PRELIMINARY
DRAINAGE STUDY

# ALVARADO SPECIFIC PLAN

June 2020

City Of La Mesa, CA

prepared for:

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# Preliminary Drainage Study and Floodplain Analysis

## Alvarado Specific Plan

## San Diego RV Resort
## La Mesa, CA

## June 2020

Prepared by:


6/12/2020

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# INTRODUCTION

## PURPOSE

This Preliminary Drainage Report and Floodplain Analysis pertains to the proposed development of a multi-family residential project along the south side of Alvarado Road between 70th Street and Fletcher Parkway. Its purpose is to present the design of the onsite drainage facilities and Alvarado Creek channel improvements of the proposed project located in La Mesa, CA.

## PROJECT DESCRIPTION

The Alvarado Specific Plan is a proposed as a master plan for a multi-family "transit-oriented development" (TOD) on approximately 12 acres located along Alvarado Road generally between 70th Street on the west and Guava Avenue on the east within the City of La Mesa. The Specific Plan is being proposed by the property owner, RV Communities, which has operated an RV campground on the site since 1998. Prior to this change in use the site was operated as a mobile-home park from approximately the time I-8 was constructed in the 1950's.

Surrounding uses include the MTS light-rail (LRT) 70th Street station immediately west of the site and the double track LRT Green Line south of the site. East of the site is a car dealership. On the north is Alvarado Road and the I-8 freeway. A significant feature of the site is Alvarado Creek which bisects the property as it intersects Alvarado Road on the easterly portion of the site. The creek continues within the property and the adjoining MTS property toward the westerly end of the site as it enters underground storm drainage facilities below Alvarado Road and the trolley line as it flows westerly through San Diego until reaching the San Diego River in Mission Valley.

The Specific Plan proposes to include four parcels, with four primary development sites. The plan is for construction to occur in two phases. Phase 1 is planned for the properties west of the intersection of Alvarado Creek and Alvarado Road with three development parcels for Buildings 1-3. Phase 2, the parcel east of the Alvarado Road/Alvarado Creek intersection, is planned for a later development schedule with a similar development concept in Building 4, and the San Diego RV Resort facilities remaining as an interim use. Each development parcel is proposed to include Type V residential wood frame construction of dwelling units in five stories on a 1-3 level concrete parking garage podium.

In its existing state, the project site is occupied by the San Diego RV Resort, owned by RV Communities, LLC. The facilities of the RV resort include paved access roads, paved RV spaces, a clubhouse with pool, and additional structures. The project site is bordered to the north by Alvarado Road, to the west by the 70th Street trolley station, to the east by an existing car dealership, and to the south by the Mission Valley East trolley tracks. Alvarado Creek runs through the center of the site and then runs along the southerly property line on the westerly portion of the site.

Please refer to Appendix A for vicinity map.

## BASIN DESCRIPTION

### Existing Conditions:

The existing site can be divided into 2 major basins. Basin 1 consists of the area to the east of Alvarado Creek, while Basin 2 consists of the area to the west of Alvarado Creek. Please refer to the "Existing Hydrology Exhibit" in Appendix B.

#### Basin 1

The portion of the project site on the east side of Alvarado Creek is generally very flat, with the exception of the slopes along the southerly end of the basin. The trolley tracks and the associated storm drain lines intercept all drainage to south of the trolley line. The basin also accepts drainage from a portion of Alvarado Road. This drainage enters the site through the two entrances from Alvarado Road. The onsite drainage collects in the RV park streets and flows over the creek bank in several locations. Basin 1 consists of 4.5 acres.

#### Basin 2

Basin 2 consists of the portion of the project site that is to the west and north of Alvarado Creek. This basin generally slopes to the west at about 1.5%. Runoff from the site flows along the RV park streets, and roughly parallels the Creek. Basin 2 also accepts drainage from a small section of Alvarado Road immediately to the west of the bridge. Drainage from Basin 2 exits the westerly end of the site and is intercepted by a storm drain system constructed as part of the 70$^{th}$ Street trolley station. The area of Basin 2 is 7.7 acres.

### Proposed Conditions:

The proposed development of Alvarado Creek will preserve the delineation between Basins 1 and 2. The proposed site can be divided into 2 major basins and 4 sub basins. Basin 1 will include Sub Basin 100 and 300, while Basin 2 will consist of Sub Basin 200 and 400. Alvarado Road will no longer drain into the site, due to the raising of the project site and widening of Alvarado Road. Proposed redevelopment portions of Alvarado Road, outlined in Sub Basin 300 and 400 will require additional water quality treatment. Modular Wetland Biofiltration system has been selected to treat this section. Please refer to the "Proposed Hydrology Exhibit" in Appendix B.

#### Sub Basin 100

Sub Basin 100 will continue to encompass the area of the site to the east of Alvarado Creek, excluding Alvarado Road. Drainage from the building roofs and project streets will be directed to grass-lined swales or area drains. The swales will lead to storm drain catch basins. From the catch basins, drainage will be directed to a treatment/detention system for water quality treatment and detention of the peak flow from the project site. This treatment system will be in the southwesterly corner of Sub Basin 100. The discharge of the flow will be controlled by an orifice. This storm drain line will then outlet to the Creek through a headwall.

Sub Basin 200

Sub Basin 200 will continue to consist of the project area to the west of Alvarado Creek, excluding Alvarado Road. Again, a system of grass-lined swales, catch basins, and storm drain pipe will be used to collect drainage from the project facilities. A treatment/detention system will be located at the westerly end of the project site and will outlet through the retaining wall into Alvarado Creek to the south. The detention system for Sub Basin 200 will be larger then the water quality basin and span the entire area underneath the neighboring park area and some.

Sub Basin 300

Sub Basin 300 will only encompass the area of the Alvarado Road to the east of Alvarado Creek. Drainage from the road will be directed to proposed gutters and drain to a biofiltration system for water quality treatment. The biofiltration system selected for this portion will be Modular Wetland and located at the south west corner of Sub Basin 300.

Sub Basin 400

Sub Basin 400 will only encompass the area of the Alvarado Road to the west of Alvarado Creek. Drainage from the road will be directed to proposed gutters and drain to two biofiltration system for water quality treatment. The biofiltration systems selected for this portion will be Modular Wetlands and located at the south west corner and midway entrance of Sub Basin 400.

# HYDROLOGY METHODOLOGY

## RUNOFF CALCULATIONS

The design criteria, as found in the County of San Diego Department of Public Works Flood Control Division Hydrology Manual, specifies the design runoff conditions within the San Diego County Flood Control District will be based on the 100-year storm frequency, as follows:

1.) Design for areas over 1 square mile will be based on the 100-year frequency storm.

2.) For areas under 1 square mile –

   a. The storm drain system shall be designed so that the combination of storm drain system capacity and overflow both inside and outside the right of way will be able to carry the 100-year frequency storm without damaging adjacent existing buildings or potential building sites.

   b. The storm drain system shall be designed so that the combination of storm drain system capacity and allowable street overflow will be able to carry the 50-year frequency storm without damaging adjacent property.

c. Where a storm drain is required under headings 1 or 2 above, then as a minimum, the drain shall be designed to carry the 10-year frequency storm.

3.) Sump areas are to be designed for a sump capacity or outfall of a 100-year frequency storm.

Runoff produced on the project site will be calculated for the 2-year, 10-year, and 100-year storm event using the methodology outlined in the San Diego County Hydrology Manual. Runoff will be calculated using the Rational Method, which is given by the following equation:

$Q = C \times I \times A$

Where:
Q = Flow rate in cubic feet per second (cfs)
C = Runoff coefficient
I = Rainfall Intensity in inches per hour (in/hr)
A = Drainage basin area in acres, (ac)

Soil Type – Hydrologic soil group D was assumed for all areas as this is the prevalent soil group near the project site as can be seen in the Soil Hydrologic Groups map provided in the appendix. Group D soils have very slow infiltration rates when thoroughly wetted. Consisting chiefly of clay soils with a high swelling potential, soils with a high permanent water table, soils with clay pan or clay layer at or near the surface, and shallow soils over nearly impervious materials, Group D soils have a very slow rate of water transmission.

Runoff Coefficient – The runoff coefficients for both the existing and proposed conditions was determined by calculating the impervious areas on the site. The runoff coefficient was then calculated using the formula given in section 3.1.2 of the Manual:

$C = 0.90x(\%Impervious) + C_p x(1 - \%Impervious)$

For soil group D, a $C_p$ value of 0.35 is used. The resulting runoff coefficients were 0.67 for the existing condition and 0.74 for the proposed condition.

Rainfall intensity was calculated using the following equation, which is given in the Manual:

$I = 7.44 \times P_6 \times (Tc^{-0.645})$

Where:
I = Rainfall Intensity in inches per hour (in/hr)
$P_6$ = Rainfall in inches for the 6-hour storm event

Tc = Time of concentration in minutes

Time of concentration was calculated for overland flow areas (sheet drainage) using the equation developed by the Federal Aviation Administration, which is given as:

$Tc = [1.8 \times (1.1 - C) \times (L^{1/2})] / (S^{1/3})$

Where:
Tc = Time of concentration in minutes
C = Runoff coefficient
L = Length of travel of runoff in feet
S = Slope in percent

The minimum time of concentration used for runoff calculations was based on Table 3-2 of the Manual. Relevant excerpts from the Manual are given in the appendix.

Time of travel in the drain and drainage channels was calculated using the Manning equation. For HDPE storm drains, a Manning "n" value of 0.012 was selected, while for RCP storm drains a Manning "n" value of 0.013 was used. For brow ditches, a Manning "n" of 0.015 was used.

To perform a node-link study, the total watershed area is divided into sub-areas which discharge at designated nodes.

The procedure for the sub-area summation model is as follows:

(1) Subdivide the watershed into an initial sub-area (generally 1 lot) and subsequent sub-areas, which are generally less than 10 acres in size. Assign upstream and downstream node numbers to each sub-area.

(2) Estimate an initial $T_c$ by using the appropriate nomograph or overland flow velocity estimation.

(3) Using the initial $T_c$, determine the corresponding values of I. Then Q = CIA.

(4) Using Q, estimate the travel time between this node and the next by Manning's equation as applied to particular channel or conduit linking the two nodes. Then, repeat the calculation for Q based on the revised intensity (which is a function of the revised time of concentration)

The nodes are joined together by links, which may be street gutter flows, drainage swales, drainage ditches, pipe flow, or various channel flows. The AES-2004a computer sub-area menu is as follows:

SUBAREA HYDROLOGIC PROCESS

1. Confluence analysis at node.
2. Initial sub-area analysis (including time of concentration calculation).
3. Pipe flow travel time (computer estimated).
4. Pipe flow travel time (user specified).
5. Trapezoidal channel travel time.
6. Street flow analysis through sub-area.
7. User-specified information at node.
8. Addition of sub-area runoff to main line.
9. V-gutter flow through area.
10. Copy main stream data to memory bank
11. Confluence main stream data with a memory bank
12. Clear a memory bank

At the confluence point of two or more basins, the following procedure is used to combine peak flow rates to account for differences in the basin's times of concentration. This adjustment is based on the assumption that each basin's hydrographs are triangular in shape.

(1). If the collection streams have the same times of concentration, then the Q values are directly summed,

$$Q_p = Q_a + Q_b;\ T_p = T_a = T_b$$

(2). If the collection streams have different times of concentration, the smaller of the tributary Q values may be adjusted as follows:

(i). The most frequent case is where the collection stream with the longer time of concentration has the larger Q. The smaller Q value is adjusted by a ratio of rainfall intensities.

$$Q_p = Q_b + Q_a\,(I_b/I_a);\ T_p = T_a$$

(ii). In some cases, the collection stream with the shorter time of concentration has the larger Q. Then the smaller Q is adjusted by a ratio of the T values.

$$Q_p = Q_b + Q_a\,(T_b/T_a);\ T_p = T_b$$

# HYDROLOGY CALCULATIONS/RESULTS

## EXISTING CONDITIONS

Calculations were performed on the existing drainage patterns on the project site to determine the current discharge during a storm event. These calculations are based on the 6 hour storm event and were performed for the 100-year storms. Basin 1 was determined to have an overall discharge of 15.28 cfs and a time of concentration ($T_c$) of 9.57 minutes under the 100-year storm conditions. The peak discharge from Basin 2 for the 100-year storm was calculated to be 18.13 cfs with a $T_c$ of 15.00 minutes. The following table lists the peak discharge and time of concentration for the existing basins for the 100 year storm event. Please refer to the "Existing Hydrology Exhibit" in the appendix.

| Basin | Area | 100-Year | |
|---|---|---|---|
| | (acres) | Q (cfs) | $T_c$ (min) |
| 1 | 4.5 | 15.28 | 9.57 |
| 2 | 7.7 | 18.13 | 15.00 |

## PROPOSED CONDITIONS

To analyze the effects of the proposed Alvarado Creek development on the downstream channels and storm drain system, an analysis of the proposed storm drain system was performed. These calculations are based on the 6 hour storm event and were performed for the 100-year storms. The peak discharge under the 100-year storm conditions from Basin 1 decreased to 12.74 cfs with a $T_c$ of 12.48 minutes, while the peak discharge from Basin 2 increased to 23.39 cfs with a $T_c$ of 13.10minutes. The following table lists the peak discharge for each proposed sub-basin for all storm events considered. Please refer to the "Proposed Hydrology Exhibit" in the appendix.

| Basin | Area | 100-Year | |
|---|---|---|---|
| | (acres) | Q (cfs) | $T_c$ (min) |
| 1 | 4.5 | 12.74 | 12.48 |
| 2 | 7.7 | 23.39 | 13.10 |

The increased discharge in Basin 2 is due primarily to the slightly increased imperviousness of the development facilities and the decreased time of concentration. To mitigate this effect, treatment/detention basins will be constructed. The detention basin will be sized to attenuate the peak discharge to pre-development levels for the 100-year storm. The decreased discharge in Basin 1 is due to the increased time of concentration with similar weighted runoff coefficient. Detailed peak detention calculations will be performed during final engineering. As detailed in the project's Storm Water Quality Management Plan, the storm water basins onsite have been designed to mitigate for hydromodification impacts and are expected to be able to provide peak detention as well.

# FLOODPLAIN ANALYSIS

This Floodplain Analysis portion of this report has been prepared to address flooding due to Alvarado Creek, and the design features of the Alvarado Specific Plan which will project the project from flooding. Alvarado Creek bisects the site, crossing the site from north to south, and then running along the southerly boundary of the site. Alvarado Creek has been mapped by FEMA, and the floodplain and floodway impact considerable portions of the project site. The effective Flood Insurance Rate Map can be found in Appendix E. The project site also has a history of experiencing flooding during large rain events. The most recent of these events occurred in fall of 2019, when the Creek overtopped the masonry wall along the north bank, causing the wall to collapse and flooding portions of the RV Resort.

## DATUMS

The project topography and grading design are based on NAVD 88. This was compared to the effective FEMA model to ensure consistency in the datums used. The effective FEMA HEC-RAS cross sections were compared to the aerial topography, and found that they were consistently off by around 2', which indicates a shift in the datums. Using the National Geodetic Survey's VERTCON program, the shift from NGVD 29 to NAVD 88 at the project location is approximately 2.12'. Output from this program has been included in Appendix E for reference. Therefore, when cross section data was imported from the effective HEC-RAS model, the cross section elevations were increased by 2.12' to account for the datum shift.

## CROSS SECTIONS

The effective HEC-RAS model for Alvarado Creek was obtained from FEMA through an FIS Data Request. The model contained cross section information through the San Diego RV Resort site. To account for the change in datums, the effective HEC-RAS cross sections were raised by 2.12' as described above. The effective cross sections were then compared to the project's aerial topography. Generally, the project's aerial topography provided a more accurate representation of the existing conditions onsite. Thus, the effective cross sections were modified to match the aerial topography where applicable. These cross sections then became the existing conditions model, or the "Corrected Effective" model. Results from the Corrected Effective model can be found in Appendix G.

For the proposed conditions, modifications to the cross sections were made based on the proposed grading and improvements contemplated by the proposed development.

## MANNING'S "N"

Manning's roughness coefficients, "n", were assigned using the effective FEMA model. The "n" value used for the main channel through the project site is 0.060. For the right overbank, an "n" value of 0.075 is used, while 0.065 is used for the left overbank. In the proposed conditions, retaining walls are proposed along the project site to increase the capacity of the channel. To reflect the relative smoothness of the faces of the retaining walls, an "n" value of 0.015 was applied to the retaining walls.

## FLOWRATE

Per the current FEMA Flood Insurance Study (FIS) for San Diego County, the 100-year flowrate in Alvarado Creek at the project site is 2,500 cfs. See excerpt from the FIS included in Appendix E. To confirm this flowrate is appropriate, other existing studies of Alvarado Creek were consulted. Under existing conditions, the maximum flowrate in Alvarado Creek is constrained by an undersized Caltrans culvert under I-8, which will only allow a maximum of 1,300 cfs to cross under the freeway. See Channel Feasibility Study from 1995 and Preliminary Flood Study from 1997 which detailed this flow restriction, included for reference in Appendix F. Additional flow enters the channel prior to the project site, which would bring the flowrate at the site to 1,900 cfs. The Alvarado Creek Master Plan prepared by Boyle envisioned an ultimate condition where the upstream restriction is removed, which would bring the total flow at the project site to 3,800 cfs. The relevant excerpts from the Boyle Alvarado Creek Master Plan are included in Appendix F. The proposed flow rate in the Alvarado Creek channel at the project site under the Master Plan is 2,200 cfs, with an additional 1,600 cfs carried in a proposed box culvert in Alvarado Road. At the time of this writing, there is no project in the works to increase the capacity of the Caltrans I-8 culverts, or to construct the box culvert in Alvarado Road.

The FEMA flowrate of 2,500 cfs has been used as the flowrate in Alvarado Creek at the project site since it is more conservative than the existing flow reaching the site (1,900 cfs) and the Boyle channel flow (2,200 cfs) at the full implementation of the Master Plan. In the event that the Caltrans culverts at I-8 are upsized in the future to remove the upstream flow restriction, some form of mitigation will be required to prevent an exceedance of the capacity of the channel at the project site.

## CHANNEL IMPROVEMENTS

The project site will be improved to remove the development pads from the floodplain/floodway and contain the 100-year flood within the Creek channel. This will be done through a combination of widening the Creek bed and raising the elevation of the top of the bank. Retaining walls will be utilized to steepen the bank, thus allowing the bed of the Creek to be widened, without significantly impacting the developable area of the pads.

To analyze the impacts of the proposed improvements on the water surface elevation, the HEC-RAS cross sections were modified to reflect the channel widening and raising of the top of bank elevation. The water surface elevations were then compared to the existing conditions model. Results from the proposed conditions model are contained in Appendix G, along with an exhibit illustrating the cross section locations, typical creek sections, and water surface elevations. As can be seen in the results, the proposed improvements will fully contain the 100-year flow within the creek channel, with no adverse impacts to the water surface elevations upstream of the project site.

## FREEBOARD

The required freeboard for the proposed channel has been calculated in accordance with the San Diego County Hydraulic Design Manual, Equation 5-1. Results of this calculation can be found in Appendix G. The maximum calculated required freeboard was 2.35 ft at Station 241+50. This was rounded to 2.50 ft and applied to all cross sections along the project site. To provide this freeboard, the retaining walls along the project site will be extended to at 2.50 ft above the water surface elevation. Finished grades within the project site will be a minimum of 1.0 ft above the water surface elevation. The top of wall and onsite finished grade elevations are reflected in the HEC-RAS cross sections and are labeled on the Preliminary Floodplain Analysis Exhibit in Appendix G.

## SCOUR

To confirm that scour and erosion within the channel will not undermine the proposed retaining walls, scour calculations were performed to determine the maximum depth of scour. Scour calculations were performed in accordance with HEC-23, Bridge Scour and Stream Instability Countermeasures, Equation 4.3. This is the equation developed to calculation scour with flow parallel to a vertical wall, which is the cased with the proposed Alvarado Creek channel. The depth of scour was calculated for all cross sections along the project- see the results of these calculations in Appendix G. The maximum scour depth was calculated to be 7.28 ft at Station 251+30. To ensure that the retaining walls are not undermined by scour during large storm events, the retaining wall footings will be constructed a minimum of 7.50 ft below grade. During final engineering, other scour mitigation measures may be applied, such as revetment of the channel bottom at the face of the retaining walls.

Existing retaining walls are present along a portion of the southern bank of the channel along the MTS light rail right-of-way. These walls are present from Stations 249+38 to 247+04. Based on the scour calculations, the maximum scour depth in this are is 6.72 ft at Station 249+38. Based on a review of available record drawings for the MTS light rail, the walls extend approximately 5-6 ft below grade at the lowest point of the adjacent grade. This would place the bottom of the wall at an elevation of approximately 402.5-403.5. The depth to bottom of wall at Station 249+38 would then be 7.5-8.5 ft, which is greater than the maximum anticipated scour depth. During final engineering, the depth to the bottom of the wall will be verified in the field to ensure that it is below the maximum depth of scour and that no additional scour protection is needed.

The existing bridge crossing of Alvarado Road is protected from scour by a concrete apron that extends 30' downstream of the bridge. Therefor the bridge abutments and piers are not considered to be susceptible to scour.

# CONCLUSION

The storm drain system for the Alvarado Specific Plan project has been designed with sufficient capacity to convey the 100-year storm event without causing flooding of the proposed streets and development. Due to the impervious areas included in the development facilities and a decrease in the time of concentration, discharges from Basin 2 will increase from the existing condition to the proposed condition. Detention basins will be provided in this basin to limit the peak discharge to the existing peak discharge for the 100-year storm. Flow throughout the project site will be collected by a system of grass-lined swales, catch basins and storm drains that have been sized for the 100-year storm. Please refer to the Storm Water Quality Management Plan for the Alvarado Specific Plan for discussion of storm water quality and hydromodification mitigation.

The floodplain analysis has shown that it is feasible to remove the development pads on the project site from the 100-year floodplain/floodway, and thus allow redevelopment of the project site. This will be done through the construction of retaining walls along the sides of the Creek, which will widen the bottom of the channel and raise the adjacent pad grades. Proposed project grades have been set a minimum of 1.0' above the proposed water surface elevation with additional freeboard provided in the channel, and no upstream impacts will be created. The proposed retaining walls will be designed to resist the maximum scour depth within the channel. To implement this solution, a Conditional Letter of Map Revision will need to be filed with FEMA during the preparation of construction documents for the project site. The revision would also require review and approval by the City of La Mesa. Upon completion of construction, a Letter of Map Revision will then be filed to formally revise the FEMA Flood Insurance Rate Map and remove the development pads from the floodplain/floodway.

# Appendices

Appendix A – Vicinity Map
Appendix B – Existing Hydrology Exhibit / Proposed Hydrology Exhibit
Appendix C – AES Calculations
Appendix D – San Diego Hydrology Manual References
Appendix E – FEMA FIRM Map, FIS Excerpt, and Datum Conversion Backup
Appendix F – Alvarado Creek Flowrate References
Appendix G –HEC-RAS Output

# References

*Bridge Scour and Stream Instability Counter Measures: Experience, Selection, and Design Guidance, Hydraulic Engineering Circular No. 23*, Federal Highway Administration, September 2009.

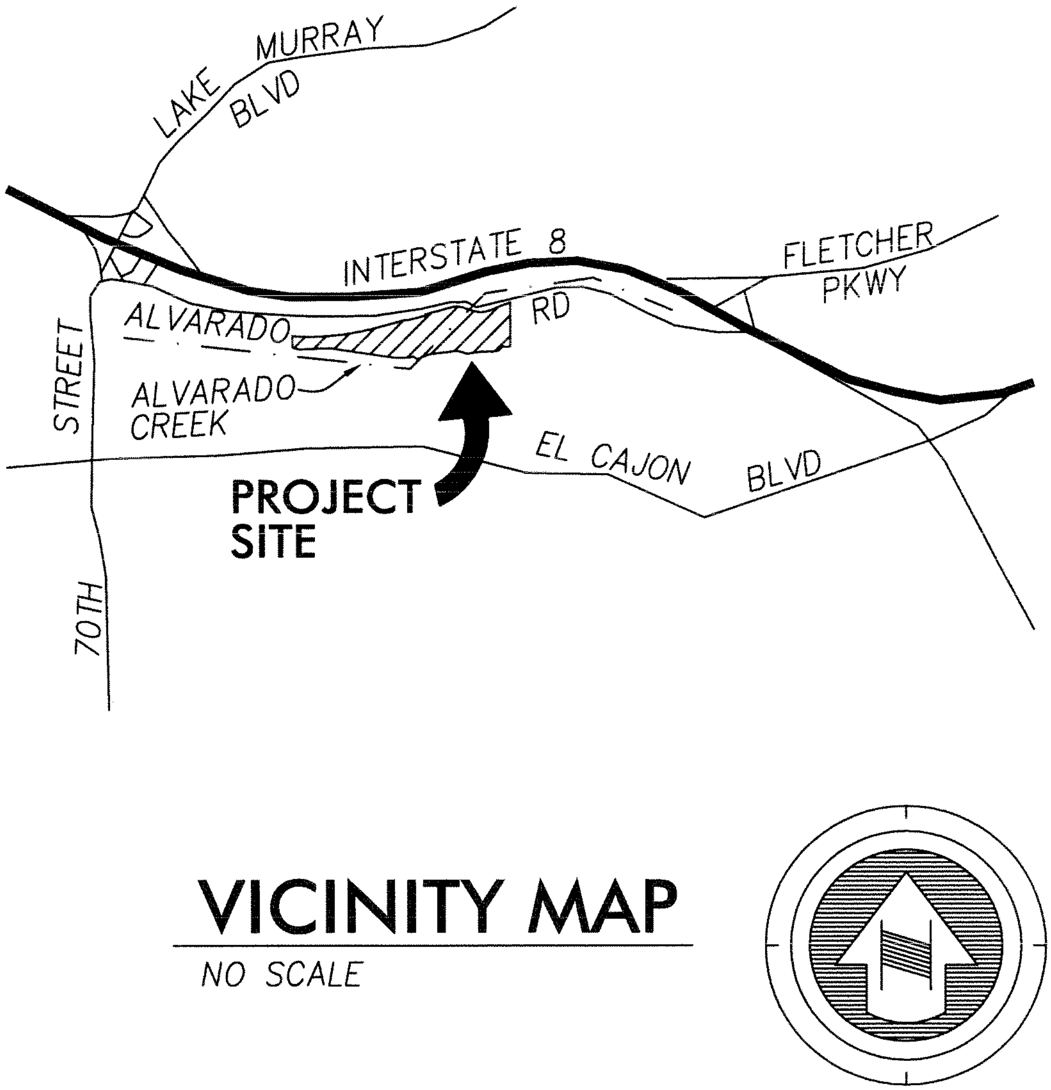
*HEC-RAS River Analysis System User's Manual, Version 4.0*, US Army Corp of Engineers Hydrologic Engineering Center, March 2008.

*HEC-RAS River Analysis System Hydraulic Reference Manual, Version 3.1*, US Army Corp of Engineers Hydrologic Engineering Center, November 2002.

*San Diego County Hydraulic Design Manual*, County of San Diego Department of Public Works Flood Control Section, September 2014.

*City of La Mesa Alvarado Channel Master Plan*, Boyle Engineering, 1989.

# Appendix A




# VICINITY MAP

*NO SCALE*

# Appendix B


# EXISTING HYDROLOGY EXHIBIT

ALVARADO SPECIFIC PLAN

FEBRUARY 2018

60' 0' 30' 60'

SCALE: 1" = 60'

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Project: Alvarado Creek
Land Use: High Density Residential
Date: 2/6/2018
Soil Type: Type D for entire site

$$C_w = \frac{\sum(C * A)}{\sum A}$$

| Node to Node | | Upstream Elev (ft) | Downstream Elev (ft) | $L_M$ (ft) | Slope | C Factor (C) | Area (a.c.) (A) | (C ) x (A) |
|---|---|---|---|---|---|---|---|---|
| 102 | 101 | 440 | 428.9 | 100 | 11.1% | 0.44 | 0.1 | 0.04 |
| 101 | 100 | 428.9 | 422 | 522 | 1.3% | 0.68 | 4.44 | 3.02 |
| 100 | 1 | 422 | 412 | 277 | 3.6% | | | 0.00 |
| Total | | | | | | | 4.5 | 3.06 |
| Weighted C Factor ($C_W$) | | | | | | | | 0.67 |

| Node to Node | | Upstream Elev (ft) | Downstream Elev (ft) | $L_M$ (ft) | Slope (%) | C Factor (C) | Area (a.c.) (A) | (C ) x (A) |
|---|---|---|---|---|---|---|---|---|
| 202 | 201 | 426 | 423 | 50 | 6.0% | 0.44 | 0.05 | 0.02 |
| 201 | 200 | 423 | 401.5 | 1717 | 1.3% | 0.67 | 7.64 | 5.12 |
| 200 | 2 | 401.5 | 397 | 72 | 6.3% | | | 0.00 |
| Total | | | | | | | 7.7 | 5.14 |
| Weighted C Factor ($C_W$) | | | | | | | | 0.67 |


# PROPOSED HYDROLOGY EXHIBIT

ALVARADO SPECIFIC PLAN

JUNE 2018

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Project: Alvarado Creek
Land Use: High Density Residential
Date: 6/28/2018
Soil Type: Type D for entire site

$$C_w = \frac{\sum(C * A)}{\sum A}$$

| Node to Node | | Upstream Elev (ft) | Downstream Elev (ft) | $L_M$ (ft) | Slope | C Factor (C) | Area (a.c.) (A) | (C ) x (A) |
|---|---|---|---|---|---|---|---|---|
| 131 | 130 | 426.7 | 426.45 | 50 | 0.5% | 0.8 | 0.04 | 0.03 |
| 130 | 120 | 422.9 | 420.83 | 374 | 0.6% | 0.7 | 0.63 | 0.44 |
| 124 | 123 | 428 | 426.83 | 50 | 2.3% | 0.62 | 0.08 | 0.05 |
| 123 | 122 | 426.83 | 425.9 | 321 | 0.3% | 0.76 | 0.66 | 0.50 |
| 122 | 121 | 423.84 | 422.19 | 329 | 0.5% | 0.79 | 0.44 | 0.35 |
| 121 | 120 | 422.19 | 420.83 | 272 | 0.5% | 0.77 | 0.58 | 0.45 |
| 120 | 110 | | | | | 0.35 | 0.14 | 0.05 |
| 114 | 113 | 428 | 427.35 | 65 | 1.0% | 0.63 | 0.05 | 0.03 |
| 113 | 112 | 427.35 | 426.4 | 96 | 1.0% | 0.75 | 0.24 | 0.18 |
| 112 | 111 | 423.7 | 420.83 | 289 | 1.0% | 0.76 | 0.83 | 0.63 |
| 110 | 100 | 416.25 | 416 | 49 | 0.5% | | | 0.00 |
| 103 | 102 | 440 | 429 | 100 | 11.0% | 0.35 | 0.06 | 0.02 |
| 102 | 101 | 429 | 424 | 386 | 1.3% | 0.35 | 0.40 | 0.14 |
| 101 | 100 | 418 | 416 | 208 | 1.0% | 0.35 | 0.05 | 0.02 |
| 100 | 1 | 416 | 412 | 16 | 25.0% | | | 0.00 |
| 302 | 301 | 427 | 425.35 | 70 | 2.4% | 0.81 | 0.04 | 0.03 |
| 301 | 300 | 425.35 | 424.7 | 303 | 0.2% | 0.84 | 0.3 | 0.25 |
| 300 | 1 | 424.7 | 412 | 369 | 3.4% | | | 0.00 |
| Total | | | | | | | 4.5 | 3.17 |
| Weighted C Factor ($C_W$) | | | | | | | | 0.70 |

| Node to Node | | Upstream Elev (ft) | Downstream Elev (ft) | $L_M$ (ft) | Slope (%) | C Factor (C) | Area (a.c.) (A) | (C ) x (A) |
|---|---|---|---|---|---|---|---|---|
| 222 | 221 | 423 | 422.75 | 50 | 0.5% | 0.67 | 0.04 | 0.03 |
| 221 | 220 | 422.75 | 422.5 | 40 | 0.6% | 0.75 | 0.12 | 0.09 |
| 220 | 213 | | | | | 0.79 | 0.41 | 0.32 |
| 215 | 214 | 423.8 | 422.5 | 75 | 1.7% | 0.79 | 0.05 | 0.04 |
| 214 | 213 | 422.5 | 421.5 | 54 | 1.9% | 0.64 | 0.09 | 0.06 |
| 207 | 206 | 423.8 | 422.75 | 74 | 1.4% | 0.63 | 0.06 | 0.04 |
| 206 | 206.5 | 422.75 | 722 | 25 | | 0.55 | 0.16 | 0.09 |
| 213 | 212 | 418 | 414 | 394 | 1.0% | 0.76 | 1.10 | 0.84 |
| 212 | 211 | 414 | 406 | 645 | 1.2% | 0.86 | 1.90 | 1.63 |
| 205 | 204 | 421.75 | 414.5 | 451 | 1.6% | 0.32 | 0.11 | 0.04 |
| 204 | 203 | | | | | 0.76 | 0.88 | 0.67 |
| 202.5 | 202.25 | 414.1 | 413.1 | 100 | 1.0% | 0.9 | 0.10 | 0.09 |
| 202.25 | 202 | 413.1 | 411.5 | 438 | 0.4% | 0.9 | 0.59 | 0.53 |
| 202 | 201 | 412.9 | 406 | 401 | 1.7% | 0.6 | 0.88 | 0.53 |
| 403 | 402 | 426 | 423 | 50 | 6.0% | 0.48 | 0.05 | 0.02 |
| 402 | 401 | 423 | 408 | 1075 | 1.4% | 0.86 | 0.84 | 0.72 |
| 410 | 400 | | | | | 0.87 | 0.29 | 0.25 |
| Total | | | | | | | 7.7 | 5.99 |
| Weighted C Factor ($C_W$) | | | | | | | | 0.78 |

# Appendix C

```
****************************************************************************

              RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
              Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                           2003,1985,1981 HYDROLOGY MANUAL
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                              Analysis prepared by:

                                Fuscoe Engineering
                                6390 Greenwich Dr
                                    Suite 300
                                  San Diego, CA

 ************************* DESCRIPTION OF STUDY **************************
* Alvarado Creek                                                           *
* Existing 100 Year Storm Basin 1                                          *
* 2018-02-01                                                               *
 **************************************************************************

  FILE NAME: ACE100.DAT
  TIME/DATE OF STUDY: 15:42 02/01/2018
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  2003 SAN DIEGO MANUAL CRITERIA

  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  6-HOUR DURATION PRECIPITATION (INCHES) =   2.700
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: USE MODIFIED RATIONAL METHOD PROCEDURES FOR CONFLUENCE ANALYSIS
  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  ================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0312 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
```

```
****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    101.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .4400
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    440.00
  DOWNSTREAM ELEVATION(FEET) =    428.90
  ELEVATION DIFFERENCE(FEET) =     11.10
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    5.515
  WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.678
  SUBAREA RUNOFF(CFS) =      0.29
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.29

****************************************************************************
  FLOW PROCESS FROM NODE    101.00 TO NODE    100.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  428.90  DOWNSTREAM ELEVATION(FEET) =  422.00
  STREET LENGTH(FEET) =   522.00   CURB HEIGHT(INCHES) =  8.0
  STREET HALFWIDTH(FEET) = 30.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  20.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.018
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.018

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       7.76
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.37
    HALFSTREET FLOOD WIDTH(FEET) =   11.68
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.73
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.02
  STREET FLOW TRAVEL TIME(MIN.) =   3.19   Tc(MIN.) =    8.70
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.977
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6800
```

```
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.675
  SUBAREA AREA(ACRES) =    4.45      SUBAREA RUNOFF(CFS) =   15.06
  TOTAL AREA(ACRES) =        4.5        PEAK FLOW RATE(CFS) =      15.28

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.44   HALFSTREET FLOOD WIDTH(FEET) =  15.66
  FLOW VELOCITY(FEET/SEC.) =  3.18   DEPTH*VELOCITY(FT*FT/SEC.) =   1.41
  LONGEST FLOWPATH FROM NODE    102.00 TO NODE    100.00 =     622.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE      1.00 IS CODE =  52
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    422.00  DOWNSTREAM(FEET) =    412.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =   277.00   CHANNEL SLOPE =  0.0361
  CHANNEL FLOW THRU SUBAREA(CFS) =      15.28
  FLOW VELOCITY(FEET/SEC) =   5.30 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   0.87   Tc(MIN.) =    9.57
  LONGEST FLOWPATH FROM NODE    102.00 TO NODE      1.00 =     899.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        4.5  TC(MIN.) =      9.57
  PEAK FLOW RATE(CFS)   =      15.28
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

```
****************************************************************************

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             Ver. 21.0 Release Date: 06/01/2014  License ID 1355

                           Analysis prepared by:

                             Fuscoe Engineering
                             6390 Greenwich Dr
                                 Suite 300
                               San Diego, CA

 ************************** DESCRIPTION OF STUDY **************************
* Alvarado Creek                                                           *
* Existing 100 Year Storm Event Basin 2                                    *
* 2018-02-01                                                               *
 **************************************************************************

  FILE NAME: ACE200.DAT
  TIME/DATE OF STUDY: 15:45 02/01/2018
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  2003 SAN DIEGO MANUAL CRITERIA

  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  6-HOUR DURATION PRECIPITATION (INCHES) =   2.700
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: USE MODIFIED RATIONAL METHOD PROCEDURES FOR CONFLUENCE ANALYSIS
  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  ================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
```

```
****************************************************************************
  FLOW PROCESS FROM NODE    202.00 TO NODE    201.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .4400
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    50.00
  UPSTREAM ELEVATION(FEET) =    426.00
  DOWNSTREAM ELEVATION(FEET) =    423.00
  ELEVATION DIFFERENCE(FEET) =      3.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.623
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.114
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.16
  TOTAL AREA(ACRES) =      0.05   TOTAL RUNOFF(CFS) =      0.16

****************************************************************************
  FLOW PROCESS FROM NODE    201.00 TO NODE    200.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  423.00  DOWNSTREAM ELEVATION(FEET) =  401.50
  STREET LENGTH(FEET) =  1717.00   CURB HEIGHT(INCHES) =  8.0
  STREET HALFWIDTH(FEET) = 30.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  20.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.018
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.018

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       9.41
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.39
    HALFSTREET FLOOD WIDTH(FEET) =   12.85
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.80
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.10
  STREET FLOW TRAVEL TIME(MIN.) =  10.22   Tc(MIN.) =   14.84
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.527
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6700
```

```
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.669
  SUBAREA AREA(ACRES) =    7.64      SUBAREA RUNOFF(CFS) =   18.05
  TOTAL AREA(ACRES) =        7.7        PEAK FLOW RATE(CFS) =      18.13

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.47   HALFSTREET FLOOD WIDTH(FEET) =  16.99
  FLOW VELOCITY(FEET/SEC.) =  3.25   DEPTH*VELOCITY(FT*FT/SEC.) =   1.52
  LONGEST FLOWPATH FROM NODE    202.00 TO NODE    200.00 =    1767.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    200.00 TO NODE      2.00 IS CODE =  52
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    401.50  DOWNSTREAM(FEET) =    397.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =    72.00   CHANNEL SLOPE =  0.0625
  CHANNEL FLOW THRU SUBAREA(CFS) =      18.13
  FLOW VELOCITY(FEET/SEC) =   7.30 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   0.16   Tc(MIN.) =   15.00
  LONGEST FLOWPATH FROM NODE    202.00 TO NODE      2.00 =    1839.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        7.7  TC(MIN.) =     15.00
  PEAK FLOW RATE(CFS)   =      18.13
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS

↑
```

```
****************************************************************************

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                           Analysis prepared by:

                             Fuscoe Engineering
                             6390 Greenwich Dr
                                 Suite 300
                               San Diego, CA

 ************************** DESCRIPTION OF STUDY **************************
* Alvarado Creek                                                           *
* Proposed 100 Year Storm Basin 1                                          *
* 2018-02-02                                                               *
 **************************************************************************

  FILE NAME: ACP100.DAT
  TIME/DATE OF STUDY: 08:06 02/02/2018
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  2003 SAN DIEGO MANUAL CRITERIA

  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  6-HOUR DURATION PRECIPITATION (INCHES) =   2.700
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   6.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: USE MODIFIED RATIONAL METHOD PROCEDURES FOR CONFLUENCE ANALYSIS
  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
```

```
****************************************************************************
  FLOW PROCESS FROM NODE    131.00 TO NODE    130.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8000
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    50.00
  UPSTREAM ELEVATION(FEET) =    426.70
  DOWNSTREAM ELEVATION(FEET) =    426.45
  ELEVATION DIFFERENCE(FEET) =      0.25
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.811
  WARNING: THE MINIMUM OVERLAND FLOW SLOPE, 0.5%, IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.114
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.23
  TOTAL AREA(ACRES) =      0.04   TOTAL RUNOFF(CFS) =      0.23

****************************************************************************
  FLOW PROCESS FROM NODE    130.00 TO NODE    120.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   422.90  DOWNSTREAM(FEET) =   420.83
  FLOW LENGTH(FEET) =   374.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN   6.0 INCH PIPE IS   3.2 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   2.16
  ESTIMATED PIPE DIAMETER(INCH) =   6.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       0.23
  PIPE TRAVEL TIME(MIN.) =   2.88    Tc(MIN.) =    7.69
  LONGEST FLOWPATH FROM NODE    131.00 TO NODE    120.00 =     424.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    130.00 TO NODE    120.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.388
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7000
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.7060
  SUBAREA AREA(ACRES) =    0.63   SUBAREA RUNOFF(CFS) =    2.38
  TOTAL AREA(ACRES) =        0.7   TOTAL RUNOFF(CFS) =       2.55
  TC(MIN.) =    7.69
```

```
****************************************************************************
  FLOW PROCESS FROM NODE    120.00 TO NODE    120.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =    7.69
  RAINFALL INTENSITY(INCH/HR) =   5.39
  TOTAL STREAM AREA(ACRES) =     0.67
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      2.55

****************************************************************************
  FLOW PROCESS FROM NODE    124.00 TO NODE    123.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6200
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    50.00
  UPSTREAM ELEVATION(FEET) =    428.00
  DOWNSTREAM ELEVATION(FEET) =    426.83
  ELEVATION DIFFERENCE(FEET) =      1.17
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.602
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.114
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.35
  TOTAL AREA(ACRES) =      0.08   TOTAL RUNOFF(CFS) =      0.35

****************************************************************************
  FLOW PROCESS FROM NODE    123.00 TO NODE    122.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    426.83  DOWNSTREAM(FEET) =    425.90
  CHANNEL LENGTH THRU SUBAREA(FEET) =   321.00   CHANNEL SLOPE =  0.0029
  CHANNEL BASE(FEET) =    5.00   "Z" FACTOR =   1.500
  MANNING'S FACTOR = 0.030   MAXIMUM DEPTH(FEET) =   1.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.633
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7600
  S.C.S. CURVE NUMBER (AMC II) =   0
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       1.54
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   1.05
  AVERAGE FLOW DEPTH(FEET) =   0.27   TRAVEL TIME(MIN.) =   5.12
```

```
  Tc(MIN.) =    9.72
  SUBAREA AREA(ACRES) =     0.66       SUBAREA RUNOFF(CFS) =    2.32
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.745
  TOTAL AREA(ACRES) =        0.7         PEAK FLOW RATE(CFS) =       2.55

  END OF SUBAREA CHANNEL FLOW HYDRAULICS:
  DEPTH(FEET) =  0.37   FLOW VELOCITY(FEET/SEC.) =   1.25
  LONGEST FLOWPATH FROM NODE    124.00 TO NODE    122.00 =     371.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    122.00 TO NODE    121.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   423.84  DOWNSTREAM(FEET) =   422.19
  FLOW LENGTH(FEET) =   329.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  15.0 INCH PIPE IS   8.1 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   3.75
  ESTIMATED PIPE DIAMETER(INCH) =  15.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       2.55
  PIPE TRAVEL TIME(MIN.) =   1.46    Tc(MIN.) =   11.18
  LONGEST FLOWPATH FROM NODE    124.00 TO NODE    121.00 =     700.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    122.00 TO NODE    121.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.233
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7900
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.7617
  SUBAREA AREA(ACRES) =    0.44   SUBAREA RUNOFF(CFS) =    1.47
  TOTAL AREA(ACRES) =        1.2   TOTAL RUNOFF(CFS) =       3.80
  TC(MIN.) =   11.18

****************************************************************************
  FLOW PROCESS FROM NODE    121.00 TO NODE    120.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   422.19  DOWNSTREAM(FEET) =   420.83
  FLOW LENGTH(FEET) =   272.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  15.0 INCH PIPE IS  10.7 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   4.07
```

```
  ESTIMATED PIPE DIAMETER(INCH) =  15.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       3.80
  PIPE TRAVEL TIME(MIN.) =   1.11    Tc(MIN.) =   12.29
  LONGEST FLOWPATH FROM NODE    124.00 TO NODE    120.00 =     972.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    121.00 TO NODE    120.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.982
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7700
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.7644
  SUBAREA AREA(ACRES) =    0.58   SUBAREA RUNOFF(CFS) =    1.78
  TOTAL AREA(ACRES) =        1.8   TOTAL RUNOFF(CFS) =       5.36
  TC(MIN.) =   12.29

****************************************************************************
  FLOW PROCESS FROM NODE    120.00 TO NODE    120.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   12.29
  RAINFALL INTENSITY(INCH/HR) =   3.98
  TOTAL STREAM AREA(ACRES) =     1.76
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      5.36

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1        2.55     7.69        5.388         0.67
      2        5.36    12.29        3.982         1.76

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
      1        5.90     7.69       5.388
      2        7.24    12.29       3.982

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
```

```
  PEAK FLOW RATE(CFS) =       7.24   Tc(MIN.) =   12.29
  TOTAL AREA(ACRES) =        2.4
  LONGEST FLOWPATH FROM NODE    124.00 TO NODE    120.00 =     972.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    120.00 TO NODE    110.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.982
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.7266
  SUBAREA AREA(ACRES) =    0.14   SUBAREA RUNOFF(CFS) =    0.20
  TOTAL AREA(ACRES) =        2.6   TOTAL RUNOFF(CFS) =      7.44
  TC(MIN.) =   12.29

****************************************************************************
  FLOW PROCESS FROM NODE    110.00 TO NODE    110.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   12.29
  RAINFALL INTENSITY(INCH/HR) =   3.98
  TOTAL STREAM AREA(ACRES) =     2.57
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      7.44

****************************************************************************
  FLOW PROCESS FROM NODE    114.00 TO NODE    113.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6300
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    65.00
  UPSTREAM ELEVATION(FEET) =    428.00
  DOWNSTREAM ELEVATION(FEET) =    427.35
  ELEVATION DIFFERENCE(FEET) =      0.65
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.821
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    65.00
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.823
```

```
  SUBAREA RUNOFF(CFS) =      0.18
  TOTAL AREA(ACRES) =      0.05   TOTAL RUNOFF(CFS) =      0.18

****************************************************************************
  FLOW PROCESS FROM NODE    113.00 TO NODE    112.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    427.35  DOWNSTREAM(FEET) =    426.40
  CHANNEL LENGTH THRU SUBAREA(FEET) =    96.00   CHANNEL SLOPE =  0.0099
  CHANNEL BASE(FEET) =    5.00   "Z" FACTOR =   1.500
  MANNING'S FACTOR = 0.030   MAXIMUM DEPTH(FEET) =   1.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.151
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7500
  S.C.S. CURVE NUMBER (AMC II) =   0
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       0.65
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   1.12
  AVERAGE FLOW DEPTH(FEET) =   0.11   TRAVEL TIME(MIN.) =   1.43
  Tc(MIN.) =    8.25
  SUBAREA AREA(ACRES) =     0.24       SUBAREA RUNOFF(CFS) =    0.93
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.729
  TOTAL AREA(ACRES) =        0.3         PEAK FLOW RATE(CFS) =       1.09

  END OF SUBAREA CHANNEL FLOW HYDRAULICS:
  DEPTH(FEET) =  0.16   FLOW VELOCITY(FEET/SEC.) =   1.34
  LONGEST FLOWPATH FROM NODE    114.00 TO NODE    112.00 =     161.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    112.00 TO NODE    111.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   423.70  DOWNSTREAM(FEET) =   420.83
  FLOW LENGTH(FEET) =   289.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN   9.0 INCH PIPE IS   5.4 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   3.91
  ESTIMATED PIPE DIAMETER(INCH) =   9.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       1.09
  PIPE TRAVEL TIME(MIN.) =   1.23    Tc(MIN.) =    9.48
  LONGEST FLOWPATH FROM NODE    114.00 TO NODE    111.00 =     450.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    112.00 TO NODE    111.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
```

```
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.709
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7600
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.7521
  SUBAREA AREA(ACRES) =    0.83   SUBAREA RUNOFF(CFS) =    2.97
  TOTAL AREA(ACRES) =        1.1   TOTAL RUNOFF(CFS) =       3.97
  TC(MIN.) =    9.48

****************************************************************************
  FLOW PROCESS FROM NODE    111.00 TO NODE    110.00 IS CODE =  52
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    420.83  DOWNSTREAM(FEET) =    416.25
  CHANNEL LENGTH THRU SUBAREA(FEET) =    40.00   CHANNEL SLOPE =  0.1145
  NOTE: CHANNEL SLOPE OF .1 WAS ASSUMED IN VELOCITY ESTIMATION
  CHANNEL FLOW THRU SUBAREA(CFS) =       3.97
  FLOW VELOCITY(FEET/SEC) =   6.32 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   0.11   Tc(MIN.) =    9.58
  LONGEST FLOWPATH FROM NODE    114.00 TO NODE    110.00 =     490.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    110.00 TO NODE    110.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =    9.58
  RAINFALL INTENSITY(INCH/HR) =   4.68
  TOTAL STREAM AREA(ACRES) =     1.12
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      3.97

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1        7.44    12.29        3.982          2.57
      2        3.97     9.58        4.675          1.12

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
```

```
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
      1       10.30     9.58       4.675
      2       10.81    12.29       3.982

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      10.81   Tc(MIN.) =   12.29
  TOTAL AREA(ACRES) =        3.7
  LONGEST FLOWPATH FROM NODE    124.00 TO NODE    110.00 =     972.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    110.00 TO NODE    100.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   416.25  DOWNSTREAM(FEET) =   416.00
  FLOW LENGTH(FEET) =    49.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  21.0 INCH PIPE IS  16.8 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   5.23
  ESTIMATED PIPE DIAMETER(INCH) =  21.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      10.81
  PIPE TRAVEL TIME(MIN.) =   0.16    Tc(MIN.) =   12.45
  LONGEST FLOWPATH FROM NODE    124.00 TO NODE    100.00 =    1021.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    100.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   12.45
  RAINFALL INTENSITY(INCH/HR) =   3.95
  TOTAL STREAM AREA(ACRES) =     3.69
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     10.81

****************************************************************************
  FLOW PROCESS FROM NODE    103.00 TO NODE    102.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    440.00
  DOWNSTREAM ELEVATION(FEET) =    429.00
  ELEVATION DIFFERENCE(FEET) =     11.00
```

```
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.267
  WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.150
  SUBAREA RUNOFF(CFS) =      0.13
  TOTAL AREA(ACRES) =      0.06   TOTAL RUNOFF(CFS) =      0.13

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    101.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    429.00  DOWNSTREAM(FEET) =    424.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =   386.00   CHANNEL SLOPE =  0.0130
  CHANNEL BASE(FEET) =    5.00   "Z" FACTOR =   1.500
  MANNING'S FACTOR = 0.030   MAXIMUM DEPTH(FEET) =   1.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.929
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       0.41
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   1.02
  AVERAGE FLOW DEPTH(FEET) =   0.08   TRAVEL TIME(MIN.) =   6.29
  Tc(MIN.) =   12.55
  SUBAREA AREA(ACRES) =     0.40       SUBAREA RUNOFF(CFS) =    0.55
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.350
  TOTAL AREA(ACRES) =        0.5         PEAK FLOW RATE(CFS) =       0.63

  END OF SUBAREA CHANNEL FLOW HYDRAULICS:
  DEPTH(FEET) =  0.10   FLOW VELOCITY(FEET/SEC.) =   1.20
  LONGEST FLOWPATH FROM NODE    103.00 TO NODE    101.00 =     486.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    101.00 TO NODE    100.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   418.00  DOWNSTREAM(FEET) =   416.00
  FLOW LENGTH(FEET) =   208.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN   9.0 INCH PIPE IS   4.0 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   3.38
  ESTIMATED PIPE DIAMETER(INCH) =   9.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       0.63
  PIPE TRAVEL TIME(MIN.) =   1.03    Tc(MIN.) =   13.58
  LONGEST FLOWPATH FROM NODE    103.00 TO NODE    100.00 =     694.00 FEET.

****************************************************************************
```

```
  FLOW PROCESS FROM NODE    101.00 TO NODE    100.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.734
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.3500
  SUBAREA AREA(ACRES) =    0.05   SUBAREA RUNOFF(CFS) =    0.07
  TOTAL AREA(ACRES) =        0.5   TOTAL RUNOFF(CFS) =       0.67
  TC(MIN.) =   13.58

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    100.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   13.58
  RAINFALL INTENSITY(INCH/HR) =   3.73
  TOTAL STREAM AREA(ACRES) =     0.51
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      0.67

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1       10.81    12.45        3.950          3.69
      2        0.67    13.58        3.734          0.51

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
      1       11.43    12.45       3.950
      2       10.89    13.58       3.734

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      11.43   Tc(MIN.) =   12.45
  TOTAL AREA(ACRES) =        4.2
  LONGEST FLOWPATH FROM NODE    124.00 TO NODE    100.00 =    1021.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE      1.00 IS CODE =  52
```

```
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    416.00  DOWNSTREAM(FEET) =    412.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =    16.00   CHANNEL SLOPE =  0.2500
  NOTE: CHANNEL SLOPE OF .1 WAS ASSUMED IN VELOCITY ESTIMATION
  CHANNEL FLOW THRU SUBAREA(CFS) =      11.43
  FLOW VELOCITY(FEET/SEC) =   8.18 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   0.03   Tc(MIN.) =   12.48
  LONGEST FLOWPATH FROM NODE    124.00 TO NODE      1.00 =    1037.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      1.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   12.48
  RAINFALL INTENSITY(INCH/HR) =   3.94
  TOTAL STREAM AREA(ACRES) =     4.20
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     11.43

****************************************************************************
  FLOW PROCESS FROM NODE    302.00 TO NODE    301.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8100
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    70.00
  UPSTREAM ELEVATION(FEET) =    427.00
  DOWNSTREAM ELEVATION(FEET) =    425.35
  ELEVATION DIFFERENCE(FEET) =      1.65
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    3.282
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.114
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.23
  TOTAL AREA(ACRES) =      0.04   TOTAL RUNOFF(CFS) =      0.23

****************************************************************************
  FLOW PROCESS FROM NODE    301.00 TO NODE    300.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
============================================================================
```

```
  UPSTREAM ELEVATION(FEET) =  425.35  DOWNSTREAM ELEVATION(FEET) =  424.70
  STREET LENGTH(FEET) =   303.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 16.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  11.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.018
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.018

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0100
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       0.96
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.28
    HALFSTREET FLOOD WIDTH(FEET) =    8.14
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.33
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.37
  STREET FLOW TRAVEL TIME(MIN.) =   3.78   Tc(MIN.) =    7.07
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.691
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8400
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.836
  SUBAREA AREA(ACRES) =    0.30      SUBAREA RUNOFF(CFS) =    1.43
  TOTAL AREA(ACRES) =        0.3        PEAK FLOW RATE(CFS) =       1.62

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.32   HALFSTREET FLOOD WIDTH(FEET) =  10.37
  FLOW VELOCITY(FEET/SEC.) =  1.49   DEPTH*VELOCITY(FT*FT/SEC.) =   0.47
  LONGEST FLOWPATH FROM NODE    302.00 TO NODE    300.00 =     373.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    300.00 TO NODE      1.00 IS CODE =  52
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    424.70  DOWNSTREAM(FEET) =    412.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =   369.00   CHANNEL SLOPE =  0.0344
  CHANNEL FLOW THRU SUBAREA(CFS) =       1.62
  FLOW VELOCITY(FEET/SEC) =   3.06 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   2.01   Tc(MIN.) =    9.08
  LONGEST FLOWPATH FROM NODE    302.00 TO NODE      1.00 =     742.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      1.00 IS CODE =   1
```

```
--------------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
================================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =    9.08
  RAINFALL INTENSITY(INCH/HR) =   4.84
  TOTAL STREAM AREA(ACRES) =     0.34
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      1.62

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1       11.43    12.48        3.943          4.20
      2        1.62     9.08        4.842          0.34

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF       Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
      1       10.92     9.08       4.842
      2       12.74    12.48       3.943

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      12.74   Tc(MIN.) =   12.48
  TOTAL AREA(ACRES) =        4.5
  LONGEST FLOWPATH FROM NODE    124.00 TO NODE      1.00 =    1037.00 FEET.
================================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        4.5  TC(MIN.) =     12.48
  PEAK FLOW RATE(CFS)   =      12.74
================================================================================
================================================================================
  END OF RATIONAL METHOD ANALYSIS
```

```
****************************************************************************

            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
            Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                         2003,1985,1981 HYDROLOGY MANUAL
         (c) Copyright 1982-2014 Advanced Engineering Software (aes)
             Ver. 21.0 Release Date: 06/01/2014  License ID 1355

                           Analysis prepared by:

                             Fuscoe Engineering
                        6390 Greenwich Dr Suite 170
                               San Diego, CA
                                   92122

----------------------------------------------------------------------------
  FILE NAME: ACP200.DAT
  TIME/DATE OF STUDY: 12:54 06/28/2018
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  2003 SAN DIEGO MANUAL CRITERIA

  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  6-HOUR DURATION PRECIPITATION (INCHES) =   2.700
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   6.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: USE MODIFIED RATIONAL METHOD PROCEDURES FOR CONFLUENCE ANALYSIS
  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0312 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

****************************************************************************
  FLOW PROCESS FROM NODE    222.00 TO NODE    221.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
```

```
===========================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6700
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    50.00
  UPSTREAM ELEVATION(FEET) =    423.00
  DOWNSTREAM ELEVATION(FEET) =    422.75
  ELEVATION DIFFERENCE(FEET) =      0.25
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.895
  WARNING: THE MINIMUM OVERLAND FLOW SLOPE, 0.5%, IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.782
  SUBAREA RUNOFF(CFS) =      0.15
  TOTAL AREA(ACRES) =      0.04   TOTAL RUNOFF(CFS) =      0.15

****************************************************************************
  FLOW PROCESS FROM NODE    221.00 TO NODE    220.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
===========================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    422.75  DOWNSTREAM(FEET) =    422.50
  CHANNEL LENGTH THRU SUBAREA(FEET) =    40.00   CHANNEL SLOPE =  0.0063
  CHANNEL BASE(FEET) =    3.00   "Z" FACTOR =   2.000
  MANNING'S FACTOR = 0.015   MAXIMUM DEPTH(FEET) =  10.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.549
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7500
  S.C.S. CURVE NUMBER (AMC II) =   0
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       0.40
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   1.47
  AVERAGE FLOW DEPTH(FEET) =   0.09   TRAVEL TIME(MIN.) =   0.45
  Tc(MIN.) =    7.35
  SUBAREA AREA(ACRES) =     0.12       SUBAREA RUNOFF(CFS) =    0.50
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.730
  TOTAL AREA(ACRES) =        0.2         PEAK FLOW RATE(CFS) =       0.65

  END OF SUBAREA CHANNEL FLOW HYDRAULICS:
  DEPTH(FEET) =  0.12   FLOW VELOCITY(FEET/SEC.) =   1.71
  LONGEST FLOWPATH FROM NODE    222.00 TO NODE    220.00 =      90.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    220.00 TO NODE    213.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
===========================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   419.00  DOWNSTREAM(FEET) =   418.00
  FLOW LENGTH(FEET) =   205.00   MANNING'S N =  0.013
```

```
  DEPTH OF FLOW IN   9.0 INCH PIPE IS   4.9 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   2.63
  ESTIMATED PIPE DIAMETER(INCH) =   9.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       0.65
  PIPE TRAVEL TIME(MIN.) =   1.30    Tc(MIN.) =    8.65
  LONGEST FLOWPATH FROM NODE    222.00 TO NODE    213.00 =     295.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    220.00 TO NODE    213.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.995
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7900
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.7732
  SUBAREA AREA(ACRES) =    0.41   SUBAREA RUNOFF(CFS) =    1.62
  TOTAL AREA(ACRES) =        0.6   TOTAL RUNOFF(CFS) =       2.20
  TC(MIN.) =    8.65

****************************************************************************
  FLOW PROCESS FROM NODE    213.00 TO NODE    213.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  3
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =    8.65
  RAINFALL INTENSITY(INCH/HR) =   5.00
  TOTAL STREAM AREA(ACRES) =     0.57
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      2.20

****************************************************************************
  FLOW PROCESS FROM NODE    215.00 TO NODE    214.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7900
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    75.00
  UPSTREAM ELEVATION(FEET) =    423.80
  DOWNSTREAM ELEVATION(FEET) =    422.50
  ELEVATION DIFFERENCE(FEET) =      1.30
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.023
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.114
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
```

```
  SUBAREA RUNOFF(CFS) =      0.28
  TOTAL AREA(ACRES) =      0.05   TOTAL RUNOFF(CFS) =      0.28

****************************************************************************
  FLOW PROCESS FROM NODE    214.00 TO NODE    213.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    422.50  DOWNSTREAM(FEET) =    421.50
  CHANNEL LENGTH THRU SUBAREA(FEET) =    54.00   CHANNEL SLOPE =  0.0185
  CHANNEL BASE(FEET) =    5.00   "Z" FACTOR =   1.500
  MANNING'S FACTOR = 0.030   MAXIMUM DEPTH(FEET) =   1.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.114
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6400
  S.C.S. CURVE NUMBER (AMC II) =   0
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       0.49
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   1.20
  AVERAGE FLOW DEPTH(FEET) =   0.08   TRAVEL TIME(MIN.) =   0.75
  Tc(MIN.) =    4.77
  SUBAREA AREA(ACRES) =     0.09       SUBAREA RUNOFF(CFS) =    0.41
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.694
  TOTAL AREA(ACRES) =        0.1         PEAK FLOW RATE(CFS) =       0.69

  END OF SUBAREA CHANNEL FLOW HYDRAULICS:
  DEPTH(FEET) =  0.10   FLOW VELOCITY(FEET/SEC.) =   1.39
  LONGEST FLOWPATH FROM NODE    215.00 TO NODE    213.00 =     129.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    213.00 TO NODE    213.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  3
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =    4.77
  RAINFALL INTENSITY(INCH/HR) =   7.11
  TOTAL STREAM AREA(ACRES) =     0.14
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      0.69

****************************************************************************
  FLOW PROCESS FROM NODE    207.00 TO NODE    206.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
```

```
  USER-SPECIFIED RUNOFF COEFFICIENT = .6300
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    74.00
  UPSTREAM ELEVATION(FEET) =    423.80
  DOWNSTREAM ELEVATION(FEET) =    422.75
  ELEVATION DIFFERENCE(FEET) =      1.05
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.262
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    69.19
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.152
  SUBAREA RUNOFF(CFS) =      0.23
  TOTAL AREA(ACRES) =      0.06   TOTAL RUNOFF(CFS) =      0.23

****************************************************************************
  FLOW PROCESS FROM NODE    206.00 TO NODE    206.50 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    422.75  DOWNSTREAM(FEET) =    422.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =    25.00   CHANNEL SLOPE =  0.0300
  CHANNEL BASE(FEET) =    3.00   "Z" FACTOR =   2.000
  MANNING'S FACTOR = 0.015   MAXIMUM DEPTH(FEET) =  10.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.049
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .5500
  S.C.S. CURVE NUMBER (AMC II) =   0
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       0.50
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   2.50
  AVERAGE FLOW DEPTH(FEET) =   0.06   TRAVEL TIME(MIN.) =   0.17
  Tc(MIN.) =    6.43
  SUBAREA AREA(ACRES) =     0.16       SUBAREA RUNOFF(CFS) =    0.53
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.572
  TOTAL AREA(ACRES) =        0.2         PEAK FLOW RATE(CFS) =       0.76

  END OF SUBAREA CHANNEL FLOW HYDRAULICS:
  DEPTH(FEET) =  0.08   FLOW VELOCITY(FEET/SEC.) =   3.04
  LONGEST FLOWPATH FROM NODE    207.00 TO NODE    206.50 =      99.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    206.50 TO NODE    213.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   418.60  DOWNSTREAM(FEET) =   418.00
```

```
  FLOW LENGTH(FEET) =   205.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN   9.0 INCH PIPE IS   6.5 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   2.22
  ESTIMATED PIPE DIAMETER(INCH) =   9.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       0.76
  PIPE TRAVEL TIME(MIN.) =   1.54    Tc(MIN.) =    7.97
  LONGEST FLOWPATH FROM NODE    207.00 TO NODE    213.00 =     304.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    213.00 TO NODE    213.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  3
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  3 ARE:
  TIME OF CONCENTRATION(MIN.) =    7.97
  RAINFALL INTENSITY(INCH/HR) =   5.27
  TOTAL STREAM AREA(ACRES) =     0.22
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      0.76

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1        2.20     8.65        4.995          0.57
      2        0.69     4.77        7.114          0.14
      3        0.76     7.97        5.268          0.22

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  3 STREAMS.

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
      1        2.36     4.77       7.114
      2        3.30     7.97       5.268
      3        3.41     8.65       4.995

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       3.41   Tc(MIN.) =    8.65
  TOTAL AREA(ACRES) =        0.9
  LONGEST FLOWPATH FROM NODE    207.00 TO NODE    213.00 =     304.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    213.00 TO NODE    212.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
```

```
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   418.00  DOWNSTREAM(FEET) =   414.00
  FLOW LENGTH(FEET) =   394.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  12.0 INCH PIPE IS   9.6 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   5.08
  ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       3.41
  PIPE TRAVEL TIME(MIN.) =   1.29    Tc(MIN.) =    9.94
  LONGEST FLOWPATH FROM NODE    207.00 TO NODE    212.00 =     698.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    213.00 TO NODE    212.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.566
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7600
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.7387
  SUBAREA AREA(ACRES) =    1.10   SUBAREA RUNOFF(CFS) =    3.82
  TOTAL AREA(ACRES) =        2.0   TOTAL RUNOFF(CFS) =       6.85
  TC(MIN.) =    9.94

****************************************************************************
  FLOW PROCESS FROM NODE    212.00 TO NODE    211.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   414.00  DOWNSTREAM(FEET) =   406.00
  FLOW LENGTH(FEET) =   645.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  15.0 INCH PIPE IS  12.0 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   6.51
  ESTIMATED PIPE DIAMETER(INCH) =  15.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       6.85
  PIPE TRAVEL TIME(MIN.) =   1.65    Tc(MIN.) =   11.59
  LONGEST FLOWPATH FROM NODE    207.00 TO NODE    211.00 =    1343.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    212.00 TO NODE    211.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.135
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8600
  S.C.S. CURVE NUMBER (AMC II) =   0
```

```
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.7974
  SUBAREA AREA(ACRES) =    1.90   SUBAREA RUNOFF(CFS) =    6.76
  TOTAL AREA(ACRES) =        3.9   TOTAL RUNOFF(CFS) =      12.96
  TC(MIN.) =   11.59

****************************************************************************
  FLOW PROCESS FROM NODE    211.00 TO NODE    211.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   11.59
  RAINFALL INTENSITY(INCH/HR) =   4.14
  TOTAL STREAM AREA(ACRES) =     3.93
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     12.96

****************************************************************************
  FLOW PROCESS FROM NODE    205.00 TO NODE    204.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3200
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   451.00
  UPSTREAM ELEVATION(FEET) =    421.75
  DOWNSTREAM ELEVATION(FEET) =    414.50
  ELEVATION DIFFERENCE(FEET) =      7.25
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =   10.104
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    71.08
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.519
  SUBAREA RUNOFF(CFS) =      0.16
  TOTAL AREA(ACRES) =      0.11   TOTAL RUNOFF(CFS) =      0.16

****************************************************************************
  FLOW PROCESS FROM NODE    204.00 TO NODE    203.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   411.00  DOWNSTREAM(FEET) =   408.00
  FLOW LENGTH(FEET) =   574.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN   6.0 INCH PIPE IS   2.6 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   1.91
```

```
  ESTIMATED PIPE DIAMETER(INCH) =   6.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       0.16
  PIPE TRAVEL TIME(MIN.) =   5.01    Tc(MIN.) =   15.11
  LONGEST FLOWPATH FROM NODE    205.00 TO NODE    203.00 =    1025.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    204.00 TO NODE    203.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.486
   *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7600
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.7111
  SUBAREA AREA(ACRES) =    0.88   SUBAREA RUNOFF(CFS) =    2.33
  TOTAL AREA(ACRES) =        1.0   TOTAL RUNOFF(CFS) =       2.45
  TC(MIN.) =   15.11

****************************************************************************
  FLOW PROCESS FROM NODE    203.00 TO NODE    211.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   406.90  DOWNSTREAM(FEET) =   406.00
  FLOW LENGTH(FEET) =    89.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  12.0 INCH PIPE IS   7.4 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   4.82
  ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       2.45
  PIPE TRAVEL TIME(MIN.) =   0.31    Tc(MIN.) =   15.42
  LONGEST FLOWPATH FROM NODE    205.00 TO NODE    211.00 =    1114.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    211.00 TO NODE    211.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   15.42
  RAINFALL INTENSITY(INCH/HR) =   3.44
  TOTAL STREAM AREA(ACRES) =     0.99
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      2.45

  ** CONFLUENCE DATA **
```

```
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1       12.96    11.59        4.135          3.93
      2        2.45    15.42        3.441          0.99

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
      1       14.80    11.59       4.135
      2       13.24    15.42       3.441

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      14.80   Tc(MIN.) =   11.59
  TOTAL AREA(ACRES) =        4.9
  LONGEST FLOWPATH FROM NODE    207.00 TO NODE    211.00 =    1343.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    211.00 TO NODE    200.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   406.00  DOWNSTREAM(FEET) =   401.00
  FLOW LENGTH(FEET) =   395.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  21.0 INCH PIPE IS  14.9 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   8.11
  ESTIMATED PIPE DIAMETER(INCH) =  21.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      14.80
  PIPE TRAVEL TIME(MIN.) =   0.81    Tc(MIN.) =   12.41
  LONGEST FLOWPATH FROM NODE    207.00 TO NODE    200.00 =    1738.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    200.00 TO NODE    200.00 IS CODE =  10
----------------------------------------------------------------------------
  >>>>>MAIN-STREAM MEMORY COPIED ONTO MEMORY BANK # 1 <<<<<
============================================================================

****************************************************************************
  FLOW PROCESS FROM NODE    202.50 TO NODE    202.25 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .9000
  S.C.S. CURVE NUMBER (AMC II) =   0
```

```
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    414.10
  DOWNSTREAM ELEVATION(FEET) =    413.10
  ELEVATION DIFFERENCE(FEET) =      1.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    2.902
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    65.00
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.114
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.64
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.64

****************************************************************************
  FLOW PROCESS FROM NODE    202.25 TO NODE    202.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    413.10  DOWNSTREAM(FEET) =    411.50
  CHANNEL LENGTH THRU SUBAREA(FEET) =   438.00   CHANNEL SLOPE =  0.0037
  CHANNEL BASE(FEET) =    3.00   "Z" FACTOR =   2.000
  MANNING'S FACTOR = 0.015   MAXIMUM DEPTH(FEET) =  10.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.249
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .9000
  S.C.S. CURVE NUMBER (AMC II) =   0
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.31
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   2.27
  AVERAGE FLOW DEPTH(FEET) =   0.29   TRAVEL TIME(MIN.) =   3.21
  Tc(MIN.) =    6.11
  SUBAREA AREA(ACRES) =     0.59       SUBAREA RUNOFF(CFS) =    3.32
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.900
  TOTAL AREA(ACRES) =        0.7         PEAK FLOW RATE(CFS) =       3.88

  END OF SUBAREA CHANNEL FLOW HYDRAULICS:
  DEPTH(FEET) =  0.38   FLOW VELOCITY(FEET/SEC.) =   2.73
  LONGEST FLOWPATH FROM NODE    202.50 TO NODE    202.00 =     538.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    202.00 TO NODE    201.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   407.50  DOWNSTREAM(FEET) =   405.00
  FLOW LENGTH(FEET) =   384.00   MANNING'S N =  0.013
```

```
  DEPTH OF FLOW IN  15.0 INCH PIPE IS   9.8 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   4.56
  ESTIMATED PIPE DIAMETER(INCH) =  15.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       3.88
  PIPE TRAVEL TIME(MIN.) =   1.40    Tc(MIN.) =    7.52
  LONGEST FLOWPATH FROM NODE    202.50 TO NODE    201.00 =     922.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    202.00 TO NODE    201.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.470
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6000
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.7318
  SUBAREA AREA(ACRES) =    0.88   SUBAREA RUNOFF(CFS) =    2.89
  TOTAL AREA(ACRES) =        1.6   TOTAL RUNOFF(CFS) =       6.28
  TC(MIN.) =    7.52

****************************************************************************
  FLOW PROCESS FROM NODE    201.00 TO NODE    200.50 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   402.53  DOWNSTREAM(FEET) =   402.00
  FLOW LENGTH(FEET) =    52.50   MANNING'S N =  0.013
  DEPTH OF FLOW IN  15.0 INCH PIPE IS  12.2 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   5.88
  ESTIMATED PIPE DIAMETER(INCH) =  15.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       6.28
  PIPE TRAVEL TIME(MIN.) =   0.15    Tc(MIN.) =    7.66
  LONGEST FLOWPATH FROM NODE    202.50 TO NODE    200.50 =     974.50 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    200.50 TO NODE    200.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   402.00  DOWNSTREAM(FEET) =   401.00
  FLOW LENGTH(FEET) =   103.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  18.0 INCH PIPE IS  10.3 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   6.02
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       6.28
```

```
  PIPE TRAVEL TIME(MIN.) =   0.29    Tc(MIN.) =    7.95
  LONGEST FLOWPATH FROM NODE    202.50 TO NODE    200.00 =    1077.50 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    200.00 TO NODE    200.00 IS CODE =  11
----------------------------------------------------------------------------
  >>>>>CONFLUENCE MEMORY BANK # 1 WITH THE MAIN-STREAM MEMORY<<<<<
============================================================================

  ** MAIN STREAM CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY     AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)   (ACRE)
     1         6.28     7.95       5.275        1.57
  LONGEST FLOWPATH FROM NODE    202.50 TO NODE    200.00 =    1077.50 FEET.

  ** MEMORY BANK #  1 CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY     AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)   (ACRE)
     1       14.80    12.41       3.959        4.92
  LONGEST FLOWPATH FROM NODE    207.00 TO NODE    200.00 =    1738.00 FEET.

  ** PEAK FLOW RATE TABLE **
  STREAM    RUNOFF       Tc      INTENSITY
  NUMBER     (CFS)     (MIN.)   (INCH/HOUR)
     1      15.77       7.95        5.275
     2      19.52      12.41        3.959

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      19.52   Tc(MIN.) =   12.41
  TOTAL AREA(ACRES) =        6.5

****************************************************************************
  FLOW PROCESS FROM NODE    200.00 TO NODE      2.00 IS CODE =  52
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    402.00  DOWNSTREAM(FEET) =    397.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =   198.00   CHANNEL SLOPE =  0.0253
  CHANNEL FLOW THRU SUBAREA(CFS) =      19.52
  FLOW VELOCITY(FEET/SEC) =   4.73 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   0.70   Tc(MIN.) =   13.10
  LONGEST FLOWPATH FROM NODE    207.00 TO NODE      2.00 =    1936.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      2.00 TO NODE      2.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
```

```
===========================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   13.10
  RAINFALL INTENSITY(INCH/HR) =   3.82
  TOTAL STREAM AREA(ACRES) =     6.49
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     19.52

****************************************************************************
  FLOW PROCESS FROM NODE    403.00 TO NODE    402.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
===========================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .4800
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    50.00
  UPSTREAM ELEVATION(FEET) =    426.00
  DOWNSTREAM ELEVATION(FEET) =    423.00
  ELEVATION DIFFERENCE(FEET) =      3.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.343
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.114
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.17
  TOTAL AREA(ACRES) =      0.05   TOTAL RUNOFF(CFS) =      0.17

****************************************************************************
  FLOW PROCESS FROM NODE    402.00 TO NODE    401.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
===========================================================================
  UPSTREAM ELEVATION(FEET) =  423.00  DOWNSTREAM ELEVATION(FEET) =  408.00
  STREET LENGTH(FEET) =  1075.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 16.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  11.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.018
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.018

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0100
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       1.81
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.26
```

```
    HALFSTREET FLOOD WIDTH(FEET) =    7.02
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.21
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.82
  STREET FLOW TRAVEL TIME(MIN.) =   5.59   Tc(MIN.) =    9.93
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.570
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8600
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.839
  SUBAREA AREA(ACRES) =    0.84      SUBAREA RUNOFF(CFS) =    3.30
  TOTAL AREA(ACRES) =        0.9        PEAK FLOW RATE(CFS) =       3.41

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.30   HALFSTREET FLOOD WIDTH(FEET) =   9.51
  FLOW VELOCITY(FEET/SEC.) =  3.65   DEPTH*VELOCITY(FT*FT/SEC.) =   1.10
  LONGEST FLOWPATH FROM NODE    403.00 TO NODE    401.00 =    1125.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    401.00 TO NODE    400.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   408.00  DOWNSTREAM(FEET) =   401.50
  FLOW LENGTH(FEET) =   418.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  12.0 INCH PIPE IS   8.0 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   6.11
  ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       3.41
  PIPE TRAVEL TIME(MIN.) =   1.14    Tc(MIN.) =   11.07
  LONGEST FLOWPATH FROM NODE    403.00 TO NODE    400.00 =    1543.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    410.00 TO NODE    400.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.261
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8700
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.8464
  SUBAREA AREA(ACRES) =    0.29   SUBAREA RUNOFF(CFS) =    1.08
  TOTAL AREA(ACRES) =        1.2   TOTAL RUNOFF(CFS) =       4.26
  TC(MIN.) =   11.07

****************************************************************************
  FLOW PROCESS FROM NODE    400.00 TO NODE      2.00 IS CODE =  52
```

```
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    401.50  DOWNSTREAM(FEET) =    397.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =    72.00   CHANNEL SLOPE =  0.0625
  CHANNEL FLOW THRU SUBAREA(CFS) =       4.26
  FLOW VELOCITY(FEET/SEC) =   5.08 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   0.24   Tc(MIN.) =   11.30
  LONGEST FLOWPATH FROM NODE    403.00 TO NODE      2.00 =    1615.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      2.00 TO NODE      2.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   11.30
  RAINFALL INTENSITY(INCH/HR) =   4.20
  TOTAL STREAM AREA(ACRES) =     1.18
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      4.26

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
     1       19.52    13.10        3.821          6.49
     2        4.26    11.30        4.203          1.18

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
     1       21.10    11.30       4.203
     2       23.39    13.10       3.821

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      23.39   Tc(MIN.) =   13.10
  TOTAL AREA(ACRES) =        7.7
  LONGEST FLOWPATH FROM NODE    207.00 TO NODE      2.00 =    1936.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        7.7  TC(MIN.) =     13.10
  PEAK FLOW RATE(CFS)   =      23.39
============================================================================
```

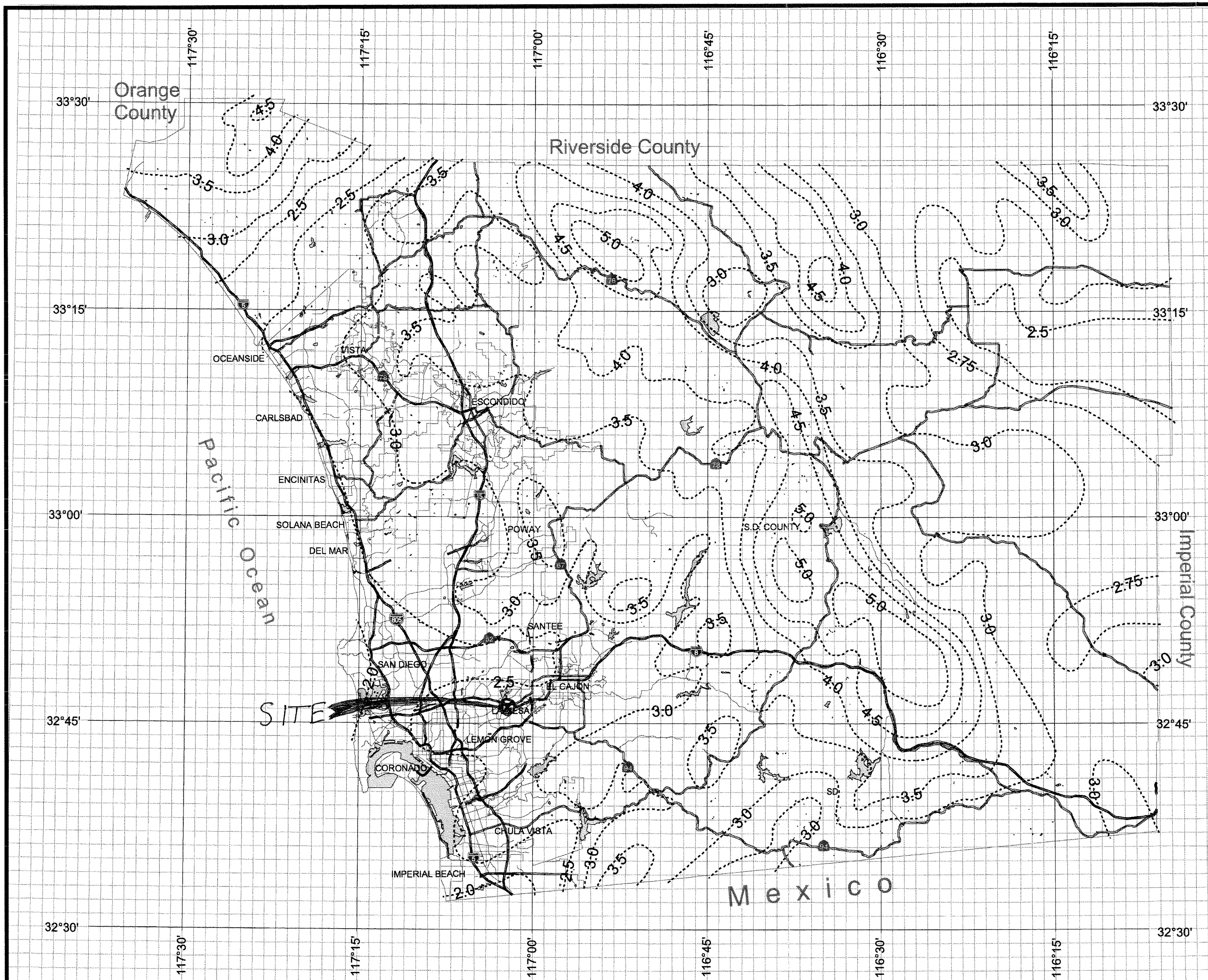
==============================================================================
END OF RATIONAL METHOD ANALYSIS

# Appendix D

# County of San Diego Hydrology Manual

*Rainfall Isopluvials*

**100 Year Rainfall Event - 6 Hours**




Isopluvial (inches)

Department of Public Works Geographic Information Services

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N S W E

3 0 3 Miles

## Table 3-1
## RUNOFF COEFFICIENTS FOR URBAN AREAS

| Land Use | | Runoff Coeffieient "C" | | | | |
|---|---|---|---|---|---|---|
| | | | Soil Type | | | |
| NRCS Elements | County Elements | % IMPER. | A | B | C | D |
| Undisturbed Natural Terrain (Natural) | Permanent Open Space | 0* | 0.20 | 0.25 | 0.30 | 0.35 |
| Low Density Residential (LDR) | Residential, 1.0 DU/A or less | 10 | 0.27 | 0.32 | 0.36 | 0.41 |
| Low Density Residential (LDR) | Residential, 2.0 DU/A or less | 20 | 0.34 | 0.38 | 0.42 | 0.46 |
| Low Density Residential (LDR) | Residential, 2.9 DU/A or less | 25 | 0.38 | 0.41 | 0.45 | 0.49 |
| Medium Density Residential (MDR) | Residential, 4.3 DU/A or less | 30 | 0.41 | 0.45 | 0.48 | 0.52 |
| Medium Density Residential (MDR) | Residential, 7.3 DU/A or less | 40 | 0.48 | 0.51 | 0.54 | 0.57 |
| Medium Density Residential (MDR) | Residential, 10.9 DU/A or less | 45 | 0.52 | 0.54 | 0.57 | 0.60 |
| Medium Density Residential (MDR) | Residential, 14.5 DU/A or less | 50 | 0.55 | 0.58 | 0.60 | 0.63 |
| High Density Residential (HDR) | Residential, 24.0 DU/A or less | 65 | 0.66 | 0.67 | 0.69 | 0.71 |
| High Density Residential (HDR) | Residential, 43.0 DU/A or less | 80 | 0.76 | 0.77 | 0.78 | 0.79 |
| Commercial/Industrial (N. Com) | Neighborhood Commercial | 80 | 0.76 | 0.77 | 0.78 | 0.79 |
| Commercial/Industrial (G. Com) | General Commereial | 85 | 0.80 | 0.80 | 0.81 | 0.82 |
| Commereial/Industrial (O.P. Com) | Office Professional/Commercial | 90 | 0.83 | 0.84 | 0.84 | 0.85 |
| Commercial/Industrial (Limited I.) | Limited Industrial | 90 | 0.83 | 0.84 | 0.84 | 0.85 |
| Commercial/Industrial (General I.) | General Industrial | 95 | 0.87 | 0.87 | 0.87 | 0.87 |

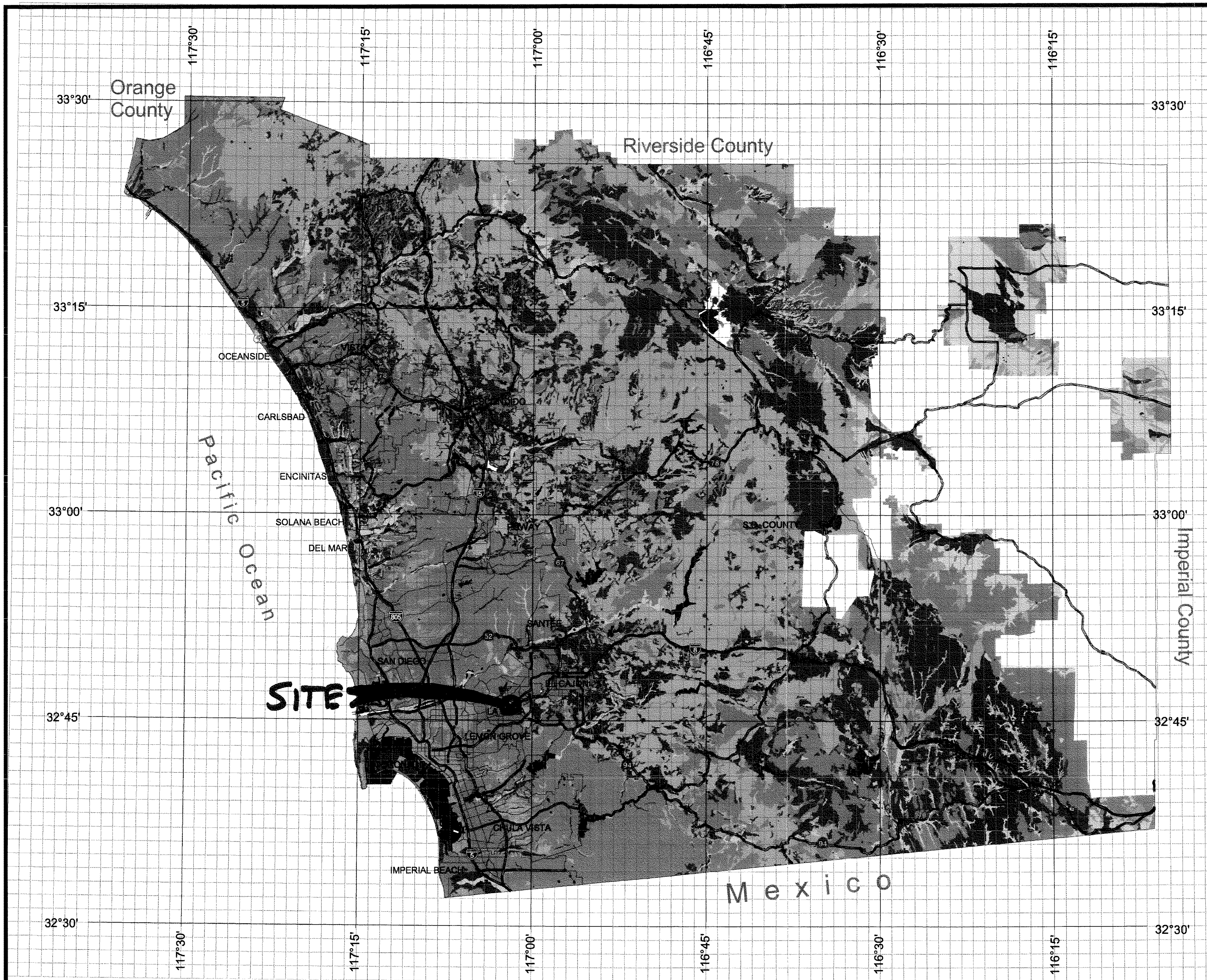
*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff eoefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is loeated in Cleveland National Forest).

DU/A = dwelling units per acre

NRCS = National Resources Conservation Service

# County of San Diego
# Hydrology Manual

*Soil Hydrologic Groups*




## Legend

Soil Groups

- Group A
- Group B
- Group C
- Group D
- Undetermined
- Data Unavailable

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N W E S

3 0 3 Miles

Note that the Initial Time of Concentration should be reflective of the general land-use at the upstream end of a drainage basin. A single lot with an area of two or less acres does not have a significant effect where the drainage basin area is 20 to 600 acres.

Table 3-2 provides limits of the length (Maximum Length ($L_M$)) of sheet flow to be used in hydrology studies. Initial $T_i$ values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved by the "Regulating Agency" when submitted with a detailed study.

**Table 3-2**

## MAXIMUM OVERLAND FLOW LENGTH ($L_M$) & INITIAL TIME OF CONCENTRATION ($T_i$)

| Element* | DU/ | .5% | | 1% | | 2% | | 3% | | 5% | | 10% | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Acre | $L_M$ | $T_i$ | $L_M$ | $T_i$ | $L_M$ | $T_i$ | $L_M$ | $T_i$ | $L_M$ | $T_i$ | $L_M$ | $T_i$ |
| Natural | | 50 | 13.2 | 70 | 12.5 | 85 | 10.9 | 100 | 10.3 | 100 | 8.7 | 100 | 6.9 |
| LDR | 1 | 50 | 12.2 | 70 | 11.5 | 85 | 10.0 | 100 | 9.5 | 100 | 8.0 | 100 | 6.4 |
| LDR | 2 | 50 | 11.3 | 70 | 10.5 | 85 | 9.2 | 100 | 8.8 | 100 | 7.4 | 100 | 5.8 |
| LDR | 2.9 | 50 | 10.7 | 70 | 10.0 | 85 | 8.8 | 95 | 8.1 | 100 | 7.0 | 100 | 5.6 |
| MDR | 4.3 | 50 | 10.2 | 70 | 9.6 | 80 | 8.1 | 95 | 7.8 | 100 | 6.7 | 100 | 5.3 |
| MDR | 7.3 | 50 | 9.2 | 65 | 8.4 | 80 | 7.4 | 95 | 7.0 | 100 | 6.0 | 100 | 4.8 |
| MDR | 10.9 | 50 | 8.7 | 65 | 7.9 | 80 | 6.9 | 90 | 6.4 | 100 | 5.7 | 100 | 4.5 |
| MDR | 14.5 | 50 | 8.2 | 65 | 7.4 | 80 | 6.5 | 90 | 6.0 | 100 | 5.4 | 100 | 4.3 |
| HDR | 24 | 50 | 6.7 | 65 | 6.1 | 75 | 5.1 | 90 | 4.9 | 95 | 4.3 | 100 | 3.5 |
| HDR | 43 | 50 | 5.3 | 65 | 4.7 | 75 | 4.0 | 85 | 3.8 | 95 | 3.4 | 100 | 2.7 |
| N. Com | | 50 | 5.3 | 60 | 4.5 | 75 | 4.0 | 85 | 3.8 | 95 | 3.4 | 100 | 2.7 |
| G. Com | | 50 | 4.7 | 60 | 4.1 | 75 | 3.6 | 85 | 3.4 | 90 | 2.9 | 100 | 2.4 |
| O.P./Com | | 50 | 4.2 | 60 | 3.7 | 70 | 3.1 | 80 | 2.9 | 90 | 2.6 | 100 | 2.2 |
| Limited I. | | 50 | 4.2 | 60 | 3.7 | 70 | 3.1 | 80 | 2.9 | 90 | 2.6 | 100 | 2.2 |
| General I. | | 50 | 3.7 | 60 | 3.2 | 70 | 2.7 | 80 | 2.6 | 90 | 2.3 | 100 | 1.9 |

*See Table 3-1 for more detailed description

# Appendix E

## 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 (BFEs)** 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 table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table 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 Universal Transverse Mercator (UTM) Zone 11. The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or UTM 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 USDA National Agriculture Imagery Program (NAIP). this information was photogrammetrically compiled at a scale of 1:24,000 from aerial photography dated 2009.

This map reflects 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.

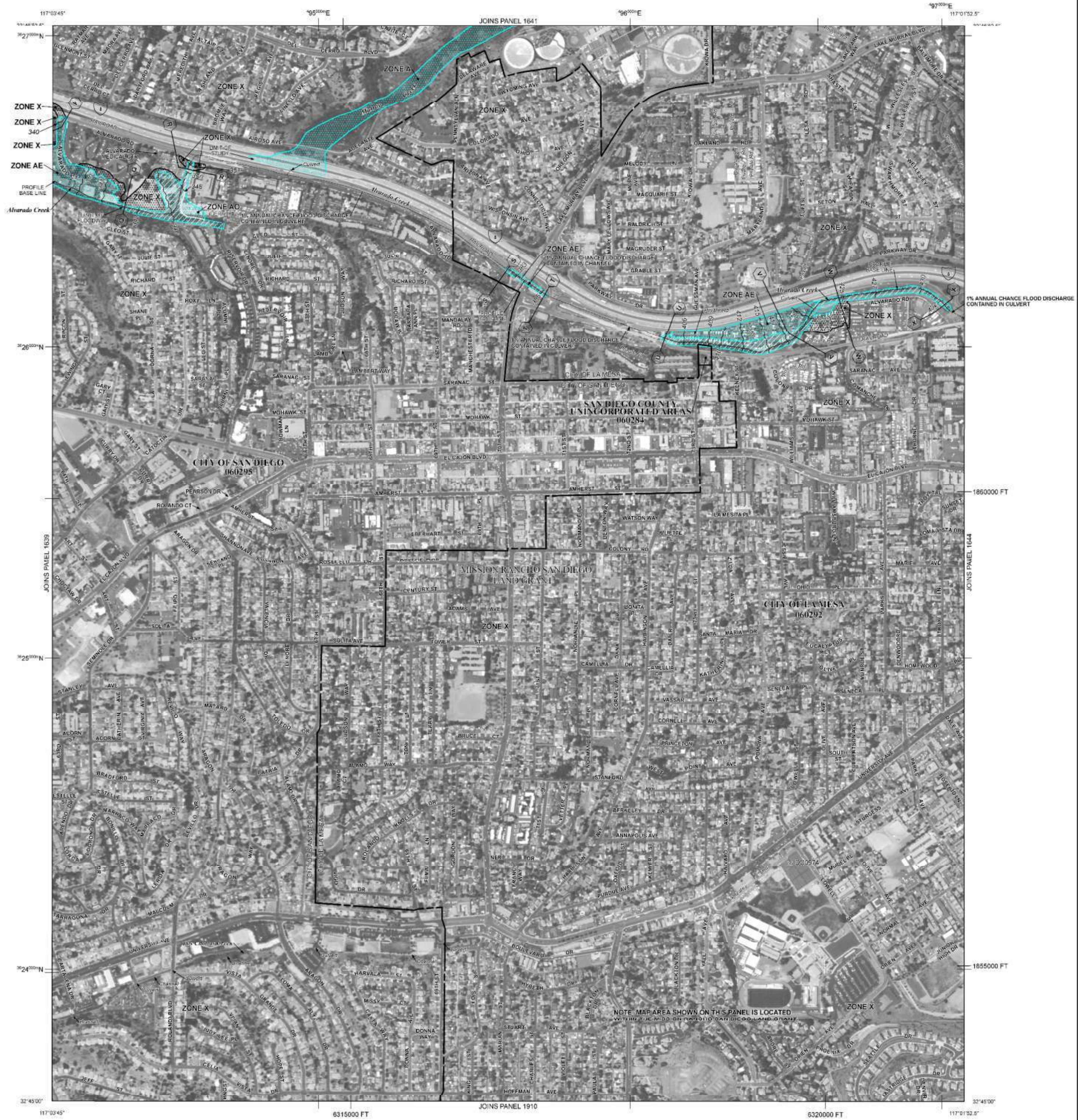
**Corporate limits** shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

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.

Contact the **FEMA Map Service Center** at 1-877-FEMA MAP (1-877-336-2627) for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov/.

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

The **"profile base lines"** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the "profile base line", in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.




## LEGEND

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

The 1% annual chance 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 | Areas to be protected from 1% annual chance flood event 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

| | |
|---|---|
| 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

| | |
|---|---|
| A —— A | Cross section line |
| 23 - - - 23 | Transect line |
| 97°07'30", 32°22'30" | Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere |
| 4275000mE | 1000-meter Universal Transverse Mercator grid ticks, zone 11 |
| 6000000 FT | 5000-foot grid values: California State Plane coordinate system, Zone VI (FIPSZONE = 406), Lambert projection |
| DX5510 | Bench mark (see explanation in Notes to Users section of this FIRM panel) |
| ● M1.5 | River Mile |

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
June 19, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
June 16, 1999

July 2, 2002

May 16, 2012 – to update corporate limits, to add roads and road names, to incorporate previously issued Letters of Map Revision, and to update map elevations to North American Vertical Datum of 1988.

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 0 250 500 750 1,000 FEET
100 0 100 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1643J

# FIRM
## FLOOD INSURANCE RATE MAP
## SAN DIEGO COUNTY, CALIFORNIA
### AND INCORPORATED AREAS

**PANEL 1643 OF 2375**

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

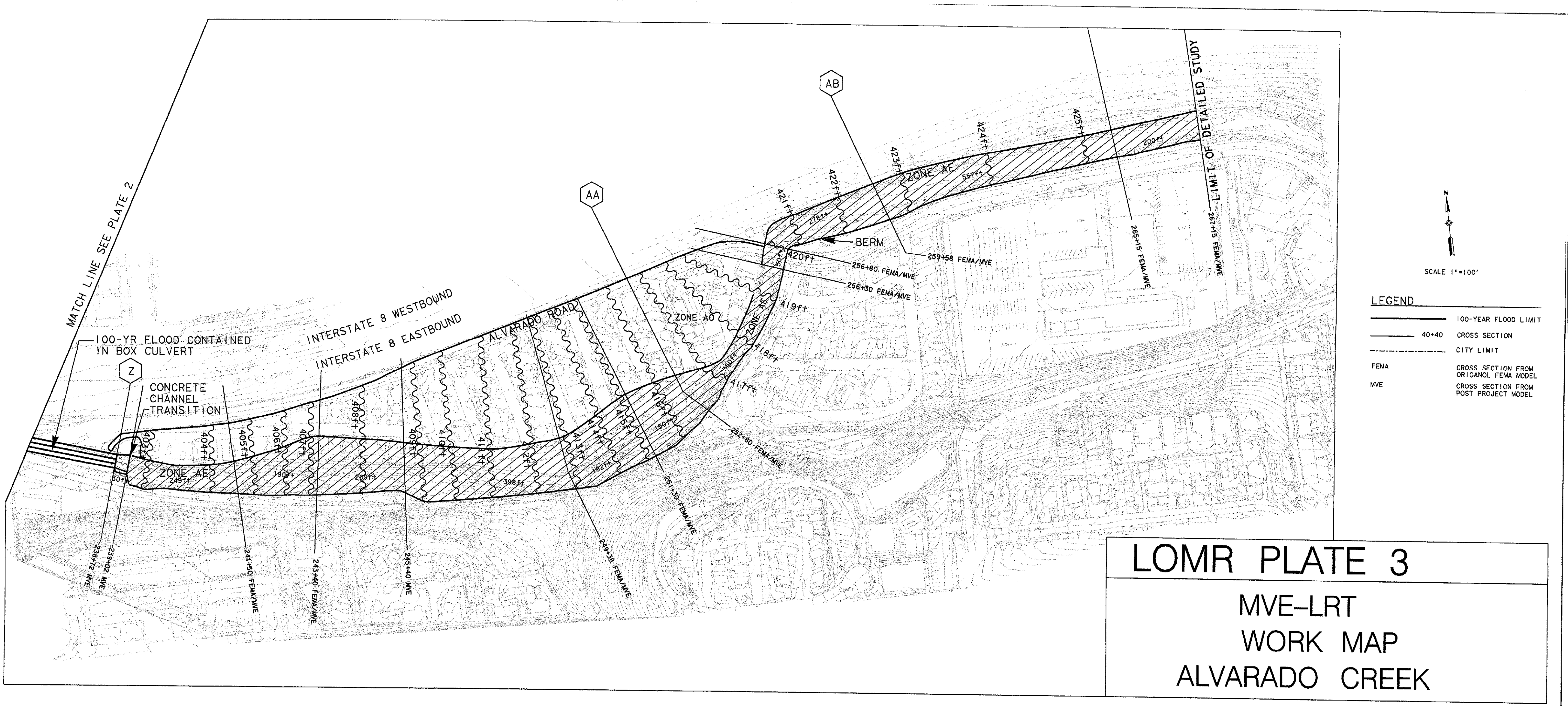
| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| LA MESA, CITY OF | 060292 | 1643 | J |
| SAN DIEGO COUNTY | 060284 | 1643 | J |
| SAN DIEGO, CITY OF | 060295 | 1643 | J |

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**
**06073C1643J**

**MAP REVISED**
**MAY 16, 2012**

Federal Emergency Management Agency




# LOMR PLATE 3

MVE–LRT
WORK MAP
ALVARADO CREEK

**From: FEMA Flood Insurance Study Number 06073CV001D, County of San Diego, 4/2016**

## TABLE 8: SUMMARY OF PEAK DISCHARGES

| | | Peak Discharges (cubic feet per second) | | | |
|---|---|---|---|---|---|
| **Flooding Source and Location** | **Drainage Area (sq. miles)** | **10% Annual-Chance** | **2% Annual-Chance** | **1% Annual-Chance** | **0.2% Annual-Chance** |
| Adobe Creek | | | | | |
| 2,200 Feet Upstream of Peet Lane | 0.67 | 375 | 485 | 560 | 710 |
| Agua Hedionda Creek | | | | | |
| At Confluence with Buena Creek | 6.3 | 1,600 | 4,800 | 7,000 | 15,500 |
| 2,200 Feet Upstream of Rancho Carlsbad Drive | 16.5 | -- | -- | 7,810 | -- |
| Upstream of Calavera Creek | 17.3 | -- | -- | 8,080 | -- |
| At El Camino Real | 23.8 | -- | -- | 9,850 | -- |
| Alvarado Creek | | | | | |
| At Lake Shore Drive | 4.6 | 1,200 | 2,000 | 2,300 | 3,000 |
| At Interstate 8, Near Trailer Park | 5.3 | 1,300 | 2,200 | 2,500 | 3,200 |
| At Interstate 8, Near Murray Boulevard | 5.7 | 1,400 | 2,400 | 2,700 | 3,500 |
| Upstream of Murray Creek | 6.3 | 1,600 | 2,600 | 3,000 | 3,800 |
| Downstream of Murray Creek | 10.1 | 1,700 | 2,900 | 3,300 | 4,200 |
| At Downstream Side of College Avenue | 11.4 | 2,100 | 3,400 | 3,900 | 5,000 |
| Upstream of Tributary Channel | 12.1 | 2,300 | 3,700 | 4,300 | 5,400 |
| Downstream of Tributary Channel | 13.4 | 2,600 | 4,300 | 4,800 | 6,100 |

-- Data Not Available

DATUM SHIFT USED FOR HEC-RAS DATA



```
VERTical CONversion (VERTCON) Transformation Program
           Between NGVD 29 and NAVD 88
                  Version 2.10

===============================================================================

Station sequence #:    1
   Latitude                Longitude    NAVD 88 - NGVD 29 (meters)
32 46 20.50000          117 02 16.04000         0.647
```

0.647 m = 2.12 ft

NAVD 88 (new topo)

2.12 ft

NGVD 29 FEMA data and old topo

# Appendix F

Original report

# CHANNEL FEASIBILITY STUDY
# for
# ALVARADO CREEK

## from BALTIMORE DRIVE to JACKSON DRIVE
## La Mesa, California

March 30, 1995

Use Letterhead Covers

*Prepared for:*

***City of La Mesa***
*San Diego County*
*California*

*Prepared by:*

***Fuscoe Engineering, Inc.***
*5897 Oberlin Drive, Suite 209*
*San Diego, California 92121*

# TABLE OF CONTENTS

# I. EXECUTIVE SUMMARY

**Purpose:**

The purpose of this study is to determine the feasibility of a covered channel solution to carry the 100-year flood for the 3,066 foot reach of Alvarado Creek along Fletcher Parkway between Baltimore Drive and Jackson Drive in the City of La Mesa.

**Context:**

The existing channel in this reach is approximately trapezoidal with a 50 foot to 60 foot top width. A variety of rubble and rock as well as cobbles line the channel. Upstream at Jackson Drive a triple 8'X 5' R.C.B. and an 84" R.C.P. along with 2 other smaller pipes outlet flows to a transition structure. Flows are carried in a concrete trapezoidal channel for about 770 feet where the rubble and rock channel begins. At the downstream end, flows enter a triple 8'X 6' R.C.B. at Baltimore Drive. From there, a series of open concrete channels and triple 8'X 6' R.C.B.'s convey flows to the south side of I-8 where the channel continues west past the La Mesa R.V. lot and the Trailer park.

The projected peak 100 year flood flow rate at Baltimore Drive is 3200 cfs. Due to downstream backwater effects, the capacity of the Baltimore Drive culvert is limited to about 1300 cfs. Therefore, under existing conditions, any flows in excess of 1300 cfs overtop the crossing and enter the intersection of Baltimore Drive and Fletcher Parkway. Some of this water flows down the Fletcher Parkway on-ramp to I-8 as sheet flow. Some water may re-enter the channel downstream of Baltimore, where the existing culverts at I-8 will again restrict flows to 1300 cfs. Any remaining excess flows will likely overtop I-8 where the triple 8'X 6' R.C.B. crosses under the freeway. Because of a continuous concrete median barrier constructed in 1981, flood flows reaching the westbound travel lanes will remain there and will not re-enter the channel until downstream of the 70th Street undercrossing. This existing flood problem can be solved by construction of downstream improvements as detailed in the Alvarado Channel Master Plan (Nov., 1989, Boyle Engineering).

**Impacts:**

Construction of channel improvements in conjunction with the development of the property south of and adjacent to the study reach will unavoidably reduce existing ponding area and flood water storage capacity. The loss of storage capacity is approximately 2 ac-ft. Before the construction of improvements, the volume of water expected to flood City streets during a 100 year storm is 138 ac-ft. After development that volume will increase to 140 ac-ft, a 1% increase.

The loss of this storage volume will slightly increase the frequency of flooding from once every 12 years, on the average, to once every 10 years, a 1.7% increase. The volume of water and peak flow being discharged from the Caltrans culvert at I-8 to the downstream channel will not be changed.

The measures considered to offset the loss of 2 acre-ft of storage onsite were:

a. Underground storage tank

b. Creation of a surface detention pond (open space)

c. Utilize parking lot areas to store flood water

d. Upstream detention offsite

These measures were ruled out due to the hardship imposed on the project area vs. the benefit received. In addition, no potential offsite detention locations were identified by the project proponents or the City.

**<u>Recommendations</u>**

Construction of improvements within the study reach must be carefully designed to not significantly change the existing flooding condition at Baltimore Drive. To adhere to existing conditions as much as possible, a target water surface was set at both the Baltimore and Jackson Drive culverts. HEC-2 And WSPG hydraulics analysis computer programs were run on three scenarios.

The result is a recommendation for 2,826 LF of double 12' x 7' R.C.B. with 240 feet of 40' wide rectangular concrete channel just upstream of Baltimore Drive. This solution provides the hydraulic grade line needed upstream at Jackson Drive and ensures that the existing water surface elevation and energy elevation are maintained at Baltimore Drive. 1900 cfs will continue to spill at the Baltimore Drive/Fletcher Parkway intersection during the 100 year storm. To maximize land use near the intersection, a 140' portion of the rectangular channel can be covered at additional expense. This option is included with the recommended channel as Alternative 3.

In the future, when downstream improvements are made, a fourth R.C.B. can be added at Baltimore. With these improvements, the rectangular concrete channel can be modified or covered and the proposed channel can easily convey the 100 year flood without flooding the intersection.

**<u>Conclusion:</u>**

There exists today a significant potential for flooding in the Baltimore Drive/Fletcher Parkway intersection and west onto the I-8 freeway. This project will not significantly change the character or degree of risk currently present.

## II. INTRODUCTION

### A. Purpose

The purpose of this study is to determine the feasibility of a covered channel solution to carry the 100-year flood for the study reach. This channel section would be in lieu of the rip rap lined 72' wide by 10' deep trapezoidal channel solution in the Alvarado Channel Master Plan.

### B. Project Location

The project location is a 3,066 LF reach of Alvarado Creek along Fletcher Parkway, between Baltimore Drive and Jackson Drive in the City of La Mesa, San Diego County. (See Figure 1, Project Reach Location Map)

### C. Previous Studies

Four previous flood control studies have been prepared for the Alvarado Creek Channel. They are:

1. Alvarado Channel Master Plan, Boyle Engineering Corporation, 1989.

2. Master Drainage Plan for the City of La Mesa. Lawrence, Fogg, Smith, Steen & Associates, 1984.

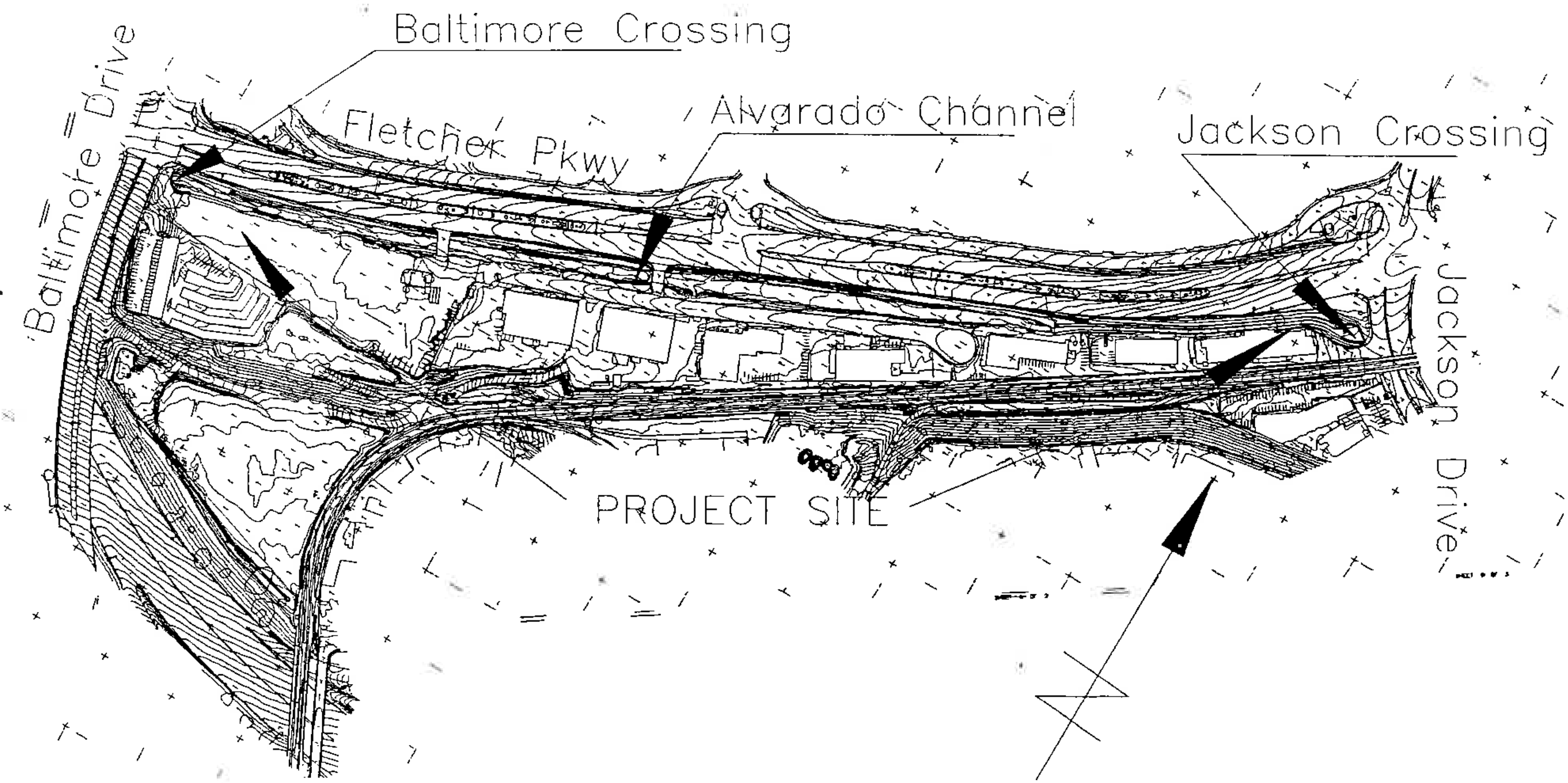
3. Final Report for Special Flood Plain Delineation Study of Alvarado Channel. County of San Diego Department of Sanitation and Flood Control, George S. Nolte and Associates, 1978.

4. Hydrology for Flood Insurance Studies - Murphy, Murray, Alvarado and Tecolote Canyons, San Diego County, California. U.S. Army Corps of Engineers Los Angeles District, 1973.

### D. Existing Channel Conditions

The existing channel in the study reach consists of about 770 LF of trapezoidal concrete channel which feeds into a rock and rubble lined trapezoidal channel with a 50 to 60 foot top width. During the 100 year flood this channel overtops it's banks and shallow flooding occurs south of the channel, particularly in the western section.

# FIGURE 1
# PROJECT REACH LOCATION MAP



E. **Existing Downstream Constraints**

At the downstream end of the study reach, the Baltimore Crossing is a triple 8'W x 6'H RCB. Under a 100-year flood, the backwater effects will choke the RCB and cause the floodwater to backup and overtop the intersection of Baltimore Drive and Fletcher Parkway.

The County's Flood Plain Study (Special Flood Plain Delineation Study of Alvarado Channel, by George Nolte, 1978) provided a detailed hydraulic study at the vicinity of the Baltimore Crossing. The study indicated that under a 100-year flood:

1. Q = 3200 cfs upstream of the crossing,

2. Q = 1900 cfs overtopping the crossing,

3. WSL = 460 -ft at the culvert entrance,

4. WSL = 458 -ft at the culvert exit,

5. Combination of weir flow and pressure flow.

1900 cfs overtops the crossing and floods the intersection of Baltimore and Fletcher Parkway. Some of this water flows down the Fletcher Parkway on-ramp to I-8 as sheet flow. Some water may re-enter the channel downstream of Baltimore, where again the same size triple 8' W x 6' H RCB culverts at I-8 restrict flows to 1300 cfs. Any remaining excess flows will spill onto I-8 at this point. Because of a continuous concrete median barrier (k-rail) constructed in 1981, flood flows reaching the westbound travel lanes will remain there and will not re-enter then channel until downstream of the 70th Street/Lake Murray Blvd undercrossing.

F. **Existing Upstream Constraints**

At the upstream end of the study reach, the Jackson Crossing is a triple 8'W x 5'H RCB designed for Grossmont Trolley Center, by Rick Engineering. Under a 100-year flood, its design condition (from hydraulic study for Grossmont Trolley Center Flood Control Project, by Rick Engineering, 1990) were:

1. Q = 2100 cfs,

2. HGL = 490 ft at the culvert entrance,

3. HGL = 487 ft at the culvert exit,

4. Pressure flow.

## G. Impacts of the Channel Improvements

Following the construction of channel improvements, there will be a loss of existing storage capacity on the development site during flooding (retention basin function) of approximately 2 ac-ft. This loss increases the frequency of flooding of the Fletcher Parkway/Baltimore Drive intersection and the I-8 on-ramp.

1. Loss of the Storage Capacity:
   The existing storage capacity (retention basin function) is approximately 2 ac-ft in the project site. This 2 ac-ft storage volume will be lost after construction of the proposed project. From a detention basin analysis, this 2 ac-ft of storage volume can reduce a peak discharge of 1450 cfs to 1300 cfs, and detain the exceeded flood volume in the project site.

2. Increase of Inundation Frequency:
   1300 cfs is the maximum culvert capacity at the intersection of Baltimore and Fletcher. This is also the peak discharge of a 10-year storm. 1450 cfs is the peak discharge of a 12-year storm. Under the existing condition, due to the storage capacity in the project site, the streets in the vicinity of the project site will be inundated during a storm greater than $Q_{12}$ = 1450 cfs. After the construction of the proposed project, due to the loss of the storage volume, the streets will be inundated during a storm greater than $Q_{10}$ = 1300 cfs. As a result, the frequency of flooding increases from every 12 years to every 10 years on the average (See Appendix F, Hydrology Analysis for detailed calculations).

3. Impact of Inundation on Fletcher Parkway:
   The total volume of water that overflows on the Fletcher Pkwy intersection during a 12-year storm after the project is 2 ac-ft. The discharge on the intersection raises from 0 cfs to 150 cfs in 9 minutes, then recesses to 0 cfs in 10 minutes. The total duration of this event is 19 minutes.

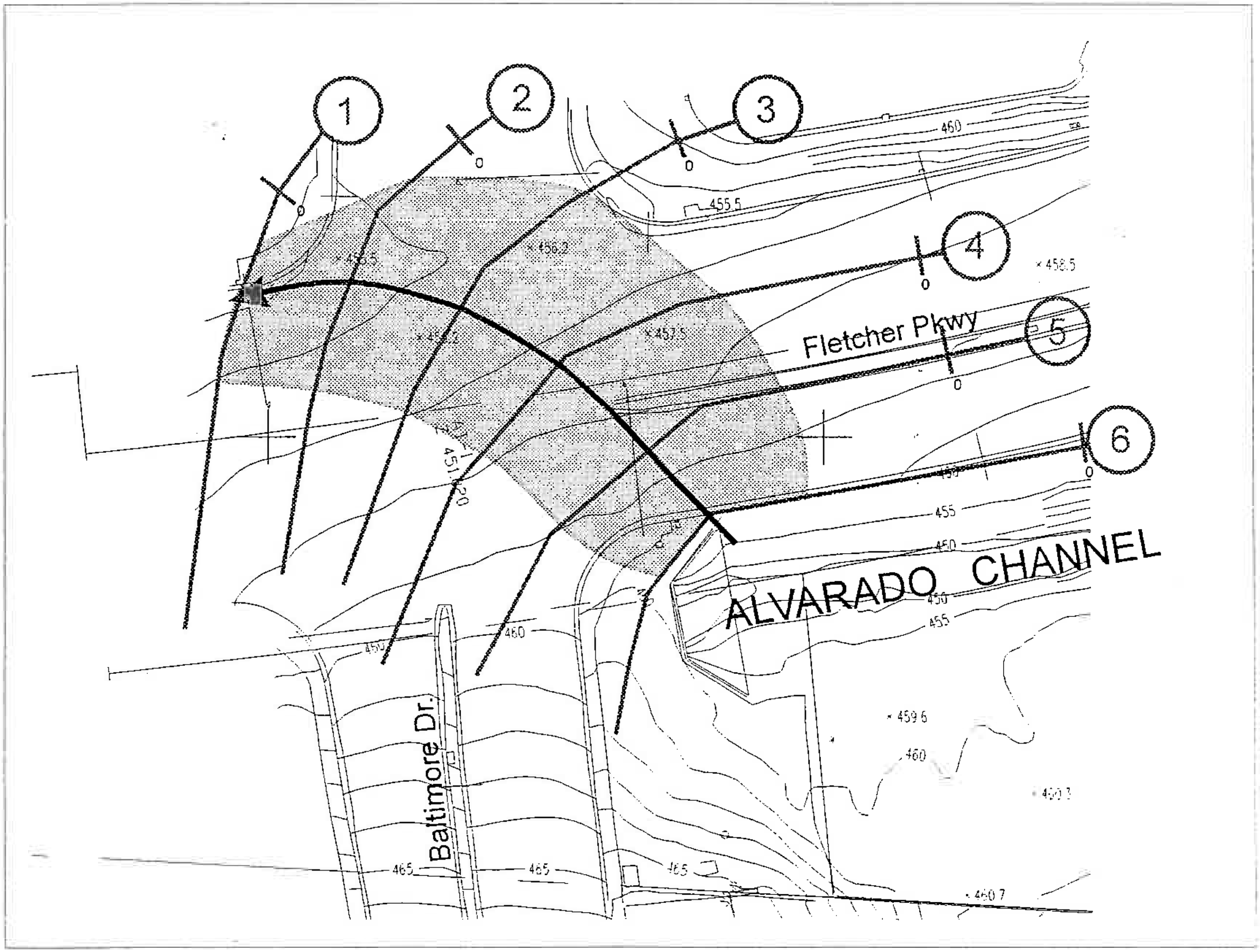
   The street width of Fletcher Pkwy varies from 100 ft to 160 ft at the intersection with Baltimore Drive, with an average street slope of 0.75% The cross street slope tilts down to the northerly curb with a slope of 4% , then rises after the curb return.

   In a 12-year storm, the peak flood flowing out from the channel is 150 cfs. It flows toward the northerly curb, crosses the median island, then turns westerly toward I-8 on-ramp (see Flood Inundation Map, Figure 2).

# FIGURE 2

## Flood Inundation Map

Intersection of Fletcher Pkwy & Baltimore Dr.



The maximum depth of flooding at the intersection is approximately 8 inches, the maximum top width of inundation is 113 ft, the maximum velocity is 3 fps (see cross section 3, HEC-2 summary report, Appendix F).

The above analysis provides a description of the hydraulic characteristics of a 150 cfs flow at the at the intersection of Fletcher Pkwy and Baltimore Dr. This condition still occurs under the existing condition, as soon as the 2 ac-ft storage volume is filled up by storm water. The impact of the lost volume due to the project is to incrementally increase flood inundation frequency. A 12-year flood occurs every 12 years, has an annual occurrence probability of 8.3%. A 10-year flood occurs every 10 years, has an annual occurrence probability of 10%. Therefore, the increase in frequency is only 1.7% due to the project.

4. Impact of Inundation on I-8:
Excess runoff will flow onto west-bound I-8. The highway is approximately 60-ft wide with a 12-ft paved shoulder, or 72-ft wide near the Lake Murray outlet. The slope of highway at this location is 1.2% Assuming all 2 ac-ft of floodwater flows onto I-8 during a 12 year storm, the inundation depth is estimated at 5" with a velocity of 6 fps, and the total duration time is still considered to be 19 minutes.

5. Impact of Increased Water Volume on Streets:
The volume of flood water that exceeds the culvert capacity (1300 cfs) is approximately 140 ac-ft during a 100 year flood. Before the project, due to the 2 ac-ft storage volume in the project site, the volume of water expected on the streets is 138 ac-ft. Therefore, there is a 1% increase in volume during the 100 year flood. Because this increase will not change the peak discharge of a 100 year storm, the effect is insignificant.

6. Impact on Flow Volume in Downstream Channels:
The maximum flow that can be discharged from the I-8 culvert into the downstream channel is 1300 cfs. The amount of water being discharged from the culvert to downstream channel is approximately 257 ac-ft during a 100 year flood. This amount will not be changed after the construction of the channel improvements. Because the proposed channel will be designed to maintain the existing hydraulic condition immediately upstream of the Baltimore Drive culvert, the discharge to the downstream channel will be the same as before the installation of the channel improvements. As a result, there is no change in the amount of water discharged to the channel downstream.

## III. ALTERNATIVES DEVELOPMENT AND EVALUATION

### A. Goals of the Design Reach

The following goals were established for the proposed covered channel solutions:

1. Convey the projected 100 year flows safely through the study reach.

2. Maintain a hydraulic grade line (HGL) of 490 feet at the Jackson Drive culvert entrance per previous design study assumptions.

3. Maintain the existing condition water surface elevation (WSL) of 460 feet at the Baltimore Drive culvert entrance to insure that flows to the downstream portions of the channel are not increased until improvements are constructed per the Alvarado Channel Master Plan. This goal also results in maintaining the existing flow split and flooding conditions downstream of the Baltimore/Fletcher Parkway intersection.

4. Insure that the proposed design will be compatible with the ultimate downstream improvements per the Alvarado Channel Master Plan.

### B. Scenario Analysis

Three scenarios were investigated to find a cost-effective solution for flood control and establish a conceptual level of channel design. They are:

Alt.1: All-Box Scenario
A 3,066-LF double 12'W x 7'H RCB through the entire reach from the Jackson Culvert to the Baltimore Culvert.

Alt.2: Box-Channel Scenario
A 2,826-LF double 12'W x 7'H RCB from the Jackson Culvert to 240 -ft upstream of the Baltimore Culvert. A 220-LF 40'W rectangular RC open channel, connecting to the existing 20-LF channel transition to the Baltimore Culvert.

Alt.3: Box-Transition-Channel Scenario
A 2,826-LF double 12'W x 7'H RCB from the Jackson Culvert to 240-ft upstream the Baltimore Culvert, connecting to a 140-LF box transition to an 80-LF 40'W rectangular RC open channel, then a 20-LF channel transition to the Baltimore Culvert.

## IV. HYDRAULIC ANALYSIS

### A. Computer Programs Used for Hydraulic Analysis

To ensure that the proposed hydraulic condition meets the design targets, both WSPG and HEC-2 computer programs were applied for the hydraulic study.

WSPG was mainly applied for the investigation of the proposed R.C.B. under the pressure flow condition and super critical flow regime, and to determine the location of a hydraulic jump along the study reach.

HEC-2 was mainly applied for the investigation of the combination of pressure flow and weir flow at the vicinity of Baltimore Crossing under the proposed condition.

### B. Hydraulics of the Scenarios

The hydraulic analysis for the above scenarios reveals that:
(see Figure 3)

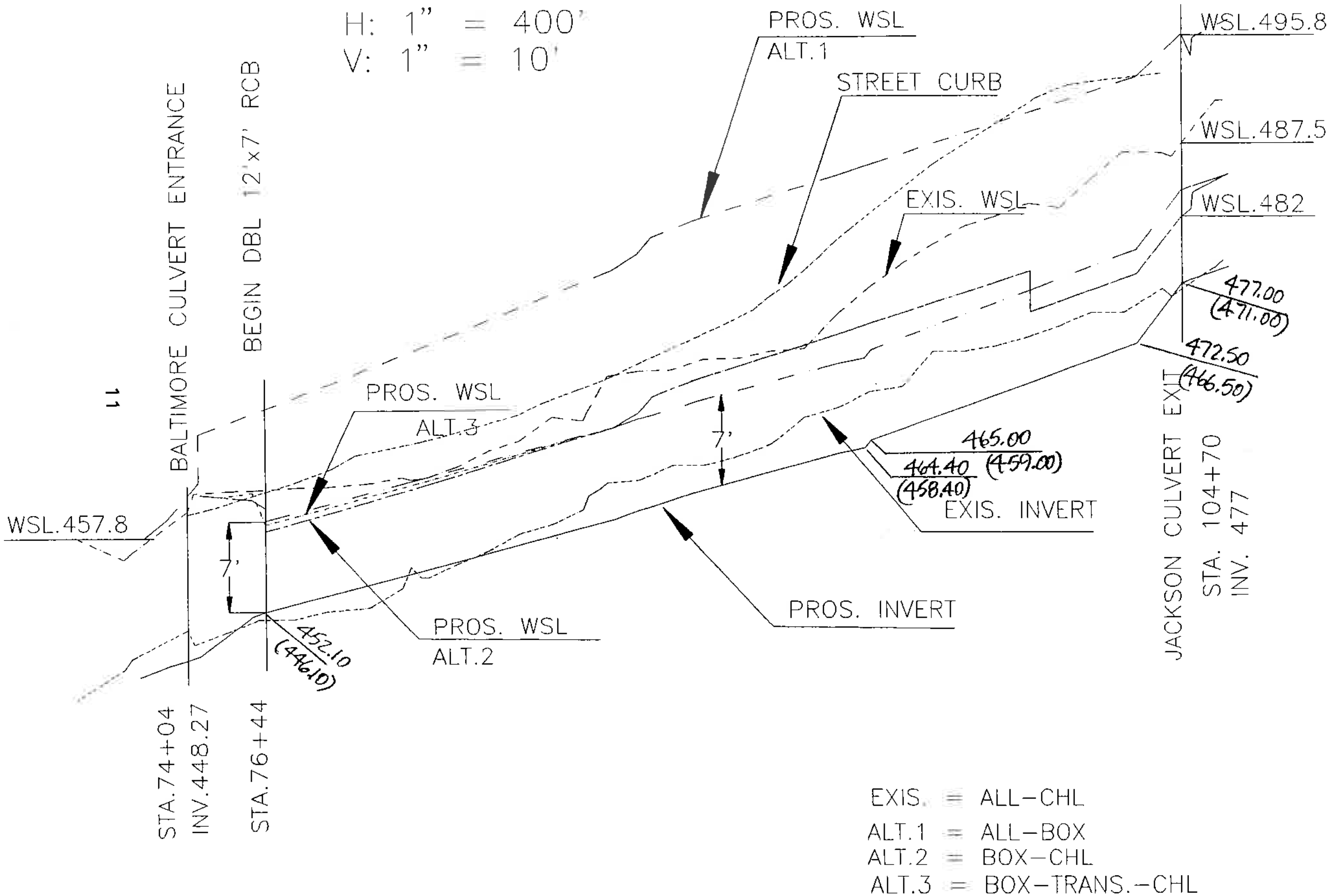
| WSL@ | Alt.1 | Alt.2 | Alt.3 | Exist. |
|---|---|---|---|---|
| Entrance of Baltimore Culvert | 465.7' | 459.8 | 459.8 | 459.8' |
| Exit of Jackson Culvert | 495.8' | 482.0' | 482.0' | 487.5' |
| Along Fletcher Parkway | above street TC | below street TC | below street TC | below street TC |

### C. Evaluation of Scenarios

From Flood Control Point of View:

According to the hydraulic analysis, Alt.1 will result in a 6 to 8-ft. higher water surface elevation than the existing condition. This will cause the flood water bubble out of the catch basins along Fletcher Pkwy, and upstream runoff will be unable to enter the existing storm drains connecting to the Alvarado Channel.

# FIGURE 3
## PROJECT REACH WATER SURFACE PROFILE



Both Alt.2 and Alt.3 have the similar flood protection level as the existing condition. Both provide a lower water surface elevation than the existing condition, and keep the 100-year flood from overtopping Fletcher Parkway. This is due to the super-critical flow regime in the RC Box. The downstream open channel section serves as a energy dissipator basin to allow the hydraulic jump to dissipate the energy, and to resume the sub-critical regime before entering the Baltimore Culvert.

At the entrance of the Baltimore Culvert, the water surface elevation and the energy elevation will resume the existing condition. As a consequence, flows under Baltimore will be limited to 1300 cfs and during the 100-year flood, 1900 cfs will spill into the intersection.

From Land Use point of View:

Alt.1 is an underground facility and has the maximum land use potential.

Alt.2 has a 240-LF open channel section in the downstream reach, to dissipate energy and resume the existing flood condition. The land use along the open channel reach is somewhat limited.

Alt.3 has a 100-LF open channel section in the downstream reach to resume the existing hydraulic condition. The land use potential is less restricted along the open channel section than in Alt.2.

From Cost-effective Point of View:

Alt.1 is a complete RC Box reach, has the highest construction costs.

Alt.2 is a combination of RC Box and RC Channel and has slightly lower construction costs.

Alt.3 is a scenario that adds a 140' long and 40' wide R.C. cover onto the Alt.2. The construction costs are expected to be relatively high.

## D. Selection of the Recommended Scenario

Alt.1 will cause a significant impact on the flood control along the Alvarado Channel in the vicinity of the project site, unless the downstream reach is improved following the City's Alvarado Channel Master Plan. The choice of Alt.1 is ruled out.

Alt.2 and Alt.3 have the same level of flood protection to the project site and do not cause any significant impact on upstream and downstream reaches.

Alt.2 incurs slightly lower construction costs than Alt.3 does. Alt.3 has more land use potential than Alt.2 does.

Since land use potential is a major consideration for this project, the best choice is Alt.3.

## V. PROPOSED CHANNEL DESIGN

### A. Proposed Channel

Based on the above evaluation, the Alt.3: Box-Transition-Channel scenario is suggested to be the proposed flood control channel to protect the project site and minimize the flood hazard.

### B. Components of Design Reach

The suggested components of the design reach include:

5. 2,826-LF double 12'W x 7'H R.C. Box,
6. A 20-LF RC Box Transition (from a double 12' x 7' RCB to a double 20' x 7' RCB),
7. A 120-LF double 18' x 7' RCB,
8. An 80-LF 40'W x 12'H RC Channel
9. A 20-LF R.C. Channel Transition to the Baltimore Culvert.

Note: The above suggested components and lengths are in a conceptual level only, and will be subject to further investigation in the engineering design stage.

## C. Hydraulics of the Proposed Channel

The proposed channel has the following hydraulic characteristics:

1. Super critical flow in the double 12'W x 7'H R.C.B. from the Jackson Culvert to the downstream 40'W open channel. Normal depth is between 5 and 7 feet. Velocity is in a range of 17 to 20 fps.

2. HGL at the entrance of Jackson Culvert will be 485', 5' lower than the existing HGL of 490'. The improvement of the channel further alleviates the backwater effects on the outlet of Jackson Culvert.

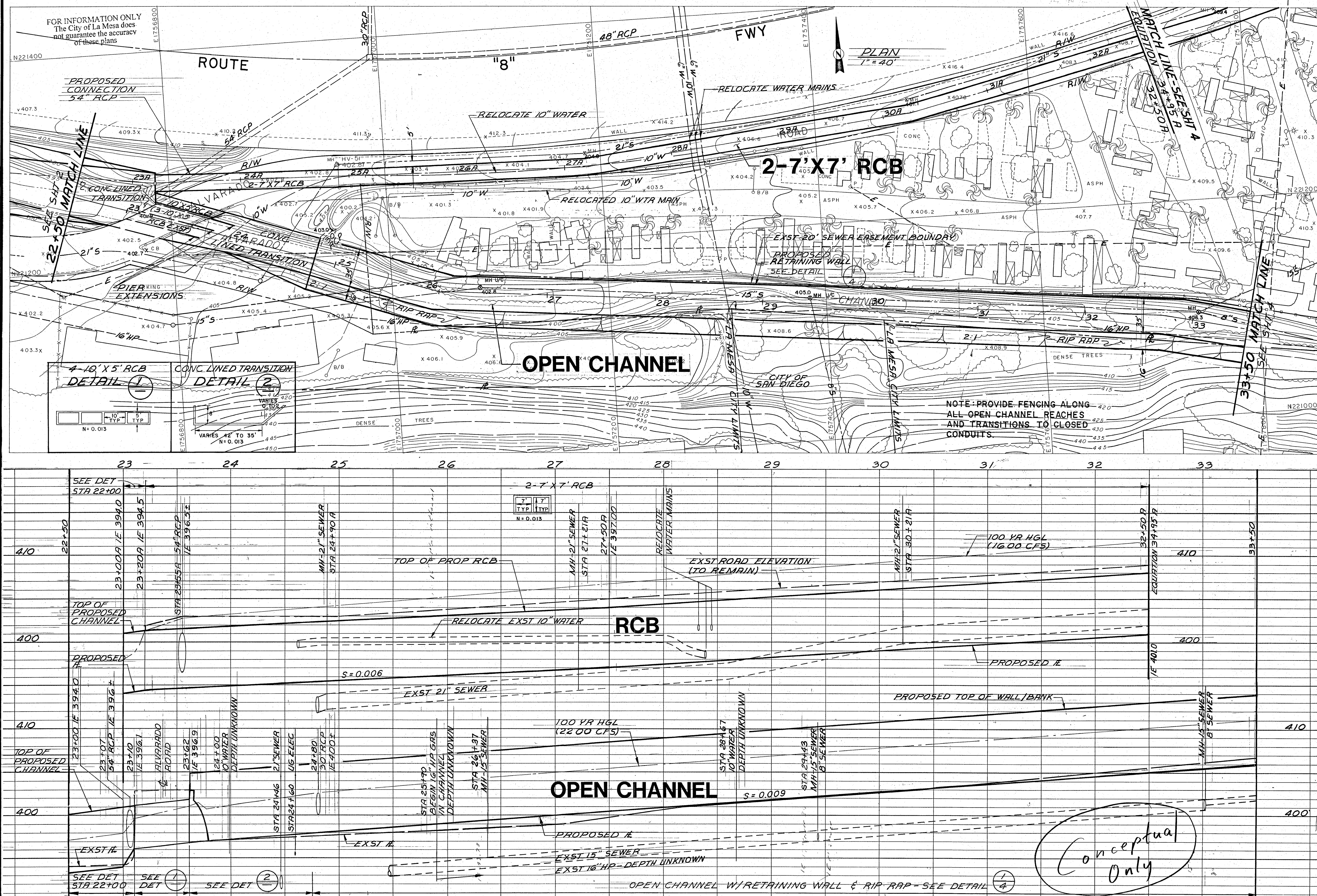
3. A hydraulic jump will occur within the box transition before the RC Open Channel. The WSL in the open channel varies from 461' to 460'. It acts as an energy dissipator, dissipating the momentum of the super critical flow from the R.C.B.

4. The WSL at the entrance of the Baltimore Culvert will match the existing WSL of 460'. With the same backwater effects at the outlet of the culvert, 1900 cfs will overtop the Baltimore intersection. The flow condition will be the same as in the existing condition.

## D. Ultimate Improvement Condition

The 200-LF downstream open channel reach of the proposed channel can be modified to a RC box in the future, when the downstream improvement (Alvarado Channel Master Plan) takes place. When an additional 8' x 6' RCB is added to the existing triple 8' x 6' RCB at the Baltimore intersection, the choking of 100-year flood at this location will be alleviated. The proposed channel can easily convey the 3200 cfs flood to the downstream without overtopping the intersection of Baltimore Drive. The open channel reach will no longer be necessary.

A WSPG hydraulic calculation was performed to confirm this point (see Appendix D).




CONCEPTUAL PLAN ONLY
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PLAN & PROFILE, STA 22+50 TO STA 33+50

CITY OF LA MESA

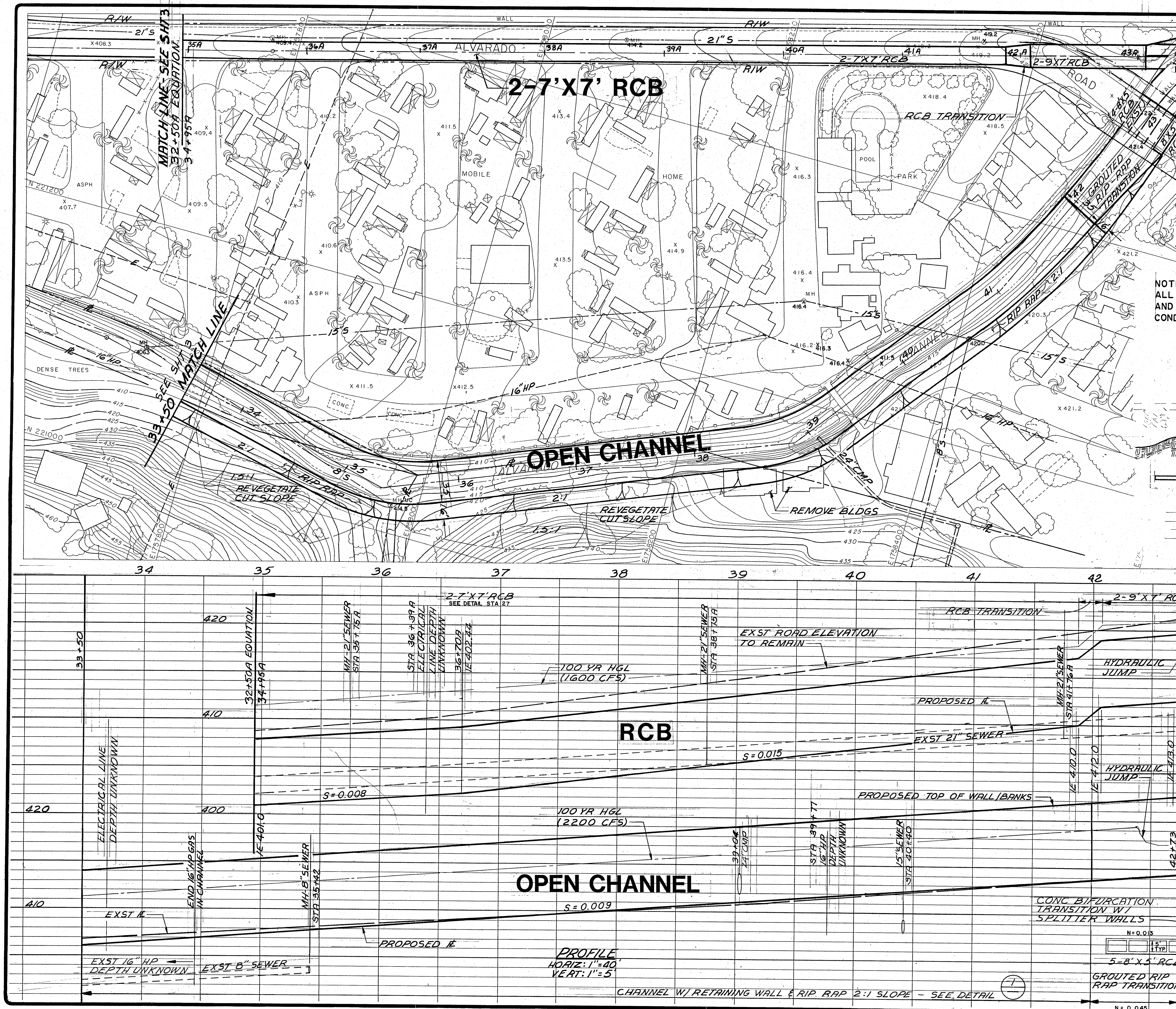
ALVARADO CHANNEL MASTER PLAN

ORIGINAL SCALE

SHEET 3 OF 20

ACCOUNT NO. SD-L03-100-00

5080

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PLAN & PROFILE, STA 33+50 TO STA 44+50

CITY OF LA MESA
ALVARADO CHANNEL MASTER PLAN

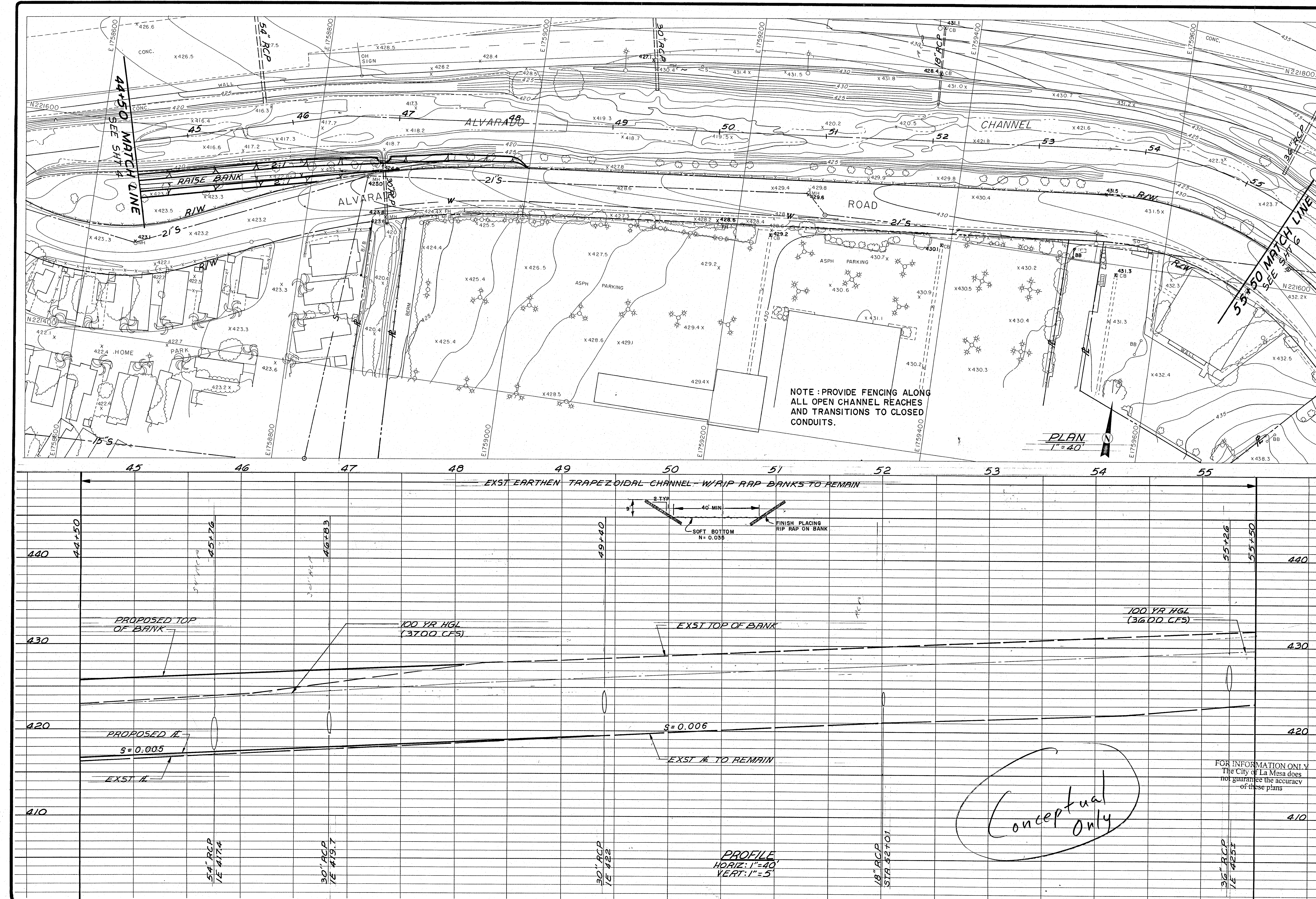
ORIGINAL SCALE 0 1 INCHES 2 3

SHEET 4 OF 20

ACCOUNT NO.
SD-L03-100-00

Conceptual Only

5081

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PLAN & PROFILE, STA 44+50 TO STA 55+50

# CITY OF LA MESA

## ALVARADO CHANNEL MASTER PLAN

ORIGINAL SCALE
0 1 INCHES 2 3

SHEET 5 OF 20

ACCOUNT NO. SD-L03-100-00

5082

# Appendix G

## Corrected Effective Model Results

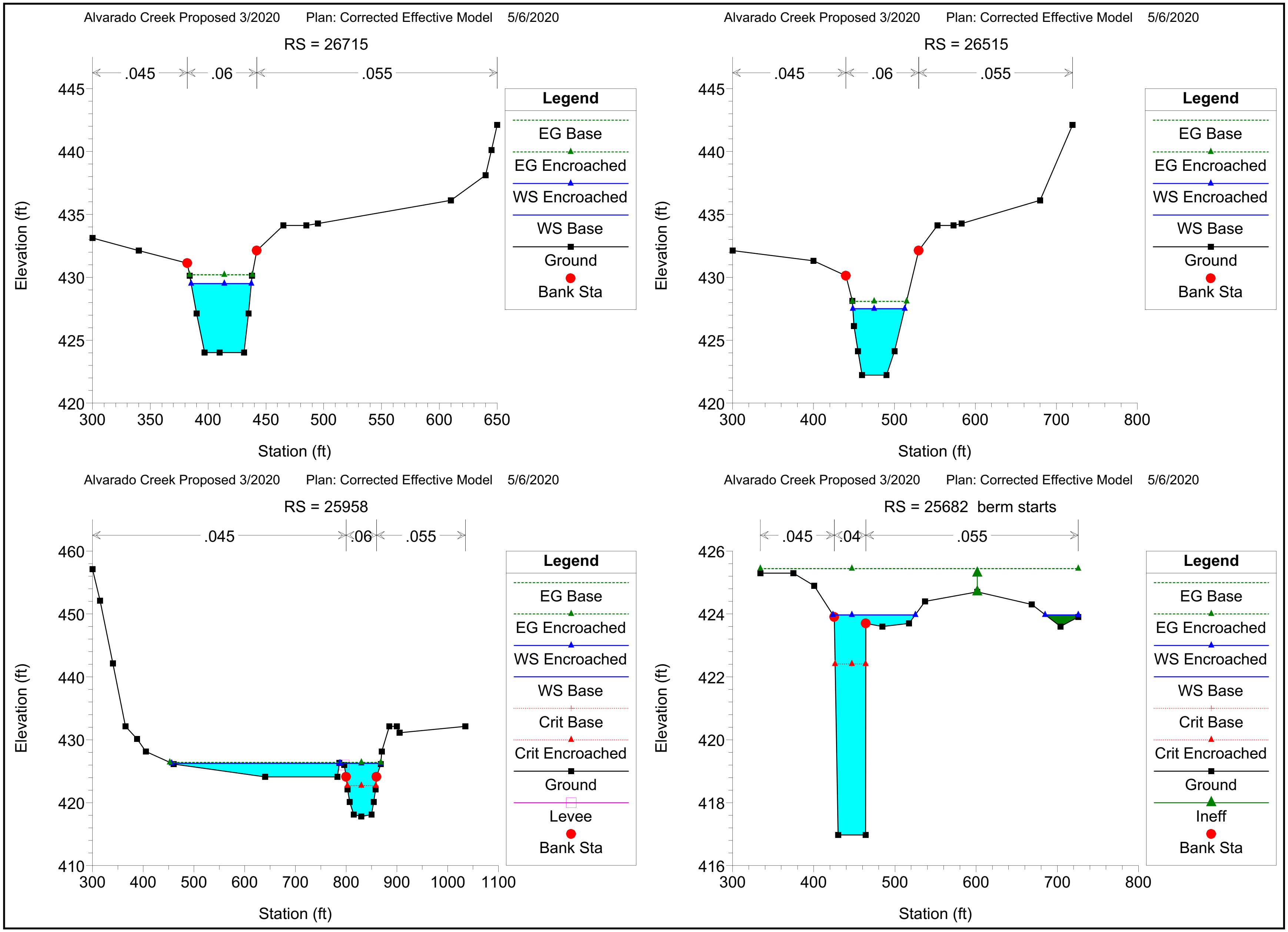
HEC-RAS Plan: Corrected Ef River: RIVER-1 Reach: Reach-1 Profile: Base

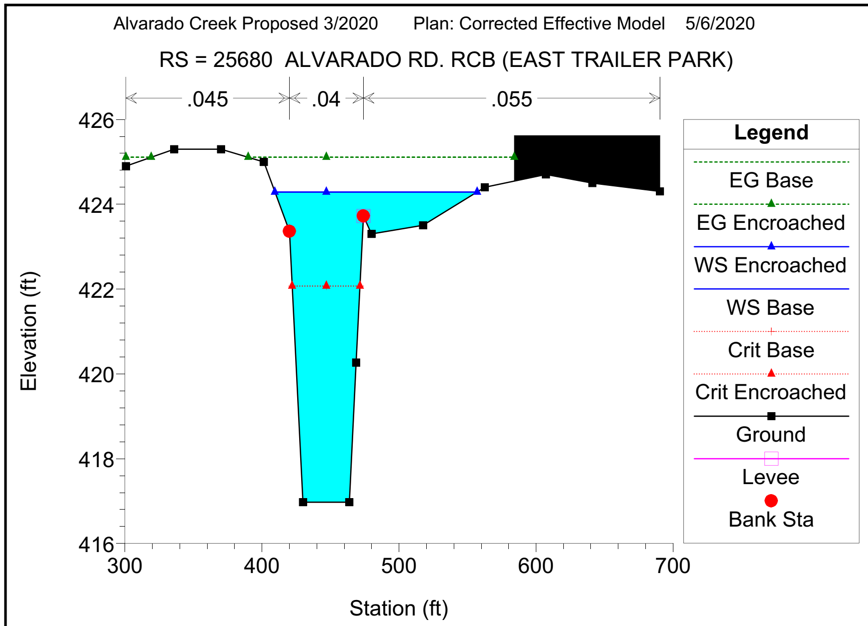
| Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Reach-1 | 26715 | Base | 1600.00 | 424.02 | 429.50 | | 430.20 | 0.010534 | 6.72 | 238.14 | 52.15 | 0.55 |
| Reach-1 | 26515 | Base | 1600.00 | 422.22 | 427.50 | | 428.10 | 0.010256 | 6.22 | 257.39 | 64.04 | 0.55 |
| Reach-1 | 25958 | Base | 2500.00 | 417.82 | 426.25 | 422.71 | 426.40 | 0.001643 | 3.62 | 959.64 | 409.45 | 0.24 |
| Reach-1 | 25682 | Base | 2500.00 | 416.97 | 423.97 | 422.41 | 425.44 | 0.007676 | 9.76 | 272.49 | 142.62 | 0.67 |
| Reach-1 | 25680 | Base | 2500.00 | 416.97 | 424.29 | 422.07 | 425.11 | 0.003899 | 7.38 | 387.06 | 147.54 | 0.53 |
| Reach-1 | 25670 | | Culvert | | | | | | | | | |
| Reach-1 | 25630 | Base | 2500.00 | 416.52 | 421.68 | 421.68 | 423.86 | 0.015550 | 11.84 | 211.16 | 48.38 | 1.00 |
| Reach-1 | 25480 | Base | 2500.00 | 413.10 | 419.39 | 418.41 | 420.80 | 0.018880 | 9.51 | 263.01 | 53.09 | 0.75 |
| Reach-1 | 25280 | Base | 2500.00 | 411.90 | 418.65 | 417.78 | 418.84 | 0.004368 | 4.78 | 913.30 | 379.70 | 0.36 |
| Reach-1 | 25130 | Base | 2500.00 | 409.90 | 417.35 | 417.15 | 417.90 | 0.009027 | 6.66 | 607.89 | 406.70 | 0.52 |
| Reach-1 | 24938 | Base | 2500.00 | 409.00 | 415.25 | 415.25 | 415.84 | 0.013007 | 7.73 | 608.02 | 406.41 | 0.59 |
| Reach-1 | 24835 | Base | 2500.00 | 408.60 | 414.20 | | 414.65 | 0.010942 | 6.70 | 643.65 | 383.84 | 0.54 |
| Reach-1 | 24772 | Base | 2500.00 | 408.50 | 413.58 | | 413.99 | 0.009104 | 6.15 | 659.80 | 372.84 | 0.50 |
| Reach-1 | 24704 | Base | 2500.00 | 407.40 | 413.15 | | 413.44 | 0.006266 | 5.10 | 711.78 | 360.50 | 0.42 |
| Reach-1 | 24540 | Base | 2500.00 | 406.20 | 411.67 | | 412.16 | 0.009923 | 6.57 | 580.46 | 278.83 | 0.53 |
| Reach-1 | 24340 | Base | 2500.00 | 405.10 | 410.21 | 409.01 | 410.51 | 0.006600 | 5.21 | 651.80 | 234.08 | 0.44 |
| Reach-1 | 24150 | Base | 2500.00 | 403.20 | 407.11 | 407.11 | 408.16 | 0.027174 | 9.04 | 346.41 | 149.06 | 0.86 |
| Reach-1 | 23902 | Base | 2500.00 | 399.27 | 406.39 | 404.50 | 407.56 | 0.000811 | 8.74 | 328.22 | 103.67 | 0.61 |
| Reach-1 | 23872 | Base | 2500.00 | 396.96 | 406.45 | 402.61 | 407.45 | 0.000602 | 8.03 | 311.16 | 32.80 | 0.46 |
| Reach-1 | 23870 | | Culvert | | | | | | | | | |
| Reach-1 | 23373 | Base | 2500.00 | 387.98 | 395.28 | 393.64 | 396.97 | 0.001280 | 10.44 | 239.52 | 32.80 | 0.68 |
| Reach-1 | 23372 | | Culvert | | | | | | | | | |
| Reach-1 | 22610 | Base | 2500.00 | 380.86 | 386.51 | 386.51 | 389.34 | 0.002731 | 13.48 | 185.41 | 32.80 | 1.00 |
| Reach-1 | 22053 | Base | 2500.00 | 376.68 | 383.98 | 382.34 | 385.67 | 0.001280 | 10.44 | 239.52 | 32.80 | 0.68 |
| Reach-1 | 22052 | | Culvert | | | | | | | | | |
| Reach-1 | 21171 | Base | 2500.00 | 370.59 | 377.89 | 376.24 | 379.58 | 0.001279 | 10.43 | 239.65 | 32.81 | 0.68 |
| Reach-1 | 21170 | | Culvert | | | | | | | | | |
| Reach-1 | 19757 | Base | 2500.00 | 356.28 | 363.59 | 361.93 | 365.27 | 0.001273 | 10.41 | 240.07 | 32.84 | 0.68 |
| Reach-1 | 19756 | | Culvert | | | | | | | | | |
| Reach-1 | 19460 | Base | 2500.00 | 351.83 | 361.09 | 357.49 | 362.14 | 0.000644 | 8.23 | 303.80 | 32.80 | 0.48 |
| Reach-1 | 19441 | | Bridge | | | | | | | | | |
| Reach-1 | 19440 | Base | 2500.00 | 351.55 | 360.95 | 356.79 | 361.76 | 0.000466 | 7.23 | 345.75 | 36.80 | 0.42 |
| Reach-1 | 19439 | | Bridge | | | | | | | | | |
| Reach-1 | 19420 | Base | 3300.00 | 351.27 | 360.70 | 357.56 | 362.10 | 0.000804 | 9.51 | 346.93 | 36.80 | 0.55 |
| Reach-1 | 19419 | | Culvert | | | | | | | | | |
| Reach-1 | 19219 | Base | 3300.00 | 347.01 | 355.80 | 353.31 | 357.42 | 0.000983 | 10.20 | 323.54 | 36.80 | 0.61 |
| Reach-1 | 19218 | | Culvert | | | | | | | | | |
| Reach-1 | 18582 | Base | 3300.00 | 343.45 | 354.03 | 349.75 | 355.14 | 0.000578 | 8.48 | 389.31 | 36.80 | 0.46 |

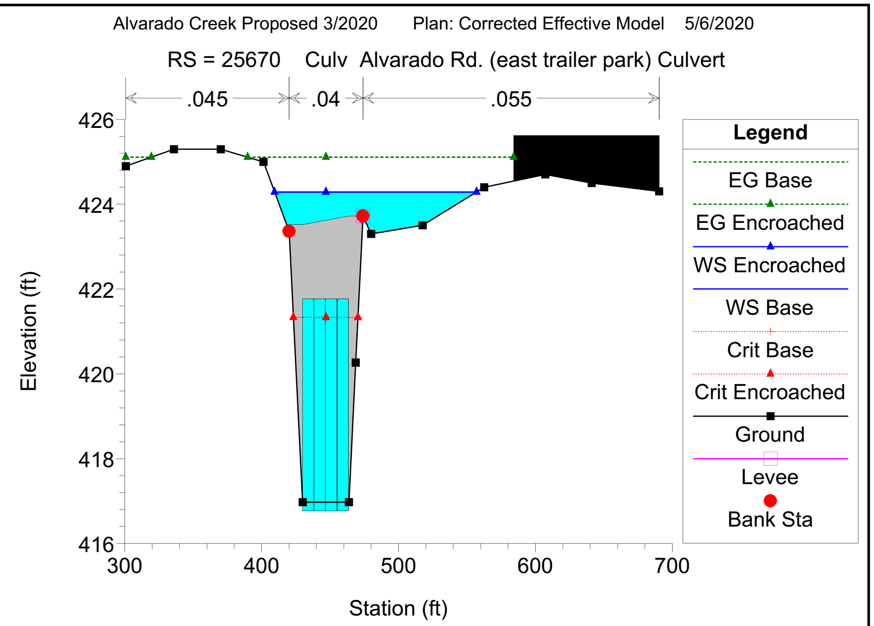
HEC-RAS Plan: Corrected Ef River: RIVER-1 Reach: Reach-1 Profile: Base (Continued)

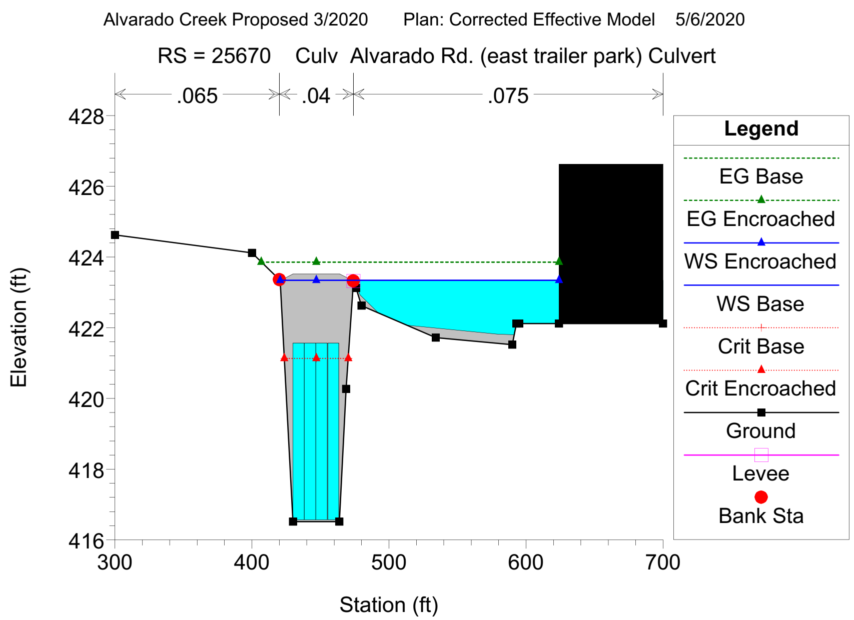
| Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Reach-1 | 18579 | | Culvert | | | | | | | | | |
| Reach-1 | 18482 | Base | 3300.00 | 343.12 | 353.03 | 349.87 | 354.61 | 0.001925 | 10.09 | 327.06 | 33.00 | 0.56 |
| Reach-1 | 18439 | Base | 3300.00 | 342.52 | 350.34 | 350.34 | 354.25 | 0.006403 | 15.86 | 208.09 | 26.60 | 1.00 |
| Reach-1 | 18437 | Base | 3300.00 | 341.42 | 350.89 | 349.24 | 353.56 | 0.004005 | 13.10 | 251.96 | 26.60 | 0.75 |
| Reach-1 | 18434.5 | | Bridge | | | | | | | | | |
| Reach-1 | 18432 | Base | 3300.00 | 341.42 | 350.70 | 349.24 | 353.47 | 0.004211 | 13.37 | 246.79 | 26.60 | 0.77 |
| Reach-1 | 18430 | Base | 3300.00 | 341.42 | 350.99 | 348.98 | 353.34 | 0.001526 | 12.32 | 267.82 | 28.00 | 0.70 |
| Reach-1 | 18380 | Base | 3300.00 | 341.02 | 349.65 | 349.65 | 352.98 | 0.002307 | 14.64 | 225.37 | 34.22 | 1.01 |
| Reach-1 | 17823 | Base | 3900.00 | 335.72 | 346.33 | 346.33 | 348.57 | 0.001271 | 12.45 | 464.23 | 179.68 | 0.80 |
| Reach-1 | 17303 | Base | 3900.00 | 332.52 | 341.88 | 341.88 | 345.07 | 0.002103 | 14.35 | 271.87 | 42.86 | 1.00 |

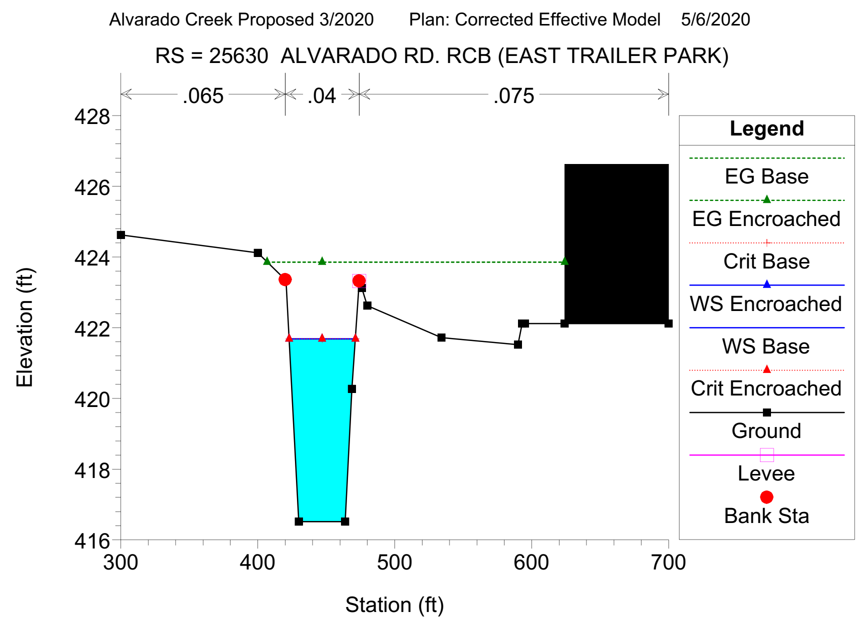
# Corrected Effective Model Cross Sections

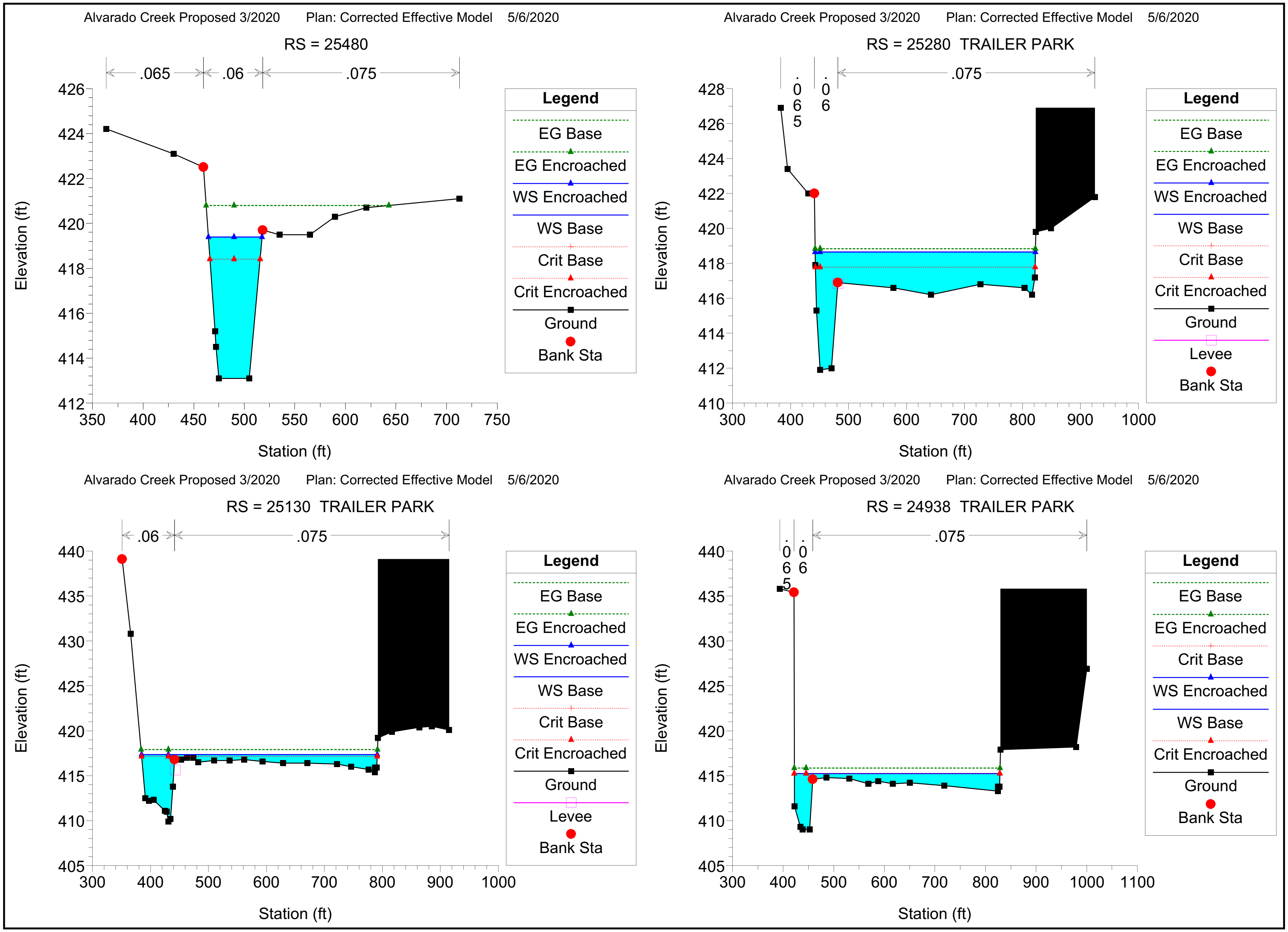


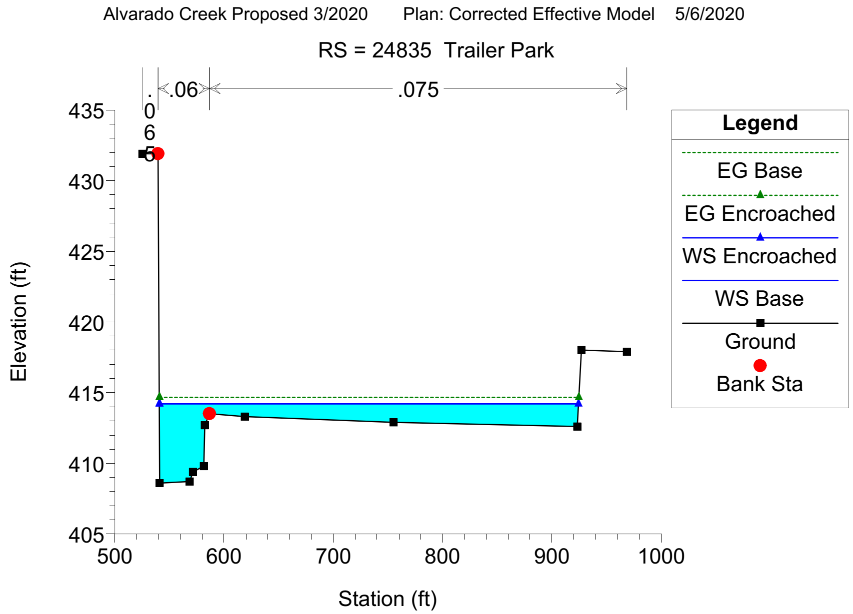

Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 25680 ALVARADO RD. RCB (EAST TRAILER PARK)
.045
.04
.055
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
426
424
422
420
418
416
300
400
500
600
700

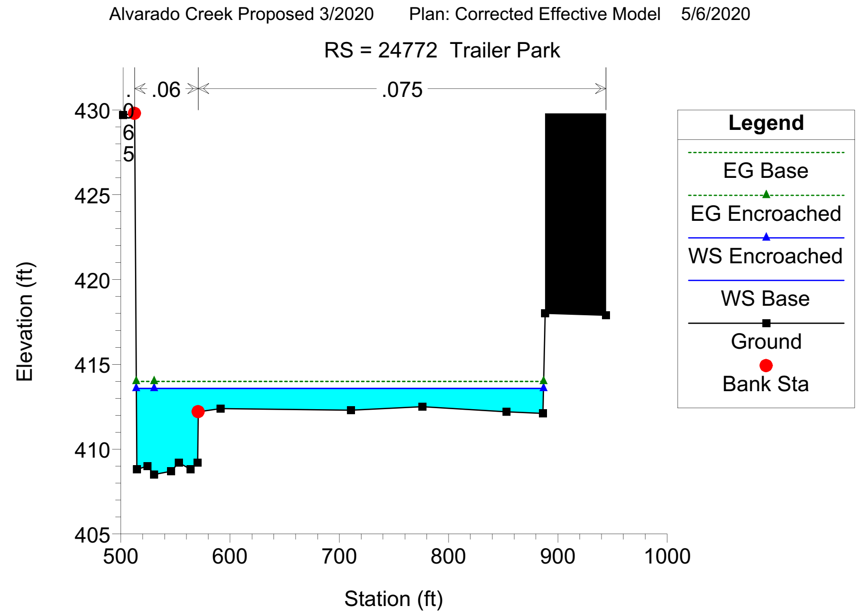

Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 25670 Culv Alvarado Rd. (east trailer park) Culvert
.045
.04
.055
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
426
424
422
420
418
416
300
400
500
600
700

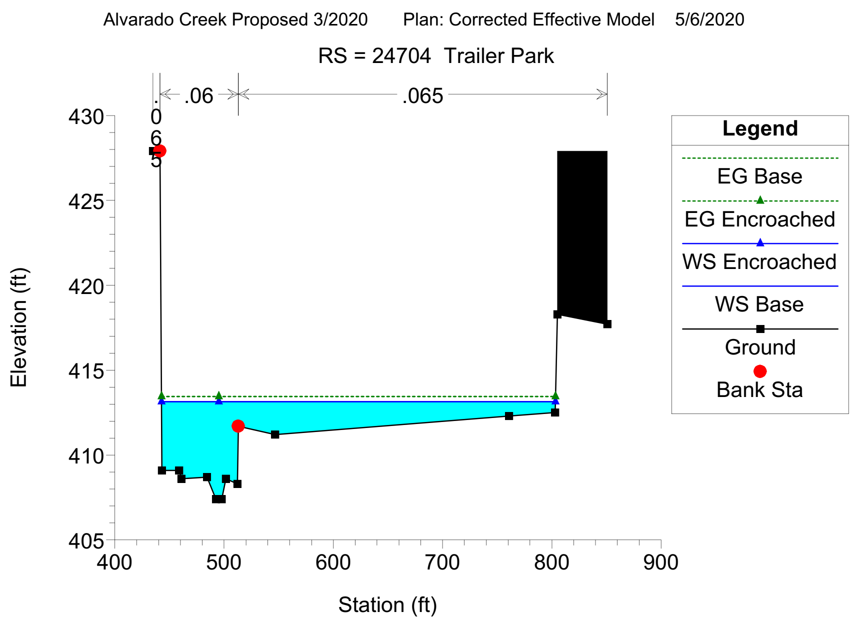

Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 25670 Culv Alvarado Rd. (east trailer park) Culvert
.065
.04
.075
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
428
426
424
422
420
418
416
300
400
500
600
700

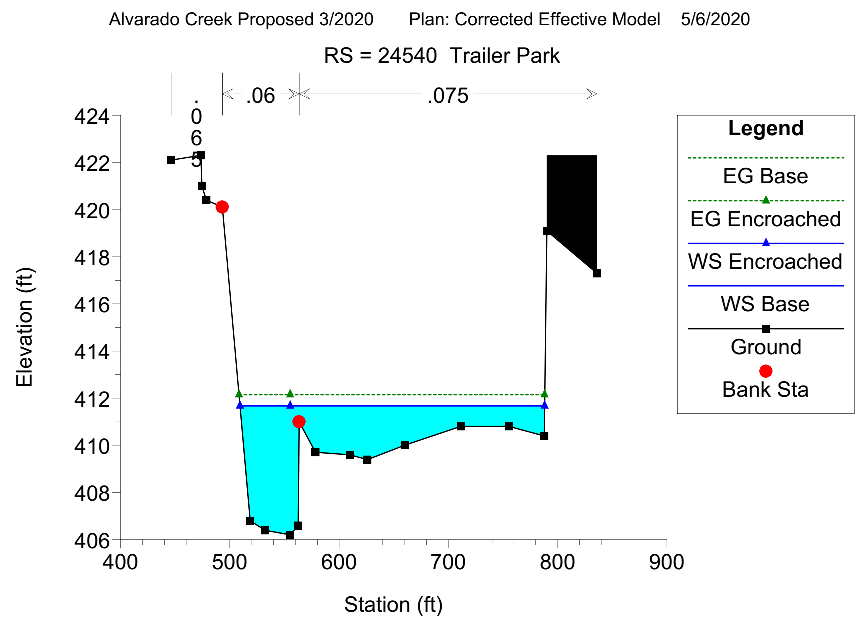

Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 25630 ALVARADO RD. RCB (EAST TRAILER PARK)
.065
.04
.075
Legend
EG Base
EG Encroached
Crit Base
WS Encroached
WS Base
Crit Encroached
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
428
426
424
422
420
418
416
300
400
500
600
700

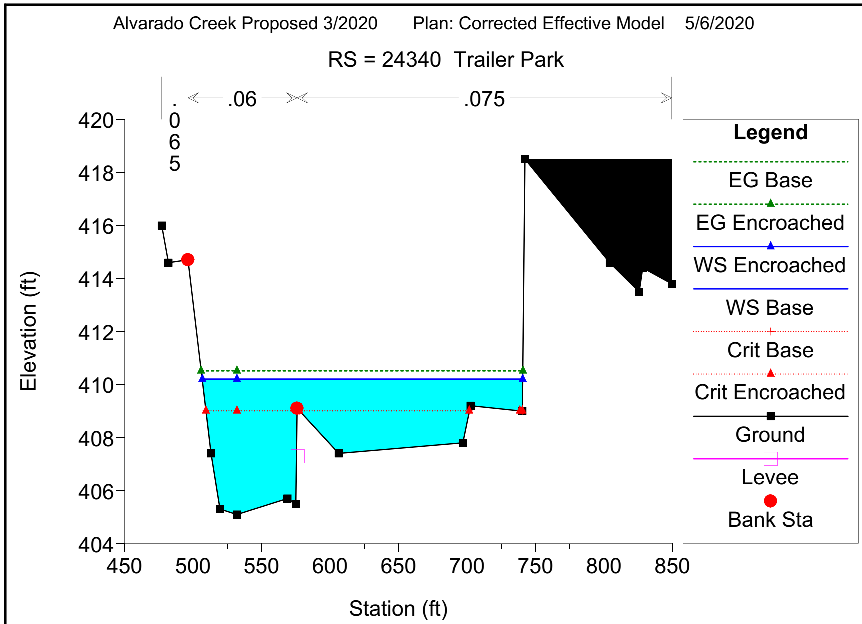

Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 25480
.065
.06
.075
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Bank Sta
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 25280 TRAILER PARK
.065
.06
.075
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 25130 TRAILER PARK
.06
.075
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 24938 TRAILER PARK
.065
.06
.075
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
Crit Base
WS Encroached
WS Base
Crit Encroached
Ground
Bank Sta


Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 24835 Trailer Park
.065
.06
.075
Elevation (ft)
Station (ft)
435
430
425
420
415
410
405
500
600
700
800
900
1000
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Ground
Bank Sta

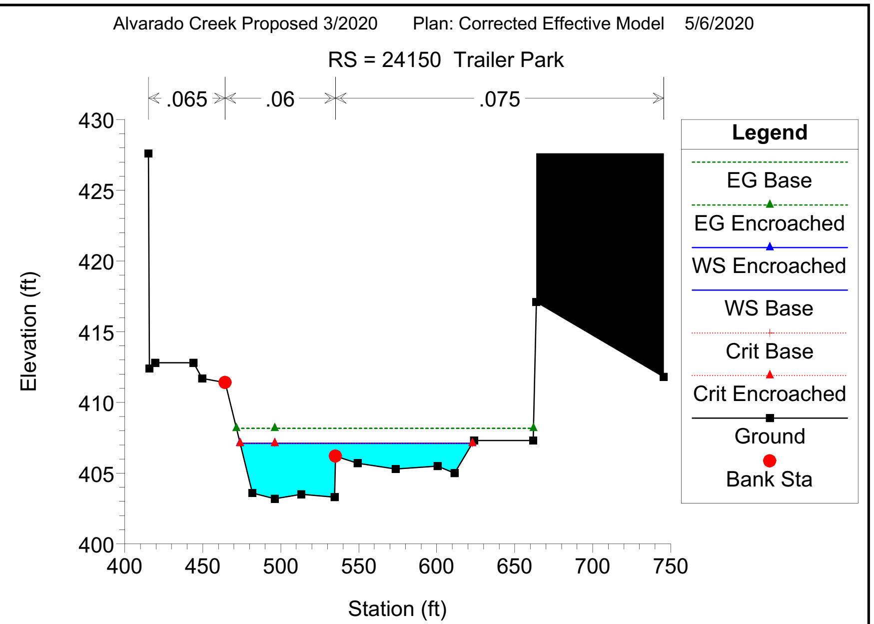

Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 24772 Trailer Park
.065
.06
.075
Elevation (ft)
Station (ft)
430
425
420
415
410
405
500
600
700
800
900
1000
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Ground
Bank Sta


Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 24704 Trailer Park
.065
.06
.065
Elevation (ft)
Station (ft)
430
425
420
415
410
405
400
500
600
700
800
900
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Ground
Bank Sta

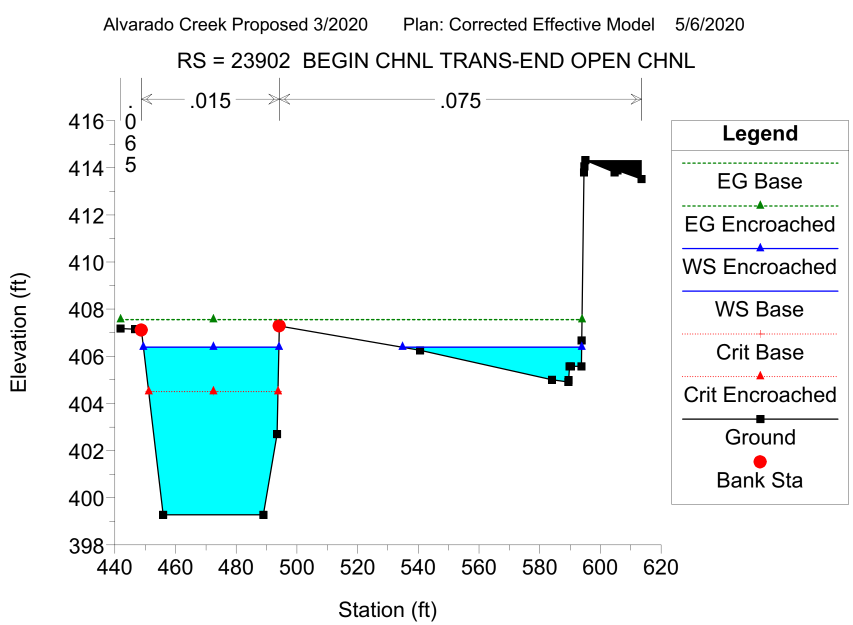

Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 24540 Trailer Park
.065
.06
.075
Elevation (ft)
Station (ft)
424
422
420
418
416
414
412
410
408
406
400
500
600
700
800
900
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Ground
Bank Sta



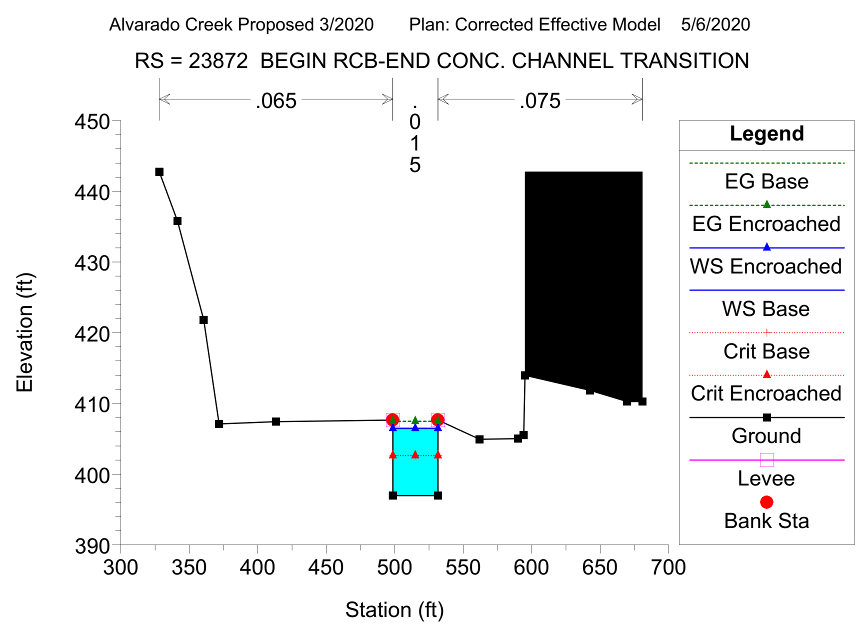
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 24340 Trailer Park
.065
.06
.075
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

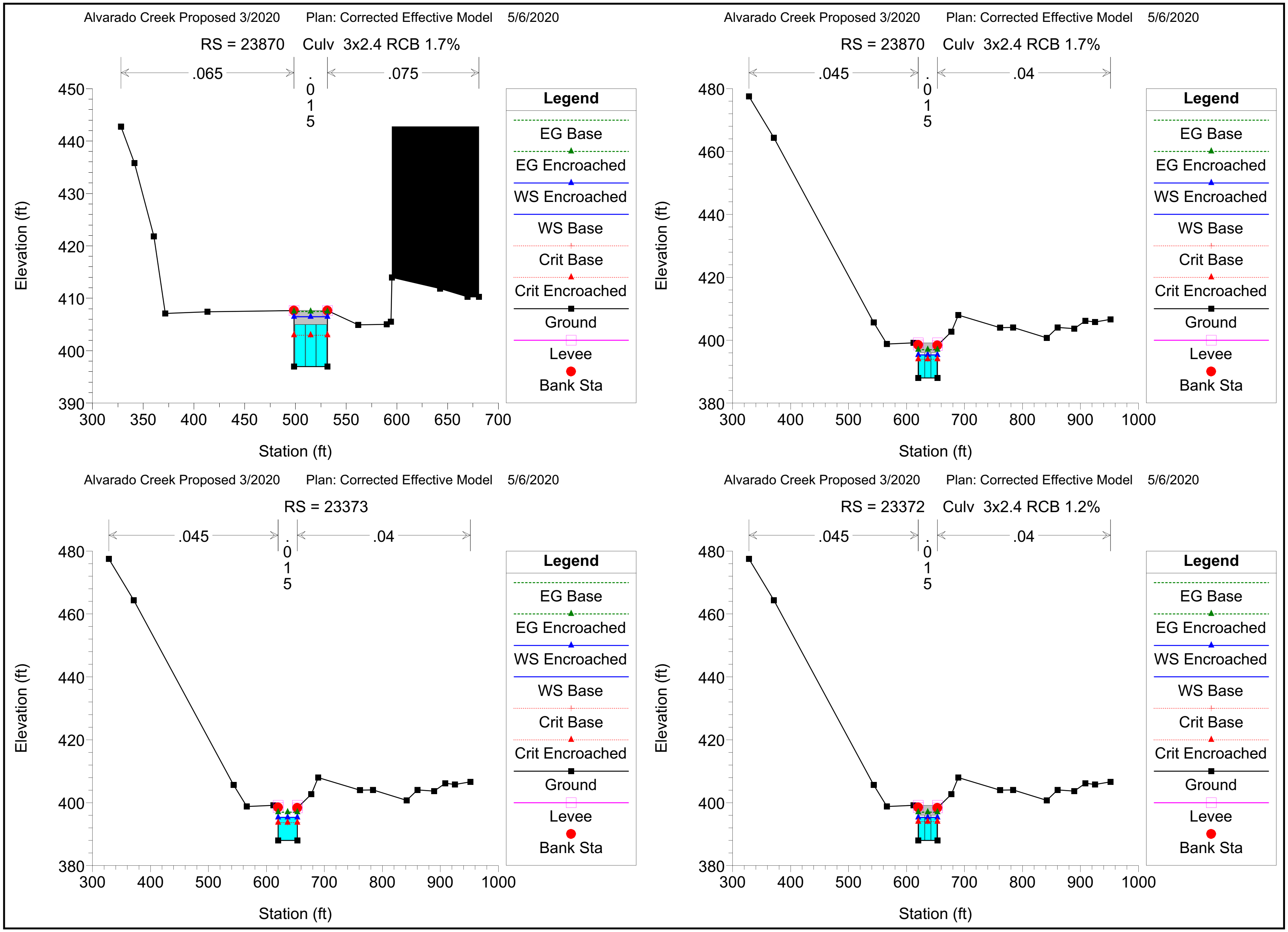
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 24150 Trailer Park
.065
.06
.075
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Bank Sta
Elevation (ft)
Station (ft)

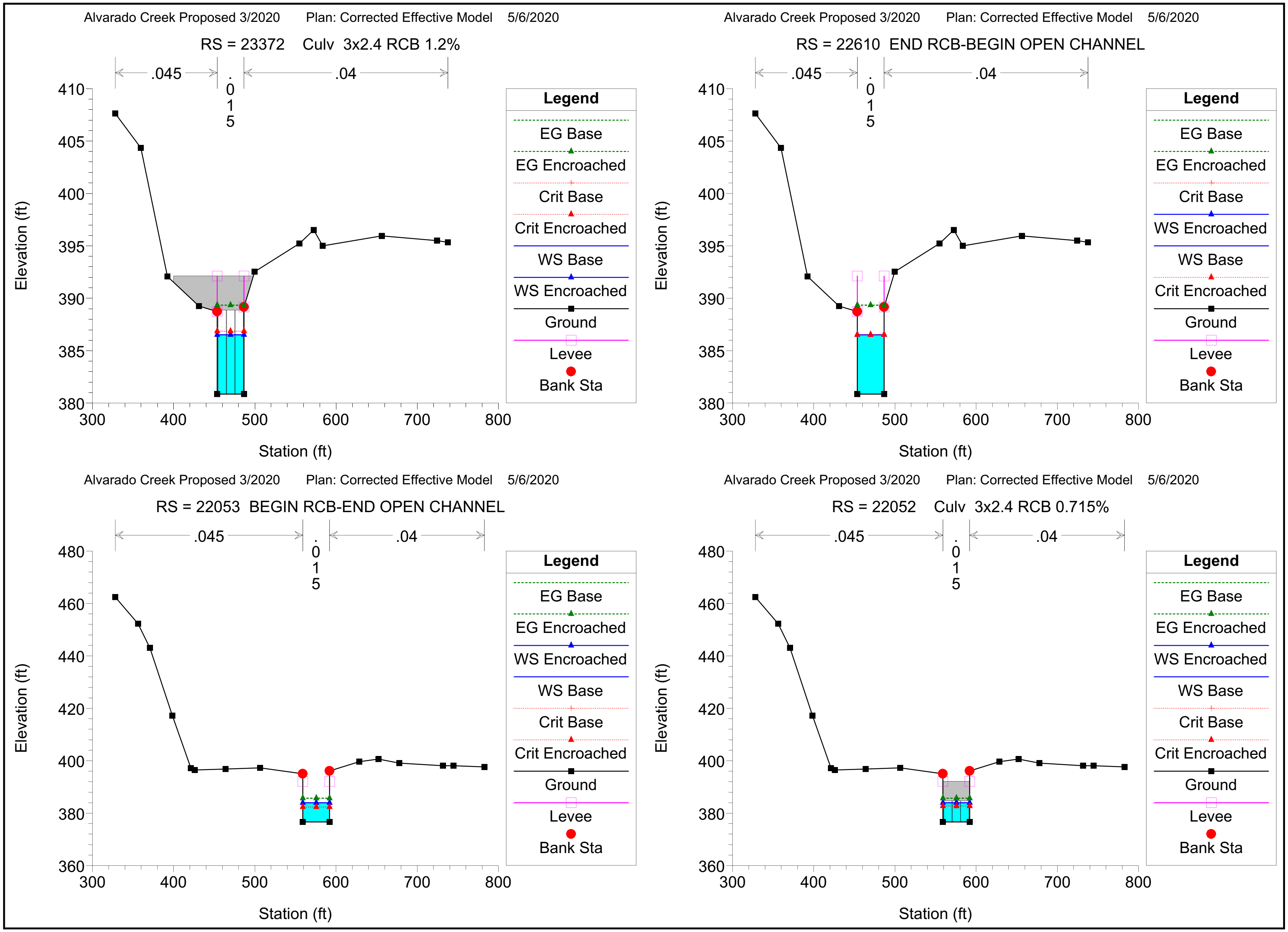
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 23902 BEGIN CHNL TRANS-END OPEN CHNL
.065
.015
.075
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Bank Sta
Elevation (ft)
Station (ft)

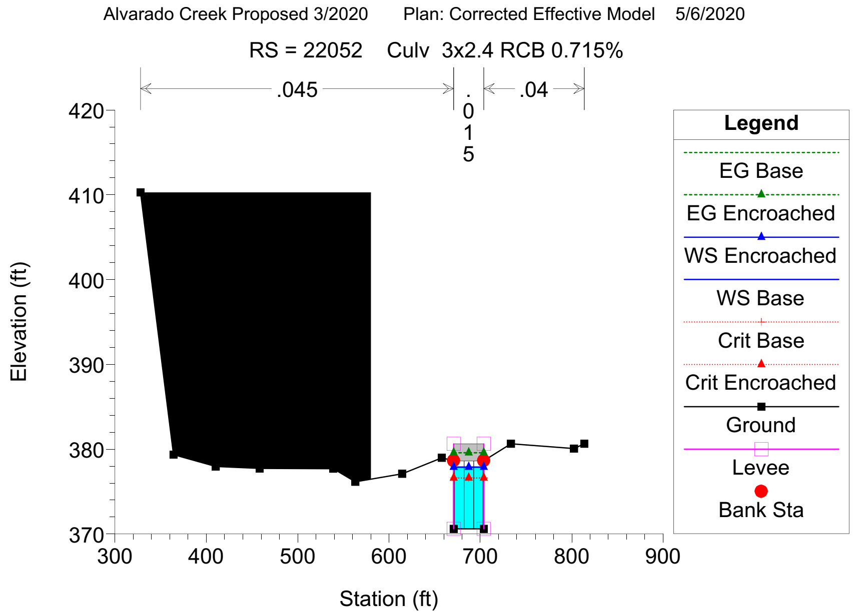
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 23872 BEGIN RCB-END CONC. CHANNEL TRANSITION
.065
.015
.075
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)



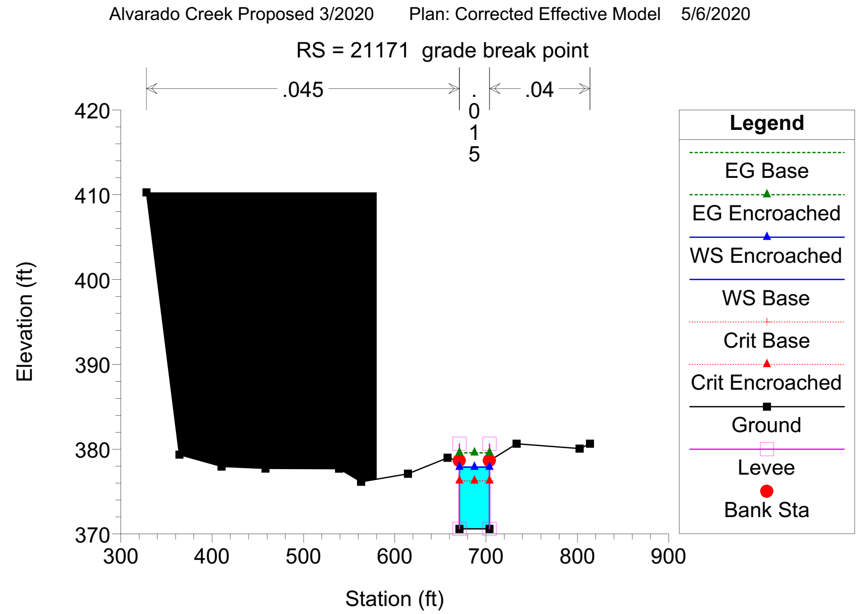
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 23870 Culv 3x2.4 RCB 1.7%
.065
.015
.075
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 23870 Culv 3x2.4 RCB 1.7%
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 23373
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 23372 Culv 3x2.4 RCB 1.2%
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta



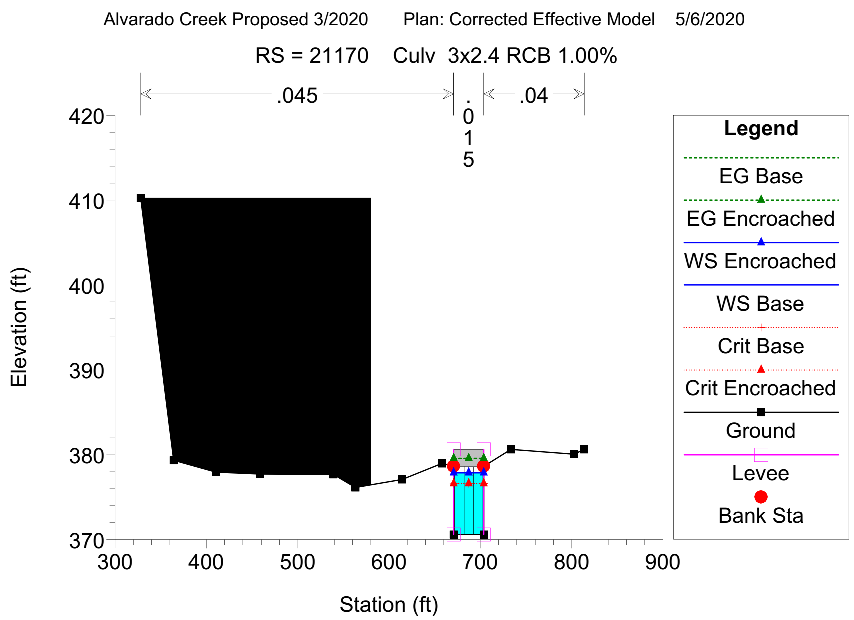
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 23372 Culv 3x2.4 RCB 1.2%
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
Crit Base
Crit Encroached
WS Base
WS Encroached
Ground
Levee
Bank Sta
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 22610 END RCB-BEGIN OPEN CHANNEL
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
Crit Base
WS Encroached
WS Base
Crit Encroached
Ground
Levee
Bank Sta
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 22053 BEGIN RCB-END OPEN CHANNEL
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 22052 Culv 3x2.4 RCB 0.715%
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta



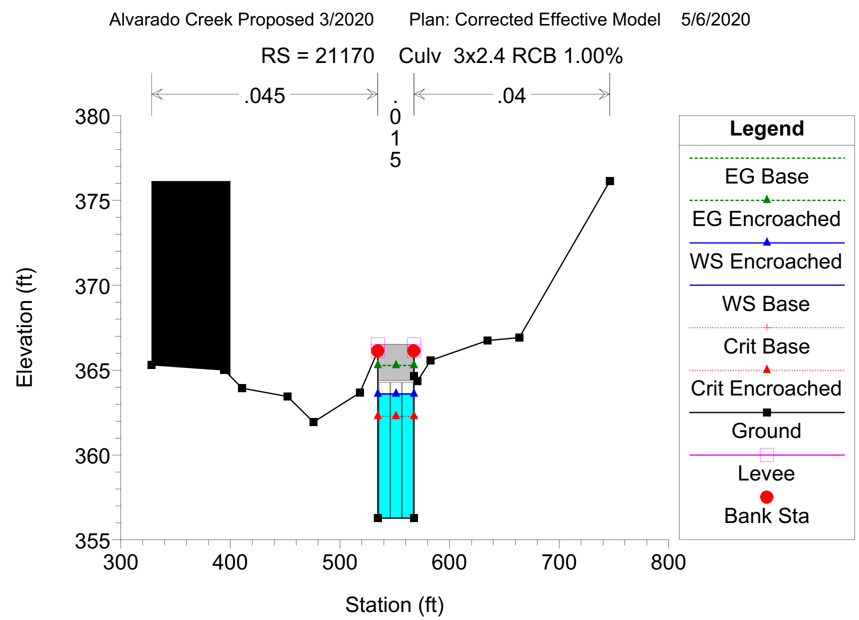
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 22052 Culv 3x2.4 RCB 0.715%
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta

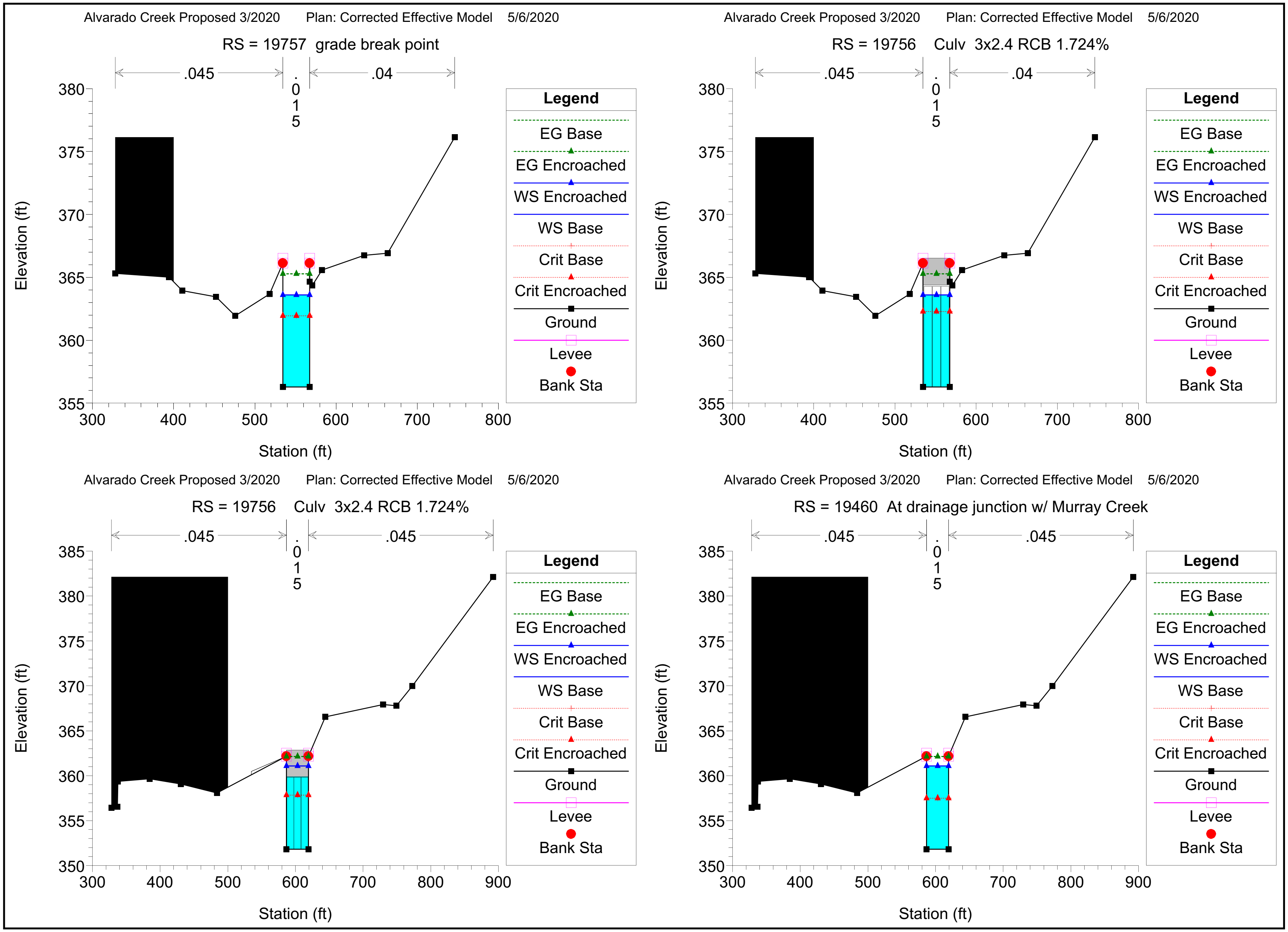
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 21171 grade break point
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta

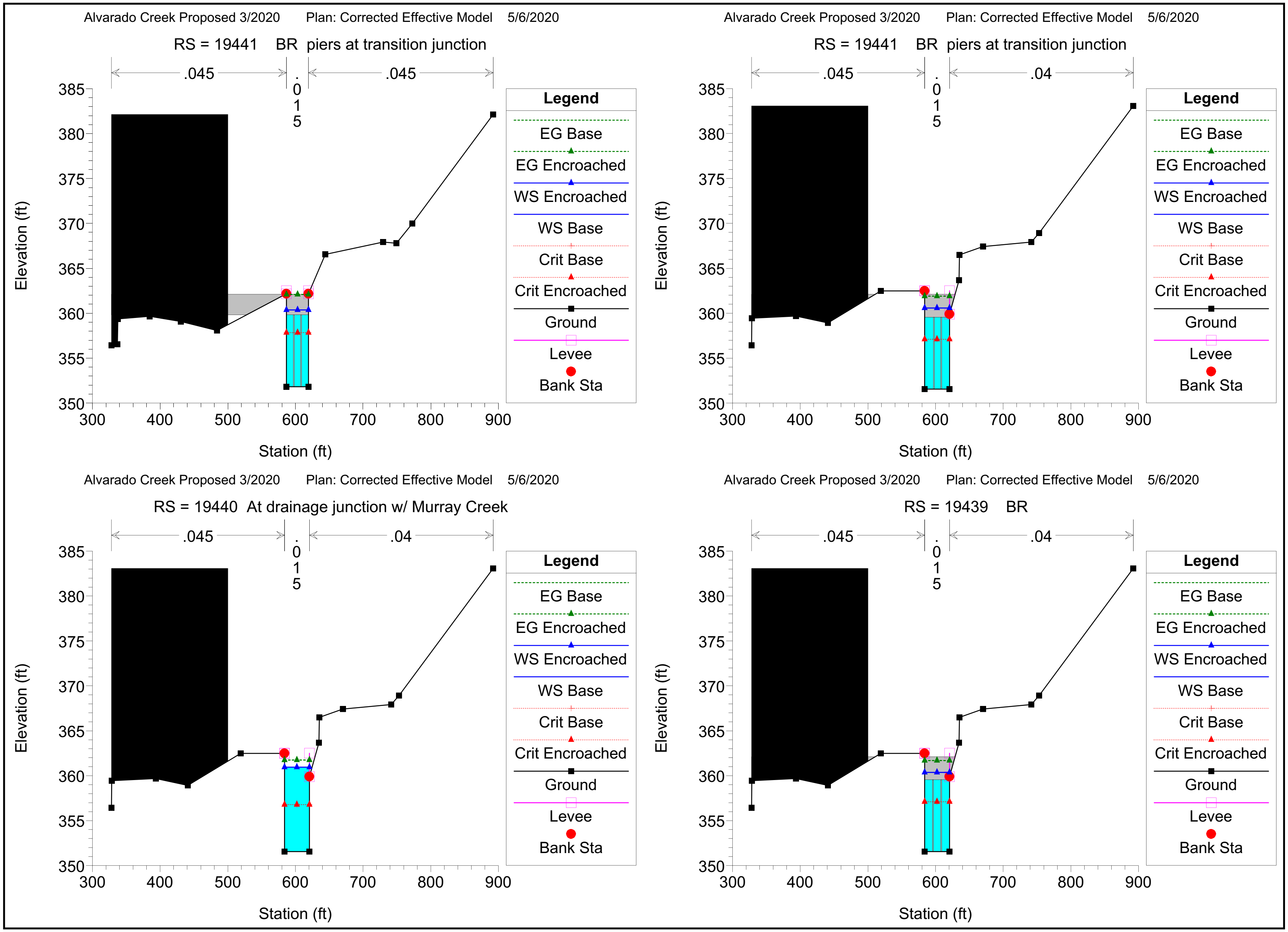
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 21170 Culv 3x2.4 RCB 1.00%
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta

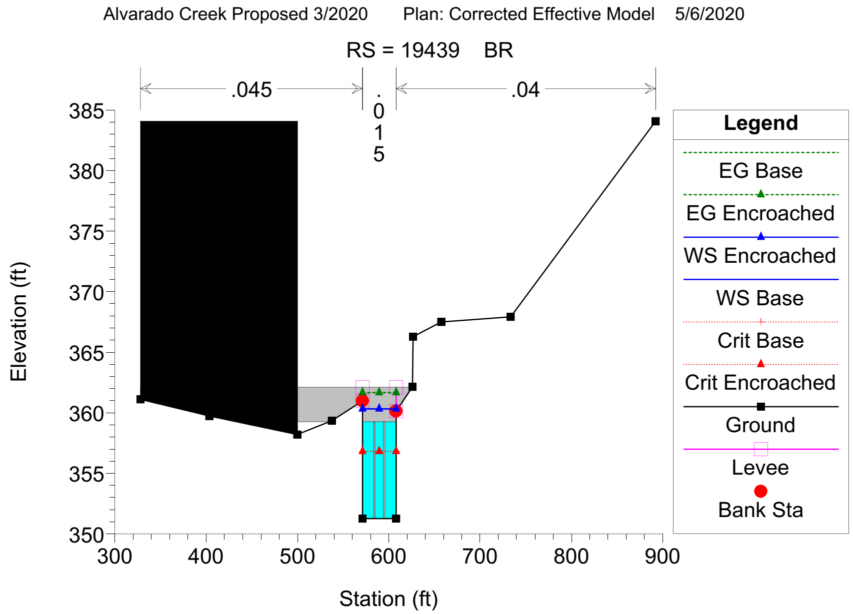
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 21170 Culv 3x2.4 RCB 1.00%
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta

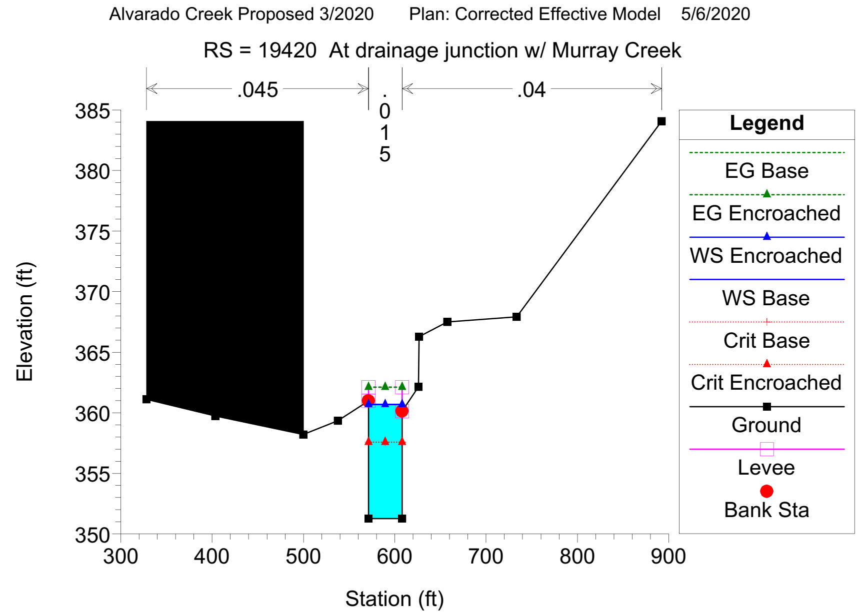


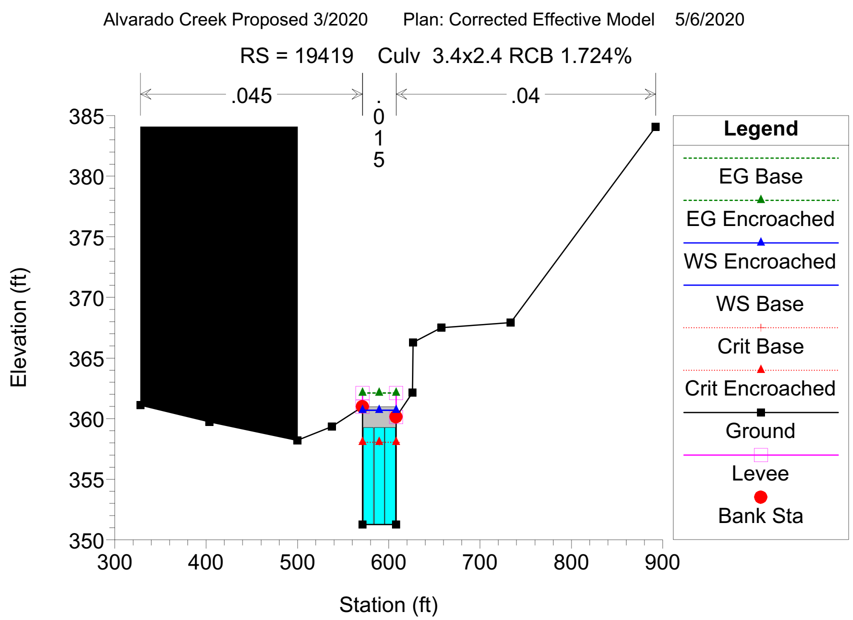
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 19757 grade break point
.045
.015
.04
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 19756 Culv 3x2.4 RCB 1.724%
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 19756 Culv 3x2.4 RCB 1.724%
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 19460 At drainage junction w/ Murray Creek

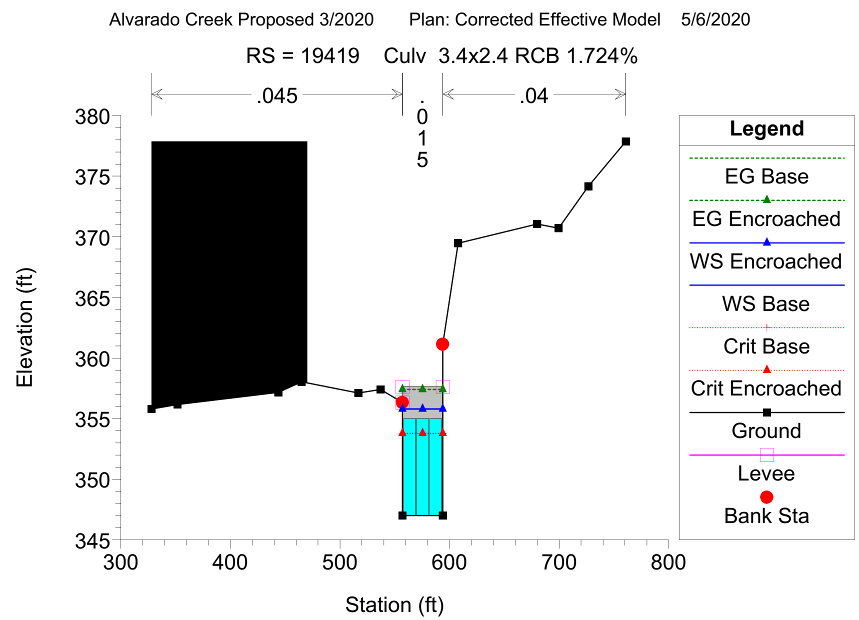


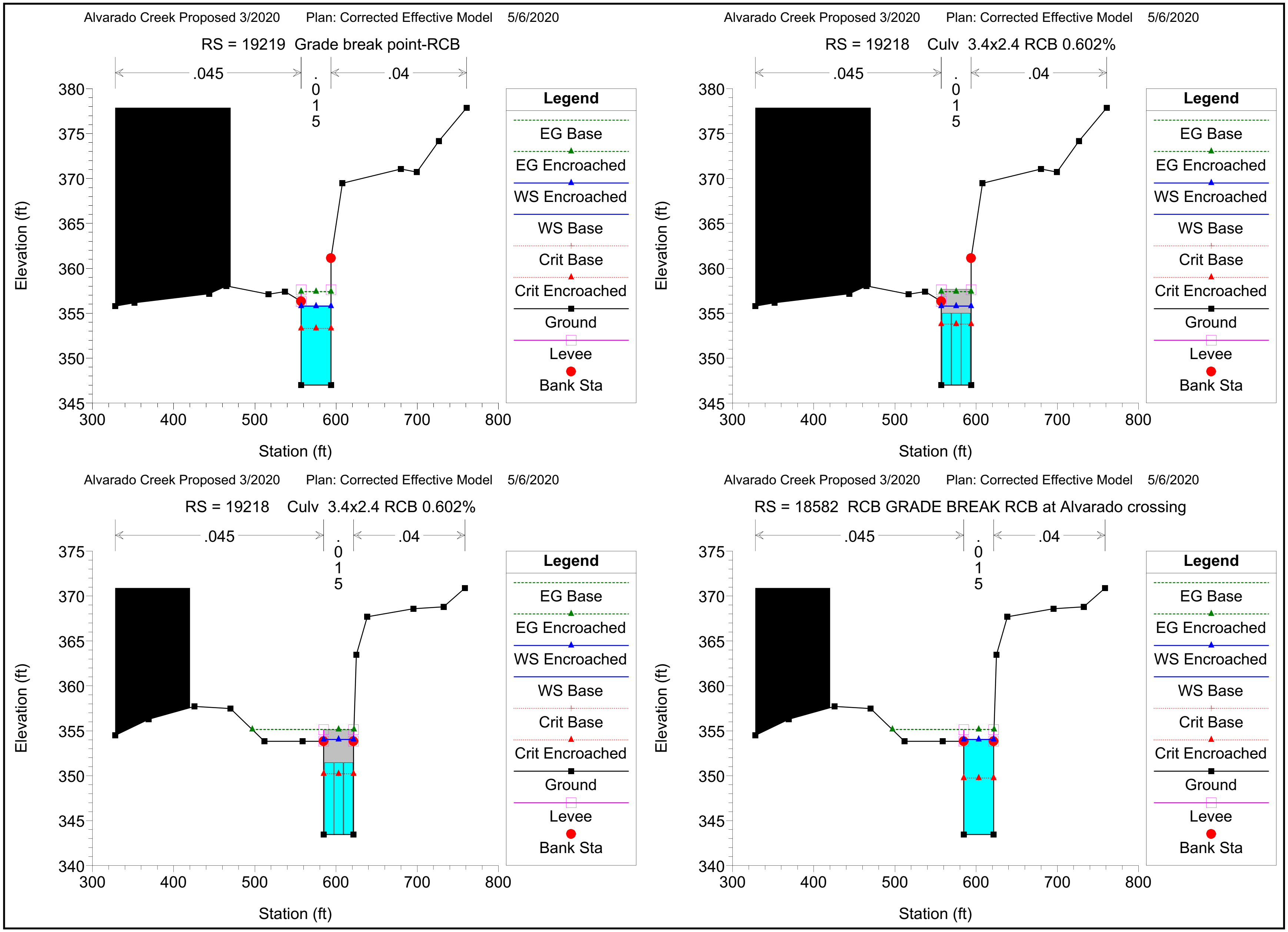
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 19441 BR piers at transition junction
.045
.015
.045
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 19441 BR piers at transition junction
.045
.015
.04
Elevation (ft)
Station (ft)
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 19440 At drainage junction w/ Murray Creek
.045
.015
.04
Elevation (ft)
Station (ft)
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 19439 BR
.045
.015
.04
Elevation (ft)
Station (ft)


Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 19439 BR
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta

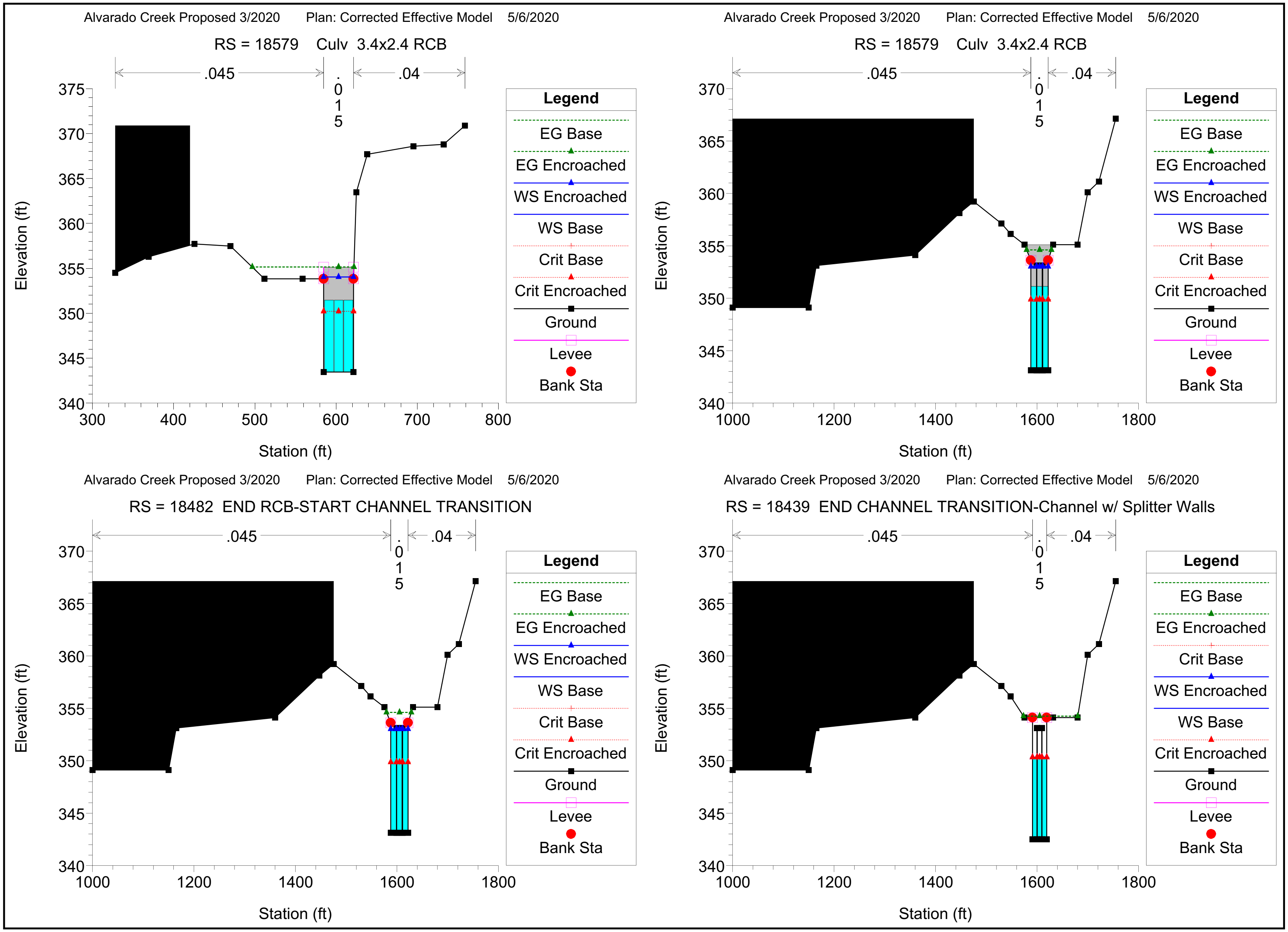

Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 19420 At drainage junction w/ Murray Creek
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta


Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 19419 Culv 3.4x2.4 RCB 1.724%
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta

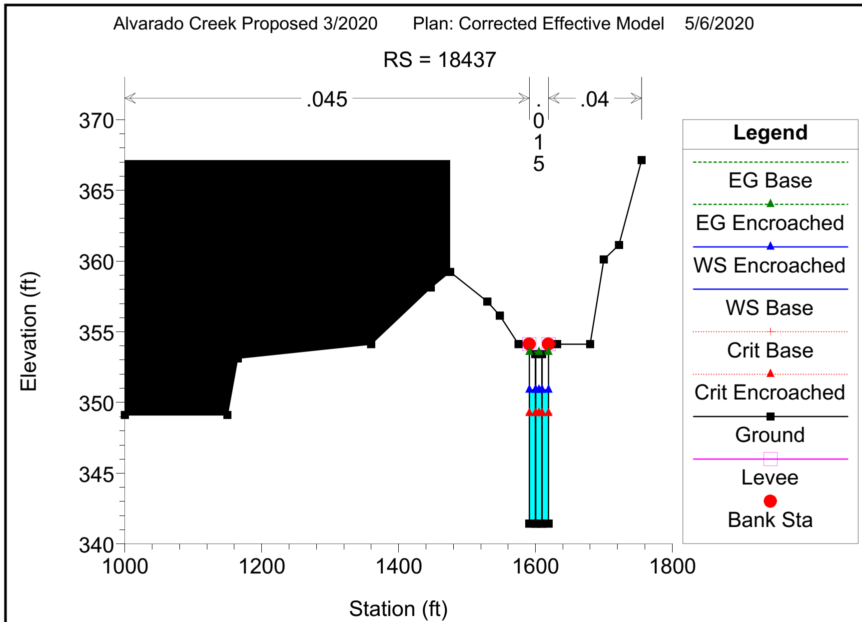

Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 19419 Culv 3.4x2.4 RCB 1.724%
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta

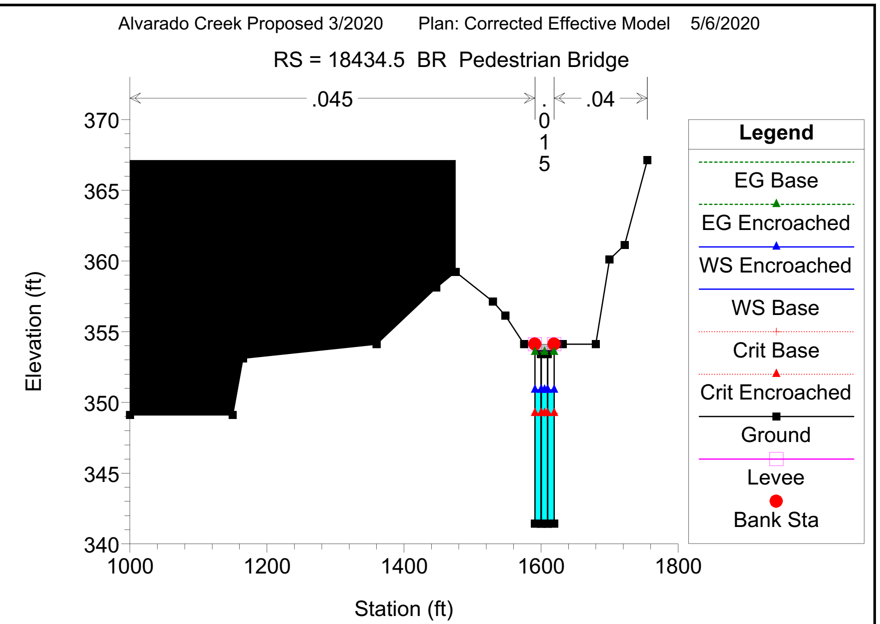


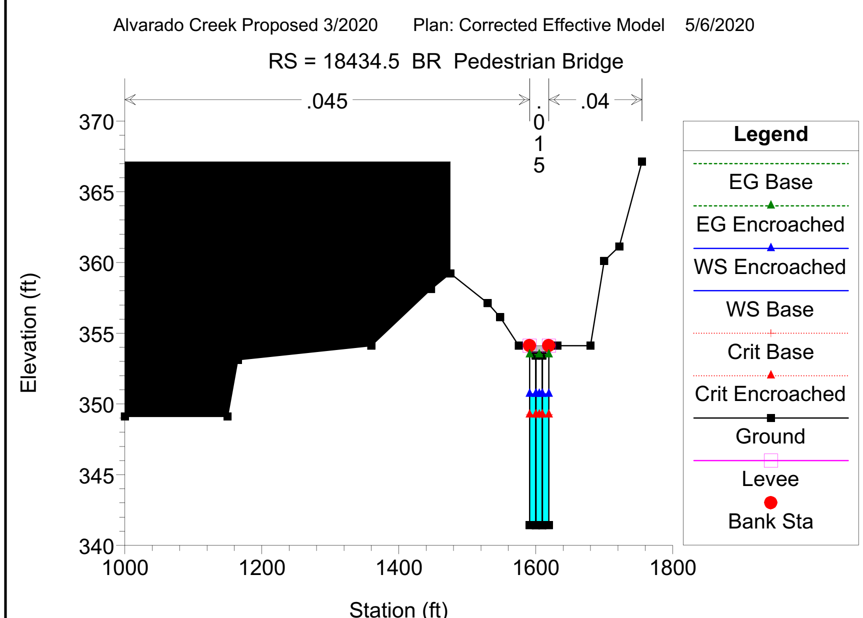
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 19219 Grade break point-RCB
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 19218 Culv 3.4x2.4 RCB 0.602%
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 19218 Culv 3.4x2.4 RCB 0.602%
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 18582 RCB GRADE BREAK RCB at Alvarado crossing
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta

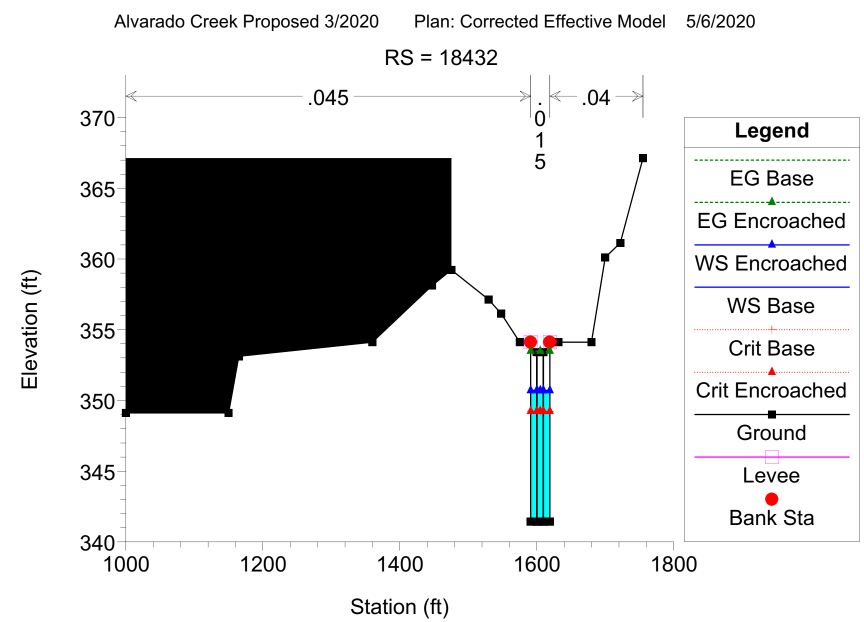


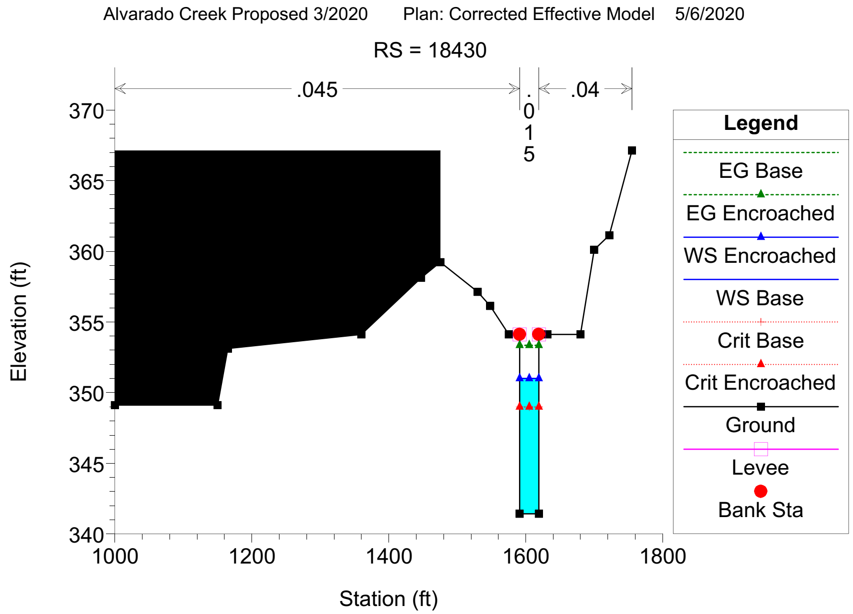
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 18579 Culv 3.4x2.4 RCB
.045
.015
.04
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 18579 Culv 3.4x2.4 RCB
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 18482 END RCB-START CHANNEL TRANSITION
Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 18439 END CHANNEL TRANSITION-Channel w/ Splitter Walls

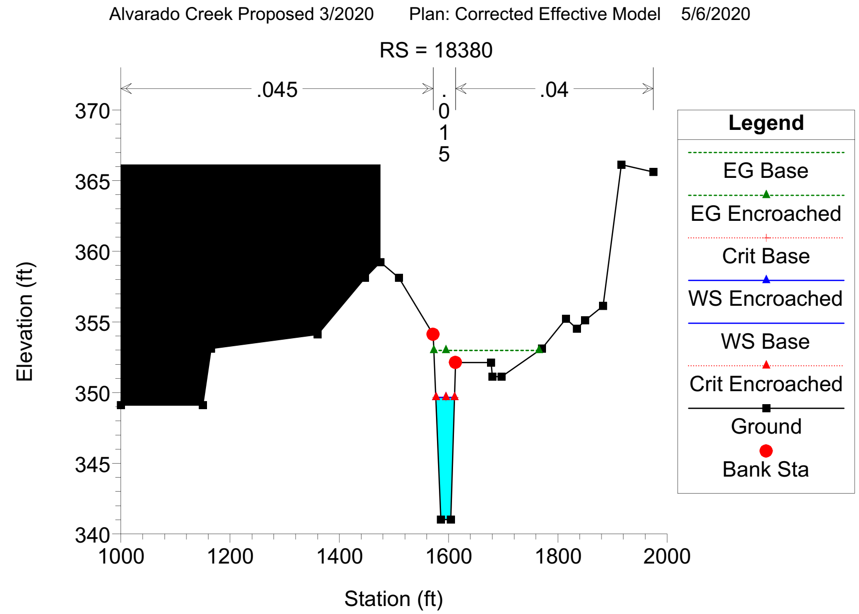

Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 18437
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta

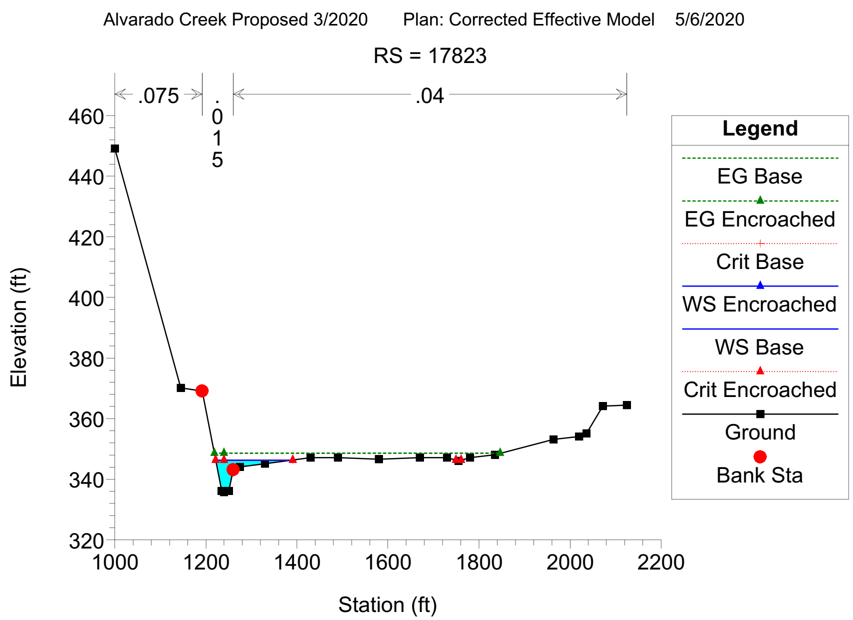

Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 18434.5 BR Pedestrian Bridge
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta

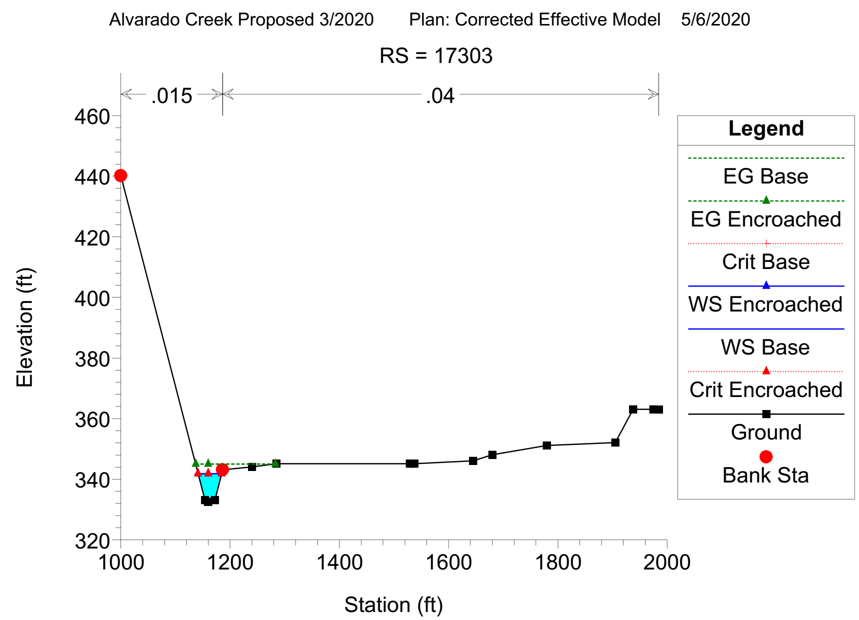

Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 18434.5 BR Pedestrian Bridge
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta


Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 18432
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta


Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 18430
.045
.015
.04
Legend
EG Base
EG Encroached
WS Encroached
WS Base
Crit Base
Crit Encroached
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 18380
.045
.015
.04
Legend
EG Base
EG Encroached
Crit Base
WS Encroached
WS Base
Crit Encroached
Ground
Bank Sta
Elevation (ft)
Station (ft)


Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 17823
.075
.015
.04
Legend
EG Base
EG Encroached
Crit Base
WS Encroached
WS Base
Crit Encroached
Ground
Bank Sta
Elevation (ft)
Station (ft)


Alvarado Creek Proposed 3/2020 Plan: Corrected Effective Model 5/6/2020
RS = 17303
.015
.04
Legend
EG Base
EG Encroached
Crit Base
WS Encroached
WS Base
Crit Encroached
Ground
Bank Sta
Elevation (ft)
Station (ft)

Proposed Model Results

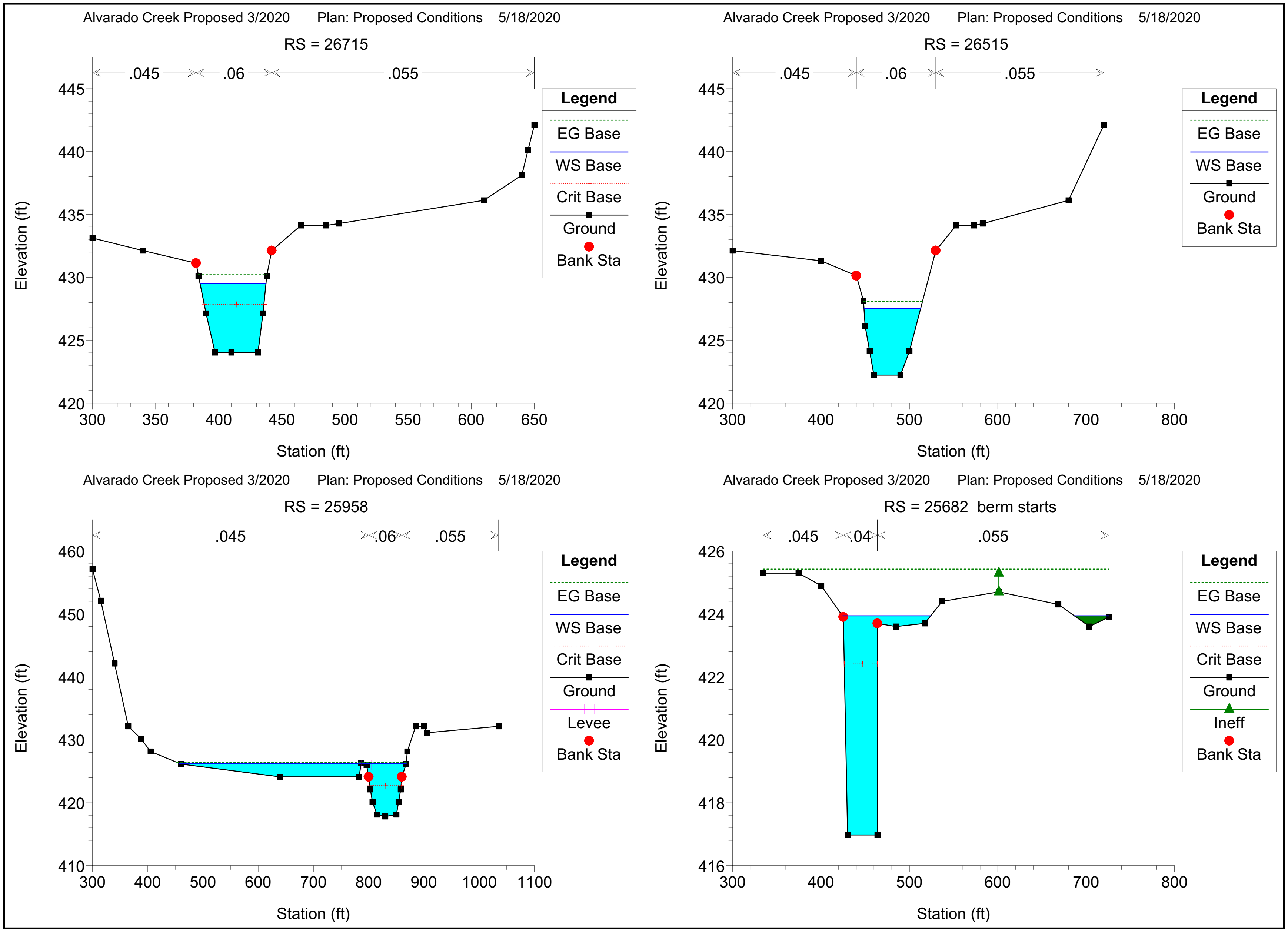
HEC-RAS Plan: 2020-05-06 River: RIVER-1 Reach: Reach-1 Profile: Base

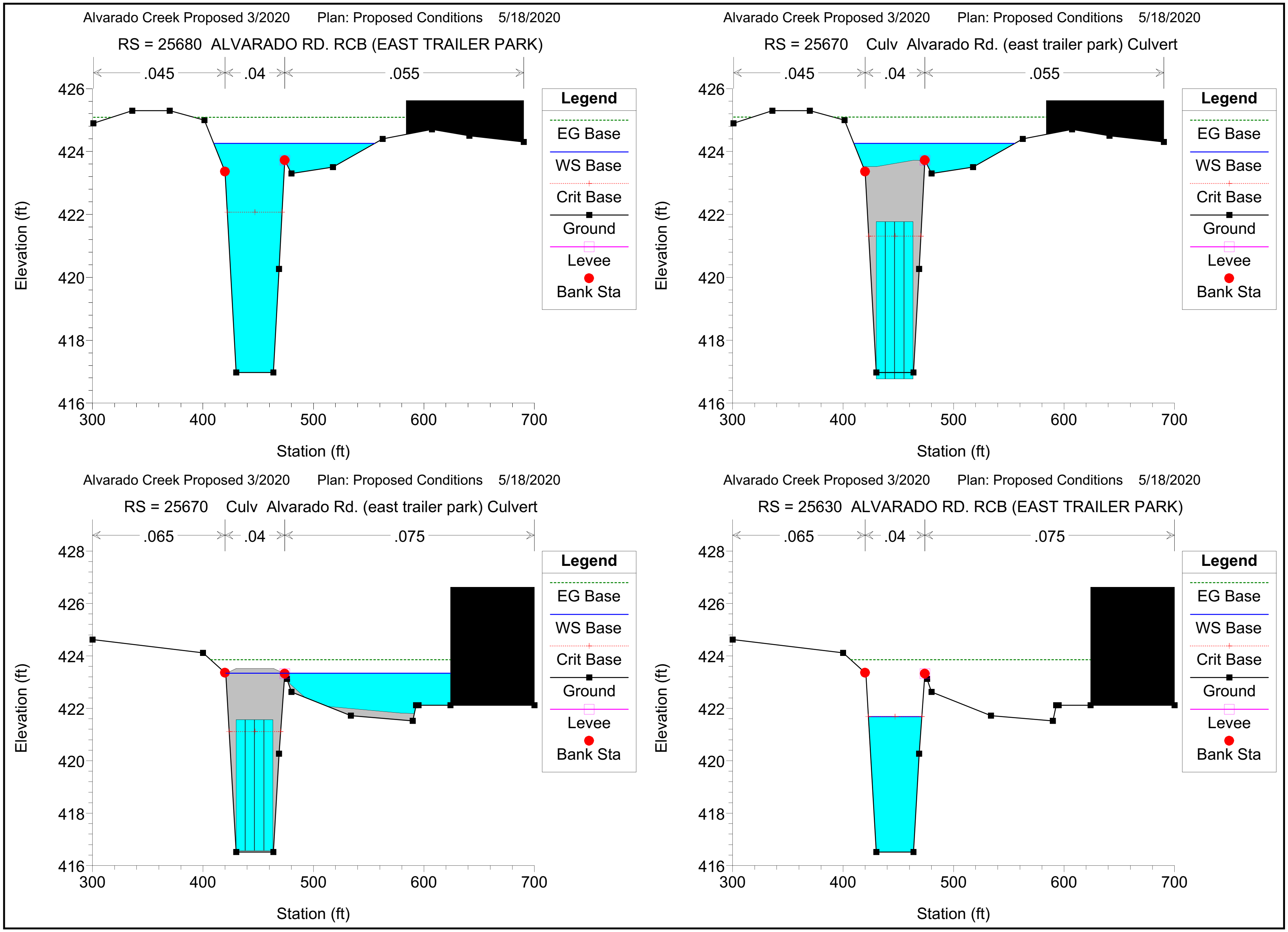
| Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Reach-1 | 26715 | Base | 1600.00 | 424.02 | 429.50 | 427.84 | 430.20 | 0.010533 | 6.72 | 238.14 | 52.15 | 0.55 |
| Reach-1 | 26515 | Base | 1600.00 | 422.22 | 427.50 | | 428.10 | 0.010244 | 6.21 | 257.50 | 64.05 | 0.55 |
| Reach-1 | 25958 | Base | 2500.00 | 417.82 | 426.25 | 422.71 | 426.40 | 0.001650 | 3.63 | 957.93 | 409.20 | 0.24 |
| Reach-1 | 25682 | Base | 2500.00 | 416.97 | 423.94 | 422.41 | 425.43 | 0.007836 | 9.83 | 268.93 | 138.95 | 0.68 |
| Reach-1 | 25680 | Base | 2500.00 | 416.97 | 424.26 | 422.07 | 425.09 | 0.003980 | 7.43 | 382.53 | 145.64 | 0.53 |
| Reach-1 | 25670 | | Culvert | | | | | | | | | |
| Reach-1 | 25630 | Base | 2500.00 | 416.52 | 421.68 | 421.68 | 423.86 | 0.015550 | 11.84 | 211.16 | 48.38 | 1.00 |
| Reach-1 | 25480 | Base | 2500.00 | 413.13 | 420.24 | 417.41 | 421.02 | 0.006245 | 7.07 | 353.52 | 49.77 | 0.47 |
| Reach-1 | 25371.2 | Base | 2500.00 | 411.89 | 419.95 | | 420.41 | 0.003642 | 5.43 | 460.40 | 64.51 | 0.36 |
| Reach-1 | 25313.62 | Base | 2500.00 | 411.82 | 419.81 | | 420.21 | 0.002763 | 5.09 | 490.79 | 61.48 | 0.32 |
| Reach-1 | 25280 | Base | 2500.00 | 411.83 | 419.66 | | 420.11 | 0.003174 | 5.38 | 464.85 | 59.81 | 0.34 |
| Reach-1 | 25130 | Base | 2500.00 | 409.90 | 418.83 | | 419.46 | 0.005686 | 6.41 | 389.82 | 57.92 | 0.44 |
| Reach-1 | 24938 | Base | 2500.00 | 409.00 | 416.11 | | 417.72 | 0.014368 | 10.18 | 245.61 | 37.21 | 0.70 |
| Reach-1 | 24835 | Base | 2500.00 | 408.60 | 415.35 | | 416.44 | 0.009411 | 8.36 | 299.08 | 44.94 | 0.57 |
| Reach-1 | 24772 | Base | 2500.00 | 408.50 | 414.94 | | 415.79 | 0.008242 | 7.40 | 338.01 | 55.70 | 0.53 |
| Reach-1 | 24704 | Base | 2500.00 | 407.40 | 414.69 | | 415.24 | 0.005269 | 5.95 | 419.82 | 68.41 | 0.42 |
| Reach-1 | 24540 | Base | 2500.00 | 406.20 | 413.01 | | 414.01 | 0.010565 | 8.01 | 312.01 | 53.59 | 0.59 |
| Reach-1 | 24340 | Base | 2500.00 | 405.10 | 411.41 | 409.27 | 412.10 | 0.007863 | 6.65 | 375.97 | 69.52 | 0.50 |
| Reach-1 | 24150 | Base | 2500.00 | 403.20 | 407.39 | 407.39 | 409.24 | 0.034663 | 10.91 | 229.12 | 61.67 | 1.00 |
| Reach-1 | 23902 | Base | 2500.00 | 399.27 | 406.37 | 404.53 | 407.58 | 0.000832 | 8.83 | 283.02 | 102.82 | 0.62 |
| Reach-1 | 23872 | Base | 2500.00 | 396.96 | 406.45 | 402.61 | 407.45 | 0.000602 | 8.03 | 311.16 | 32.80 | 0.46 |
| Reach-1 | 23870 | | Culvert | | | | | | | | | |
| Reach-1 | 23373 | Base | 2500.00 | 387.98 | 391.30 | 393.64 | 399.48 | 0.013849 | 22.95 | 108.94 | 32.80 | 2.22 |
| Reach-1 | 23372 | | Culvert | | | | | | | | | |
| Reach-1 | 22610 | Base | 2500.00 | 380.86 | 384.93 | 386.51 | 390.37 | 0.007371 | 18.71 | 133.62 | 32.80 | 1.63 |
| Reach-1 | 22053 | Base | 2500.00 | 376.68 | 380.53 | 382.34 | 386.61 | 0.008747 | 19.78 | 126.38 | 32.80 | 1.78 |
| Reach-1 | 22052 | | Culvert | | | | | | | | | |
| Reach-1 | 21171 | Base | 2500.00 | 370.59 | 374.81 | 376.24 | 379.87 | 0.006610 | 18.06 | 138.46 | 32.81 | 1.55 |
| Reach-1 | 21170 | | Culvert | | | | | | | | | |
| Reach-1 | 19757 | Base | 2500.00 | 356.28 | 360.08 | 361.93 | 366.31 | 0.009100 | 20.03 | 124.81 | 32.84 | 1.81 |
| Reach-1 | 19756 | | Culvert | | | | | | | | | |
| Reach-1 | 19460 | Base | 2500.00 | 351.83 | 361.09 | 357.49 | 362.14 | 0.000644 | 8.23 | 303.80 | 32.80 | 0.48 |
| Reach-1 | 19441 | | Bridge | | | | | | | | | |
| Reach-1 | 19440 | Base | 2500.00 | 351.55 | 360.95 | 356.79 | 361.76 | 0.000466 | 7.23 | 345.75 | 36.80 | 0.42 |
| Reach-1 | 19439 | | Bridge | | | | | | | | | |
| Reach-1 | 19420 | Base | 2500.00 | 351.27 | 360.70 | 356.50 | 361.50 | 0.000461 | 7.21 | 346.93 | 36.80 | 0.41 |
| Reach-1 | 19419 | | Culvert | | | | | | | | | |
| Reach-1 | 19219 | Base | 3300.00 | 347.01 | 355.80 | 353.31 | 357.42 | 0.000983 | 10.20 | 323.54 | 36.80 | 0.61 |

HEC-RAS  Plan: 2020-05-06   River: RIVER-1   Reach: Reach-1   Profile: Base (Continued)

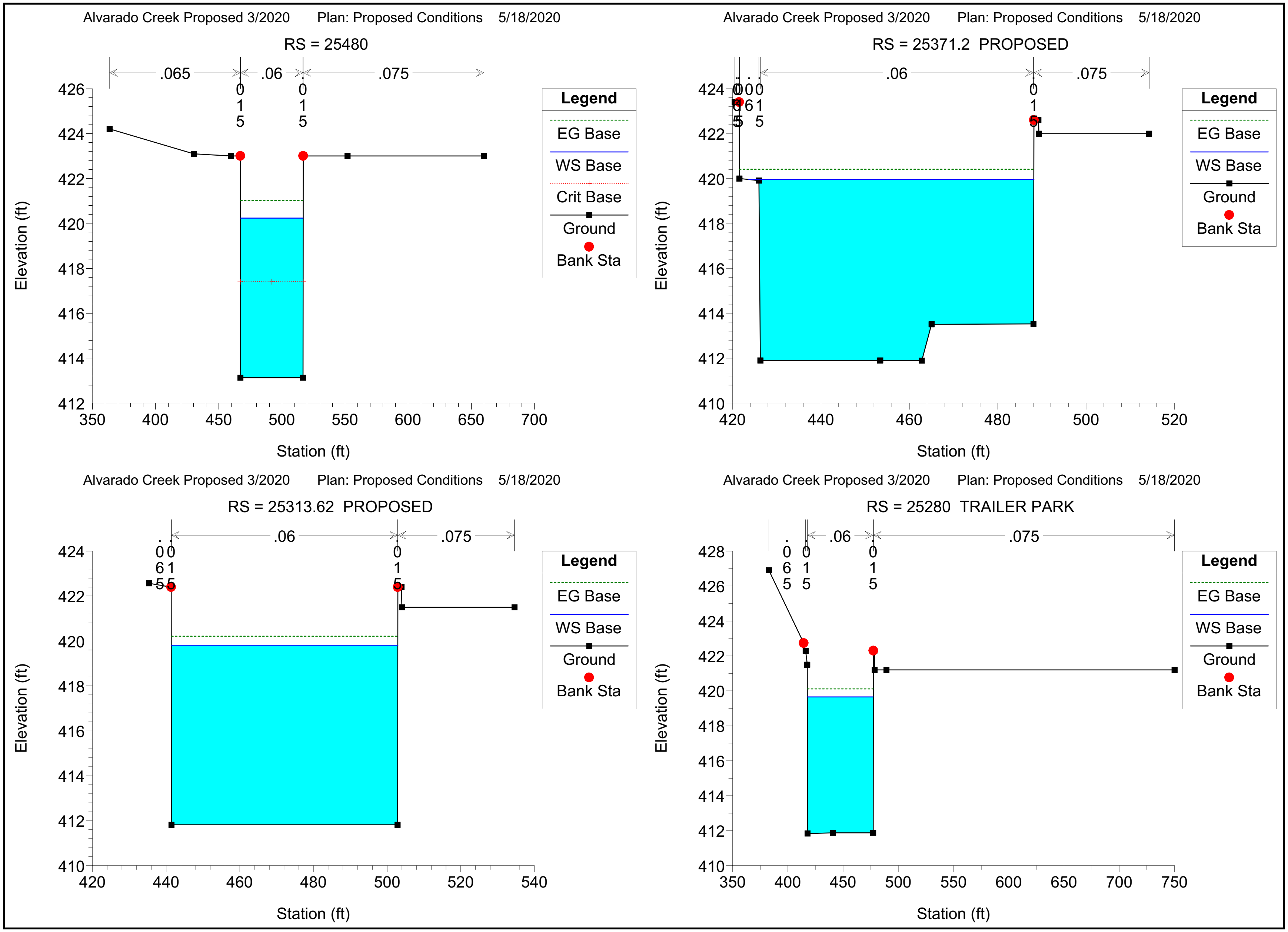
| Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Reach-1 | 19218 | | Culvert | | | | | | | | | |
| Reach-1 | 18582 | Base | 3300.00 | 343.45 | 354.03 | 349.75 | 355.14 | 0.000578 | 8.48 | 389.31 | 36.80 | 0.46 |
| Reach-1 | 18579 | | Culvert | | | | | | | | | |
| Reach-1 | 18482 | Base | 3300.00 | 343.12 | 353.03 | 349.87 | 354.61 | 0.001925 | 10.09 | 327.06 | 33.00 | 0.56 |
| Reach-1 | 18439 | Base | 3300.00 | 342.52 | 350.27 | 350.34 | 354.25 | 0.006553 | 16.01 | 206.16 | 26.60 | 1.01 |
| Reach-1 | 18437 | Base | 3300.00 | 341.42 | 350.87 | 349.24 | 353.54 | 0.004031 | 13.13 | 251.29 | 26.60 | 0.75 |
| Reach-1 | 18434.5 | | Bridge | | | | | | | | | |
| Reach-1 | 18432 | Base | 3300.00 | 341.42 | 350.67 | 349.24 | 353.46 | 0.004244 | 13.41 | 246.00 | 26.60 | 0.78 |
| Reach-1 | 18430 | Base | 3300.00 | 341.42 | 350.96 | 348.98 | 353.33 | 0.001538 | 12.36 | 267.08 | 28.00 | 0.71 |
| Reach-1 | 18380 | Base | 3300.00 | 341.02 | 349.69 | 349.69 | 352.98 | 0.002274 | 14.57 | 226.53 | 34.29 | 1.00 |
| Reach-1 | 17823 | Base | 3900.00 | 335.72 | 343.19 | 346.28 | 350.70 | 0.006515 | 22.00 | 177.31 | 35.24 | 1.70 |
| Reach-1 | 17303 | Base | 3900.00 | 332.52 | 339.41 | 341.89 | 347.15 | 0.007091 | 22.33 | 174.65 | 35.85 | 1.78 |

# Proposed Model Cross Sections





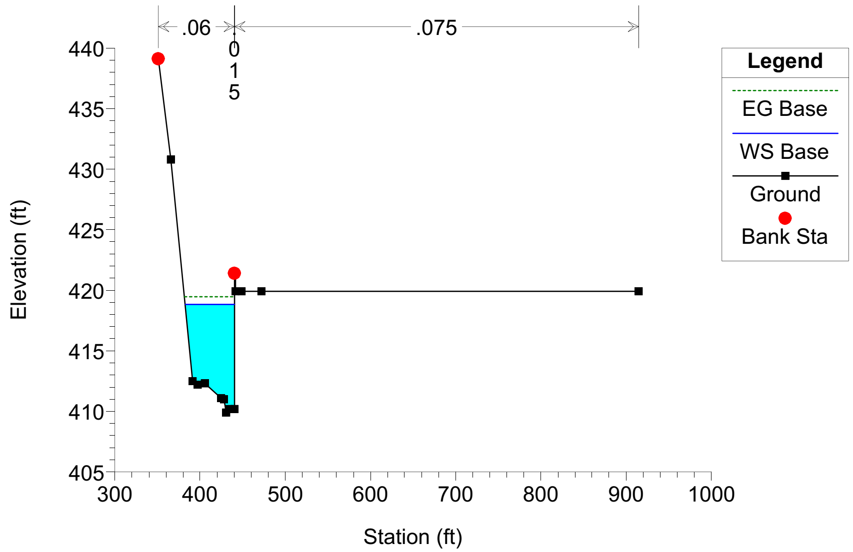
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 25680 ALVARADO RD. RCB (EAST TRAILER PARK)
.045 .04 .055
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 25670 Culv Alvarado Rd. (east trailer park) Culvert
.045 .04 .055
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 25670 Culv Alvarado Rd. (east trailer park) Culvert
.065 .04 .075
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 25630 ALVARADO RD. RCB (EAST TRAILER PARK)
.065 .04 .075



Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 25480
.065
.06
.075
Elevation (ft)
Station (ft)
Legend
EG Base
WS Base
Crit Base
Ground
Bank Sta
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 25371.2 PROPOSED
.06
.075
Elevation (ft)
Station (ft)
Legend
EG Base
WS Base
Ground
Bank Sta
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 25313.62 PROPOSED
.06
.075
Elevation (ft)
Station (ft)
Legend
EG Base
WS Base
Ground
Bank Sta
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 25280 TRAILER PARK
.06
.075
Elevation (ft)
Station (ft)
Legend
EG Base
WS Base
Ground
Bank Sta

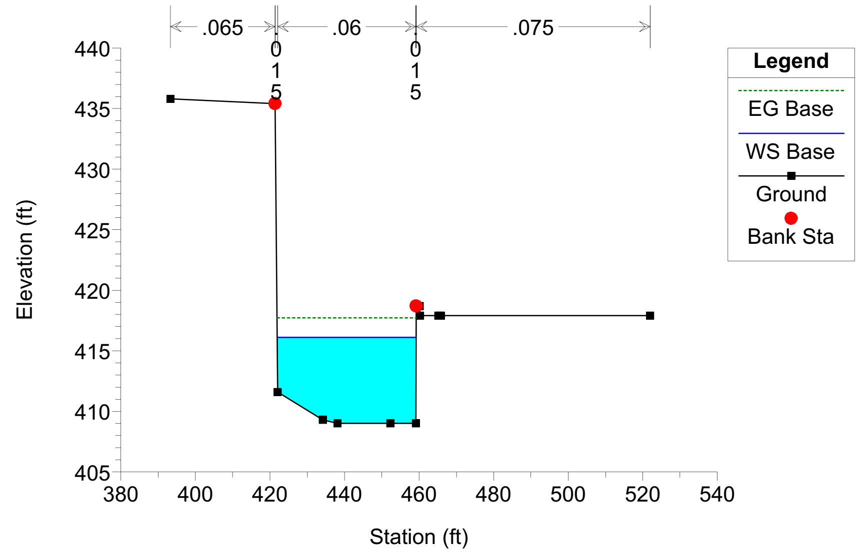
Alvarado Creek Proposed 3/2020    Plan: Proposed Conditions    5/18/2020

RS = 25130  TRAILER PARK



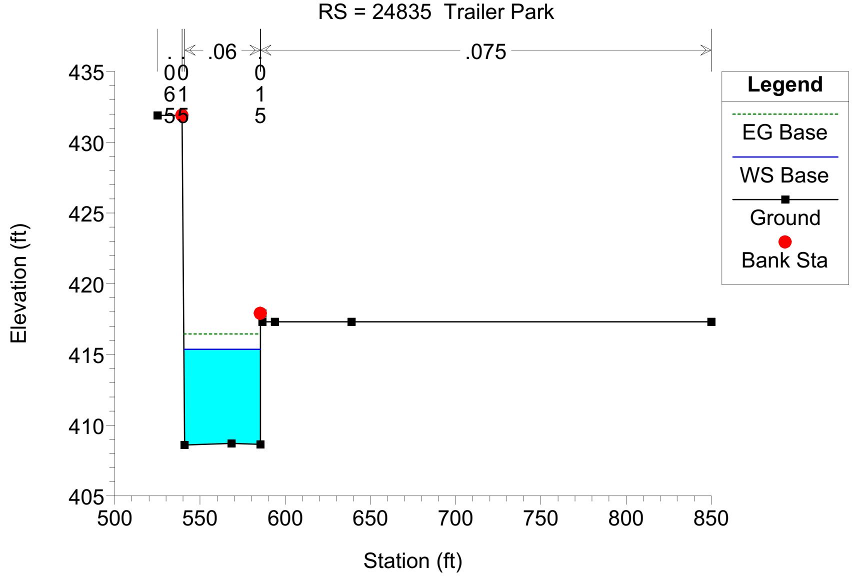

Alvarado Creek Proposed 3/2020    Plan: Proposed Conditions    5/18/2020

RS = 24938  TRAILER PARK



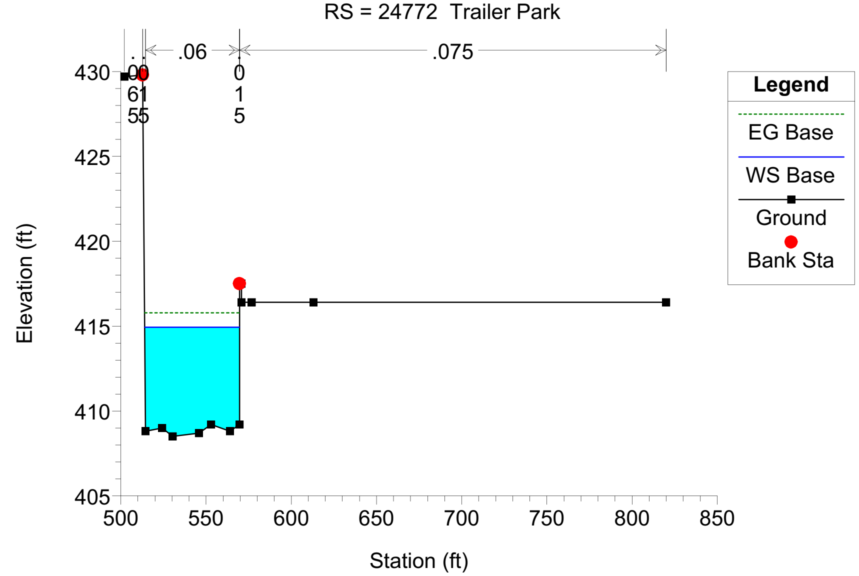

Alvarado Creek Proposed 3/2020    Plan: Proposed Conditions    5/18/2020

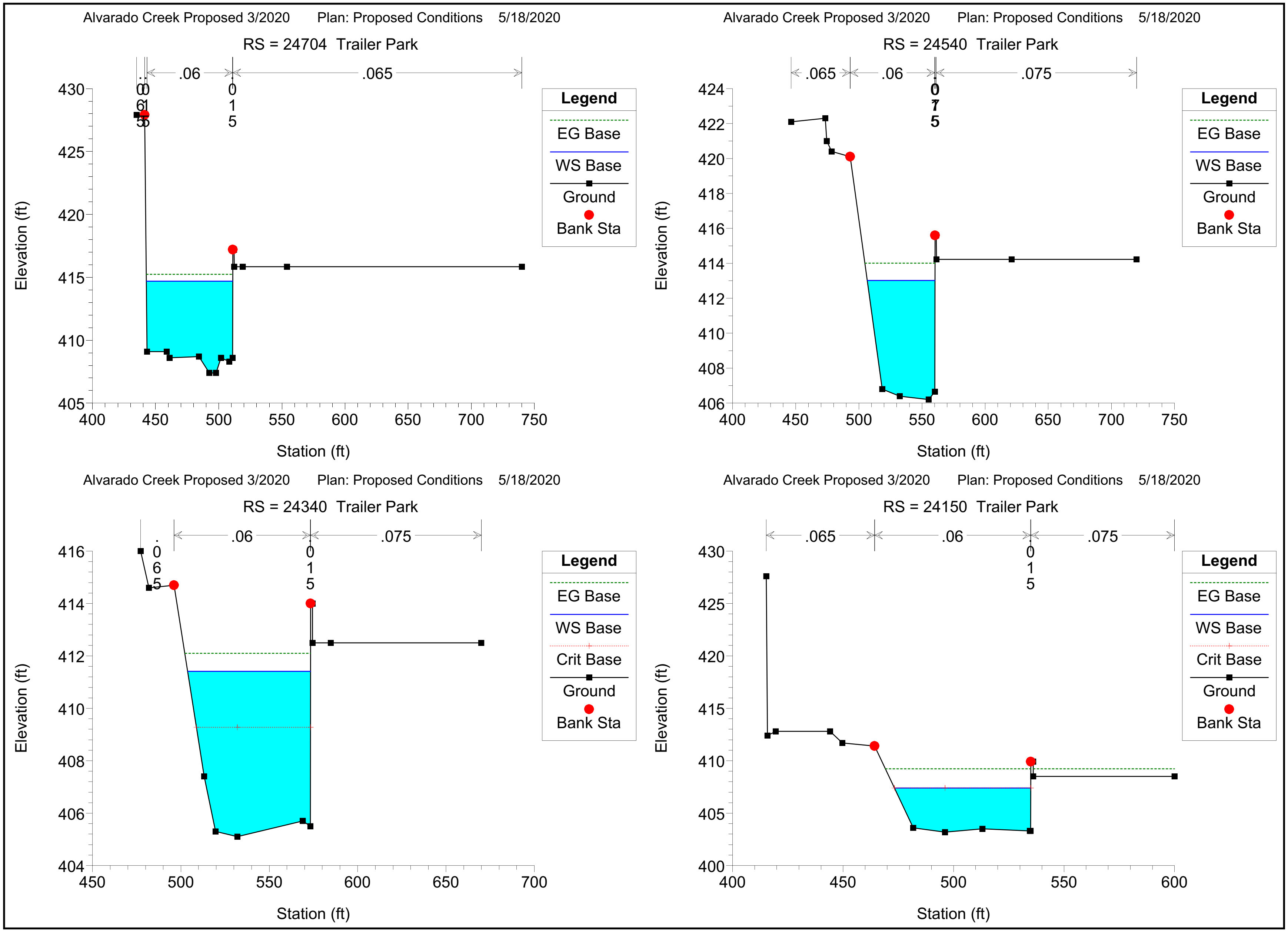
RS = 24835  Trailer Park

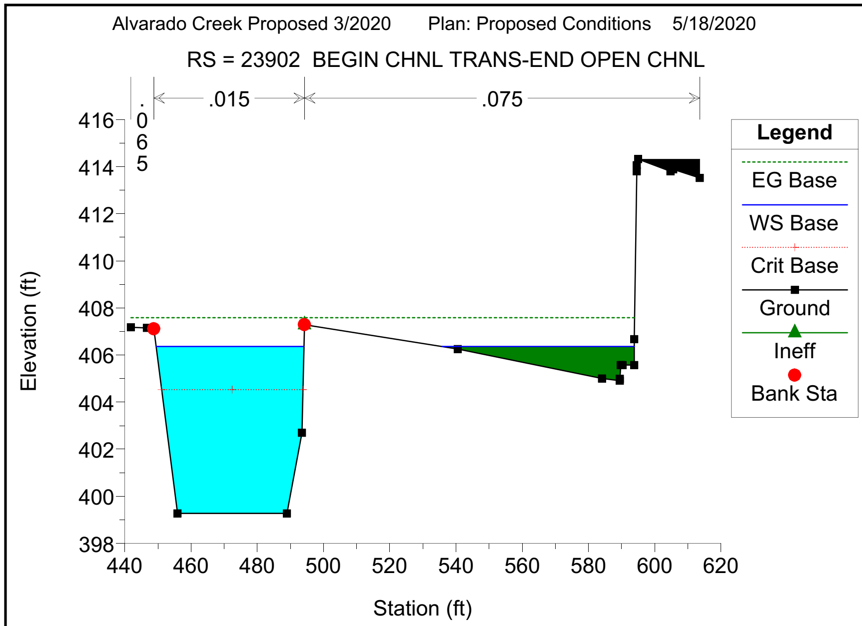


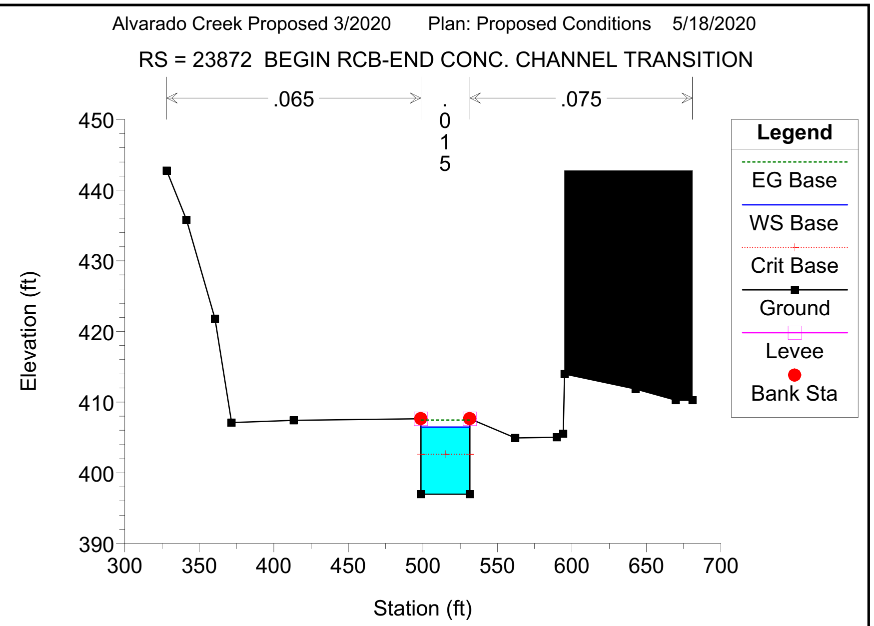

Alvarado Creek Proposed 3/2020    Plan: Proposed Conditions    5/18/2020

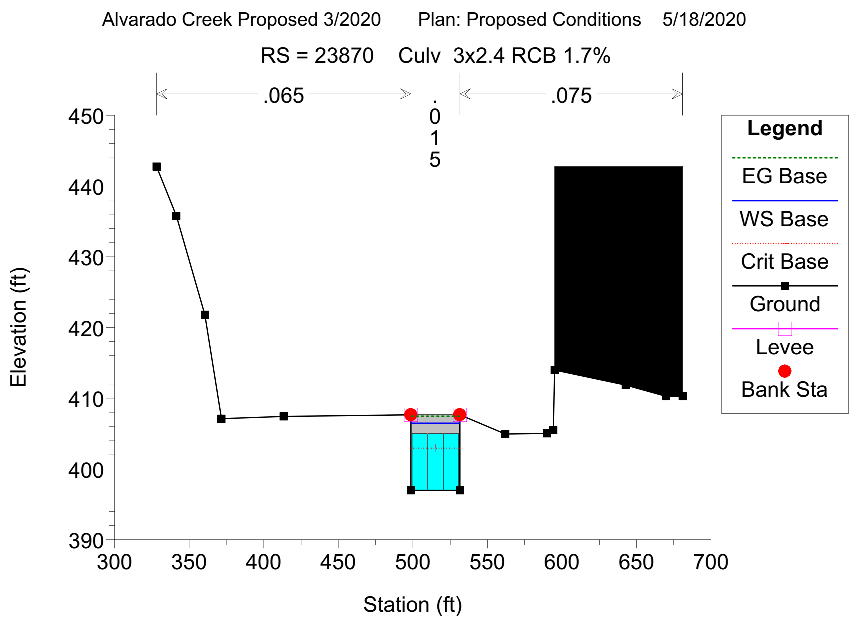
RS = 24772  Trailer Park

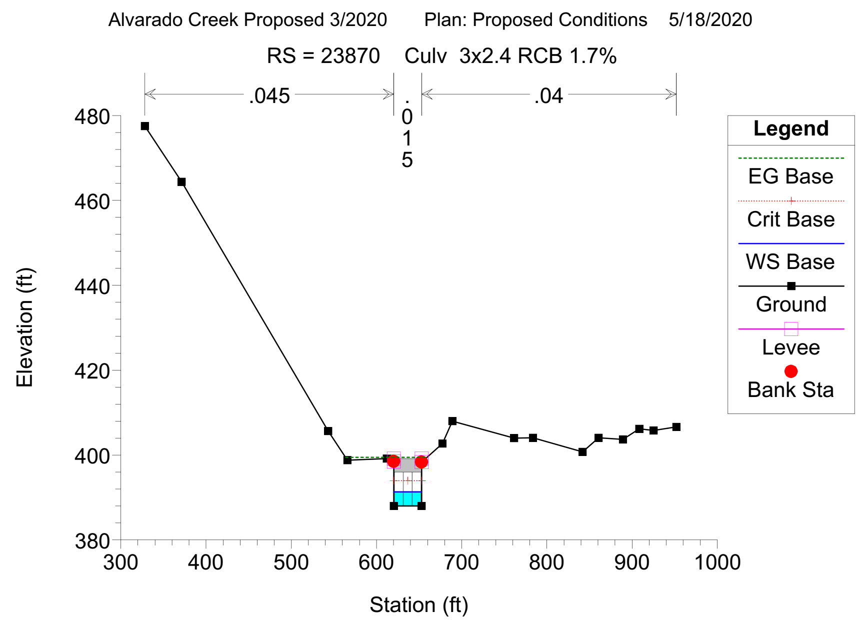


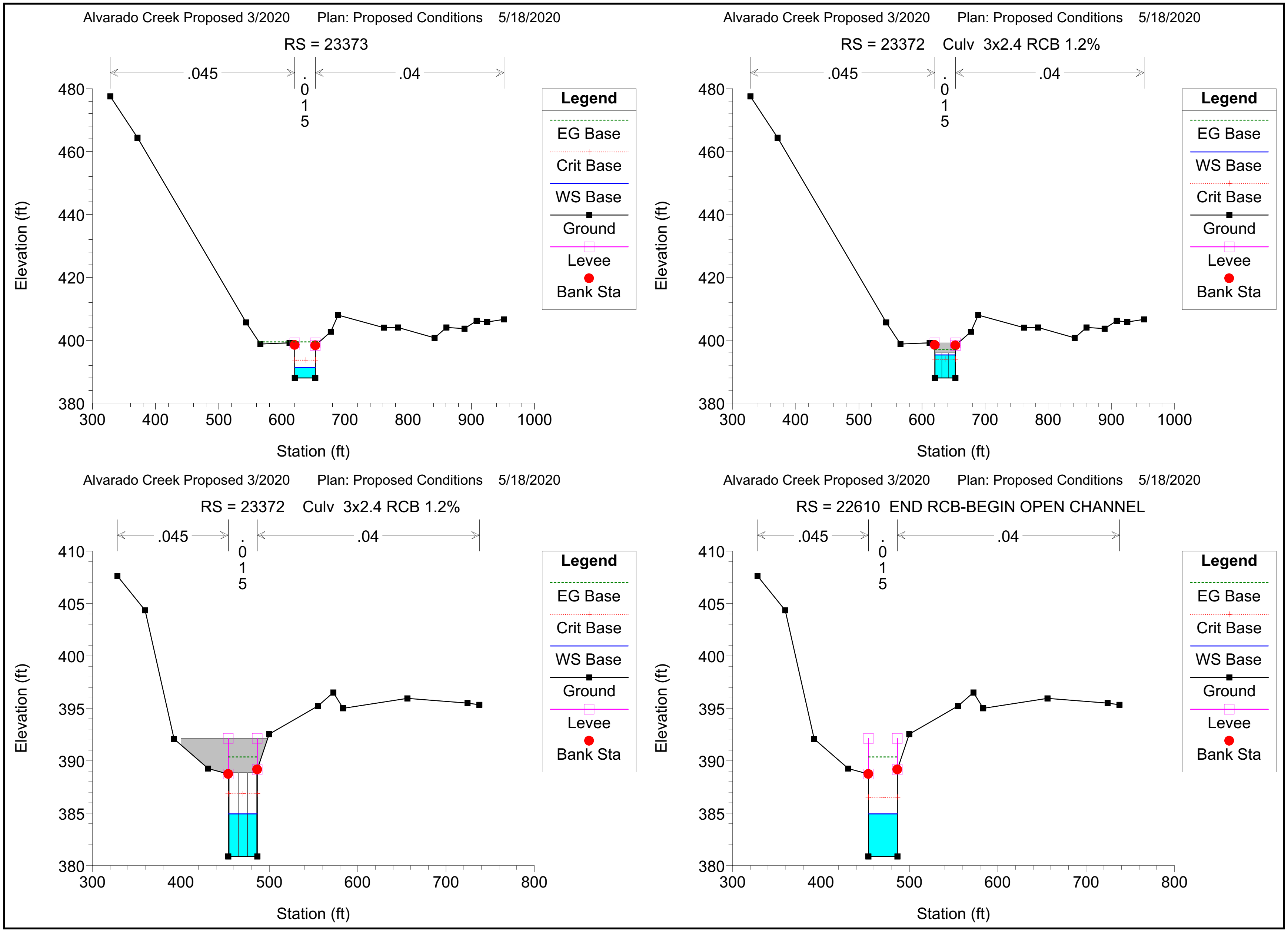

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 24704 Trailer Park
.06
.065
Legend
EG Base
WS Base
Ground
Bank Sta
Elevation (ft)
Station (ft)
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 24540 Trailer Park
.065
.06
.075
Legend
EG Base
WS Base
Ground
Bank Sta
Elevation (ft)
Station (ft)
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 24340 Trailer Park
.06
.075
Legend
EG Base
WS Base
Crit Base
Ground
Bank Sta
Elevation (ft)
Station (ft)
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 24150 Trailer Park
.065
.06
.075
Legend
EG Base
WS Base
Crit Base
Ground
Bank Sta
Elevation (ft)
Station (ft)

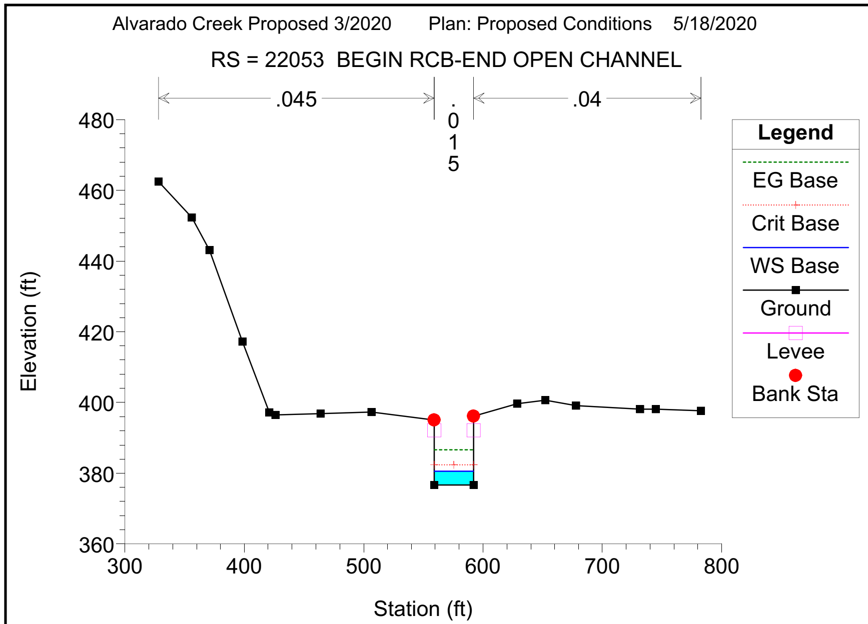

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 23902 BEGIN CHNL TRANS-END OPEN CHNL
.065
.015
.075
Elevation (ft)
Station (ft)
Legend
EG Base
WS Base
Crit Base
Ground
Ineff
Bank Sta

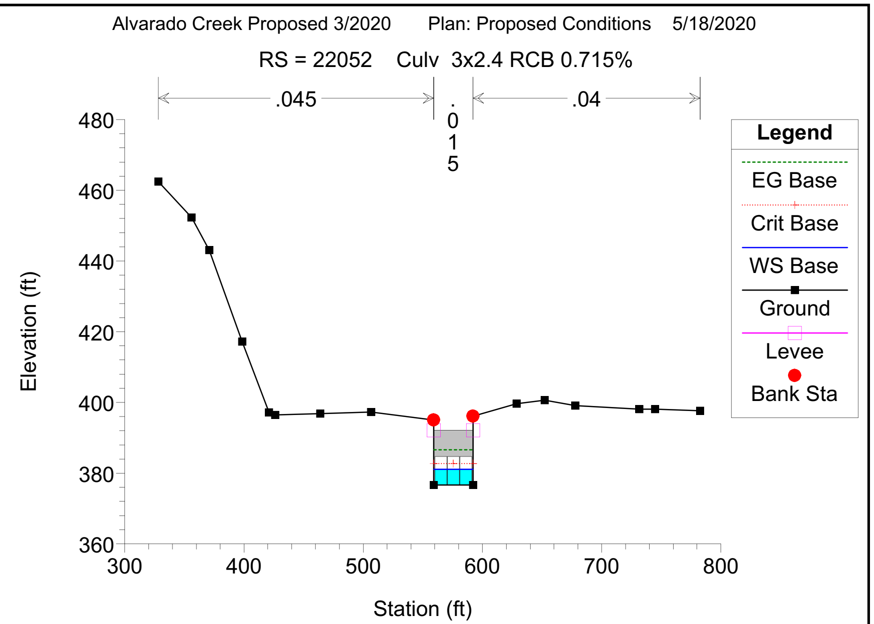

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 23872 BEGIN RCB-END CONC. CHANNEL TRANSITION
.065
.015
.075
Elevation (ft)
Station (ft)
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta

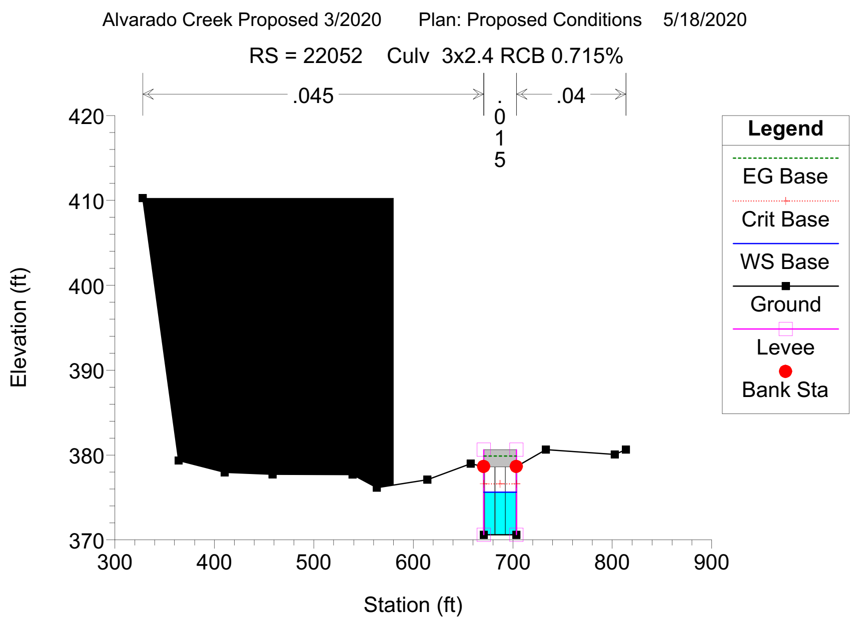

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 23870 Culv 3x2.4 RCB 1.7%
.065
.015
.075
Elevation (ft)
Station (ft)
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta

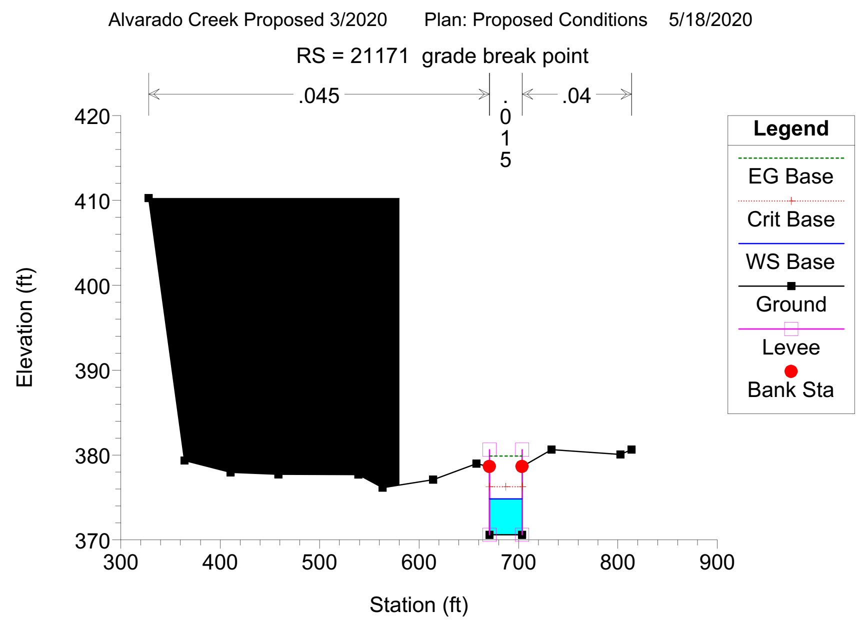

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 23870 Culv 3x2.4 RCB 1.7%
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
Crit Base
WS Base
Ground
Levee
Bank Sta

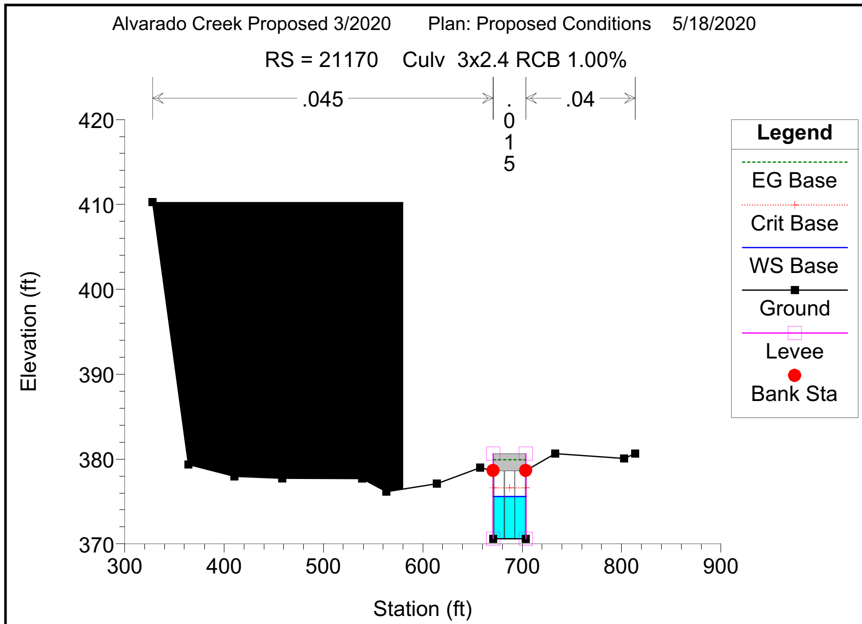

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 23373
.045
.015
.04
Legend
EG Base
Crit Base
WS Base
Ground
Levee
Bank Sta
Elevation (ft)
480
460
440
420
400
380
300
400
500
600
700
800
900
1000
Station (ft)
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 23372 Culv 3x2.4 RCB 1.2%
.045
.015
.04
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 23372 Culv 3x2.4 RCB 1.2%
.045
.015
.04
Legend
EG Base
Crit Base
WS Base
Ground
Levee
Bank Sta
Elevation (ft)
410
405
400
395
390
385
380
300
400
500
600
700
800
Station (ft)
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 22610 END RCB-BEGIN OPEN CHANNEL
.045
.015
.04
Legend
EG Base
Crit Base
WS Base
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

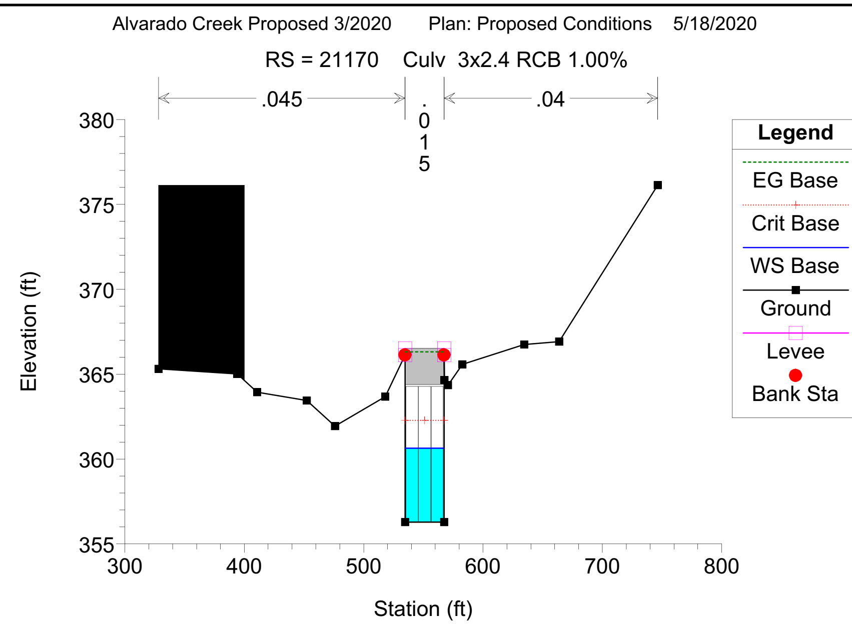

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 22053 BEGIN RCB-END OPEN CHANNEL
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
Crit Base
WS Base
Ground
Levee
Bank Sta

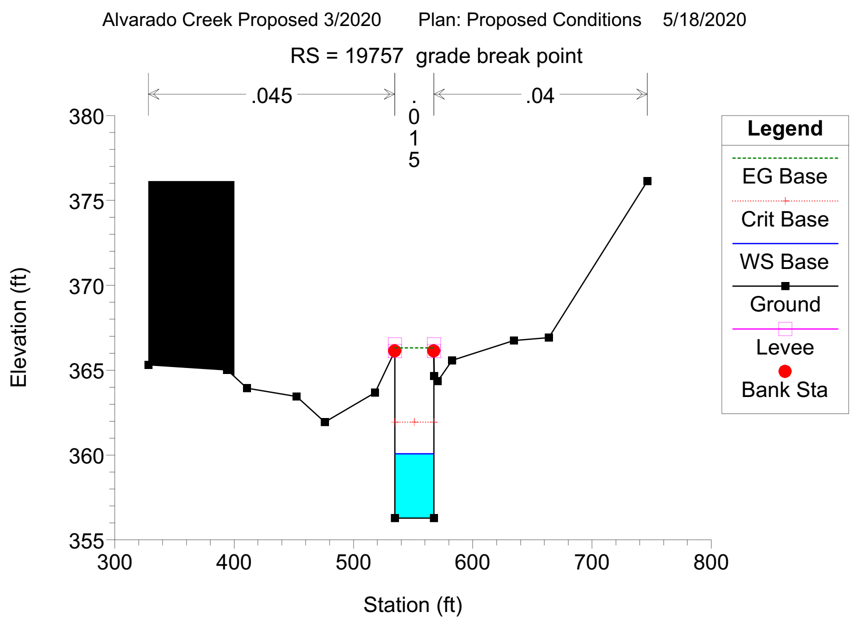

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 22052 Culv 3x2.4 RCB 0.715%
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
Crit Base
WS Base
Ground
Levee
Bank Sta

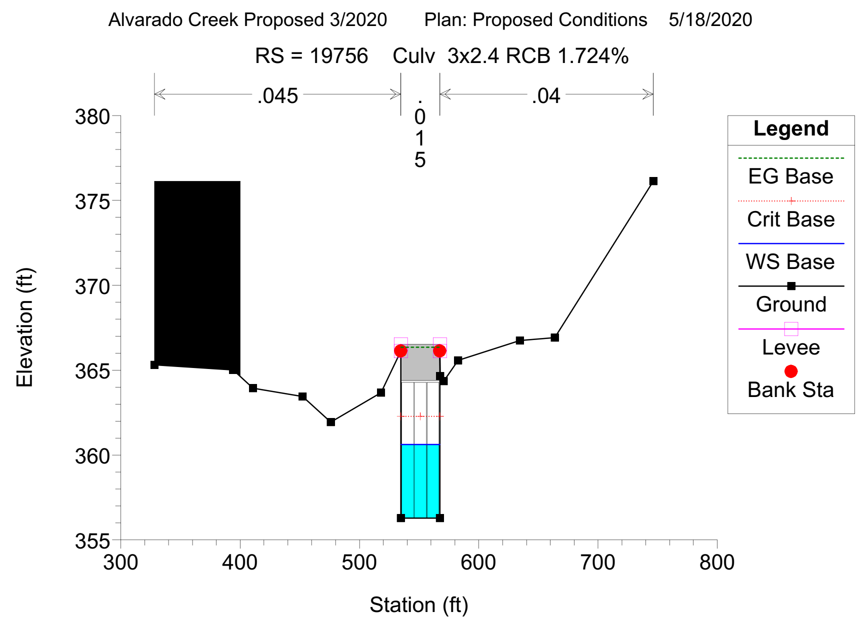

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 22052 Culv 3x2.4 RCB 0.715%
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
Crit Base
WS Base
Ground
Levee
Bank Sta

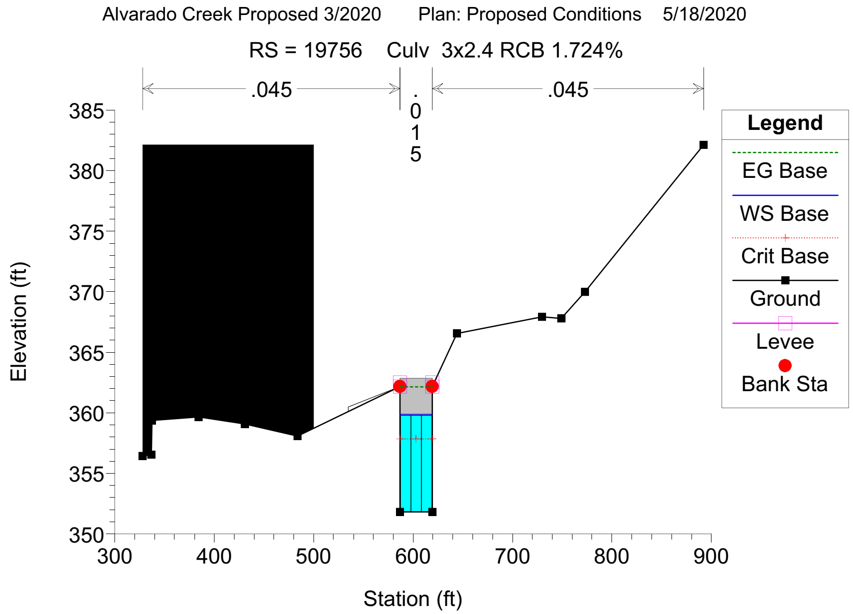

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 21171 grade break point
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
Crit Base
WS Base
Ground
Levee
Bank Sta

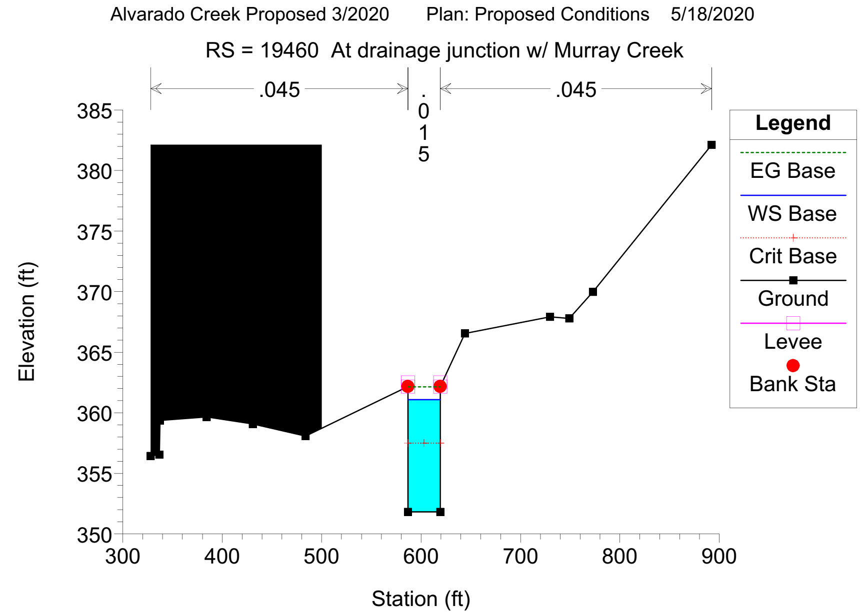

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 21170 Culv 3x2.4 RCB 1.00%
.045
.015
.04
Legend
EG Base
Crit Base
WS Base
Ground
Levee
Bank Sta
Elevation (ft)
370
380
390
400
410
420
Station (ft)
300
400
500
600
700
800
900

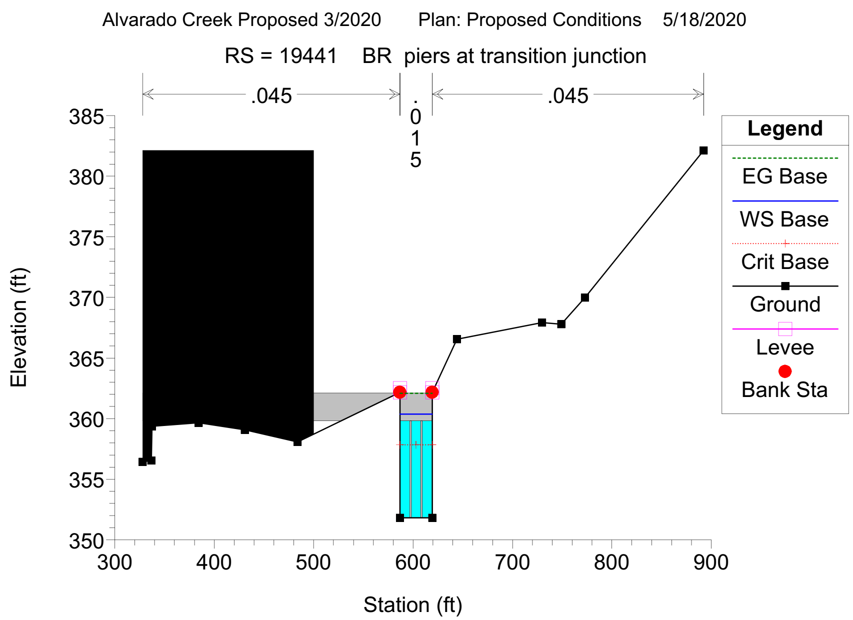

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 21170 Culv 3x2.4 RCB 1.00%
.045
.015
.04
Legend
EG Base
Crit Base
WS Base
Ground
Levee
Bank Sta
Elevation (ft)
355
360
365
370
375
380
Station (ft)
300
400
500
600
700
800

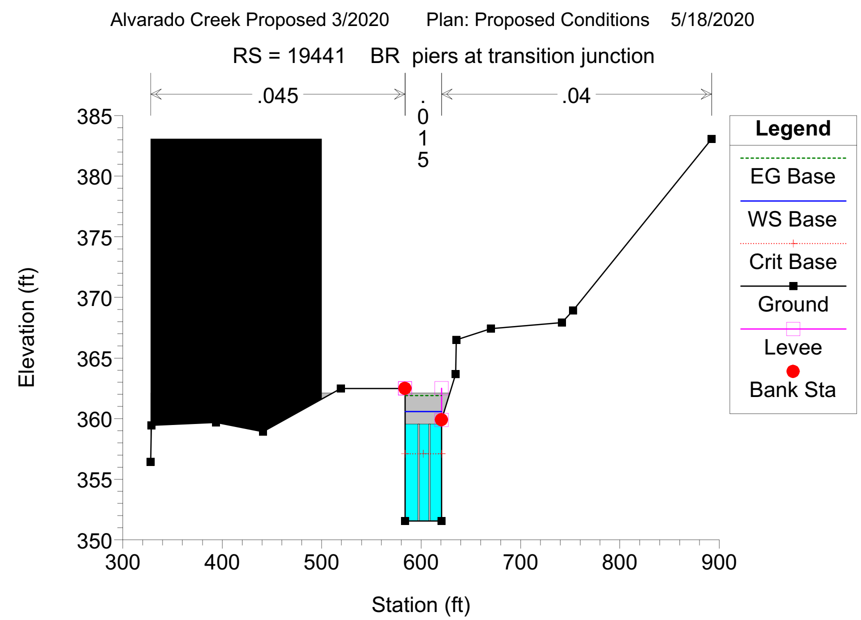

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 19757 grade break point
.045
.015
.04
Legend
EG Base
Crit Base
WS Base
Ground
Levee
Bank Sta
Elevation (ft)
355
360
365
370
375
380
Station (ft)
300
400
500
600
700
800

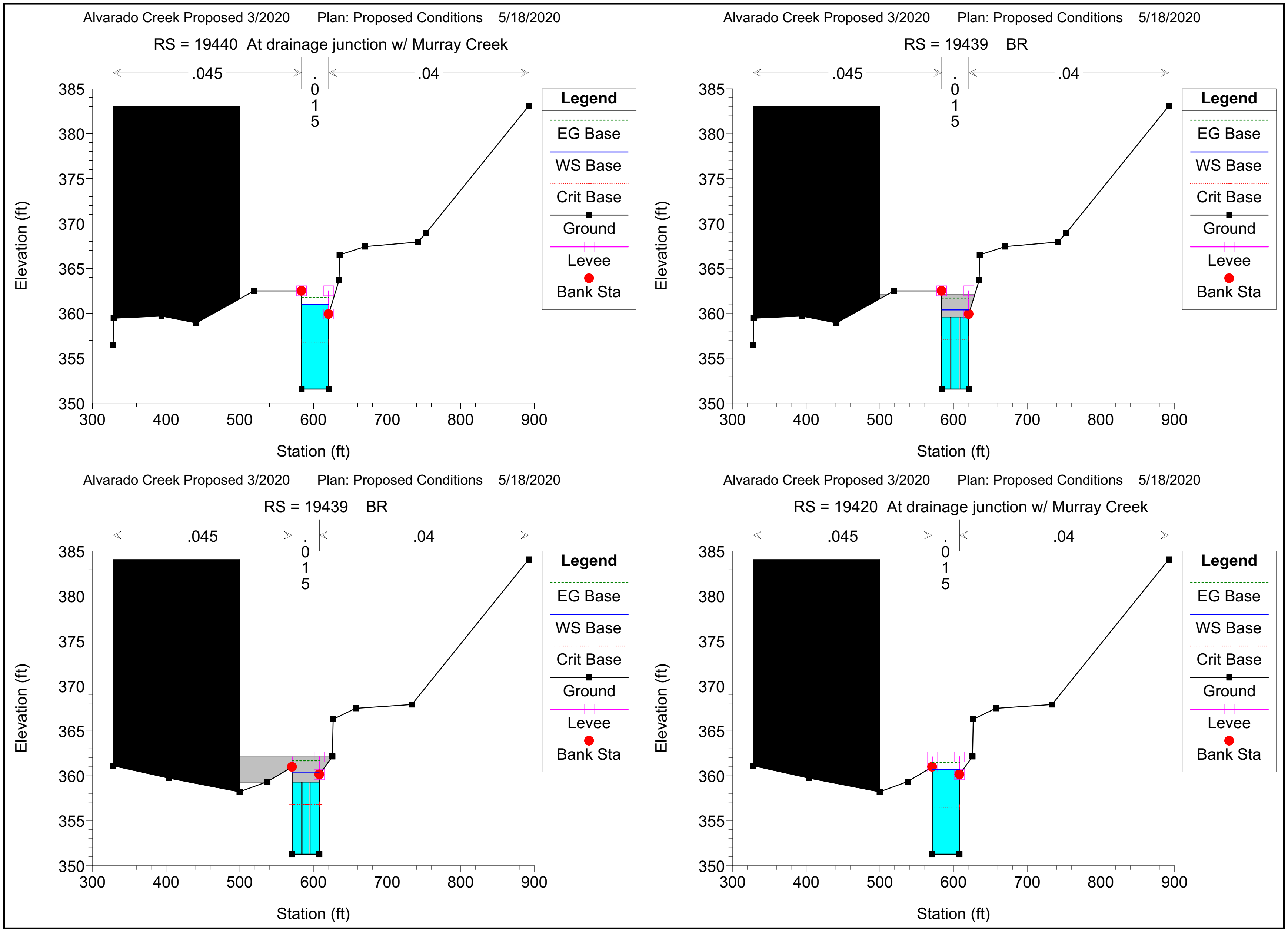

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 19756 Culv 3x2.4 RCB 1.724%
.045
.015
.04
Legend
EG Base
Crit Base
WS Base
Ground
Levee
Bank Sta
Elevation (ft)
355
360
365
370
375
380
Station (ft)
300
400
500
600
700
800

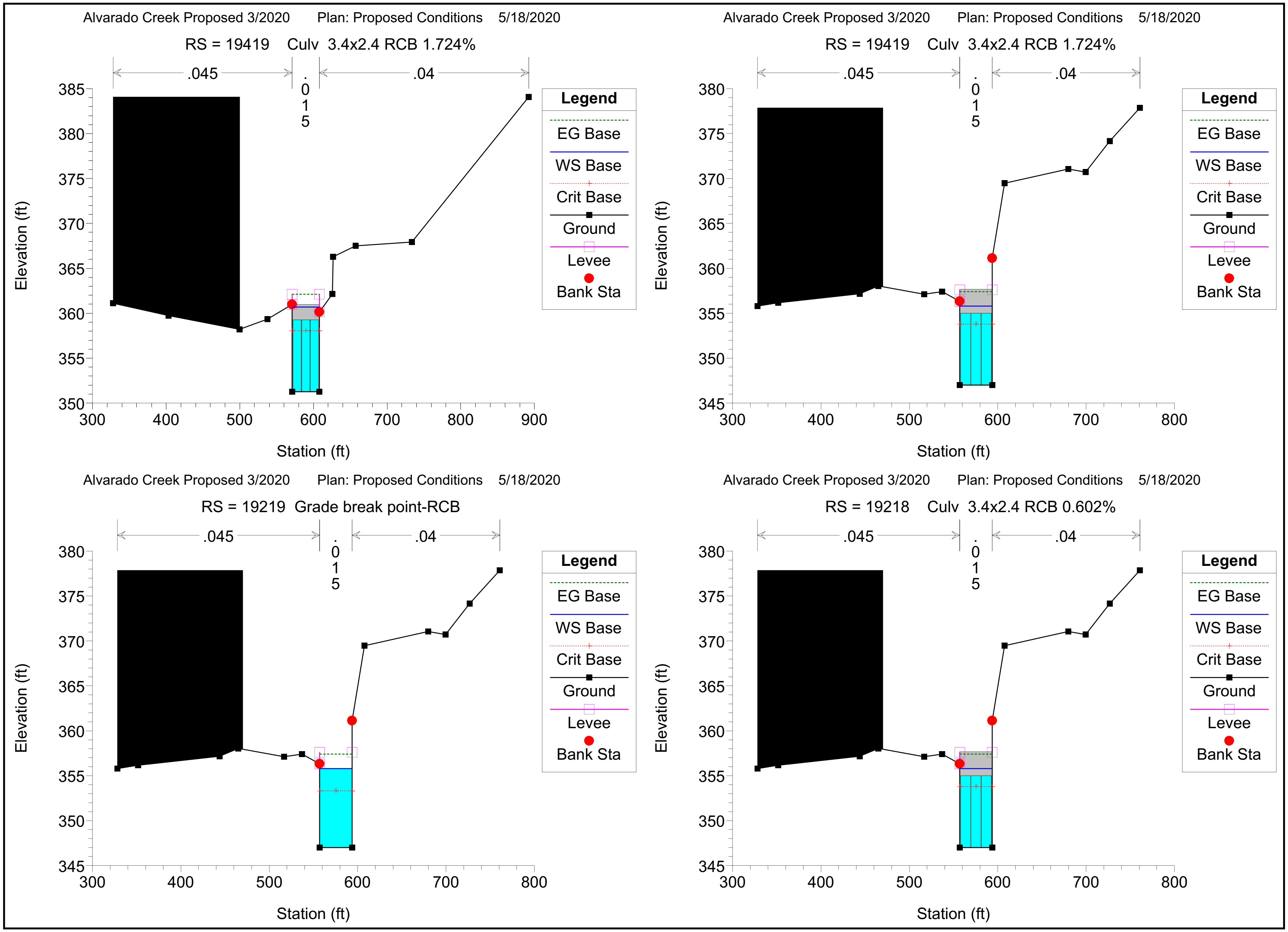

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 19756 Culv 3x2.4 RCB 1.724%
.045
.015
.045
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
385
380
375
370
365
360
355
350
300
400
500
600
700
800
900


Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 19460 At drainage junction w/ Murray Creek
.045
.015
.045
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
385
380
375
370
365
360
355
350
300
400
500
600
700
800
900

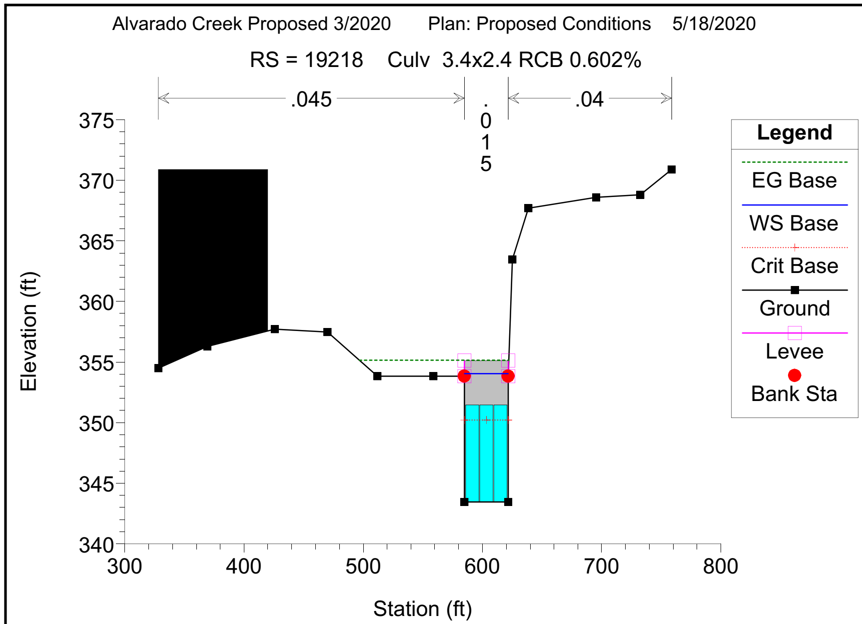

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 19441 BR piers at transition junction
.045
.015
.045
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
385
380
375
370
365
360
355
350
300
400
500
600
700
800
900


Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 19441 BR piers at transition junction
.045
.015
.04
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
385
380
375
370
365
360
355
350
300
400
500
600
700
800
900

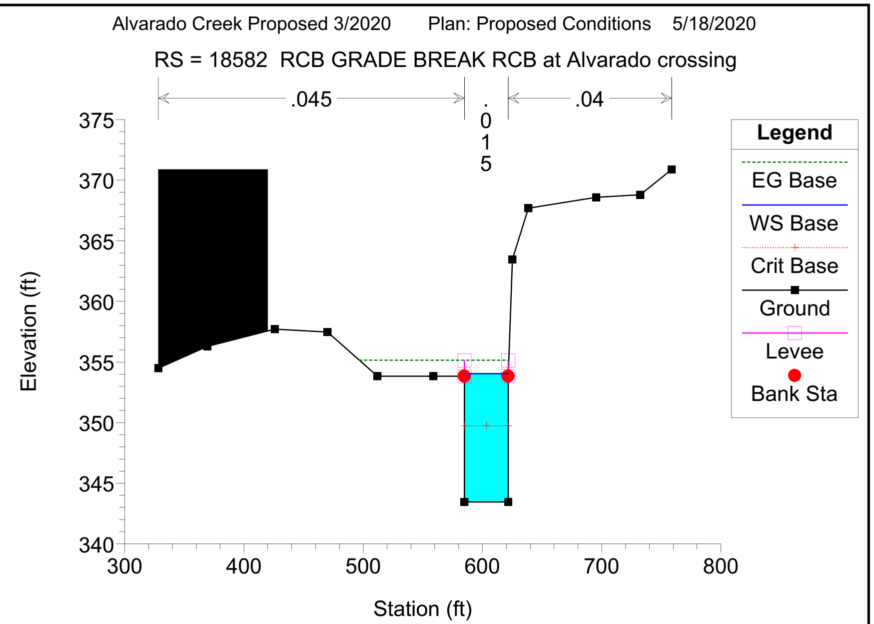

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 19440 At drainage junction w/ Murray Creek
.045
.015
.04
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 19439 BR
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 19439 BR
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 19420 At drainage junction w/ Murray Creek



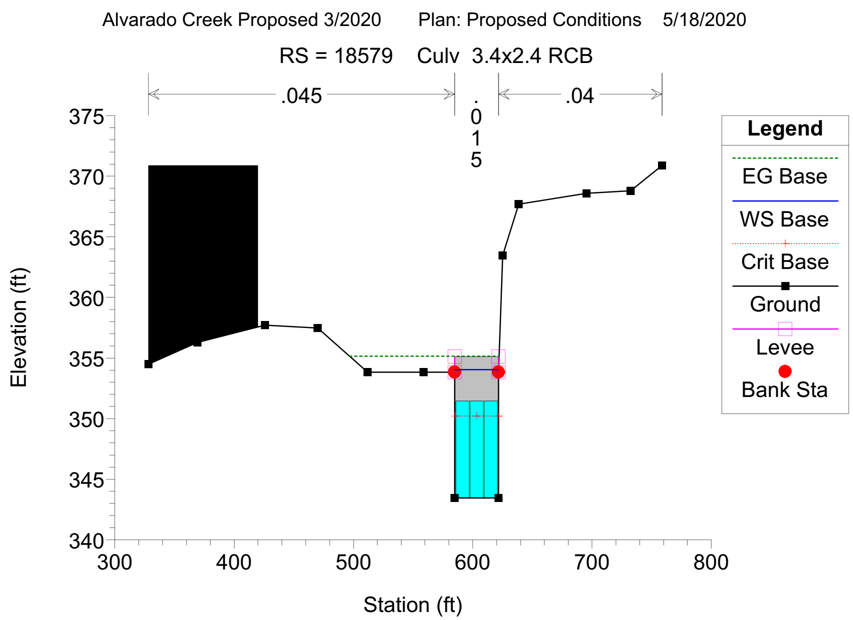
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 19419 Culv 3.4x2.4 RCB 1.724%
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 19419 Culv 3.4x2.4 RCB 1.724%
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 19219 Grade break point-RCB
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 19218 Culv 3.4x2.4 RCB 0.602%



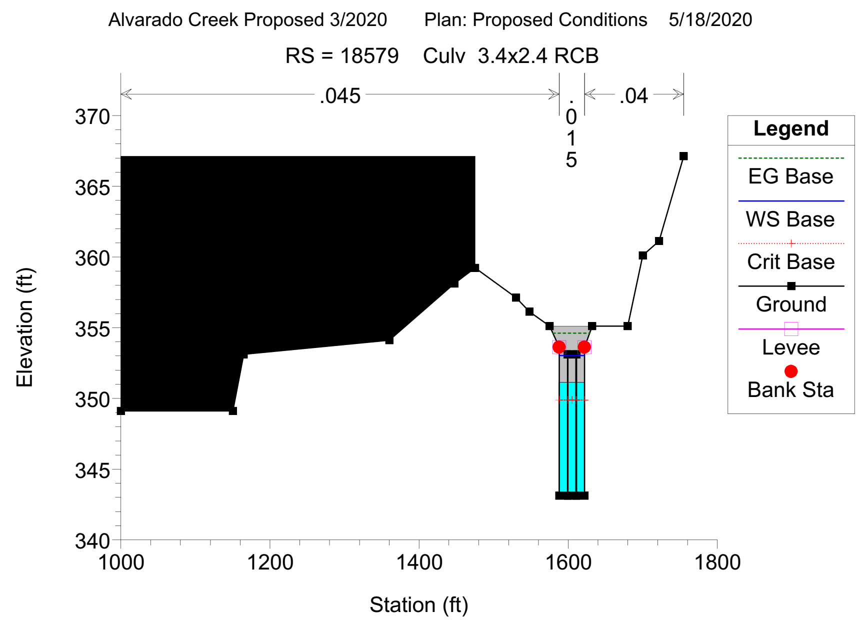
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 19218 Culv 3.4x2.4 RCB 0.602%
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta

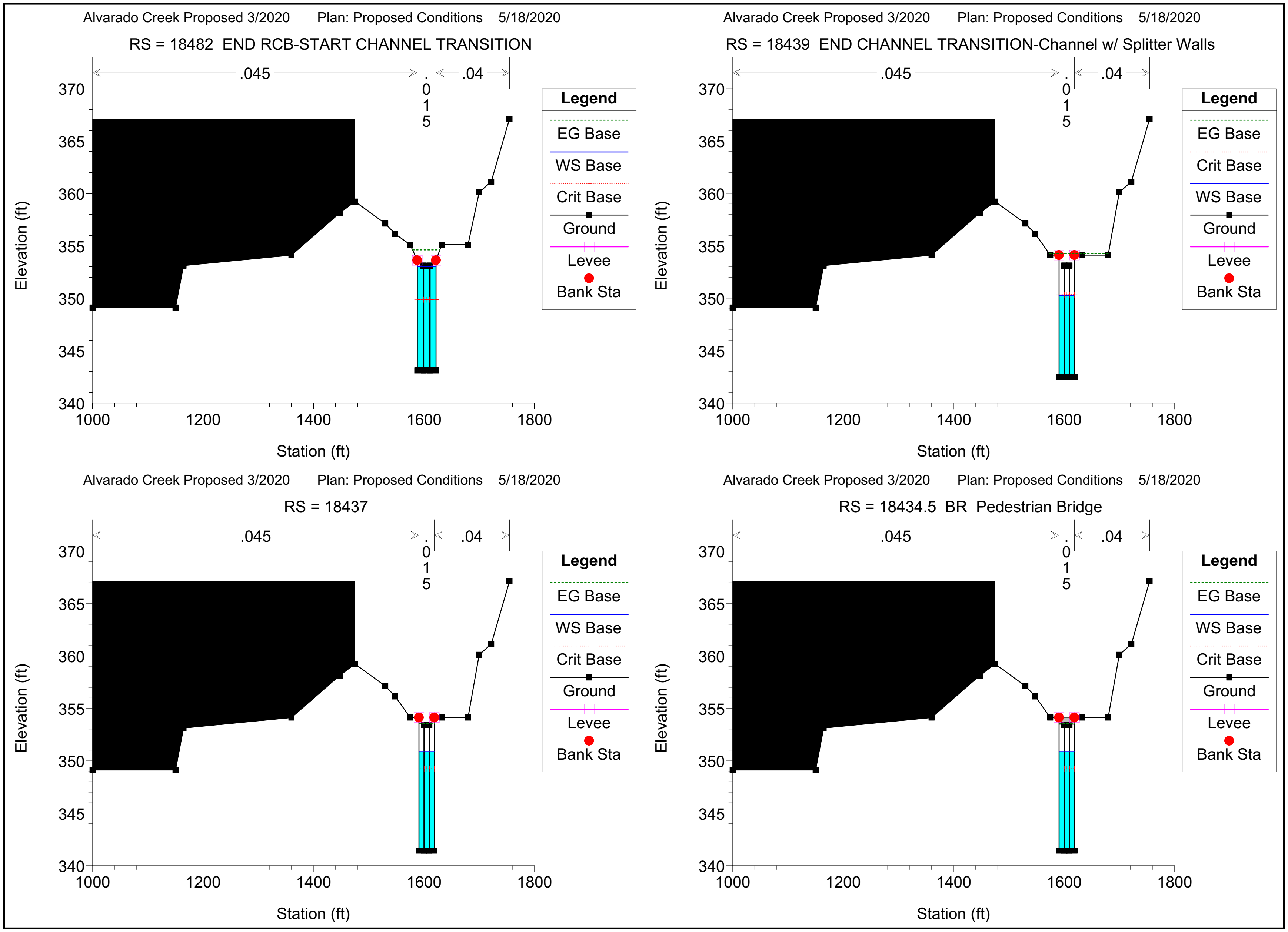
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 18582 RCB GRADE BREAK RCB at Alvarado crossing
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta

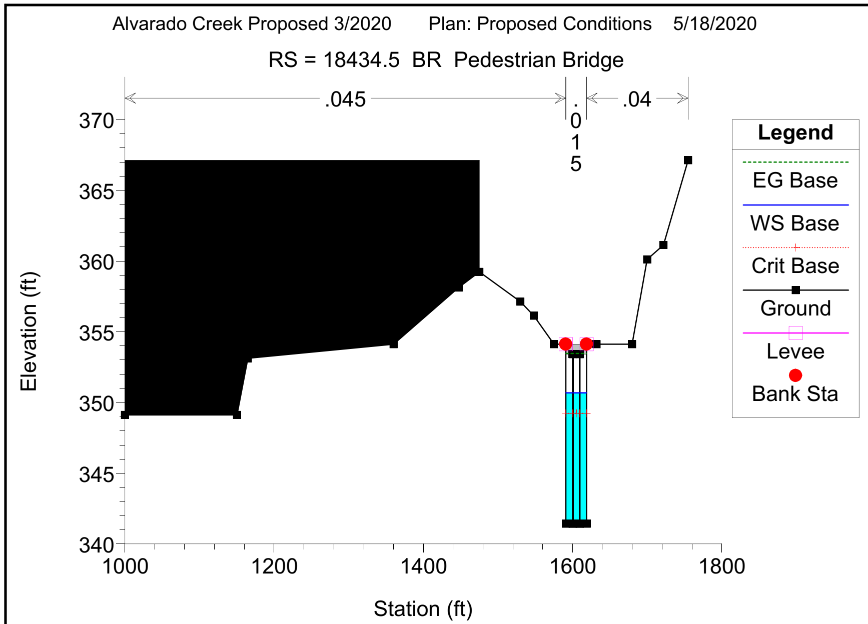



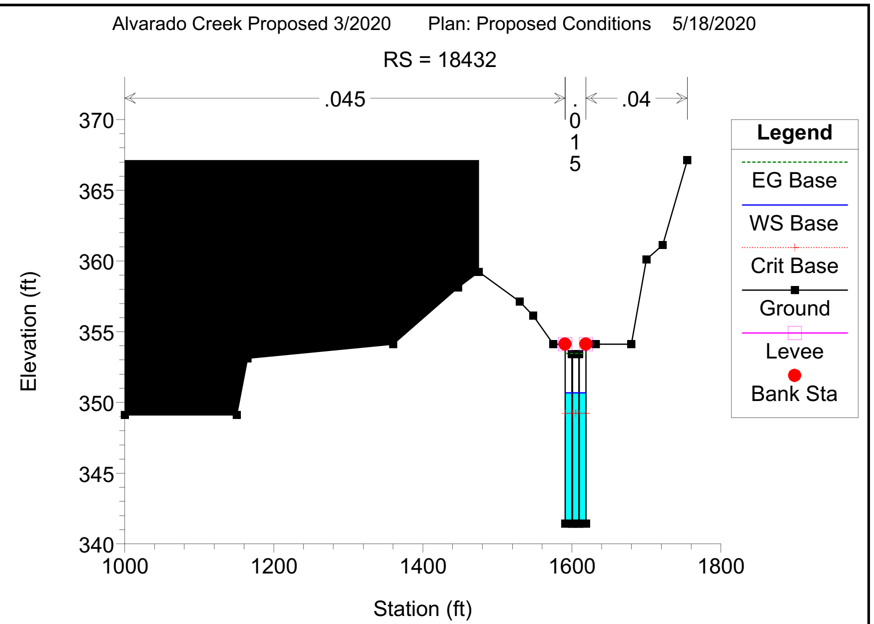
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 18579 Culv 3.4x2.4 RCB
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta

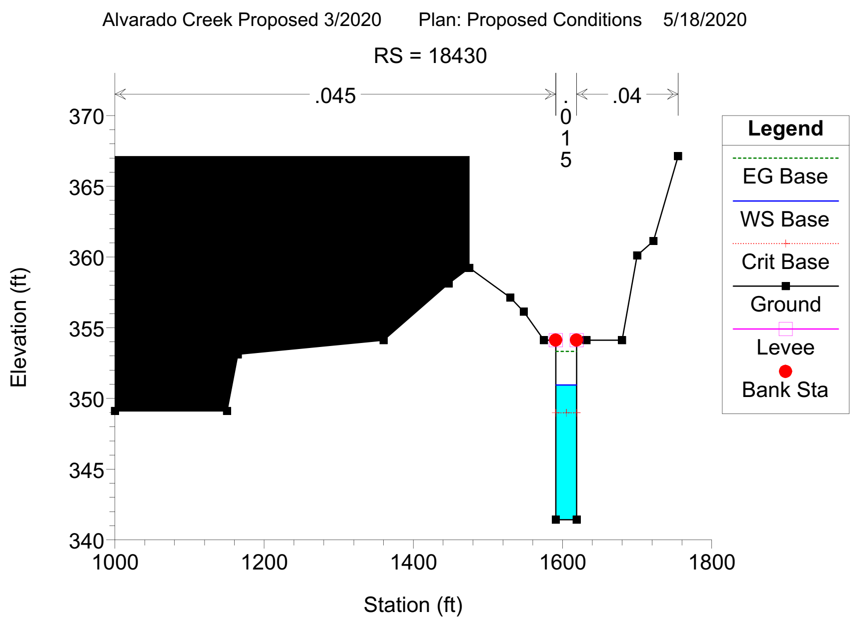



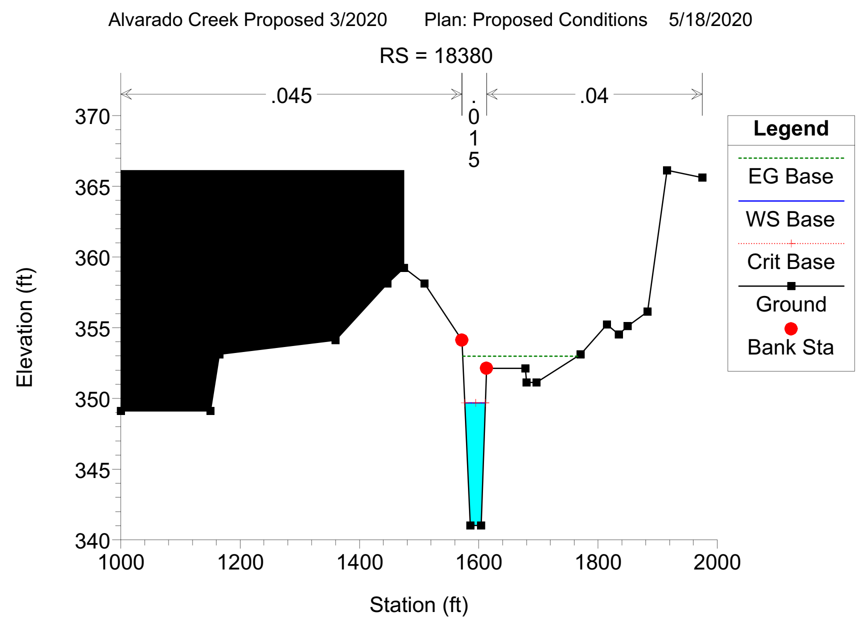
Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 18579 Culv 3.4x2.4 RCB
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta

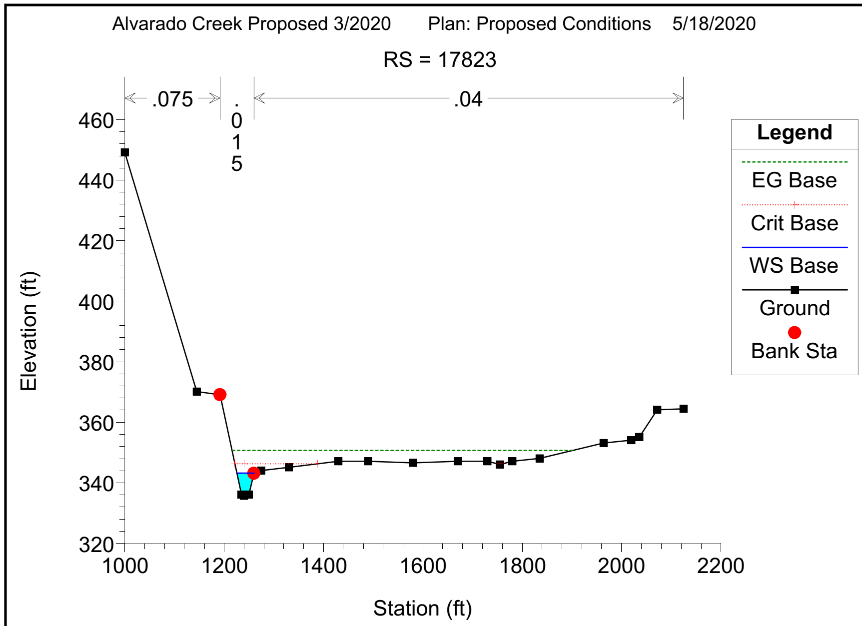

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 18482 END RCB-START CHANNEL TRANSITION
RS = 18439 END CHANNEL TRANSITION-Channel w/ Splitter Walls
RS = 18437
RS = 18434.5 BR Pedestrian Bridge
.045
.015
.04
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
370
365
360
355
350
345
340
1000
1200
1400
1600
1800


Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 18434.5 BR Pedestrian Bridge
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta

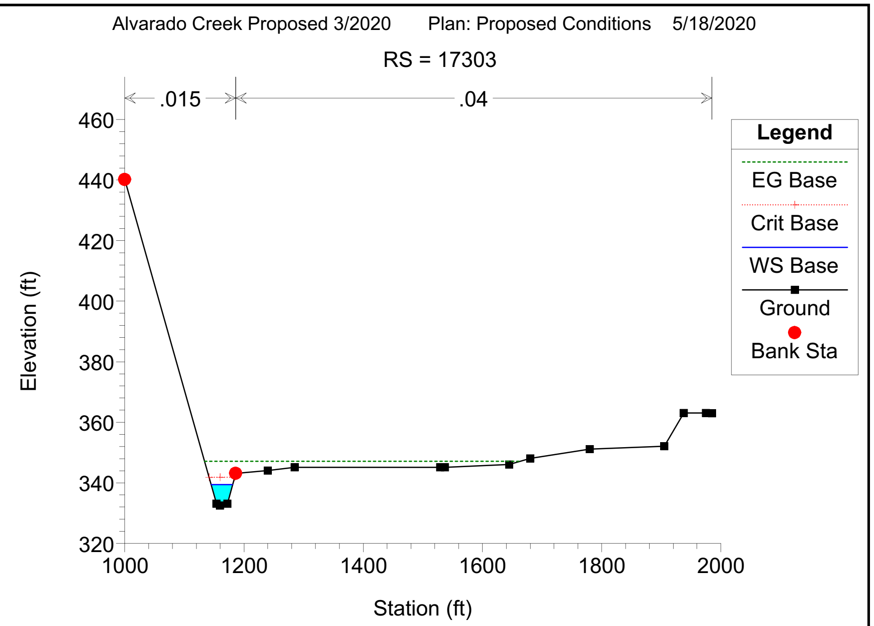

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 18432
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta


Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 18430
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
WS Base
Crit Base
Ground
Levee
Bank Sta


Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 18380
.045
.015
.04
Elevation (ft)
Station (ft)
Legend
EG Base
WS Base
Crit Base
Ground
Bank Sta



Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 17823
.075
.
0
1
5
.04
Legend
EG Base
Crit Base
WS Base
Ground
Bank Sta
Elevation (ft)
Station (ft)
320
340
360
380
400
420
440
460
1000
1200
1400
1600
1800
2000
2200

Alvarado Creek Proposed 3/2020 Plan: Proposed Conditions 5/18/2020
RS = 17303
.015
.04
Legend
EG Base
Crit Base
WS Base
Ground
Bank Sta
Elevation (ft)
Station (ft)
320
340
360
380
400
420
440
460
1000
1200
1400
1600
1800
2000

Alvarado Specific Plan
Preliminary Drainage Study and Floodplain Analysis

Alvarado Creek Freeboard Calculations

Methodology
Per San Diego County Hydraulic Design Manual, September 2014

$$\left(h_{fr}\right)_{SUBCRITICAL} = \max\begin{cases} 1.0 \\ 0.5+\dfrac{v^2}{2g}+\dfrac{Cv^2T_W}{rg}+\Delta y \end{cases} \tag{5-1}$$

$$\left(h_{fr}\right)_{SUPERCRITICAL} = 1.0+0.025vd^{1/3}+\frac{Cv^2T_W}{rg}+\Delta y \tag{5-2}$$

where …

$h_{fr}$ = minimum required freeboard (ft);
$v$ = flow velocity (ft/s);
$g$ = gravitational acceleration (32.2 ft/s$^2$);
$\dfrac{Cv^2T_W}{rg}$ = superelevation allowance (ft), see Section 5.10.6; and
$\Delta y$ = allowances for other hydraulic phenomenon (ft), (e.g., standing waves, slug flow – see Section 5.10.5.3).

Superelevation Allowance = 0
since project walls are on the inside of the curve
delta y= 0

Gives:
h = max [1.0, 0.5 + ((v^2)/2g)]

Alvarado Creek Required Freeboard

| Station | v (ft/sec) | h (ft) | WSE | Freeboard | Min. Top of Wall | |
|---|---|---|---|---|---|---|
| 254+80 | 7.07 | 1.28 | 420.24 | 2.50 | 422.74 | |
| 253+71.2 | 5.43 | 0.96 | 419.95 | 2.50 | 422.45 | |
| 253+13.62 | 5.09 | 0.90 | 419.81 | 2.50 | 422.31 | |
| 252+80 | 5.38 | 0.95 | 419.66 | 2.50 | 422.16 | |
| 251+30 | 6.41 | 1.14 | 418.83 | 2.50 | 421.33 | |
| 249+38 | 10.18 | 2.11 | 416.11 | 2.50 | 418.61 | |
| 248+35 | 8.36 | 1.59 | 415.35 | 2.50 | 417.85 | |
| 247+72 | 7.40 | 1.35 | 414.94 | 2.50 | 417.44 | |
| 247+04 | 5.95 | 1.05 | 414.69 | 2.50 | 417.19 | |
| 245+40 | 8.01 | 1.50 | 413.01 | 2.50 | 415.51 | |
| 243+40 | 6.65 | 1.19 | 411.41 | 2.50 | 413.91 | |
| 241+50 | 10.91 | 2.35 | 407.39 | 2.50 | 409.89 | Max. Required Freeboar |

Alvarado Specific Plan
Preliminary Drainage Study and Floodplain Analysis

Alvarado Creek Scour Calculations

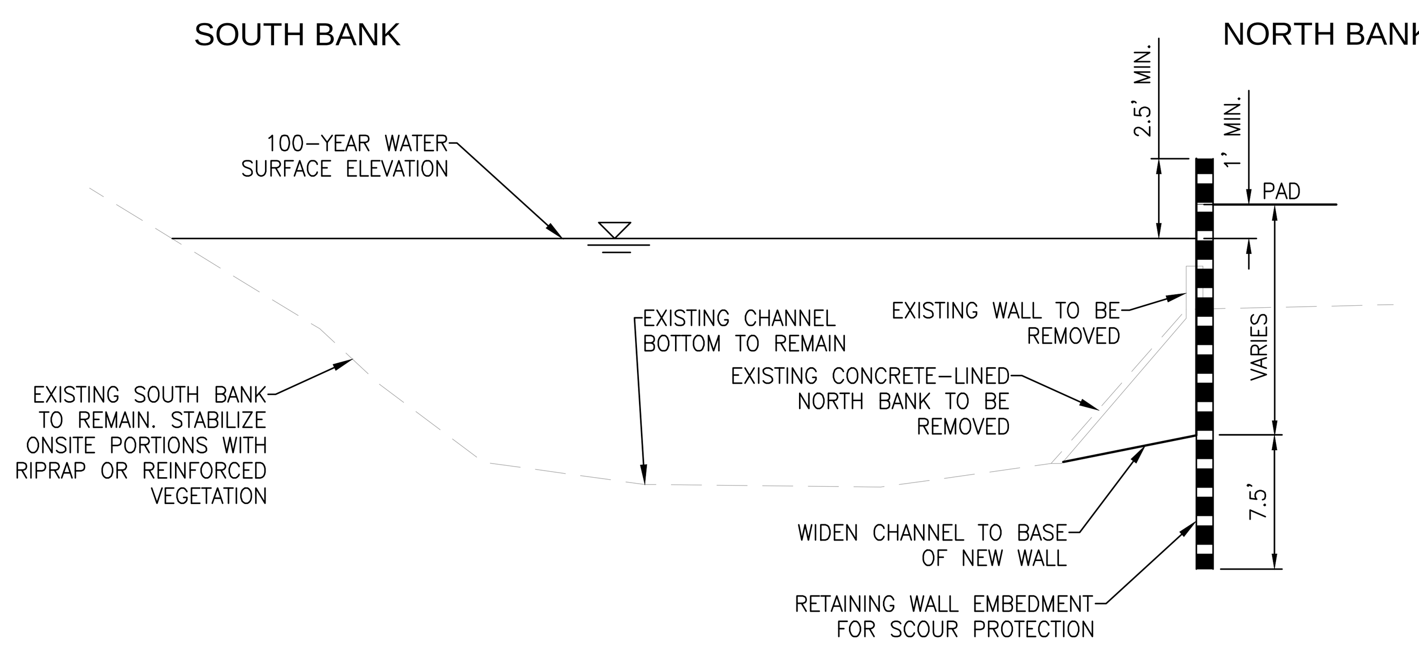
Methodology
Per HEC-23, Eqn 4.3
Scour with Flow Parallel to Wall
$ys/y1 = 0.73 + 0.14(3.14)(Fr^2)$

Where:
ys= Equilibrium depth of scour
y1= Average upstream depth
Fr= Upstream Froude number

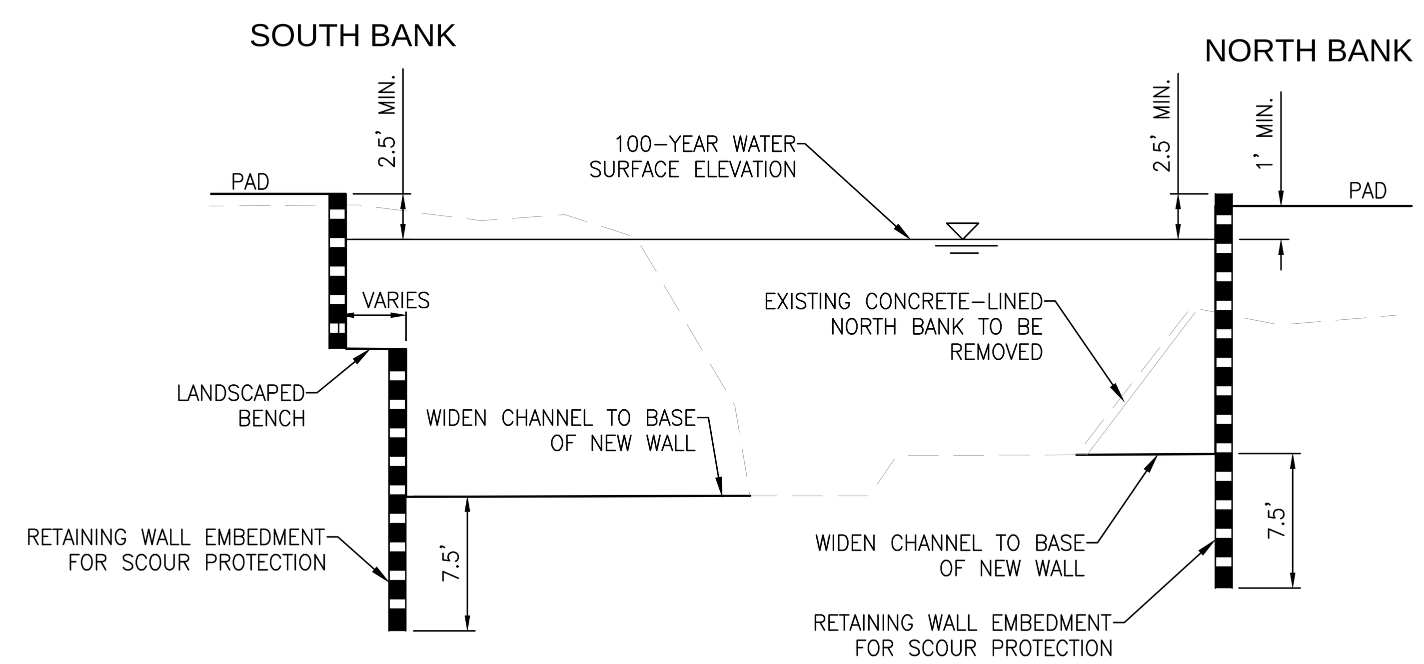
Solving for ys:
$ys = (0.73 + 0.14(3.14)(Fr^2)) * y1$

Proposed Conditions Alvarado Creek Scour Depths

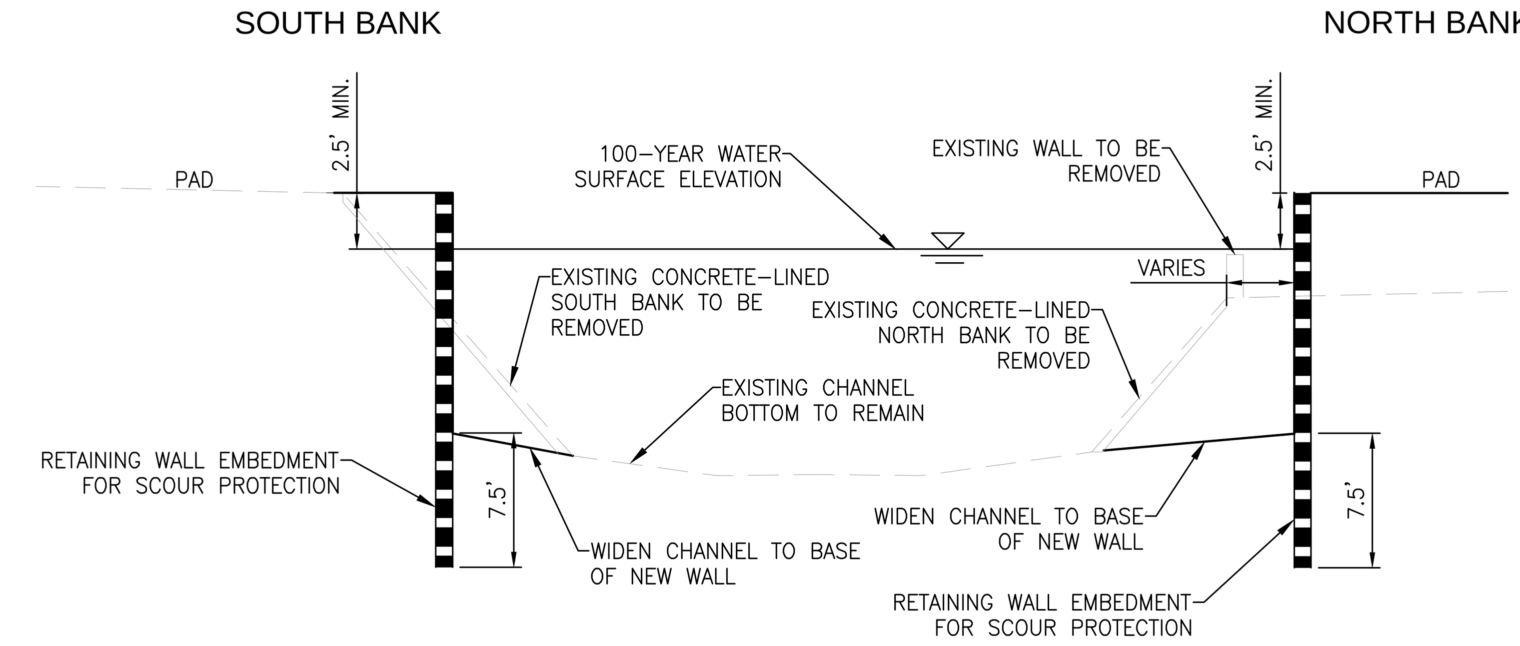
| Station | Fr | y1 (ft) | ys (ft) | |
|---|---|---|---|---|
| 254+80 | 0.47 | 7.16 | 5.92 | |
| 253+71.2 | 0.36 | 8.12 | 6.39 | |
| 253+13.62 | 0.32 | 8.04 | 6.23 | |
| 252+80 | 0.34 | 7.88 | 6.15 | |
| 251+30 | 0.44 | 8.93 | 7.28 | Max. Scour Depth |
| 249+38 | 0.70 | 7.11 | 6.72 | |
| 248+35 | 0.57 | 6.75 | 5.89 | |
| 247+72 | 0.53 | 6.44 | 5.50 | |
| 247+04 | 0.42 | 7.29 | 5.89 | |
| 245+40 | 0.59 | 6.81 | 6.01 | |
| 243+40 | 0.50 | 6.32 | 5.31 | |
| 241+50 | 1.00 | 4.19 | 4.90 | |



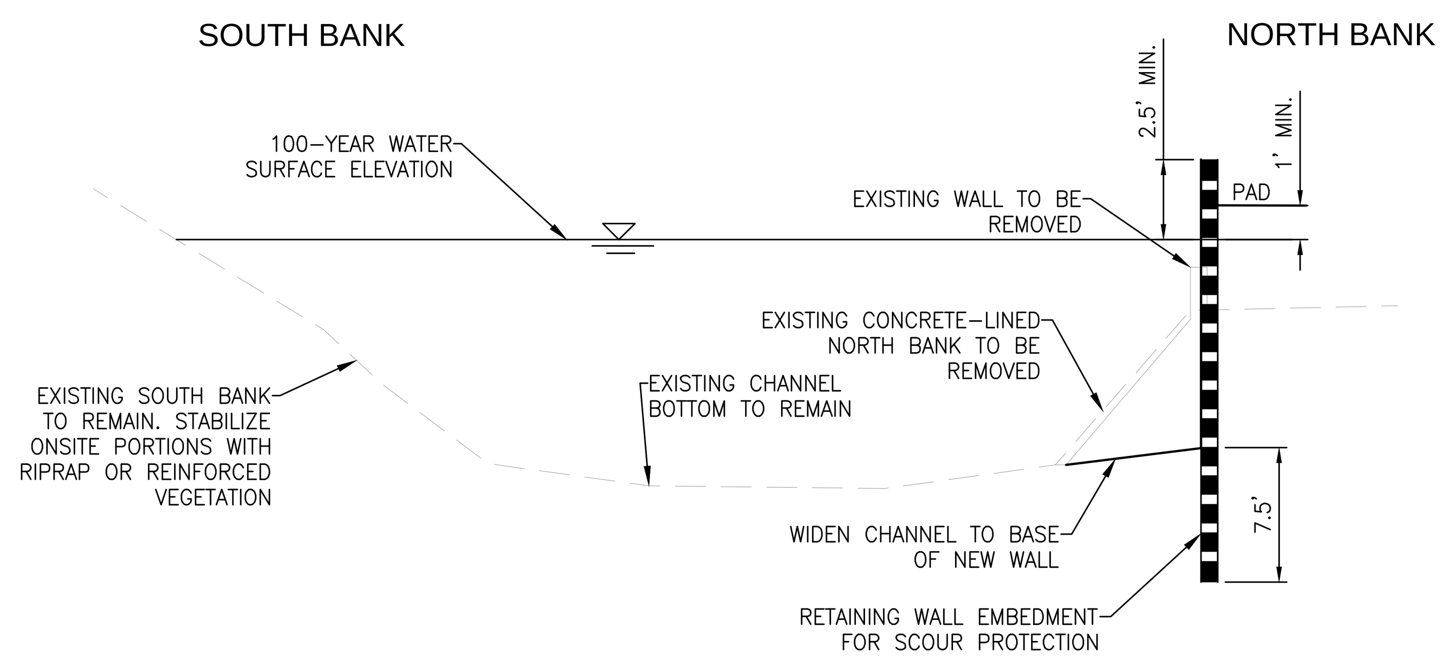

A
1
TYPICAL CHANNEL SECTION
NOT TO SCALE




C
1
TYPICAL CHANNEL SECTION
NOT TO SCALE




D
1
TYPICAL CHANNEL SECTION
NOT TO SCALE




B
1
TYPICAL CHANNEL SECTION
NOT TO SCALE


## LEGEND

LA MESA DRAINAGE MASTER PLAN FLOWRATE OF 2500 CFS

| | |
|---|---|
| (409.6 W.S.) | EXISTING WATER SURFACE |
| 408.6 W.S. | PROPOSED WATER SURFACE |
| XXX.XTW | PROPOSED TOP OF WALL ELEVATION |
| XXX.XFG | PROPOSED FINISHED GRADE ELEVATION |

# PRELIMINARY FLOODPLAIN ANALYSIS
# ALVARADO SPECIFIC PLAN
# MAY 2020

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