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FLOOD AND DRAINAGE REPORT
SACRAMENTO AGGREGATES CARLI EXPANSION PROJECT

Vulcan Materials Company
Sacramento Aggregates
11501 Florin Road
Sacramento, CA 95830

August 2017
Revised: September 2019

Prepared for: Vulcan Materials Company
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1.0 INTRODUCTION

Triangle Rock Products, LLC operates the Sacramento Aggregate mine and processing plant located at 11501 Florin Road in Sacramento County, California. Vulcan Materials Company (Vulcan) purchased the 151-acre parcel (referred to as the Carli parcel) west of the current mining operation and has submitted an application to the County to expand the mining operation and amend the Reclamation Plan to include the Carli parcel (see Figures 1 and 2). Sespe Consulting, Inc. (Sespe) has prepared this Flood and Drainage Report on behalf of Vulcan, to identify potential hydrologic impacts from this proposed expansion of the Sacramento Aggregates mine (Project). The 140-acre Carli expansion site, located immediately west of Sacramento Aggregates existing processing facility, would provide an estimated 10 million tons of additional aggregates reserves. The Project would move existing excavation pit operations to this adjacent area. The approved production rates stipulated in the existing use permit for the Sacramento Aggregate mining operation would not change.

2.0 PROJECT DESCRIPTION

The proposed Carli expansion would cover 140 acres of the 151-acre parcel (see Figure 3). The Project area would be used for extracting aggregate reserves and include an asphalt and concrete recycle plant; no changes to the existing aggregate processing plant or processing and production rates would be required for the Project. Mining (extraction of the aggregate material) activities currently being conducted in the previously approved expansion area south of Florin Road (Phase E) will be completed prior to starting the material extraction at the Project site.

Mined aggregate would be transferred from the expansion area to the existing processing plant (located east of the Project site in Phase X) via a conveyor system.

2.1 Sacramento Aggregates Mining and Processing Operations

Vulcan's Sacramento Aggregate mine and processing plant has been permitted for extraction and processing of aggregates since 1996. The mining and processing operations have been operating under the authority of Use Permit (Control #01-ZGB-UPB-0107) and the approved Reclamation Plan (CA Mine ID #91-34-0038). In February 2009, Use Permit (Control #2007-CZB-UPB-REB-00397) was approved and the Reclamation Plan was revised to include a 98-acre expansion south of Florin Road. Vulcan is currently requesting an additional expansion to the west / southwest of the processing plant, referred to as the Carli expansion, which is the proposed Project being addressed in this report.

2.2 Description of Pre-Project Carli Expansion Study Area

Vulcan purchased the 151-acre parcel immediately west of the current mining operation and is preparing an application to the County to expand the mining operation and amend the Reclamation Plan to include the Carli expansion site. The proposed Carli expansion would cover 140 acres of the 151-acre property and provide an estimated 10 million tons of reserves over 10 years (see Figure 3).

The Carli expansion area is bordered to the north and east by the existing Sacramento Aggregate mine site, to the south by Florin Road, and to the west by Eagles Nest Road. Existing topography of the site is gentle with the site sloping primarily north to south-southeast, except for the southwestern portion of the site, which slopes to the southwest.

The undeveloped areas of the Project site are primarily non-native and native grasslands. Potential seasonal marshes/wetlands are located in the southeast corner of the parcel where the Project site is located. Disturbance of this area is not included as part of the Project. The topography of the site is gentle with the site sloping primarily north to south-southeast, except for the southwestern portion of the site that slopes to the southwest. Surface runoff from the study area primarily leaves the site via a 36" concrete culvert that carries water south under Florin Road and discharges to the adjacent property to the south. Minor amounts of surface runoff from the site collect in earthen swales along Eagles Nest Road. The earthen swales eventually discharge water to the adjacent property to the west via two (2) 24" CMP culverts under the road.

A commercial composting operation is located in the northeastern portion of the site. It is anticipated that this operation will continue until the final phase of the mining. The surrounding land uses consist of Vulcan's current aggregate operations, the composting operations, cattle, horse, and sheep grazing, farmland, and several farm residences.

2.3 Mining Plan

The Carli expansion would be mined in phases, starting in the northern portion of the site, extending south down and around the existing composting facility and then to the east and finally back up towards the northeast to excavate the area currently occupied by the composting operation.

The proposed excavation setbacks will be the same as for the existing permitted operations and include the following:

- 30 feet from the Florin Road right-of-way; and
- 30 feet from the Eagles Nest Road right-of-way.

Overburden material would be removed in phases to expose the aggregate resources. Ground surface elevation at the site ranges from 114 to 130 feet above mean sea level (amsl), and aggregate would be mined to an estimated depth of 70 to 75 feet below existing grade (see Figure 5).

2.4 Reclamation

The bottom of the excavation would be backfilled with roughly 40 feet of overburden and reclaimed back to approximately 36 feet below the original grade (see Figure 6).

Reclamation of the Project site is designed to complement the reclamation currently approved for the existing phases of the mining operation. The planned end use of the site is open space and grazing.

3.0 EXISTING SETTING

3.1 Laguna Creek Watershed

The Sacramento Aggregates mining and processing operation lies within the Laguna Creek watershed (See Figure 4). Laguna Creek is an intermittent stream, generally dry during the summer and fall months, which primarily supports fresh water marshes. Laguna Creek eventually joins Morrison Creek approximately 12 miles southwest of the Vulcan property, which then flows through the Sacramento Delta to the San Francisco Bay. The Folsom South Canal, a man-made water conveyance facility operated by the U.S. Bureau of Reclamation, parallels the eastern boundary of the Sacramento Aggregates operations but is not hydrologically connected to the mining operation areas.

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs), the Project site is not within a federally designated floodplain. Full-scale sections of the FIRMs that include the Project area are provided in Appendix 2.

3.2 Seasonal Marshes

Potential seasonal marshes/wetlands located on the southeastern portion of the property, adjacent to the Project site's southeastern boundary and just north of Florin Road, appear to be supported by natural surface runoff from the site. Mining operations may result in the reduction in surface runoff flow to the potential seasonal wetlands. The potential wetland area will not be mined or disturbed and has been removed from the active mining area in the mine plan, as shown in Figure 3.

4.0 METHODOLOGY

This report relied largely on drainage and flood report data previously completed by West Yost Associates in May 2007 (2007 drainage report) for the Vulcan expansion south of Florin road (Expansion E). The 2007 drainage report required as intensive study due to the 2009 expansion's proximity to Laguna Creek and location within the floodplain. The 2007 drainage report analyzed flows in Laguna Creek using the US Army Corps of Engineers Hydrologic Engineering Center's River Analysis System (HEC-RAS) computer model. Sacramento County's Water Resources Division developed an unsteady flow model using HEC-RAS and its pre-processor, Sacramento County Hydrologic Calculator (SacCalc), to develop hydrologic input to the existing HEC-1 model.

The drainage and flood report for the Expansion E included mitigation measures for flood waters from Laguna Creek since the area was within the models 100-year floodplain. The complete 2007 drainage study for Expansion E can be found in Appendix 4.

The Carli expansion does not lie within the FEMA 100-year floodplain, and is not expected to receive significant local runoff from the surrounding properties due to the existing topography and surrounding land uses. The existing Sacramento Aggregates mine to the north and east, Florin Road to the south, and Eagles Nest Road to the west of the Project obstruct run on flows from the surrounding properties. Therefore, the Project will ultimately result in the reduction of runoff from the study area due to the large storage capacity of the mining pits.

The analyses conducted for this study assess the possible Project impacts by quantifying the potential surface flows from the existing site (pre-Project), total storage capacity required for on-site rainfall as required by the Surface Mining and Reclamation Act (SMARA), and the post-Project effects on surrounding water bodies (Laguna Creek).

The maximum potential surface flow from the study area in the existing condition was calculated using the County SacCalc program's Nolte method. Precipitation values used to calculate the necessary storage capacity for on-site rainfall were generated from National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 6, Version 2, Precipitation Frequency Data Server (PFDS). Due to the large storage capacity of the mining pits that will capture and infiltrate on-site rainfall, post-Project analysis is not necessary since discharges from the site will be eliminated.

5.0 HYDROLOGY

The hydrology of the Project's study area (Carli parcel) is comprised of on-site rainfall and potential seasonal marsh/wetlands. Historical aerial photography suggests that low and moderate rain event flows rarely discharge to Laguna Creek and are captured in low areas, existing water supply retention basins, or seasonal marshes. During larger storm events, the majority of the runoff from the Project area generally flows to the south and spills into low-lying areas on the adjacent property, south of Florin Road. To analyze the effects of the Project on Laguna Creek, this report assumes that the Project site currently drains indirectly to the creek via sheet flow through the adjacent property.

5.1 On-Site Hydrology

The Project site is not expected to receive significant local runoff from the surrounding properties due to the existing topography and surrounding land uses. The existing Sacramento Aggregates mine site borders the Carli expansion to the north and east. Historic mine pits, silt ponds, and detention basins on the existing mine site are adequate to contain the on-site rainfall and flood flows (as described in the 2007 drainage report). Florin Road to the south and Eagles Nest Road to the west of the Project obstruct run on flows from the surrounding properties. Earthen swales that run adjacent to these roads capture water and prevent flows from crossing the roads and entering the Project area.

The mining Project will ultimately result in the reduction of runoff from the study area. A SacCalc model for the existing site conditions was prepared to calculate the estimate maximum pre-Project runoff flow from the site. At the completion of mining and post-reclamation, the Project area will result in a lowered pit that will retain all on-site rainfall (see Figures 5 and 6).

The SacCalc model used for the existing site conditions assumes that the Carli expansion area is comprised of one (1) subwatershed that drains to the property south of the project site via the culvert under Florin Road. This is a conservative assumption, as the Project area likely maintains most of the surface water on-site and the southwestern portion of the site drains to the west. Table 1 displays the SacCalc model inputs and computed peak flows from the Project site and Laguna Creek.

Table 1: Carli Expansion Hydrologic Data, Pre-Project

Sub-shed	Area (acres)	Percent Impervious (%)[A]	Nolte Hydrologic Zone	Project Existing Condition Peak Flow (cfs)[B]	Laguna Creek Peak Flow, 10-year Frequency (cfs)[C]	Computed Laguna Creek Flow Post-Mining (cfs)
CARLI	153.0	20	3	60.90	1,100	1,039.1

[A] Lowest percent available for Nolte Method; use for rural, low density land (City and County of Sacramento Drainage Manual, Volume 2, Page 2-5).

[B] Nolte method design frequency based on size of drainage, greater than 100 acres uses 5-10 year recurrence interval (City and County of Sacramento Drainage Manual, Volume 2, Page 2-5).

[C] Laguna Creek peak flow at Florin Road for 10-year recurrence frequency (West Yost Associates 2007 Drainage and Flood Report, Page 3-3).

During mining and post-mining, on-site rainfall will not flow from the Project area (see Section 6.0). Therefore, the computed post-Project Laguna Creek 10-year peak flow is the existing pre-Project Laguna Creek peak flow less the existing pre-Project existing condition peak flow.

Post-Project analysis of the Project site is not necessary due to the large storage capacity of the mining pits that will capture on-site rainfall and prevent surface water discharges from the site.

5.1.1 SMARA Requirements

SMARA regulations require surface mining and reclamation activities to be conducted in such a way to protect both on-site and downstream beneficial uses of water. In addition, erosion and sedimentation control is necessary during all phases of construction, operation, reclamation, and final closure of the mine. Erosion control methods on site must be designed to handle runoff from not less than the 20-year, 1-hour storm. The NOAA PFDS estimate for a 25-year, 1-hour storm is 0.837 inches. Therefore, the total volume of rainwater that falls on the Project area in the design storm is 9.8 acre-feet.

5.2 Flood Waters from Laguna Creek

Previous analysis on the Laguna Creek channel in the 2007 drainage report for Expansion E included modeling of the existing 100-year floodplain, during-mining mitigation measures, and post-mining mitigation measures. Mining on the Carli expansion will not commence until the completion of mining activities on the expansion area south of Florin Road (Expansion/Phase E). Mitigation measures detailed in the 2007 drainage include temporary flood diversion berms along the western and southern top-of-slope of the Phase E pit, and installation of a temporary detention basin and side channel weir structure to prevent the expansion of the floodplain onto adjacent properties. The specified weir crest elevation is 111.0 feet amsl. Visual inspection of the current site conditions indicated that these measures are already in place.

The 2007 drainage report also includes post-mining mitigation, which includes installation of a side channel weir to divert peak flows from Laguna Creek to the southernmost pit (Phase E). The specified weir crest elevation for post-mining flooding mitigation is 107.8 feet amsl.

With either of the proposed mitigations in place (during-mining or post-mining), flood waters from Laguna Creek are not expected to impact the Carli expansion area. Based on the topographic data, the lowest

elevation contour for the Project area is 114 amsl. Conservatively assuming that the higher weir crest elevation controls the 100-year flood water surface elevation (111.0 feet), the Project site is not expected to be affected by flood water from Laguna Creek due to its elevation.

The 2007 drainage study based 100-year flood elevations off of HEC-RAS modeling data since FEMA flood maps (FIRMs) were not available for the expansion area at the time of the report. According to the published FEMA maps that are now available, the site is not within a federally designated floodplain. Full-scale sections of the FIRMs that show the Project area are provided in Appendix 2.

6.0 SUMMARY OF IMPACTS AND MITIGATION MEASURES

The implementation of the Carli mining expansion Project, as described in this report, is not expected to cause any adverse effects on the physical Laguna Creek or its floodplain, adjacent properties, or the drainage within the study area.

6.1 Potential Impacts to Laguna Creek and the Laguna Creek Floodplain

No direct encroachment into the creek or existing floodplain is planned during the Carli expansion Project. The current approved mining and reclamation plan for the Sacramento Aggregates mining operations include existing and future measures that mitigate for the loss of natural floodplain storage by the previous expansion.

There will be no need for additional mitigation work affecting the creek or floodplain upstream or downstream of the site as a result of this Project.

6.2 Potential Impacts on the Project Site Drainage

Local drainage within the mining operation will be collected in the excavated pits and will not be released to the creek. If necessary, storm water collected on the project site will be pumped to the existing settling ponds on the Sacramento Aggregates processing area adjacent to the Project area. Post-reclamation, the bottom of the excavation will temporarily retain all storm water from direct rainfall on-site and may result in the development of seasonal marshes in the low areas of the Project site. Outside of the Project area, land will drain to the creek as it does at present.

However, during the initial phases of the mining plan (overburden removal), the ground disturbance activities have the potential contribute sediment to surface water flows from the site. To ensure that the Project does not deteriorate the downstream or off-site water quality, the following Mitigation Measure HW-1 is recommended.

Mitigation Measure HW-1:

> *Prior to ground preparation (overburden removal) activities, a minimum 3-foot tall temporary earthen berm shall be constructed along the western and southern border of the expansion boundary. The temporary berm shall remain in place until (1) the mining pit is large enough to hold 9.8 acre-feet of water and (2) areas disturbed as part of the mining expansion are graded to drain to the pit bottom.*

The approximate location of the berm described in HW-1 is illustrated on Figure 7 in Appendix 1.

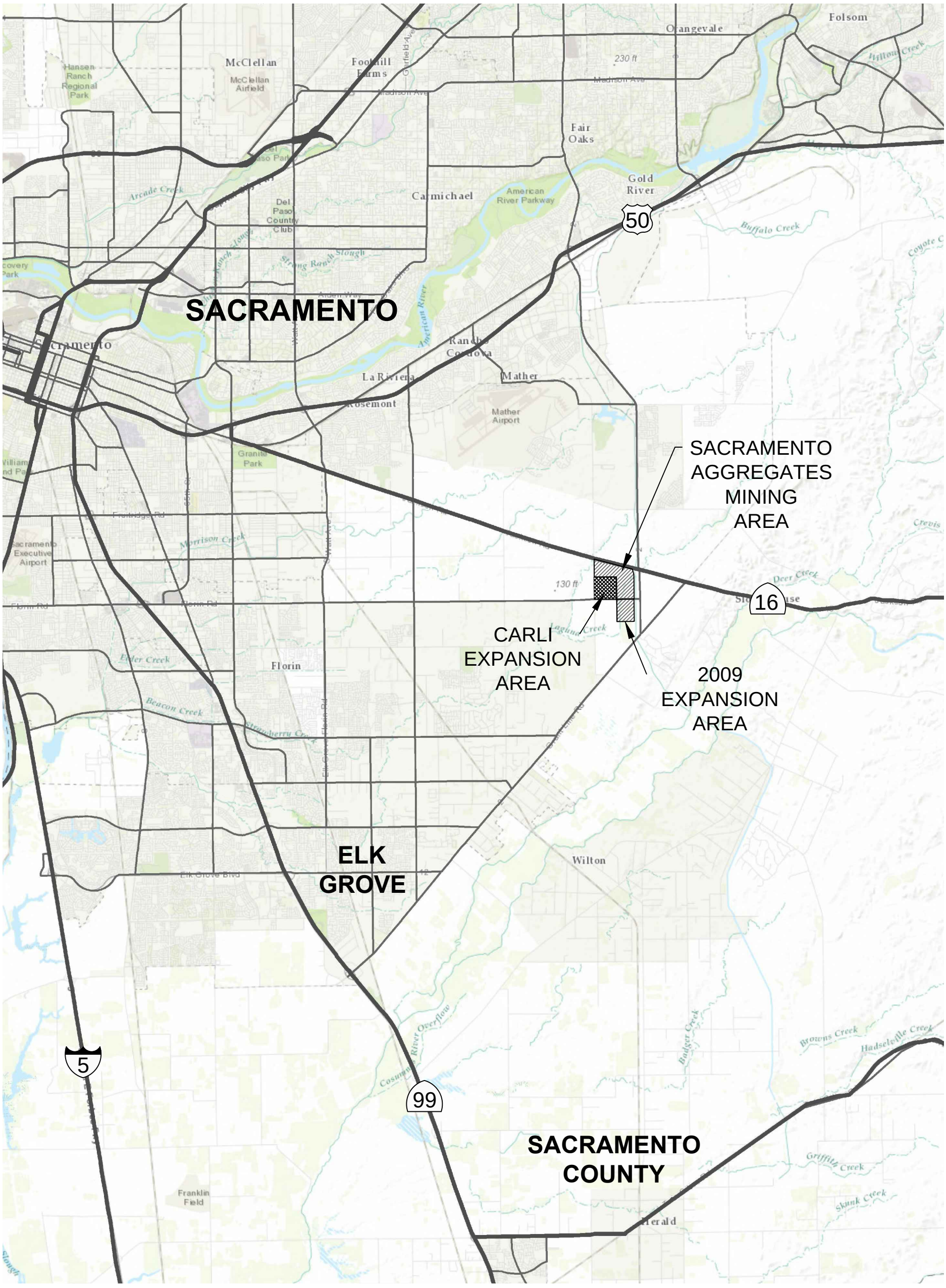
7.0 REFERENCES

Sacramento County Water Resources Division and the City of Sacramento Department of Utilities Division of Engineering Services. Sacramento City / County Drainage Manual, Volume 2: Hydrology Standards. December 1996 (Updated October 2006).

West Yost Associates Consulting Engineers. Sacramento Aggregates Expansion Flood and Drainage Report (May 2007). Prepared for Triangle Rock Products, Inc.

APPENDIX 1

FIGURES



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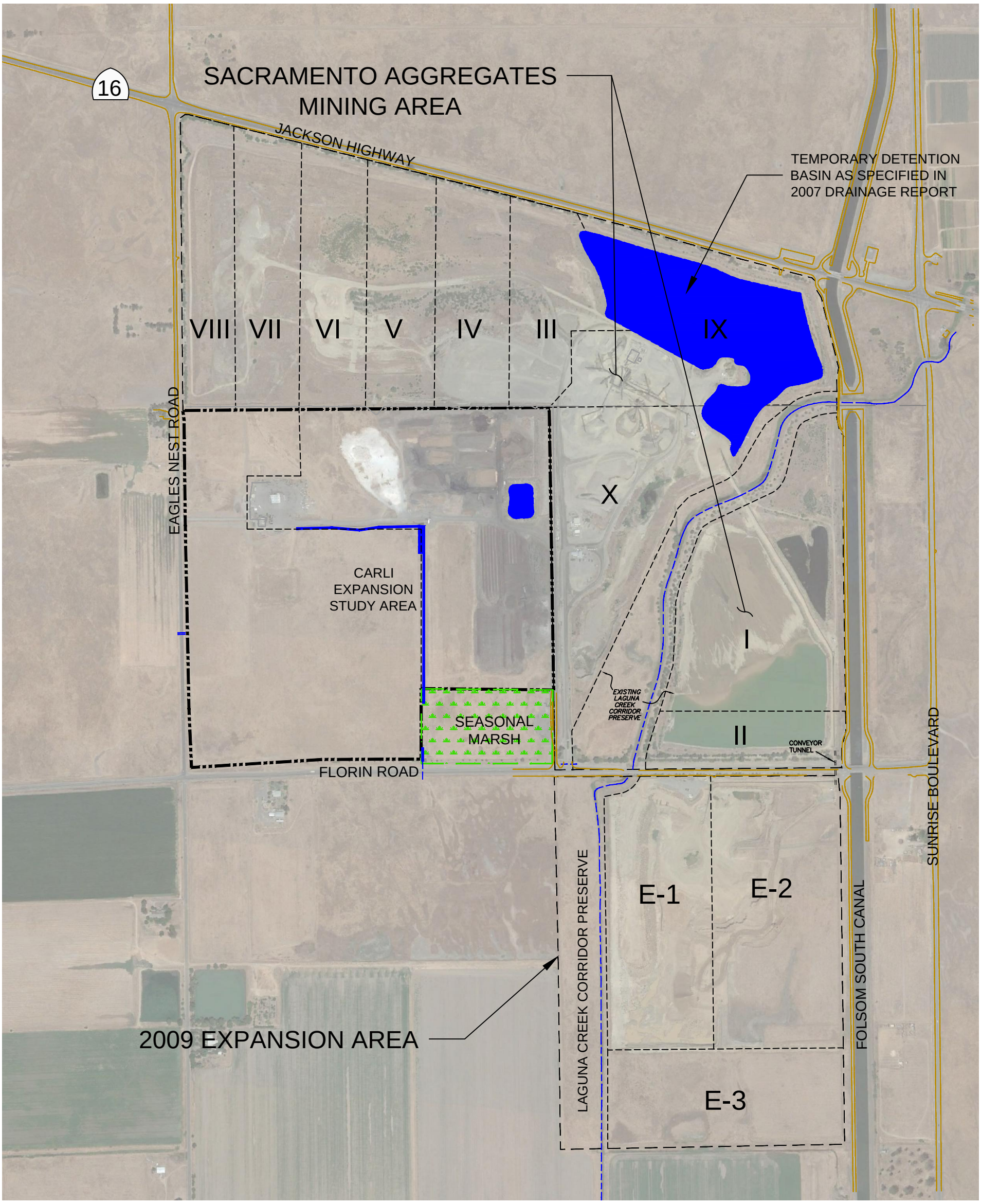
SACRAMENTO AGGREGATES MINING EXPANSION
VULCAN MATERIALS COMPANY
VICINITY MAP

SCALE: HORIZ. AS SHOWN VERT. AS SHOWN
DRAWN BY: APS
DATE: NOVEMBER 2016

FIGURE NUMBER 1



LEGEND

EXISTING MINING AREAS

CARLI EXPANSION AREA

MINING PHASES

AERIAL: GOOGLE EARTH DATABASE, DATED 2016

600 0 600 1200

SCALE IN FEET

N

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SACRAMENTO AGGREGATES
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VULCAN MATERIALS COMPANY

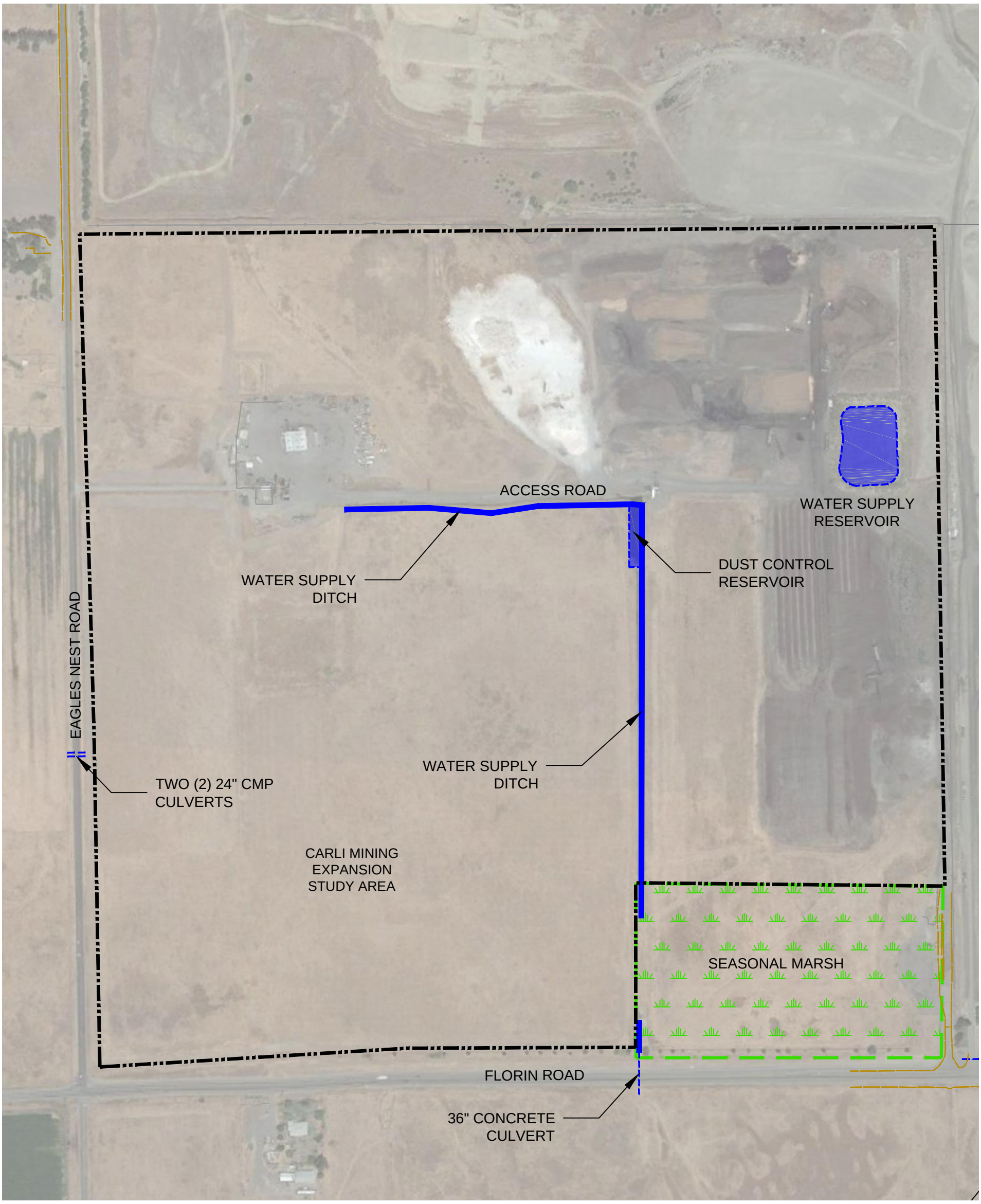
SITE MAP

SCALE: HORIZ. AS SHOWN VERT. AS SHOWN

DRAWN BY: G. CAMUS / APS

DATE: MARCH 2017

FIGURE NUMBER 2



LEGEND

CARLI EXPANSION AREA

AERIAL: GOOGLE EARTH DATABASE, DATED 2016

300 0 300 600

SCALE IN FEET

N

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SITE MAP

SCALE: HORIZ. AS SHOWN VERT. AS SHOWN

DRAWN BY: G. CAMUS / APS

DATE: MARCH 2017

FIGURE NUMBER 3

Laguna Creek Watershed

0 1.25 2.5 5 Miles

N

Political Jurisdictions
- Elk Grove
- Rancho Cordova
- City of Sacramento
- Sacramento County

CARLI EXPANSION AREA

SACRAMENTO AGGREGATES MINING AREA

Upper Laguna Creek

Lower Laguna Creek

Whitehouse Creek

Elk Grove Creek

Morrison Creek

Mingo Creek

Toad Creek

Kyle Creek

Sun Creek

Kaseberg Creek

Laguna Creek

Stone Lakes National Wildlife Refuge

JACKSON

SUNRISE

GRANT LINE

CALVINE

EXCELSIOR

SHELDON

BRUCEVILLE

LAGUNA

ELK GROVE FLORIN

BOND

WATERMAN

BRADSHAW

Legend
- Laguna Creek Streams
- Streets
- Morrison Creek
- 100 Year Floodplain

Subwatersheds
- Lower Laguna Creek
- Elk Grove Creek
- Whitehouse Creek
- Toad Creek
- Upper Laguna Creek

Basemap: ©2013 Esri, DeLorme, NAVTEQ
Created by Elyse Cheung-Sutton
Date Created: 8/22/2013

SOURCE: LAGUNA CREEK WATERSHED COUNCIL WEBSITE

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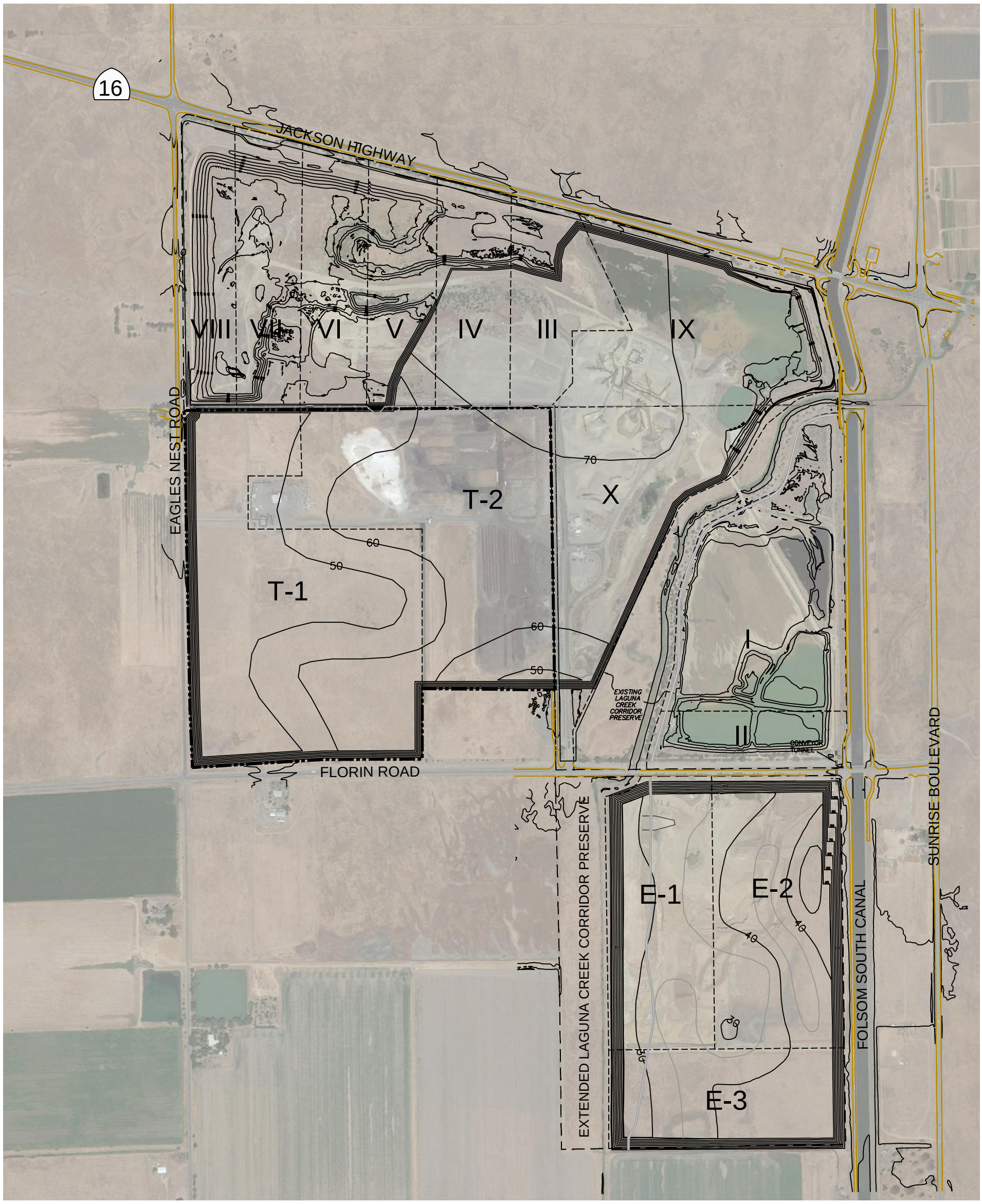
SACRAMENTO AGGREGATES MINING EXPANSION
VULCAN MATERIALS COMPANY
LAGUNA CREEK WATERSHED MAP

SCALE: HORIZ: AS SHOWN VERT: AS SHOWN
DRAWN BY: APS
DATE: NOVEMBER 2016

FIGURE NUMBER 4



LEGEND

——————— FINAL PIT CONTOURS

– – – – – – – – – – – – MINING PHASES

——————— EXISTING TOPOGRAPHY (2010)

TOPOGRAPHY PROVIDED BY VULCAN MATERIALS COMPANY, DATED MARCH 19, 2010
AERIAL: GOOGLE EARTH DATABASE, DATED 2016

600 0 600 1200
SCALE IN FEET

N

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SACRAMENTO AGGREGATES MINING EXPANSION
VULCAN MATERIALS COMPANY
FINAL PIT DESIGN

SCALE: HORIZ. AS SHOWN VERT. AS SHOWN
DRAWN BY: G. CAMUS / APS
DATE: MARCH 2017

FIGURE NUMBER 5

16

JACKSON HIGHWAY

EAGLES NEST ROAD

FLORIN ROAD

RECLAIM BACK TO 15 FEET BELOW ORIGINAL GRADE

RECLAIM BACK TO
50 FEET BELOW
ORIGINAL GRADE

RECLAIM BACK TO
36 FEET BELOW
ORIGINAL GRADE

RECLAIM BACK TO
70-75 FEET BELOW
ORIGINAL GRADE

EXISTING LAGUNA CREEK CORRIDOR PRESERVE

CONVEYOR TUNNEL BACKFILLED

EXPANDED LAGUNA CREEK CORRIDOR PRESERVE

PERMANENT OVERFLOW WEIR/DROP STRUCTURE W/GROUTED RIPRAP

RIPARIAN WETLAND

EMERGENT WETLAND

ADDITIONAL LOW FLOW CHANNEL

EXTENDED PUBLIC TRAIL

FOLSOM SOUTH CANAL

SUNRISE BOULEVARD

LEGEND

RECLAMATION CONTOURS

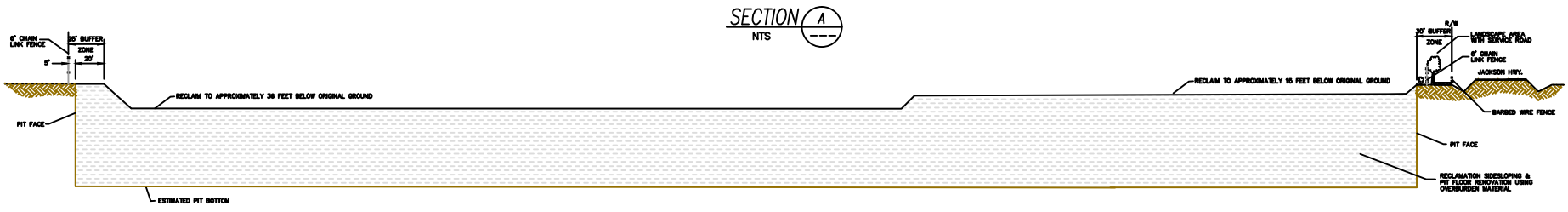
EXISTING TOPOGRAPHY (2010)

600 0 600 1200

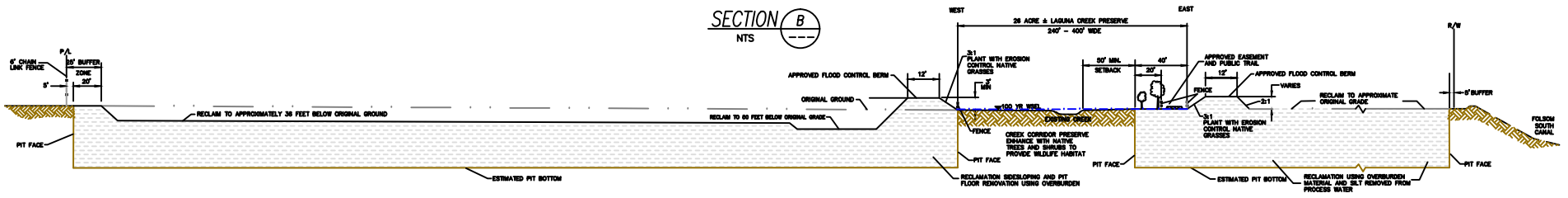
SCALE IN FEET

N

SECTION A
NTS



SECTION B
NTS



TOPOGRAPHY PROVIDED BY VULCAN MATERIALS COMPANY, DATED MARCH 19, 2010
AERIAL: GOOGLE EARTH DATABASE, DATED 2016

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SACRAMENTO AGGREGATES
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RECLAMATION PLAN

SCALE: HORIZ. AS SHOWN VERT. AS SHOWN
DRAWN BY: G. CAMUS / APS
DATE: MARCH 2017

FIGURE NUMBER 6

S:\Vulcan\Sacramento Permitting\Hydrology\CAD\VU01_Sacramento_Agg_Site Plan_030617.dwg, 3/7/2017 6:06:19 PM, DWG To PDF.pc3

EAGLES NEST ROAD

CARLI MINING
EXPANSION
STUDY AREA

MITIGATION MEASURE HW-1:
TEMPORARY EARTHEN BERM (3' MIN.)
(SEE DETAIL A)

FLORIN ROAD

AERIAL: GOOGLE EARTH DATABASE, DATED 2016

LEGEND

CARLI EXPANSION AREA

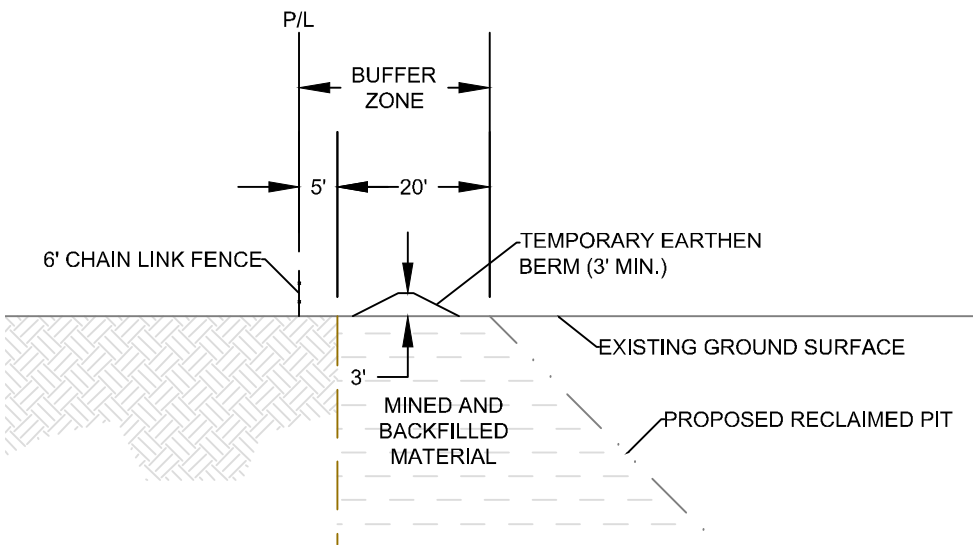
300 0 300 600

SCALE IN FEET

N

DETAIL A

MITIGATION MEASURE HW-1
TEMPORARY EARTHEN BERM



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SACRAMENTO AGGREGATES
MINING EXPANSION
VULCAN MATERIALS COMPANY
MITIGATION MEASURES

SCALE: HORIZ. AS SHOWN
VERT. AS SHOWN
DRAWN BY: G. CAMUS / APS
DATE: SEPTEMBER 2019

FIGURE NUMBER
7

APPENDIX 2

FLOOD INSURANCE RATE MAPS (FIRMs)

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was California State Plane Zone II (FIPSZONE 0402). The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was provided in digital format by the County of Sacramento Water Resources Department. This information was derived from digital orthophotos produced with 6-inch pixel resolution and 3.3-foot horizontal accuracy from aerial photography dated March 2001.

This map may reflect more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have **questions about this map**, how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange (FMIX) at **1-877-FEMA-MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS
OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Limit of Moderate Wave Action
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

- Cross section line
- Transect line
- Culvert, Flume, Penstock or Aqueduct
- Road or Railroad Bridge
- Footbridge
- 87°07'45", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
- 4276000mN — 1000-meter Universal Transverse Mercator grid values, zone 10
- 600000 FT — 5000-foot grid values: California State Plane coordinate system, zone II (FIPSZONE 0402), Lambert Conformal Conic projection
- DX5510 × — Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
AUGUST 16, 2012

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

PANEL 0219H

FIRM

FLOOD INSURANCE RATE MAP

SACRAMENTO COUNTY, CALIFORNIA AND INCORPORATED AREAS

PANEL 219 OF 705
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
SACRAMENTO COUNTY	060262	0219	H

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06067C0219H

EFFECTIVE DATE
AUGUST 16, 2012

Federal Emergency Management Agency

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT HTTP://MSC.FEMA.GOV

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A,V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN — Area of Minimal Flood Hazard *Zone X*
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- E 18.2 / 17.5 — Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 — Coastal Transect
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature
- 513 — Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base Map information shown on this FIRM was provided in digital format by the USDA National Agriculture Imagery Program (NAIP). This information was photogrammetrically compiled at a scale of 1:12,000 from aerial photography dated 2012.

SCALE

N

Map Projection:
State Plane California II FIPS 0402 Feet; North American Datum 1983; Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet 1:6,000

0 500 1,000 2,000 Feet

0 125 250 500 Meters

PANEL LOCATOR

* PANEL NOT PRINTED

FEMA

National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

SACRAMENTO COUNTY, CALIFORNIA
And Incorporated Areas

PANEL 332 OF 705

FEMA

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
SACRAMENTO COUNTY	060262	0332	J

VERSION NUMBER
2.3.3.0

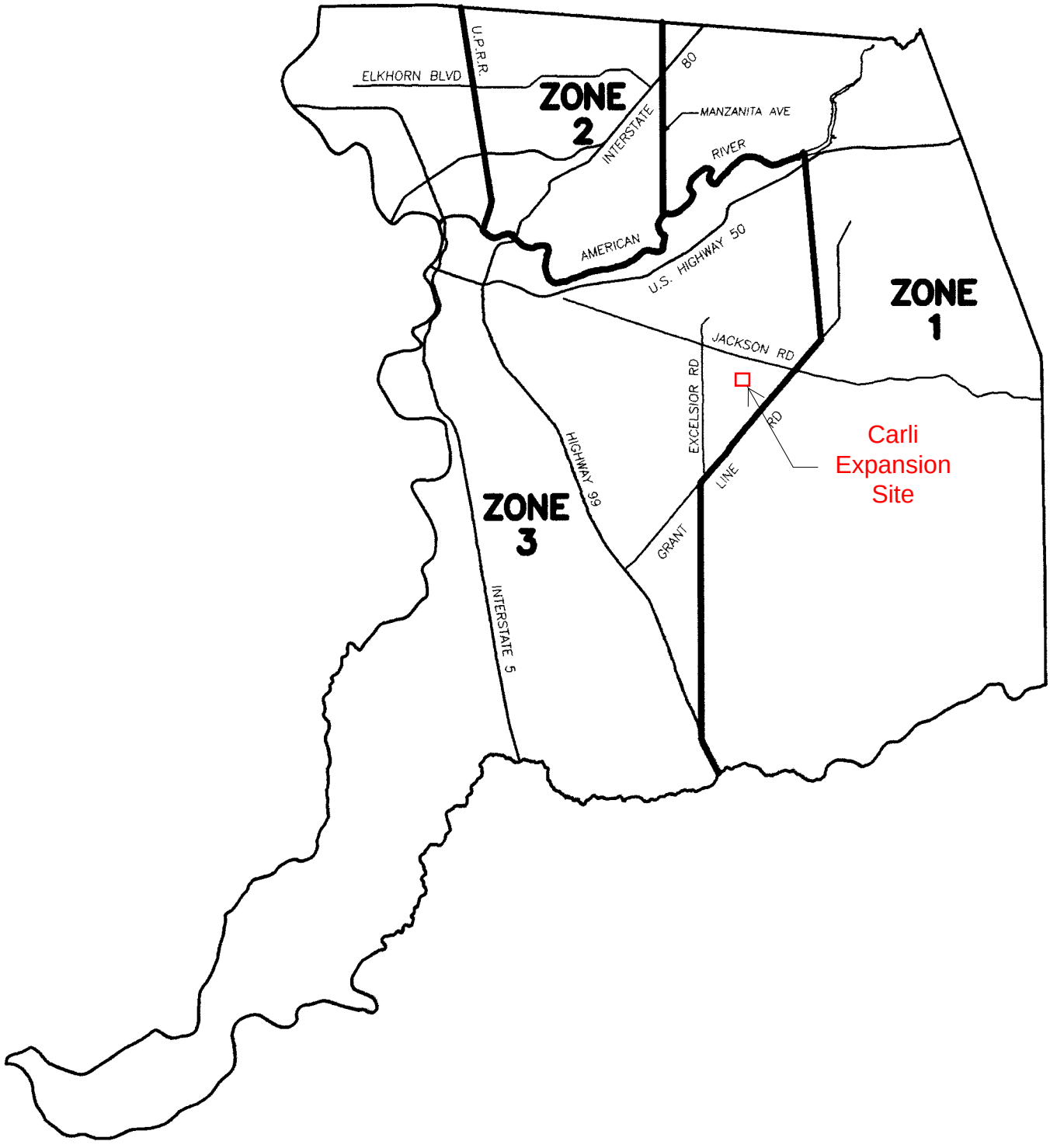
MAP NUMBER
06067C0332J

MAP REVISED
JULY 19, 2018

APPENDIX 3

SUPPORTING DOCUMENTATION

SACCALC MODEL OUTPUT FILES
NOAA PRECIPITATION ESTIMATES



Source : County of Sacramento Master Drainage Plan, Part 1, County-wide Hydrology, Nolte and Assoc.

Sacramento City and County Hydrologic Zones Nolte Method

Date December 1996

Figure 2-4

Sacramento Hydrologic Calculator Report

November 29, 2016 15:25

Project Title: Carli Expansion Project
Comments:
Prepared by: APS

Method: Nolte method
Date: 11/7/2016

Watershed Hydrologic Summary Data

Watershed	Area (acres)	Area Percent											
		Given as	90	85	80	75	70	60	50	40	30	25	20
CARLI	153	fraction											100

Refer to the Drainage manual for Land Use Impervious Area Percent

Nolte method results
(Project: Carli Expansion Project)
(Hydrologic zone 3)

ID	Drainage area (acres)	Impervious area (%)	Design Q (cfs)
CARLI	153.00	20.00	60.90

APPENDIX 4

SACRAMENTO AGGREGATES EXPANSION FLOOD AND DRAINAGE REPORT

WEST YOST ASSOCIATES, MAY 2007

Sacramento Aggregates Expansion Flood and Drainage Report

May 2007

Prepared for

Triangle Rock Products, Inc.

WEST YOST ASSOCIATES
Consulting Engineers

Sacramento Aggregates Expansion Flood and Drainage Report

Prepared for

Triangle Rock Products, Inc.

May 2007

WEST YOST ASSOCIATES
Consulting Engineers

222-00-05-06

TABLE OF CONTENTS

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CHAPTER 1. OVERVIEW

SACRAMENTO AGGREGATES MINING AREA

Triangle Rock Products Inc. (Triangle) operates its current Sacramento Aggregates mining facility on 248 acres located in Sacramento County south of Jackson Highway and west of Sunrise Boulevard and the Folsom South Canal, Figure 1. Triangle has mined this area since 1997. The mining area, Figure 2, includes an aggregate processing plant, material stockpiles, office, mining excavation pits, access roads, and settling ponds. The entrance to the facilities is from Florin Road. Trucks travel north from Florin Road to the loading area and scales, returning to Florin Road. Materials processed at the plant are used at construction sites throughout the region.

Triangle is planning to expand the mining operation onto approximately 100 acres of a 125 acre parcel located immediately south of Florin Road, Figure 2. A drainage study was conducted by West Yost Associates (WYA) for Triangle to identify flood and drainage issues, determine the impact of the proposed expansion on Laguna Creek and recommend actions to be implemented to protect the project site and the Laguna Creek corridor during mining and following reclamation.

LAGUNA CREEK WATERSHED

The Sacramento Aggregates existing and proposed mining area is bisected by Laguna Creek, one of Sacramento County's major streams and part of the Morrison Creek Stream Group. The Laguna Creek watershed extends from eastern Sacramento County and flows southwest and west to its confluence with Morrison Creek 21 miles downstream, draining a watershed of 48 square miles, Figure 3.

The mining area lies in the upper reach of Laguna Creek, about 6 miles downstream of its headwaters. The watershed has a drainage area of 5,536 acres upstream of Jackson Highway, the northern boundary of the Sacramento Aggregates property. After leaving the Sacramento Aggregates site, Laguna Creek flows 14 miles downstream joining with Morrison Creek immediately upstream of upper Beach Lake. The combined flow passes through lower Beach Lake and the Stone Lake system before entering sloughs and outflowing to the Sacramento River.

The Laguna Creek watershed has been the subject of a number of studies over the past forty years. County of Sacramento policies regarding treatment of natural creeks have changed over this time to reflect changing public attitudes about creeks, open space, recreation and water quality and rapid downstream development in the County in Elk Grove and in Sacramento.

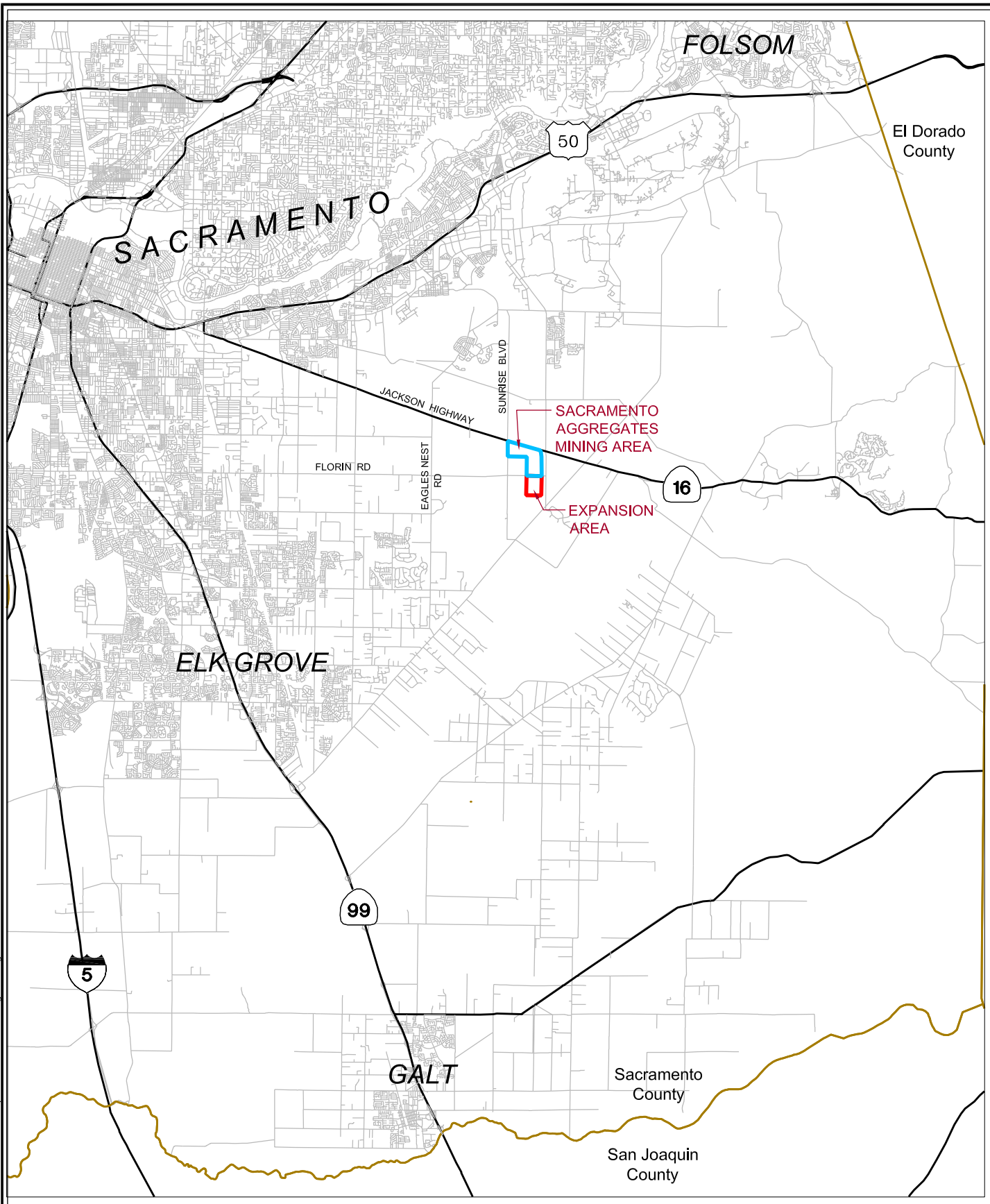

Figure 1

Sacramento Aggregates Mining Expansion
VICINITY MAP

WEST YOST ASSOCIATES
Consulting Engineers

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Figure 2

Sacramento Aggregates
Mining Expansion
SITE MAP

WEST YOST ASSOCIATES
Consulting Engineers

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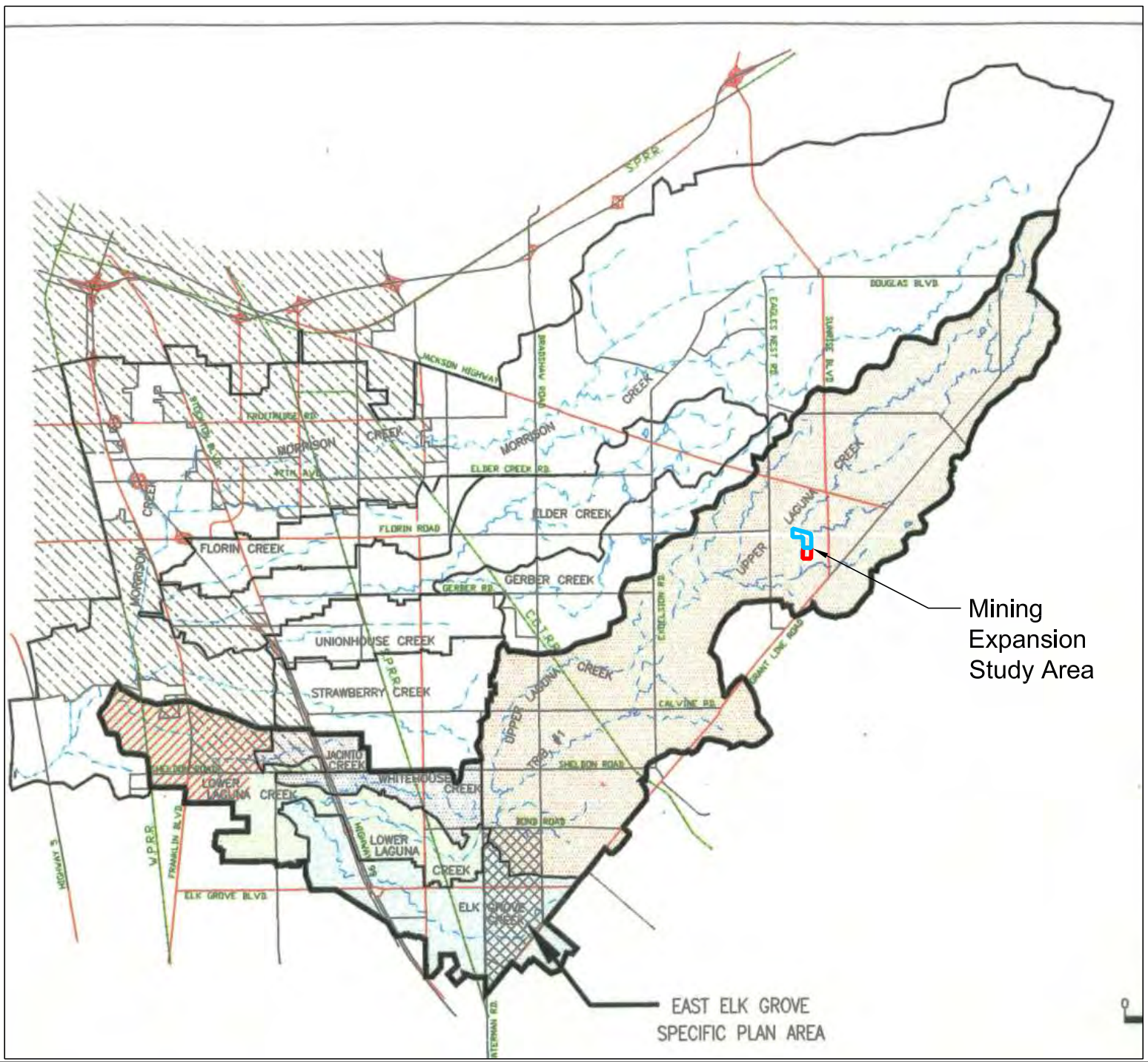


Figure 3

Sacramento Aggregates Mining Expansion

LAGUNA CREEK WATERSHED AND MORRISON CREEK STREAM GROUP

LEGEND

NOTES

WEST YOST ASSOCIATES
Consulting Engineers

DRAINAGE STUDY METHODOLOGY

The Sacramento Aggregates Expansion Flood and Drainage Study relied largely on work previously completed by Sacramento County's Water Resources Division. Over the years, Laguna Creek was analyzed using the Corps of Engineers computer model HEC-1 for hydrology and HEC-2 for the creek hydraulic analysis. With the advent of the HEC-RAS model, the Laguna Creek analyses were updated to RAS. After the watershed plan was modified to include detention storage in upper Laguna Creek, an unsteady flow model was developed by the County using the UNET computer program. The County has more recently developed an unsteady flow model using HEC-RAS with its new pre-processor, SacCalc, to develop hydrologic input to the HEC-1 model. Computed hydrographs are stored as DSS files for easy viewing and use.

The present analysis uses the County SacCalc / HEC-1 model for hydrology and a modified County HEC-RAS unsteady flow model for creek hydraulics. All files are written to DSS. Models were modified to reflect local conditions, compute results at additional locations, analyze alternative berm locations and evaluate side channel weir/detention basin options.

CHAPTER 2. DESCRIPTION OF EXPANSION STUDY AREA

The Sacramento Aggregates expansion study area (study area) is a 125 acre parcel south of the existing facility, Figure 4. The mining expansion site (project site) includes approximately 100 acres of the study area. The project site's eastern boundary is the Folsom South Canal property and the western boundary is 50 feet east of the eastern top bank of Laguna Creek. The remainder of the study area, the western 25 acres, will be preserved as native habitat, including Laguna Creek, the 50 feet east of the eastern top bank of Laguna Creek, and the property west of Laguna Creek.

The study area is rectangular in shape and lies adjacent to the west slope of the Folsom South Canal. At the present time, the only use of the land is for cattle grazing. Land generally slopes south and southwest toward Laguna Creek. A low area or swale traverses the site from northeast to southwest draining most of the site. Low areas adjacent to the south property line collect runoff before it drains to the creek via two pipes in the bank of the creek. Elevations range from 114 feet along Florin Road to 107 feet in the lower land near the south property line.

Laguna Creek passes under Florin Road and enters the study area. The creek turns west and then with a 90 degree bend, turns and flows south through the study area. After leaving the study area, Laguna Creek turns toward the west, crosses Eagles Nest Road and continues downstream.

Land west of the creek drains to the creek with a gentle, flat slope. All of the site shows signs of frequent shallow flooding from overbank creek flows. A fairly sizable area east of the Folsom South Canal drains west through four 48 inch diameter pipes into the property south of the study area, Figure 4, and continues on to the creek. Field investigation shows that during high runoff events, water spills from the south into low areas on the project site.

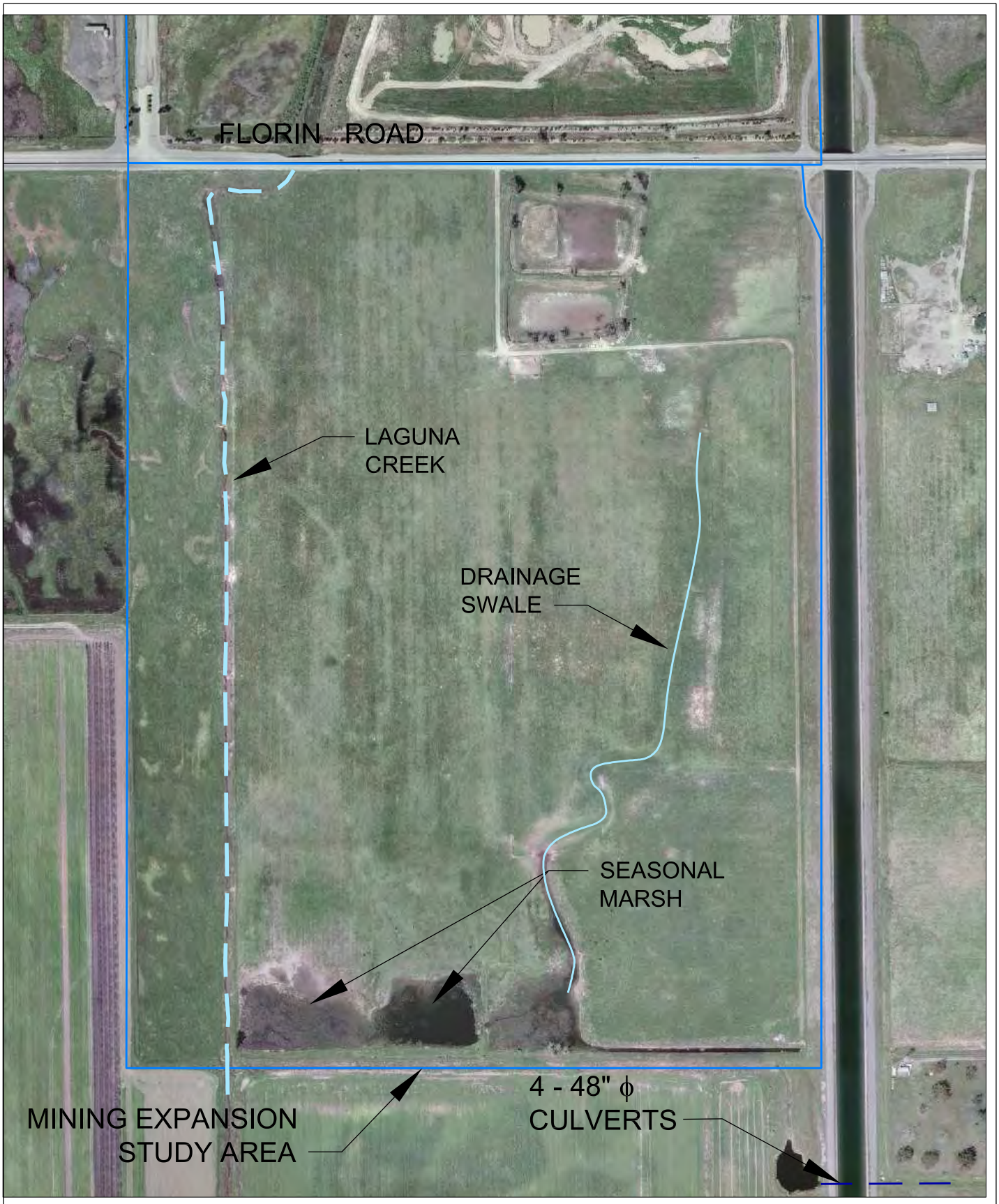
PROPOSED PROJECT

Mine Plan

The project site will be mined in three (3) phases, Figure 5. The first phase will begin in the west half of the site mining from the north to southern third of the site. The second phase will be the east half of the site mining from the north to southern third of the site. The third phase will be the southern third of the site.

An estimated 20 feet of overburden will be removed in phases to expose the aggregate. The overburden will be saved for use in reclamation. Aggregate will be mined to an estimated depth of approximately 75 feet in three phases. Excavation setbacks include the following:

- 50 feet east of the eastern top bank of Laguna Creek
- 30 feet from Florin Road right-of-way
- 5 feet from the east property line (approximately 85 feet from the Folsom South Canal)
- 5 feet from south property line



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SCALE IN FEET

Figure 4
Sacramento Aggregates
Mining Expansion
MINING EXPANSION STUDY AREA SITE MAP

WEST YOST ASSOCIATES
Consulting Engineers

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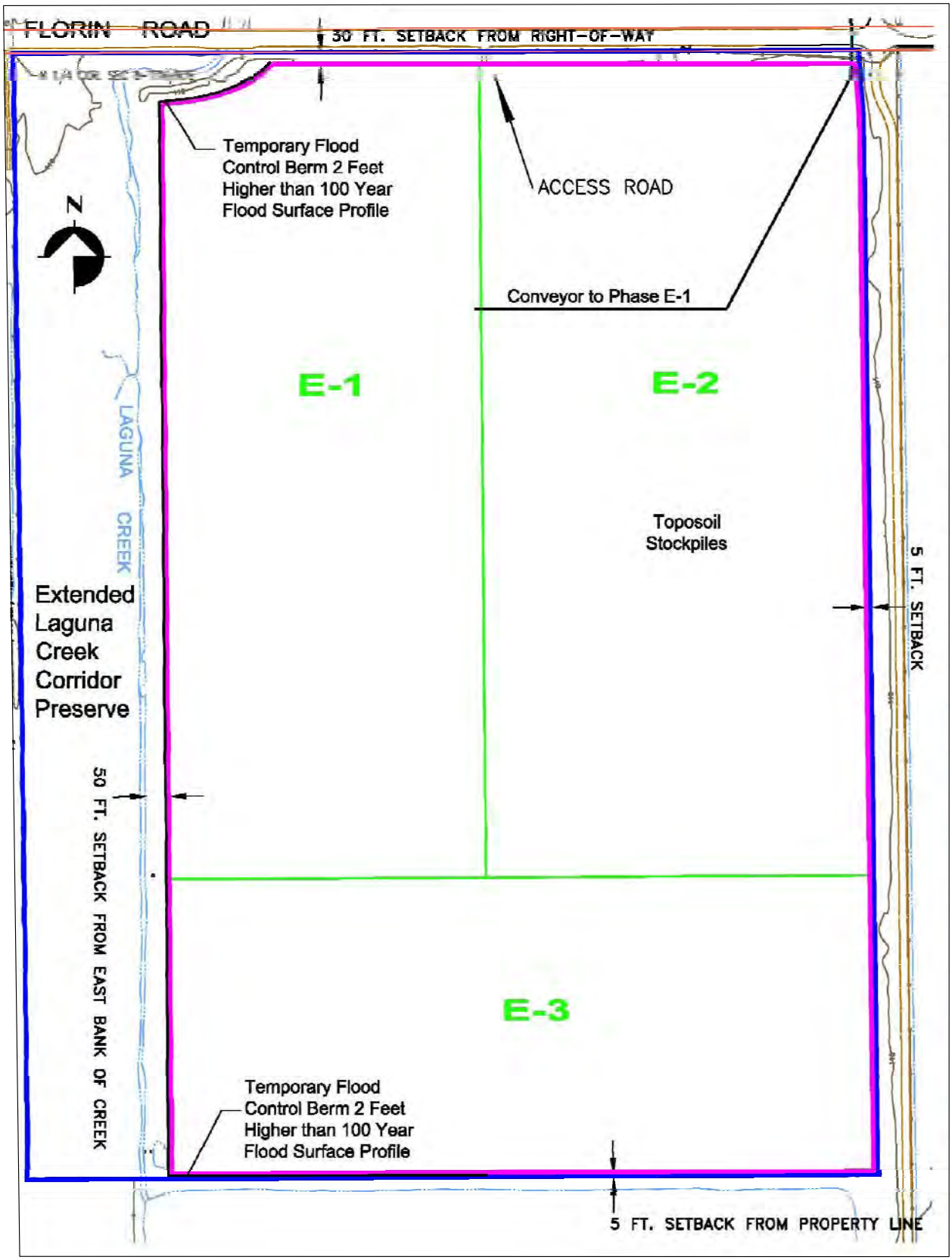

LEGEND

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Figure 5

Sacramento Aggregates
Mining Expansion
MINE PLAN

WEST YOST ASSOCIATES
Consulting Engineers

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Aggregate will be mined from the project site using existing equipment, including a hydraulic excavator and a front-loader. Excavated aggregate will be transported to an extendable pit conveyor by existing haul trucks and conveyed north to the existing processing plant via a conveyor tunnel to be constructed under Florin Road.

Reclamation Plan

The mined area will be reclaimed only to include the following:

- **Florin Road:** Overburden will be backfilled to create final undulating slopes between 1.5:1 and 2:1 (horizontal:vertical). The backfill material will be compacted to at least 90 percent.
- **East Property Line (adjacent to Folsom South Canal):** Overburden will be backfilled to approximate original grade a distance of 20 feet from excavation cut for a final reclaimed setback of 25 feet from the property line (approximately 105 feet from Folsom South Canal). The backfill material will be compacted to at least 90 percent with final undulating slopes between 1.5:1 and 2:1.
- **South Property Line:** Overburden will be backfilled to original grade a distance of 20 feet from excavation cut for a final reclaimed setback of 25 feet from the property line. Final reclaimed slopes will undulate with slopes between 1.5:1 and 2:1.
- **Laguna Creek Corridor:** The existing Laguna Creek Corridor Preserve north of Florin Road will be extended south adjacent to the expansion site. An expanded creek corridor with an approximate, average width of 600 feet will be created including approximately 250 feet to be preserved west of the creek and approximately 350 feet to be enhanced east of the creek, Figure 6. The existing narrow creek channel will be widened to create emergent wetland where none currently exists as mitigation for wetlands to be removed from the expansion site during mining. In addition to the existing low-flow channel, a new, meandering, low-channel will be created matching the elevation of the existing low-flow channel which will remain in its current location. The system of proposed terraces between the bank and channel invert will provide a channel with an increased and varying flow area. Hydraulic grade lines will be maintained similar to present conditions so as not to negatively impact the creek downstream or upstream and assure that water levels are maintained in the Laguna Creek corridor upstream of Florin Road

  Overburden will be used to fill the portion of the mined area within the expanded corridor to form a riparian terrace to be vegetated with native plants. A public trail will constructed along the east edge of the corridor as an extension of the trail to be built north of Florin Road under the existing approved reclamation plan resulting in a continuous mile long creek trail.

A permanent flood control berm, two (2) feet higher than the computed 100-year water surface profile, will be constructed along the east edge of the reclaimed setback and along the western portion of the south property line. The berms, 12 feet wide at the top, will be constructed of overburden compacted to 90% and planted with native and erosion control grasses. Upon completion of excavation and the final sloping and reclamation of the expansion site, a side channel weir structure will be constructed just south of where the creek turns 90 degrees to the south. The weir height and length will be designed to divert the same volume of flood water that currently overflows onto the expansion site during various flood events. The resulting floodplain on adjoining properties following reclamation would be the same as experienced under pre-project conditions. Final reclaimed slopes east of the berm will be compacted to at least 90 percent and will undulate with slopes between 1.5:1 and 2:1.

- **Reclaimed End Use:** The bottom of the excavation will slope to the southwest due to the natural depth of the aggregate deposit. Approximately three (3) feet of overburden will be backfilled on the bottom and the expansion site will be returned to grazing land at an elevation approximately 70 feet lower than the existing ground surface. The bottom and banks will be planted with seasonal, native and erosion control grasses for grazing and wildlife habitat. Seasonal marsh will also develop in the southwestern corner of the bottom where on-site storm water will drain.

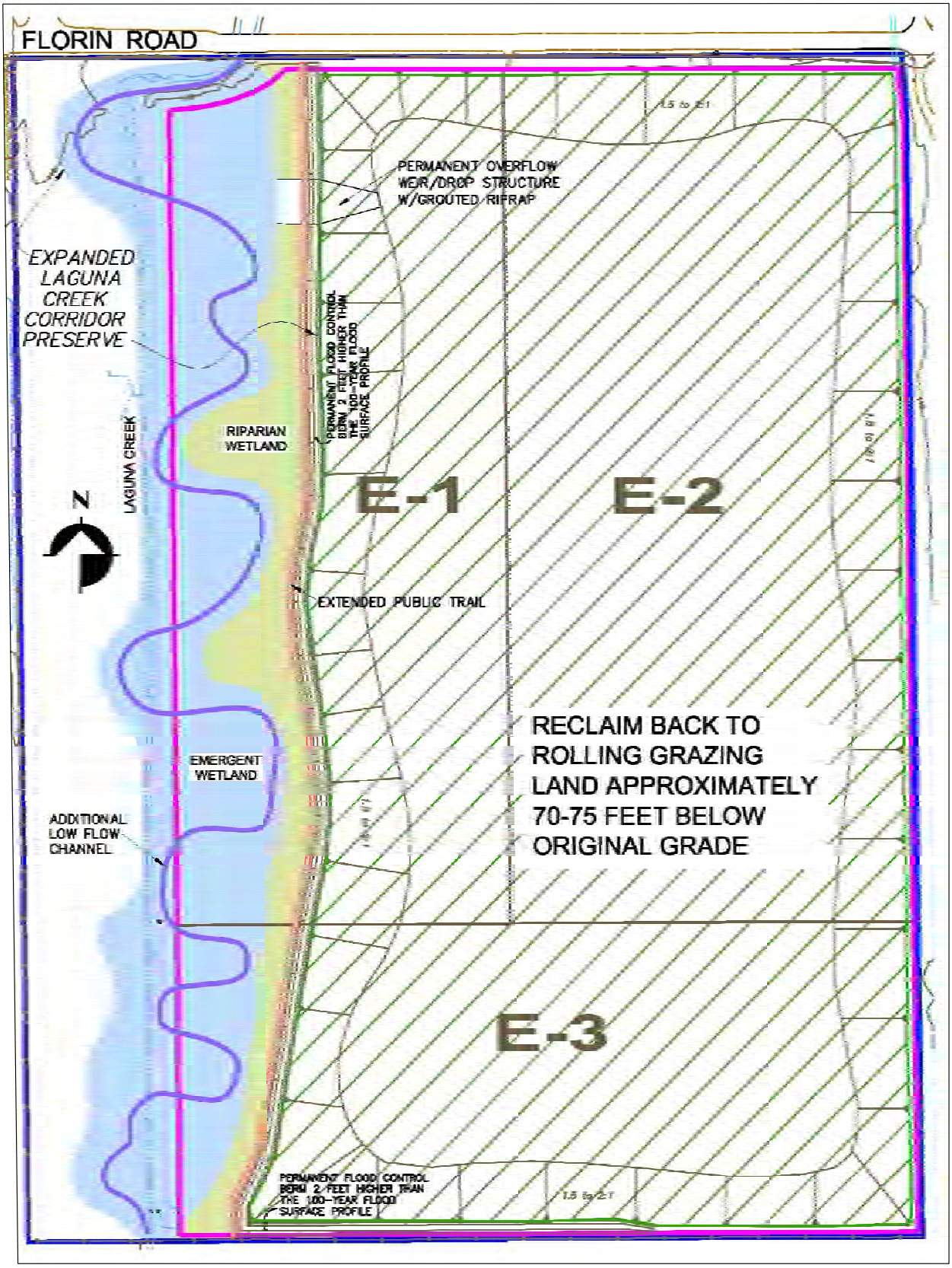

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Figure 6
Sacramento Aggregates Mining Expansion
PROPOSED CREEK CORRIDOR RESTORATION PLAN

WEST YOST ASSOCIATES
Consulting Engineers

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CHAPTER 3. HYDROLOGY

The hydrology of the study area comprises the Laguna Creek watershed, on-site rainfall, seasonal marsh and wetlands, runoff to Laguna Creek and flooding from property to the south that spills into low lying areas adjacent to the south property boundary.

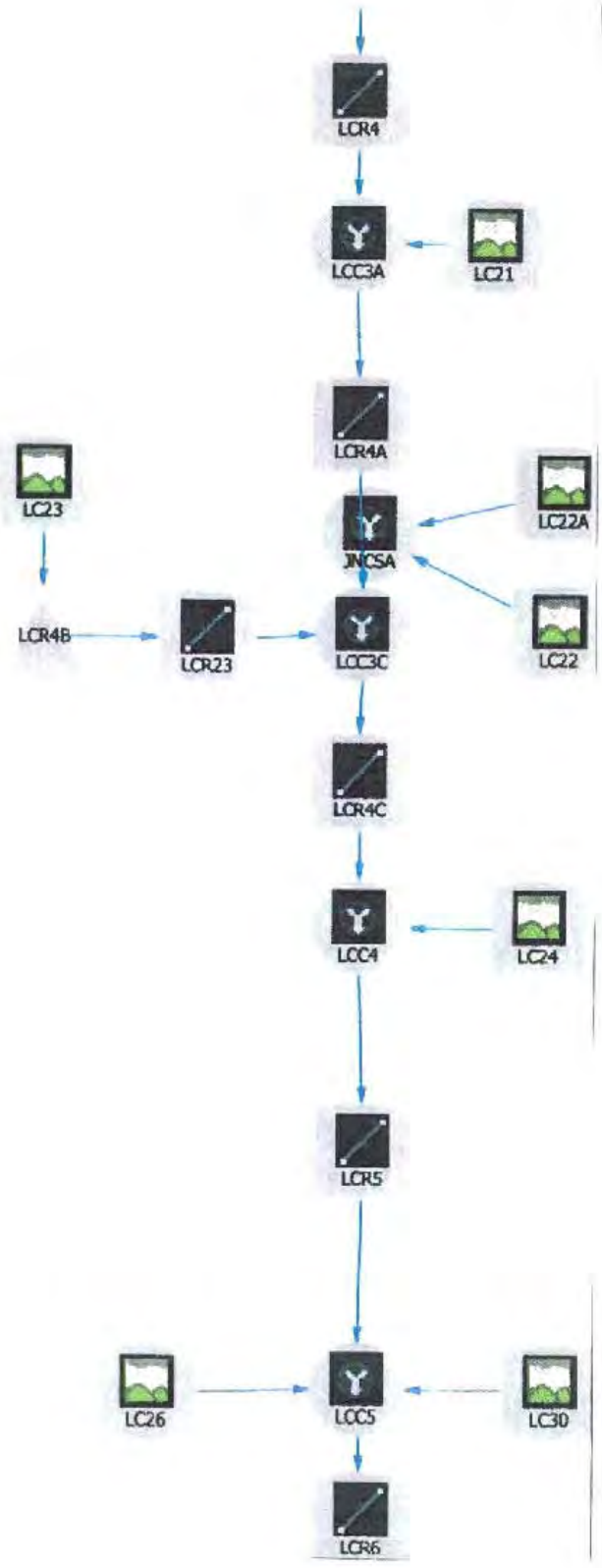
The study area lies within the Upper Laguna Creek watershed. The study area is at the lower end of a sub-shed of 11.4 square miles comprised primarily of open space. Ground elevations range from 123 feet in the headwaters to 110 feet in the study area.

The latest County analysis of upper Laguna Creek used the SacCalc preprocessor to develop input to the HEC-1 computer model. WYA obtained these models and made small modifications to allow computation points at locations needed for this study.

The SacCalc model schematic for Laguna Creek in the vicinity of the study area is shown in Figure 7. Modifications were made to the County model to allow computation of runoff through the study area. Subsheds and computational nodes in the modified County hydrologic model are described in Table 1.

Table 1. Model Sub-sheds

LCR4	Routed Laguna Creek flow crossing the Folsom South Canal and Sunrise Boulevard.
LC21	Total runoff from Sacramento Aggregates north of Florin Road.
LCC3A	Total Laguna Creek flow at Florin Road.
LC22	Total runoff from expansion study area (portion of County LC22 sub-shed).
LC22A	Remaining portion of County LC22 sub-shed.
LC23	Sub-shed east of Folsom South Canal that drains to Laguna Creek through the parcel south of the study area along the study area south property line.
LCC3C	Total flow at south boundary of the study area.



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SCALE IN N.T.S.

Figure 7

Sacramento Aggregates
Mining Expansion
SAC CALC MODEL SCHEMATIC

WEST YOST ASSOCIATES
Consulting Engineers

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Data for the study area vicinity sub-sheds as input to the SacCalc program are shown in Table 2. Input for the HEC-1 program using the Sacramento Method methodology was developed by Sacramento County. Computed hydrographs were saved as DSS files for ease of viewing and use in further analysis.

Table 2. Sub-shed Hydrologic Data

Sub-shed	Area, acres	Flow Length, feet	Flow Length to Centroid, feet	Slope, foot/feet
LC22	108	3,200	2,125	.0039
LC22A	86	3,634	2,412	.00390
LC23	649	6,289	3,451	.0061

The computed Laguna Creek peak flows through the Sacramento Aggregates expansion area with existing conditions are shown in Table 3 and an existing conditions Laguna Creek 100-year runoff hydrograph is shown on Figure 8.

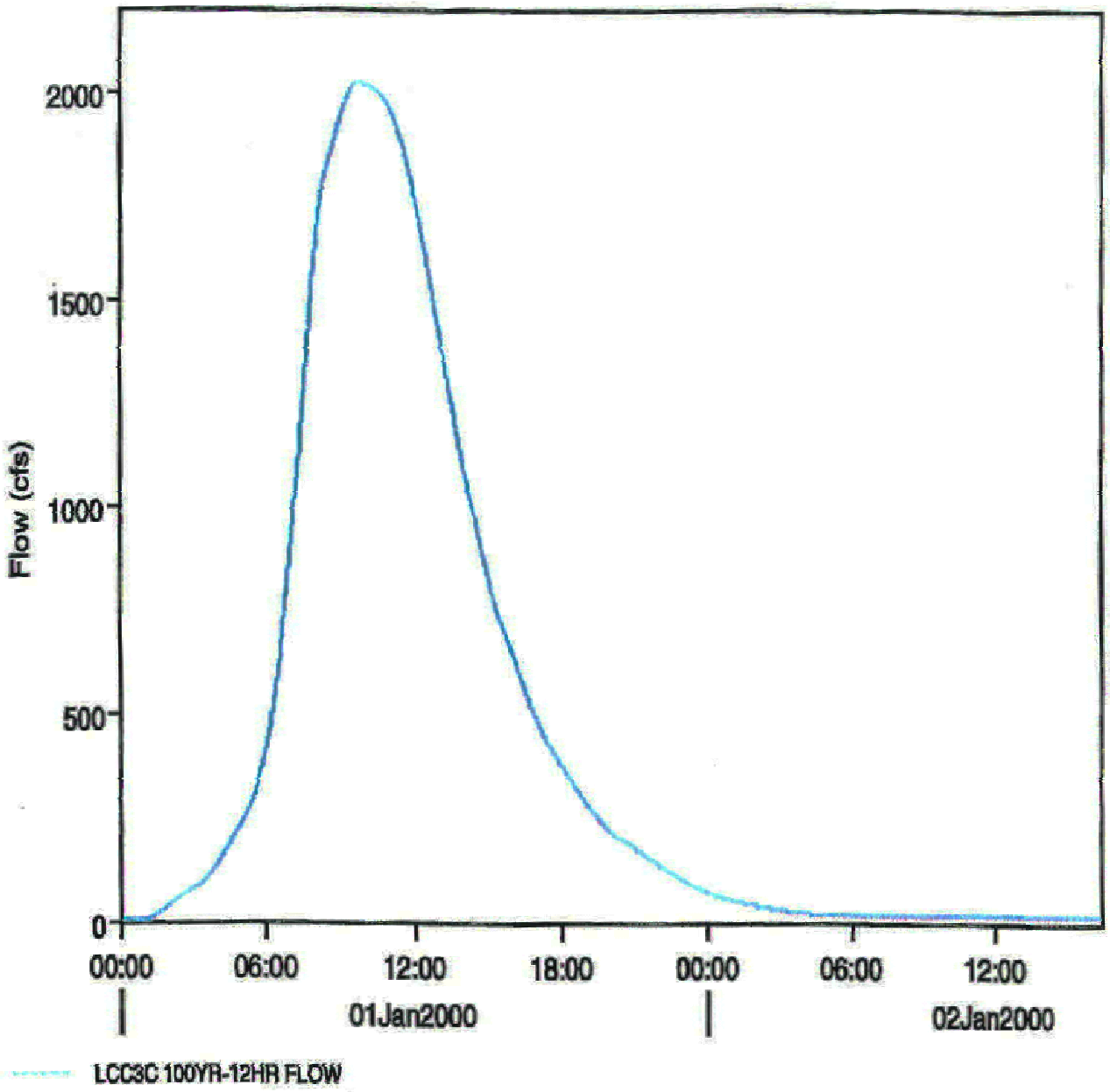
Table 3. Laguna Creek – Peak Flow – Frequency at Florin Road

Frequency	Peak Flow
10-year	1,100 cfs
50-year	1,660 cfs
100-year	1,810 cfs
500-year	2,500 cfs

FLOOD WATERS FROM LAGUNA CREEK

The most recent major storm to impact the study area occurred on New Years Eve 2005-2006. Rainfall was moderately intense throughout most of Sacramento County with some pockets of rainfall with recurrence intervals of up to 50-years. In the vicinity of the Sacramento Aggregates expansion site the rainfall gage to the west along Laguna Creek at Eagles Nest Road recorded 2.48 inches of rain in a 12 hour period. This storm was estimated to be approximately a 20 year rainfall event.

Applying this rainfall depth to the Laguna Creek models used for the study area gives a peak Laguna Creek runoff of 1,440 cfs, a flow that results in overbank flow covering much of the project site. The areal extent of flooding was about 80 percent of the 100-year floodplain with a depth of usually less than a foot.



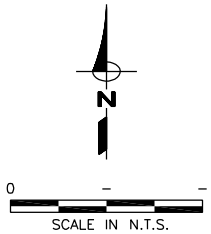


Figure 8
Sacramento Aggregates
Mining Expansion
LAGUNA CREEK 100-YEAR
RUNOFF HYDROGRAPH

WEST YOST ASSOCIATES
Consulting Engineers

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ON-SITE HYDROLOGY

The hydrology of the study area is affected only by rainfall. Other than Laguna Creek flowing through the study area and some occasional spill from flooding of the land to the south, all of the runoff from the study area originates on-site from direct rainfall.

The study area topography slopes toward the southwest draining into the creek. A small swale about 2,000 feet long, begins on the eastern portion of the project site about halfway between the southern boundary and Florin Road. The swale is small and carries low and moderate runoff to the low area near the southern boundary. During any significant rainfall, the swale is inundated and runoff becomes sheet flow south and southwest across the project site.

The project site generates about 124 cfs during a 100-year event. In a 10-year runoff, about 70 cfs enters Laguna Creek from the site via two existing pipes or as overflow to the creek.

FLOOD WATERS FROM THE SOUTH

The ponds along the western half of the south boundary of the project site collect most of the runoff from the project site and drain west to Laguna Creek via the two pipes, with the pond bottoms eventually drying by evaporation.

There is visual evidence that during large runoff events, some flow from land south of the project site may spill across into the low area along the project site south property boundary. Runoff from a 650 acre parcel east of Sunrise Boulevard passes under the Folsom South Canal in four – 48 inch diameter concrete pipes south of the project site. The total estimated flow that crosses from that sub-shed to Laguna Creek south of the project site, Figure 9, is 490 cfs. Based on the site topography, the 100-year flow into the project site from this area was estimated to be about 160 cfs. This flow could result in a volume of 50 acre feet in a 100-year event and 10 acre feet in a moderate 10-year event. A smaller storm runoff, such as a mean annual event, would likely result in a peak flow of 20 cfs and a volume of 2 acre feet crossing the property line into the project site.

N

0 250 500
SCALE IN FEET

Figure 9
Sacramento Aggregates
Mining Expansion
SOUTH PROPERTY LINE
VICINITY MAP

WEST YOST ASSOCIATES
Consulting Engineers

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CHAPTER 4. HYDRAULIC ANALYSIS OF THE STUDY AREA

Laguna Creek enters the existing Sacramento Aggregates site after crossing Jackson Highway and the Folsom South Canal. The creek passes through an area that has been mined extensively. Throughout the mining activities, Laguna Creek has been protected and continues to flow in its recent historical alignment. The Laguna Creek corridor within the Triangle Rock mining area north of Florin Road is the Triangle Rock Laguna Creek Corridor Preserve. The preserve includes the creek and its overbank area and ranges from 350 to 700 feet wide.

The creek through the expansion site is a fairly stable channel averaging about 35 feet wide and 5 feet deep. At normal flows, there is little evidence of significant erosion and deposition. Even at flood flows, the creek has maintained its straight alignment with minimal erosion. Physical changes have been observed where cattle have crossed or walked in the creek bed.

Sacramento County has conducted several hydrologic and hydraulic studies in the Laguna Creek watershed. Key among them is the Upper Laguna Creek Drainage Master Plan that was last updated in 1997. A number of hydrologic and hydraulic models have been developed by the County and the Corps of Engineers including the present SacCalc/HEC-1 and HEC-RAS models that were used as the basis for this study.

The hydraulic analysis investigated flows in Laguna Creek as the creek flows along the western edge of the proposed mining area and runoff within the project site. The analysis also considered off-site drainage entering the project site. The Sacramento Aggregates site is in the Upper Laguna Creek Study Area and has been included in a number of Upper Laguna Creek hydraulic studies over the past several years.

Most of the County's efforts were directed toward a traditional HEC-1 and HEC-2 analysis. Then, to gain the advantages of unsteady flow analysis, the County went to using HEC-1 to compute sub-basin runoff hydrographs and UNET to provide unsteady flow analysis. Most recent analyses use the recently developed SacCalc pre-processor with HEC-1 to compute hydrographs and a HEC-RAS unsteady flow model to model hydraulics.

Sacramento County has developed a hydraulic model of Laguna Creek using the Corps of Engineers Hydrologic Engineering Center's River Analysis System (RAS). This unsteady state model was used to compute water surface elevations along the creek through the expansion mining area. The runoff hydrographs computed with the SacPre/HEC-1 hydrologic model were saved as DSS files that were brought back into the RAS model. The RAS model uses these stored runoff hydrographs and Laguna Creek channel geometry to compute a water surface profile, channel flow depths and flow velocities. The water surface elevations are used to plot the floodplain boundaries for each flow. For this study, WYA used the RAS model developed by the County and added cross sections to better define the creek through the Sacramento Aggregates site and the expansion study area.

EXISTING CONDITIONS

The Laguna Creek channel through the expansion study area averages about 20 to 40 feet wide and 4 to 6.5 feet deep. Cattle walking in the creek channel have caused the sides to slough and through their continued action have caused both blockages and side slope failures in the creek.

The Laguna Creek channel is almost triangular in shape with a minimum of less than one foot to 2 foot bottom width and depths ranging from 4 to 6.5 feet. Side slopes average 2.5 to 1 and vary between 2:1 and 2.9:1. There is an adverse bottom slope along most of the creek length keeping the bottom wet during much of the year. The creek overspills its banks at discharges of 200 to 300 cfs. The floodplain is broad and shallow along both sides of the creek.

The minimal channel capacity through the study area results in overbank flow at relatively small storm events. Even a 10-year runoff spreads over most of the project site. Flooding is shallow with depths averaging one foot deep during a 100-year event with some depths in the low `lying southern areas of the project site increasing to over three feet. The pre-project 100-year floodplain is shown on Figure 10 and includes most of the expansion site.

Water surface profiles were computed through the project site using the HEC-RAS model. A 100-year profile is shown in Figure 11. Computed elevations are shown in Table 4. Model output is included in Appendix A.

On-site flow is characterized by swales that collect runoff and flow generally northeast to southwest to low areas near the southern property boundary and to Laguna Creek. Swales are relatively small and there are broad expanses of overland flow. No off-site drainage flows enter the project site. Flow from the outside west slope of the Folsom South Canal is collected in a ditch along the toe and carried south. Runoff from a 650 acre property east of the Folsom South Canal flows through the property to the south of the project site near the property line separating the two parcels. This tributary flow is substantial with a peak of 490 cfs during a 100-year runoff and appears to occasionally flood and spill over the south property line of the project site. This flood spill collects in the low wetland area in the southern part of the project site along with the project area on-site runoff described above. This area was shown in Figure 6.

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LEGEND

FLOODPLAIN LINE

N

0 250 500

SCALE IN FEET

Figure 10

Sacramento Aggregates
Mining Expansion
EXISTING FLOODPLAIN

WEST YOST ASSOCIATES
Consulting Engineers

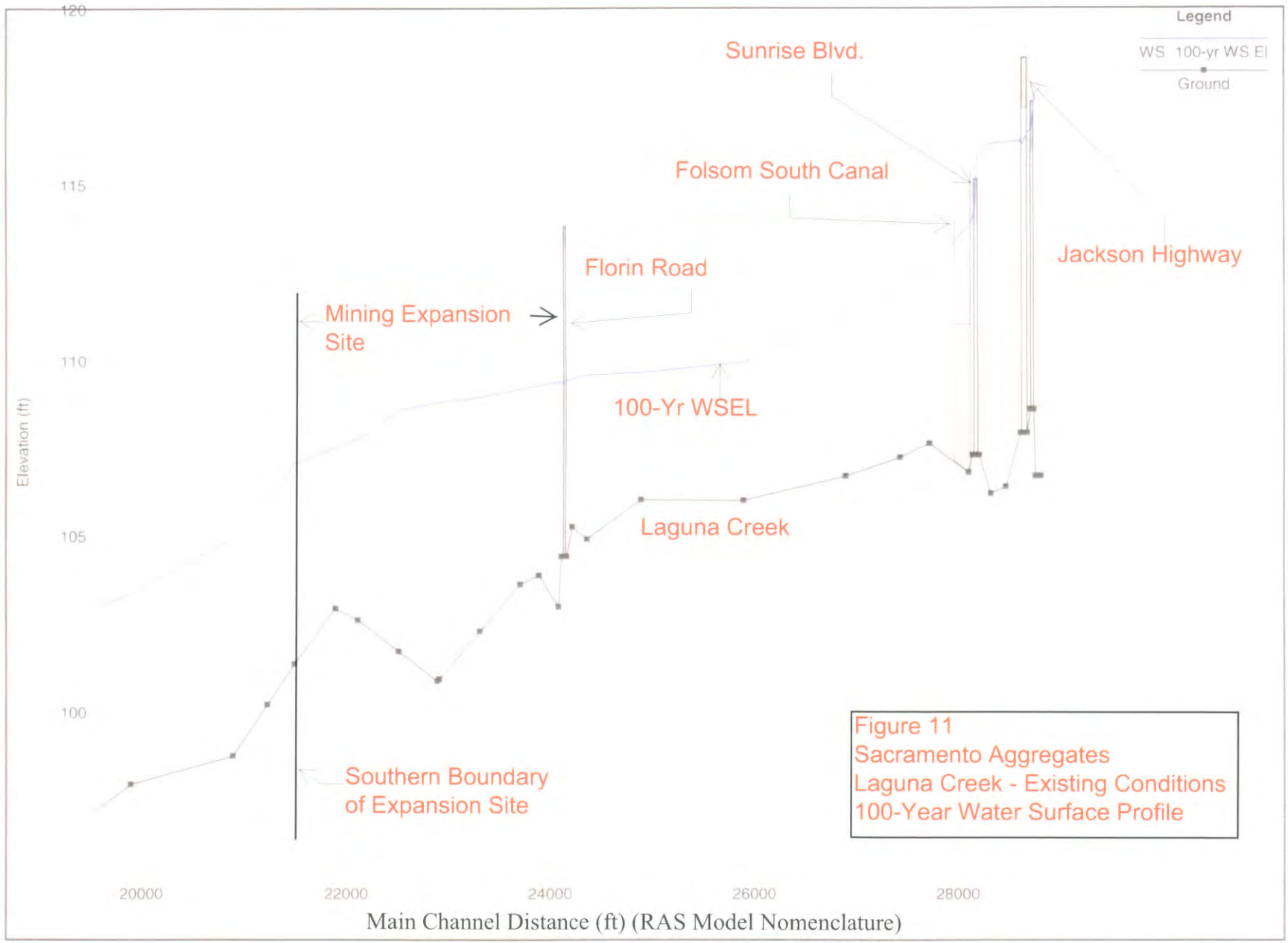

Figure 11
Sacramento Aggregates
Laguna Creek - Existing Conditions
100-Year Water Surface Profile

Table 4. Laguna Creek Water Surface Elevations—100–year Runoff

Existing Conditions	
Laguna Creek Mile Point[a]	Water Surface Elevations — 100–year
60773 DS Florin Road Bridge	110.7
60403	110.2
59603	109.1
59584	109.1
58803	108.1
58184	107.5
57919 South Property Line	107.0

(a) Sacramento County Model Mile Points.

Hydraulic analyses were also conducted for each phase of the mining operation and proposed mitigation measures. These analyses are discussed in Chapter 5.

CHAPTER 5. HYDRAULIC ANALYSIS OF PROPOSED PROJECT

Conduct of a successful mining operation adjacent to Laguna Creek within the Laguna Creek floodplain will require some protection of the mining operation from flooding and a long term restoration plan for the creek corridor after mining is completed.

The floodplain shown on Figure 10 is the existing 100-year floodplain. The depth across the floodplain during a 100-year event varies from one to three feet. The creek channel overtops its banks even during more frequent (less than 10 year) runoff events. A similar situation exists along the south property line where the flooded land south of the project site spills onto the project site during large storm events. This shallow flooding by itself may not be a significant constraint to mining but even a few inches of overbank flow falling into the excavated pit can quickly cause erosion that would travel back toward the creek causing significant damage to the creek bank and the creek itself. The erosion can create head cuts that may enter the creek and work their way upstream within the creek channel and cause damage within the creek channel and possibly upstream at the Florin Road bridge.

MITIGATION DURING MINING

Alternative measures to reduce flooding of the project site during mining were identified and analyzed to determine their effectiveness. Initially, alternative mitigation measures were identified within the project site. All resulted in time periods, sometimes up to a year or two years, when adjacent lands were vulnerable to flooding. The most promising mitigation included a lateral weir and detention basin constructed in the first phase mining area that could be expanded in volume as mining moved into Phases 2 and 3. Because the berm was to be constructed prior to excavation of the basin, there would be a time of one to two years when flooding would not be entirely mitigated and land west of the creek would be subject to increased flooding. Other mitigation measures were sought that could be in place before mining begins and would not have a period with no protection of adjacent land during construction. The most effective alternative was selected as the preferred alternative mitigation.

Under the mitigation preferred alternative, the project will be separated from Laguna Creek during mining by a temporary berm constructed along the western edge of the proposed project site (see Proposed Mine Plan Figure 4). The berm, two (2) feet higher than the computed 100-year water surface profile, will extend along the entire creek from Florin Road to the southern boundary of the project site. The berm would be a temporary structure to protect the mining site during the mining period. No special construction would be undertaken since if the berm is overtopped, Triangle could rapidly complete repairs. Before mining begins on the third phase, a second berm will be constructed along the western portion of the south property line to prevent overflow from the property south of the project site.

Analysis showed an expansion of the floodplain onto land west of the creek caused by confinement of flow by the berm and the loss of floodplain storage. A floodplain boundary that is 200 to 500 feet west of the creek under existing conditions would be extended to several hundred feet with construction of the temporary, protective berm on the east side, Figure 12.

To prevent the expansion of the floodplain onto adjacent land, during mining, a temporary detention basin to be created north of Florin Road in mining area IX will be used for storage that would reduce peak flows through the project site, Figure 13. A side channel weir structure constructed on the right bank downstream of the Folsom South Canal crossing would divert, approximately 200 acre feet and a peak diversion flow of about 1,030 cfs into the basin during a 100-year event. The detention basin is designed to provide 1,000 acre feet of storage. There are several combinations of weir crest length and elevation that will have similar positive impacts in the mining expansion area. The preferred plan would have a weir crest elevation of 111.0 feet with a length of 200 feet. Table 5 shows comparative water surface elevations as calculated using the HEC-RAS model.

Diverting flows that currently flood the project site to the temporary detention basin, which would be created north of Florin Road, would reduce the peak 100-year flow in Laguna Creek through the study area during mining to 650 cfs. This flow results in the same floodplain as experienced under pre-project conditions, and there should be no flood impacts to adjoining properties during mining.

POST-MINING MITIGATION

Expansion and restoration of the Laguna Creek corridor will proceed following the plans prepared by LSA with the completion of the Phase 1 mining excavation. The restoration plan concept was shown in Figure 6 and was modeled using the RAS model previously developed by the County and WYA. The system of terraces proposed between bank and channel invert provide a channel with a varying flow area. The terraces and marsh lands along the creek will provide an increased flow area than exists now. Hydraulic grade lines will be maintained similar to present conditions so as not to negatively impact the creek downstream or upstream and assure that water levels are maintained in the Laguna Creek corridor upstream of Florin Road.

A permanent two (2) foot-high berm, two (2) feet higher than the computed 100-year water surface profile, will be constructed along the east edge of the reclaimed setback and along the western portion of the south property line, Figure 5. The berms will be constructed of overburden compacted to 90%. Upon completion of excavation and the final sloping and reclamation of the project site, a side channel weir structure will be constructed just south of where the creek turns 90 degrees to the south. The berm shall be riprapped for approximately 100 feet upstream and downstream of the side channel weir structure. During a projected 100-year event, the weir would divert a peak flow of about 1,030 cfs and approximately 700 acre feet into the reclaimed project site which will have an estimated detention storage capacity of over 3,900 acre feet. The weir length would be 200 feet with a crest elevation of 107.8 feet.

Velocity distributions and changes in velocities with the permanent flood control berm and changing flow widths created by the expansion of the creek corridor are shown in Table 6. These are preliminary and can be used to evaluate and complete designs and will be modified to match the restoration plan design as it is finalized.

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LEGEND

FLOODPLAIN LINE

N

0 250 500

SCALE IN FEET

Figure 12

Sacramento Aggregates
Mining Expansion
PROPOSED TEMPORARY BERM

WEST YOST ASSOCIATES
Consulting Engineers

LEGEND

TEMPORARY DETENTION BASIN

N

0 400 800

SCALE IN FEET

Figure 13
Sacramento Aggregates
Mining Expansion
TEMPORARY DETENTION BASIN
MITIGATION (EXISTING MINING AREA IX)

WEST YOST ASSOCIATES
Consulting Engineers

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With the proposed post-mining mitigation, the peak 100-year flow in the Laguna Creek through the study area would be reduced to 650 cfs, a flow that results in a floodplain similar as experienced under pre-project conditions and there should be no flood impact to adjoining properties following reclamation. At station 58803, can increase in water surface elevation of 0.1 foot is shown. Final design of the creek corridor plan will be modified to result in no increase.

Table 5. Mining Expansion – South of Florin Road
100-Year Water Surface Elevations under Pre-mining Conditions and with North Weir Mitigation

Station	Pre-Mining Conditions	With North Weir Mitigation
60803	110.6	109.8
60773	110.7	109.8
60584	110.5	109.6
60403	110.2	109.5
60003	109.6	109.3
59603	109.1	109.1
59584	109.1	109.1
59203	108.8	108.8
58803	108.1	108.1
58584	107.9	107.9
58184	107.5	107.1
57919	107.0	106.4

Notes:
(1) Conceptual design only, field surveys needed for final design.
(2) Stationing is along Laguna Creek from Florin Road south to the mining expansion area boundary.

Table 6. Mining Expansion – South of Florin Road
100-Year Water Surface Elevations with Creek Corridor Expansion and Permanent Flood Control Berms

Station	Reconstruction Plan		
	Water Surface Elevation, ft		
	Pre Mining	Reconstruction Plan	Velocity (ft/sec.)
60803	110.6	109.6	2.6
60773	110.7	109.6	1.0
60584	110.5	109.6	0.6
60403	110.2	109.6	1.0
Lat Weir	—	—	—
60003	109.6	109.3	
59603	109.1	—	0.30
59584	109.1	109.1	1.4
59203	108.8	108.8	0.3
58803	108.1	108.2	3.8
58584	107.9	107.5	1.2
58184	107.5	107.2	3.0
57919	107.0	106.4	2.6

Notes:
(1) Conceptual design only, field surveys needed for final design.
(2) Stationing is along Laguna Creek from Florin Road south to the mining expansion area boundary.

SUMMARY OF IMPACTS

The drainage analysis for the mining expansion area was directed toward areas identified as having potential impact on the creek, on drainage within the study area and off-site impacts either upstream or downstream. The analysis addressed:

1. Potential impacts on the physical Laguna Creek.
2. Potential impacts on the Laguna Creek floodplain including loss of storage.
3. Potential impacts due to the mining operation proximity to the creek.
4. Potential impacts on the project site drainage and runoff to the creek.
5. Potential impacts to the Florin Road Laguna Creek bridge.
6. Potential impacts from post-mining conditions

POTENTIAL IMPACTS TO LAGUNA CREEK

Within the mining expansion area, the mining excavation will be east of the creek. The plan is to maintain the edge of excavation 50 feet from the creek. No direct encroachment into the creek is planned. There will be no need for mitigation work affecting the creek upstream or downstream of the site.

POTENTIAL IMPACTS TO THE LAGUNA CREEK FLOODPLAIN

Most of the project site lies within the Laguna Creek floodplain. With construction of the temporary berm during mining, the natural floodplain on the project site will be lost. The proposed temporary detention basin north of Florin Road in Phase IX will mitigate for the loss of natural floodplain storage.

POTENTIAL IMPACTS DURING MINING IN PROXIMITY TO THE CREEK

During a 100-year storm runoff, the total flow in Laguna Creek passing under Florin Road would be about 1,800 cfs. The hydraulic analysis shows that without mitigation about 500 cfs or 250 acre feet would likely flow into the excavation during a 100-year event. Overbank flow begins at about 100 cfs. Without mitigation a storm event with a frequency of 5-year or greater will cause some flooding in the mining excavation. The proposed temporary berms along the east side of the creek and along the western portion of the south property line and the proposed temporary detention basin north of Florin Road in Phase IX will mitigate for these potential impacts by diverting the potential project site overbank flow to the temporary detention basin north of Florin Road.

POTENTIAL IMPACTS ON PROJECT SITE DRAINAGE

Local drainage within the mining operation will be collected in the excavation and will not be released to the creek. If necessary, stormwater collected on the project site will be pumped to the existing settling ponds north of Florin Road via the conveyor tunnel under Florin Road. Sloping the bottom of the excavation during reclamation to the southwest for drainage will retain all stormwater from direct rainfall on-site and result in the development of seasonal marsh in the southwest corner of the project site. Outside of the project site other land will drain to the creek as it does at present.

POTENTIAL IMPACTS TO THE FLORIN ROAD LAGUNA CREEK BRIDGE

The hydraulic analysis shows that flow rates, flow velocities and potential scour velocities are essentially the same as the existing situation, and with the proposed mitigation, the proposed activities during mining and following reclamation would not have a significant creek impact on the existing Florin Road bridge. Channel velocities at the bridge for typical small storms up to a mean annual runoff are less than one foot per second. With a 100-year runoff, the velocity at the bridge will increase to 5 feet per second with a head loss across the bridge of 0.8 feet.

POTENTIAL IMPACTS FROM POST MINING CONDITIONS

After the site has been mined, the reclamation of the site will be performed. The reclamation plan includes construction of the permanent berms along the east side of the creek and along the western portion of the south property line, construction of the side channel weir structure to divert overbank flow into the reclaimed project site, and the completion of Laguna Creek restoration plan. This planning level analyses clearly shows that the creek corridor concept will meet all objectives. The final design and a re-analyses of the resulting water surface elevations will reduce all elevations to existing conditions or lower. There also will be no impact on the creek or structures upstream or downstream of the project site.

CHAPTER 6. CONCLUSIONS

The flood and drainage analysis was prepared to address County standards, criteria and policies and to provide both protection and mitigation as needed for a successful project. Conclusions that resulted from the drainage analysis include:

1. All mining and construction activities should avoid contact with Laguna Creek. Protection of the creek corridor should be paramount.
2. Overbank flow to the project site is estimated to begin at about 100 cfs on pages 5-7 or less than a 5-year frequency event.
3. The recommended treatment of the Laguna Creek corridor is to construct a temporary berm along the east bank to protect the mining excavation from overbank flows. The primary purpose of this berm is to protect against erosion of the mining excavation slope and the formation of head cuts that could migrate upstream and damage the creek channel and adjacent structures. The top of the berm shall be elevation 112.5 feet at Florin Road tapering to 109 feet at the south property line.
4. It will be necessary to construct a berm along the south property boundary to stop offsite runoff from large storm events from entering the mining expansion site from the south. The berm shall be constructed to an elevation of 108 feet.
5. During the mining period, there is a potential loss of 250 acre feet of floodplain storage during a 100-year event. The proposed temporary detention basin in existing the Phase IX area north of Florin Road would mitigate this loss of storage.
6. The proposed mining expansion will have no impact on the Laguna Creek bridge at Florin Road. The project will completely avoid the creek and the hydraulic analysis shows that flow velocities are similar to pre-project conditions and are well within the acceptable limits for protection from bridge scour.
7. Implementation of the proposed reclamation plan, diversion of overbank flows into the reclaimed site and restoration of the Laguna Creek corridor is expected to result in creek levels that are equal to or lower than existing conditions with no impact on the creek or structures upstream or downstream of the project site.
8. Sloping the bottom of the excavation during reclamation to the southwest will retain all stormwater from direct rainfall on-site, provide adequate on-site treatment of stormwater, will not downgrade downstream water quality, and will result in the development of seasonal marsh in the southwest corner of the project site.

APPENDIX A

APPENDED HYDRAULIC ANALYSIS, HEC-RAS RESULTS

As reported in the main report, the hydraulic analyses were conducted using the Corps of Engineers HEC-RAS River Analysis System. Model output for the existing conditions, proposed project and proposed restoration plan are included in this appendix. During design of the proposed facilities, the models will be updated to represent the dimensions, berms and weir details of the final adopted plan.

Figure A-1 on the following page is a site plan with the Laguna Creek stationing used in the RAS modeling.

N

0 250 500

SCALE IN FEET

Figure A-1

Sacramento Aggregates Mining Expansion

CROSS SECTION STATIONING

WEST YOST ASSOCIATES
Consulting Engineers

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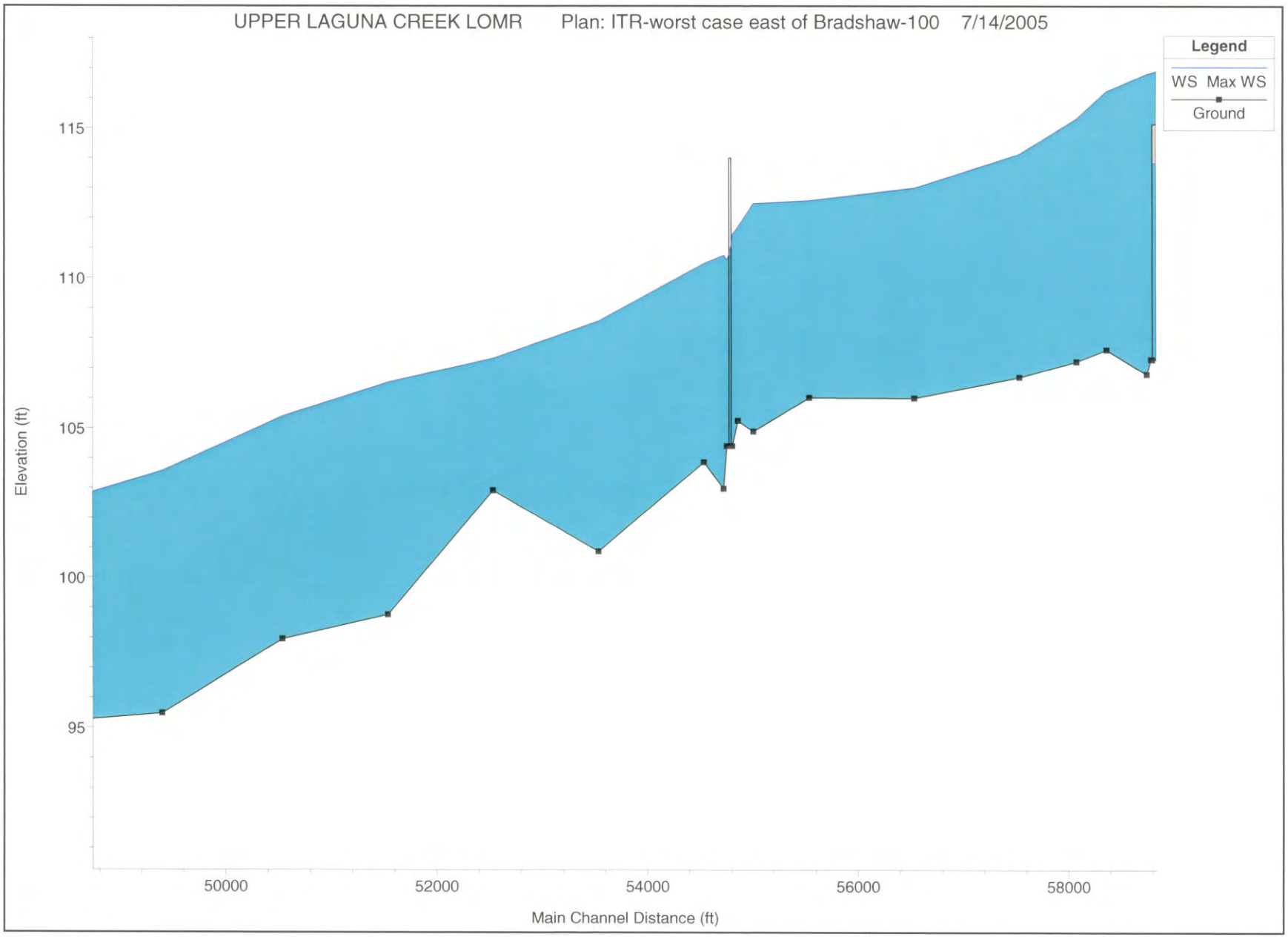
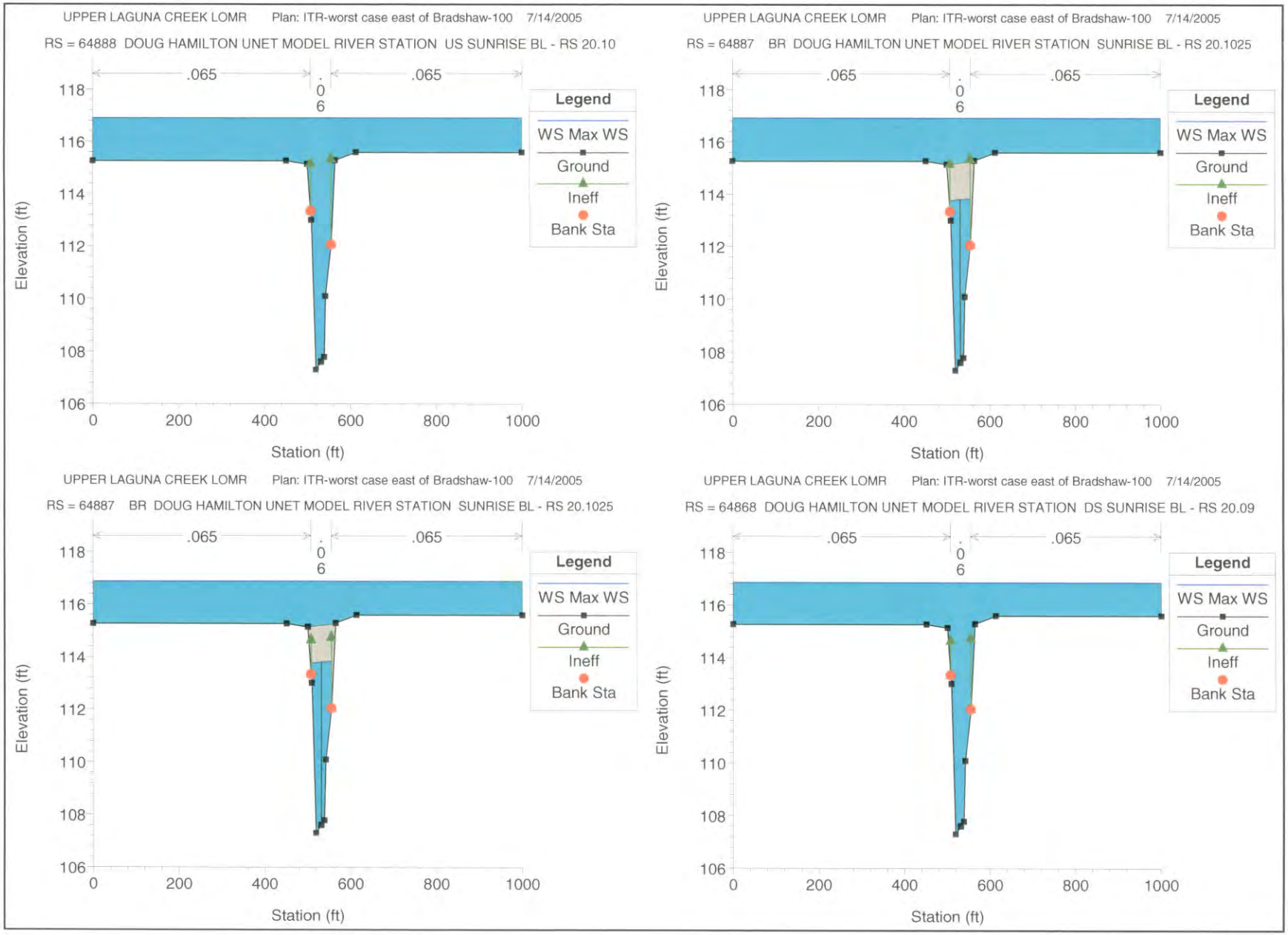
EXISTING CONDITIONS

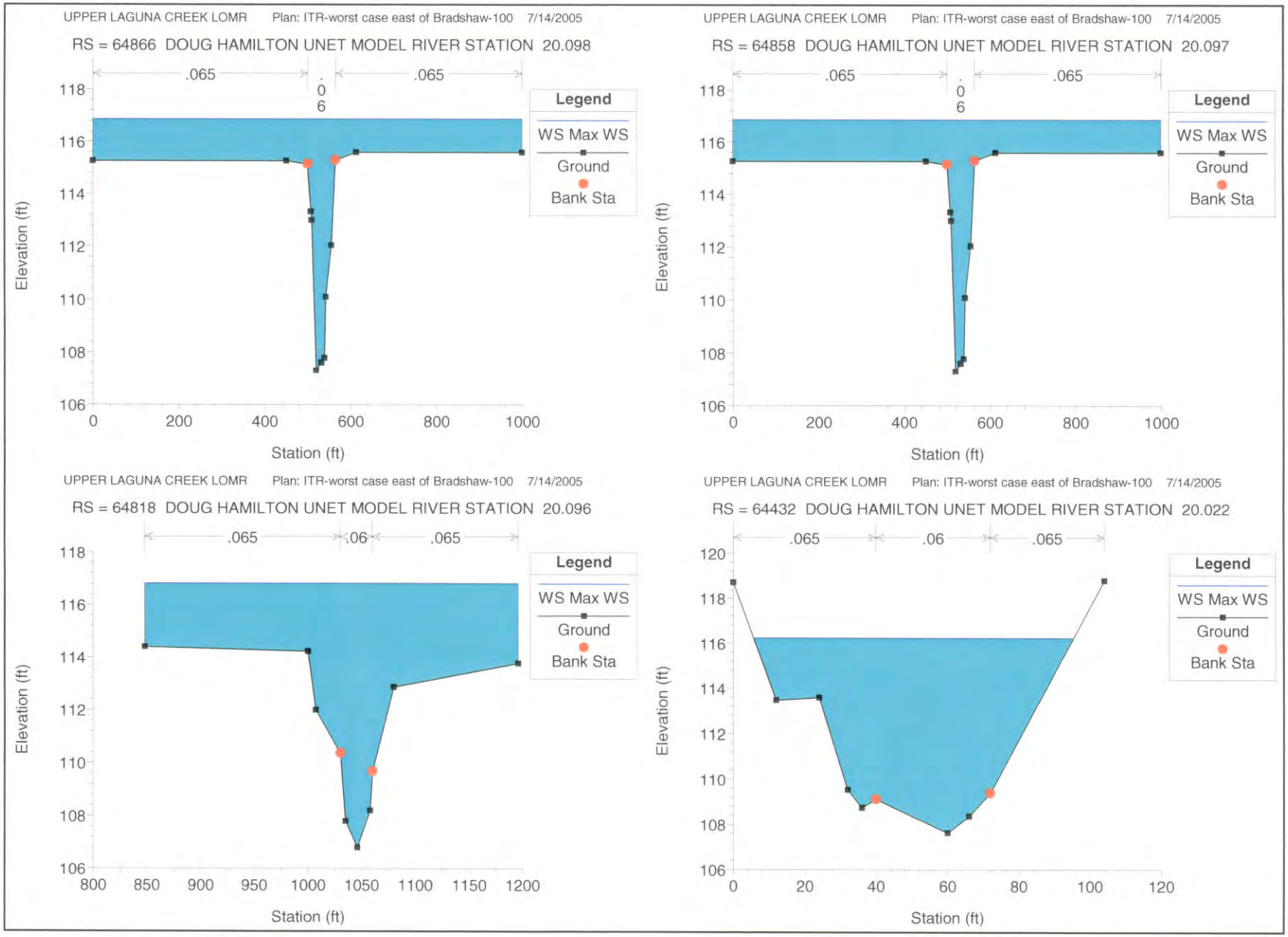
The hydraulic analysis of existing condition in the expansion study area were included in Chapter 4 and in Table 4 of the main report. HEC-RAS output, profile summary table and Laguna Creek cross sections are shown on the following pages.

HEC-RAS Plan: ITR-east River: UPPER LAGUNA CRK Reach: UPPER LAGUNA CRK Profile: Max WS

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)	
UPPER LAGUNA CRK	64888	Max WS	1592.27	107.30	116.90	112.55	116.92	0.000452	1.84	1810.84	1000.00	0.12
UPPER LAGUNA CRK	64887		Bridge									
UPPER LAGUNA CRK	64868	Max WS	1592.27	107.30	116.85		116.88	0.000479	1.90	1764.64	1000.00	0.12
UPPER LAGUNA CRK	64866	Max WS	1592.20	107.30	116.85		116.88	0.000474	1.78	1764.44	1000.00	0.12
UPPER LAGUNA CRK	64858	Max WS	1592.20	107.30	116.85		116.87	0.000477	1.78	1760.54	1000.00	0.13
UPPER LAGUNA CRK	64818	Max WS	1592.09	106.80	116.81		116.85	0.000383	2.04	1321.58	348.00	0.12
UPPER LAGUNA CRK	64432	Max WS	1587.77	107.63	116.24		116.46	0.001938	4.29	467.31	89.66	0.27
UPPER LAGUNA CRK	64148	Max WS	1805.67	107.23	115.31		115.66	0.003357	5.39	420.58	86.64	0.35
UPPER LAGUNA CRK	63606	Max WS	1803.75	106.70	114.12		114.22	0.001726	3.09	901.03	484.63	0.24
UPPER LAGUNA CRK	62606	Max WS	1831.96	106.00	113.00		113.03	0.000622	1.80	1284.19	339.34	0.14
UPPER LAGUNA CRK	61606	Max WS	1860.54	106.02	112.58		112.60	0.000248	1.26	2120.42	710.93	0.09
UPPER LAGUNA CRK	61075	Max WS	1876.44	104.89	112.48		112.49	0.000121	0.95	2702.92	633.00	0.07
UPPER LAGUNA CRK	60930	Max WS	1876.41	105.25	111.71		112.21	0.007884	5.71	328.67	77.06	0.49
UPPER LAGUNA CRK	60875	Max WS	1876.41	104.40	111.44	108.62	111.85	0.005310	5.16	363.69	72.60	0.41
UPPER LAGUNA CRK	60855		Bridge									
UPPER LAGUNA CRK	60825	Max WS	1876.36	104.40	110.58		111.17	0.008573	6.17	304.01	66.70	0.51
UPPER LAGUNA CRK	60795	Max WS	1876.41	102.97	110.75		110.77	0.000537	1.68	1609.01	551.00	0.13
UPPER LAGUNA CRK	60606	Max WS	1876.32	103.86	110.48		110.54	0.002046	2.96	1566.97	1813.45	0.25
UPPER LAGUNA CRK	59606	Max WS	1882.99	100.87	108.57		108.60	0.001973	2.25	1626.83	1656.89	0.22
UPPER LAGUNA CRK	58606	Max WS	1887.85	102.92	107.33		107.34	0.000567	1.10	2236.57	1255.82	0.11
UPPER LAGUNA CRK	57606	Max WS	1893.90	98.76	106.52		106.55	0.001054	2.23	2144.41	2009.88	0.18


UPPER LAGUNA CREEK LOMR
Plan: ITR-worst case east of Bradshaw-100
7/14/2005
Legend
WS Max WS
Ground
115
110
105
100
95
Elevation (ft)
50000
52000
54000
56000
58000
Main Channel Distance (ft)


UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 64888 DOUG HAMILTON UNET MODEL RIVER STATION US SUNRISE BL - RS 20.10
.065
.06
.065
Legend
WS Max WS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 64887 BR DOUG HAMILTON UNET MODEL RIVER STATION SUNRISE BL - RS 20.1025
UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 64887 BR DOUG HAMILTON UNET MODEL RIVER STATION SUNRISE BL - RS 20.1025
UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 64868 DOUG HAMILTON UNET MODEL RIVER STATION DS SUNRISE BL - RS 20.09


UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 64866 DOUG HAMILTON UNET MODEL RIVER STATION 20.098
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.06
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 64858 DOUG HAMILTON UNET MODEL RIVER STATION 20.097
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.06
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Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 64818 DOUG HAMILTON UNET MODEL RIVER STATION 20.096
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.06
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Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 64432 DOUG HAMILTON UNET MODEL RIVER STATION 20.022
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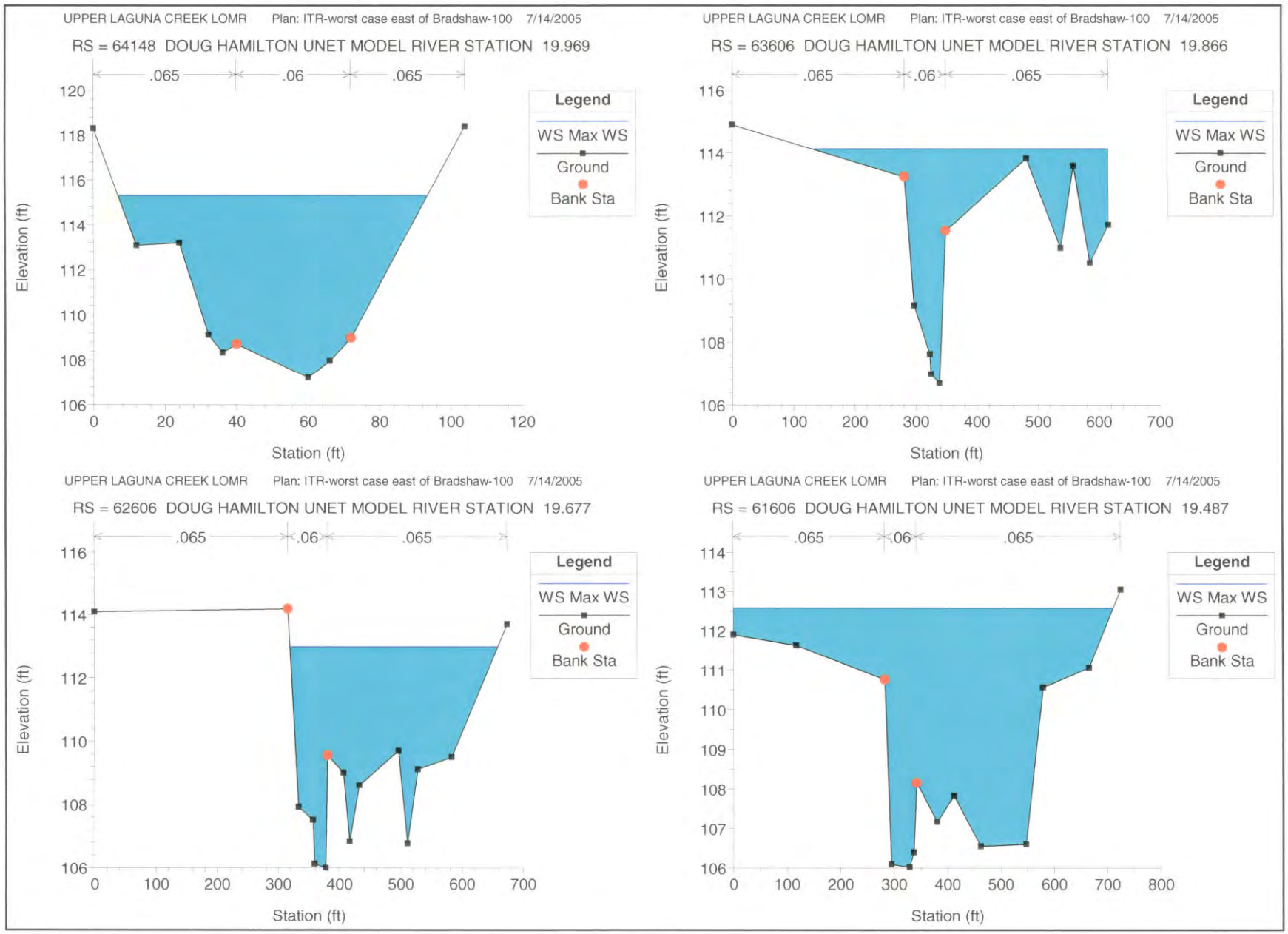
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)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RS = 64148 DOUG HAMILTON UNET MODEL RIVER STATION 19.969
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.06
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 63606 DOUG HAMILTON UNET MODEL RIVER STATION 19.866
.065
.06
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 62606 DOUG HAMILTON UNET MODEL RIVER STATION 19.677
.065
.06
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 61606 DOUG HAMILTON UNET MODEL RIVER STATION 19.487
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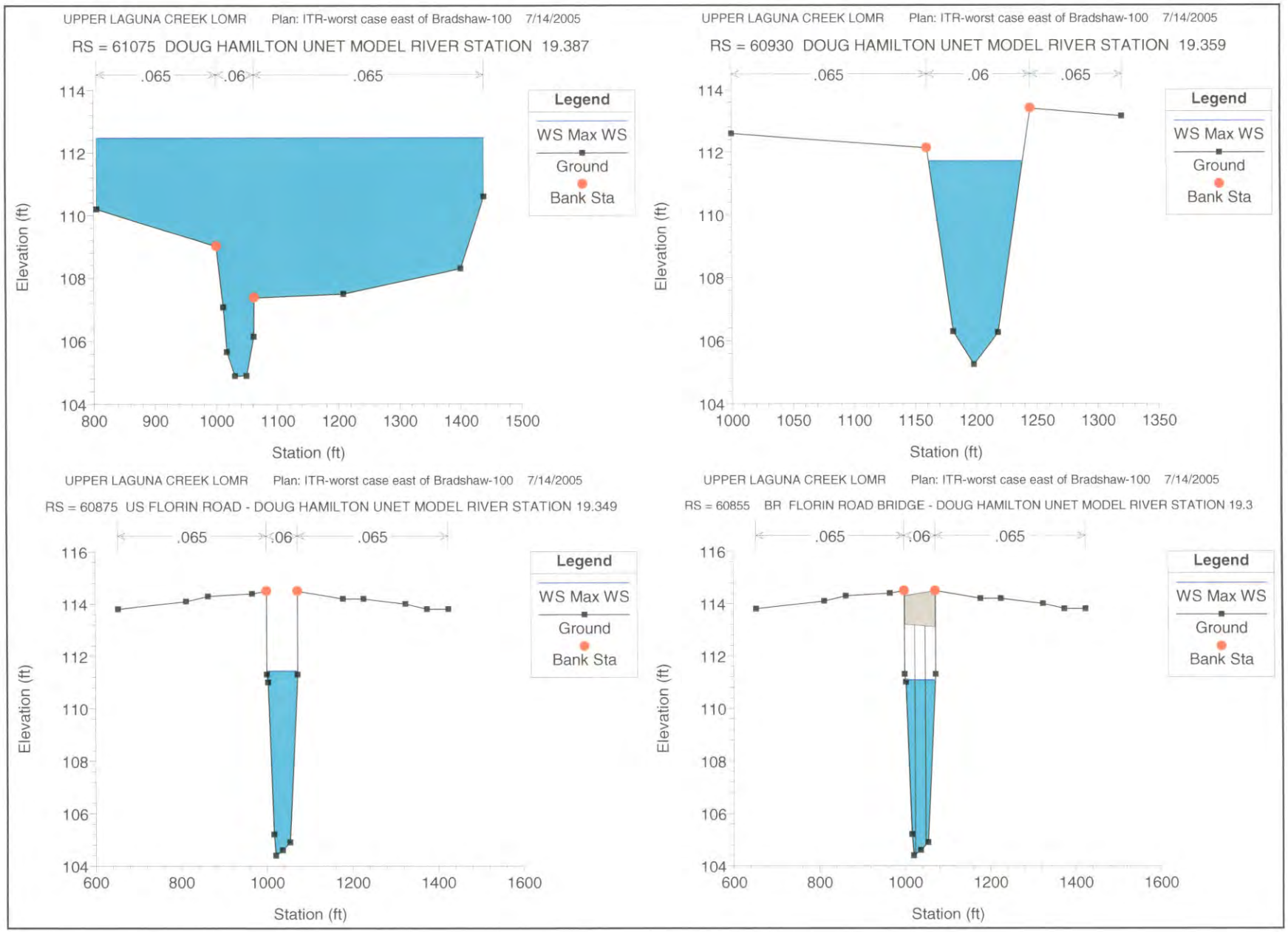
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)


UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 61075 DOUG HAMILTON UNET MODEL RIVER STATION 19.387
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.06
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 60930 DOUG HAMILTON UNET MODEL RIVER STATION 19.359
.065
.06
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 60875 US FLORIN ROAD - DOUG HAMILTON UNET MODEL RIVER STATION 19.349
.065
.06
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 60855 BR FLORIN ROAD BRIDGE - DOUG HAMILTON UNET MODEL RIVER STATION 19.3
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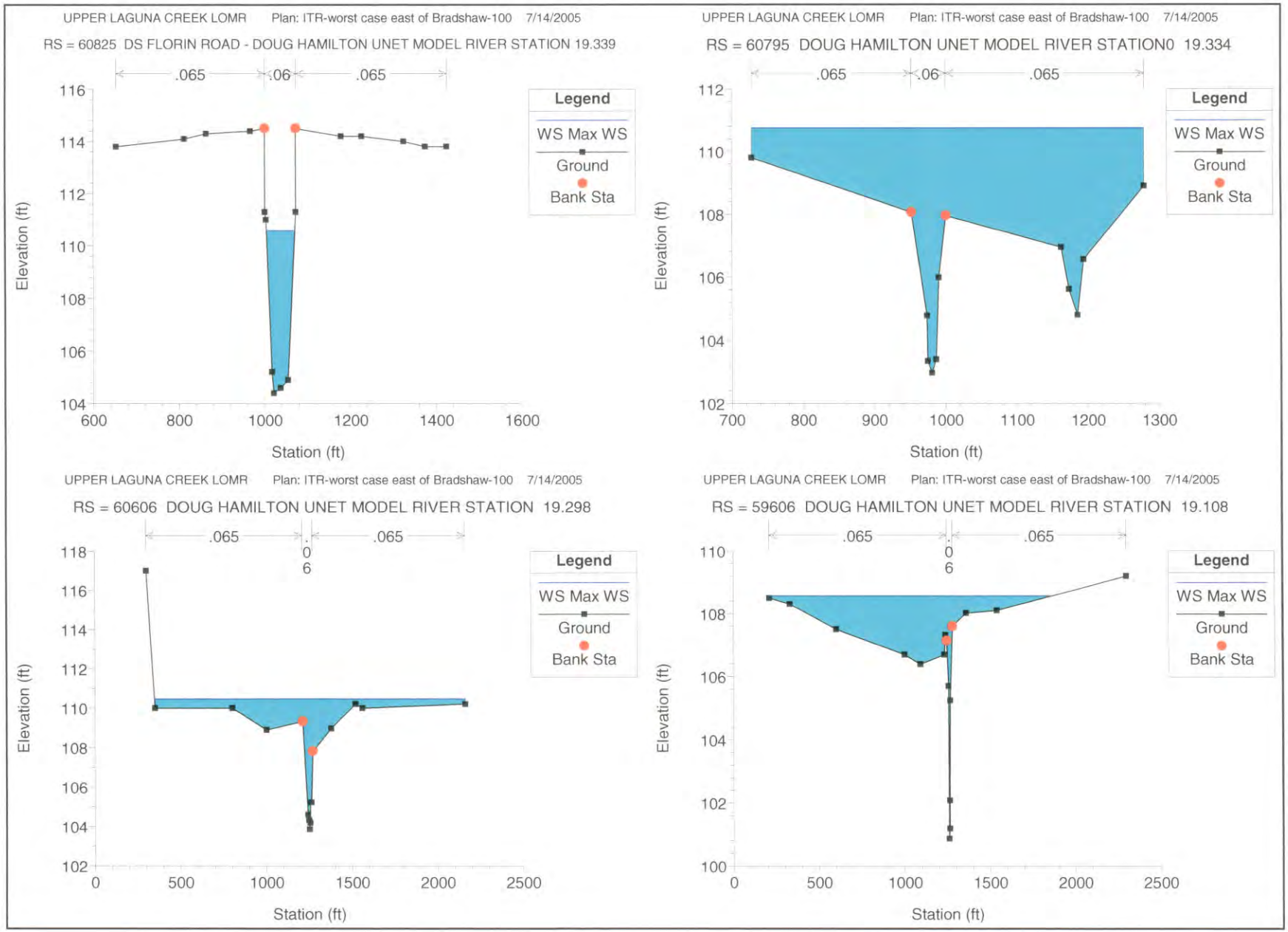
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)


UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 60825 DS FLORIN ROAD - DOUG HAMILTON UNET MODEL RIVER STATION 19.339
.065
.06
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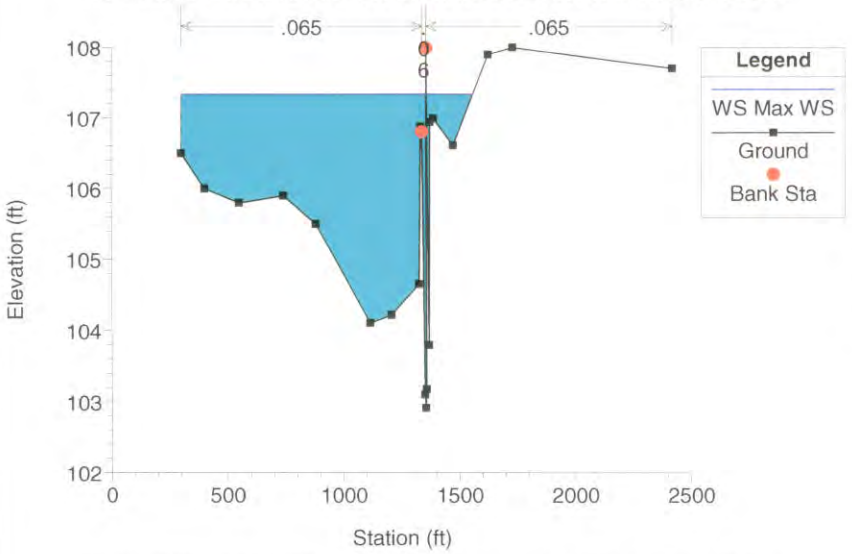
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 60795 DOUG HAMILTON UNET MODEL RIVER STATION0 19.334
.065
.06
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 60606 DOUG HAMILTON UNET MODEL RIVER STATION 19.298
.065
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005
RS = 59606 DOUG HAMILTON UNET MODEL RIVER STATION 19.108
.065
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)

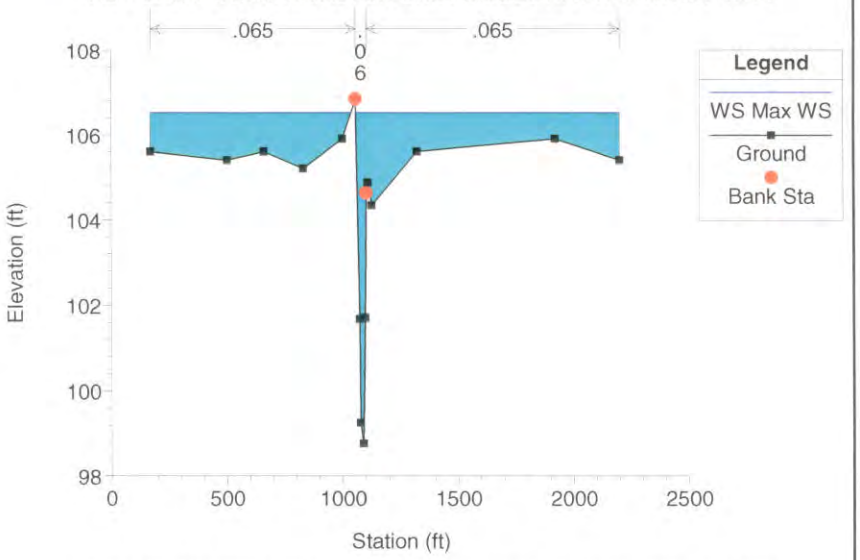
UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005

RS = 58606 DOUG HAMILTON UNET MODEL RIVER STATION 18.919



UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005

RS = 57606 DOUG HAMILTON UNET MODEL RIVER STATION 18.73



UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005

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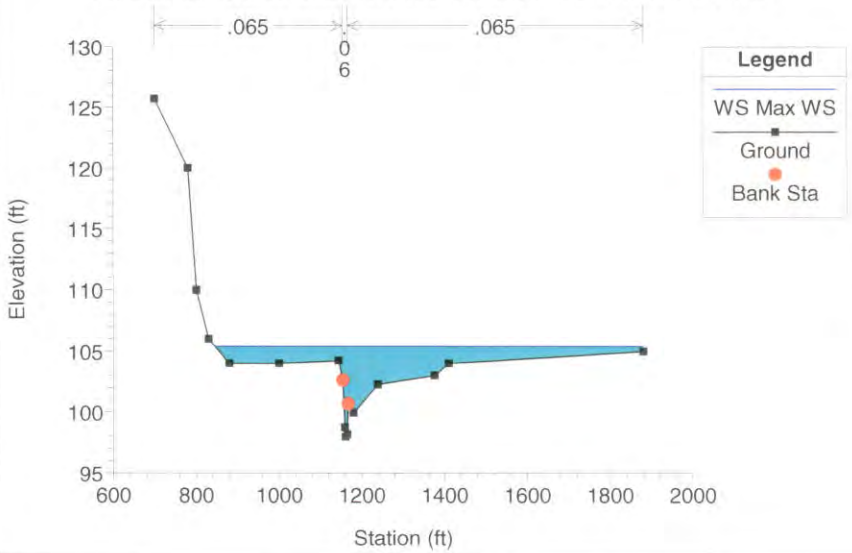

UPPER LAGUNA CREEK LOMR Plan: ITR-worst case east of Bradshaw-100 7/14/2005

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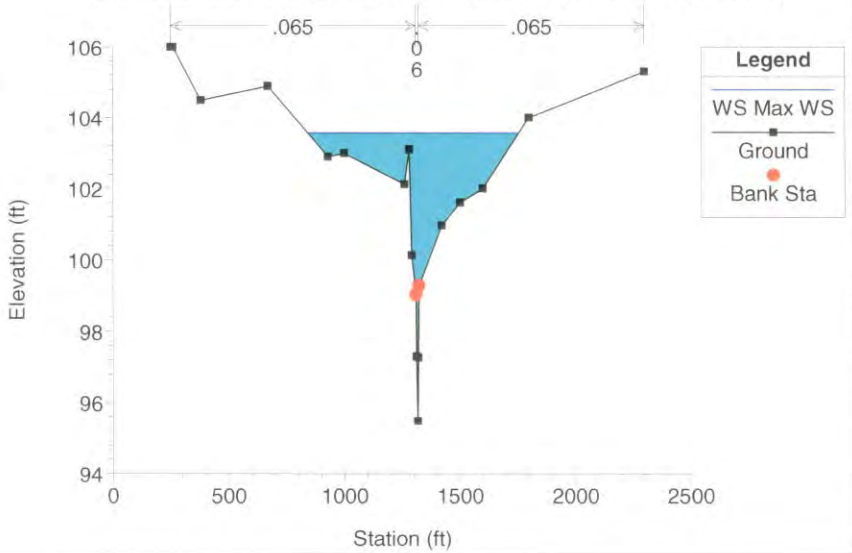
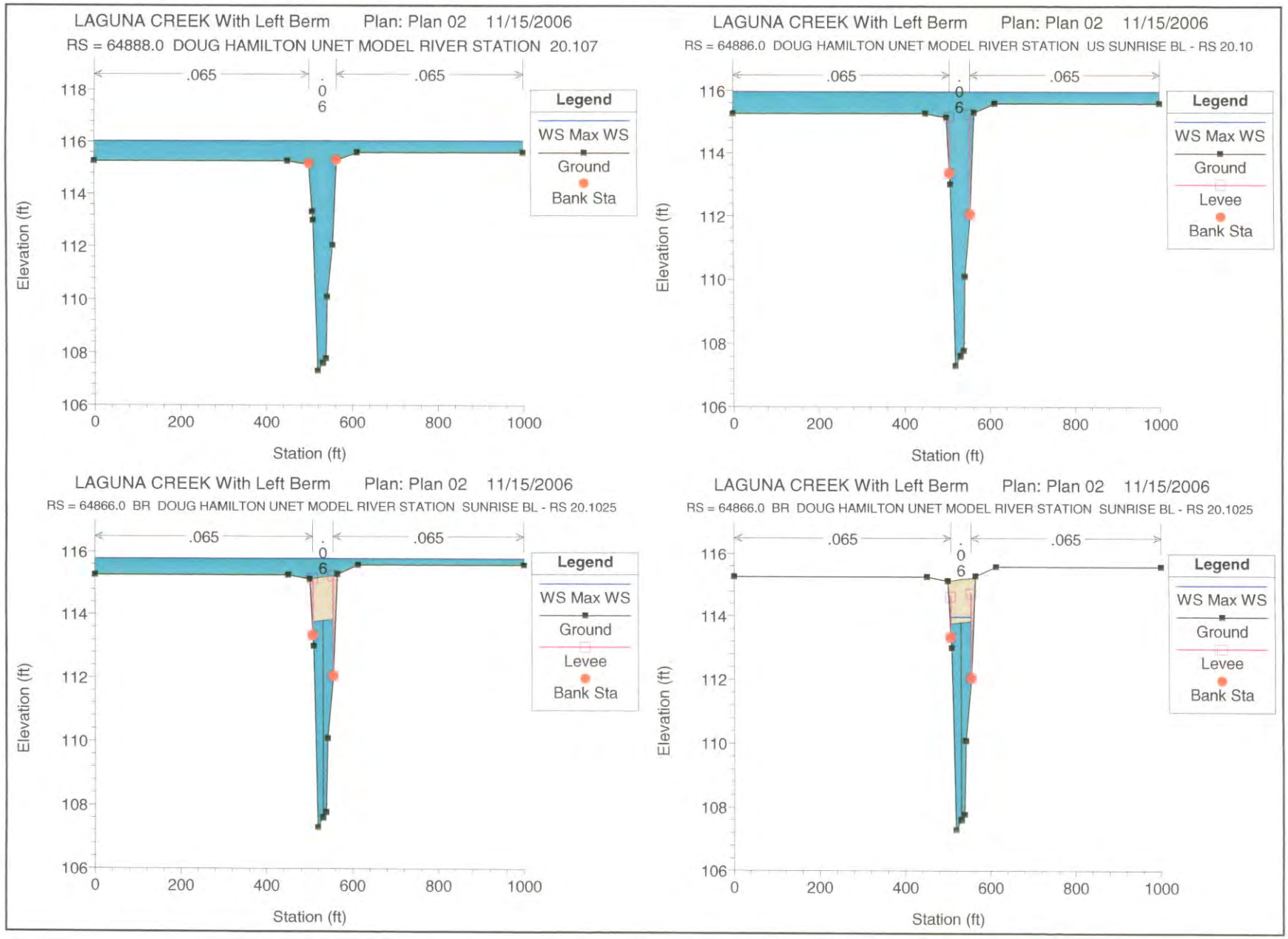


PROPOSED PROJECT

The hydraulic analysis of proposed project conditions in the expansion study area were included in Chapter 5 and in Table 5 of the main report. HEC-RAS output, profile summary table and Laguna Creek cross sections are shown on the following pages.

HEC-RAS Plan: Plan 02 River: UPPER LAGUNA CRK Reach: UPPER LAGUNA CRK Profile: Max WS

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)	
UPPER LAGUNA CRK	65509.0	Max WS	1580.75	106.70	117.82		117.85	0.000437	1.91	1282.34	391.00	0.12
UPPER LAGUNA CRK	65454.0	Max WS	1580.70	106.70	117.77		117.84	0.000924	2.81	1390.60	1236.09	0.17
UPPER LAGUNA CRK	65436.0	Max WS	1580.48	108.60	117.62	113.92	117.81	0.002144	3.61	683.07	1000.00	0.25
UPPER LAGUNA CRK	65421.0		Bridge									
UPPER LAGUNA CRK	65406.0	Max WS	1578.66	108.60	116.78		117.10	0.004009	4.55	347.11	62.20	0.34
UPPER LAGUNA CRK	65371.0	Max WS	1578.36	107.93	116.73	112.87	116.98	0.002595	4.03	391.61	62.36	0.28
UPPER LAGUNA CRK	65343.5		Bridge									
UPPER LAGUNA CRK	65316.0	Max WS	1577.01	107.93	116.44		116.72	0.002996	4.22	373.64	62.36	0.30
UPPER LAGUNA CRK	65314.0	Max WS	1577.13	107.93	116.44		116.71	0.002875	4.22	375.18	65.78	0.30
UPPER LAGUNA CRK	65306.0	Max WS	1577.01	107.93	116.41		116.46	0.000922	2.38	1333.77	1000.00	0.17
UPPER LAGUNA CRK	65166.0	Max WS	1576.47	106.40	116.28		116.30	0.000309	1.60	2099.00	946.83	0.10
UPPER LAGUNA CRK	65016.0	Max WS	1576.34	106.20	116.25		116.26	0.000230	1.42	2252.75	888.31	0.09
UPPER LAGUNA CRK	64896.0	Max WS	1576.24	107.30	115.78		115.98	0.002964	3.92	693.24	1000.00	0.30
UPPER LAGUNA CRK	64888.0	Max WS	1576.23	107.30	115.74		115.96	0.003201	4.05	650.15	1000.00	0.31
UPPER LAGUNA CRK	64886.0	Max WS	1576.23	107.30	115.66	112.52	115.96	0.003671	4.64	573.94	1000.00	0.33
UPPER LAGUNA CRK	64866.0		Bridge									
UPPER LAGUNA CRK	64846.0	Max WS	1574.61	107.30	113.89		114.73	0.013276	7.32	215.19	47.52	0.61
UPPER LAGUNA CRK	64844.0	Max WS	1574.74	107.30	113.92		114.70	0.013722	7.07	222.67	55.67	0.62
UPPER LAGUNA CRK	64836.0	Max WS	1571.31	107.30	113.72		114.58	0.015642	7.43	211.62	54.24	0.66
UPPER LAGUNA CRK	64826		Lat Struct									
UPPER LAGUNA CRK	64796.0	Max WS	995.66	106.80	114.14		114.29	0.001930	3.63	418.05	195.72	0.25
UPPER LAGUNA CRK	64410.0	Max WS	448.79	107.63	113.80		113.85	0.000736	2.06	265.58	75.77	0.16
UPPER LAGUNA CRK	64126.0	Max WS	688.49	107.23	113.29		113.43	0.001885	3.26	257.39	75.15	0.25
UPPER LAGUNA CRK	63584.0	Max WS	686.88	106.70	112.33		112.41	0.001842	2.53	334.93	194.17	0.23
UPPER LAGUNA CRK	62584.0	Max WS	727.99	106.00	111.18		111.19	0.000567	1.38	705.93	294.89	0.13
UPPER LAGUNA CRK	61584.0	Max WS	769.07	106.02	110.81		110.82	0.000191	0.87	1086.67	346.64	0.08
UPPER LAGUNA CRK	61053.0	Max WS	790.74	104.89	110.73		110.74	0.000108	0.73	1596.45	633.00	0.06
UPPER LAGUNA CRK	60908.0	Max WS	790.46	105.25	110.38		110.56	0.003654	3.39	233.21	67.31	0.32
UPPER LAGUNA CRK	60853.0	Max WS	790.35	104.40	110.29	106.96	110.41	0.001827	2.77	285.03	65.20	0.23
UPPER LAGUNA CRK	60833.0		Bridge									
UPPER LAGUNA CRK	60803.0	Max WS	789.80	104.40	110.13		110.25	0.002034	2.88	274.36	64.34	0.25
UPPER LAGUNA CRK	60773.0	Max WS	789.89	102.97	110.17		110.18	0.000207	0.97	1128.16	389.00	0.08
UPPER LAGUNA CRK	60584.0	Max WS	789.26	103.86	109.95		110.02	0.001711	2.48	480.03	329.59	0.22
UPPER LAGUNA CRK	60403	Max WS	790.68	103.60	109.77		109.78	0.000656	1.51	1045.91	922.08	0.14
UPPER LAGUNA CRK	60003	Max WS	795.03	102.27	109.54		109.56	0.000547	1.54	1143.69	1037.80	0.13
UPPER LAGUNA CRK	59603	Max WS	799.26	100.93	109.37		109.38	0.000391	1.40	1318.88	1129.34	0.11
UPPER LAGUNA CRK	59584.0	Max WS	799.49	100.87	109.36		109.37	0.000500	1.30	1242.12	1132.00	0.11
UPPER LAGUNA CRK	59203	Max WS	803.73	101.71	109.10		109.12	0.000543	1.50	1238.40	1142.72	0.12
UPPER LAGUNA CRK	58803	Max WS	808.09	102.59	108.50		108.54	0.002377	2.63	768.56	1153.72	0.25
UPPER LAGUNA CRK	58584.0	Max WS	810.46	102.92	108.12		108.16	0.001143	1.78	853.60	1161.00	0.16
UPPER LAGUNA CRK	58184	Max WS	814.68	101.35	107.28		107.32	0.003042	2.84	735.98	1177.00	0.28
UPPER LAGUNA CRK	57919	Max WS	817.45	100.20	106.54		106.59	0.002550	2.66	749.10	1121.16	0.26
UPPER LAGUNA CRK	57584.0	Max WS	820.63	98.76	105.88		105.94	0.001683	2.65	857.96	1903.45	0.22
UPPER LAGUNA CRK	56584.0	Max WS	956.68	97.96	104.51		104.55	0.001812	2.80	808.10	782.01	0.22
UPPER LAGUNA CRK	55443.0	Max WS	611.90	95.48	102.88		102.90	0.000551	1.68	791.19	649.03	0.12
UPPER LAGUNA CRK	54443.0	Max WS	929.63	95.19	101.32		101.34	0.000930	1.81	1220.33	1472.25	0.16
UPPER LAGUNA CRK	53949.0	Max WS	927.06	93.50	101.08		101.08	0.000121	0.76	2492.23	1631.54	0.05
UPPER LAGUNA CRK	53849.0	Max WS	926.94	92.00	100.96	96.09	101.06	0.001422	2.58	423.32	362.08	0.18
UPPER LAGUNA CRK	53829.0		Bridge									
UPPER LAGUNA CRK	53789.0	Max WS	926.91	92.00	100.67		100.79	0.001693	2.74	343.15	96.22	0.19
UPPER LAGUNA CRK	53669.0	Max WS	926.90	93.50	100.23		100.45	0.004041	3.78	251.42	63.57	0.30
UPPER LAGUNA CRK	53389.0	Max WS	929.45	92.30	99.67		99.70	0.000872	1.96	880.93	470.00	0.14


LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
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.065
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Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 64886.0 DOUG HAMILTON UNET MODEL RIVER STATION US SUNRISE BL - RS 20.10
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.065
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Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 64866.0 BR DOUG HAMILTON UNET MODEL RIVER STATION SUNRISE BL - RS 20.1025
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.065
.06
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 64866.0 BR DOUG HAMILTON UNET MODEL RIVER STATION SUNRISE BL - RS 20.1025
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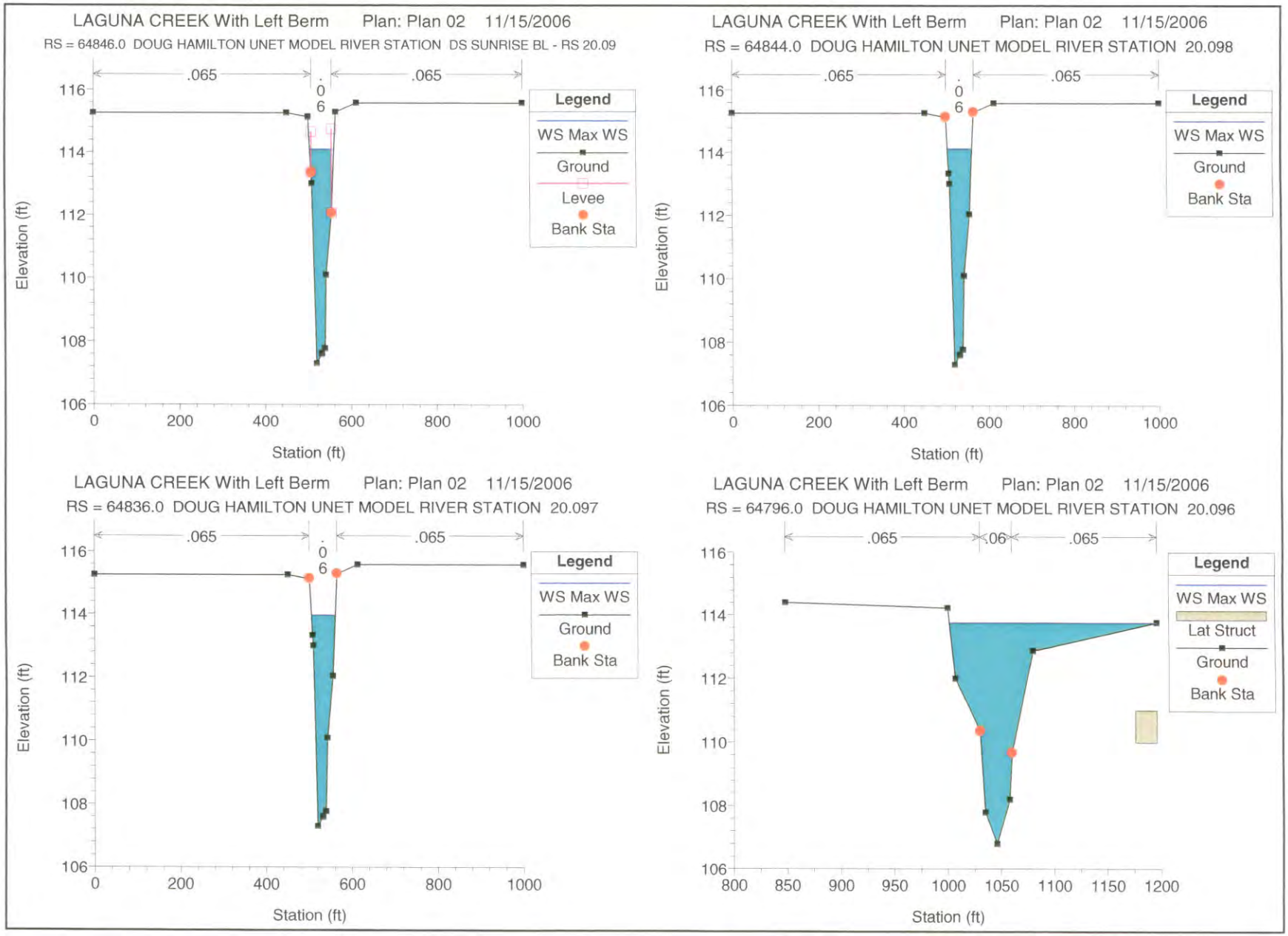
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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RS = 64846.0 DOUG HAMILTON UNET MODEL RIVER STATION DS SUNRISE BL - RS 20.09
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.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 64844.0 DOUG HAMILTON UNET MODEL RIVER STATION 20.098
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.06
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Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 64836.0 DOUG HAMILTON UNET MODEL RIVER STATION 20.097
.065
.06
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 64796.0 DOUG HAMILTON UNET MODEL RIVER STATION 20.096
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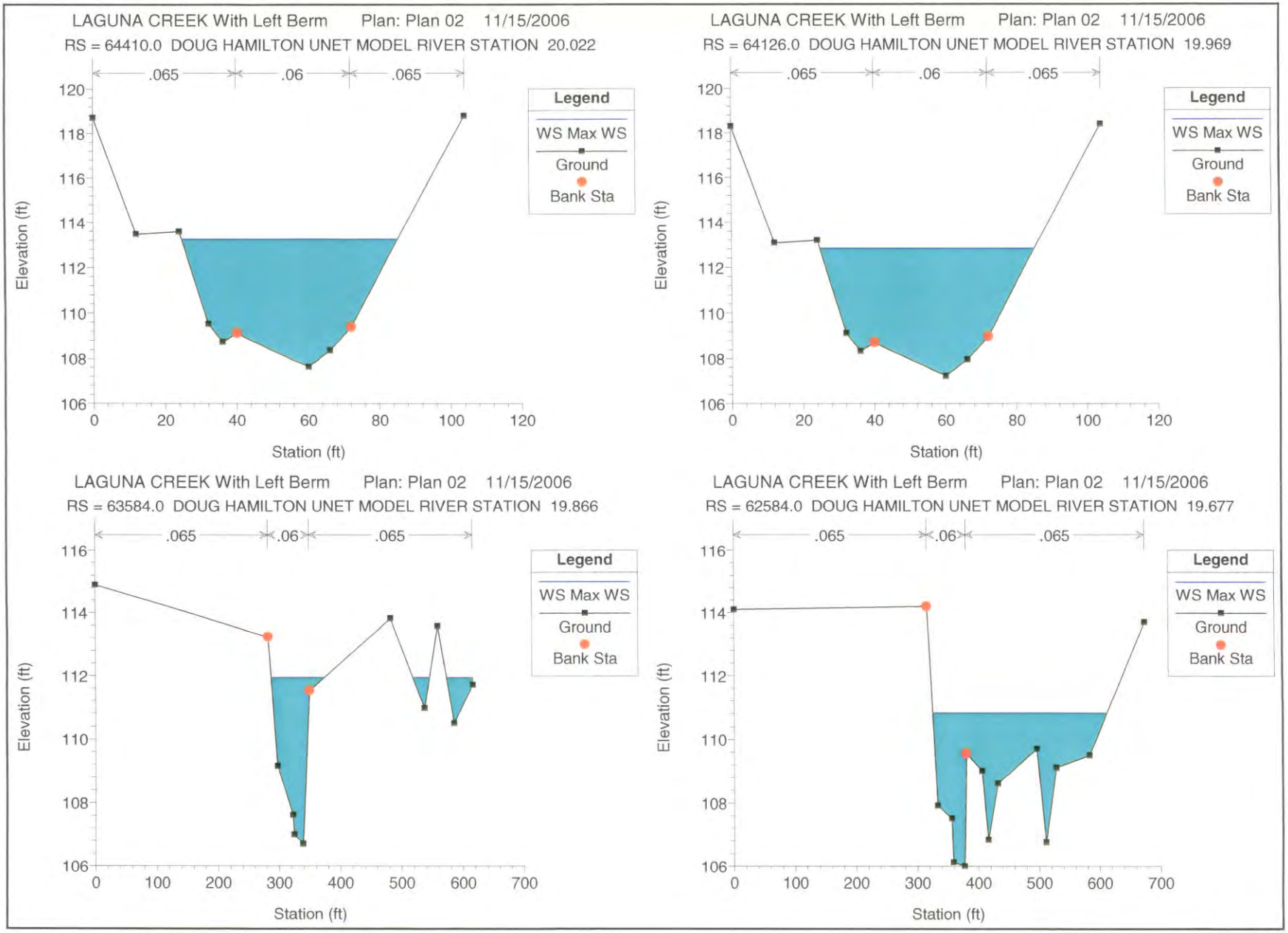
Legend
WS Max WS
Lat Struct
Ground
Bank Sta
Elevation (ft)
Station (ft)


LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 64410.0 DOUG HAMILTON UNET MODEL RIVER STATION 20.022
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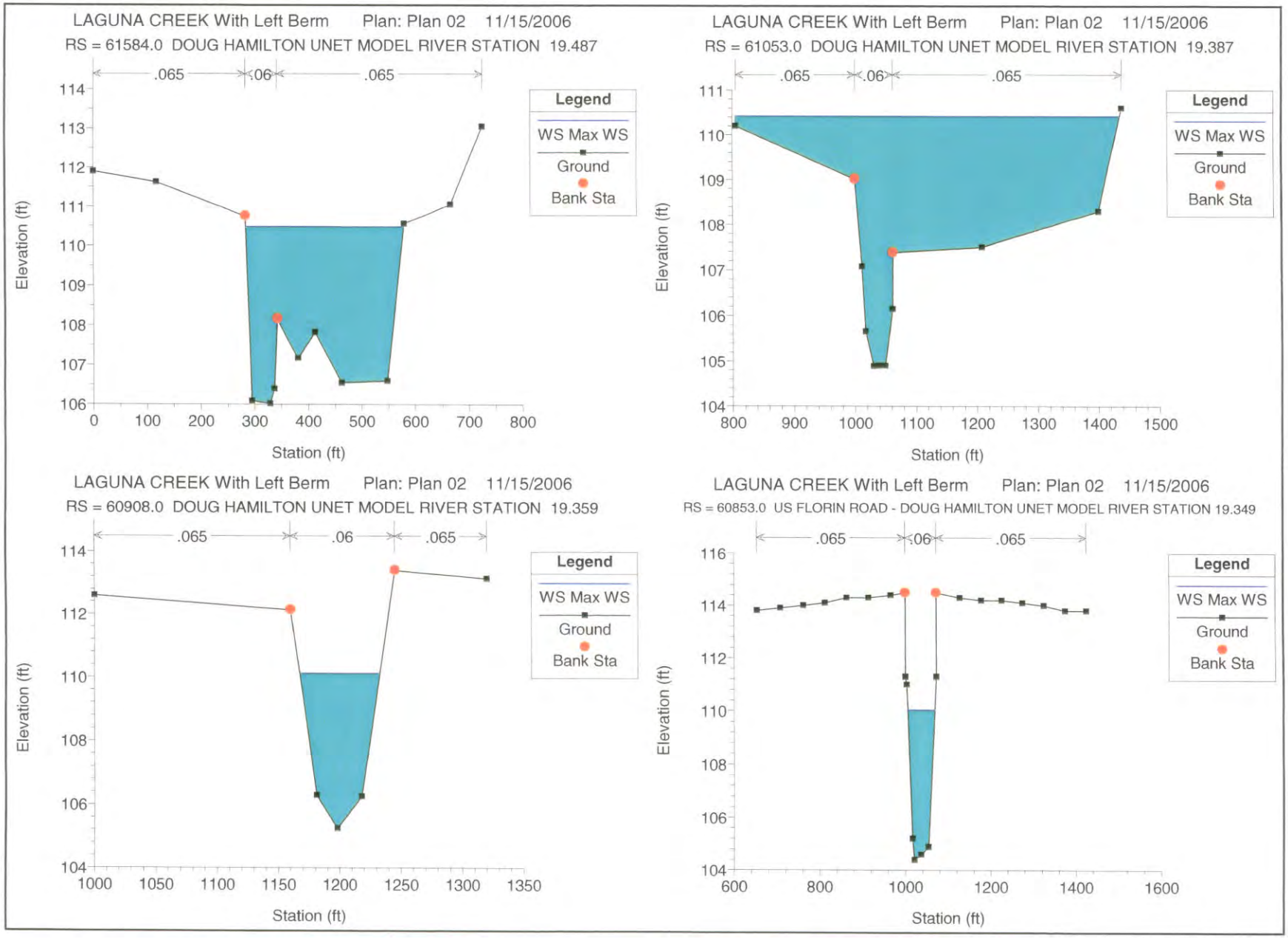
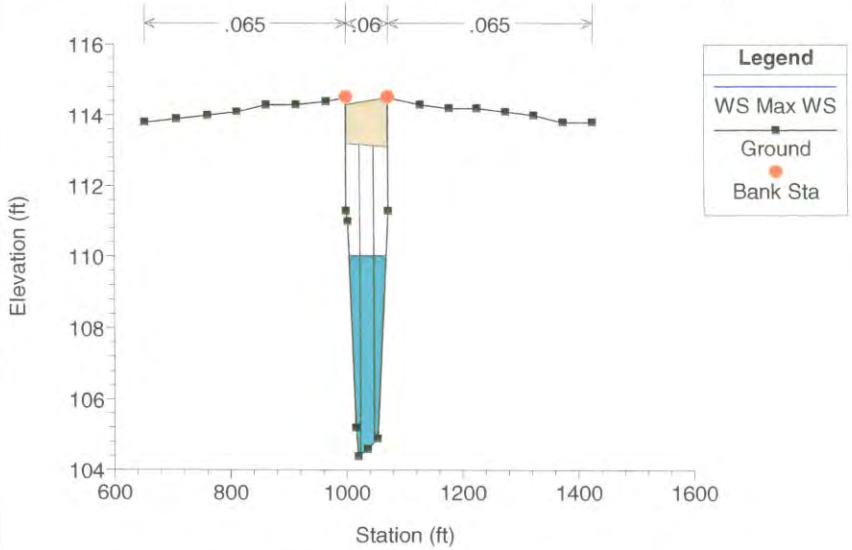
.06
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 64126.0 DOUG HAMILTON UNET MODEL RIVER STATION 19.969
.065
.06
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 63584.0 DOUG HAMILTON UNET MODEL RIVER STATION 19.866
.065
.06
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 62584.0 DOUG HAMILTON UNET MODEL RIVER STATION 19.677
.065
.06
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)


LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 61584.0 DOUG HAMILTON UNET MODEL RIVER STATION 19.487
.065
.06
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 61053.0 DOUG HAMILTON UNET MODEL RIVER STATION 19.387
.065
.06
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 60908.0 DOUG HAMILTON UNET MODEL RIVER STATION 19.359
.065
.06
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 60853.0 US FLORIN ROAD - DOUG HAMILTON UNET MODEL RIVER STATION 19.349
.065
.06
.065
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)

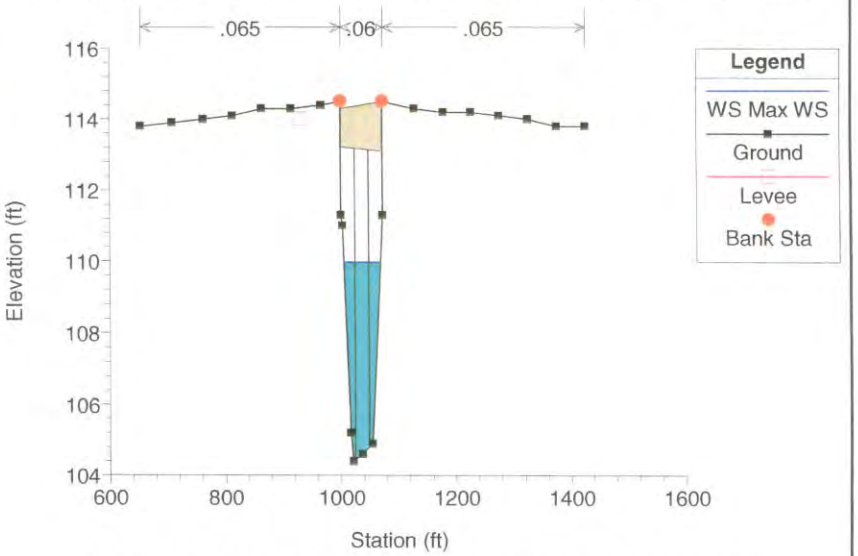
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006

RS = 60833.0 BR FLORIN ROAD BRIDGE - DOUG HAMILTON UNET MODEL RIVER STATION 19.3



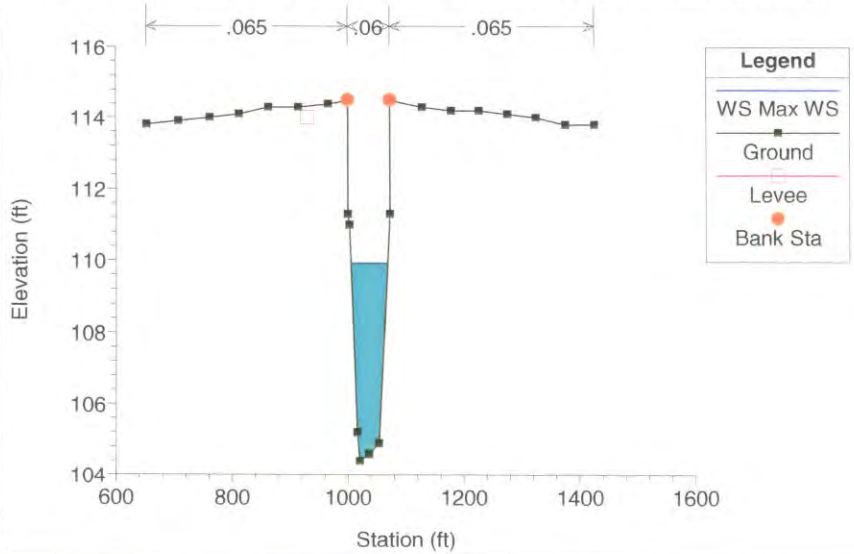
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006

RS = 60833.0 BR FLORIN ROAD BRIDGE - DOUG HAMILTON UNET MODEL RIVER STATION 19.3



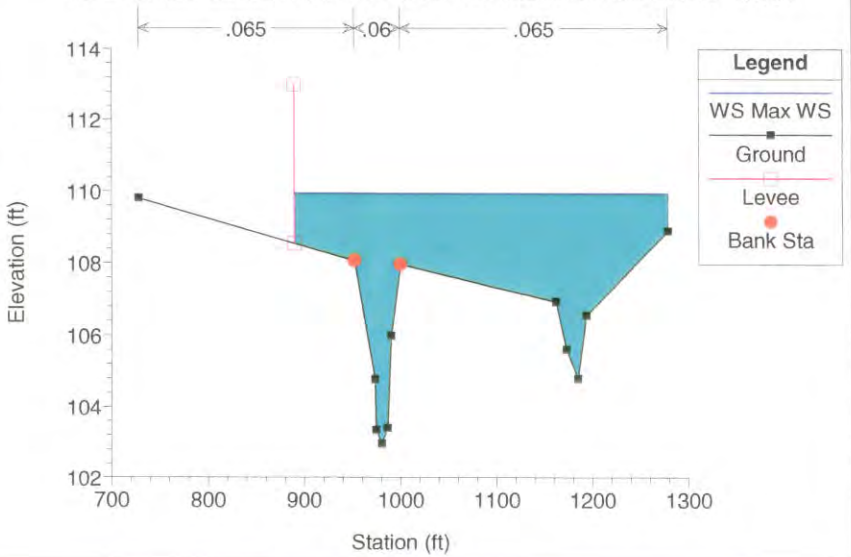
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006

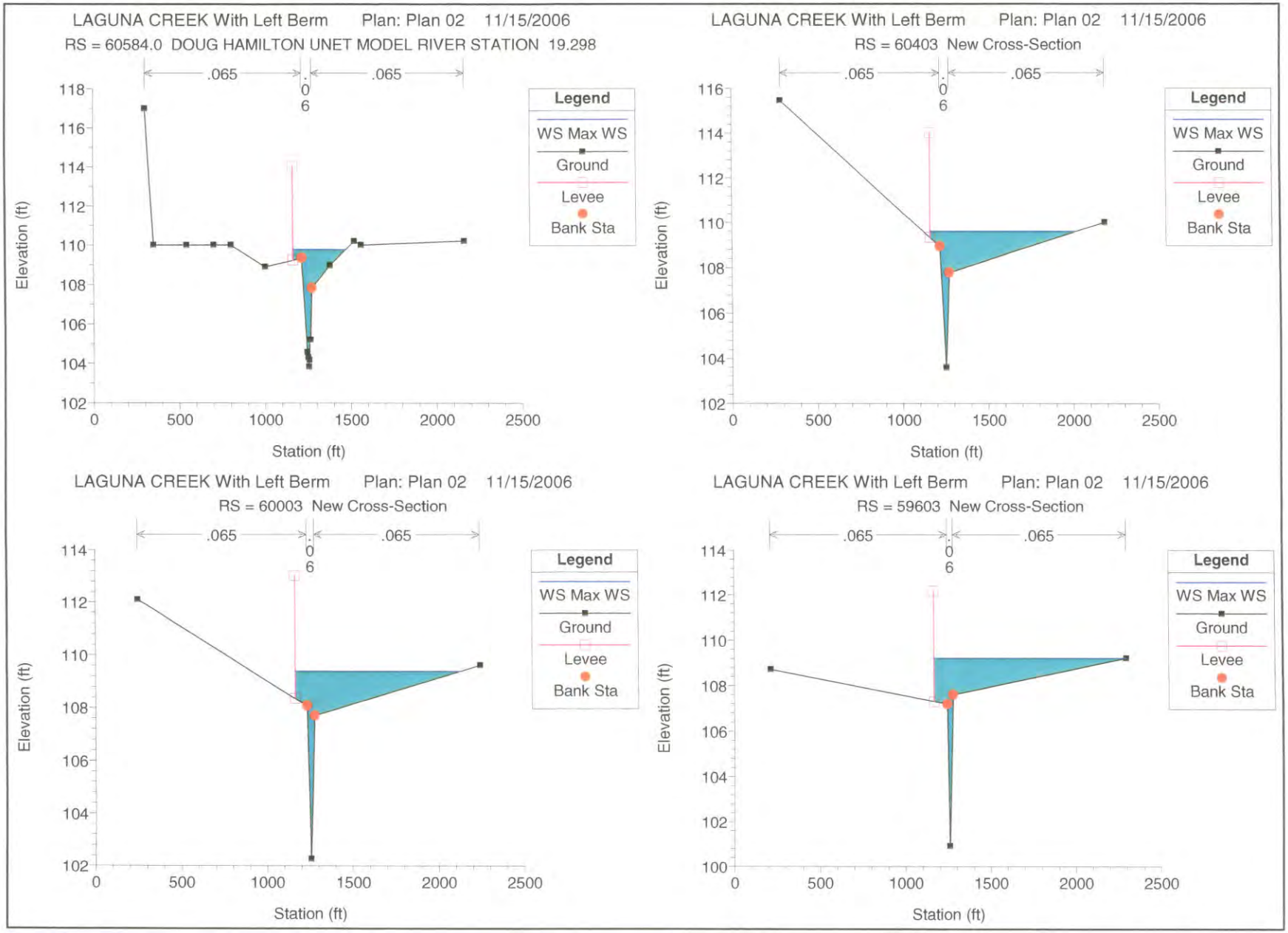
RS = 60803.0 DS FLORIN ROAD - DOUG HAMILTON UNET MODEL RIVER STATION 19.339

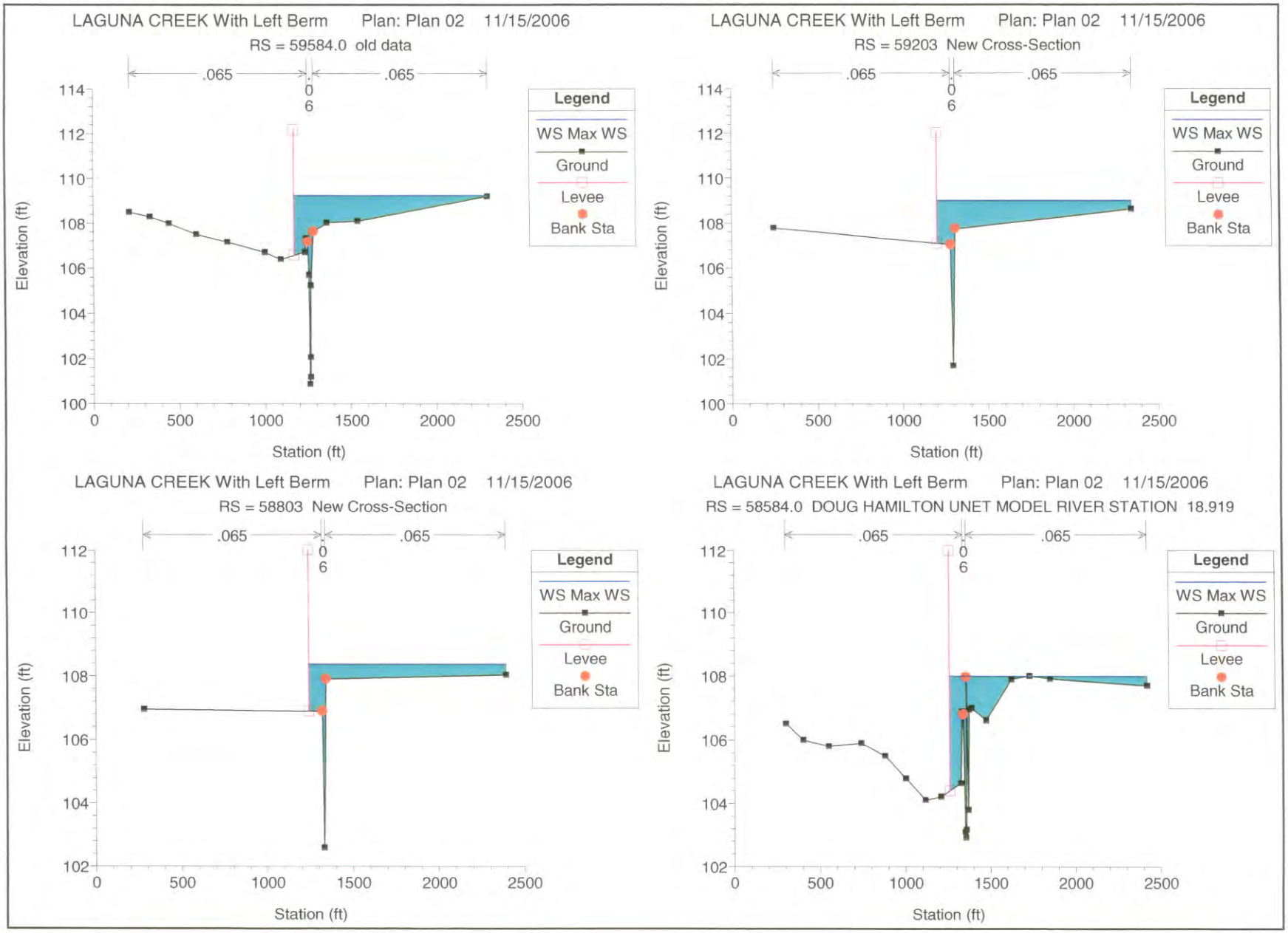


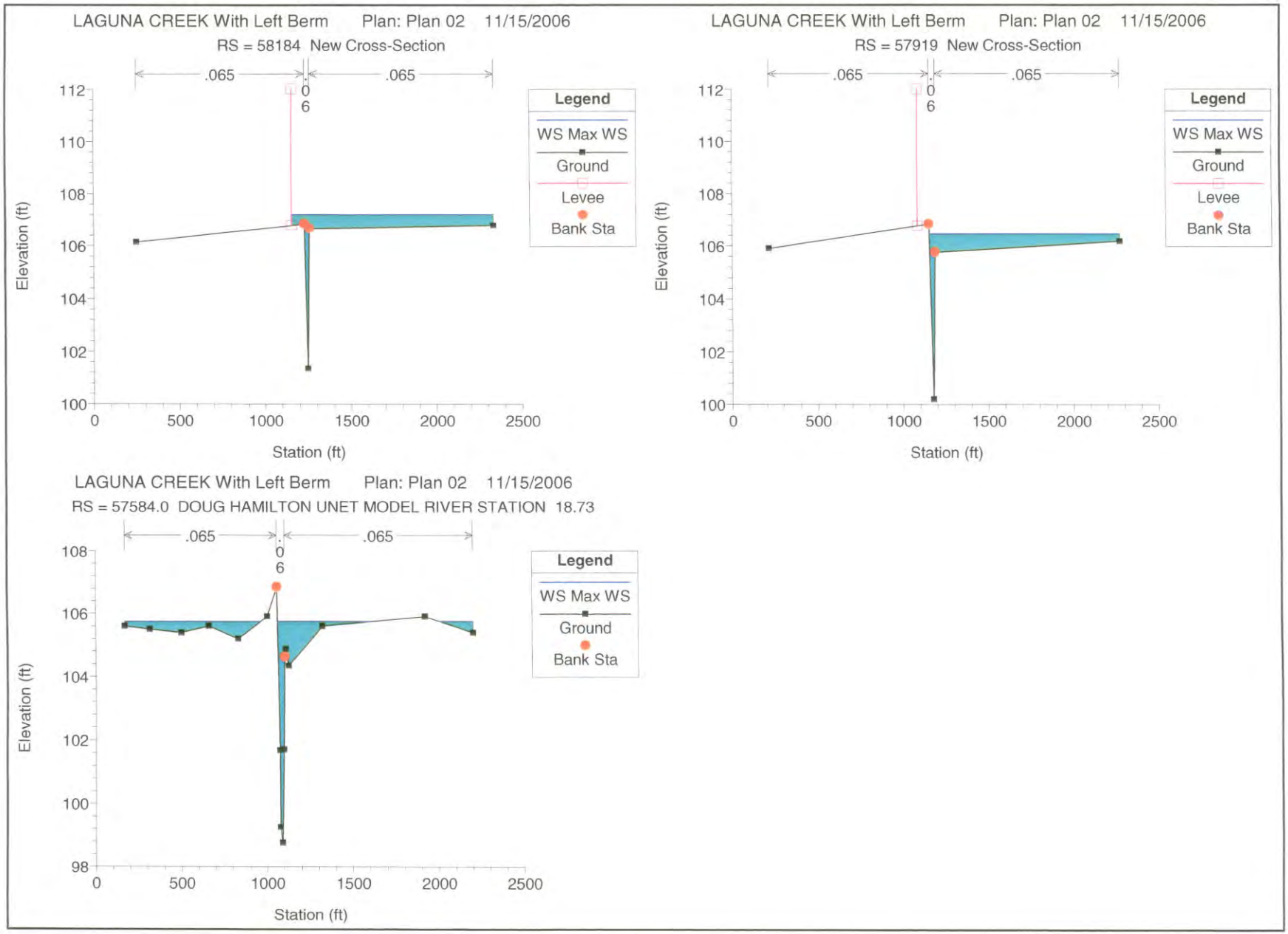
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006

RS = 60773.0 DOUG HAMILTON UNET MODEL RIVER STATION0 19.334




LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 60584.0 DOUG HAMILTON UNET MODEL RIVER STATION 19.298
.065
.065
0.06
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 60403 New Cross-Section
.065
.065
0.06
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 60003 New Cross-Section
.065
.065
0.06
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 59603 New Cross-Section
.065
.065
0.06
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 59584.0 old data
.065
.065
0
6
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 59203 New Cross-Section
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 58803 New Cross-Section
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 58584.0 DOUG HAMILTON UNET MODEL RIVER STATION 18.919


LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 58184 New Cross-Section
.065
.065
0.06
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 57919 New Cross-Section
.065
.065
0.06
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 02 11/15/2006
RS = 57584.0 DOUG HAMILTON UNET MODEL RIVER STATION 18.73
.065
.065
0.06
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)

HEC-RAS Plan: Plan 02 River: UPPER LAGUNA CRK Reach: UPPER LAGUNA CRK Profile: Max WS

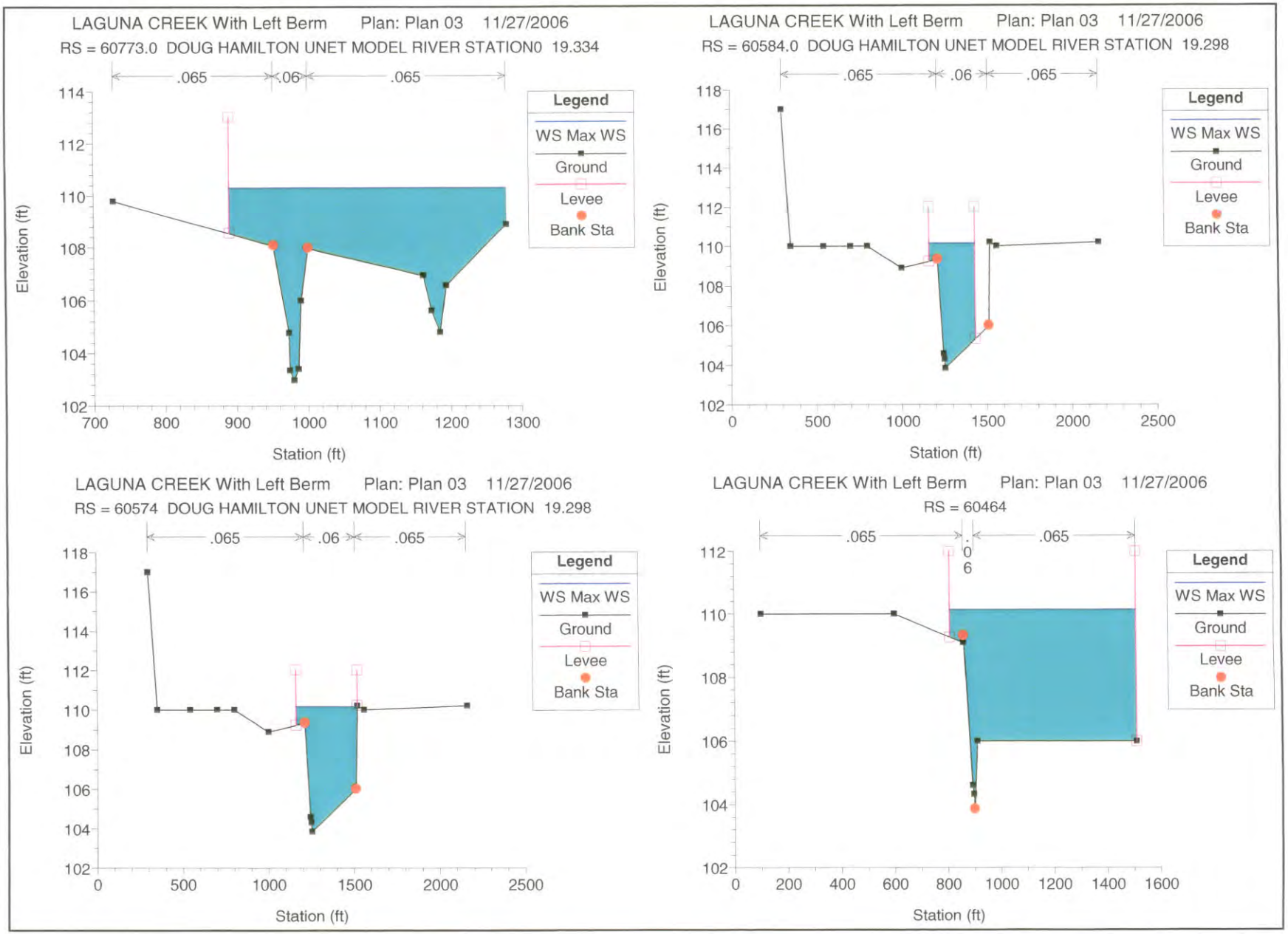
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
UPPER LAGUNA CRK	65509.0	Max WS	1580.75	106.70	117.82		117.85	0.000437	1.91	1282.34	391.00	0.12
UPPER LAGUNA CRK	65454.0	Max WS	1580.70	106.70	117.77		117.84	0.000924	2.81	1390.60	1236.09	0.17
UPPER LAGUNA CRK	65436.0	Max WS	1580.48	108.60	117.62	113.92	117.81	0.002144	3.61	683.07	1000.00	0.25
UPPER LAGUNA CRK	65421.0		Bridge									
UPPER LAGUNA CRK	65406.0	Max WS	1578.66	108.60	116.78		117.10	0.004009	4.55	347.11	62.20	0.34
UPPER LAGUNA CRK	65371.0	Max WS	1578.36	107.93	116.73	112.87	116.98	0.002595	4.03	391.61	62.36	0.28
UPPER LAGUNA CRK	65343.5		Bridge									
UPPER LAGUNA CRK	65316.0	Max WS	1577.01	107.93	116.44		116.72	0.002996	4.22	373.64	62.36	0.30
UPPER LAGUNA CRK	65314.0	Max WS	1577.13	107.93	116.44		116.71	0.002875	4.22	375.18	65.78	0.30
UPPER LAGUNA CRK	65306.0	Max WS	1577.01	107.93	116.41		116.46	0.000922	2.38	1333.77	1000.00	0.17
UPPER LAGUNA CRK	65166.0	Max WS	1576.47	106.40	116.28		116.30	0.000309	1.60	2099.00	946.83	0.10
UPPER LAGUNA CRK	65016.0	Max WS	1576.34	106.20	116.25		116.26	0.000230	1.42	2252.75	888.31	0.09
UPPER LAGUNA CRK	64896.0	Max WS	1576.24	107.30	115.78		115.98	0.002964	3.92	693.24	1000.00	0.30
UPPER LAGUNA CRK	64888.0	Max WS	1576.23	107.30	115.74		115.96	0.003201	4.05	650.15	1000.00	0.31
UPPER LAGUNA CRK	64886.0	Max WS	1576.23	107.30	115.66	112.52	115.96	0.003671	4.64	573.94	1000.00	0.33
UPPER LAGUNA CRK	64866.0		Bridge									
UPPER LAGUNA CRK	64846.0	Max WS	1574.61	107.30	113.89		114.73	0.013276	7.32	215.19	47.52	0.61
UPPER LAGUNA CRK	64844.0	Max WS	1574.74	107.30	113.92		114.70	0.013722	7.07	222.67	55.67	0.62
UPPER LAGUNA CRK	64836.0	Max WS	1571.31	107.30	113.72		114.58	0.015642	7.43	211.62	54.24	0.66
UPPER LAGUNA CRK	64826		Lat Struct									
UPPER LAGUNA CRK	64796.0	Max WS	995.66	106.80	114.14		114.29	0.001930	3.63	418.05	195.72	0.25
UPPER LAGUNA CRK	64410.0	Max WS	448.79	107.63	113.80		113.85	0.000736	2.06	265.58	75.77	0.16
UPPER LAGUNA CRK	64126.0	Max WS	688.49	107.23	113.29		113.43	0.001885	3.26	257.39	75.15	0.25
UPPER LAGUNA CRK	63584.0	Max WS	686.88	106.70	112.33		112.41	0.001842	2.53	334.93	194.17	0.23
UPPER LAGUNA CRK	62584.0	Max WS	727.99	106.00	111.18		111.19	0.000567	1.38	705.93	294.89	0.13
UPPER LAGUNA CRK	61584.0	Max WS	769.07	106.02	110.81		110.82	0.000191	0.87	1086.67	346.64	0.08
UPPER LAGUNA CRK	61053.0	Max WS	790.74	104.89	110.73		110.74	0.000108	0.73	1596.45	633.00	0.06
UPPER LAGUNA CRK	60908.0	Max WS	790.46	105.25	110.38		110.56	0.003654	3.39	233.21	67.31	0.32
UPPER LAGUNA CRK	60853.0	Max WS	790.35	104.40	110.29	106.96	110.41	0.001827	2.77	285.03	65.20	0.23
UPPER LAGUNA CRK	60833.0		Bridge									
UPPER LAGUNA CRK	60803.0	Max WS	789.80	104.40	110.13		110.25	0.002034	2.88	274.36	64.34	0.25
UPPER LAGUNA CRK	60773.0	Max WS	789.89	102.97	110.17		110.18	0.000207	0.97	1128.16	389.00	0.08
UPPER LAGUNA CRK	60584.0	Max WS	789.26	103.86	109.95		110.02	0.001711	2.48	480.03	329.59	0.22
UPPER LAGUNA CRK	60403	Max WS	790.68	103.60	109.77		109.78	0.000656	1.51	1045.91	922.08	0.14
UPPER LAGUNA CRK	60003	Max WS	795.03	102.27	109.54		109.56	0.000547	1.54	1143.69	1037.80	0.13
UPPER LAGUNA CRK	59603	Max WS	799.26	100.93	109.37		109.38	0.000391	1.40	1318.88	1129.34	0.11
UPPER LAGUNA CRK	59584.0	Max WS	799.49	100.87	109.36		109.37	0.000500	1.30	1242.12	1132.00	0.11
UPPER LAGUNA CRK	59203	Max WS	803.73	101.71	109.10		109.12	0.000543	1.50	1238.40	1142.72	0.12
UPPER LAGUNA CRK	58803	Max WS	808.09	102.59	108.50		108.54	0.002377	2.63	768.56	1153.72	0.25
UPPER LAGUNA CRK	58584.0	Max WS	810.46	102.92	108.12		108.16	0.001143	1.78	853.60	1161.00	0.16
UPPER LAGUNA CRK	58184	Max WS	814.68	101.35	107.28		107.32	0.003042	2.84	735.98	1177.00	0.28
UPPER LAGUNA CRK	57919	Max WS	817.45	100.20	106.54		106.59	0.002550	2.66	749.10	1121.16	0.26
UPPER LAGUNA CRK	57584.0	Max WS	820.63	98.76	105.88		105.94	0.001683	2.65	857.96	1903.45	0.22
UPPER LAGUNA CRK	56584.0	Max WS	956.68	97.96	104.51		104.55	0.001812	2.80	808.10	782.01	0.22
UPPER LAGUNA CRK	55443.0	Max WS	611.90	95.48	102.88		102.90	0.000551	1.68	791.19	649.03	0.12
UPPER LAGUNA CRK	54443.0	Max WS	929.63	95.19	101.32		101.34	0.000930	1.81	1220.33	1472.25	0.16
UPPER LAGUNA CRK	53949.0	Max WS	927.06	93.50	101.08		101.08	0.000121	0.76	2492.23	1631.54	0.05
UPPER LAGUNA CRK	53849.0	Max WS	926.94	92.00	100.96	96.09	101.06	0.001422	2.58	423.32	362.08	0.18
UPPER LAGUNA CRK	53829.0		Bridge									
UPPER LAGUNA CRK	53789.0	Max WS	926.91	92.00	100.67		100.79	0.001693	2.74	343.15	96.22	0.19
UPPER LAGUNA CRK	53669.0	Max WS	926.90	93.50	100.23		100.45	0.004041	3.78	251.42	63.57	0.30
UPPER LAGUNA CRK	53389.0	Max WS	929.45	92.30	99.67		99.70	0.000872	1.96	880.93	470.00	0.14

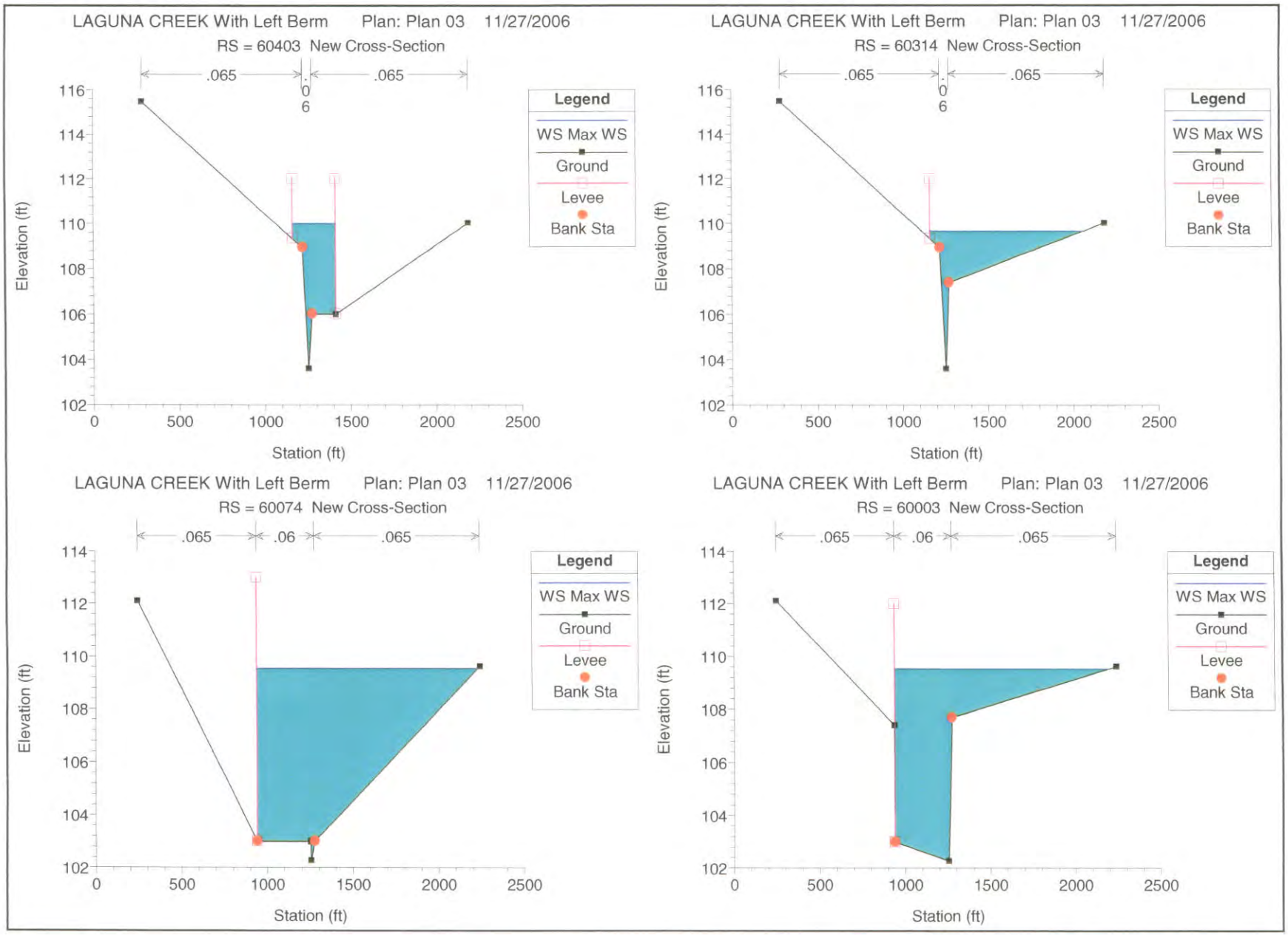
RESTORATION PLAN

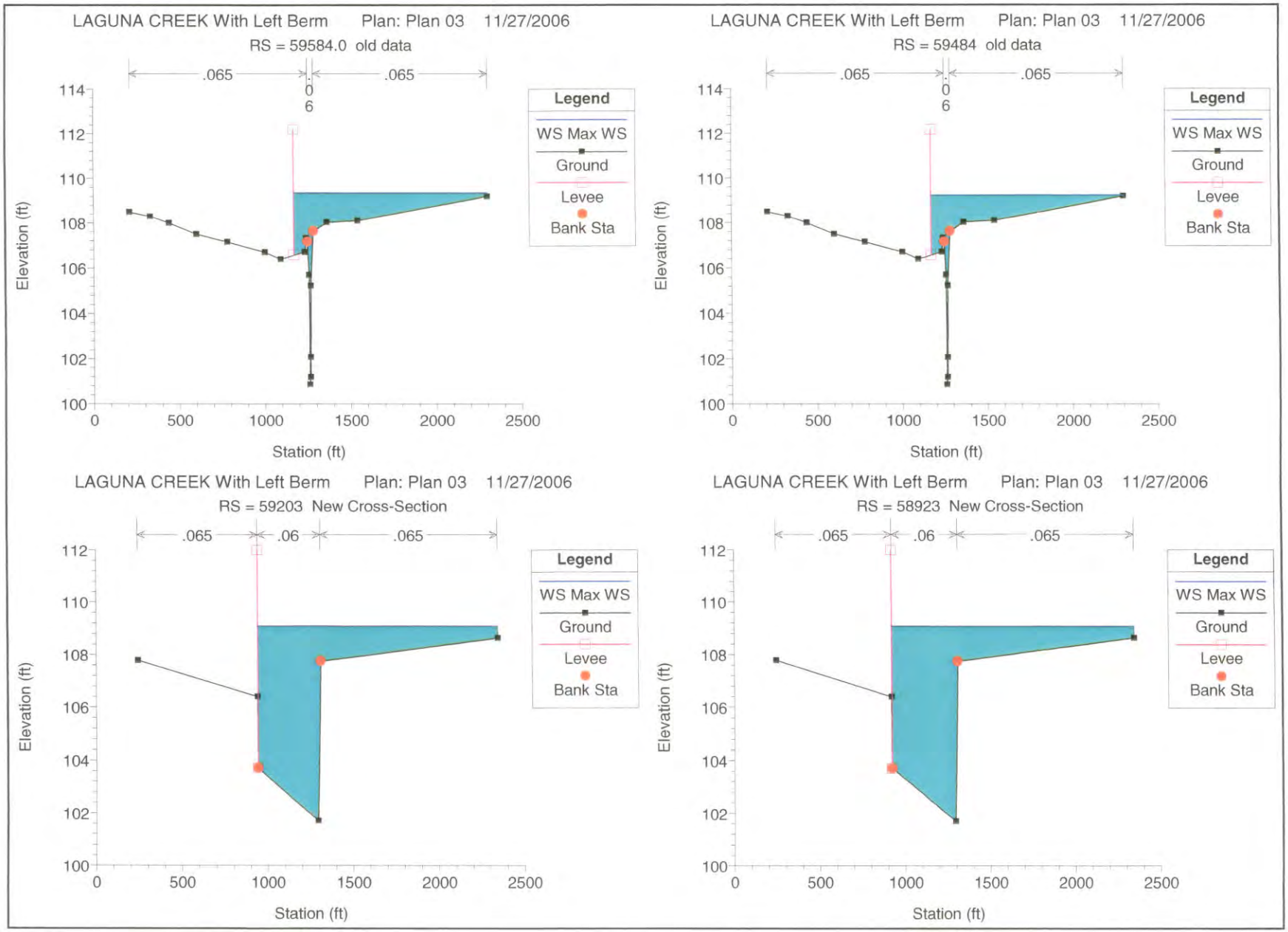
Results of the hydraulic analysis of the proposed restoration plan was reported in Chapter 5. The profile summary table and the hydraulic cross sections are included in the following pages. The results show that with the permanent detention storage that reduces the peak creek discharge to under 1,000 cfs, there will be no problems with flow velocities or flood flows. This analysis will be modified as part of the final design process for the restoration plan implementation.

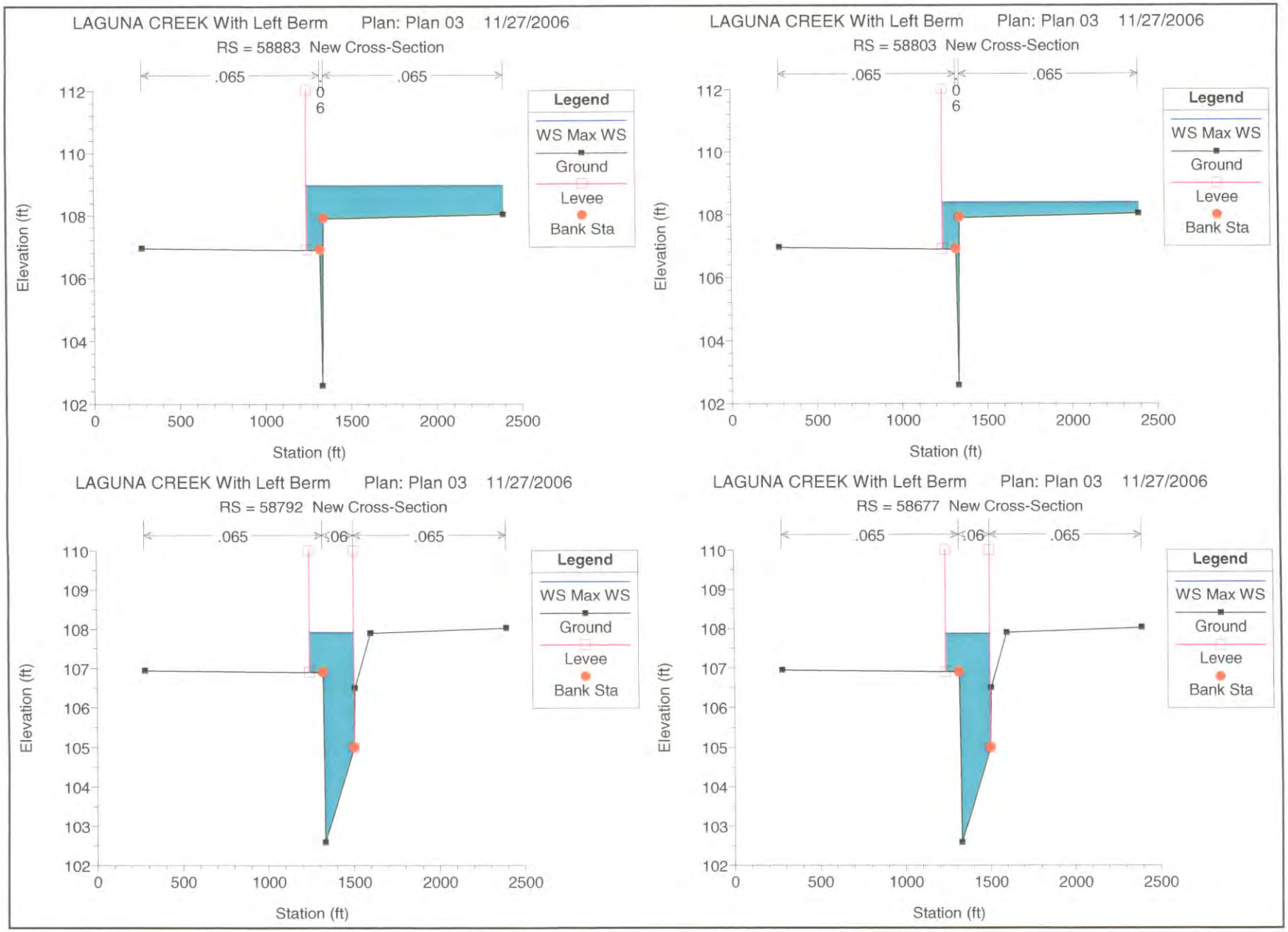
HEC-RAS Plan: Plan 03 River: UPPER LAGUNA CRK Reach: UPPER LAGUNA CRK Profile: Max WS

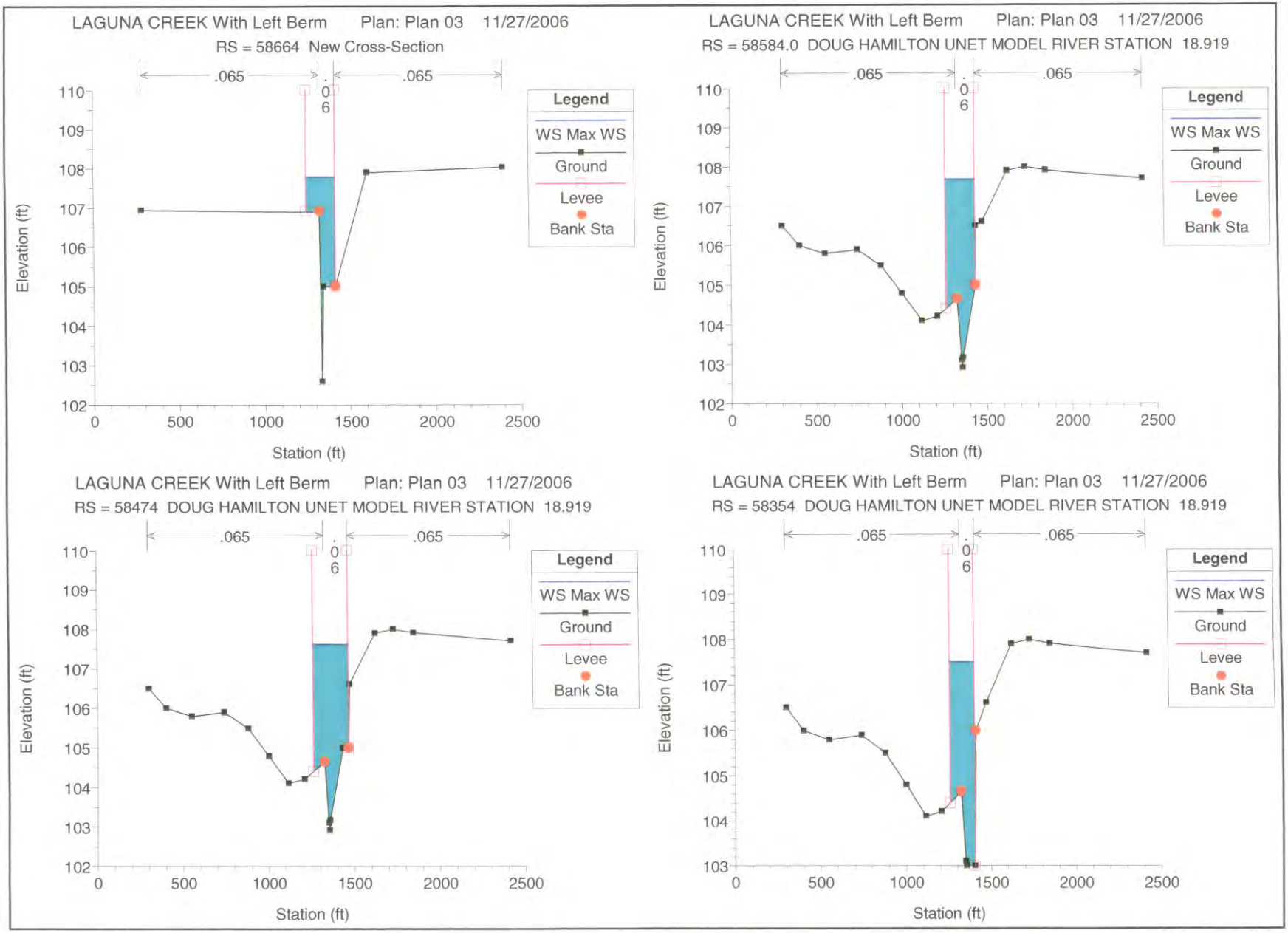
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
UPPER LAGUNA CRK	65509.0	Max WS	1577.70	106.70	117.97		118.00	0.000385	1.82	1340.56	391.00	0.11
UPPER LAGUNA CRK	65454.0	Max WS	1577.66	106.70	117.93		117.99	0.000718	2.51	1601.97	1352.62	0.15
UPPER LAGUNA CRK	65436.0	Max WS	1577.37	108.60	117.79	113.91	117.93	0.001655	3.23	855.27	1000.00	0.22
UPPER LAGUNA CRK	65421.0		Bridge									
UPPER LAGUNA CRK	65406.0	Max WS	1575.12	108.60	116.98		117.26	0.003370	4.26	385.41	76.03	0.31
UPPER LAGUNA CRK	65371.0	Max WS	1574.87	107.93	116.92	112.86	117.16	0.002358	3.90	403.39	62.36	0.27
UPPER LAGUNA CRK	65343.5		Bridge									
UPPER LAGUNA CRK	65316.0	Max WS	1573.48	107.93	116.64		116.90	0.002703	4.08	385.70	62.36	0.29
UPPER LAGUNA CRK	65314.0	Max WS	1573.35	107.93	116.63		116.89	0.002569	4.08	388.05	66.41	0.29
UPPER LAGUNA CRK	65306.0	Max WS	1573.34	107.93	116.61		116.64	0.000663	2.06	1530.78	1000.00	0.15
UPPER LAGUNA CRK	65166.0	Max WS	1572.66	106.40	116.49		116.51	0.000236	1.42	2298.33	953.33	0.09
UPPER LAGUNA CRK	65016.0	Max WS	1572.53	106.20	116.47		116.47	0.000178	1.27	2447.00	889.77	0.08
UPPER LAGUNA CRK	64896.0	Max WS	1572.46	107.30	116.06		116.17	0.001766	3.13	970.04	1000.00	0.24
UPPER LAGUNA CRK	64888.0	Max WS	1572.46	107.30	116.02		116.14	0.001891	3.23	933.14	1000.00	0.24
UPPER LAGUNA CRK	64886.0	Max WS	1572.44	107.30	115.95	112.52	116.11	0.002179	3.69	863.54	1000.00	0.25
UPPER LAGUNA CRK	64866.0		Bridge									
UPPER LAGUNA CRK	64846.0	Max WS	1572.07	107.30	114.07		114.84	0.011765	7.03	223.51	47.52	0.57
UPPER LAGUNA CRK	64844.0	Max WS	1572.16	107.30	114.11		114.81	0.012114	6.75	233.07	56.98	0.59
UPPER LAGUNA CRK	64836.0	Max WS	1571.68	107.30	113.95		114.71	0.013445	7.01	224.06	55.84	0.62
UPPER LAGUNA CRK	64826		Lat Struct									
UPPER LAGUNA CRK	64796.0	Max WS	1516.07	106.80	113.76		114.28	0.006621	6.46	344.51	193.57	0.47
UPPER LAGUNA CRK	64410.0	Max WS	316.48	107.63	113.23		113.26	0.000513	1.60	226.99	60.36	0.13
UPPER LAGUNA CRK	64126.0	Max WS	544.75	107.23	112.81		112.91	0.001541	2.76	225.97	60.27	0.22
UPPER LAGUNA CRK	63584.0	Max WS	543.48	106.70	111.91		111.99	0.001854	2.38	262.58	153.54	0.23
UPPER LAGUNA CRK	62584.0	Max WS	582.94	106.00	110.69		110.71	0.000691	1.41	566.28	283.11	0.14
UPPER LAGUNA CRK	61584.0	Max WS	621.13	106.02	110.27		110.28	0.000179	0.78	922.83	292.31	0.07
UPPER LAGUNA CRK	61053.0	Max WS	640.94	104.89	110.19		110.19	0.000137	0.77	1253.21	624.03	0.06
UPPER LAGUNA CRK	60908.0	Max WS	637.47	105.25	109.82		109.99	0.003846	3.24	196.72	63.18	0.32
UPPER LAGUNA CRK	60853.0	Max WS	637.05	104.40	109.73	106.67	109.83	0.001739	2.55	249.35	62.27	0.22
UPPER LAGUNA CRK	60833.0		Bridge									
UPPER LAGUNA CRK	60803.0	Max WS	635.86	104.40	109.58		109.69	0.001930	2.65	240.17	61.50	0.24
UPPER LAGUNA CRK	60773.0	Max WS	636.18	102.97	109.62		109.62	0.000261	0.99	913.43	389.00	0.09
UPPER LAGUNA CRK	60584.0	Max WS	636.02	103.86	109.58		109.59	0.000082	0.62	1041.06	270.00	0.05
UPPER LAGUNA CRK	60574	Max WS	636.12	103.86	109.59		109.59	0.000050	0.47	1365.98	357.54	0.04
UPPER LAGUNA CRK	60464	Max WS	636.89	103.86	109.58		109.59	0.000026	0.27	2345.85	700.00	0.03
UPPER LAGUNA CRK	60403	Max WS	637.38	103.60	109.55		109.57	0.000271	1.00	725.81	250.00	0.09
UPPER LAGUNA CRK	60314	Max WS	639.43	103.60	109.39		109.40	0.000598	1.36	890.17	805.69	0.13
UPPER LAGUNA CRK	60074	Max WS	641.89	102.27	109.28		109.28	0.000004	0.17	5002.63	1253.23	0.01
UPPER LAGUNA CRK	60003	Max WS	642.34	102.27	109.28		109.28	0.000010	0.28	2820.41	1133.32	0.02
UPPER LAGUNA CRK	59584.0	Max WS	644.90	100.87	109.14		109.15	0.000566	1.34	994.66	1088.67	0.12
UPPER LAGUNA CRK	59484	Max WS	645.52	100.87	109.07		109.08	0.000670	1.44	919.41	1039.89	0.13
UPPER LAGUNA CRK	59203	Max WS	647.27	101.71	108.97		108.97	0.000010	0.26	3070.07	1402.72	0.02
UPPER LAGUNA CRK	58923	Max WS	649.02	101.71	108.96		108.96	0.000009	0.25	3191.45	1422.72	0.02
UPPER LAGUNA CRK	58883	Max WS	621.22	102.59	108.87		108.88	0.000406	1.16	1195.55	1153.72	0.10
UPPER LAGUNA CRK	58803	Max WS	653.35	102.59	108.21		108.33	0.005628	3.82	432.94	1153.72	0.37
UPPER LAGUNA CRK	58792	Max WS	654.72	102.59	107.65		107.67	0.000242	0.93	747.44	260.00	0.08
UPPER LAGUNA CRK	58677	Max WS	655.47	102.59	107.63		107.64	0.000249	0.94	740.06	260.00	0.08
UPPER LAGUNA CRK	58664	Max WS	655.56	102.59	107.55		107.64	0.002769	2.47	298.09	170.00	0.26
UPPER LAGUNA CRK	58584.0	Max WS	656.10	102.92	107.48		107.50	0.000474	1.22	572.79	174.00	0.12
UPPER LAGUNA CRK	58474	Max WS	656.79	102.92	107.44		107.45	0.000398	1.07	645.99	207.00	0.10
UPPER LAGUNA CRK	58354	Max WS	657.59	103.00	107.37		107.40	0.000558	1.44	506.65	144.00	0.13
UPPER LAGUNA CRK	58309	Max WS	657.90	102.92	107.37		107.38	0.000193	0.88	806.22	214.00	0.08
UPPER LAGUNA CRK	58214	Max WS	658.53	102.92	107.35		107.36	0.000168	0.81	868.10	234.00	0.07
UPPER LAGUNA CRK	58184	Max WS	659.03	101.35	107.15		107.21	0.003655	3.03	582.97	1177.00	0.30
UPPER LAGUNA CRK	58049	Max WS	660.67	102.92	106.65		106.66	0.000332	1.01	703.62	234.00	0.10
UPPER LAGUNA CRK	57919	Max WS	661.42	100.20	106.44		106.49	0.002552	2.63	632.52	1120.77	0.26
UPPER LAGUNA CRK	57584.0	Max WS	662.51	98.76	105.72		105.80	0.001756	2.66	587.94	1453.06	0.22
UPPER LAGUNA CRK	56584.0	Max WS	772.52	97.96	104.19		104.23	0.001786	2.66	582.01	594.48	0.21
UPPER LAGUNA CRK	55443.0	Max WS	553.40	95.48	102.84		102.86	0.000484	1.56	764.99	631.89	0.11
UPPER LAGUNA CRK	54443.0	Max WS	761.02	95.19	100.96		100.99	0.001670	2.27	762.21	1055.30	0.22
UPPER LAGUNA CRK	53949.0	Max WS	756.69	93.50	100.53		100.54	0.000184	0.88	1661.35	1395.99	0.07
UPPER LAGUNA CRK	53849.0	Max WS	756.57	92.00	100.42	95.74	100.50	0.001283	2.34	323.72	56.06	0.17
UPPER LAGUNA CRK	53829.0		Bridge									
UPPER LAGUNA CRK	53789.0	Max WS	756.55	92.00	100.26		100.35	0.001390	2.40	315.37	53.50	0.17
UPPER LAGUNA CRK	53669.0	Max WS	756.46	93.50	99.90		100.07	0.003357	3.32	231.46	57.51	0.27
UPPER LAGUNA CRK	53389.0	Max WS	758.71	92.30	99.41		99.44	0.000840	1.86	760.66	466.14	0.14

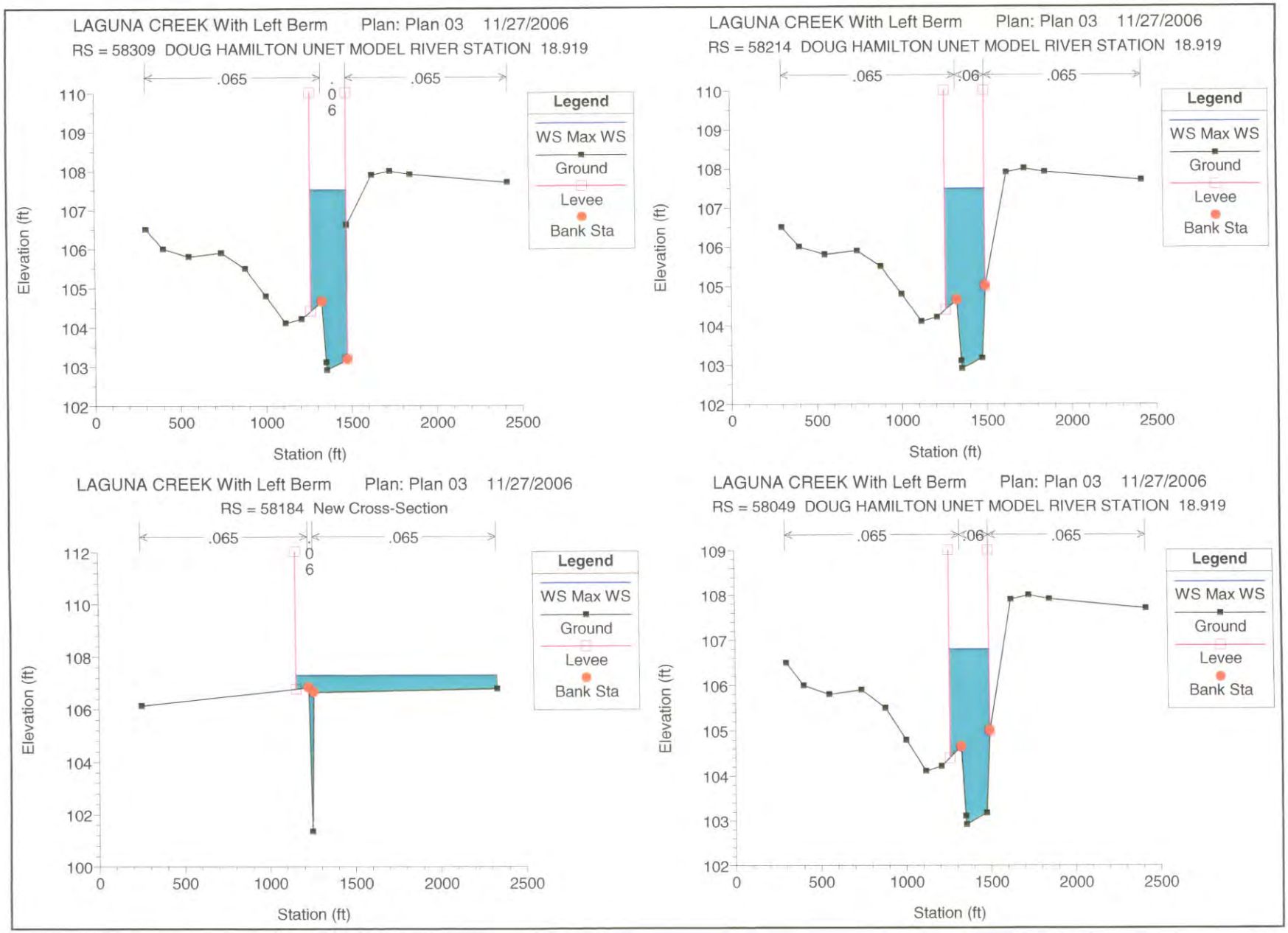

LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 60773.0 DOUG HAMILTON UNET MODEL RIVER STATION0 19.334
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 60584.0 DOUG HAMILTON UNET MODEL RIVER STATION 19.298
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 60574 DOUG HAMILTON UNET MODEL RIVER STATION 19.298
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 60464
.065
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

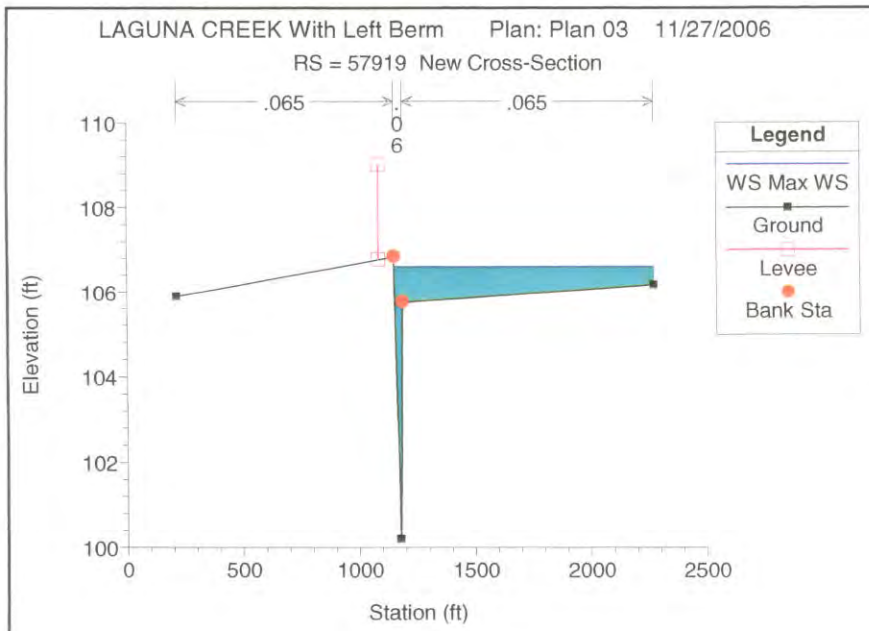

LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 60403 New Cross-Section
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 60314 New Cross-Section
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 60074 New Cross-Section
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 60003 New Cross-Section
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

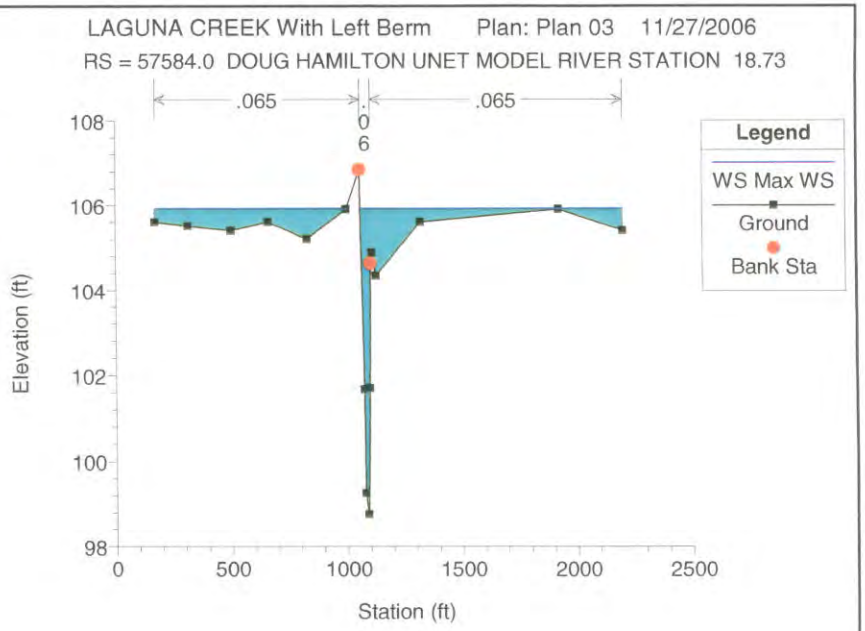

LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 59584.0 old data
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 59484 old data
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 59203 New Cross-Section
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 58923 New Cross-Section
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 58883 New Cross-Section
.065
.065
0
6
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 58803 New Cross-Section
.065
.065
0
6
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 58792 New Cross-Section
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 58677 New Cross-Section
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 58664 New Cross-Section
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 58584.0 DOUG HAMILTON UNET MODEL RIVER STATION 18.919
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 58474 DOUG HAMILTON UNET MODEL RIVER STATION 18.919
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 58354 DOUG HAMILTON UNET MODEL RIVER STATION 18.919


LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 58309 DOUG HAMILTON UNET MODEL RIVER STATION 18.919
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 58214 DOUG HAMILTON UNET MODEL RIVER STATION 18.919
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 58184 New Cross-Section
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 58049 DOUG HAMILTON UNET MODEL RIVER STATION 18.919
.065
.06
.065
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 57919 New Cross-Section
.065
.065
0
6
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (ft)
110
108
106
104
102
100
0
500
1000
1500
2000
2500
Station (ft)


LAGUNA CREEK With Left Berm Plan: Plan 03 11/27/2006
RS = 57584.0 DOUG HAMILTON UNET MODEL RIVER STATION 18.73
.065
.065
0
6
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
108
106
104
102
100
98
0
500
1000
1500
2000
2500
Station (ft)