb/ft s)	3.92	16.81	2.62
Frctn Loss (ft)	0.01	Cum Volume (acre-ft)	26.41	34.21	19.61
C & E Loss (ft)	0.12	Cum SA (acres)	3.01	1.65	2.86

Potential Abutment Scour Using Froehlich Equation, 100 - Year flood

ABUTMENT 1

Ys =	Depth of potential scour, m	
K1 =	0.55	Abutment shape coefficient
Theta =	90	Angle of abutment to bank downstream
K2 =	1.00	Coefficient for angle of embankment to flow
L' =	9.2	Length of abutment projected normal to flow, m
ya =	2.4	Depth of flow adjacent abutment, m
Ve =	1.16	Velocity approaching abutment, m/s *
Fr =	0.237	Ve/(g x ya)^0.5
Ys/ya =	0.92	=2.27 x K1 x K2 x (L'/ya)^0.43 x Fr^0.61+1 **

Ys = ya x (Ys/ya) = **2.2** meters **7.3** feet

* Velocity is a function of area and potential flow in the absence of the abutment. This value can be approximated conservatively by using the flow in the channel adjacent to the abutment or flow at a cross section upstream of the bridge abutment.

** The safety factor of 1 added to the end of the Froelich equation was not included in the calculation.

Potential Abutment Scour Using Froehlich Equation, 100 - Year flood

ABUTMENT 2

Ys = Depth of potential scour, m

K1 = 0.55 Abutment shape coefficient

Theta = 90 Angle of abutment to bank downstream

K2 = 1.00 Coefficient for angle of embankment to flow

L' = 4.6 Length of abutment projected normal to flow, m

ya = 2.4 Depth of flow adjacent abutment, m

Ve = 1.16 Velocity approaching abutment, m/s *

Fr = 0.237 Ve/(g x ya)^0.5

Ys/ya = 0.68 =2.27 x K1 x K2 x (L'/ya)^0.43 x Fr^0.61+1 **

Ys = ya x (Ys/ya) = **1.7** meters **5.4** feet

* Velocity is a function of area and potential flow in the absence of the abutment. This value can be approximated conservatively by using the flow in the channel adjacent to the abutment or flow at a cross section upstream of the bridge abutment.

** The safety factor of 1 added to the end of the Froelich equation was not included in the calculation.

APPENDIX D

References

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