Southeast Policy Area Drainage Study

Prepared for

City of Elk Grove

January 2014

WEST YOST ASSOCIATES
Consulting Engineers

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1.0 INTRODUCTION

The Southeast Policy Area (SEPA) in the City of Elk Grove (City) covers approximately 1,200 acres at the southwest corner of the City and is the largest remaining new development area in the City (see Figure 1). The SEPA is also referred to as the Meridian Community Plan Area. Previous drainage planning for this area is described in Chapter 15 of the City of Elk Grove Storm Drainage Master Plan (SDMP) Volume II (June 2011), which was prepared by West Yost Associates (West Yost). The SDMP envisions that a multi-functional drainage corridor will be created to serve the SEPA at buildout. The corridor will provide multiple benefits including flood control, wildlife habitat, wetlands, recreation, and stormwater quality treatment.

The drainage concept plan in the SDMP defines an approximate configuration, alignment, and size for the future drainage channel that will serve the area, and defines approximate locations and sizes of required detention basins to mitigate for increased runoff due to development. The sizing of these facilities was based on runoff rates generated from assumed future land use data based on the available information at that time. Since then, a more comprehensive planning effort has been completed and a new land-use plan has been developed for the SEPA. Using the latest land-use planning information, West Yost has prepared this updated drainage study for the SEPA and this report provides a description of the updated analysis.

2.0 WATERSHED DESCRIPTION

The SEPA lies within Drainage Shed C, which covers nearly 7,900 acres in southern Sacramento County (see Figure 1). Of that total, approximately 2,100 acres lie within the City. The watershed generally slopes from east to west with an average slope of about 0.10 percent. The existing land use within the watershed is agricultural with the exception of the Elk Grove Promenade site, which covers 525 acres in the upstream (eastern) portion of the watershed. Although the Promenade project stalled before completion, many of the site improvements were constructed including roads, parking lots, buildings, and underground utilities including a storm drainage pipe system. The pipe system that collects runoff from the Promenade site delivers it to a detention basin that was constructed on the west side of the future Sterling Meadows project.

Downstream of the existing detention basin, runoff is conveyed through the SEPA in an agricultural drainage channel, which is referred to as the Shed C Channel in this report. The Shed C Channel begins near the western boundary of the future Sterling Meadows project and conveys runoff to the southwest for approximately 12,600 feet until it reaches Bruceville Road. At that point, the channel exits the City and continues west for approximately 22,000 feet where it crosses under Interstate 5 and enters the Stone Lakes National Wildlife Refuge.

3.0 DRAINAGE PLAN CONCEPT

As development occurs in Shed C, drainage system improvements will be required to provide flood protection and mitigation, stormwater quality treatment, and hydromodification mitigation. The preliminary drainage plan included in the SDMP for Shed C was developed with input from the Expert Advisory Committee (EAC) that was formed by the City to help guide the development of the SDMP. The drainage concept for Shed C was developed with consideration of the guiding principles that were developed by the EAC for the drainage SDMP:

1. Stormwater management systems shall be designed to take maximum advantage of the natural hydrological processes of the existing landscape.
2. Alternative stormwater management approaches shall be adopted, wherever and whenever feasible, to complement approaches to traditional stormwater management systems. Alternative approaches may include distributed systems (e.g. low impact development systems), flow duration control basins, and/or instream rehabilitation.
3. Design of stormwater management projects shall balance considerations related to environmental effects, capital and operating costs, property rights, economic development impacts, and recreational opportunities without compromising public safety and/or property protection.
4. Stormwater management systems shall be designed so that the volume, quality, and timing of downstream discharges will minimize impacts to downstream resources, such as the Stone Lakes National Wildlife Refuge.
5. The SDMP shall comply with applicable local, state, and federal laws and regulations.

With these guiding principles in mind, the drainage concept for Shed C includes a multi-functional drainage corridor that will create and enhance the natural stream and habitat values. The multi-functional corridor will include a low flow channel that is stable and self-sustaining and will be designed based on natural processes. The low flow channel will meander within a larger floodplain corridor that will provide flood storage and conveyance as well as an opportunity for the creation of wetlands habitat. Although not specifically defined in this plan, it is anticipated that the corridor will also include an access path that will provide recreational and educational opportunities for the City's residents.

Additional key components of the drainage concept are detention basins that will be included at major inflow points to the drainage corridor. These detention basins will provide flood storage and flow duration control to mitigate for potential flood flow increases and hydromodification effects due to the proposed urban development in the watershed. They will also provide stormwater quality treatment and will provide an opportunity for wetlands creation.

4.0 ANALYSIS APPROACH

As shown on Figure 1, the SEPA lies within the Shed C watershed. The drainage plan for the SEPA must reflect the needs of the entire Shed C watershed. Therefore, the drainage analysis for the SEPA included an analysis of the entire Shed C watershed with a focus on the area located within the City. The Shed C analysis consisted of two major components: 1) a continuous hydrologic analysis; and 2) an event based analysis as described below.

4.1 Continuous Hydrologic Analysis

An important consideration in the Shed C analysis is the potential hydromodification effects of development in the watershed. Hydromodification is the change in runoff characteristics within a watershed caused by land use changes. These altered runoff characteristics can result in increased erosion and sedimentation, degradation of stream habitat, increased flood flows, and other negative impacts. Research has shown that a large percentage of the sediment transport and erosion in a stream system occurs at flow rates less than generated by the 2-year storm (Geosyntec, 2007).

Because of this, traditional hydrologic analyses that focus on individual design storms (e.g. 2-year, 10-year, etc.) are not suitable for hydromodification analyses. To insure that the cumulative effects of all potentially erosive flows are considered, a continuous hydrologic model is required. For the SDMP, a continuous hydrologic simulation was performed using the Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) software. The model was used to evaluate the long-term rainfall-runoff response for the Shed C watershed for two land-use conditions:

- Base Conditions – this represents existing land-use conditions within the watershed plus proposed projects that already have approved tentative maps. Projects with approved tentative maps will not be required to include hydromodification mitigation. Therefore, these projects were included in the base conditions modeling to provide a reasonable starting point that could be used to assess the potential impacts of development of the SEPA.
- Buildout Conditions – this represents full buildout of City land within Shed C. The results from buildout conditions were compared against those for base conditions to assess the performance of the drainage facilities proposed for hydromodification mitigation.

4.2 Event Based Analysis

A traditional event based analysis was also performed to assess the flood control performance of the proposed system. Single event hydrologic and hydraulic models were prepared for the 10-year and 100-year storms for both pre-development conditions and for mitigated buildout conditions. The results were used to confirm that the ultimate improvements will adequately mitigate for potential impacts to flood flows and to confirm the required size of the flood control channel.

5.0 CONTINUOUS SIMULATION MODEL – BASE CONDITIONS

A continuous simulation model was developed for base conditions using HEC-HMS. The model input data is described below.

5.1 Watershed Boundaries

For the hydrologic modeling, Shed C was divided into the subsheds shown on Figure 2. Watershed areas and other model parameters are listed in Table 1, which can be found at the end of the report text along with the other tables and figures. Note that for the continuous simulation modeling, not all of the subsheds shown on Figure 2 and listed in Table 1 were included in the model. Because of the long model run times and large output files, only the subsheds within, and immediately downstream (west), of the City limits at Bruceville Road were included in the continuous simulation model. This was reasonable because the proposed facilities for the SEPA will be designed to mitigate for potential drainage impacts at the City boundary at Bruceville Road.

5.2 Land Use

For base conditions, the majority of the watershed was assumed to be undeveloped agricultural land. However, there are some exceptions including the Elk Grove Promenade and Sterling Meadows properties at the upstream end of Shed C (Subsheds A1 and A2 on Figure 2). The Promenade project was previously approved by the City and the site improvements were largely completed prior to the project being stalled due to the recent economic recession. The project construction included a large detention basin to serve both the Promenade and Sterling Meadows sites. The Sterling Meadows project has an approved tentative map. Therefore, for the base condition model, full buildout was assumed for the Promenade and Sterling Meadows projects and the existing detention basin that serves these sites was also included.

The other exception is the Laguna Ridge Specific Plan (LRSP) area. Tentative maps and drainage studies have already been approved for the projects within that specific plan. The development of that area will include construction of a detention basin for stormwater quality treatment and flood control and will also include a constructed channel that will convey flows from the project area to the Shed C Channel. Because the proposed drainage approach has already been approved, buildout conditions were assumed for the LRSP area.

5.3 Unit Hydrographs

Unit hydrographs for the continuous simulation model were developed by creating SacCalc models based on the Sacramento City/County Drainage Manual, which has been adopted for use in Elk Grove. These unit hydrographs created with SacCalc were imported into HEC-HMS. The input parameters for the calculation of unit hydrographs in SacCalc are presented in Table 1.

5.4 Precipitation Data

For the continuous simulation analysis, 53 years of hourly precipitation for water years 1957 through 2009 was obtained from various gages in the area as summarized in Table 2. To better represent precipitation in Elk Grove, the rainfall data from the Sacramento Post Office gage was adjusted using a ratio of the average annual rainfall between the Post Office and Elk Grove rain gages. Based on this approach, a factor of 0.94 was applied to the Sacramento Post Office hourly rainfall values.

5.5 Soil Moisture Accounting Parameters

The rainfall loss method was used for this study was the Soil Moisture Accounting method, which was incorporated into HEC-HMS specifically for continuous simulations. This method allows for a continuous accounting of rainfall losses including evapotranspiration, surface storage, infiltration, and interflow. Ideally, the model parameters assigned to represent the various processes would be determined from a calibration analysis based on measured stream flow data. Unfortunately, stream flow records for the Shed C watershed are not available. Therefore, the model input from a calibrated HEC-HMS model for Laguna Creek was used to guide the input choices for this study. The Laguna Creek model was prepared by Geosyntec (Geosyntec, 2007) and the information developed for that study was applied to this one. The soils types within the Shed C watershed were determined using the latest soil survey data from the Natural Resources Conservation Service. Subsheds in the Laguna Creek model with the same soil types as those within Shed C were identified and the Soil Moisture Accounting parameters those subsheds were applied to the Shed C model. Table 3 presents the values used for this study.

6.0 CONTINUOUS SIMULATION MODEL – BUILDOUT CONDITIONS

For buildout conditions, the continuous simulation model parameters were updated to represent full buildout within the City limits. The specific buildout assumptions for the continuous simulation model are discussed below.

6.1 Watershed Boundaries

Subshed boundaries within the City for buildout conditions are shown on Figure 3. The SEPA was divided into nine subsheds (S1a through S8), each of which will drain directly into a detention basin. Watershed boundaries outside of the SEPA were unchanged from base conditions.

6.2 Land Use

For the buildout conditions model, the base conditions model was updated to include full buildout within the SEPA based on the land use plan shown on Figure 4. The other areas within the City were already assumed to be developed for base conditions. Subsheds outside of the City limits were assumed to be unchanged from existing conditions. Table 1 presents the land-use assumed for each subshed for both base and buildout conditions. The assumed imperviousness associated with each land-use type is listed in the table.

6.3 Unit Hydrographs

Unit hydrographs were calculated using a SacCalc model representing buildout conditions. The input parameters for the calculation of unit hydrographs in SacCalc for buildout conditions are presented in Table 1.

6.4 Detention Basins

Detention basins are proposed at inflow points to the drainage corridor. These nine detention basins will provide runoff storage volume that will mitigate for potential increases in peak flood flows and will provide flow duration control to mitigate for the potential hydromodification effects. The basins will also provide stormwater quality treatment and the opportunity to create wetlands to mitigate for potential impacts to existing wetland features in the watershed. The general locations of the detention basins are shown in Figure 4.

For stormwater quality treatment purposes, the detention basins were assumed to be configured as Constructed Wetland Basins per the Sacramento Stormwater Quality Manual (Sacramento Stormwater Quality Partnership, 2007). This configuration assumes that each basin will include a permanent pool of water and will include four zones: a forebay, an open water zone, a wetland zone with aquatic plants, and an outlet zone. An area above the permanent pool will be provided to detain the stormwater quality treatment volume and slowly release it after a storm. Additional storage volume is provided above what is required for stormwater quality treatment to mitigate hydromodification and flood control impacts. A typical detention basin layout is presented on Figure 5.

Wetland detention basins can be community amenities that provide multiple benefits including wildlife habitat, stormwater quality treatment, flood control, and flow duration control. Along with these benefits comes a higher level of maintenance to insure proper function and also the need to provide a supplemental water supply to maintain the permanent pool. It may not be necessary, or desirable, to configure each detention basin as a constructed wetland area. The wetland area required to mitigate for impacts will be determined after a more detailed biological study is performed that defines the existing habitat in the watershed and after discussions with the appropriate permitting agencies are held and the mitigation requirements are determined. At that time, a more informed decision can be made on the exact configuration of each of the proposed detention basins.

The storage volumes required for flood and hydromodification control were determined through a series of model runs using the continuous simulation hydrologic model. Combinations of detention basin volumes and outlet configurations were iteratively tested with the model until the desired results were achieved. The outlets were assumed to consist of a riser pipe with a round orifice at the bottom for low flows and a notch at the top of the riser for larger flows. During large storm events that exceed the design event (100-year) excess flow can spill over the top of the riser. An emergency outlet weir will also be provided in the embankment between the basin and the channel in case the riser becomes plugged. The configuration of the outlet is shown on Figure 5. Tables 4 through 12 provide summaries of the detention basin volumes and outlet sizes. More discussion of the results from the modeling and the effectiveness of the detention basins in providing mitigation is presented later in this report.

For this study, it is assumed that all runoff from developed areas will be directed into a detention basin. As refined drainage and grading studies are prepared with proposed projects in the watersheds, if it is found that runoff from some small, isolated areas cannot be feasibly directed to a detention basin, some direct discharge of runoff into the channel may be allowed. In such cases, separate stormwater quality treatment facilities will be necessary and a detailed study will be required that demonstrates the overall flood control and hydromodification goals for the watershed are still met.

6.5 Stable Channel Design

The existing Shed C Channel is essentially a man-made agricultural ditch that has been highly altered from its natural form. Its original alignment has been straightened and it has numerous 90 degree bends. The channel side slopes are uniform and steep and vegetation has been removed from many reaches. It is desired to create a more naturalized multi-functional channel corridor that will include a low flow channel designed to be stable based on the anticipated flow regime and natural processes. The low flow channel will meander within a larger floodplain corridor that will provide flood storage and conveyance, wetlands habitat, and passive recreation opportunities. The sizing of the channel involved the following steps:

- Develop an alignment for the channel.
- Determine the channel forming discharge and low flow geometry.
- Determine the channel meander dimensions.
- Check to insure that the geometry provides adequate flood conveyance capacity.

6.5.1 Channel Alignment

A channel alignment was developed in consultation with the City during development of the land plan by the City. The proposed channel alignment generally follows the existing channel alignment but provides a more natural, meandering path that eliminates the sharp bends. The channel ties into the fixed points at the upstream end near the existing detention basin and at the downstream end at Bruceville Road. The proposed alignment is shown on Figure 4.

6.5.2 Channel Forming Discharge

The channel forming discharge is the flow rate that is most effective in shaping a stream channel. The channel forming discharge was estimated using the effective work method, which provides a way to estimate the flow magnitude associated with the maximum potential erosion over a long period. First, a histogram was used to create a flow frequency distribution of hourly peak flows (in 10 cfs intervals) from the continuous simulation model results. The potential erosion was determined using the Andrew Simon's effective work equation for consolidated materials:

$$W = \sum_{i=1}^{n} k(\tau_i - \tau_c)^{1.5} \Delta t$$

Where:

W = the total work performed in dimensionless units

k = erodibility coefficient

τ_i = the applied hydraulic shear stress, lbs/sf

τ_c = the critical shear stress that initiates erosion, lbs/sf

The value k was ignored (or assumed to be 1.0) because it is the same for base conditions and buildout conditions and does not affect the results. The applied shear stress was based on the following equation:

$$\tau_i = \gamma DS$$

Where:

γ = the unit weight of water (62.4 lbs/sf)

D = the depth of flow, ft

S = the slope of the channel, ft/ft

The critical shear stress was determined based on Figure 3-1 from Guidance Manual for Design of Multi-Functional Drainage Corridors, County of Sacramento, 2003. That figure is provided as Figure 6. Based on that information, the critical shear stress was estimated to be 0.10 lbs/sf, which is an appropriate value for fairly compact to loose clay soil.

To perform the work calculations, it was necessary to make an initial estimate of the channel forming flow and channel geometry. The channel forming flow was first estimated by determining the flow-frequency relationship in the channel for mitigated buildout conditions. Channel forming discharges typically vary between a 1-year to 2-year event, with a 1.5-year event being a reasonable average (Leopold, 1964). Therefore, the 1.5-year event was used as a starting point to estimate the channel forming discharge.

Using the estimated channel forming discharge, the average width and depth of the low flow channel was determined using the Manning's Equation:

$$d = \left[\frac{Q \times n}{1.49 (W / D) \sqrt{S}} \right]^{3/8}$$

Where:

d = the average depth of the low flow channel, ft

Q = the channel forming discharge, cfs

n = Manning's roughness coefficient

W/D = the width the depth ratio of the low flow channel

S = the slope of the channel, ft/ft

To use the equation it is necessary to estimate the width to depth ratio (W/D) for the channel. This ratio is dependent on the ability of the channel to resist erosion, which is a function of soil characteristics and vegetation. Measurements of width to depth ratios for existing creeks in the Sacramento area were performed by Zentner and Zentner and are published in the Guidance Manual for Design of Multi-Functional Drainage Corridors, County of Sacramento, 2003. Laguna Creek near Bradshaw Road, which has the same soil type as those along the Shed C Channel, had a measured W/D ratio between 12 and 14. Therefore, a W/D ratio of 12 was selected for the Shed C Channel.

Using the initial channel dimensions, the effective work method was applied and the channel forming discharge was calculated. If the calculated discharge was different than the original estimate, the new value was used to re-size the channel and the process continued iteratively until the flow value used to size the channel matched the channel forming flow calculated by the effective work method. The reasonableness of the channel forming flow was then checked against the flood frequency curve.

Using the process described above, the preliminary channel forming discharge and low flow channel geometry was determined for four reaches along the channel. The reaches are shown on Figure 4 and are described below.

- Reach 1 – From Lotz Parkway to the outfall from Detention Basin S1a.
- Reach 2 – From the outfall from Detention Basin S1a to extension of Big Horn Boulevard.

- Reach 3 – From the extension of Big Horn Boulevard. to the confluence with the channel from the LRSP area.
- Reach 4 – From the confluence with the LRSP channel to Bruceville Road.

Figures 7 through 10 present the results from the effective work method for the four reaches. As shown on Figure 7, in Reach 1 the large majority of peak flows over the 53 year period of record are 55 cfs or less. However, flows in that range are too small to produce shear stresses above the critical shear stress and therefore those flows do not perform work (i.e. cause erosion) on the channel. It appears the flow rate that produces the most work over the modeled period is approximately 85 cfs. Therefore 85 cfs is selected as the channel forming discharge for Reach 1. The results for Reaches 2, 3, and 4 are shown on Figures 8, 9, and 10, respectively. As shown on those figures, the channel forming discharge is approximately 125 cfs for Reach 2, 115 cfs for Reach 3, and 265 cfs for Reach 4. Figure 11 presents the flow frequency curves for the four reaches. As can be seen on that figure, the return periods of the channel forming flows for the four reaches vary between 0.9 and 2.2 years, which is very close to the 1 to 2 year range that is considered typical.

Using these flows along with Manning's equation and the assumed width to depth ratio as discussed above, the average dimensions of the low flow channel were calculated using a Manning's n of 0.04 and a slope of 0.0001 feet per foot for Reaches 1, 2, and 3 and 0.0006 feet per foot for Reach 4. Because the equation provides the average dimensions based on a rectangular channel, the resultant dimensions were converted to an equivalent trapezoidal shape based on a side slope of 3 to 1 (horizontal to vertical). Table 13 presents an initial estimate of the low flow channel dimensions for each reach.

6.5.3 Channel Meander Dimensions

After determining average low flow channel sizes, the meander dimensions can be estimated. The meander dimensions are based on equations developed from empirical observations. The meander dimensions were estimated using the equations presented in the Stream Corridor Restoration, Principles, Processes, and Practices, Federal Interagency Stream Restoration Group, USDA, 2001. These equations are as follows:

$$B = 3.7w^{1.12}$$

$$M_L = 4.4w^{1.12}$$

$$L = 6.5w^{1.12}$$

$$r_c = 1.3w^{1.12}$$

The variables in the above equations are shown in Figure 12. For this study, because detailed channel design was not performed, the main variable of interest was the meander amplitude (B) also called the belt width. This variable provides an estimate of the required minimum width of the floodway corridor (i.e. the bottom width of the flood control channel). The estimated meander dimensions for the low flow channel are presented in Table 13.

6.6 Effectiveness of Mitigation Measures for Hydromodification

The City, as a member of the Sacramento Stormwater Quality Partnership, has prepared a Hydromodification Management Plan (HMP) that establishes the criteria for assessing the effectiveness of hydromodification mitigation measures. Although, the plan has yet to be approved by State regulators, the plan contains the best available information at this time for compliance criteria. According to the HMP, satisfactory hydromodification mitigation is achieved by meeting specific flow duration control as follows:

- For flow rates ranging from either 25 percent or 45 percent of the pre-project 2-year recurrence interval event ($0.25Q_2$ to $0.45Q_2$) up to the pre-project 10-year runoff event (Q_{10}), the post-project discharge rates and durations shall not deviate above the pre-project rates and durations by more than 10 percent over more than 10 percent of the length of the flow duration curve.

The specific low flow threshold to be used is dependent on the erosion susceptibility of the subject waterway. No susceptibility testing has been performed for the Shed C Channel. According to results from the susceptibility tests that were conducted during preparation of the HMP, most tested waterways in Sacramento County are categorized with medium to very high susceptibility to vertical erosion and high to very high susceptibility to lateral erosion. Based on that, it is assumed for this study that the Shed C Channel would fall in the high susceptibility category and, therefore, the low end of the flow duration assessment of $0.25Q_2$ should be used.

The effectiveness of the proposed mitigation measures for hydromodification were assessed by comparing the flow durations results for base conditions and buildout conditions at the downstream boundary of the City (Bruceville Road). Figure 13 presents a comparison of the flow duration results. As indicated on the figure, the proposed drainage plan provides adequate flow duration control within the critical flow range between $0.25Q_2$ (61 cfs) and Q_{10} (425 cfs). The flow duration curve for buildout conditions is lower than the curve for base conditions for all but the low end of the relevant flow range. Because the increases at the low end of the flow range occur for less than 10 percent of the length of the flow duration curve, the mitigation measures are considered acceptable.

As an additional check on the effectiveness of the hydromodification mitigation, a comparison was made of the cumulative effective work performed in the channel at Bruceville Road. The cumulative effective work was based on Simon's effective work equation presented earlier in this study. For the comparison, the change in erosion potential due to buildout was measured as the ratio of the cumulative effective work for buildout conditions versus base conditions as follows:

$E_p = W_{post}/W_{base}$, where:

E_p = the erosion potential

W_{post} = the cumulative work performed for post project conditions (buildout conditions)

W_{base} = the cumulative work performed for base conditions

As shown on Figure 14, it is estimated that the proposed facilities would decrease the erosion potential at the downstream boundary by approximately 13 percent. This verifies that the proposed facilities provide reasonable mitigation of potential hydromodification effects.

7.0 EVENT BASED ANALYSIS

A traditional event based analysis was performed to assess the flood control performance of the proposed facilities. For flood control purposes, the proposed drainage facilities must accomplish two key objectives:

- Mitigate for potential increases in flood flows downstream from the City (Bruceville Road)
- Safely convey flood flows through the project area

For the event based analysis, hydrologic models were prepared to estimate flood flows into the Shed C Channel (or detention basins) for the 10-year and 100-year storm events. Hydraulic models were used to route the flood flows through the Shed C Channel and to calculate water surface elevations along the channel. These analyses were performed for both pre-development conditions and buildout conditions within the City limits.

7.1 Event Based Analysis – Pre-Development Conditions

7.1.1 Hydrologic Analysis – Pre-Development

Hydrologic models were prepared with SacCalc to determine the 10-year and 100-year flows entering the Shed C Channel for pre-development conditions. These models very similar to the SacCalc models that were used as the starting point for development of base conditions continuous simulation model. The main difference is that the Promenade, Sterling Meadows, and LRSP areas were modeled as undeveloped. Shed C was divided into the 29 subsheds as shown on Figure 2. Table 1 presents the key hydrologic parameters for each subshed for existing conditions. Note that the SacCalc models were used only to calculate the flows from each subshed before they enter collector channels or the Shed C Channel. The flows were then combined and routed through the channel system using a hydraulic model as discussed below.

7.1.2 Hydraulic Analysis – Pre-Development

A hydraulic analysis was performed using HEC-RAS to determine the flows and water surface elevations within the Shed C Channel for the 10-year and 100-year storm events. Descriptions of the various features of the HEC-RAS model are provided below.

7.1.2.1 Channel Geometry and Manning's Roughness Coefficients

The hydraulic model of the Shed C Channel begins just downstream of the existing Promenade detention basin at the west boundary of Subshed A2 (near Lotz Parkway). The model extends downstream to the west side of Interstate 5. The channel geometry was defined using approximately 150 cross sections. The cross section locations within the City limits are shown on Figure 15. For pre-development conditions, the cross sections from the upstream end of the model to approximately 1,000 feet downstream of the future extension of

Big Horn Boulevard (currently McMillan Road at the Shed C Channel crossing) are based on a field survey performed by West Yost in 2009. The remaining cross sections are based on a combination of field survey data collected by Murray Smith & Associates (Murray Smith) in the late 1990's and LIDAR generated topographic mapping. All elevations in this report are based on the National Geodetic Vertical Datum of 1929. The original Murray Smith survey data was unavailable for review, but it is considered adequate for estimating pre-development flood flows and water surface elevations. Manning's roughness coefficients range from 0.04 to 0.06 within the main channel and 0.04 to 0.05 in the overbank areas.

7.1.2.2 Bridges and Culverts

There are nine existing bridge or culvert crossings included in the model. Within the City limits, there are six culvert crossings. Five of these culverts are small pipe culverts used for farm roads that cross the channel. The other set of culverts within the City is located at Bruceville Road, where two 48-inch concrete pipelines cross under the roadway. Downstream of the City there are bridge structures at the Union Pacific Railroad and Interstate 5. At Franklin Boulevard, there are four 15 feet x 4.5 feet concrete box culverts.

7.1.2.3 Downstream Boundary Condition

For the 10-year and 100-year water surface calculations, the water surface elevations at the downstream end of the hydraulic model (near Interstate 5) were set at constant elevations of 7.3 feet and 8.6 feet, respectively. These are the estimated water surface elevations in the Beach Stone Lakes area at the time of peak flows in the local Shed C Channel as determined from hydraulic modeling prepared by for Sacramento County for the Beach Stone Lakes area. Although the values are lower than the peak water surface elevations in the Beach Stone Lakes area, they are considered reasonable for this study because the peak flows from Shed C are expected to occur well before the peak stage occurs in the Beach Stone Lakes area west of Interstate 5. Peak stages in the Beach Stone Lakes area are controlled by flows from the Cosumnes River and Mokelumne River watersheds that back up into the Beach Stone Lakes area. Due to the large size of the Cosumnes and Mokelumne River watersheds, the peak flows from these rivers occur well after the peak flows from Shed C. As a sensitivity test, the downstream stage for the 100-year storm event was increased from 8.6 feet to 12.0 feet. Even with the large increase in the starting downstream water surface elevation, the water surface elevations from the original model and the test model merge at Franklin Boulevard, which is well downstream of the study area. Therefore, the results of this study are not sensitive to variations in the starting water surface elevation at the downstream end of the hydraulic model.

7.2 Event Based Analysis – Buildout Conditions

7.2.1 Hydrologic Analysis – Buildout

For buildout conditions, it was assumed that the entire area within the City limits was developed. The buildout land-use conditions for the event based analysis are exactly the same as those used for the continuous simulation modeling. The subshed boundaries for areas within the City are shown on Figure 3. Subshed limits for areas outside of the City are the same as for pre-development conditions, as shown on Figure 2. Table 1 presents the key hydrologic parameters for each subshed for buildout conditions. The calculated flow hydrographs were input into

HEC-RAS to determine the resultant flows and water surface elevations in the Shed C Channel and detention basins for buildout conditions.

7.2.2 Hydraulic Analysis – Buildout

A hydraulic analysis was performed using HEC-RAS to evaluate the flood control performance of the proposed detention basin and channel improvements proposed for the SEPA and to determine the adequacy of the flood flow mitigation at the downstream limits of the City at Bruceville Road.

7.2.2.1 Channel Geometry and Manning's Roughness Coefficients

For buildout conditions, the cross sections within the City limits were configured to represent the proposed buildout channel geometry. Cross section locations within the City limits for buildout conditions are shown on Figure 16. The general channel configuration is the same for all channel reaches within the City. A typical cross section is shown on Figure 17. The average side slopes of the low flow and flood control channel were set at 3:1 and 4:1, respectively. These are average values and the expectation is that the side slopes will be varied to provide a more natural appearance.

The specific channel dimensions adopted for each reach of the Shed C Channel are listed in Table 14. The limits of each reach can be seen on Figure 16. The low flow channel dimensions are primarily based on the results from the continuous simulation analysis as summarized in Table 13. Some adjustments to the low flow channel dimensions were made in Reaches 2 and 4. For Reach 2, the channel forming flow was estimated to be 125 cfs. Just downstream in Reach 3, the channel forming flow was estimated to be 115 cfs, which is counter-intuitive given that the watershed draining to Reach 3 is larger than that for Reach 2. This result demonstrates the approximate nature of the method for estimating the channel forming flow rate. For consistency, the same low flow channel dimensions were adopted for Reaches 2 and 3 based on a channel forming flow rate of 115 cfs. For Reach 4, the depth of the low flow channel was reduced to allow the flood control bench to be lowered to provide more flood conveyance capacity for this reach.

The channel floodway widths were initially set equal to the belt width (meander amplitude) values in Table 13. An initial model run was made and the floodway bottom width was adjusted where needed based on the flood control requirements. In the lower reaches of the channel (Reaches 3b and 4), which will be relatively shallow, it was necessary to increase the floodway width to 207 feet, which is larger that calculated the belt width value, to provide adequate flood conveyance. Even with the extra width, it is anticipated that fill will be required along the channel banks between cross section 6625 and Bruceville Road to provide adequate freeboard (1 foot minimum) for the 100-year event. The channel is relatively shallow along this reach compared to the upper reaches of the channel due to the need to tie into the existing channel downstream of Bruceville Road. To provide as much depth as possible in this reach, it is proposed that some excavation be performed to deepen the existing channel downstream of Bruceville Road. The excavation will be limited to construction of a small pilot channel to eliminate existing high points in the existing channel. This will allow the proposed SEPA channel to be constructed deeper. The off-site excavation is only intended to provide some extra depth in the on-site channel and is not intended to provide a significant increase in capacity downstream of Bruceville Road. It is estimated that the pilot channel will extend approximately

3,200 feet downstream of Bruceville Road and the average depth of excavation will be approximately 1.8 feet. The limits of the offsite channel deepening are shown on Figure 18.

In the upper reaches, the channel will be deeper and the initial model results showed a significant amount of freeboard during the 100-year storm. Based on that, it was determined that the floodway width in the upper reaches could be reduced from the belt width that was determined from the natural channel design described previously. The belt width value represents the theoretical width of the corridor that the low flow channel can be expected to meander within (see Figure 12). There is a desire to not design a channel that is conservatively large from the flood control and short-term economic perspective. However, there is also a desire not to excessively constrain the channel, which could produce long-term maintenance problems.

To find an appropriate balance between the two competing perspectives, the natural channel design elements were re-evaluated. The belt width value is based on theoretical equations related to the channel forming flow. A larger channel forming flow produces a larger predicted belt width. The channel forming flow typically ranges between the 1-year and 2-year flow event. For the upper reaches of the channel between the Promenade detention basin and Big Horn Boulevard, the channel forming flow for this study ranged between a 1.7-year to 2-year event, which are at the high end of the typical range. Therefore, a smaller predicted belt width for the 1-year storm was used to establish a minimum channel floodway width. This reduced the floodway width of the channel between 11 feet and 17 feet. These reduced widths still provided adequate flood capacity and, therefore, were adopted for this study.

For buildout conditions, the roughness coefficients for the proposed Shed C Channel were set at 0.04 within the low flow channel and 0.08 within the overbank areas. The relatively large value used in the overbank area for buildout conditions is intended to allow for the establishment of significant riparian vegetation which would help reduce maintenance requirements.

A channel will be constructed through the SEPA to convey runoff from a portion of the LRSP area to the Shed C Channel. The general configuration of the channel was established during planning for the LRSP and carried forward to this study. The dimensions of the channel are presented on Table 14. The channel alignment, which is shown on Figure 16, has been modified from that originally conceived during the planning for the LRSP due to land use planning requirements for the SEPA.

7.2.2.2 Bridges and Culverts

There are five road crossings proposed within the SEPA. Box culverts were sized for each of the crossings using the HEC-RAS model. The sizes of the proposed box culverts are shown on Figure 16. During the design of the road crossings, alternative bridge designs may be proposed as long as they do not produce significantly larger head losses than the culverts proposed with this study.

7.2.2.3 Detention Basins

The proposed detention basins that are to be located adjacent to the Shed C Channel were included in the HEC-RAS model. The elevation-storage volume information and outlet configurations assumed for the modeling are presented in Tables 4 through 12. These tables provide the assumed dimensions of each detention basin. The general shape of the detention basins was generally based on the shape of the basins included on the SEPA land use plan. When the basins are designed, they will likely differ from the shapes assumed for this study and this is acceptable as long as the elevation-storage volume relationship is reasonably close. Significant deviations may need to be tested with modeling.

Two detention basins, DETS1a and DET2, are not located adjacent to the channel and backwater from the channel is not expected to affect the outflow characteristics from them. Therefore, these detention basins were not included in the HEC-RAS model. Outflow from these detention basins was calculated with the SacCalc hydrologic model and the resulting hydrographs were input directly into the channel in the HEC-RAS model.

7.3 Results from the Hydrologic and Hydraulic Analyses

7.3.1 Results for Pre-development Conditions

The HEC-RAS model was used to route the inflows from the tributary subsheds through the Shed C Channel and to calculate water surface elevations in the channel using an unsteady-state analysis. For pre-development conditions, the channel and culvert capacities are insufficient to pass the 10-year flows or the 100-year flows and significant overbank flooding is predicted as shown on Figure 15. Figure 19 presents the calculated water surface profiles for pre-development conditions within the City limits. Figure 15 shows the approximate pre-development floodplain limits for the 100-year event. It appears that structure flooding may occur during a 100-year storm near cross sections 5685, 7040, and 9730. The pre-development modeling and floodplain mapping was previously prepared for the City's SDMP and was not revised during this study. The floodplain mapping is considered approximate. Detailed output tables from the HEC-RAS model for pre-development conditions are provided in Attachment A.

7.3.2 Results for Buildout Conditions

For buildout conditions, the proposed detention basins and channel improvements will provide adequate storage and conveyance to protect the SEPA form flooding and mitigate for potential flood flow increases downstream. Figure 20 presents the calculated water surface profiles in the Shed C Channel for buildout conditions within the City limits. Figure 21 presents the same information for the channel from the LRSP area. Detailed output tables from the HEC-RAS model for buildout conditions are provided in Attachment B. Table 15 lists the calculated peak flood flows at the downstream end of the City (Bruceville Road). As shown in the table, the peak flood flows for the 10-year and 100-year storms are predicted to be reduced slightly at that location.

8.0 SUMMARY OF RECOMMENDED FACILITIES

It is recommended that a multi-functional drainage system be constructed in the SEPA to accommodate future development in the watershed and to create and enhance the natural stream and habitat values. The multi-functional corridor should include a low flow channel that is stable and self-sustaining, and meanders within a larger floodway corridor that will provide flood conveyance as well as wetlands habitat. At key points along the corridor, detention basins should be constructed as defined by this study to provide storage volume to mitigate for potential flood flow and hydromodification impacts. The channel and detention basins will also provide the opportunity to establish riparian habitat. Specific drainage facilities that are proposed with the plan are summarized below.

8.1 Channel Improvements

8.1.1 On-Site Channel and Culvert Improvements

A new channel will be constructed between Lotz Parkway and Bruceville Road. The approximate alignment of the channel is shown on Figure 16. The channel includes five reaches, which are also shown on Figure 16. Within each reach, the channel cross section will have the same general configuration, but with different dimensions. The specific dimensions of each channel reach are presented in Table 14.

Based on discussions with engineers representing future development projects, there is a desire to use the channel corridor to create water features that would be an amenity to the surrounding area. These features may include creation of permanent water features within the stream corridor or within widened areas along the corridor. The permanent pools would be created by either excavating a deeper area within the channel corridor or by constructing a berm to back up flow. These types of features are acceptable and even desirable in that they provide variation along the corridor and utilize the stream corridor as a public amenity, which is a goal of this drainage plan. Specific proposals will be reviewed on a case by case basis to insure that they do not compromise flood protection or the natural channel features within the corridor.

Box culverts are proposed at the five road crossings within the SEPA. The specific sizes of the culverts are shown on Figure 16. Different culvert or bridge configurations are acceptable as long as the capacities are similar to those proposed by the study.

8.1.2 Off-site Channel Improvements

The downstream end of the proposed channel, especially Reach 4 (see Figure 16), is relatively shallow. To provide as much depth as possible in this reach of the channel, it is proposed that some excavation be performed to deepen the existing channel downstream of Bruceville Road. The excavation will be limited to construction of a small pilot channel to eliminate existing high points in the existing channel. This will allow the proposed SEPA channel to be constructed deeper. The off-site excavation is only intended to provide some extra depth in the on-site channel and is not intended to provide a significant increase in capacity downstream of Bruceville Road. It is estimated that the pilot channel will extend approximately 3,200 feet downstream of Bruceville Road and the average depth of excavation will be approximately 1.8 feet.

8.2 Detention Basins

Runoff from the SEPA will be directed into one of nine detention basins proposed with the drainage plan. The general locations and approximate areas of the basins are shown on Figure 16. Tables 4 through 12 present the assumed dimensions, elevations, and storage volumes for the detention basin. When the basins are designed, they will likely differ from the shapes assumed for this study and this is acceptable as long as the elevation-storage volume relationship is reasonably close. Significant deviations may need to be tested with modeling. Figure 22 shows a typical outlet configuration for a basin.

Underground pipe systems will convey runoff from small to moderate storms to the detention basins. During large events that exceed the capacity of the pipe systems, excess flow will be conveyed overland through streets and open space. It will be important to ensure that the grading plans for the proposed projects in the SEPA are designed in such a way to direct all overland flow into the detention basins. During the design of individual projects, if it is found that runoff from some small, isolated areas cannot be feasibly directed to a detention basin, some direct discharge of runoff into the channel may be allowed. In such cases, separate stormwater quality treatment facilities will be necessary and a detailed study will be required that demonstrates the overall flood control and hydromodification goals for the watershed are still met.

9.0 REFERENCES

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Sacramento Stormwater Quality Partnership, 2007. Stormwater Quality Design Manual for the Sacramento and South Placer Regions.

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Wood Rodgers, 2005. Drainage Document for Laguna Ridge Specific Plan, Supplemental Master Drainage Plan for Local Drainage Area Shed C.

Table 1. Hydrologic Parameters

						Land-use, acres											
Subshed	Area, acres	Mean Elevation, ft, NGVD29	Basin Length. ft	Basin Centroid Length, ft	Basin Slope, ft/ft	Ag. 2%	Park, Open Space, Rec 5%	Estate Res. 30%	LDR 40%	School, Res. 6-8 du/ac 50%	Res. 8-10 du/ac 60%	MDR 70%	Light Industrial/ Flex 75%	HDR 80%	Mixed Use 85%	Office, Comm. 90%	Watershed Impervious Percent
Pre-Development Conditions																	
A1	319.2	42	5,547	1,324	0.0008	319.2	0	0	0	0	0	0	0	0	0	0	2.0
A2	202.4	40	5,800	1,600	0.0008	202.4	0	0	0	0	0	0	0	0	0	0	2.0
A4	118.0	39	3,720	2550	0.0013	118	0	0	0	0	0	0	0	0	0	0	2.0
A4A	290.7	39	4,700	1,500	0.0008	290.7	0	0	0	0	0	0	0	0	0	0	2.0
A4B	215.5	39	4,800	1,400	0.0008	215.5	0	0	0	0	0	0	0	0	0	0	2.0
A4C	93.6	39	2,200	1,100	0.0008	93.6	0	0	0	0	0	0	0	0	0	0	2.0
A5	247.7	36	4,800	2,000	0.0012	247.7	0	0	0	0	0	0	0	0	0	0	2.0
A5A	222.5	32	4,880	2,446	0.0015	222.5	0	0	0	0	0	0	0	0	0	0	2.0
A5B	91.6	30	4,000	1,700	0.0008	91.6	0	0	0	0	0	0	0	0	0	0	2.0
A5C	184.3	30	3,700	1,840	0.0012	184.3	0	0	0	0	0	0	0	0	0	0	2.0
MA5C	40.5	28	1,200	500	0.0017	40.5	0	0	0	0	0	0	0	0	0	0	2.0
A6	95	27	3,500	1,700	0.0008	95	0	0	0	0	0	0	0	0	0	0	2.0
A8	216.4	27	5,200	2,600	0.0008	216.4	0	0	0	0	0	0	0	0	0	0	2.0
A10	557	20	6,400	1,900	0.0008	557	0	0	0	0	0	0	0	0	0	0	2.0
A11	213.2	19	5,300	1,000	0.0008	213.2	0	0	0	0	0	0	0	0	0	0	2.0
A12	470.8	42	7,400	3,500	0.0008	470.8	0	0	0	0	0	0	0	0	0	0	2.0
A13	257.9	38	5,400	2,700	0.0008	257.9	0	0	0	0	0	0	0	0	0	0	2.0
A14	481.7	38	7,500	1,400	0.0008	481.7	0	0	0	0	0	0	0	0	0	0	2.0
A15	487.3	35	6,900	1,400	0.0008	487.3	0	0	0	0	0	0	0	0	0	0	2.0
A16	723.2	32	10,000	1,300	0.0008	723.2	0	0	0	0	0	0	0	0	0	0	2.0
A17	722.6	28	9,000	1,200	0.0008	722.6	0	0	0	0	0	0	0	0	0	0	2.0
A18	699.3	20	12,000	6,300	0.0008	699.3	0	0	0	0	0	0	0	0	0	0	2.0
A19	223.6	18	5,300	1,200	0.0008	223.6	0	0	0	0	0	0	0	0	0	0	2.0
A20	80.9	16	2,800	600	0.0008	80.9	0	0	0	0	0	0	0	0	0	0	2.0
A21	156.4	14	5,000	2,600	0.0008	156.4	0	0	0	0	0	0	0	0	0	0	2.0
A22	96.7	18	3,600	900	0.0008	96.7	0	0	0	0	0	0	0	0	0	0	2.0
A23	66.6	16	2,900	600	0.0008	66.6	0	0	0	0	0	0	0	0	0	0	2.0
A24	88.5	13	3,700	2,000	0.0008	88.5	0	0	0	0	0	0	0	0	0	0	2.0
A25	219.5	12	5,000	1,900	0.0008	219.5	0	0	0	0	0	0	0	0	0	0	2.0
Base Conditions (These subsheds are assumed to be developed and replace A1, A2, A5A, and A5C from existing conditions, all other subsheds the same as existing conditions)																	
A1	319.2	42	5,547	1,324	0.0008	0	0	0	0	0	0	0	0	0	0	319.2	90.0
A2	202.4	40	5,800	1,600	0.0008	0	0	0	202.4	0	0	0	0	0	0	0	40.0
LRSP1	217.1	31	5,940	3,130	0.0014	0	5.3	0	103.2	95.2	0	13.1	0	0	0	0	45.3
LRSP2	178.7	29	4,450	2,130	0.0019	0.0	24.4	0.0	131.8	0.0	0.0	22.5	0.0	0.0	0.0	0.0	39.0
Buildout Conditions (These subsheds represent the buildout subsheds within the SEPA, all other subsheds are the same as base conditions)																	
S1A	154.4	39	3,000	1100	0.0016	0.0	8.2	0.0	18.5	0.0	0.0	24.7	0.0	11.5	0.0	91.5	75.6
S1B	103.3	38	2,930	1500	0.0010	0.0	19.8	0.0	67.0	0.0	0.0	4.7	0.0	11.8	0.0	0.0	39.2
S2	102.0	36	3,400	1550	0.0021	0.0	10.7	0.0	34.8	11.2	0.0	23.1	0.0	11.3	0.0	10.9	54.0
S3	241.0	36	4,750	1,700	0.0013	0.0	41.1	0.0	77.4	9.8	0.0	39.2	0.0	18.5	45.0	10.0	52.9
S4	147.2	36	2,970	1,310	0.0010	0.0	7.9	0.0	0.0	0.0	0.0	0.0	51.1	0.0	0.0	88.2	80.2
S5	104.5	34	3,000	1,390	0.0019	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.0	84.7
S6	89.7	27	3,630	1,700	0.0013	0.0	23.3	6.8	27.1	8.5	0.0	0.0	0.0	0.0	0.0	24.0	44.5
S7	87.4	25	3,200	1,600	0.0013	0.0	3.5	58.1	0.0	0.0	0.0	13.4	0.0	12.3	0.0	0.0	42.2
S8	86.6	28	3,550	2,120	0.0013	0.0	7.2	0.0	0.0	0.0	0.0	0.0	64.6	0.0	0.0	14.7	71.7
SC1	11.8	33	1,780	730	0.0010	11.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
SC2	14.8	31.5	2,290	1,370	0.0010	14.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
SC3	11.9	31	1,770	740	0.0010	11.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
SC4	24.4	26	3,270	1660	0.0010	24.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
SC5	21.3	25	2,210	1,100	0.0006	21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0

Table 2. Summary of Precipitation Data Sources

Gage ID	Gage Description	Date Range
HPD047630	Sacramento Post Office National Weather Service (Adjusted)	10/1/1956 to 12/3/1962 and 05/9/1974 to 8/4/1974
ElkGroveFD	The Elk Grove Fire Station on Elk Grove Boulevard	12/04/1962 to 5/8/1974
ElkGroveFH	The Elk Grove Fish Hatchery on Bond Road	8/5/1975 to 6/5/1985
ElkGroveFH ALERT	ALERT gage at the Elk Grove Fish Hatchery on Bond Road	6/6/1985 to 11/6/2002
0270td3240	ALERT gage Laguna Creek at Waterman Road	11/7/2002 to 9/30/2009

Table 3. Soil Moisture Accounting Parameters

Subshed	Canopy Storage, in	Surface Storage, in	Maximum Infiltration, in/hr	Imp., %	Soil Storage, in	Tension Storage, in	Soil Percolation, in/hr	Gw 1 Storage, in	Gw 1 Percolation, in	Gw 1 Storage Coeff.
A01	0.08	0.3	0.07	90	6	4.8	0.07	10	0.07	200
A02	0.08	0.3	0.07	40	6	4.8	0.07	10	0.07	200
A04	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
A04A	0.08	0.3	0.07	2	6	4.8	0.07	10	0.08	200
A04B	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
A04C	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
A05	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
A05B	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
LRSP1	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
LRSP2	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
MA5C	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
A06	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
A08	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
A10	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200

Table 4. Detention Basin Data for DETS1a

Hydraulic Data		
Tributary Area	154.4	acres
Outlet Orifice Size	12	inches
Outlet Orifice Elevation	32.3	feet
Main Spillway Width (Notch)	4	feet
Main Spillway Elevation (Notch)	34	feet
Top of Riser Elevation	37.3	feet
Emergency Weir Elevation	37.5	feet
10-Year Peak WSEL	35.9	feet
100-Year Peak WSEL	37.0	feet

Elevation-Volume-Flow Data

Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow[b][c], cfs	Spill Flow[b][c], cfs	Total Outflow[b], cfs
Bottom or Permanent Pool	32.3	0.0	357	571	203918	4.7	0.0	0.0	0.0	0.0
Water Quality Pool (Approx)	33.9	1.6	370	584	215963	5.0	7.7	4.9	0.0	4.9
	34.0	1.7	371	585	216727	5.0	8.2	5.0	0.0	5.0
	35.0	2.7	379	593	224434	5.2	13.3	6.3	11.2	17.5
	36.0	3.7	387	601	232269	5.3	18.5	7.4	31.7	39.1
	37.0	4.7	395	609	240232	5.5	23.9	8.3	58.2	66.5
	38.0	5.7	403	617	248324	5.7	29.5	9.2	89.6	98.8

Notes:

[a] All elevations are based on NGVD29.

[b] Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.

[c] An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

Table 5. Detention Basin Data for DETS1b

Hydraulic Data		
Tributary Area	103.3	acres
Outlet Orifice Size	10	inches
Outlet Orifice Elevation	28.6	feet
Main Spillway Width (Notch)	2.6	feet
Main Spillway Elevation (Notch)	31.0	feet
Top of Riser Elevation	34.5	feet
Emergency Weir Elevation	34.6	feet
10-Year Peak WSEL	32.8	feet
100-Year Peak WSEL	34.1	feet

Elevation-Volume-Flow Data										
Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow[b][c], cfs	Spill Flow[b][c], cfs	Total Outflow[b], cfs
Bottom or Permanent Pool	28.6	0.0	304	304	92416	2.1	0.0	0.0	0.0	0.0
Water Quality Pool (Approx)	29.8	1.2	314	314	98345	2.3	2.6	2.9	0.0	2.9
	30.0	1.4	315	315	99351	2.3	3.1	3.2	0.0	3.2
	31.0	2.4	323	323	104458	2.4	5.4	4.1	0.0	4.1
	31.5	2.9	327	327	107060	2.5	6.6	4.5	2.6	7.1
	32.0	3.4	331	331	109482	2.5	7.8	4.9	6.8	11.7
	33.0	4.4	339	339	115057	2.6	10.5	5.6	20.6	26.2
	34.0	5.4	347	347	120548	2.8	13.2	6.2	37.8	44.0
	35.0	6.4	355	355	126167	2.9	16.0	6.8	58.2	65.0

Notes:

[a] All elevations are based on NGVD29.

[b] Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.

[c] An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

Table 6. Detention Basin Data for DETS2

Hydraulic Data		
Tributary Area	102	acres
Outlet Orifice Size	10	inches
Outlet Orifice Elevation	27.7	feet
Main Spillway Width (Notch)	2.7	feet
Main Spillway Elevation (Notch)	29.8	feet
Top of Riser Elevation	33.1	feet
Emergency Weir Elevation	33.2	feet
10-Year Peak WSEL	31.5	feet
100-Year Peak WSEL	32.7	feet

Elevation-Volume-Flow Data										
Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow[b)(c], cfs	Spill Flow[b)(c], cfs	Total Outflow[b], cfs
Bottom or Permanent Pool	27.7	0.0	245	441	108045	2.5	0.0	0.0	0.0	0.0
Water Quality Pool (Approx)	29.0	1.3	255	451	115288	2.6	3.3	3.0	0.0	3.0
	30.0	2.3	263	459	121006	2.8	6.0	4.0	0.7	4.7
	31.0	3.3	271	467	126852	2.9	8.9	4.9	9.9	14.8
	32.0	4.3	279	475	132827	3.0	11.9	5.5	24.7	30.2
	32.7	5.0	285	481	137085	3.1	14.0	6.0	37.3	43.3
	33.7	6.0	293	489	143277	3.3	17.3	6.5	58.2	64.8

Notes:

[a] All elevations are based on NGVD29.

[b] Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.

[c] An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

Table 7. Detention Basin Data for DETS3

Hydraulic Data		
Tributary Area	241	acres
Outlet Orifice Size	15	inches
Outlet Orifice Elevation	24.6	feet
Main Spillway Width (Notch)	5.7	feet
Main Spillway Elevation (Notch)	26.3	feet
Top of Riser Elevation	30.0	feet
Emergency Weir Elevation	30.1	feet
10-Year Peak WSEL	28.4	feet
100-Year Peak WSEL	29.6	feet

Elevation-Volume-Flow Data										
Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow[b][c], cfs	Spill Flow[b][c], cfs	Total Outflow[b], cfs
Bottom or Permanent Pool	24.6	0.0	507	507	257049	5.9	0.0	0.0	0.0	0.0
	25.6	1.0	515	515	265225	6.1	6.0	6.0	0.0	6.0
Water Quality Pool (Approx)	25.9	1.3	517	517	267703	6.1	7.8	6.8	0.0	6.8
	26.3	1.7	521	521	271024	6.2	10.3	7.8	0.0	7.8
	28.5	3.9	538	538	289659	6.6	24.3	11.9	52.1	63.9
	29.5	4.9	546	546	298334	6.8	31.1	13.3	91.4	104.7
	30.5	5.9	554	554	307138	7.1	38.0	14.6	137.4	152.0

Notes:

[a] All elevations are based on NGVD29.

[b] Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.

[c] An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

Table 8. Detention Basin Data for DETS4

Hydraulic Data		
Tributary Area	147.2	acres
Outlet Orifice Size	12	inches
Outlet Orifice Elevation	27.7	feet
Main Spillway Width (Notch)	3.7	feet
Main Spillway Elevation (Notch)	30.0	feet
Top of Riser Elevation	33.4	feet
Emergency Weir Elevation	33.6	feet
10-Year Peak WSEL	31.9	feet
100-Year Peak WSEL	33.1	feet

Elevation-Volume-Flow Data

Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow[b][c], cfs	Spill Flow[b][c], cfs	Total Outflow[b], cfs
Bottom or Permanent Pool	27.7	0.0	240	720	172800	4.0	0.0	0.0	0.0	0.0
	28.7	1.0	248	728	180544	4.1	4.1	3.8	0.0	3.8
Water Quality Pool (Approx)	29.7	2.0	256	736	188416	4.3	8.3	5.4	0.0	5.4
	30.0	2.3	258	738	190803	4.4	9.6	5.8	0.0	5.8
	31.0	3.3	266	746	198841	4.6	14.1	7.0	10.4	17.3
	32.0	4.3	274	754	207007	4.8	18.7	8.0	29.3	37.3
	33.0	5.3	282	762	215302	4.9	23.6	8.9	53.8	62.7
	34.0	6.3	290	770	223724	5.1	28.6	9.7	82.9	92.5

Notes:

[a] All elevations are based on NGVD29.

[b] Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.

[c] An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

Table 9. Detention Basin Data for DETS5

Hydraulic Data		
Tributary Area	104.5	acres
Outlet Orifice Size	10	inches
Outlet Orifice Elevation	24.6	feet
Main Spillway Width (Notch)	2.7	feet
Main Spillway Elevation (Notch)	27.5	feet
Top of Riser Elevation	30.9	feet
Emergency Weir Elevation	31.0	feet
10-Year Peak WSEL	29.2	feet
100-Year Peak WSEL	30.5	feet

Elevation-Volume-Flow Data										
Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow[b][c], cfs	Spill Flow[b][c], cfs	Total Outflow[b], cfs
Bottom or Permanent Pool	24.6	0.0	215	516	110940	2.5	0.0	0.0	0.0	0.0
	25.0	0.4	218	519	113289	2.6	1.0	1.7	0.0	1.7
Water Quality Pool (Approx)	26.0	1.4	226	527	119253	2.7	3.7	3.2	0.0	3.2
	26.9	2.3	233	534	124729	2.9	6.2	4.0	0.0	4.0
	27.5	2.9	238	539	128437	2.9	8.0	4.5	0.0	4.5
	29.0	4.4	250	551	137910	3.2	12.6	5.6	13.9	19.5
	30.5	5.9	262	563	147671	3.4	17.5	6.5	39.3	45.8
	31.5	6.9	270	571	154338	3.5	21.0	7.0	60.5	67.5

Notes:

[a] All elevations are based on NGVD29.

[b] Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.

[c] An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

Table 10. Detention Basin Data for DETS6

Hydraulic Data		
Tributary Area	89.7	acres
Outlet Orifice Size	10	inches
Outlet Orifice Elevation	20.7	feet
Main Spillway Width (Notch)	10.3	feet
Main Spillway Elevation (Notch)	22.7	feet
Top of Riser Elevation	24.9	feet
Emergency Weir Elevation	25.1	feet
10-Year Peak WSEL	24.0	feet
100-Year Peak WSEL	24.6	feet

Elevation-Volume-Flow Data

Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow[b][c], cfs	Spill Flow[b][c], cfs	Total Outflow[b], cfs
Bottom or Permanent Pool	20.7	0.0	247	296	73211	1.7	0.0	0.0	0.0	0.0
	21.0	0.3	249	299	74521	1.7	0.5	1.5	0.0	1.5
	22.0	1.3	257	307	78970	1.8	2.3	3.0	0.0	3.0
Water Quality Pool (Approx)	22.3	1.6	260	309	80330	1.8	2.8	3.4	0.0	3.4
	22.7	2.0	263	312	82161	1.9	3.6	3.8	0.0	3.8
	24.0	3.3	273	323	88254	2.0	6.1	4.9	42.7	47.6
	24.5	3.8	277	327	90654	2.1	7.1	5.2	69.6	74.9
	25.5	4.8	285	335	95552	2.2	9.3	5.8	135.1	141.0

Notes:

[a] All elevations are based on NGVD29.

[b] Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.

[c] An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

Table 11. Detention Basin Data for DETS7

Hydraulic Data		
Tributary Area	87.4	acres
Outlet Orifice Size	10	inches
Outlet Orifice Elevation	19.4	feet
Main Spillway Width (Notch)	8.6	feet
Main Spillway Elevation (Notch)	21.0	feet
Top of Riser Elevation	23.5	feet
Emergency Weir Elevation	23.7	feet
10-Year Peak WSEL	22.5	feet
100-Year Peak WSEL	23.2	feet

Elevation-Volume-Flow Data										
Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow(b)(c), cfs	Spill Flow(b)(c), cfs	Total Outflow(b), cfs
Bottom or Permanent Pool	19.4	0.0	193	367	70773	1.6	0.0	0.0	0.0	0.0
	20.0	0.6	198	372	73483	1.7	1.0	2.1	0.0	2.1
Water Quality Pool (Approx)	20.8	1.4	204	378	77167	1.8	2.4	3.2	0.0	3.2
	21.0	1.6	206	380	78101	1.8	2.7	3.4	0.0	3.4
	21.5	2.1	210	384	80458	1.8	3.6	3.9	8.5	12.4
	22.5	3.1	218	392	85269	2.0	5.5	4.7	44.2	48.9
	23.0	3.6	222	396	87722	2.0	6.5	5.1	68.1	73.2
	24.2	4.8	231	405	93740	2.2	9.0	5.8	137.8	143.7

Notes:

(a) All elevations are based on NGVD29.

(b) Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.

(c) An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

Table 12. Detention Basin Data for DETS8

Hydraulic Data		
Tributary Area	87.4	acres
Outlet Orifice Size	10	inches
Outlet Orifice Elevation	19.4	feet
Main Spillway Width (Notch)	8.6	feet
Main Spillway Elevation (Notch)	21.0	feet
Top of Riser Elevation	24.4	feet
Emergency Weir Elevation	24.6	feet
10-Year Peak WSEL	23.4	feet
100-Year Peak WSEL	24.1	feet

Elevation-Volume-Flow Data

Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow[b][c], cfs	Spill Flow[b][c], cfs	Total Outflow[b], cfs
Bottom or Permanent Pool	19.7	0.0	180	450	81000	1.9	0.0	0.0	0.0	0.0
	21.0	1.3	190	460	87660	2.0	2.5	3.0	0.0	3.0
Water Quality Pool (Approx)	21.75	2.1	196	466	91601	2.1	4.1	3.8	0.0	3.8
	21.8	2.1	197	467	91866	2.1	4.2	3.9	0.0	3.9
	23.0	3.3	206	476	98329	2.3	6.8	4.9	24.7	29.5
	24.0	4.3	214	484	103855	2.4	9.1	5.5	61.2	66.8
	25.0	5.3	222	492	109510	2.5	11.5	6.1	107.4	113.5

Notes:

[a] All elevations are based on NGVD29.

[b] Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.

[c] An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

Table 13. Preliminary Estimate of Low Flow Channel Geometry

Reach	Est. Channel Forming Flow, cfs	Approx. Return Period, years	Depth, ft	Average Width w, ft	Trapezoidal Bottom Width, ft	Trapezoidal Top Width, ft	Wave Length L, ft	Belt Width B, ft	Radius of Curvature rc, ft
1.Lotz Parkway to Road near DETS1b Outfall	85	1.7	1.9	23	18	29	222	126	44
2. Roadway near DETS1b Outfall to Big Horn Blvd.	125	2.0	2.3	27	20	34	261	149	52
3. Big Horn Blvd. to LRSP Channel	115	0.9	2.2	26	20	33	252	143	50
4. LRSP Channel to Bruceville Road	265	2.2	3.0	36	27	45	358	204	72

Note: LRSP = Laguna Ridge Specific Plan

Table 14. Proposed Channel Dimensions								
Reach	HEC-RAS Cross Section Limits	Approximate Longitudinal Slope	Reach Length, ft	Low Flow Depth, ft	Low Flow Bottom Width, ft	Low Flow Top Width, ft	Flood Control Bottom Width, ft	Approx. Flood Control Top Width, ft
1.Lotz Parkway to Road near DETS1b Outfall	15074 to 13395	0.00102	1,679	1.9	18	29	115	153
2. Road near DETS1b Outfall to Big Horn Blvd.	13341 to 9275	0.00102	4,066	2.2	20	33	126	168
3a. Big Horn Blvd. to Upstream of DETS6	9196 to 6625	0.0010	2,571	2.2	20	33	143	175
3b. Upstream of DETS6 to LRSP Channel	6625 to 5419	0.00102	1,206	2.2	20	33	207	235
4. LRSP Channel to Bruceville Road	5419 to 3696	0.00060	1,723	2.5	27	45	207	237
LRSP Channel	0 to 3510	0.00045	2,446	1.0	8	14	25	55
Note: LRSP = Laguna Ridge Specific Plan								

Table 15. Comparison of Flood Flows in cfs				
Location	10-Year		100-Year	
	Pre-Development	Buildout	Pre-Development	Buildout
Bruceville Road	504	409	802	772

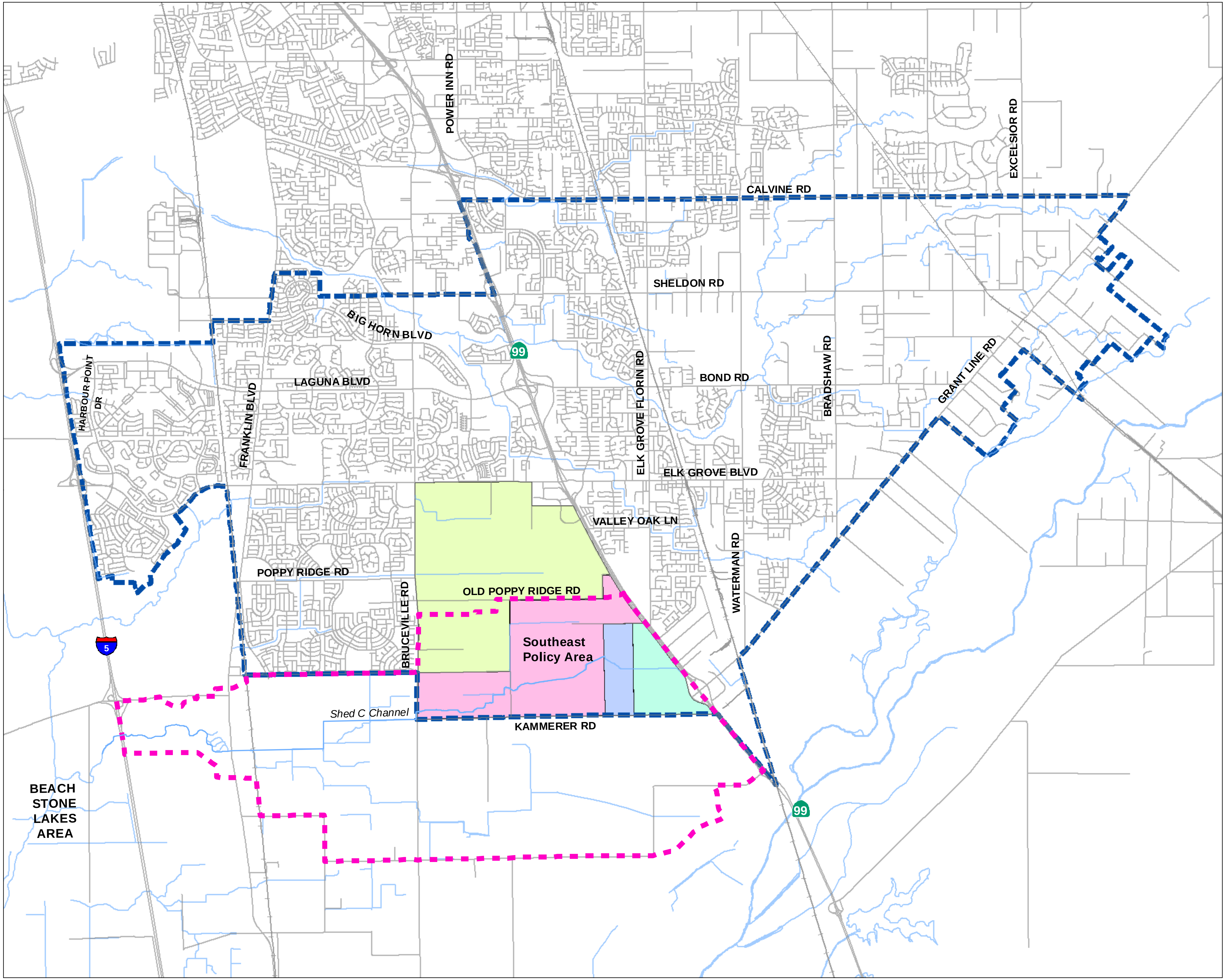

FIGURE 1

City of Elk Grove Southeast Policy Area Drainage Study

LOCATION MAP

0 0.5 1 2

Scale in Miles

NOTES:

LEGEND:

- City Limit
- Shed C Watershed
- Laguna Ridge Specific Plan Area
- Southeast Policy Area
- Sterling Meadows
- Elk Grove Promenade

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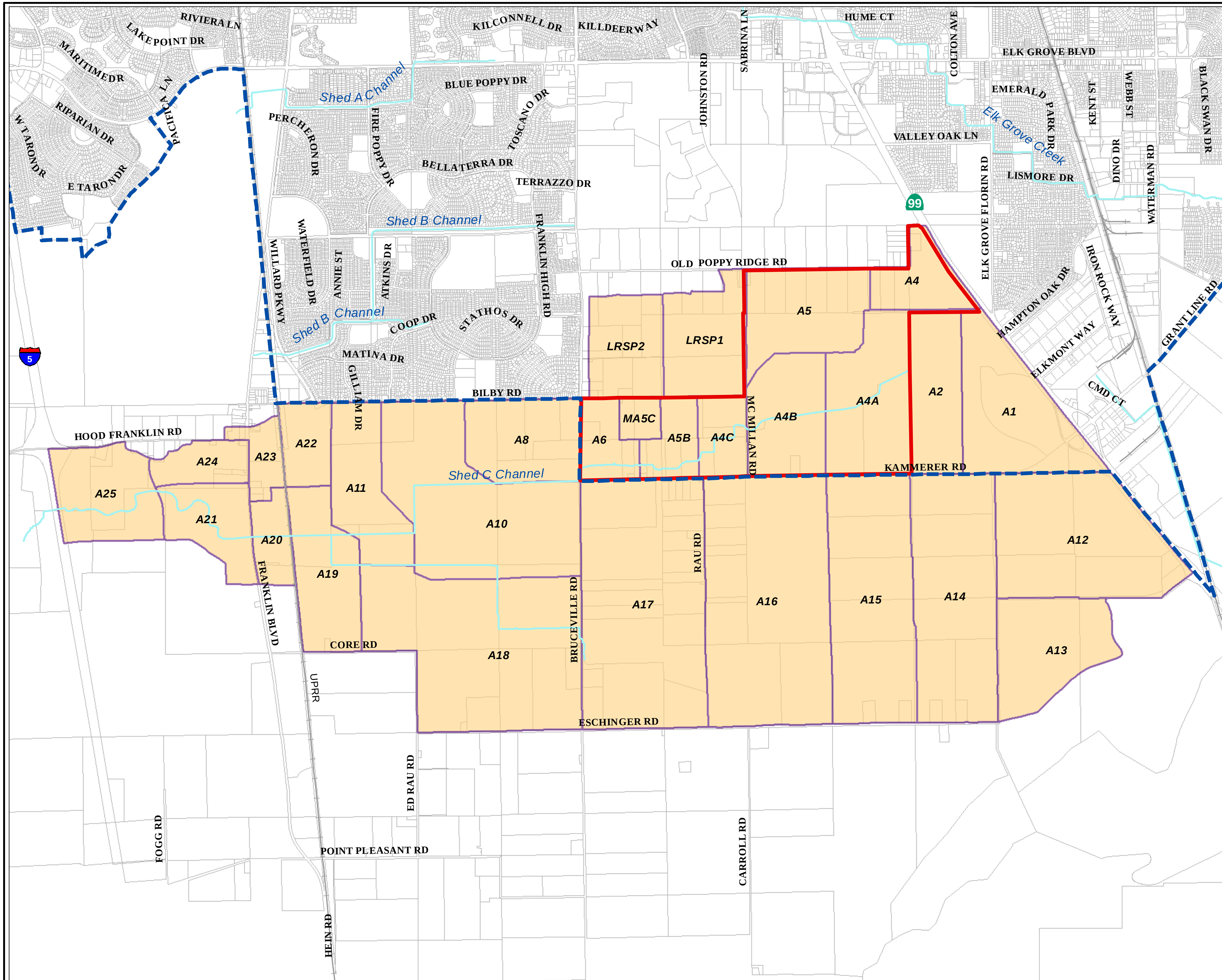

FIGURE 2

City of Elk Grove
Southeast Policy Area
Drainage Study

SUBSHED MAP FOR PRE-DEVELOPMENT AND BASE CONDITIONS

LEGEND:

- City Limit
- Southeast Policy Area
- Shed C Subsheds
- Existing Channel

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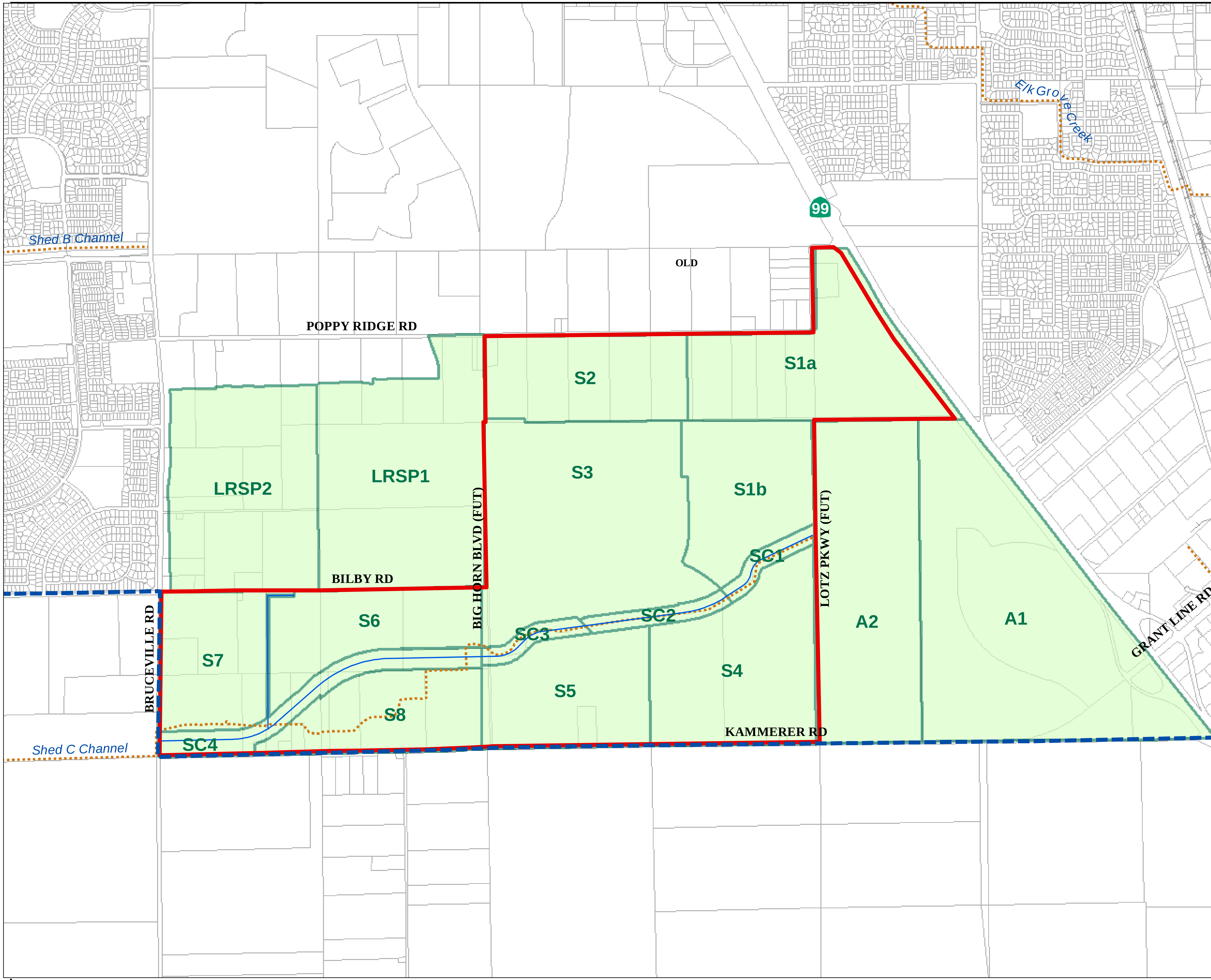

FIGURE 3

City of Elk Grove Southeast Policy Area Drainage Study

CITY SUBSHEDS FOR BUILDOUT CONDITIONS

0 750 1,500

Scale in Feet

LEGEND:

- City Limit
- Southeast Policy Area
- Shed C Subsheds Within City Limits
- Existing Channel
- Proposed Channel

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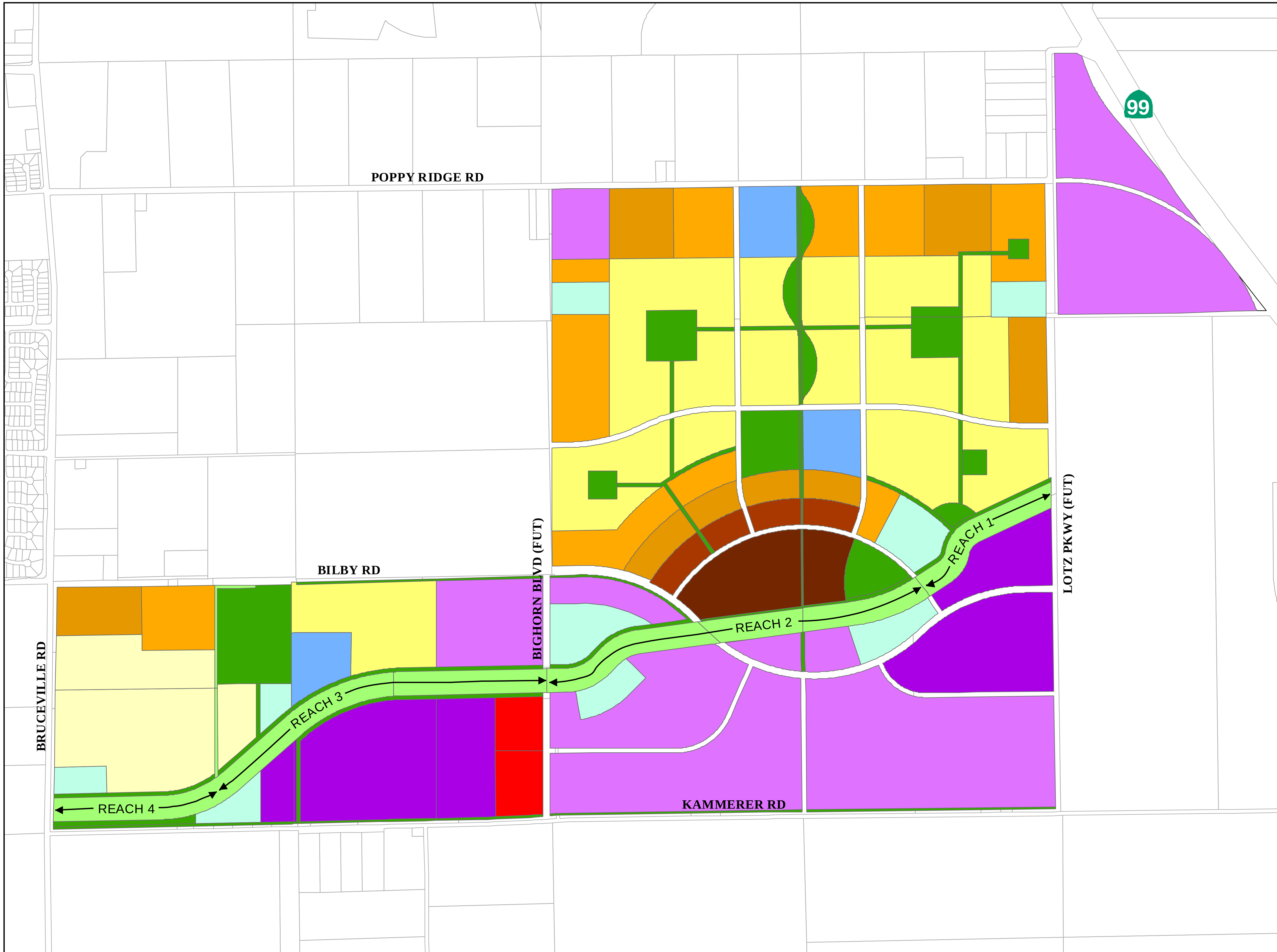
FIGURE 4

City of Elk Grove
Southeast Policy Area
Drainage Study

PROPOSED LAND USE AND CHANNEL REACHES



N

0 500 1,000
Scale in Feet

LEGEND

- Detention Basin
- Commercial
- Drainage Channel
- Estate Residential
- School
- Greenway
- High Density Residential
- Low Density Residential
- Light Industrial/Flex
- Medium Density Residential
- Mixed Use Residential
- Mixed Use Villace Center
- Office
- Open Space
- Road

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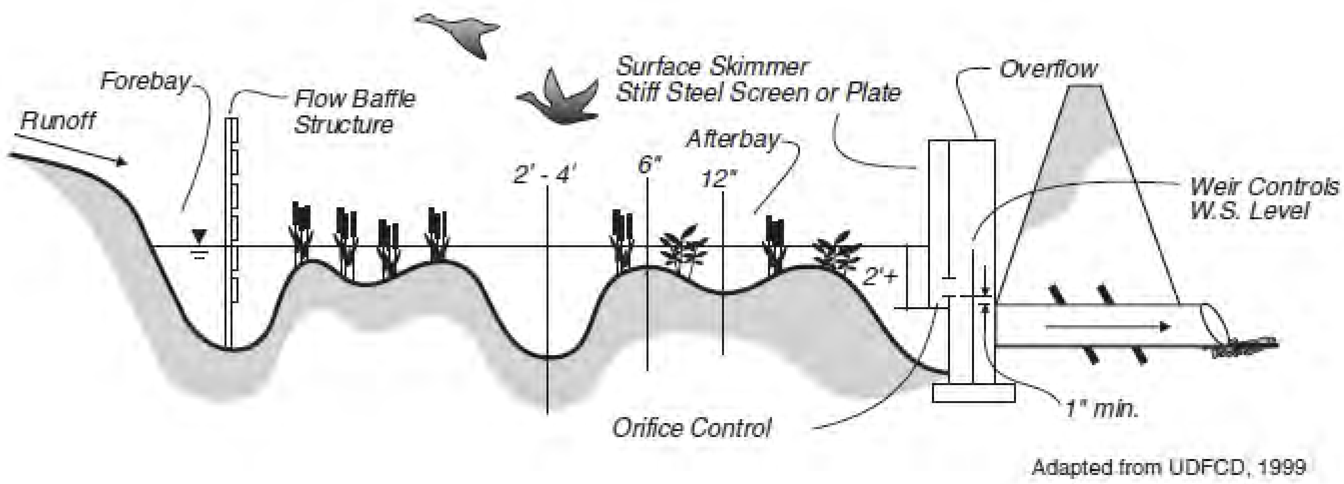

Figure CWB-1. Constructed Wetland Basin

Figure 5. Typical Detention Basin Layout

Note: Adapted from Figure CWB-1 from Stormwater Quality Design Manual for the Sacramento and south Placer Region.

(ASCE Manual No. 77, pg 329)

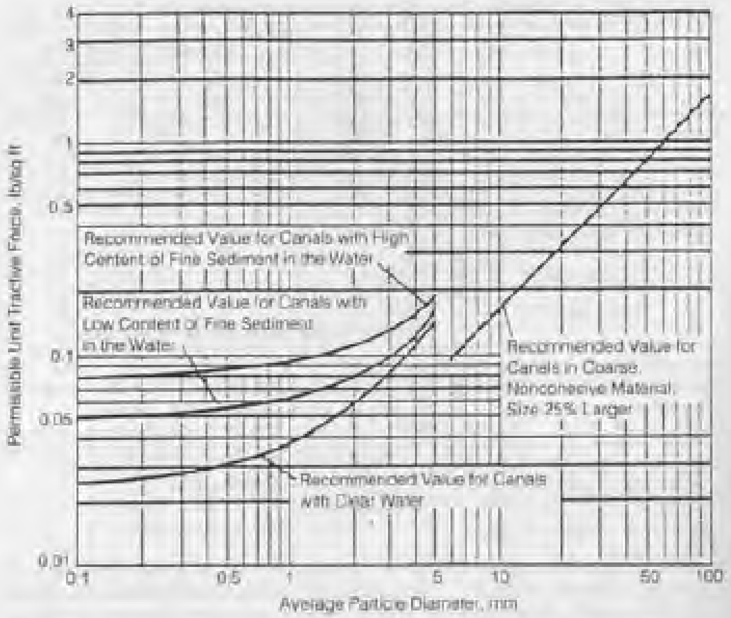

Figure 9.5—Recommended permissible unit tractive forces for canals in noncohesive material (lb/sq ft × 47.88 = Pa) (Chow, 1959).

bridge piers is caused by the vortex resulting from water piling up on the upstream edge and subsequent acceleration of flow around the nose of the pier.

Local scour is a function of a combination of several of the following factors:

(a) Slope of the channel

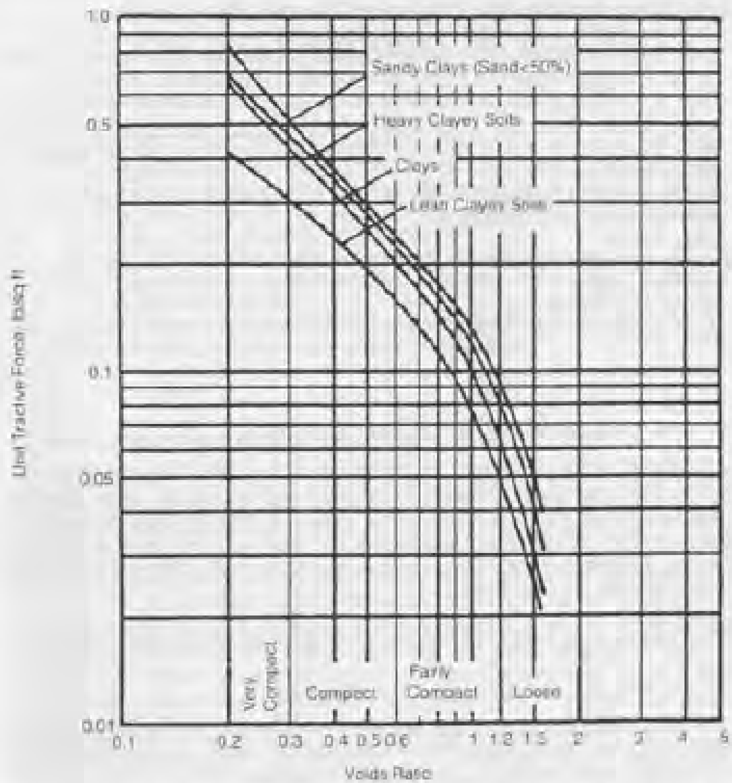

Figure 9.6—Permissible unit tractive forces for canals in cohesive material as converted from data on permissible velocities (lb/sq ft × 47.88 = Pa) (USBR and Hydrotech. Const., 1936).

Figure 6. Determination of Critical Channel Shear Stress

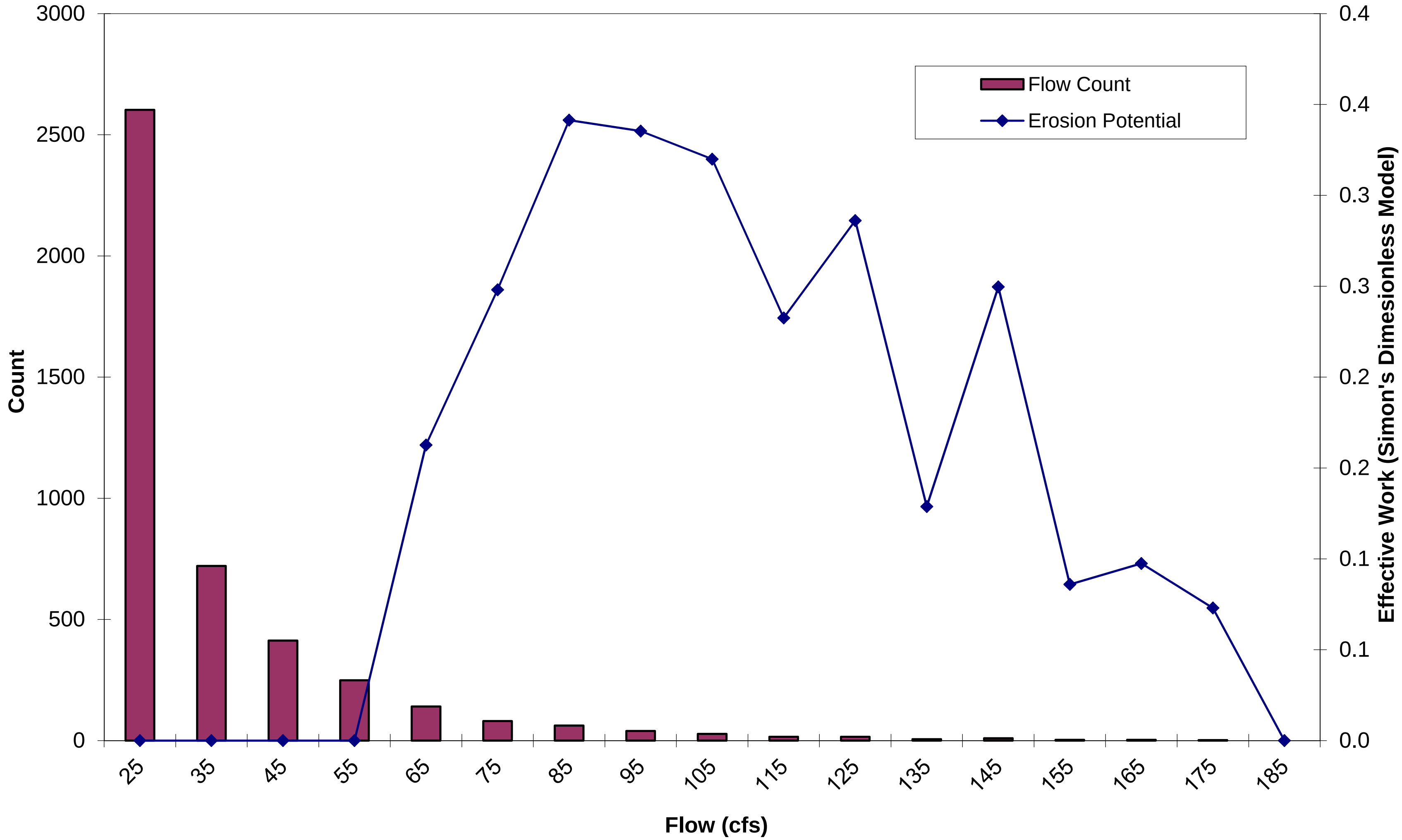

Figure 7

City of Elk Grove

Southeast Policy Area Drainage Study

SHED C CHANNEL REACH 1 – CHANNEL FORMING FLOW CALCULATIONS

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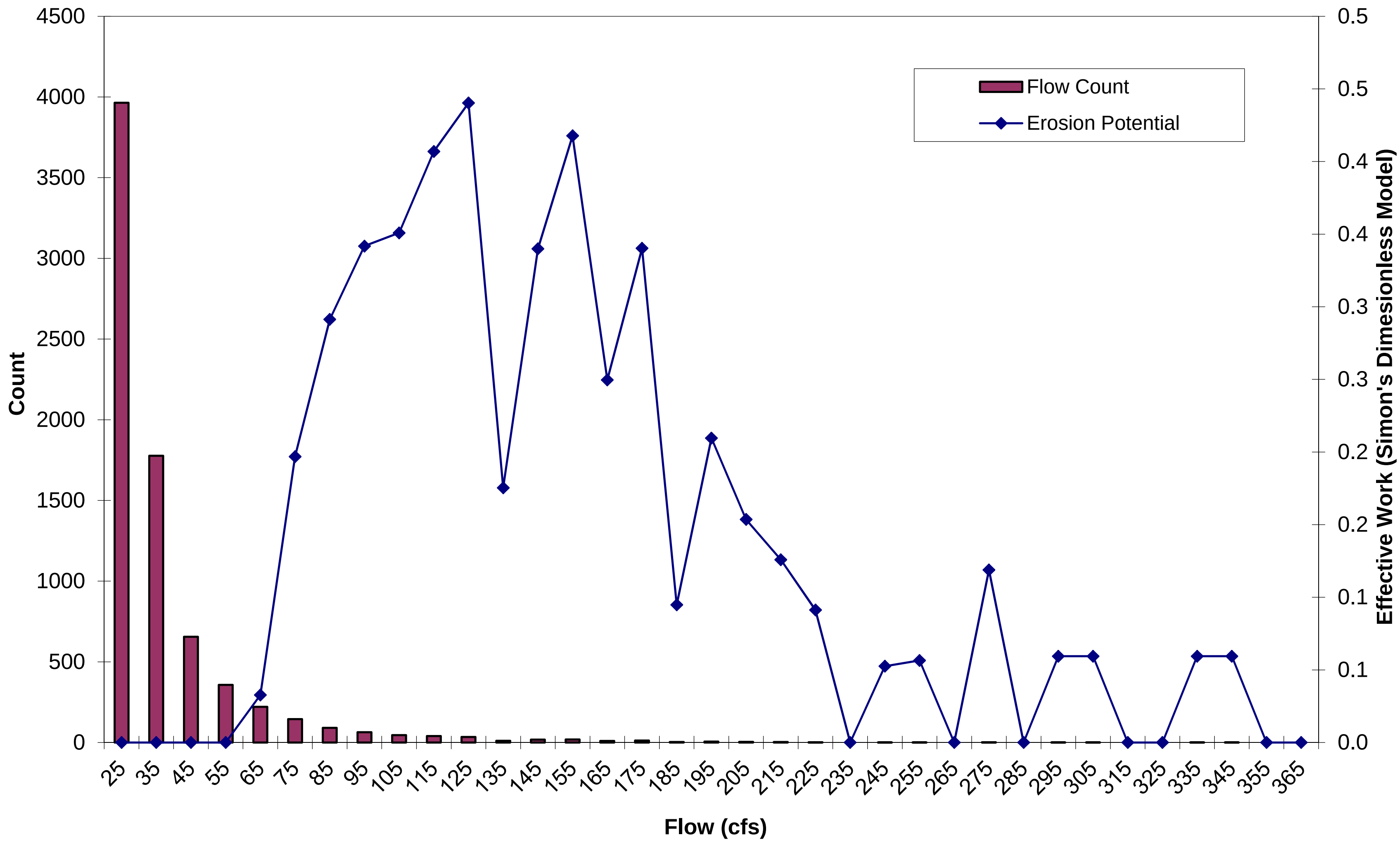

Figure 8

City of Elk Grove

Southeast Policy Area Drainage Study

SHED C CHANNEL REACH 2 – CHANNEL FORMING FLOW CALCULATIONS

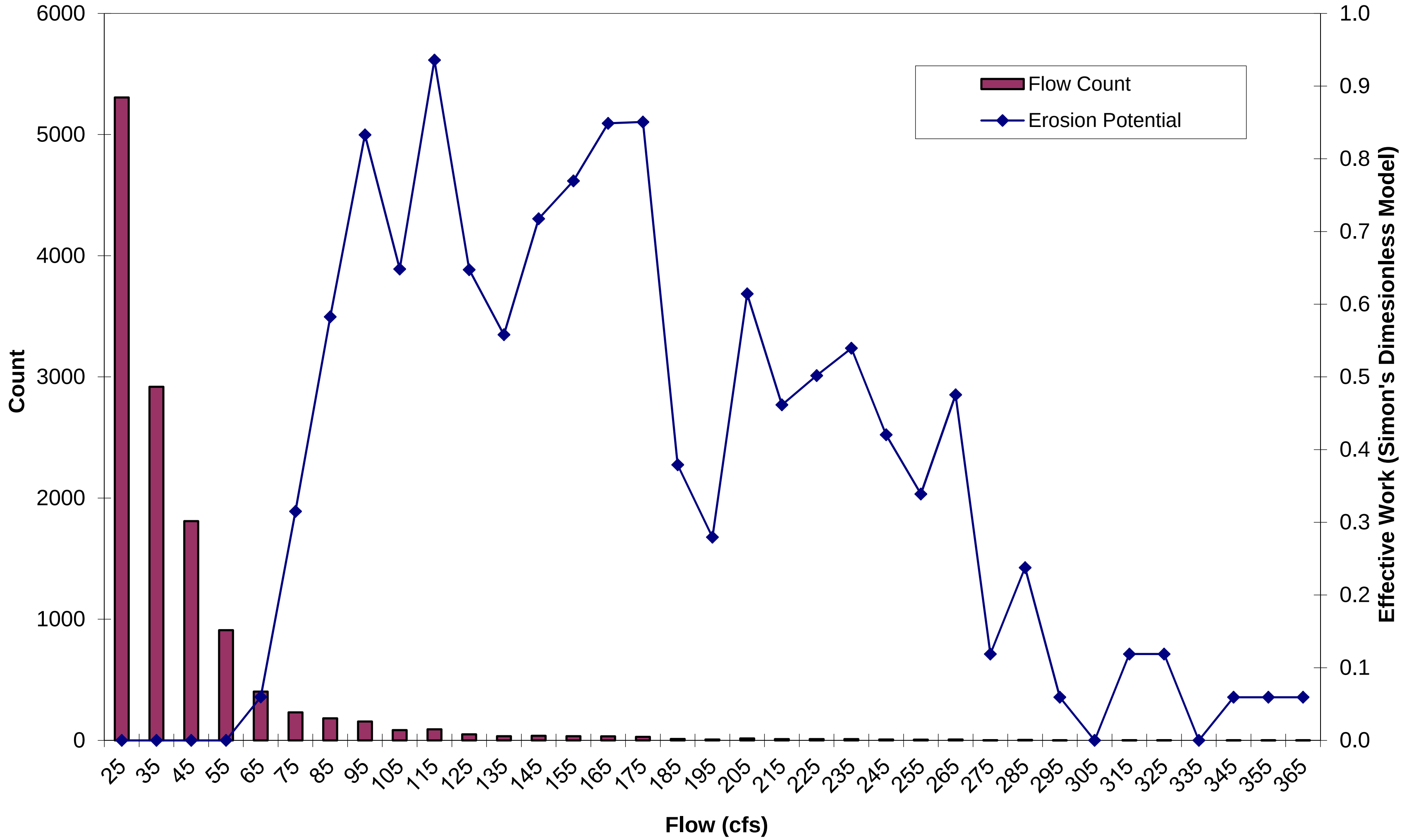

Figure 9

City of Elk Grove

Southeast Policy Area Drainage Study

SHED C CHANNEL REACH 3 – CHANNEL FORMING FLOW CALCULATIONS

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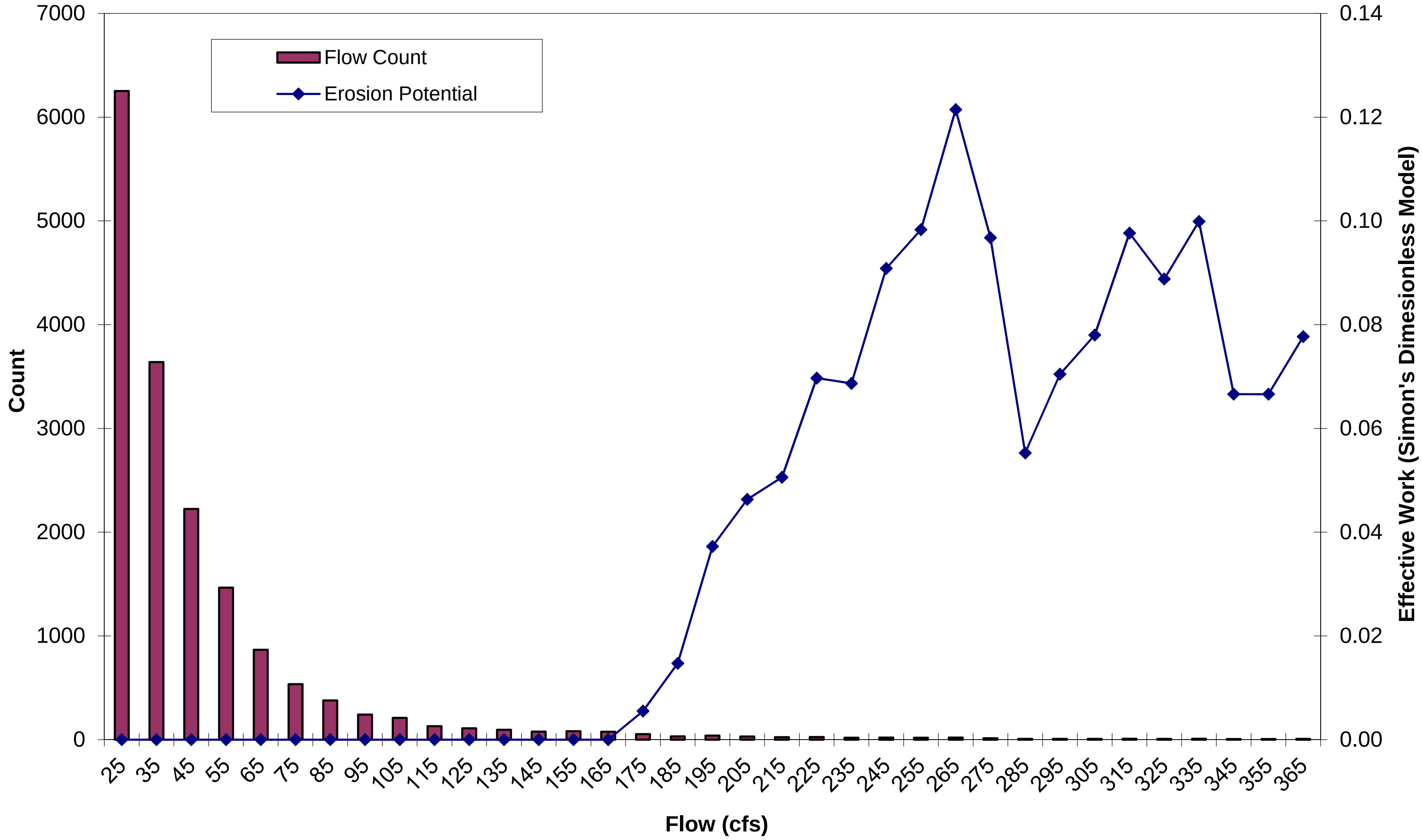

Figure 10

City of Elk Grove

Southeast Policy Area Drainage Study

SHED C CHANNEL REACH 4 – CHANNEL FORMING FLOW CALCULATIONS

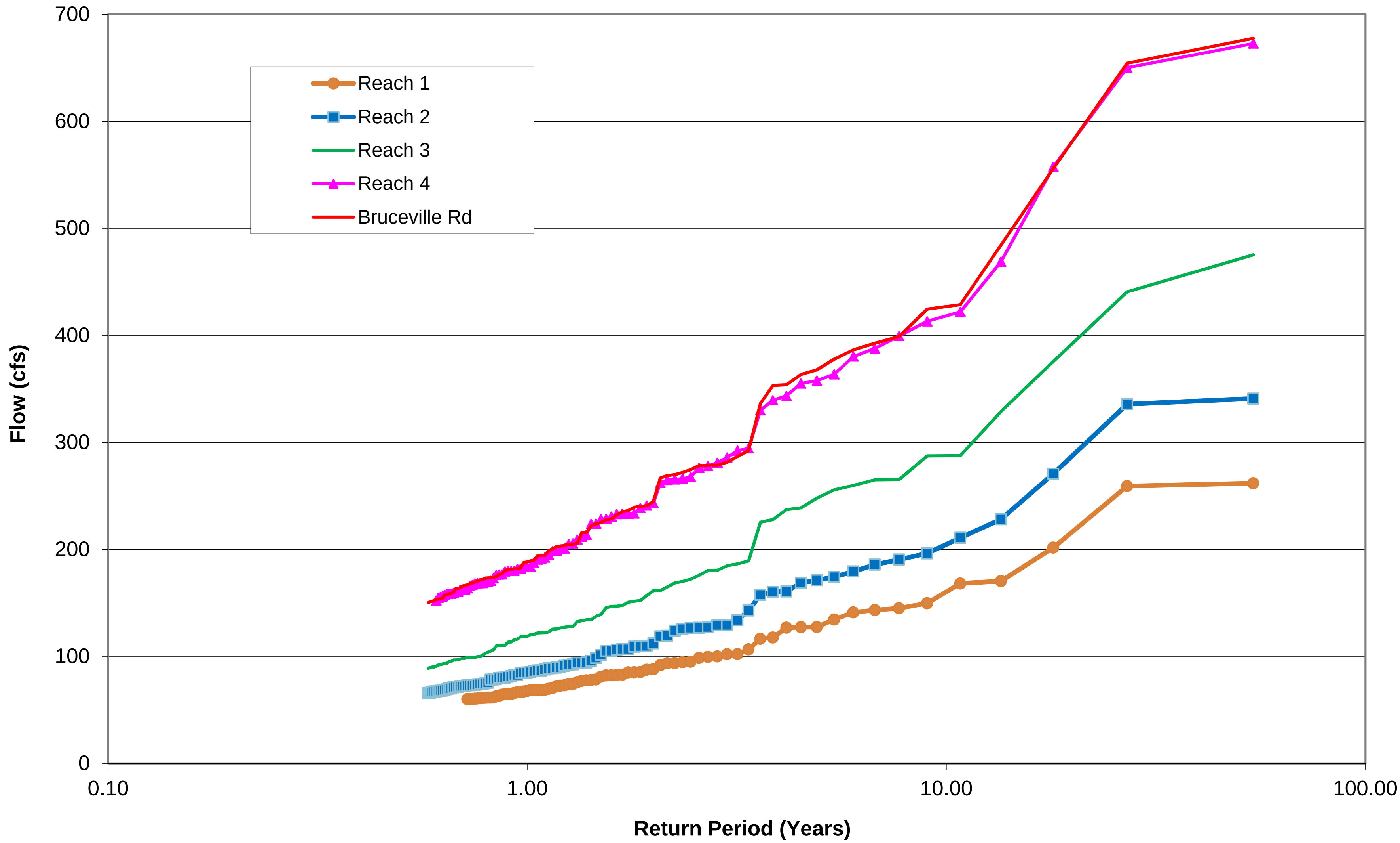

Figure 11

City of Elk Grove

Southeast Policy Area Drainage Study

FLOW FREQUENCY FOR SHED C CHANNEL FOR MITIGATED BUILDOUT CONDITIONS

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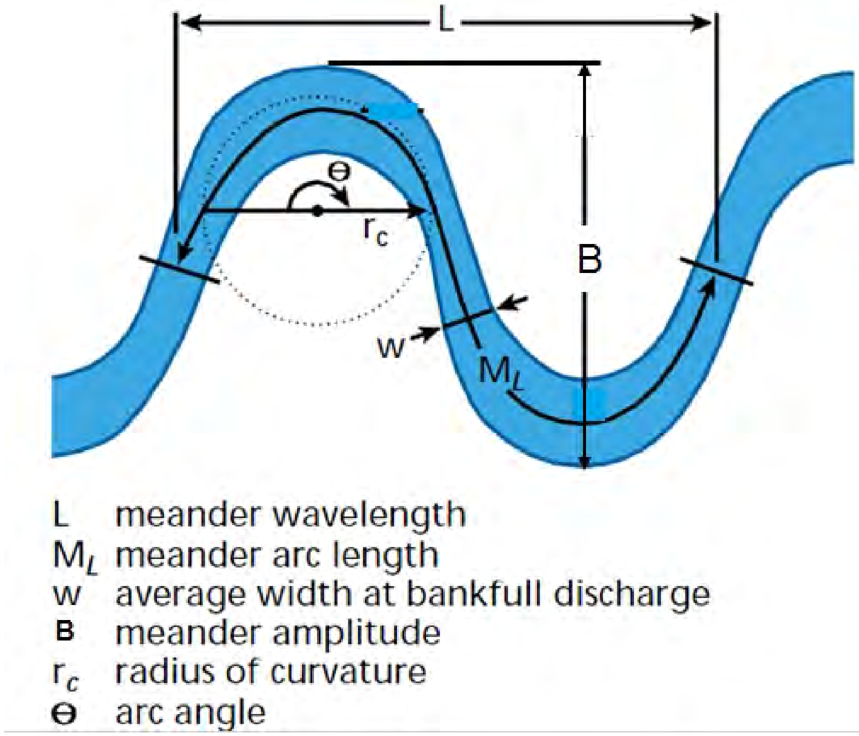

Figure 12. Typical Low Flow Channel Meander Dimensions

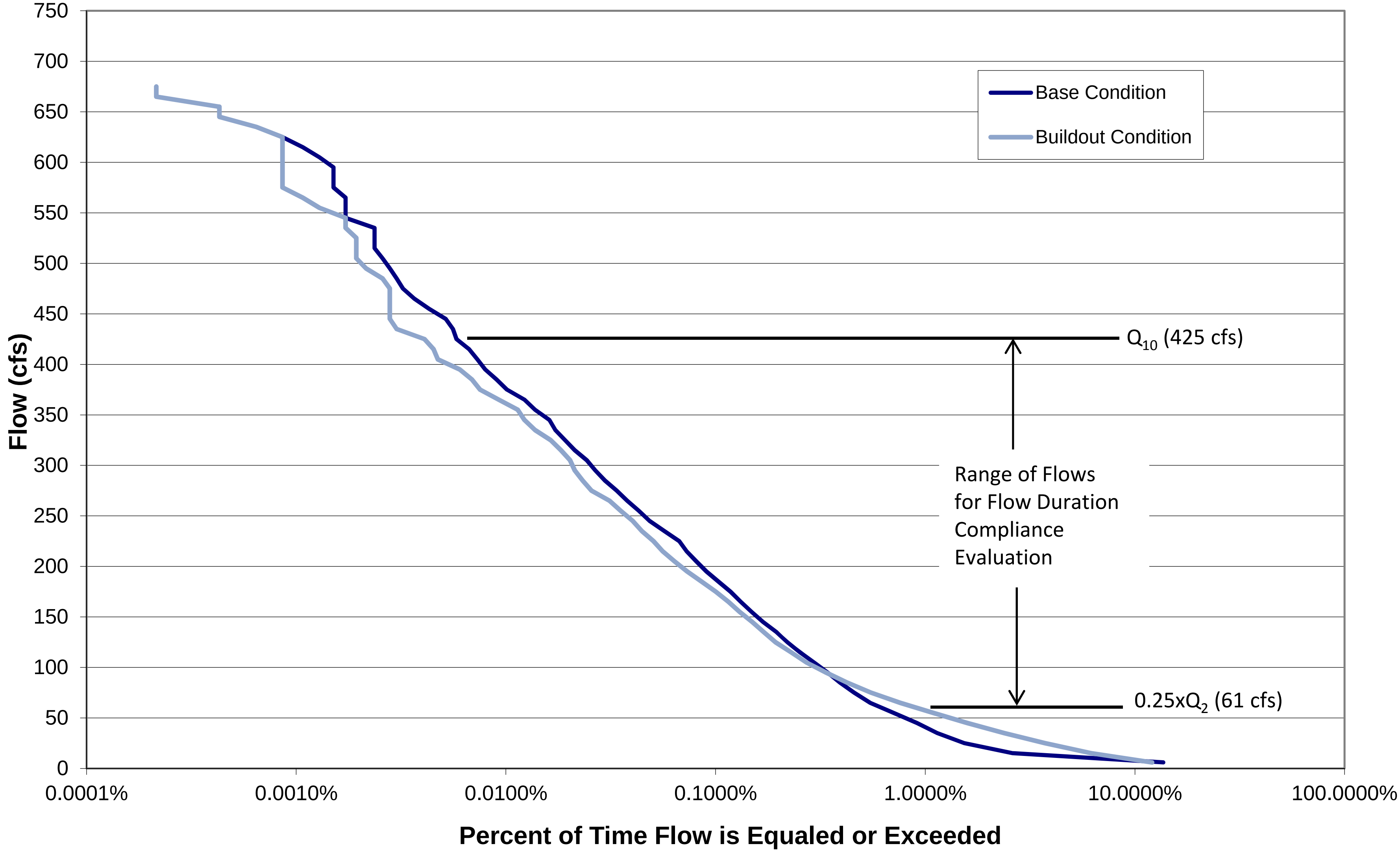

Figure 13

City of Elk Grove

Southeast Policy Area Drainage Study

FLOW DURATION COMPARISON AT BRUCEVILLE ROAD

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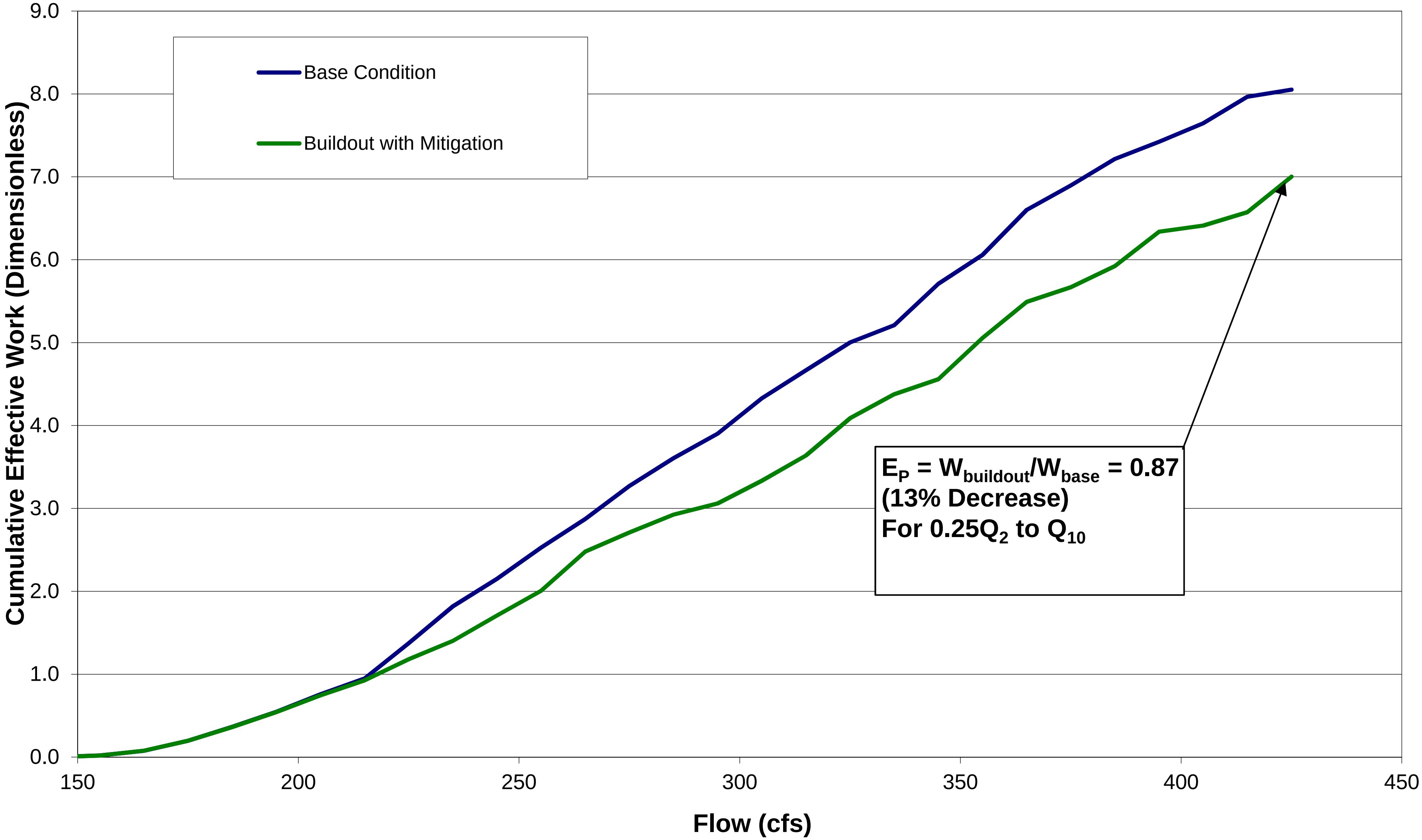

Figure 14

City of Elk Grove

Southeast Policy Area Drainage Study

CUMULATIVE EFFECTIVE WORK AT BRUCEVILLE ROAD

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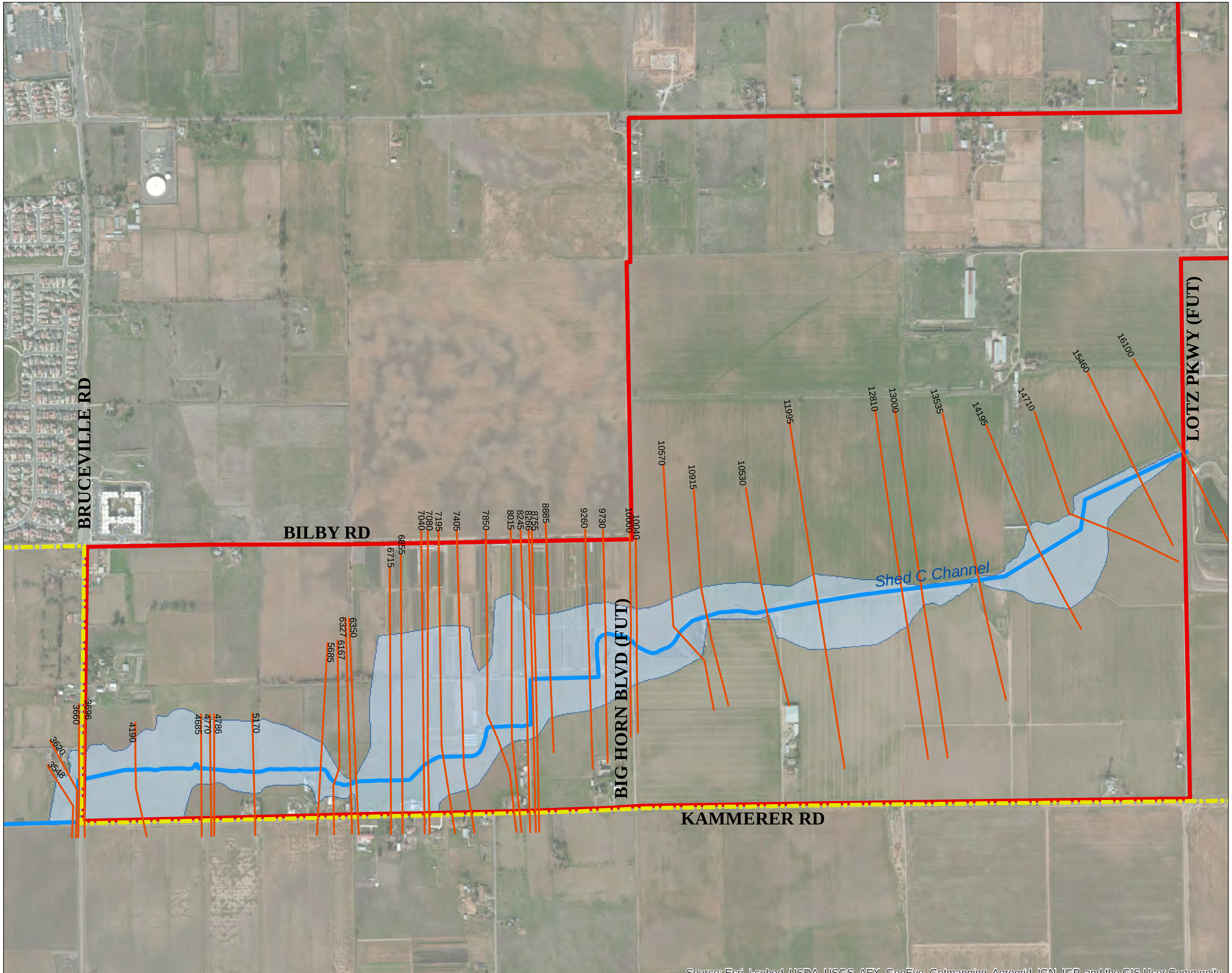
FIGURE 15

City of Elk Grove
Southeast Policy Area
Storm Drainage Study

PRE-DEVELOPMENT
APPROXIMATE 100-YEAR FLOODPLAIN



N

0 450 900

Scale in Feet

NOTES:

Legend

- HEC-RAS Cross Section
- City Limit
- Southeast Policy Area
- Existing Channel
- Approximate 100-Year Floodplain

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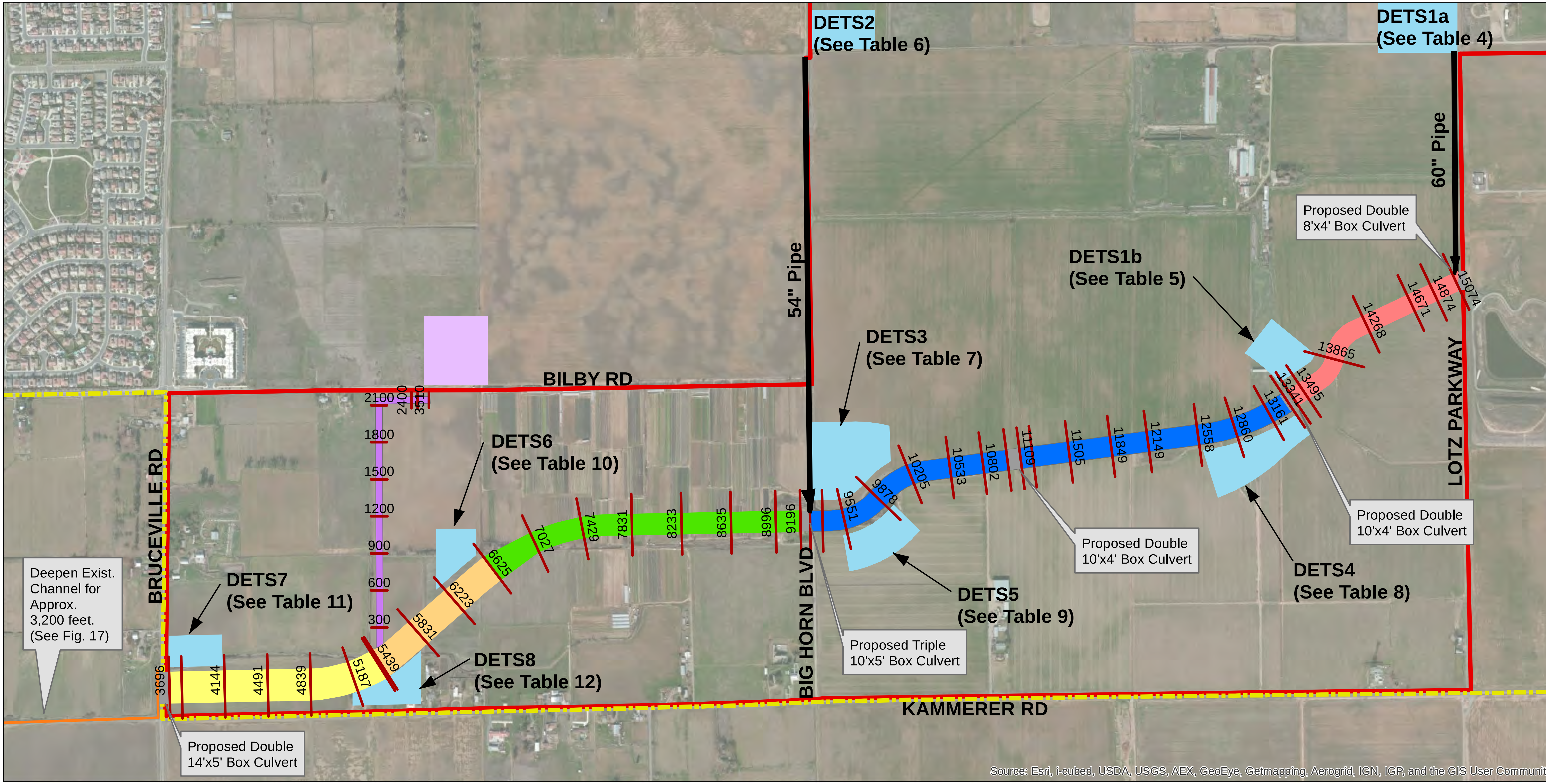


Legend

- City Limits
- Proposed Detention Basin
- HEC-RAS Cross Section Location and Station
- Proposed Channel Reach 1
- Proposed Channel Reach 2
- Proposed Channel Reach 3
- Proposed Channel Reach 3b
- Proposed Channel Reach 4
- Channel Proposed with Laguna Ridge Specific Plan
- Detention Proposed with Laguna Ridge Specific Plan
- Offsite Channel Improvements
- Southeast Policy Area

Notes

1. Detention basin locations and sizes are approximate. See Tables 4 through 12 for required storage volumes.
2. See Table 14 for channel dimensions.

N

0 400 800

Scale in Feet

FIGURE 16

City of Elk Grove
Southeast Policy Area
Drainage Study

PROPOSED FACILITIES AND CHANNEL REACHES

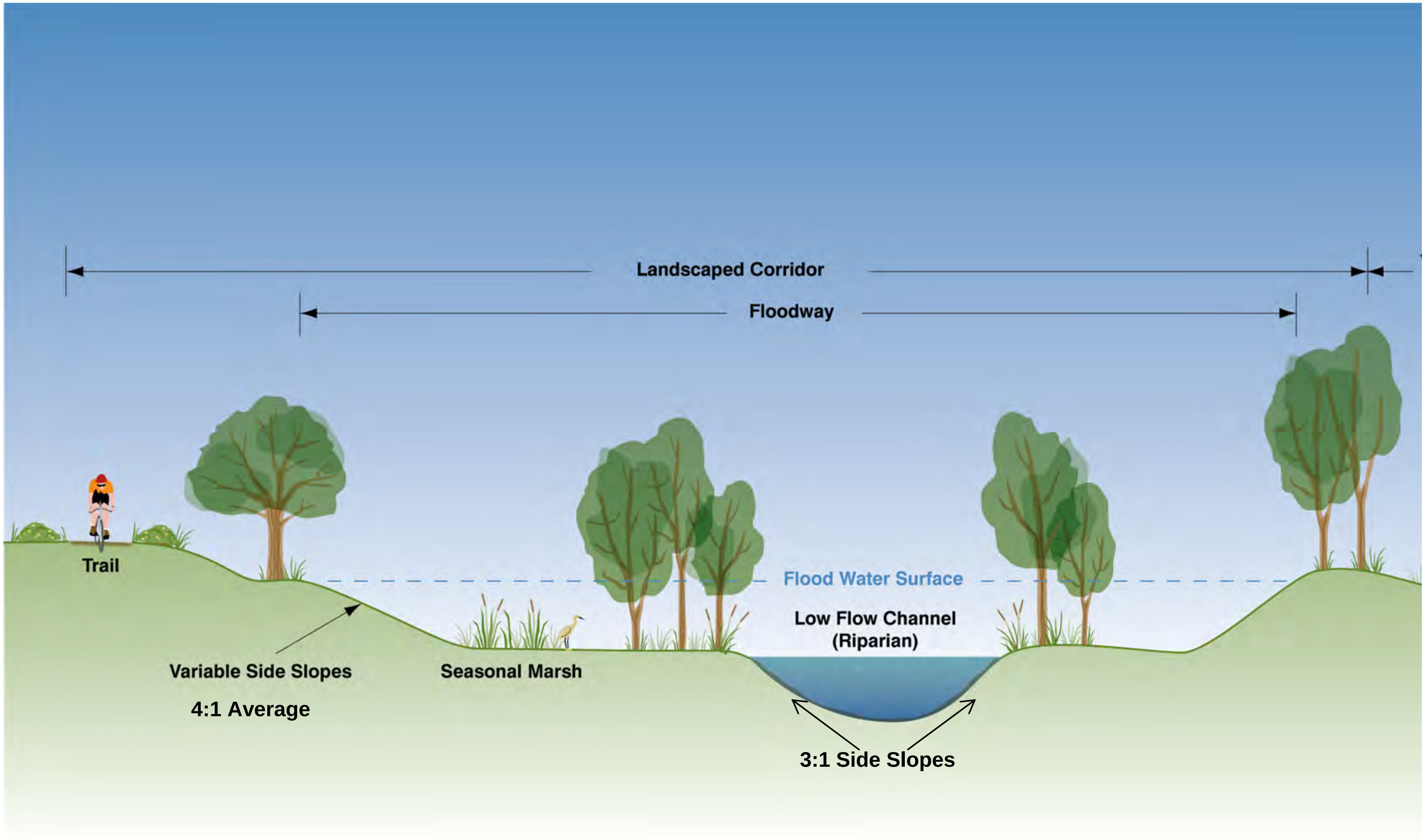
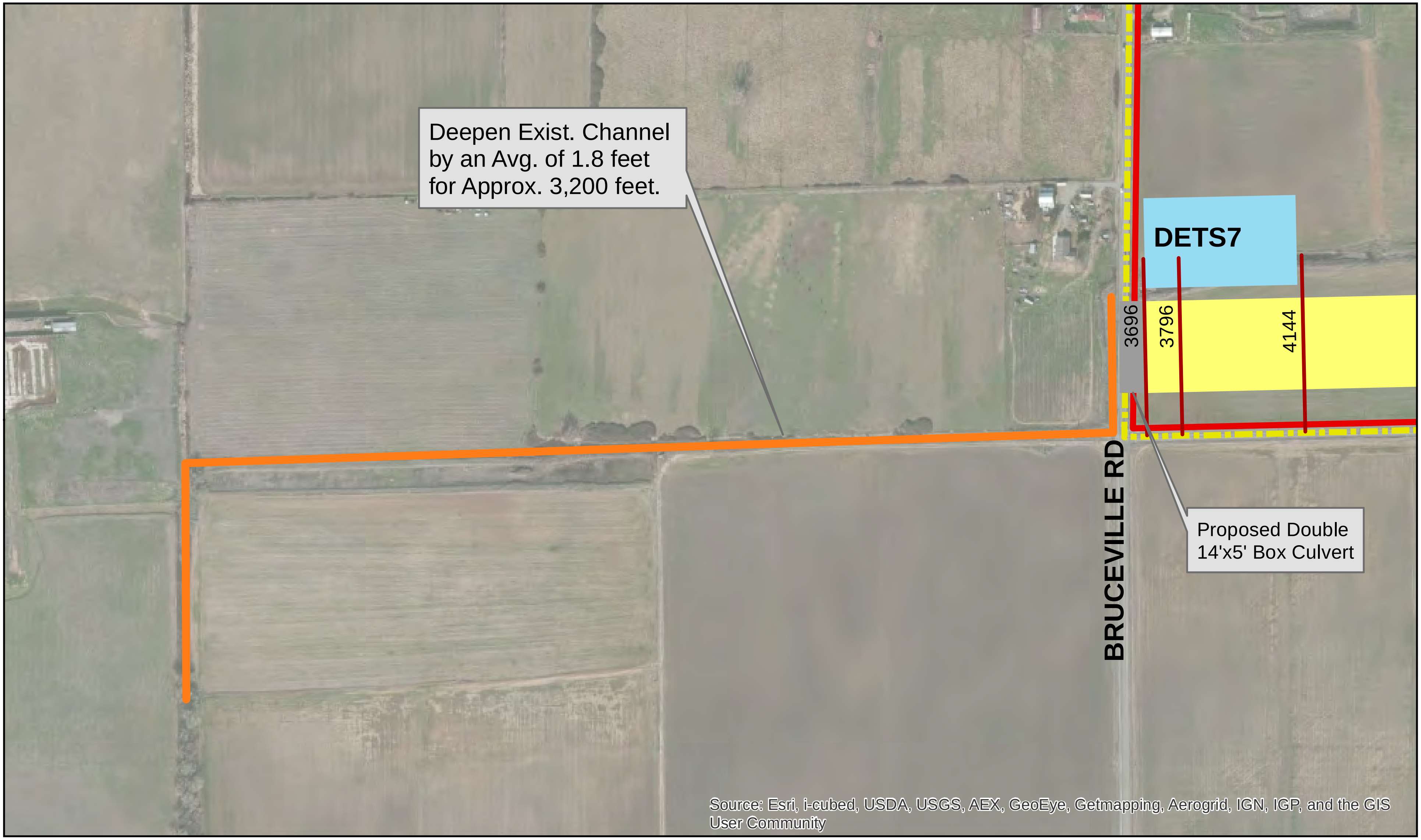


Figure 17. Shed C Channel – Proposed Cross Section



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LEGEND

- City Limits
- Proposed Detention Basin
- HEC-RAS Cross Section Location and Station
- Proposed Channel Reach 4
- Offsite Channel Improvements
- Southeast Policy Area

N

0 200 400

Scale in Feet

FIGURE 18

City of Elk Grove
Southeast Policy Area
Drainage Study

PROPOSED OFFSITE CHANNEL IMPROVEMENTS

WEST YOST ASSOCIATES
Consulting Engineers

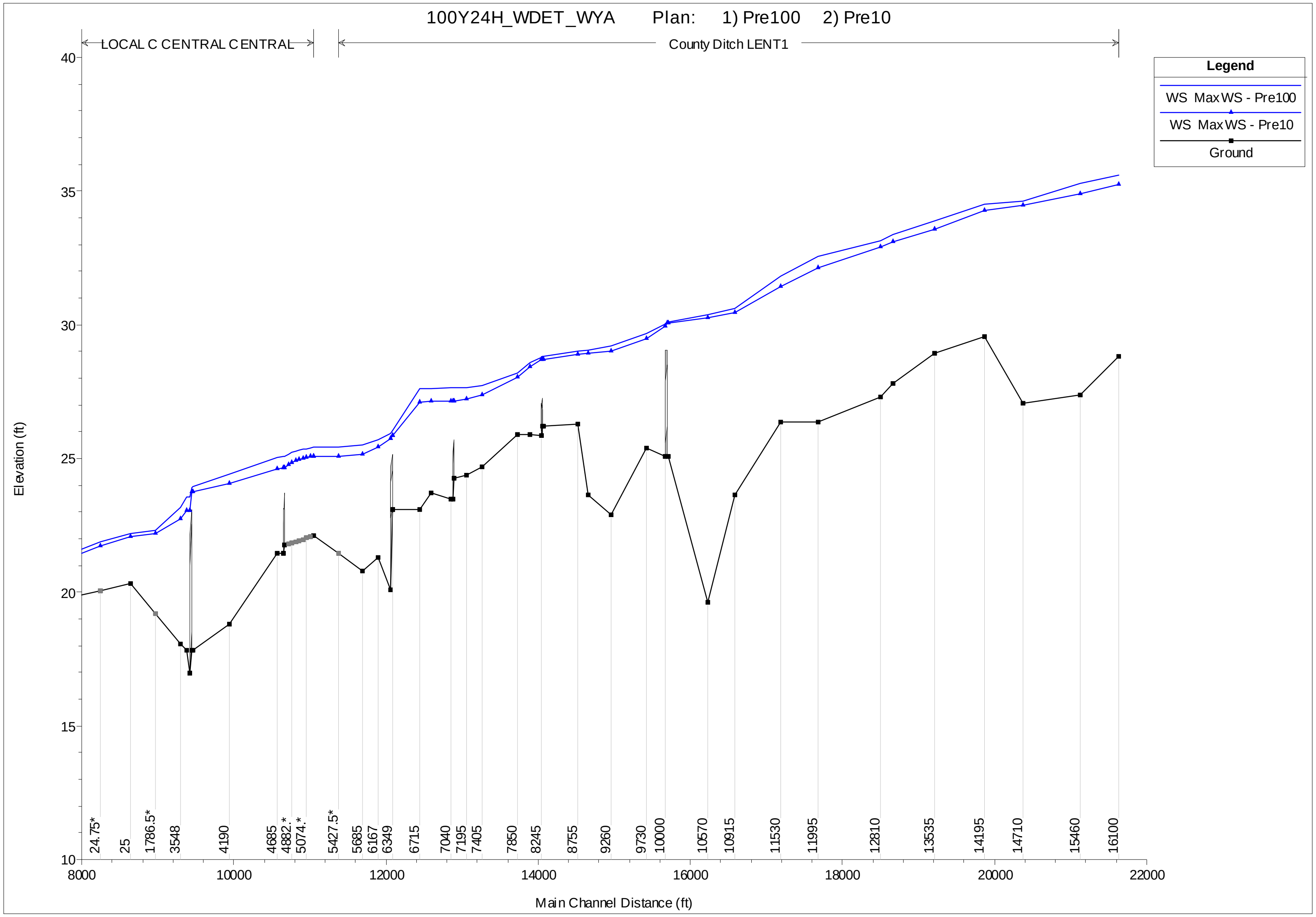


Figure 19. Pre-Development Water Surface Profiles – Shed C Channel

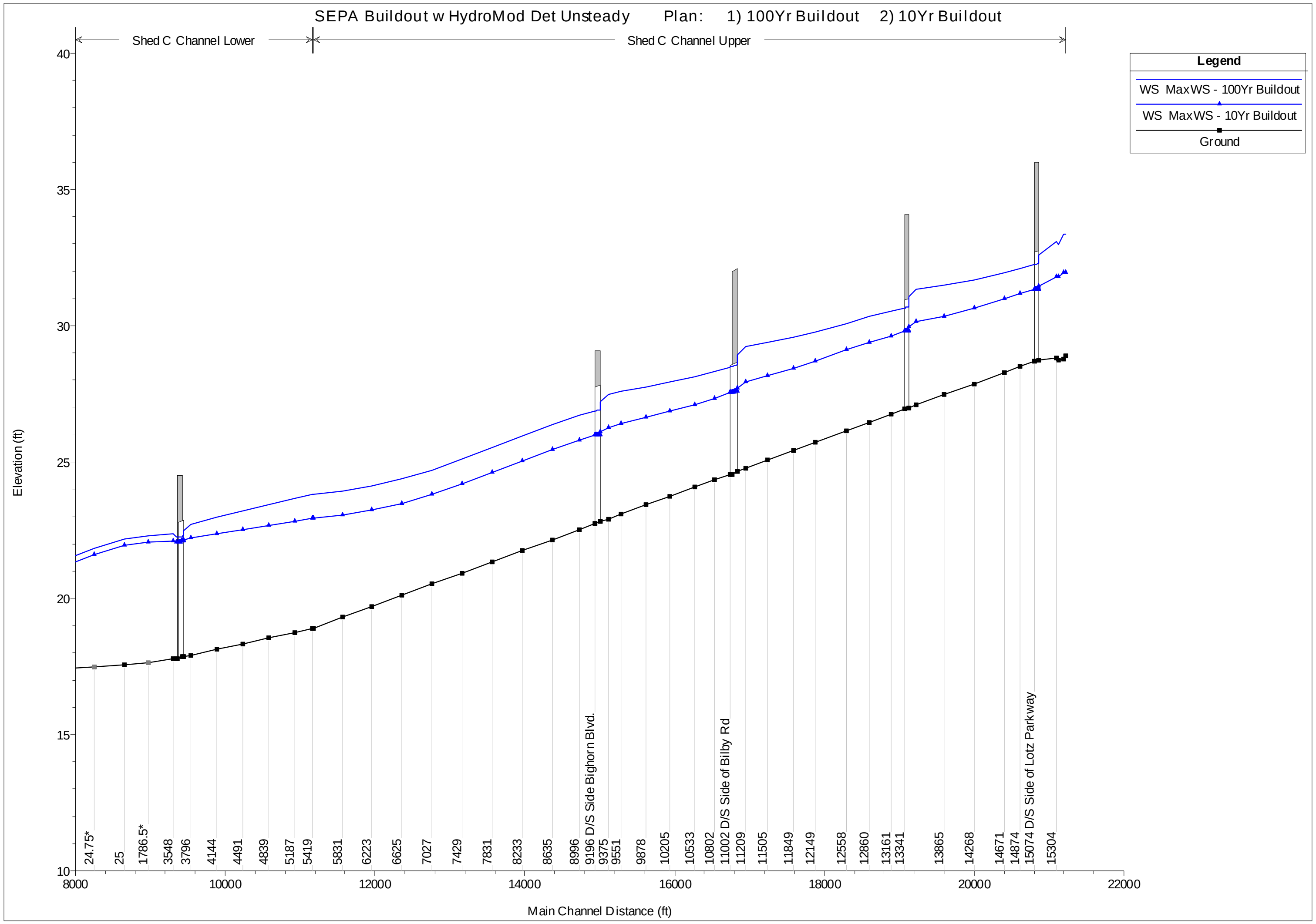


Figure 20. Buildout Water Surface Profiles – Shed C Channel

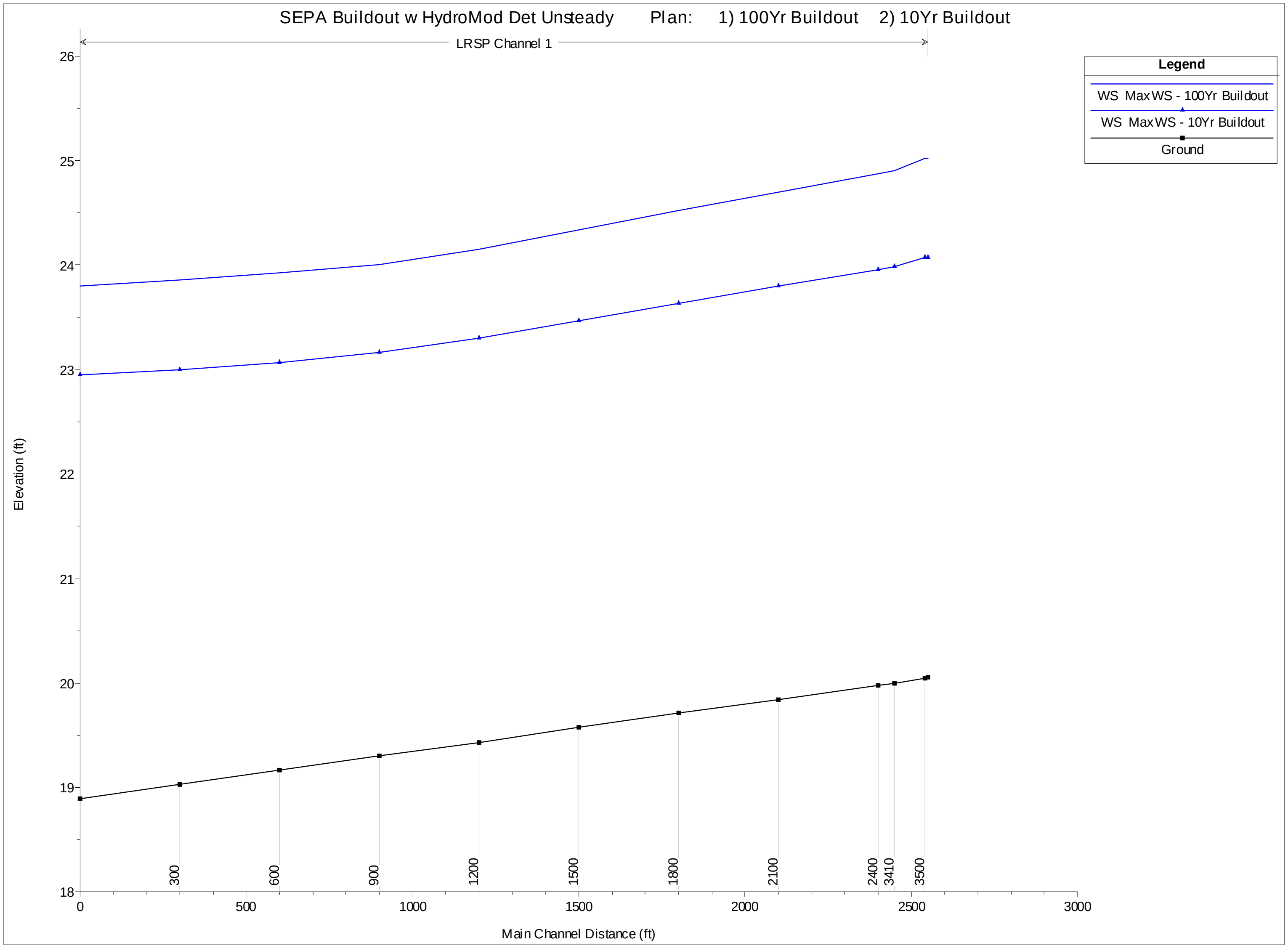
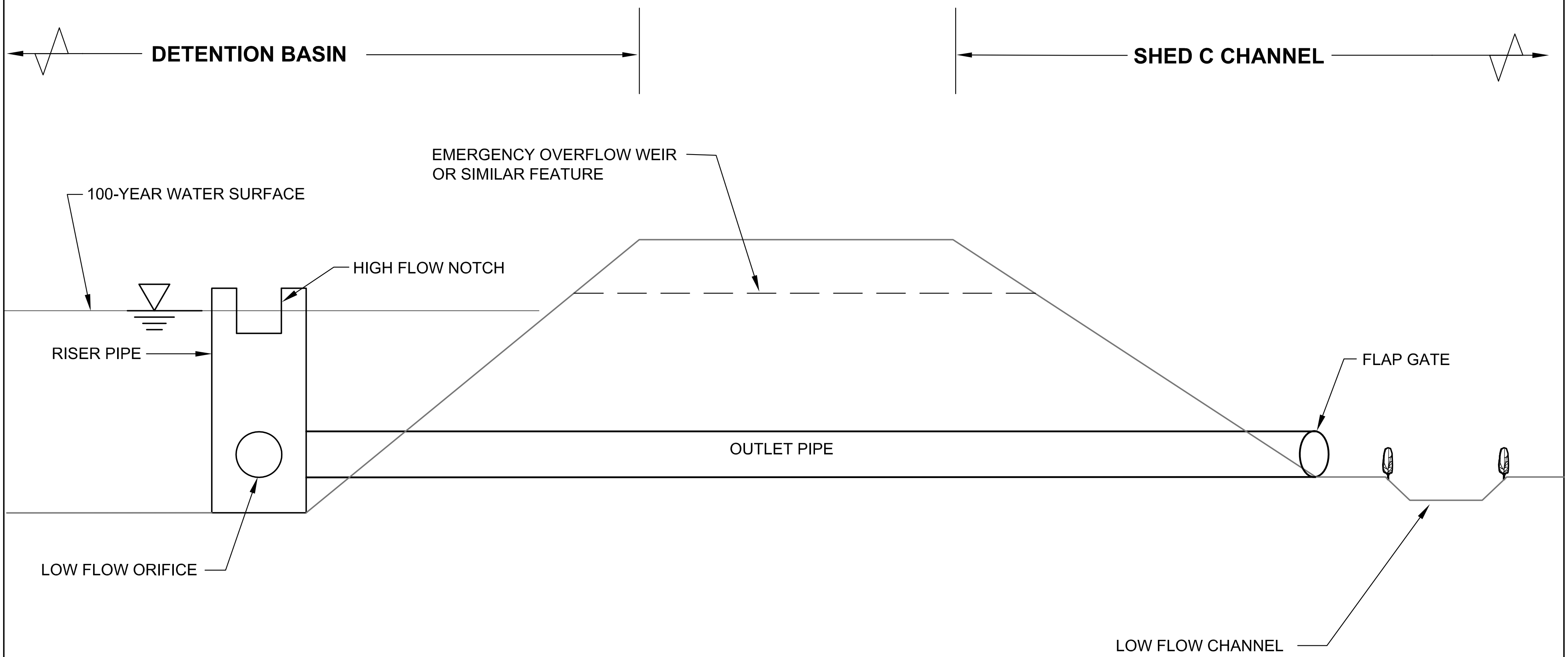


Figure 21. Buildout Water Surface Profiles – Laguna Ridge Specific Plan Channel



City of Elk Grove
SOUTHEAST POLICY AREA
DRAINAGE STUDY
FIGURE 22
TYPICAL DETENTION BASIN OUTLET

WEST YOST ASSOCIATES
Consulting Engineers

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ATTACHMENT A

HEC-RAS Output – Pre-Development Conditions

HEC-RAS Profile: Max WS

River	Reach	River Sta	Profile	Plan	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)	
LOCAL C CENTRAL	CENTRAL	5170	Max WS	Pre100	781.98	22.10	25.42		25.43	0.000439	1.57	1289.16	1463.65	0.16
LOCAL C CENTRAL	CENTRAL	5170	Max WS	Pre10	501.02	22.10	25.10		25.11	0.000509	1.57	858.39	1202.65	0.17
LOCAL C CENTRAL	CENTRAL	5122.*	Max WS	Pre100	781.71	22.06	25.40		25.41	0.000495	1.66	1211.56	1378.73	0.17
LOCAL C CENTRAL	CENTRAL	5122.*	Max WS	Pre10	500.60	22.06	25.07		25.08	0.000578	1.66	802.52	1125.56	0.18
LOCAL C CENTRAL	CENTRAL	5074.*	Max WS	Pre100	781.46	22.02	25.37		25.38	0.000559	1.75	1138.05	1298.37	0.18
LOCAL C CENTRAL	CENTRAL	5074.*	Max WS	Pre10	500.26	22.02	25.04		25.05	0.000659	1.76	749.44	1053.77	0.19
LOCAL C CENTRAL	CENTRAL	5026.*	Max WS	Pre100	781.13	21.98	25.34		25.35	0.000643	1.87	1057.29	1210.25	0.19
LOCAL C CENTRAL	CENTRAL	5026.*	Max WS	Pre10	500.04	21.98	25.00		25.02	0.000759	1.87	691.95	966.79	0.21
LOCAL C CENTRAL	CENTRAL	4978.*	Max WS	Pre100	780.82	21.94	25.30		25.32	0.000732	1.98	987.61	1132.23	0.21
LOCAL C CENTRAL	CENTRAL	4978.*	Max WS	Pre10	499.39	21.94	24.97		24.98	0.000853	1.97	643.26	885.38	0.22
LOCAL C CENTRAL	CENTRAL	4930.*	Max WS	Pre100	780.27	21.89	25.26		25.28	0.000847	2.12	913.94	1050.88	0.22
LOCAL C CENTRAL	CENTRAL	4930.*	Max WS	Pre10	499.25	21.89	24.92		24.94	0.000997	2.11	590.92	814.15	0.24
LOCAL C CENTRAL	CENTRAL	4882.*	Max WS	Pre100	779.60	21.85	25.22		25.24	0.001057	2.36	818.09	954.10	0.25
LOCAL C CENTRAL	CENTRAL	4882.*	Max WS	Pre10	498.56	21.85	24.86		24.89	0.001301	2.39	518.84	736.15	0.27
LOCAL C CENTRAL	CENTRAL	4834.*	Max WS	Pre100	778.68	21.81	25.16		25.19	0.001267	2.56	748.53	887.96	0.27
LOCAL C CENTRAL	CENTRAL	4834.*	Max WS	Pre10	498.50	21.81	24.78		24.82	0.001760	2.74	454.84	684.79	0.31
LOCAL C CENTRAL	CENTRAL	4786	Max WS	Pre100	776.50	21.77	25.08		25.12	0.001722	2.95	646.90	796.31	0.31
LOCAL C CENTRAL	CENTRAL	4786	Max WS	Pre10	494.75	21.77	24.65		24.72	0.003081	3.52	350.44	588.93	0.41
LOCAL C CENTRAL	CENTRAL	4785			Culvert									
LOCAL C CENTRAL	CENTRAL	4770	Max WS	Pre100	776.85	21.47	25.07		25.08	0.000296	1.35	1113.27	828.45	0.13
LOCAL C CENTRAL	CENTRAL	4770	Max WS	Pre10	495.46	21.47	24.65		24.66	0.000270	1.17	800.30	686.08	0.13
LOCAL C CENTRAL	CENTRAL	4685	Max WS	Pre100	776.62	21.47	25.04		25.05	0.000259	0.77	1132.38	1175.84	0.11
LOCAL C CENTRAL	CENTRAL	4685	Max WS	Pre10	494.96	21.47	24.63		24.63	0.000325	0.71	728.83	755.51	0.12
LOCAL C CENTRAL	CENTRAL	4190	Max WS	Pre100	777.07	18.79	24.40		24.49	0.001746	3.60	481.93	577.72	0.33
LOCAL C CENTRAL	CENTRAL	4190	Max WS	Pre10	492.61	18.79	24.08		24.16	0.001351	2.98	334.54	358.85	0.28
LOCAL C CENTRAL	CENTRAL	4000	Max WS	Pre100	775.24	17.84	23.93		23.98	0.000280	1.75	646.77	656.79	0.14
LOCAL C CENTRAL	CENTRAL	4000	Max WS	Pre10	491.94	17.84	23.75		23.78	0.000139	1.21	538.05	555.64	0.10
LOCAL C CENTRAL	CENTRAL	3696	Max WS	Pre100	802.18	17.84	23.93		23.98	0.000302	1.82	643.05	653.59	0.15
LOCAL C CENTRAL	CENTRAL	3696	Max WS	Pre10	504.11	17.84	23.75		23.77	0.000146	1.24	536.74	554.31	0.10
LOCAL C CENTRAL	CENTRAL	3695			Culvert									
LOCAL C CENTRAL	CENTRAL	3660	Max WS	Pre100	801.83	16.98	23.54		23.59	0.000441	2.07	691.94	658.10	0.17
LOCAL C CENTRAL	CENTRAL	3660	Max WS	Pre10	503.75	16.98	23.04		23.08	0.000375	1.76	409.99	432.33	0.16
LOCAL C CENTRAL	CENTRAL	3620	Max WS	Pre100	801.72	17.85	23.55		23.56	0.000228	1.40	1221.95	872.99	0.12
LOCAL C CENTRAL	CENTRAL	3620	Max WS	Pre10	503.79	17.85	23.05		23.06	0.000225	1.27	825.92	703.55	0.12
LOCAL C CENTRAL	CENTRAL	3548	Max WS	Pre100	801.51	18.08	23.16	22.07	23.78	0.005737	6.65	193.36	356.79	0.58
LOCAL C CENTRAL	CENTRAL	3548	Max WS	Pre10	503.65	18.08	22.76		23.16	0.003896	5.12	103.79	93.92	0.47
LOCAL C CENTRAL	CENTRAL	1786.5*	Max WS	Pre100	801.03	19.20	22.33		22.33	0.000033	0.32	2544.01	1571.15	0.04
LOCAL C CENTRAL	CENTRAL	1786.5*	Max WS	Pre10	499.18	19.20	22.19		22.19	0.000017	0.22	2327.90	1513.14	0.03
LOCAL C CENTRAL	CENTRAL	25	Max WS	Pre100	799.14	20.33	22.20		22.21	0.000795	0.55	1326.57	3078.87	0.16
LOCAL C CENTRAL	CENTRAL	25	Max WS	Pre10	496.97	20.33	22.07		22.08	0.000791	0.43	948.49	2914.10	0.15
LOCAL C CENTRAL	CENTRAL	24.75*	Max WS	Pre100	795.18	20.06	21.89		21.90	0.000871	0.65	1212.44	2661.62	0.17
LOCAL C CENTRAL	CENTRAL	24.75*	Max WS	Pre10	494.32	20.06	21.74		21.74	0.001077	0.57	812.96	2437.12	0.18
LOCAL C CENTRAL	CENTRAL	24.5*	Max WS	Pre100	792.28	19.78	21.46		21.47	0.001404	0.82	951.02	2177.34	0.21
LOCAL C CENTRAL	CENTRAL	24.5*	Max WS	Pre10	494.26	19.78	21.28		21.30	0.002193	0.78	589.17	1880.74	0.25
LOCAL C CENTRAL	CENTRAL	24.25*	Max WS	Pre100	790.42	19.51	20.85		20.87	0.002688	1.05	782.42	2100.08	0.29
LOCAL C CENTRAL	CENTRAL	24.25*	Max WS	Pre10	493.23	19.51	20.67		20.69	0.002533	1.13	477.63	1229.52	0.29
LOCAL C CENTRAL	CENTRAL	24	Max WS	Pre100	787.43	19.24	20.42		20.43	0.000557	0.61	1404.28	2395.91	0.14
LOCAL C CENTRAL	CENTRAL	24	Max WS	Pre10	490.74	19.24	20.22		20.23	0.000476	0.58	978.44	1885.64	0.13
LOCAL C CENTRAL	CENTRAL	23.5*	Max WS	Pre100	838.07	18.15	19.93		19.94	0.001711	1.04	810.65	1468.16	0.25
LOCAL C CENTRAL	CENTRAL	23.5*	Max WS	Pre10	513.53	18.15	19.74		19.75	0.001646	0.91	562.21	1188.79	0.23
LOCAL C CENTRAL	CENTRAL	23	Max WS	Pre100	830.29	17.05	19.39		19.40	0.000777	0.80	1144.04	1880.59	0.17
LOCAL C CENTRAL	CENTRAL	23	Max WS	Pre10	511.57	17.05	19.17		19.18	0.000881	0.71	758.86	1622.42	0.17
LOCAL C CENTRAL	CENTRAL	22.75*	Max WS	Pre100	824.21	16.91	19.07		19.08	0.000816	0.87	966.77	1355.93	0.18
LOCAL C CENTRAL	CENTRAL	22.75*	Max WS	Pre10	509.52	16.91	18.82		18.83	0.000906	0.79	658.89	1135.20	0.18
LOCAL C CENTRAL	CENTRAL	22.5*	Max WS	Pre100	819.89	16.78	18.75		18.77	0.000793	0.84	984.23	1411.12	0.17
LOCAL C CENTRAL	CENTRAL	22.5*	Max WS	Pre10	507.72	16.78	18.50		18.51	0.000736	0.76	673.06	1053.09	0.17
LOCAL C CENTRAL	CENTRAL	22.25*	Max WS	Pre100	814.04	16.65	18.49		18.50	0.000624	0.81	1032.00	1471.13	0.16
LOCAL C CENTRAL	CENTRAL	22.25*	Max WS	Pre10	504.78	16.65	18.24		18.24	0.000641	0.71	711.24	1120.98	0.15
LOCAL C CENTRAL	CENTRAL	22	Max WS	Pre100	811.46	16.51	18.32		18.32	0.000300	0.62	1543.30	2026.43	0.11
LOCAL C CENTRAL	CENTRAL	22	Max WS	Pre10	502.36	16.51	18.05		18.06	0.000360	0.56	1035.04	1802.09	0.12
LOCAL C CENTRAL	CENTRAL	21.8571*	Max WS	Pre100	905.56	16.20	18.16		18.17	0.000402	0.73	1431.83	1875.77	0.13

HEC-RAS Profile: Max WS (Continued)

River	Reach	River Sta	Profile	Plan	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)	
LOCAL C CENTRAL	CENTRAL	21.8571*	Max WS	Pre10	544.68	16.20	17.88		17.89	0.000467	0.66	936.65	1636.60	0.13
LOCAL C CENTRAL	CENTRAL	21.7142*	Max WS	Pre100	896.18	15.89	17.98		17.99	0.000471	0.78	1297.14	1718.51	0.14
LOCAL C CENTRAL	CENTRAL	21.7142*	Max WS	Pre10	541.12	15.89	17.67		17.67	0.000558	0.72	807.28	1381.31	0.15
LOCAL C CENTRAL	CENTRAL	21.5714*	Max WS	Pre100	890.02	15.58	17.78		17.79	0.000514	0.82	1182.79	1559.22	0.15
LOCAL C CENTRAL	CENTRAL	21.5714*	Max WS	Pre10	537.58	15.58	17.42		17.43	0.000622	0.78	710.32	1049.11	0.16
LOCAL C CENTRAL	CENTRAL	21.4285*	Max WS	Pre100	882.97	15.26	17.56		17.57	0.000541	0.85	1088.76	1382.74	0.15
LOCAL C CENTRAL	CENTRAL	21.4285*	Max WS	Pre10	533.63	15.26	17.15		17.16	0.000691	0.84	641.57	871.54	0.17
LOCAL C CENTRAL	CENTRAL	21.2857*	Max WS	Pre100	820.43	14.95	17.34		17.35	0.000473	0.81	1038.27	1178.64	0.14
LOCAL C CENTRAL	CENTRAL	21.2857*	Max WS	Pre10	527.47	14.95	16.87		16.88	0.000701	0.88	600.52	710.99	0.17
LOCAL C CENTRAL	CENTRAL	21.1428*	Max WS	Pre100	669.91	14.64	17.19		17.19	0.000252	0.62	1102.52	1161.48	0.10
LOCAL C CENTRAL	CENTRAL	21.1428*	Max WS	Pre10	501.85	14.64	16.59		16.60	0.000591	0.86	583.18	626.39	0.16
LOCAL C CENTRAL	CENTRAL	21	Max WS	Pre100	634.38	14.33	17.10		17.11	0.000156	0.51	1276.93	1292.27	0.08
LOCAL C CENTRAL	CENTRAL	21	Max WS	Pre10	377.78	14.33	16.42		16.43	0.000236	0.59	635.82	597.85	0.10
LOCAL C CENTRAL	CENTRAL	20.6666*	Max WS	Pre100	628.01	13.21	17.06		17.06	0.000046	0.29	2176.22	1809.80	0.05
LOCAL C CENTRAL	CENTRAL	20.6666*	Max WS	Pre10	357.76	13.21	16.35		16.36	0.000077	0.33	1093.90	1088.33	0.06
LOCAL C CENTRAL	CENTRAL	20.3333*	Max WS	Pre100	624.77	12.09	17.05		17.05	0.000014	0.18	3519.18	2632.44	0.03
LOCAL C CENTRAL	CENTRAL	20.3333*	Max WS	Pre10	352.12	12.09	16.33		16.33	0.000025	0.18	1923.51	1992.37	0.03
LOCAL C CENTRAL	CENTRAL	20	Max WS	Pre100	623.52	10.97	17.05		17.05	0.000005	0.12	5373.51	3416.40	0.02
LOCAL C CENTRAL	CENTRAL	20	Max WS	Pre10	351.19	10.97	16.33		16.33	0.000006	0.11	3230.56	2588.00	0.02
County Ditch	LENT1	16100	Max WS	Pre100	338.78	28.80	35.58		35.61	0.000153	1.33	255.17	61.12	0.11
County Ditch	LENT1	16100	Max WS	Pre10	205.63	28.80	35.23		35.24	0.000071	0.88	234.31	58.70	0.08
County Ditch	LENT1	15460	Max WS	Pre100	334.68	27.38	35.29		35.35	0.000916	2.30	236.40	239.16	0.22
County Ditch	LENT1	15460	Max WS	Pre10	196.84	27.38	34.91		35.01	0.001099	2.46	80.16	23.21	0.23
County Ditch	LENT1	14710	Max WS	Pre100	286.71	27.08	34.62		34.70	0.000688	2.34	146.32	89.29	0.20
County Ditch	LENT1	14710	Max WS	Pre10	194.73	27.08	34.47		34.51	0.000369	1.68	133.54	85.00	0.14
County Ditch	LENT1	14195	Max WS	Pre100	230.48	29.56	34.50		34.54	0.000573	1.68	136.90	50.71	0.18
County Ditch	LENT1	14195	Max WS	Pre10	189.49	29.56	34.27		34.30	0.000474	1.51	125.61	47.51	0.16
County Ditch	LENT1	13535	Max WS	Pre100	230.37	28.93	33.89		33.97	0.001717	2.39	96.37	33.40	0.25
County Ditch	LENT1	13535	Max WS	Pre10	189.27	28.93	33.58		33.66	0.001555	2.19	86.47	31.77	0.23
County Ditch	LENT1	13000	Max WS	Pre100	230.33	27.82	33.36		33.39	0.000472	1.48	189.43	105.92	0.13
County Ditch	LENT1	13000	Max WS	Pre10	188.59	27.82	33.09		33.11	0.000473	1.41	162.83	91.04	0.13
County Ditch	LENT1	12810	Max WS	Pre100	227.88	27.31	33.15		33.24	0.001330	2.44	102.75	73.48	0.22
County Ditch	LENT1	12810	Max WS	Pre10	187.44	27.31	32.90		32.98	0.001145	2.19	87.89	47.79	0.20
County Ditch	LENT1	11995	Max WS	Pre100	411.68	26.38	32.54		32.55	0.000268	0.86	680.31	727.57	0.08
County Ditch	LENT1	11995	Max WS	Pre10	319.64	26.38	32.15		32.17	0.000794	1.40	294.15	264.58	0.14
County Ditch	LENT1	11530	Max WS	Pre100	411.37	26.37	31.82		31.95	0.002373	2.86	143.93	36.66	0.25
County Ditch	LENT1	11530	Max WS	Pre10	319.44	26.37	31.43		31.53	0.001883	2.45	130.12	35.07	0.22
County Ditch	LENT1	10915	Max WS	Pre100	408.89	23.64	30.61		30.67	0.001856	2.07	250.99	270.99	0.22
County Ditch	LENT1	10915	Max WS	Pre10	319.35	23.64	30.44		30.49	0.001625	1.91	205.52	235.94	0.20
County Ditch	LENT1	10570	Max WS	Pre100	400.04	19.63	30.39		30.40	0.000008	0.31	1537.50	544.12	0.02
County Ditch	LENT1	10570	Max WS	Pre10	319.31	19.63	30.25		30.25	0.000006	0.26	1458.94	517.81	0.02
County Ditch	LENT1	10040	Max WS	Pre100	532.00	25.08	30.10		30.12	0.001010	1.62	520.52	722.12	0.16
County Ditch	LENT1	10040	Max WS	Pre10	389.92	25.08	30.06		30.08	0.000620	1.26	493.02	705.56	0.13
County Ditch	LENT1	10030			Culvert									
County Ditch	LENT1	10000	Max WS	Pre100	532.92	25.08	30.04		30.07	0.001243	1.77	475.01	681.99	0.18
County Ditch	LENT1	10000	Max WS	Pre10	388.48	25.08	29.94		30.00	0.002543	2.49	245.24	427.05	0.26
County Ditch	LENT1	9730	Max WS	Pre100	530.48	25.38	29.66		29.68	0.001690	1.62	491.00	867.33	0.20
County Ditch	LENT1	9730	Max WS	Pre10	387.32	25.38	29.50		29.52	0.001995	1.67	356.88	750.53	0.21
County Ditch	LENT1	9260	Max WS	Pre100	525.40	22.91	29.20		29.24	0.000888	1.87	415.25	529.97	0.16
County Ditch	LENT1	9260	Max WS	Pre10	379.74	22.91	29.03		29.06	0.000632	1.55	335.96	419.95	0.13
County Ditch	LENT1	8885	Max WS	Pre100	523.23	23.62	29.06		29.07	0.000179	0.72	1019.92	1036.55	0.07
County Ditch	LENT1	8885	Max WS	Pre10	378.03	23.62	28.93		28.94	0.000129	0.60	891.30	959.92	0.06
County Ditch	LENT1	8755	Max WS	Pre100	522.84	26.30	29.02		29.03	0.000448	0.73	898.37	1330.51	0.10
County Ditch	LENT1	8755	Max WS	Pre10	377.78	26.30	28.90		28.90	0.000377	0.63	745.63	1195.96	0.09
County Ditch	LENT1	8266	Max WS	Pre100	522.90	26.20	28.80		28.81	0.000532	0.72	1014.39	2170.13	0.11
County Ditch	LENT1	8266	Max WS	Pre10	371.64	26.20	28.71		28.71	0.000458	0.63	822.77	1938.62	0.10
County Ditch	LENT1	8265			Culvert									
County Ditch	LENT1	8245	Max WS	Pre100	522.90	25.85	28.80		28.81	0.000375	1.34	710.64	560.19	0.15
County Ditch	LENT1	8245	Max WS	Pre10	371.26	25.85	28.71		28.71	0.000235	1.03	660.23	553.58	0.12
County Ditch	LENT1	8015	Max WS	Pre100	522.17	25.90	28.58		28.62	0.002420	2.28	538.10	1567.20	0.34
County Ditch	LENT1	8015	Max WS	Pre10	381.21	25.90	28.43		28.49	0.003235	2.45	333.79	1183.29	0.39

HEC-RAS Profile: Max WS (Continued)

River	Reach	River Sta	Profile	Plan	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)	
County Ditch	LENT1	7850	Max WS	Pre100	517.87	25.90	28.21		28.25	0.002207	2.63	608.17	1889.32	0.34
County Ditch	LENT1	7850	Max WS	Pre10	368.03	25.90	28.03		28.07	0.001988	2.33	365.85	783.82	0.32
County Ditch	LENT1	7405	Max WS	Pre100	427.85	24.67	27.71		27.71	0.000200	0.95	1293.70	2018.88	0.11
County Ditch	LENT1	7405	Max WS	Pre10	364.22	24.67	27.36		27.37	0.000687	1.60	689.61	1456.97	0.19
County Ditch	LENT1	7195	Max WS	Pre100	385.74	24.38	27.67		27.67	0.000159	0.92	953.60	980.00	0.10
County Ditch	LENT1	7195	Max WS	Pre10	336.31	24.38	27.23		27.24	0.000542	1.52	538.61	841.96	0.17
County Ditch	LENT1	7080	Max WS	Pre100	341.06	24.25	27.63		27.64	0.000152	0.92	751.25	616.00	0.09
County Ditch	LENT1	7080	Max WS	Pre10	334.12	24.25	27.13		27.15	0.000695	1.74	442.32	616.00	0.20
County Ditch	LENT1	7079			Culvert									
County Ditch	LENT1	7040	Max WS	Pre100	341.06	23.50	27.63		27.63	0.000005	0.20	3895.33	2900.00	0.02
County Ditch	LENT1	7040	Max WS	Pre10	334.38	23.50	27.14		27.14	0.000023	0.36	2451.34	2900.00	0.04
County Ditch	LENT1	6855	Max WS	Pre100	281.39	23.71	27.63		27.63	0.000007	0.22	2708.09	1750.00	0.02
County Ditch	LENT1	6855	Max WS	Pre10	334.22	23.71	27.13		27.13	0.000033	0.43	1833.76	1750.00	0.04
County Ditch	LENT1	6715	Max WS	Pre100	292.22	23.08	27.62		27.62	0.000039	0.56	1291.88	1100.34	0.05
County Ditch	LENT1	6715	Max WS	Pre10	334.17	23.08	27.11		27.12	0.000146	0.99	818.95	765.83	0.09
County Ditch	LENT1	6350	Max WS	Pre100	547.49	23.08	26.03		26.28	0.008286	5.78	243.31	484.57	0.66
County Ditch	LENT1	6350	Max WS	Pre10	332.87	23.08	25.86		26.07	0.006538	4.87	165.50	388.66	0.58
County Ditch	LENT1	6349			Culvert									
County Ditch	LENT1	6327	Max WS	Pre100	522.87	20.08	25.95		25.98	0.000205	1.42	560.41	379.06	0.12
County Ditch	LENT1	6327	Max WS	Pre10	332.52	20.08	25.74		25.76	0.000108	1.00	483.28	350.97	0.09
County Ditch	LENT1	6167	Max WS	Pre100	513.71	21.29	25.70		25.78	0.002610	3.52	406.94	849.83	0.38
County Ditch	LENT1	6167	Max WS	Pre10	331.55	21.29	25.44		25.56	0.003173	3.63	225.79	558.98	0.41
County Ditch	LENT1	5685	Max WS	Pre100	505.82	20.80	25.49		25.50	0.000182	1.13	1003.30	1018.06	0.11
County Ditch	LENT1	5685	Max WS	Pre10	329.76	20.80	25.17		25.18	0.000152	0.97	715.24	775.44	0.10
County Ditch	LENT1	5427.5*	Max WS	Pre100	492.73	21.45	25.42		25.43	0.000265	1.30	1014.25	1220.86	0.13
County Ditch	LENT1	5427.5*	Max WS	Pre10	342.88	21.45	25.10		25.10	0.000312	1.31	676.95	914.45	0.14

ATTACHMENT B

HEC-RAS Output – Buildout Conditions

HEC-RAS   Profile: Max WS

River	Reach	River Sta	Profile	Plan	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)	
Shed C Channel	Upper	16230	Max WS	100Yr Final	0.00	28.89	33.37		33.37	0.000000	0.00	80.92	18.12	0.00
Shed C Channel	Upper	16230	Max WS	10Yr Final	0.00	28.89	31.96		31.96	0.000000	0.00	55.46	18.09	0.00
Shed C Channel	Upper	16225	Max WS	100Yr Final	0.00	28.89	33.37		33.37	0.000000	0.00	80.92	18.12	0.00
Shed C Channel	Upper	16225	Max WS	10Yr Final	0.00	28.89	31.96		31.96	0.000000	0.00	55.46	18.09	0.00
Shed C Channel	Upper	16220			Lat Struct									
Shed C Channel	Upper	16200	Max WS	100Yr Final	0.00	28.78	33.37		33.37	0.000000	0.00	82.91	18.13	0.00
Shed C Channel	Upper	16200	Max WS	10Yr Final	0.00	28.78	31.96		31.96	0.000000	0.00	57.45	18.09	0.00
Shed C Channel	Upper	16125	Max WS	100Yr Final	271.26	28.73	32.98		33.18	0.000308	3.53	76.82	18.12	0.30
Shed C Channel	Upper	16125	Max WS	10Yr Final	133.84	28.73	31.78		31.87	0.000201	2.44	54.95	18.08	0.25
Shed C Channel	Upper	15304	Max WS	100Yr Final	271.64	28.80	33.09		33.16	0.000687	2.18	124.41	43.79	0.23
Shed C Channel	Upper	15304	Max WS	10Yr Final	133.88	28.80	31.81		31.86	0.000691	1.81	74.08	34.89	0.22
Shed C Channel	Upper	15128	Max WS	100Yr Final	270.04	28.75	32.60		32.86	0.002050	4.13	65.39	130.57	0.37
Shed C Channel	Upper	15128	Max WS	10Yr Final	133.51	28.75	31.47		31.60	0.001593	2.89	46.23	121.55	0.31
Shed C Channel	Upper	15100			Culvert									
Shed C Channel	Upper	15074	Max WS	100Yr Final	265.21	28.70	32.25		32.55	0.002585	4.40	60.34	128.20	0.41
Shed C Channel	Upper	15074	Max WS	10Yr Final	133.36	28.70	31.33		31.47	0.001776	2.98	44.71	120.84	0.32
Shed C Channel	Upper	14874	Max WS	100Yr Final	263.11	28.50	32.10		32.13	0.000519	1.82	251.85	128.58	0.18
Shed C Channel	Upper	14874	Max WS	10Yr Final	133.11	28.50	31.17		31.20	0.000620	1.59	135.61	121.14	0.18
Shed C Channel	Upper	14671	Max WS	100Yr Final	326.22	28.29	31.95		32.00	0.000735	2.20	259.66	129.04	0.21
Shed C Channel	Upper	14671	Max WS	10Yr Final	169.14	28.29	30.99		31.04	0.000945	1.98	139.06	121.35	0.23
Shed C Channel	Upper	14268	Max WS	100Yr Final	323.18	27.88	31.69		31.73	0.000596	2.04	278.86	130.27	0.19
Shed C Channel	Upper	14268	Max WS	10Yr Final	167.75	27.88	30.63		30.68	0.000830	1.88	146.11	121.84	0.21
Shed C Channel	Upper	13865	Max WS	100Yr Final	321.80	27.47	31.48		31.52	0.000461	1.86	305.40	131.86	0.17
Shed C Channel	Upper	13865	Max WS	10Yr Final	167.16	27.47	30.34		30.38	0.000660	1.74	160.50	122.76	0.19
Shed C Channel	Upper	13495	Max WS	100Yr Final	321.33	27.10	31.33		31.36	0.000356	1.70	335.07	133.66	0.15
Shed C Channel	Upper	13495	Max WS	10Yr Final	166.96	27.10	30.13		30.16	0.000493	1.56	180.70	124.08	0.17
Shed C Channel	Upper	13400			Lat Struct									
Shed C Channel	Upper	13395	Max WS	100Yr Final	363.33	27.00	31.09		31.32	0.001657	3.87	94.00	132.50	0.34
Shed C Channel	Upper	13395	Max WS	10Yr Final	187.16	27.00	29.97		30.09	0.001272	2.74	68.35	123.57	0.28
Shed C Channel	Upper	13368			Culvert									
Shed C Channel	Upper	13341	Max WS	100Yr Final	359.83	26.94	30.66		30.96	0.002429	4.40	81.86	138.14	0.40
Shed C Channel	Upper	13341	Max WS	10Yr Final	186.89	26.94	29.79		29.93	0.001591	2.98	62.72	131.20	0.31
Shed C Channel	Upper	13161	Max WS	100Yr Final	358.58	26.76	30.54		30.60	0.000779	2.28	267.39	138.65	0.22
Shed C Channel	Upper	13161	Max WS	10Yr Final	186.65	26.76	29.64		29.69	0.000882	1.97	145.71	131.43	0.22
Shed C Channel	Upper	12860	Max WS	100Yr Final	356.61	26.45	30.32		30.38	0.000679	2.17	280.72	139.40	0.21
Shed C Channel	Upper	12860	Max WS	10Yr Final	186.34	26.45	29.39		29.44	0.000780	1.89	154.11	131.93	0.21
Shed C Channel	Upper	12670			Lat Struct									
Shed C Channel	Upper	12558	Max WS	100Yr Final	410.41	26.14	30.08		30.14	0.000829	2.43	289.55	139.88	0.23
Shed C Channel	Upper	12558	Max WS	10Yr Final	215.57	26.14	29.11		29.17	0.000999	2.15	157.34	132.12	0.24
Shed C Channel	Upper	12149	Max WS	100Yr Final	405.79	25.73	29.77		29.83	0.000716	2.30	303.61	140.71	0.21
Shed C Channel	Upper	12149	Max WS	10Yr Final	214.36	25.73	28.71		28.77	0.000957	2.11	159.65	132.27	0.23
Shed C Channel	Upper	11849	Max WS	100Yr Final	403.96	25.42	29.57		29.62	0.000618	2.18	319.81	141.61	0.20
Shed C Channel	Upper	11849	Max WS	10Yr Final	213.54	25.42	28.44		28.50	0.000884	2.05	164.88	132.58	0.22
Shed C Channel	Upper	11505	Max WS	100Yr Final	402.95	25.07	29.38		29.43	0.000511	2.04	342.74	142.89	0.18
Shed C Channel	Upper	11505	Max WS	10Yr Final	212.90	25.07	28.16		28.21	0.000778	1.96	174.13	133.13	0.21
Shed C Channel	Upper	11209	Max WS	100Yr Final	402.69	24.77	29.25		29.29	0.000426	1.92	366.51	144.22	0.17
Shed C Channel	Upper	11209	Max WS	10Yr Final	212.69	24.77	27.95		28.00	0.000665	1.85	186.35	133.86	0.20
Shed C Channel	Upper	11109	Max WS	100Yr Final	402.40	24.67	28.93		29.28	0.002341	4.72	85.20	142.47	0.40
Shed C Channel	Upper	11109	Max WS	10Yr Final	212.54	24.67	27.72		27.91	0.001992	3.49	60.97	132.78	0.35
Shed C Channel	Upper	11055			Culvert									
Shed C Channel	Upper	11002	Max WS	100Yr Final	401.66	24.56	28.49		28.89	0.003060	5.11	78.54	139.84	0.45
Shed C Channel	Upper	11002	Max WS	10Yr Final	212.31	24.56	27.55		27.74	0.002129	3.55	59.73	132.30	0.36
Shed C Channel	Upper	10802	Max WS	100Yr Final	401.38	24.36	28.33		28.39	0.000766	2.35	293.42	140.15	0.22
Shed C Channel	Upper	10802	Max WS	10Yr Final	212.07	24.36	27.35		27.40	0.000932	2.09	160.01	132.30	0.23
Shed C Channel	Upper	10533	Max WS	100Yr Final	401.10	24.08	28.13		28.19	0.000686	2.26	305.95	140.85	0.21
Shed C Channel	Upper	10533	Max WS	10Yr Final	211.84	24.08	27.11		27.16	0.000860	2.03	165.74	132.64	0.22

HEC-RAS Profile: Max WS (Continued)

River	Reach	River Sta	Profile	Plan	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)	
Shed C Channel	Upper	10205	Max WS	100Yr Final	400.97	23.75	27.93		27.98	0.000589	2.14	323.89	141.85	0.20
Shed C Channel	Upper	10205	Max WS	10Yr Final	211.71	23.75	26.85		26.90	0.000758	1.94	175.34	133.21	0.21
Shed C Channel	Upper	9878	Max WS	100Yr Final	400.96	23.42	27.76		27.80	0.000492	2.01	346.41	143.10	0.18
Shed C Channel	Upper	9878	Max WS	10Yr Final	211.70	23.42	26.63		26.67	0.000629	1.81	190.03	134.08	0.19
Shed C Channel	Upper	9600			Lat Struct									
Shed C Channel	Upper	9551	Max WS	100Yr Final	438.74	23.09	27.59		27.64	0.000494	2.07	369.87	144.47	0.18
Shed C Channel	Upper	9551	Max WS	10Yr Final	230.57	23.09	26.42		26.47	0.000612	1.84	206.67	135.10	0.19
Shed C Channel	Upper	9400			Lat Struct									
Shed C Channel	Upper	9375	Max WS	100Yr Final	532.57	22.91	27.46		27.53	0.000690	2.47	377.20	144.86	0.21
Shed C Channel	Upper	9375	Max WS	10Yr Final	280.28	22.91	26.27		26.33	0.000867	2.20	210.32	135.31	0.23
Shed C Channel	Upper	9275	Max WS	100Yr Final	571.72	22.81	27.22		27.44	0.001462	3.82	149.78	143.67	0.32
Shed C Channel	Upper	9275	Max WS	10Yr Final	299.68	22.81	26.12		26.23	0.001040	2.66	112.59	134.91	0.26
Shed C Channel	Upper	9235			Culvert									
Shed C Channel	Upper	9196	Max WS	100Yr Final	570.76	22.73	26.87		27.13	0.001790	4.05	140.81	158.55	0.35
Shed C Channel	Upper	9196	Max WS	10Yr Final	299.46	22.73	25.97		26.09	0.001112	2.71	110.30	151.36	0.27
Shed C Channel	Upper	8996	Max WS	100Yr Final	570.40	22.52	26.73		26.81	0.001031	2.85	361.55	159.03	0.26
Shed C Channel	Upper	8996	Max WS	10Yr Final	299.22	22.52	25.81		25.87	0.001028	2.36	218.61	151.68	0.25
Shed C Channel	Upper	8635	Max WS	100Yr Final	569.47	22.15	26.36		26.44	0.001027	2.84	361.53	159.05	0.26
Shed C Channel	Upper	8635	Max WS	10Yr Final	298.69	22.15	25.44		25.51	0.001018	2.35	219.15	151.72	0.25
Shed C Channel	Upper	8233	Max WS	100Yr Final	568.50	21.75	25.94		26.02	0.001043	2.86	359.03	158.92	0.26
Shed C Channel	Upper	8233	Max WS	10Yr Final	298.21	21.75	25.03		25.10	0.001030	2.36	217.75	151.65	0.25
Shed C Channel	Upper	7831	Max WS	100Yr Final	567.59	21.34	25.52		25.60	0.001053	2.87	357.35	158.89	0.26
Shed C Channel	Upper	7831	Max WS	10Yr Final	297.81	21.34	24.62		24.68	0.001033	2.36	217.27	151.65	0.25
Shed C Channel	Upper	7429	Max WS	100Yr Final	566.65	20.93	25.09		25.18	0.001072	2.88	354.54	158.72	0.26
Shed C Channel	Upper	7429	Max WS	10Yr Final	297.57	20.93	24.20		24.27	0.001043	2.37	216.23	151.58	0.25
Shed C Channel	Upper	7027	Max WS	100Yr Final	565.52	20.52	24.65		24.74	0.001105	2.91	350.05	158.45	0.27
Shed C Channel	Upper	7027	Max WS	10Yr Final	297.49	20.52	23.78		23.85	0.001066	2.39	214.22	151.45	0.25
Shed C Channel	Upper	6625	Max WS	100Yr Final	564.52	20.11	24.32		24.37	0.000681	2.32	491.31	223.14	0.21
Shed C Channel	Upper	6625	Max WS	10Yr Final	297.45	20.11	23.44		23.48	0.000716	1.99	297.26	216.06	0.21
Shed C Channel	Upper	6250			Lat Struct									
Shed C Channel	Upper	6223	Max WS	100Yr Final	583.85	19.70	24.07		24.11	0.000603	2.24	525.52	224.32	0.20
Shed C Channel	Upper	6223	Max WS	10Yr Final	310.17	19.70	23.18		23.21	0.000601	1.88	329.37	217.22	0.19
Shed C Channel	Upper	5831	Max WS	100Yr Final	583.82	19.30	23.86		23.89	0.000482	2.07	568.74	225.86	0.18
Shed C Channel	Upper	5831	Max WS	10Yr Final	309.27	19.30	22.98		23.01	0.000430	1.66	373.76	218.84	0.16
Shed C Channel	Upper	5439	Max WS	100Yr Final	583.71	18.90	23.69		23.72	0.000372	1.89	622.47	227.75	0.16
Shed C Channel	Upper	5439	Max WS	10Yr Final	306.31	18.90	22.84		22.86	0.000286	1.43	431.83	220.96	0.13
Shed C Channel	Lower	5419	Max WS	100Yr Final	735.01	18.88	23.69		23.75	0.000576	2.35	586.77	225.54	0.20
Shed C Channel	Lower	5419	Max WS	10Yr Final	391.32	18.88	22.84		22.88	0.000453	1.81	398.02	218.73	0.17
Shed C Channel	Lower	5187	Max WS	100Yr Final	734.48	18.74	23.56		23.62	0.000571	2.34	588.34	225.52	0.20
Shed C Channel	Lower	5187	Max WS	10Yr Final	390.82	18.74	22.74		22.78	0.000428	1.77	406.54	219.00	0.17
Shed C Channel	Lower	5185			Lat Struct									
Shed C Channel	Lower	4839	Max WS	100Yr Final	753.80	18.54	23.35		23.41	0.000607	2.41	586.55	225.58	0.20
Shed C Channel	Lower	4839	Max WS	10Yr Final	401.48	18.54	22.60		22.63	0.000422	1.77	417.88	219.49	0.16
Shed C Channel	Lower	4491	Max WS	100Yr Final	753.53	18.33	23.14		23.20	0.000607	2.41	586.28	225.52	0.20
Shed C Channel	Lower	4491	Max WS	10Yr Final	400.78	18.33	22.46		22.49	0.000382	1.71	433.68	220.04	0.16
Shed C Channel	Lower	4144	Max WS	100Yr Final	753.36	18.12	22.93		22.99	0.000607	2.41	586.16	225.47	0.20
Shed C Channel	Lower	4144	Max WS	10Yr Final	400.17	18.12	22.33		22.36	0.000341	1.64	452.73	220.69	0.15
Shed C Channel	Lower	3800			Lat Struct									
Shed C Channel	Lower	3796	Max WS	100Yr Final	760.13	17.91	22.72		22.78	0.000621	2.44	585.20	225.50	0.21
Shed C Channel	Lower	3796	Max WS	10Yr Final	402.26	17.91	22.22		22.25	0.000304	1.58	474.75	221.54	0.14
Shed C Channel	Lower	3696	Max WS	100Yr Final	771.61	17.85	22.48		22.71	0.001551	3.78	203.89	237.07	0.31
Shed C Channel	Lower	3696	Max WS	10Yr Final	407.19	17.85	22.14		22.21	0.000558	2.16	188.84	234.33	0.18
Shed C Channel	Lower	3695			Culvert									
Shed C Channel	Lower	3596	Max WS	100Yr Final	767.57	17.77	22.25		22.51	0.001635	4.08	188.10	242.80	0.34
Shed C Channel	Lower	3596	Max WS	10Yr Final	405.76	17.77	22.08		22.16	0.000520	2.24	180.94	241.43	0.19
Shed C Channel	Lower	3548	Max WS	100Yr Final	770.96	17.77	22.36		22.42	0.000589	2.33	520.43	243.71	0.19

HEC-RAS Profile: Max WS (Continued)

River	Reach	River Sta	Profile	Plan	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)	
Shed C Channel	Lower	3548	Max WS	10Yr Final	406.45	17.77	22.11		22.13	0.000229	1.40	459.12	241.69	0.12
Shed C Channel	Lower	1786.5*	Max WS	100Yr Final	769.86	17.62	22.28		22.28	0.000032	0.31	2497.95	1551.72	0.04
Shed C Channel	Lower	1786.5*	Max WS	10Yr Final	405.78	17.62	22.08		22.08	0.000013	0.19	2189.89	1446.05	0.03
Shed C Channel	Lower	25	Max WS	100Yr Final	767.58	17.55	22.17		22.18	0.000761	0.54	1306.33	3043.54	0.15
Shed C Channel	Lower	25	Max WS	10Yr Final	405.21	17.55	21.95		21.95	0.001102	0.45	672.87	2362.82	0.17
Shed C Channel	Lower	24.75*	Max WS	100Yr Final	765.56	17.48	21.84		21.85	0.000996	0.67	1123.40	2597.67	0.18
Shed C Channel	Lower	24.75*	Max WS	10Yr Final	404.73	17.48	21.62		21.63	0.001950	0.62	567.35	2283.57	0.23
Shed C Channel	Lower	24.5*	Max WS	100Yr Final	763.79	17.40	21.41		21.42	0.001672	0.86	868.78	2071.60	0.23
Shed C Channel	Lower	24.5*	Max WS	10Yr Final	404.44	17.40	21.14		21.16	0.003371	0.95	388.21	1252.98	0.31
Shed C Channel	Lower	24.25*	Max WS	100Yr Final	763.22	17.32	20.81		20.83	0.002507	1.05	758.25	1957.84	0.28
Shed C Channel	Lower	24.25*	Max WS	10Yr Final	403.73	17.32	20.50		20.53	0.004140	1.19	338.15	1045.86	0.35
Shed C Channel	Lower	24	Max WS	100Yr Final	763.18	17.24	20.37		20.38	0.000669	0.66	1284.58	2307.85	0.15
Shed C Channel	Lower	24	Max WS	10Yr Final	402.97	17.24	20.09		20.10	0.000695	0.60	742.58	1717.37	0.15
Shed C Channel	Lower	23.5*	Max WS	100Yr Final	815.53	17.15	19.92		19.94	0.001592	1.00	814.08	1463.97	0.24
Shed C Channel	Lower	23.5*	Max WS	10Yr Final	429.21	17.15	19.65		19.66	0.001966	0.92	467.46	1120.82	0.25
Shed C Channel	Lower	23	Max WS	100Yr Final	812.70	17.05	19.40		19.41	0.000866	1.66	1162.35	1888.99	0.21
Shed C Channel	Lower	23	Max WS	10Yr Final	428.32	17.05	19.10		19.11	0.000929	1.53	654.12	1549.46	0.21
Shed C Channel	Lower	22.75*	Max WS	100Yr Final	810.19	16.91	19.06		19.07	0.000813	0.86	956.02	1328.36	0.18
Shed C Channel	Lower	22.75*	Max WS	10Yr Final	427.23	16.91	18.74		18.75	0.000944	0.76	574.10	1079.69	0.18
Shed C Channel	Lower	22.5*	Max WS	100Yr Final	808.34	16.78	18.75		18.76	0.000787	0.83	976.58	1406.25	0.17
Shed C Channel	Lower	22.5*	Max WS	10Yr Final	425.92	16.78	18.42		18.43	0.000726	0.72	589.79	970.47	0.16
Shed C Channel	Lower	22.25*	Max WS	100Yr Final	806.15	16.65	18.49		18.50	0.000618	0.80	1028.35	1467.11	0.16
Shed C Channel	Lower	22.25*	Max WS	10Yr Final	423.36	16.65	18.16		18.17	0.000630	0.67	630.93	1044.01	0.15
Shed C Channel	Lower	22	Max WS	100Yr Final	805.06	16.51	18.32		18.32	0.000296	0.61	1541.58	2025.84	0.11
Shed C Channel	Lower	22	Max WS	10Yr Final	421.58	16.51	17.98		17.99	0.000343	0.53	910.57	1643.71	0.11
Shed C Channel	Lower	21.8571*	Max WS	100Yr Final	905.35	16.20	18.16		18.17	0.000402	0.73	1431.74	1875.73	0.13
Shed C Channel	Lower	21.8571*	Max WS	10Yr Final	468.55	16.20	17.81		17.82	0.000467	0.63	831.43	1515.06	0.13
Shed C Channel	Lower	21.7142*	Max WS	100Yr Final	897.50	15.89	17.98		17.99	0.000474	0.78	1295.97	1718.12	0.14
Shed C Channel	Lower	21.7142*	Max WS	10Yr Final	466.41	15.89	17.60		17.60	0.000551	0.69	716.33	1255.78	0.15
Shed C Channel	Lower	21.5714*	Max WS	100Yr Final	889.89	15.58	17.78		17.79	0.000517	0.82	1179.64	1558.21	0.15
Shed C Channel	Lower	21.5714*	Max WS	10Yr Final	464.55	15.58	17.34		17.35	0.000641	0.76	626.22	974.84	0.16
Shed C Channel	Lower	21.4285*	Max WS	100Yr Final	884.37	15.26	17.56		17.57	0.000549	0.86	1083.34	1378.14	0.15
Shed C Channel	Lower	21.4285*	Max WS	10Yr Final	462.35	15.26	17.05		17.06	0.000734	0.83	556.47	748.60	0.17
Shed C Channel	Lower	21.2857*	Max WS	100Yr Final	838.68	14.95	17.32		17.33	0.000520	0.84	1017.77	1167.80	0.15
Shed C Channel	Lower	21.2857*	Max WS	10Yr Final	459.69	14.95	16.74		16.76	0.000735	0.89	517.79	624.98	0.17
Shed C Channel	Lower	21.1428*	Max WS	100Yr Final	661.52	14.64	17.15		17.16	0.000268	0.63	1064.42	1120.77	0.11
Shed C Channel	Lower	21.1428*	Max WS	10Yr Final	405.60	14.64	16.47		16.48	0.000488	0.79	512.02	539.13	0.14
Shed C Channel	Lower	21	Max WS	100Yr Final	604.43	14.33	17.07		17.07	0.000155	0.50	1232.49	1262.26	0.08
Shed C Channel	Lower	21	Max WS	10Yr Final	347.41	14.33	16.31		16.32	0.000247	0.61	574.18	543.21	0.10
Shed C Channel	Lower	20.6666*	Max WS	100Yr Final	593.95	13.21	17.03		17.03	0.000045	0.28	2114.52	1796.49	0.05
Shed C Channel	Lower	20.6666*	Max WS	10Yr Final	336.18	13.21	16.24		16.24	0.000085	0.34	975.62	969.45	0.06
Shed C Channel	Lower	20.3333*	Max WS	100Yr Final	589.74	12.09	17.02		17.02	0.000013	0.17	3432.72	2482.06	0.03
Shed C Channel	Lower	20.3333*	Max WS	10Yr Final	333.13	12.09	16.21		16.21	0.000031	0.20	1694.79	1839.06	0.04
Shed C Channel	Lower	20	Max WS	100Yr Final	588.73	10.97	17.01		17.01	0.000005	0.11	5259.03	3390.08	0.02
Shed C Channel	Lower	20	Max WS	10Yr Final	332.75	10.97	16.21		16.21	0.000008	0.11	2924.00	2533.18	0.02
LRSP Channel	1	3510	Max WS	100Yr Final	0.00	20.05	25.01		25.01	0.000000	0.00	162.73	48.78	0.00
LRSP Channel	1	3510	Max WS	10Yr Final	0.00	20.05	24.07		24.07	0.000000	0.00	119.25	43.10	0.00
LRSP Channel	1	3500	Max WS	100Yr Final	0.00	20.04	25.01		25.01	0.000000	0.00	163.29	48.87	0.00
LRSP Channel	1	3500	Max WS	10Yr Final	0.00	20.04	24.07		24.07	0.000000	0.00	119.73	43.19	0.00
LRSP Channel	1	3455			Lat Struct									
LRSP Channel	1	3410	Max WS	100Yr Final	260.09	20.00	24.89		24.96	0.000586	2.54	159.27	48.36	0.20
LRSP Channel	1	3410	Max WS	10Yr Final	163.83	20.00	23.97		24.02	0.000532	2.10	117.41	42.85	0.19
LRSP Channel	1	2400	Max WS	100Yr Final	259.79	19.98	24.86		24.93	0.000594	2.49	153.22	48.33	0.20
LRSP Channel	1	2400	Max WS	10Yr Final	163.66	19.98	23.94		23.99	0.000555	2.08	111.50	42.83	0.19
LRSP Channel	1	2100	Max WS	100Yr Final	258.06	19.84	24.68		24.75	0.000606	2.50	151.21	48.06	0.20
LRSP Channel	1	2100	Max WS	10Yr Final	162.76	19.84	23.78		23.82	0.000565	2.09	110.26	42.63	0.19
LRSP Channel	1	1800	Max WS	100Yr Final	256.06	19.71	24.49		24.56	0.000626	2.52	148.56	47.74	0.21
LRSP Channel	1	1800	Max WS	10Yr Final	161.67	19.71	23.60		23.65	0.000583	2.11	108.44	42.39	0.19

HEC-RAS Profile: Max WS (Continued)

River	Reach	River Sta	Profile	Plan	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)	
LRSP Channel	1	1500	Max WS	100Yr Final	253.05	19.57	24.30		24.37	0.000639	2.53	146.10	47.41	0.21
LRSP Channel	1	1500	Max WS	10Yr Final	160.05	19.57	23.42		23.48	0.000595	2.11	106.83	42.14	0.20
LRSP Channel	1	1200	Max WS	100Yr Final	247.53	19.43	24.11		24.18	0.000633	2.50	145.11	47.87	0.21
LRSP Channel	1	1200	Max WS	10Yr Final	156.27	19.43	23.25		23.30	0.000587	2.08	106.06	42.50	0.19
LRSP Channel	1	900	Max WS	100Yr Final	200.70	19.30	23.93		23.98	0.000440	2.07	141.30	46.78	0.17
LRSP Channel	1	900	Max WS	10Yr Final	135.41	19.30	23.09		23.13	0.000458	1.83	104.04	41.73	0.17
LRSP Channel	1	600	Max WS	100Yr Final	159.51	19.16	23.83		23.86	0.000267	1.62	143.33	47.02	0.14
LRSP Channel	1	600	Max WS	10Yr Final	109.94	19.16	22.97		22.99	0.000295	1.47	104.87	41.83	0.14
LRSP Channel	1	300	Max WS	100Yr Final	154.72	19.03	23.76		23.79	0.000239	1.55	146.01	47.38	0.13
LRSP Channel	1	300	Max WS	10Yr Final	97.60	19.03	22.90		22.92	0.000218	1.28	107.36	42.20	0.12
LRSP Channel	1	0	Max WS	100Yr Final	151.30	18.89	23.69		23.72	0.000215	1.48	149.44	47.78	0.12
LRSP Channel	1	0	Max WS	10Yr Final	85.01	18.89	22.84		22.86	0.000151	1.08	111.00	42.69	0.10