

ANGEL PARK MIDDLE BRANCH DRAINAGE STUDY



FINAL REPORT
VOLUME 1

AUGUST 8, 2008



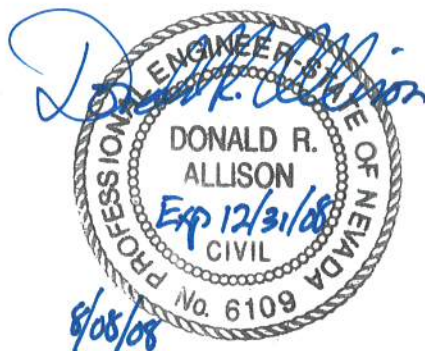
FINAL REPORT
VOLUME 1

FOR

**ANGEL PARK MIDDLE BRANCH
DRAINAGE STUDY**

PREPARED FOR

**CITY OF LAS VEGAS
DEPARTMENT OF PUBLIC WORKS
City Hall, Fourth Floor
400 East Stewart Street
Las Vegas, Nevada 89101**



**PREPARED
AUGUST 8, 2008**

BY

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Angel Park Middle Branch Hydraulic Report

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Foreword

The City of Las Vegas engaged Bureau Veritas North America, Inc. to prepare this Angel Park Middle Branch Preliminary Drainage Report on March 21, 2008 under Agreement No. 07-25283. The City of Las Vegas prepared the aerial topographic map used in this report.

We are pleased to thank the following project team that provided input and support to this project:

- Robert Welch, P.E., City of Las Vegas
- Oh Sang Kwon, P.E., City of Las Vegas
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1.0 Hydraulic Conditions

1.1 Background

The project site is located on 80 acres of undeveloped land in the western Las Vegas Valley, in the NE1/4, NW1/4 of Section 31, Township 20 South, Range 60 East, Mount Diablo Base and Meridian (MDB&M). The site is located east of Hualapai Way and north of Alta Drive in the Summerlin master plan community of Las Vegas. The parcel is zoned C-V (Civic), APN# 138-31-101-002, and is owned by the City of Las Vegas (see Figures 1 and 2).



Project Site

Figure 1. Vicinity Map. The project site is located in the western Las Vegas Valley. Not to scale. North is to the top.

The Angel Park Golf Course is in the vicinity of the site, abutting the west right-of-way of Hualapai Way. A natural channel that is approximately 400 to 500 feet wide at various cross sections traverses the Angel Park Golf Course, is conveyed east under Hualapai Way, and continues east through the project site. The top of the existing channel is naturally armored with caliche, a calcium carbonate rich, cemented, desert hardpan that is very strong and resistant. It appears the channel bed and adjacent sides have been graded.



Figure 2. Location Map. The project site is located immediately east of Hualapai Way, and north of Alta Drive, in the City of Las Vegas. Not to scale. North is to the top.



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The channel slope varies approximately between 2 and 3 percent to the east (see Figure 3).



Figure 3. View of channel looking east from Hualapai Way. Note the caliche at the top of the channel. The bottom and sides appear graded, comprised of sand and gravel.

The upstream (west) boundary of the site is Hualapai Way, where a dual 12-foot by 10-foot reinforced concrete box culvert (2, 12' x 10' RCB) conveys flows from west to east (Figures 4 and 5). The two (2) 12' x 10' RCB structure is approximately 350-feet long and has a dog-legged alignment. Upstream of the 2, 12' x 10' RCB, the culvert transitions to a 50-foot long dual 18-foot by 12-foot section (2, 180' x 12' RCB, Figure 6). Local drainage structures tie into the north and south barrels of the dual box culvert.



Figure 4. (2), 12' x 10' RCB outlet under Hualapai Way, looking west (upstream). Note 24-inch outlet on south wingwall.



Figure 5. (2), 18' x 12' RCB inlet under Hualapai Way, looking northeast (downstream). Angel Park Golf Course is immediately to the north (left).

Bureau Veritas measured the boxes on May 15, 2008, and found that the upstream boxes at the entrance were:

- ◆ North Box: 18' 0" wide by 11' 9" high
- ◆ South Box: 17' 11" wide by 11' 9" high
- ◆ Center Wall: 8" rounded

The downstream boxes were 12' wide by 10' 5" high with 1' fillets. This information was used in the hydraulic models.





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1.2 Geomorphology

Before development of the western Las Vegas Valley, the natural wash traversing the site was part of an alluvial drainage network, conveying storm flows west to east across the Las Vegas Valley. The Las Vegas Valley is part of the Basin and Range Physiographic Province, consisting of isolated mountain ranges that rise from alluvial filled desert basins. Typical features are the abrupt, narrow mountain ranges that trend north-south, the adjacent piedmont slopes, and the basin floor. Many basins (bolsons) within the province are closed to drainage, with large playas located at the lower elevations of the basin. The Las Vegas Valley is a semi-bolson that drains through the Las Vegas Wash to Lake Mead, the inundated portion of the ancient Colorado River valley. The subject site is located on the piedmont east of the Spring Mountains, consisting of alluvial fan remnants, inset fans, and other alluvial fan related topography.

The Spring Mountains to the west provide the source rock for the subject site, including carbonate rich limestone and dolomite with interbedded layers of sandstone, siltstone, and shale. Much of the limestone and dolomite stratigraphy includes chert nodules that weather out of the limestone. The chert nodules and limestone rich source rock have added to weather resistant lithology in desert pavement at the site. Generally, caliche (or calcrete) is formed when carbonate rich soils form cemented, indurated layers that are highly resistant to erosion.

Natural, underlying soils at the site have been classified as Soil Type 152, *Cave*. This soil is characterized by gravelly fine sandy loam on 0 to 4% slopes, consisting of lenticular fan remnants with a convex cross section. *Cave* has three distinct layers, namely, 1) 0 to 12 inches of gravelly fine sandy loam, 2) 12 to 36 inches of indurated soil, and 3) 36 to 60 inches of very gravelly sandy loam (see Figure 7).

Examples of cemented, indurated, caliche soils typical of *Cave* can be seen in Figure 3. The soils provide a natural resistant layer to erosion, consisting predominantly of cemented limestone and chert clasts. The natural wash traversing the subject site is therefore armored naturally by the presence of the caliche in *Cave* soils and is comparatively more resistant to erosion.



Figure 7. Soils map of the Las Vegas Valley (from Natural Resources Conservation Service). Soil Type 152, *Cave*, consists of remnant fan deposits.



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1.3 Regional and Local Flood Control Facilities

The project site is part of the Clark County Regional Flood Control District (CCRFCD) facilities, Angel Park Middle Branch (APMD) 0030 to 0133. Figure 8 (below) is taken from the CCRFCD 2002 Las Vegas Valley Master Plan Update (2002 MPU) showing the existing facilities at the site, including the natural channel and the 2, 12' x 10' RCB under Hualapai Way.

Local facilities are primarily the storm drain system installed as part of the Summerlin Master Plan, shown in black on Figure 8. Three local facilities are tied to the 2, 12' x 10' RCB in Hualapai Way, namely 1) a 60-inch reinforced concrete pipe (RCP) that drains into the south barrel, 2) a 48-inch RCP that drains into the north barrel, and 3) a 24-inch RCP that drains to the south wingwall on the downstream side of the 2, 12' x 10' RCB. The 60-inch RCP drains local Summerlin Master Plan villages, whereas the 48-inch RCP drains the Angel Park Golf Course. The 24-inch RCP is a nuisance drain located in the sag at the vertical curve on Hualapai Way.



Figure 8. Master Plan Facility APMD 0030 traverses the subject site. APMD 0132 represents 2, 12' x 10' RCB's under Hualapai Way. Blue indicates existing facilities in 2002 MPU. Black lines represent local storm drain facilities part of the Summerlin Master Plan. Not to scale. North is to the top (From CCRFCD 2002 MPU for the Las Vegas Valley, Sheet No. F-11)

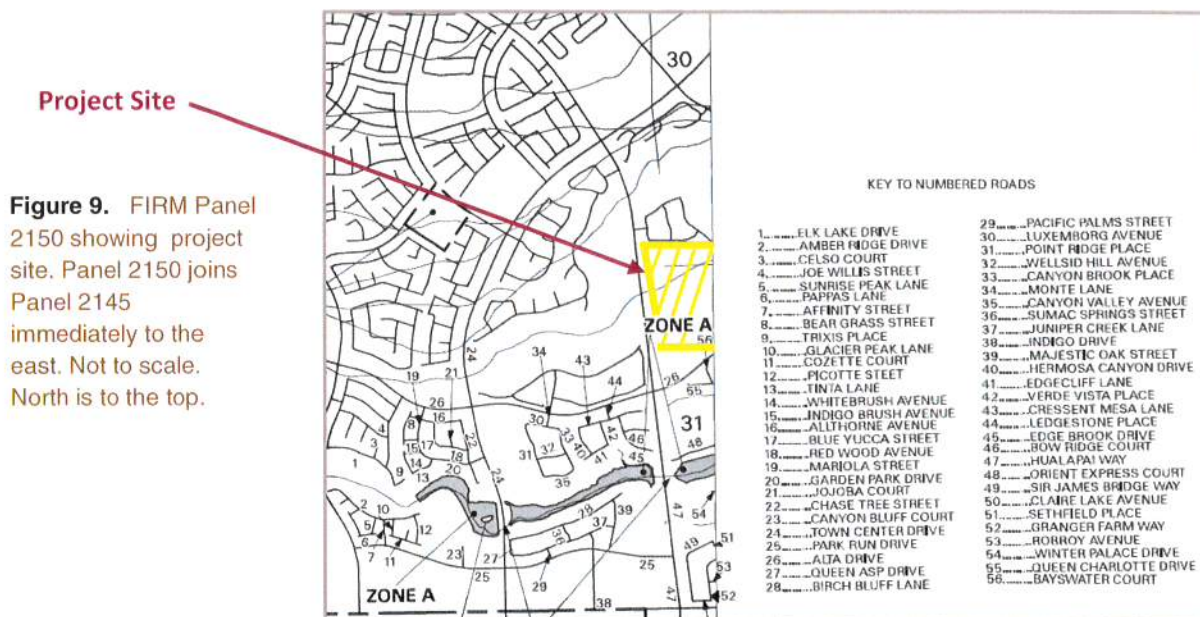


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1.4 Federal Emergency Management Agency (FEMA)

A review of Flood Insurance Rate Maps (FIRMs) indicates the subject site is not in a Special Flood Hazard Area (SFHA) and does not require amendments to the Flood Insurance Rate Maps (FIRMs). FIRM Panel No. 32003C2150E, revised September 27, 2002, is shown in Figure 9.



1.5 Hydrology

The existing and developed watershed consists of approximately 11.78 square miles of drainage area that drains west to east until reaching Hualapai Way. The existing conditions represent partial build-out of the ultimate, master planned watershed. Design flows reflect developed conditions and are the worst-case peak discharge through the project site.

1.5.1 Existing Conditions

The existing watershed is partially developed, consisting of undeveloped, mountainous terrain to the west, to the developed high density residential villages of Summerlin to the east. Undeveloped alluvial piedmont is typical of the western Las Vegas Valley, with many natural, indurated, incised washes. Detention Basin No. 5 (DB5) catches storm runoff from natural washes upstream, and discharges the attenuated hydrograph downstream into natural washes, ultimately to the Angel Park system. DB5 was constructed in 1997 and has undergone modifications since that time. The emergency spillway on DB5 drains storm flows greater than the 100-yr storm onto an indurated, hardened, side wash in the alluvial piedmont. Generally, storm flows approaching DB5 and north of DB5 drain towards the I-215 beltway channel and into the Angel Park system, until reaching Hualapai Way in a natural wash.



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1.5.2 Developed Conditions

The developed, upstream drainage area extends into the mountains west of the site, to undeveloped terrain similar to existing conditions. The drainage area also includes future medium density residential buffer at the development boundary, and high density residential development for the remainder of the watershed. Curve numbers for the watershed vary depending on soils and development. For the undeveloped, western edge of the watershed, curve numbers vary approximately between 83 and 85. By contrast, the developed, eastern edge of the watershed shows curve numbers between 88 and 90.

Storm flows are conveyed through master planned facilities, such as Angel Park Middle 5 Branch (APM5) to DB5. Flows from DB5 are routed through the Angel Park – Alta Drive Branch (APAD) to the I-215 beltway. Likewise, storm flows north of DB5 approach the I-215 Angel Park Beltway Branch (APBE) and are conveyed south until Alta Drive. At the Alta Drive, I-215 overpass, APAD 0000 represents 2, 12' x 8' reinforced concrete box culverts (RCBC) and APBE 0000 represents 3, 12' x 8' RCBC. Both systems combine to form the Angel Park Middle Branch (APMD) 0200, a concrete channel 50' wide, 6.5' deep, with 2:1 side slopes. The facility transitions to APMD 0150, a concrete channel 40' wide, 7.5' deep with 2:1 side slopes, which ultimately discharges into the natural wash at the Angel Park Golf Course. Concentration Point C3A is located immediately west of Hualapai Way, upstream of the project site.

1.5.3 Design Storm

Clark County criteria uses the 6-hour storm as a basis for facility design. Because the watershed area is 11.78 square miles, this corresponds to Storm Distribution Number 4 according to the CCRFCD Hydrologic Criteria and Drainage Design Manual (Design Manual) because the drainage area is between 8 and 12 square miles. CCRFCD provided the hydrology into two series, that is, Series A and Series B. Series A provided the worst case peak discharge for the site, at 6,047 cfs with a lag time of 3.83 hours. A depth area reduction factor of 0.85 was applied for storm areas between 11 and 12 square miles. File "allgow4.dat" of the CCRFCD

Technical Appendix was run to produce an output hydrograph at concentration point C3A, associated with the west side of Hualapai Way (Figure 10).

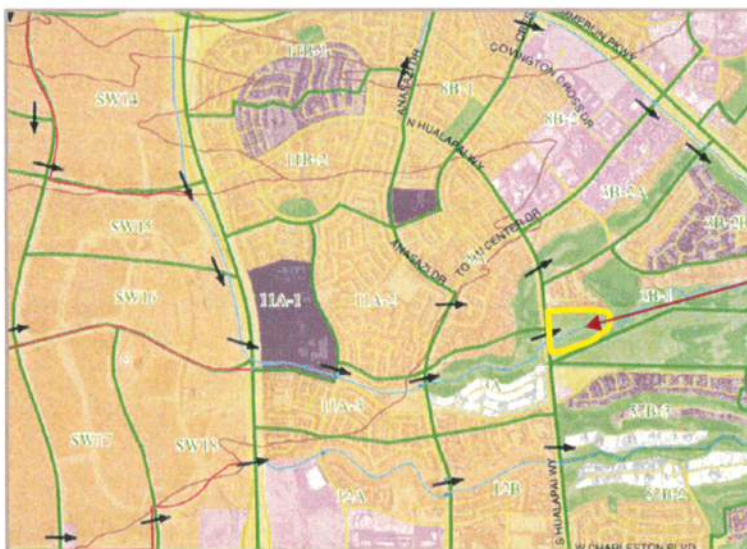


Figure 10. Project site is located in subbasin 3A, immediately east of Hualapai Way. Concentration Point C3A indicates 6,047 cfs at the 2, 12' x 10' RCB's under Hualapai. Not to scale. North is to the top. (From CCRFCD 2002 MPU for the Las Vegas Valley, Sheet No. H-11).



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The discharge of 6,047 cfs represents the peak discharge of a synthetic hydrograph generated by HEC-1, a US Army Corp of Engineer's Flood Hydrograph Package that utilizes SCS Unit Hydrograph Methodology, used as a basis for the CCRFCD 2008 MPU. Input data for the SCS Dimensionless Unit Hydrograph method consists of a single parameter, TLAG, which is equal to the lag (in hours) between the center of mass of rainfall excess and the peak of the unit hydrograph. Because Clark County uses a 6-hour design storm, the center of mass of rainfall excess is approximately 3 hours.

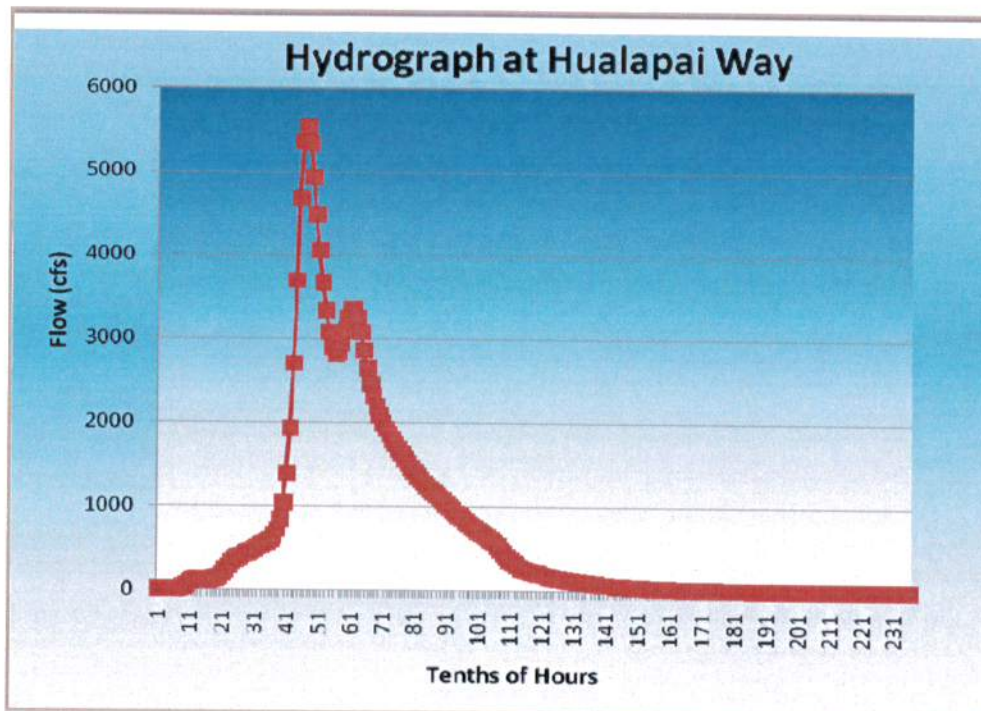


Figure 11. Hydrograph at Hualapai Way, immediately upstream of the project site. Peak discharge is 6,047 cfs at 3.83 hours lag. Note that the time to peak corresponds to 6.83 hours, according to SCS unit hydrograph methodology. (CCRFCD 2008 MPU output at concentration point C3A, file no. allgow4.dat).

The HEC-1 model and CCRFCD 2002 MPU file allgow4.dat was modified to provide the output values for the hydrograph at concentration point C3A. The resultant hydrograph was then imported into Microsoft Excel, and plotted (see Figure 11 above). It is important to note that routing of the hydrograph through the 2, 12' x 10' RCB under Hualapai Way results in backwater developing behind the box culverts, until about 4,000 cfs is reached. At this discharge, flow begins to spill over into the adjacent ravine on the west side of Hualapai Way, effectively truncating the hydrograph above 4,000 cfs. The volume of flow between 4,000 cfs and the peak discharge is stored until the hydrograph passes, and the adjacent ravine is drained, similar in function as an offline peaking basin.

Local drainage facilities also drain to concentration point C3A, such as the 60-inch storm drain on Hualapai Way, or the 48-inch storm drain from the Angel Park Golf Course. The hydrograph from the corresponding drainage area peaks earlier than the regional hydrograph, and therefore should not add to the regional flow peak discharge.



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2.0 Hydraulic Model Input

Three steady-state HEC-RAS hydraulic models (v 4.0) were used to simulate Alternative 1 – the natural channel, including 4,000 cfs, 5,548 cfs, and 6,047 cfs models.

Additionally, two steady state, alternatives were modeled in HEC-RAS at 6,047 cfs. The Alternative II model with riprap side slopes, 1.5:1, was prepared to simulate an improved channel with a base width of 100 feet. Alternative III, with riprap in the lower 10-feet, and side slopes cut back to 3:1, was also prepared to simulate an improved channel with the same channel base width of 100-feet. In Alternative II and Alternative III, it was assumed that the site would be graded to fit the channel configuration.

The United States Army Corp of Engineers (USACE) developed HEC-RAS to perform one-dimensional hydraulic calculations for natural and man-made channels. In this case, HEC-RAS was used to simulate the 2, 12' x 10' culverts under Hualapai Way and the downstream natural channel. Water surface elevations were calculated for steady, gradually varied flow in the channel by solving for the energy equation. However, the momentum equation was used where flow becomes rapidly varied, such as at hydraulic jumps, or at the dual box culverts. Losses are based on channel friction, and entrance and exit losses associated with the dual box culverts.

The natural channel was modeled at 4,000 cfs, 5,548 cfs, and 6,047 cfs. The 4,000 cfs flow rate corresponds to the upstream culvert and channel capacity, west of Hualapai Way. Flows above 4,000 cfs over top the left over bank and spill into the channel immediately to the north. The flow rate of 5,548 cfs corresponds to the published flow rate in the 2002 CCRFCD MPU, and the flow rate of 6,047 cfs was provided by the City of Las Vegas as the 2008 CCRFCD MPU. This latest flow rate models the completely developed upstream watershed. These three flow rates were used to model the existing channel.

Similar input values were used for all flow simulations, including hydraulic cross sections, over bank stations, culvert routine input, bridge routine input, and other input values necessary to perform the hydraulic analyses. Manning's roughness coefficients were established from the CCRFCD Design Manual with the natural bank set at $n=0.35$, riprap banks at $n=0.35$ and channel bottom set at $n=0.25$.

2.1 Hydraulic Cross Sections

Hydraulic cross sections were taken at 100-foot spacing, from Station -39+00 on the downstream limit of the project site, to Station -4+85 upstream of Hualapai Way. The cross sections were taken from an aerial photogrammetric map of the site prepared by the City of Las Vegas for this report. Cross section station and elevation data were input from left to right looking downstream, using the latest project topography, consistent with USACE procedures. Negative centerline stations were used to reconcile hydraulic cross sections in HEC-RAS to centerline cross sections established in Autodesk Land Desk. Typically, HEC-RAS cross sections increase from downstream to upstream, which is consistent with the negative stationing. Cross sections were later interpolated to 1-foot between the 100-foot cross sections. This was done to reduce conveyance changes between the 100-foot cross sections.



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Hydraulic cross sections immediately downstream and upstream of the culverts have been input consistent with USACE protocol. Ineffective flow areas were input at Station -10+05 and Station -5+95 to the top of the respective culvert soffits. Both sections were taken five feet downstream and upstream of the culvert face. At Station -10+05, ineffective flow stations were set -12.3 feet and +12.3 off the channel centerline, assuming an 8-inch thick interior wall for the double box culvert. Similarly, at Station -5+95, ineffective flow stations were set at -18.3 feet and +18.3 feet off the channel centerline.

Flows above 4,000 cfs at Hydraulic cross section Station -5+95, west of Hualapai Way, were assumed to spill over into the adjacent golf course fairway, west of Hualapai and north of the main channel.

Left over bank and right over bank stations were artificially set at the base of the natural channel to distinguish between channel and side slope roughness coefficients. Also, hydraulic cross sections -35+00 to -39+00 were taken adjacent a green at the Angel Park Golf Course. A straight wall was input to reflect the retaining wall that supports the green.

2.2 Culvert Routine

The HEC-RAS culvert editor was used to input the culvert under Hualapai Way. The culvert editor was used to input the two 350-ft long, 12' x 10' RCBs. Immediately upstream of the 2, 12' x 10' RCB, the dual RCB transitions over 50-feet to a 2, 18'x 12' RCB at the culvert entrance. The culvert routine could not simulate this transition.

The culvert station was set at Station -9+00. Hualapai Way was assumed to behave as a straight, broad crested weir ($C=2.6$), with a high chord set at elevation 2895 feet. This assumption was made for the possibility that the flow would overtop Hualapai Way. The low chord of the 2, 12' x 10' RCB was input at the soffit of the box, and the adjacent ground surface. This effectively simulated the blocked flow condition at Hualapai Way forcing conveyance of storm flows through the 2, 12' x 10' RCB under Hualapai Way.

The energy equation was used to estimate conveyance through the culverts. Cross sections were taken 5-feet upstream and downstream of the culvert face to simulate both contraction and expansion losses. It was assumed that expansion at the culvert outlet occurred within the first 5 feet of the downstream culvert face, with ineffective flow areas set at the dual culvert width of 25-feet. It was also assumed that contraction occurred gradually between Stations -4+85 and -5+95, where ineffective flow areas were set at the dual culvert width of 40.7-feet. Contraction and expansion losses were set at 0.3 and 0.5 respectively, for the bridge entrance and culvert exit.

2.3 Manning's Roughness Coefficients

Roughness coefficients for various channel linings were compared to estimate friction losses associated with bottom channel and side channel surfaces. A Manning's roughness coefficient of 0.025 was set to simulate the channel bottom, comprised mostly of sand and gravel. By contrast, the natural channel sides are comprised of caliche and rock, and therefore a



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Manning's roughness coefficient of 0.035 was used. These values compare favorably with other arid locations in the desert southwest, such as natural channels found in Arizona, and are consistent with the USGS, and CCRFCD Hydrologic Criteria and Drainage Design Manual roughness coefficient guidelines. Where rock was used as an alternative to leaving the channel in its natural condition, 0.035 was also used as the Manning's roughness coefficient. Concrete surfaces at the culvert were set at 0.013. It is important to note that the model output velocities are sensitive to the roughness coefficient selection.

3.0 Hydraulic Model Output

The natural channel (Alternative I) was modeled for flow rates of 4000 cfs, 5,548 cfs, and 6,047 cfs using the HEC-RAS model in the mixed flow regime (both subcritical and supercritical flow). Alternative II and Alternative III were simulated at 6,047 cfs. The following discusses the model output for each model.

ALTERNATIVE I

3.1 Natural Channel: 4,000 cfs

Results of the 4,000 cfs model show that flow is predominantly supercritical in the natural channel downstream of the Hualapai Way box culverts. Flow upstream of Hualapai Way is also supercritical until the flow constriction upstream of the dual box culverts forces a hydraulic jump, into the subcritical flow regime. The model has this jump occurring upstream of Station -4+85.4,000 cfs was roughly estimated as the maximum flow that could occur through the dual box culverts under Hualapai Way without causing overflow to the adjacent channel, immediately north of the natural channel being modeled, and west of Hualapai Way. Station -5+95 shows a water surface elevation of 2882.28 feet, which approximately corresponds to the highest physical point of the left over bank.

A hydraulic jump may appear in the vicinity of Station -17+00 as the Froude number is less than 0.85. This location is associated with a widening of the channel which may serve as a natural energy dissipater at that location. A gully draining from the north contributes to the wider channel configuration. It is important to note that both supercritical and subcritical flow is contained in the natural channel with more than adequate freeboard.

Velocities for the entire reach from Station 39+00 to -4+85 were averaged for the left over bank, channel, and right over banks. The left over bank and right over bank velocities averaged about 8.5 fps, as compared to an average channel velocity of 19 fps. Recalling that the left and right over bank stations were set at the left and right base of the channel, the left and right over bank values estimate velocities against the side of the channel. The velocities are therefore sensitive to the difference in roughness values assigned to the channel bottom versus the channel sides. As expected, a minimum velocity of 10.2 fps occurs upstream of the culverts at Hualapai Way, at Station -4+85, reflecting the backwater condition upstream of the culverts. By contrast, maximum velocities occur between Stations -11+00 and -15+00, with a peak velocity of 30.79 fps at Station -11+00. Flow through the culverts transitions from subcritical to supercritical, exiting at supercritical velocities until Station -17+00. After the hydraulic jump in the vicinity of Station -17+00, the 4,000 cfs model flows return to the supercritical flow regime at



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comparatively slower velocities than at the culvert outlet.

Depth of flow ranges from 2.15 feet at Station -19+00 to 12.78 feet at Station -5+95, as expected given the backwater conditions upstream of Hualapai Way. Depth of flow increases from approximately 3.4 feet at Station -16+00 to 6.2 feet at Station -17+00, reflecting the change from supercritical to subcritical flow. The average flow depth is approximately 5.1 feet.

The Froude number also reflects the above conveyance parameters. The average Froude number shows supercritical flow, at 1.76, with the minimum Froude number occurring at backwater conditions in subcritical flow at Station -5+95. The maximum Froude number of 3.13 occurs at Station -34+00.

The HEC-RAS flow data is included in the Appendix for the 4,000 cfs, 5,548 cfs, and 6,047 cfs runs along with cross sections.

3.2 Natural Channel: 5,548 cfs

Results of the 5,548 cfs model show that flow is also predominantly supercritical in the natural channel downstream of the Hualapai Way box culverts. Flow upstream of Hualapai Way is supercritical until the flow constriction upstream of the dual box culverts forces a hydraulic jump, into the subcritical flow regime. The model has this jump occurring somewhere upstream of Station -4+85.

Flow in the natural channel remains supercritical at this flow rate. Although a hydraulic jump may appear in the vicinity of Station -17+00 at 4,000 cfs, this is not the case at 5,548 cfs.

Velocities for the entire reach from Station -39+00 to -4+85 were averaged for the left over bank, channel, and right over banks. Velocities for the left over bank averaged about 8.9 fps, whereas velocities for the right over bank averaged higher, at 9.5 cfs. The average channel velocity was about 20 fps.

As expected, a minimum velocity of 7.34 fps occurs upstream of the culverts at Hualapai Way, at Station -4+85, reflecting the backwater condition upstream of the culverts. By contrast, maximum velocities occur between Stations -11+00 and -15+00, with a peak velocity of 33 fps at Station -12+00. Flow through the culverts transitions from subcritical to supercritical, exiting at supercritical velocities.

Depth of flow ranges from 2.8 feet at Station -19+00 to 20.6 feet at Station -5+95, as expected given the backwater conditions upstream of Hualapai Way. The average flow depth is approximately 6.6 feet.

The Froude number also reflects the above conveyance parameters. The average Froude number shows supercritical flow, at 1.8, with the minimum Froude number occurring at backwater conditions in subcritical flow at Station -5+95. The maximum Froude number of 3.2 occurs at Station -34+00.

The HEC-RAS flow data is included in the Appendix for the 4,000 cfs, 5,548 cfs, and 6,047 cfs runs. Also included is a profile of the 6,047 run along with cross sections.



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3.3 Natural Channel: 6,047 cfs

Results of the 6,047 cfs model show that flow is also predominantly supercritical in the natural channel downstream of the Hualapai Way box culverts. Flow upstream of Hualapai Way is supercritical until the flow constriction upstream of the dual box culverts forces a hydraulic jump, into the subcritical flow regime. The model has this jump occurring somewhere upstream of Station -4+85.

Velocities for the entire reach from Station -39+00 to -4+85 were averaged for the left over bank, channel, and right over banks. Velocities for the left over bank averaged about 9.2 fps, whereas velocities for the right over bank averaged higher, at 9.8 fps. The average channel velocity was about 21 fps. As expected, a minimum velocity of 6.4 fps occurs upstream of the culverts at Hualapai Way, at Station -5+95, reflecting the backwater condition upstream of the culverts. By contrast, maximum velocities occur between Stations -11+00 and -19+00, with a peak velocity of 34 fps at Station -12+00. Flow through the culverts transitions from subcritical to supercritical, exiting at supercritical velocities.

Depth of flow ranges from 3.2 feet at Station -34+00 to 23 feet at Station -5+95, as expected given the backwater conditions upstream of Hualapai Way. The average flow depth is approximately 7.4 feet.

The Froude number also reflects the above conveyance parameters. The average Froude number shows supercritical flow, at 1.7, with the minimum Froude number occurring at backwater conditions in subcritical flow at Station -5+95. The maximum Froude number of 3.2 occurs at Station -34+00.

The HEC-RAS flow data is included in the Appendix for the 4,000 cfs, 5,548 cfs, and 6,047 cfs runs along with cross sections.

This latest run simulates the current, 2008 MPU Flow rate. This is the design flow rate to be used for the project site.



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ALTERNATIVE II

3.4 Improved Channel: 6,047 cfs, 1.5:1 riprap side slopes

This model simulates optimizing the developable area on the site by restricting the channel width.

Results of this model run show that flow is supercritical in the natural channel downstream of the Hualapai Way box culverts. Flow upstream of Hualapai Way is also supercritical until the flow constriction upstream of the dual box culverts forces a hydraulic jump, into the subcritical flow regime. The model has this jump occurring somewhere upstream of Station -4+85.

Velocities for the entire reach from Station -39+00 to -4+85 were averaged for the left over bank, channel, and right over banks. The left over bank averaged about 6.5 fps, whereas velocities for the right over bank averaged about 7.2 fps. The channel velocity averaged 18 fps. The comparatively slower left and right over bank velocities reflect the roughness associated with riprap, and are well within the velocity range of 5 to 10 fps for riprap. Recalling that the left and right over bank stations were set at the left and right base of the channel, the left and right over bank values estimate velocities against the side of the channel. The velocities are therefore sensitive to the difference in roughness values assigned to the channel bottom versus the channel sides.

As expected, a minimum velocity of 5 fps occurs upstream of the culverts at Hualapai Way, at Station -5+95, reflecting the backwater condition upstream of the culverts. By contrast, maximum velocities occur between Stations -11+00 and -15+00, with a peak velocity of 34 fps at Station -11+00. Flow through the culverts transitions from subcritical to supercritical.

Depth of flow ranges from 1.8 feet at Station -11+00 to 27 feet at Station -5+95, as expected given the backwater conditions upstream of Hualapai Way. The average flow depth is approximately 6 feet.

The Froude number also reflects the above conveyance parameters. The average Froude number shows supercritical flow, at 1.7, with the minimum Froude number occurring at backwater conditions in subcritical flow at Station -5+95. The maximum Froude number of 4.5 occurs at Station -11+00.

The HEC-RAS flow data is included in the Appendix for the 6,047 cfs runs along with cross sections.



Angel Park Middle Branch Hydraulic Report

Final Report

ALTERNATIVE III

3.5 Improved Channel: 6,047 cfs, 3:1 riprap slopes

Results of this model run show that flow is supercritical in the natural channel downstream of the Hualapai Way box culverts. Flow upstream of Hualapai Way is also supercritical until the flow constriction upstream of the dual box culverts forces a hydraulic jump, into the subcritical flow regime. The model has this jump occurring somewhere upstream of Station -4+85.

Velocities for the entire reach from Station -39+00 to -4+85 were averaged for the left over bank, channel, and right over banks. The left over bank averaged about 8.4 fps, whereas velocities for the right over bank averaged about 9.3 fps. The channel velocity averaged 21 fps. The comparatively higher left and right over bank velocities reflect the roughness associated with a graded channel, and would still require some form of armoring according to CCRFCD criteria. Recalling that the left and right over bank stations were set at the left and right base of the channel, the left and right over bank values estimate velocities against the side of the channel. The velocities are therefore sensitive to the difference in roughness values assigned to the channel bottom versus the channel sides.

As expected, a minimum velocity of 5 fps occurs upstream of the culverts at Hualapai Way, at Station -5+95, reflecting the backwater condition upstream of the culverts. By contrast, maximum velocities occur between Stations -11+00 and -15+00, with a peak velocity of 34 fps at Station -11+00. Flow through the culverts transitions from subcritical to supercritical.

Depth of flow ranges from 1.7 feet at Station -11+00 to 26 feet at Station -5+95, as expected given the backwater conditions upstream of Hualapai Way. The average flow depth is approximately 5.7 feet.

The Froude number also reflects the above conveyance parameters. The average Froude number shows supercritical flow, at 1.73, with the minimum Froude number occurring at backwater conditions in subcritical flow at Station -5+95. The maximum Froude number of 4.62 occurs at Station -11+00.

The HEC-RAS flow data is included in the Appendix for the 6,047 cfs runs along with cross sections.



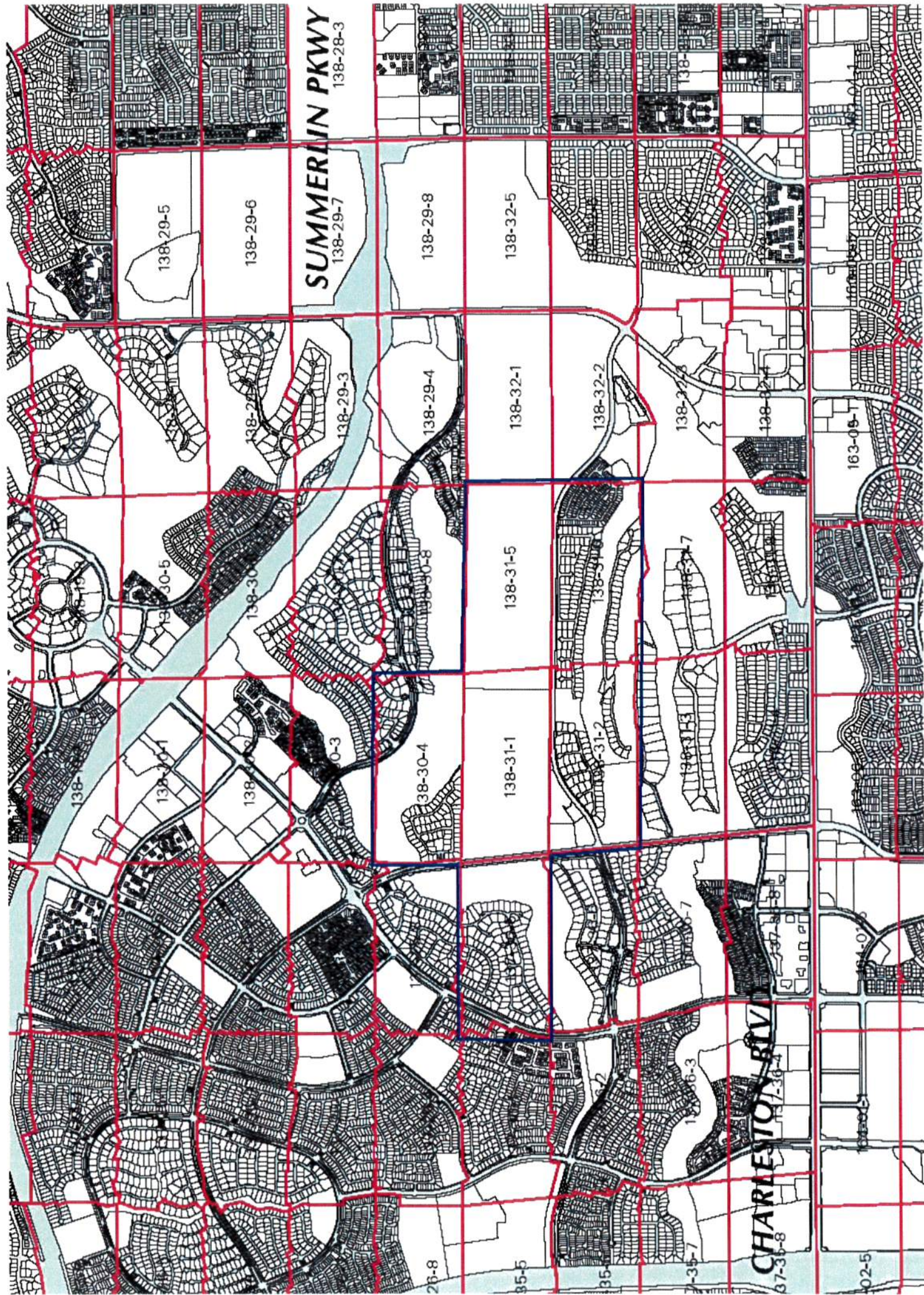
Angel Park Middle Branch Hydraulic Report

Final Report

4.0 Assessor Parcel Information

The Angel Park Middle Branch site is Assessor Parcel 138-31-101-002, consisting of 80.19 gross acres. On the following page is a map showing the adjacent parcels to "138-31-1" which is the parcel map page for Parcel 138-31-101-002. This parcel map, along with all adjoining maps, are on the following this pages. We have included an aerial photograph of this parcel outlined in red, so that the adjacent development can be seen.

More specific parcel information is available at the Clark County Assessor's Office at the Government Center (500 S. Grand Central Parkway, Las Vegas, NV 89155-1401).





NOTES

This map is for assessment use only and does NOT represent a survey. No liability is assumed for the accuracy of the data delineated herein. Information on roads and other non-assessed parcels may be obtained from the Road Document Listing in the Assessor's Office.

This map is compiled from official records, including surveys and deeds, but only contains the information required for assessment. See the recorded documents for more detailed legal information.

USE THIS SCALE(Feet) WHEN MAP REDUCED FROM 1:117 ORIGINAL

MAP LEGEND

- PARCEL BOUNDARY
- SUBD BOUNDARY
- ROAD EASEMENT
- PW/D BOUNDARY
- NON-PARCEL LOT LINE
- MATCH LINE / LEADER LINE

ASSESSOR'S PARCELS - CLARK CO., NV.
M. W. Schofield, Assessor

AVERAGE DA VALUE
35

T20S R59E

RSBE	RSSE	R60E
127	126	125
136	137	138
165	164	163

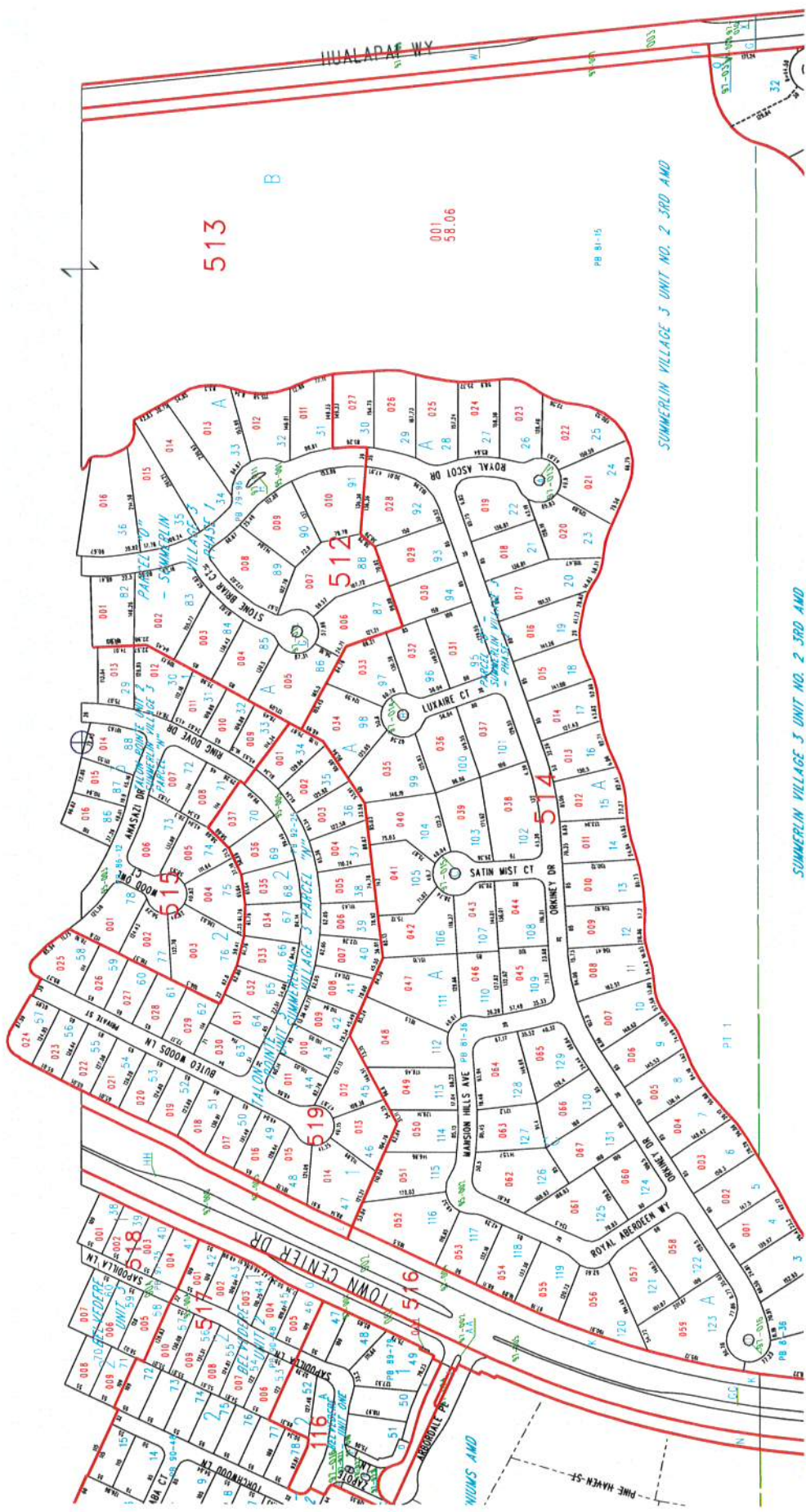
Scale: 1"=200' **Rev: 01/12/00**

PARCEL NUMBER
1.00
202
PLAT RECORDING NUMBER
5
5
BLOCK NUMBER
5
5
LOT NUMBER

36

8	4	3	2	1
8	4	3	2	1
5	1	5	1	1
6	2	6	2	2
7	3	7	3	3
8	4	8	4	4

137-36-5



GENERAL INFORMATION	
PARCEL NO.	137-36-513-001
OWNER AND MAILING ADDRESS	TOURNAMENT PLAYERS CLUB 9851 CANYON RUN DR LAS VEGAS NV 89144-0801
LOCATION ADDRESS CITY/UNINCORPORATED TOWN	LAS VEGAS
ASSESSOR DESCRIPTION	SUMMERLIN VILLAGE 3 UNIT #2 3RD AMD PLAT BOOK 81 PAGE 15 LOT 1 BLOCK B PUBLIC DRAINAGE EASEMENT SEC 36 TWP 20 RNG 59
RECORDED DOCUMENT NO.	* 20020509:00349
RECORDED DATE	05/09/2002
VESTING	NO STATUS

*Note: Only documents from September 15, 1999 through present are available for viewing.

ASSESSMENT INFORMATION AND SUPPLEMENTAL VALUE	
TAX DISTRICT	200
APPRAISAL YEAR	2007
FISCAL YEAR	08-09
SUPPLEMENTAL IMPROVEMENT VALUE	0
SUPPLEMENTAL IMPROVEMENT ACCOUNT NUMBER	N/A

REAL PROPERTY ASSESSED VALUE		
FISCAL YEAR	2007-08	2008-09
LAND	45676	46956
IMPROVEMENTS	0	0
PERSONAL PROPERTY	0	0
EXEMPT	0	0
GROSS ASSESSED	45676	46956
TAXABLE VALUE LAND+IMP	130503	134160
ESTIMATED LOT SIZE AND APPRAISAL INFORMATION		
ESTIMATED SIZE	58.06 Acres	
ORIGINAL CONST. YEAR	0	
LAST SALE PRICE MONTH/YEAR	10000000 05/02	
LAND USE	3-47 COMMERCIAL PRIVATE GOLF COURSE	
DWELLING UNITS	0	

ASSESSOR'S PARCELS - CLARK CO., NV.
M. W. Schofield, Assessor

AVERAGE DA VALUE
22

MAP LEGEND

Parcel Boundary
Sub Boundary
Road Easement
Pw/LD Boundary
Non-Parcel Lot Line
Match Line / Leader Line

Parcel Number
Acreage
Parcel Sub/Seq Number
Plat Recording Number
Block Number
Lot Number
Gov. Lot Number
Road ID Number

138-30-4

S 2 SW 4

30

T20S R60E

Scale: 1"=200'

Rev: 03/03/03

NOTES

This map is for assessment use only and does NOT represent a survey. No liability is assumed for the accuracy of the data delineated herein. Information on roads and other non-assessed parcels may be obtained from the Road Document Listing in the Assessor's Office.

This map is compiled from official records, including surveys and deeds, but only contains the information required for assessment. See the recorded documents for more detailed legal information.

USE THIS SCALE (FEET) WHEN MAP REDUCED FROM 1:12,167 ORIGINAL

0 50 100 200 400 600 800

RSSE R60E R61E

126	125	124
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GENERAL INFORMATION	
PARCEL NO.	138-31-101-002
OWNER AND MAILING ADDRESS	CITY OF LAS VEGAS 400 E STEWART AVE LAS VEGAS NV 89101-2913
LOCATION ADDRESS CITY/UNINCORPORATED TOWN	LAS VEGAS
ASSESSOR DESCRIPTION	GOV LOT 1 & PT NE4 NW4 SEC 31 20 60 SEC 31 TWP 20 RNG 60
RECORDED DOCUMENT NO.	* 0435:0350687
RECORDED DATE	04/08/1963
VESTING	NO STATUS

*Note: Only documents from September 15, 1999 through present are available for viewing.

ASSESSMENT INFORMATION AND SUPPLEMENTAL VALUE	
TAX DISTRICT	200
APPRAISAL YEAR	2007
FISCAL YEAR	08-09
SUPPLEMENTAL IMPROVEMENT VALUE	0
SUPPLEMENTAL IMPROVEMENT ACCOUNT NUMBER	N/A

REAL PROPERTY ASSESSED VALUE		
FISCAL YEAR	2007-08	2008-09
LAND	18243225	18243225
IMPROVEMENTS	0	0
PERSONAL PROPERTY	0	0
EXEMPT	18243225	18243225
GROSS ASSESSED	18243225	18243225
TAXABLE VALUE LAND+IMP	52123500	52123500
ESTIMATED LOT SIZE AND APPRAISAL INFORMATION		
ESTIMATED SIZE	80.19 Acres	
ORIGINAL CONST. YEAR	0	
LAST SALE PRICE MONTH/YEAR	0	
LAND USE	0-00 VACANT	
DWELLING UNITS	0	

ASSESSOR'S PARCELS - CLARK CO., NV.

M. W. Schofield, Assessor

MAP LEGEND

- PARCEL BOUNDARY
- SUBD BOUNDARY
- ROAD EASTMENT
- PM/LD BOUNDARY
- NON-PARCEL LOT LINE
- MATCH LINE / LEADER LINE
- ROAD ID NUMBER

138-31-2

S 2 NW 4

31

T20S R60E

Scale: 1"=200'

Rev: 06/18/08

AVERAGE DA VALUE

35

001 PARCEL NUMBER

1.00 ACRES

202 PARCEL SUB/SEQ NUMBER

137 138 139

125 126 127

128 129 130

131 132 133

134 135 136

137 138 139

140 141 142

143 144 145

146 147 148

149 150 151

152 153 154

155 156 157

158 159 160

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NOTES

This map is for assessment use only and does NOT represent a survey.

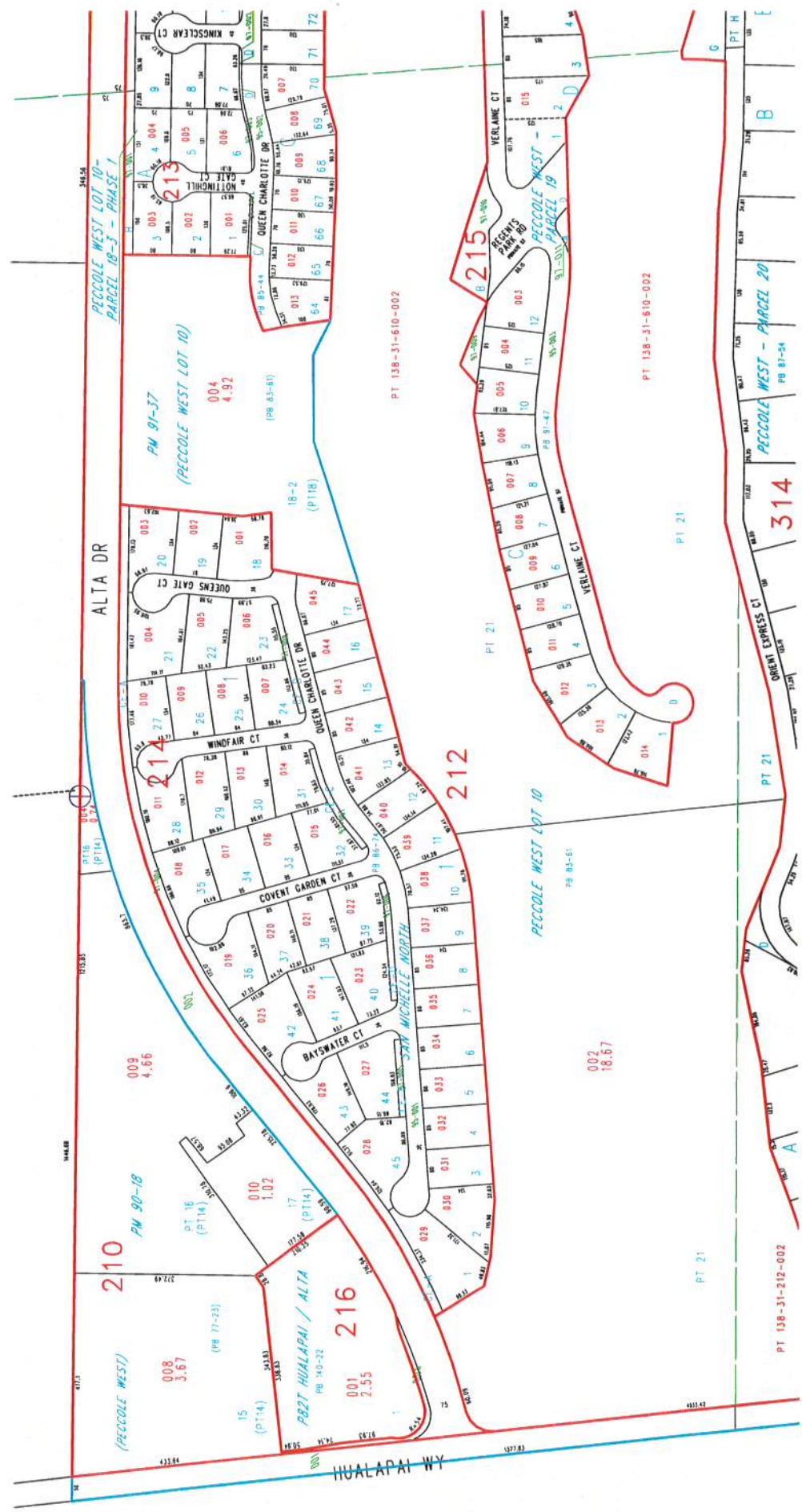
No liability is assumed for the accuracy of the data delineated herein.

Information on roads and other non-assessed parcels may be obtained from the Road Document Listing in the Assessor's Office.

This map is compiled from official records, including surveys and deeds, but only contains the information required for assessment. See the recorded documents for more detailed legal information.

USE THIS SCALE(Feet) WHEN MAP REDUCED FROM THIS ORIGINAL

0 50 100 200 400 600 800



NOTES

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USE THIS SCALE (FEET) WHEN MAP REDUCED FROM 1:12,500 ORIGINAL

MAP LEGEND

- Parcel Boundary
- Subd Boundary
- Road Easement
- PM/LD Boundary
- Non-Parcel Lot Line
- Match Line / Leader Line
- Road ID Number

ASSASSOR'S PARCELS - CLARK CO., NV.
M. W. Schofield, Assessor

AVERAGE
ON VALUE
35

120S R60E

159E	120E	121E	122E	123E	124E	125E	126E	127E	128E	129E	130E	131E	132E	133E	134E	135E	136E
125	125	124	124	123	123	122	122	121	121	120	120	119	119	118	118	117	117

Parcel Number
202

Parcel Sub/Seq Number
138

Plat Recording Number
138

Block Number
165

Lot Number
162

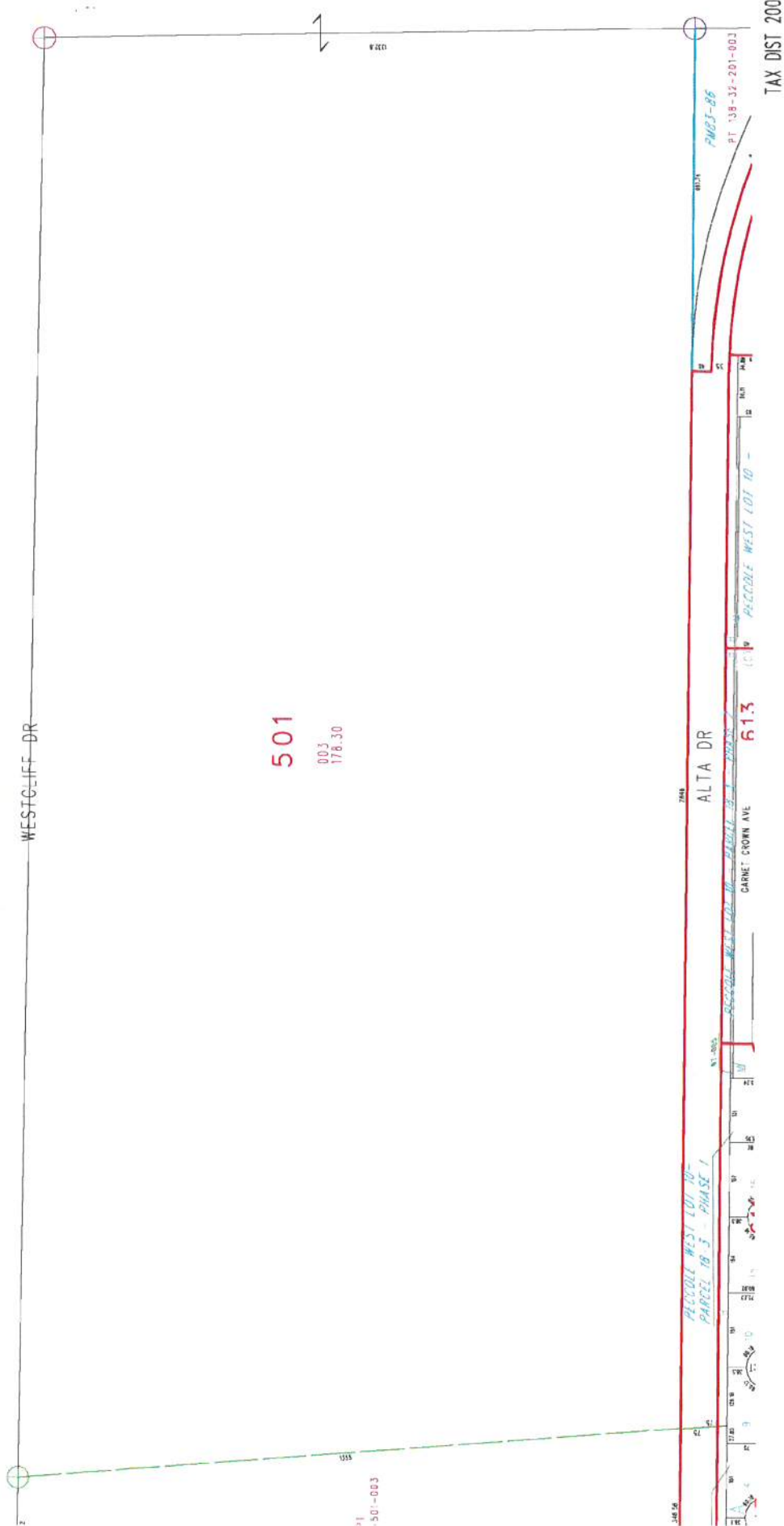
Gov. Lot Number
162

Scale: 1"=200' Rev: 07/02/03

138-31-5

N 2 NE 4

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36



TAX DIST 200

GENERAL INFORMATION	
PARCEL NO.	138-31-501-003
OWNER AND MAILING ADDRESS	CITY OF LAS VEGAS 400 E STEWART AVE LAS VEGAS NV 89101-2913
LOCATION ADDRESS CITY/UNINCORPORATED TOWN	15 S RAMPART BLVD LAS VEGAS
ASSESSOR DESCRIPTION	PT N2 N2 SEC 31 20 60 & ALL N2 NW4 SEC 32 20 60 SEC 31 TWP 20 RNG 60
RECORDED DOCUMENT NO.	* 0435:0350687
RECORDED DATE	04/08/1963
VESTING	NO STATUS

*Note: Only documents from September 15, 1999 through present are available for viewing.

ASSESSMENT INFORMATION AND SUPPLEMENTAL VALUE	
TAX DISTRICT	200
APPRAISAL YEAR	2007
FISCAL YEAR	08-09
SUPPLEMENTAL IMPROVEMENT VALUE	0
SUPPLEMENTAL IMPROVEMENT ACCOUNT NUMBER	N/A

REAL PROPERTY ASSESSED VALUE		
FISCAL YEAR	2007-08	2008-09
LAND	5121684	5126340
IMPROVEMENTS	0	0
PERSONAL PROPERTY	0	0
EXEMPT	5121684	5126340
GROSS ASSESSED	5121684	5126340
TAXABLE VALUE LAND+IMP	14633383	14646686
ESTIMATED LOT SIZE AND APPRAISAL INFORMATION		
ESTIMATED SIZE	178.30 Acres	
ORIGINAL CONST. YEAR	0	
LAST SALE PRICE MONTH/YEAR	0	
LAND USE	3-46 COMMERCIAL PUBLIC GOLF COURSE	
DWELLING UNITS	0	

This map is for assessment use only and does NOT represent a survey. No liability is assumed for the accuracy of the data delineated herein. Information on roads and other non-assessed parcels may be obtained from the Road Document Listing in the Assessor's Office.

This map is compiled from official records, including surveys and deeds, but only contains the information required for assessment. See the recorded documents for more detailed legal information.

USE THIS SCALE(FEET) WHEN MAP REDUCED FROM 11X17 ORIGINAL



ASSESSOR'S PARCELS - CLARK CO., NV.
M. W. Schofield, Assessor

AVERAGE
DA VALUE
TC

MAP LEGEND

- | | 001 | 1.00 | 202 | 202 | 5 | 5 | 5 | 5 | 5 |
|-----------------|-----|------|-----|-----|---|---|---|---|---|
| | 001 | 1.00 | 202 | 202 | 5 | 5 | 5 | 5 | 5 |
| PARCEL NUMBER | 001 | 1.00 | 202 | 202 | 5 | 5 | 5 | 5 | 5 |
| ACREAGE | 001 | 1.00 | 202 | 202 | 5 | 5 | 5 | 5 | 5 |
| PARCEL SUB/SEQ | 001 | 1.00 | 202 | 202 | 5 | 5 | 5 | 5 | 5 |
| PLAT RECORDING | 001 | 1.00 | 202 | 202 | 5 | 5 | 5 | 5 | 5 |
| LOT NUMBER | 001 | 1.00 | 202 | 202 | 5 | 5 | 5 | 5 | 5 |
| GOV. LOT NUMBER | 001 | 1.00 | 202 | 202 | 5 | 5 | 5 | 5 | 5 |

T20S	R60E	R59E	R60E	R61E
121S	120S	126	125	124
		137	138	139
		164	163	162

Scale: 1"=200'

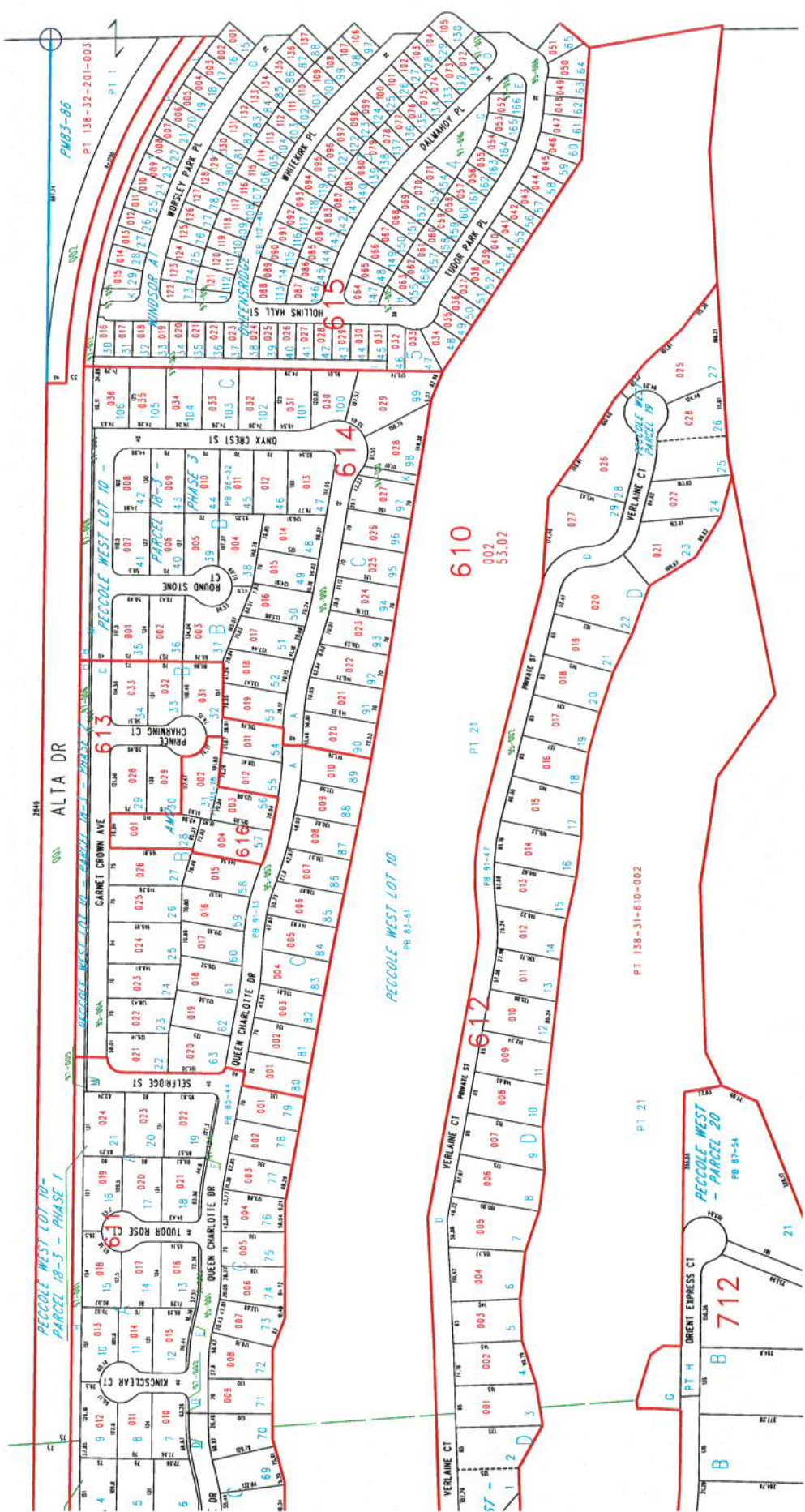
Rev:06/23/06

T20S R60E

31

S 2 NE 4

138-31-6





Angel Park Middle Branch Hydraulic Report

Final Report

5.0 Alternative Analysis

Two alternatives were considered to leaving the natural condition (Alternative I) as it exists. Alternative II consists of grading the channel to have a 100-foot wide base width with 1.5:1 side slopes to benches at a height of 20-feet from the invert. After the benches, the slope changes to 2:1 slope to allow placement of earth fill to the top of the slope. Alternative III consists of grading the channel to have the same 100-foot wide base width, but with 3:1 side slopes. There will be benches at 20-feet from the invert.

In order to price the alternatives, a preliminary design of Alternatives II and III were prepared in AutoCAD. Using Digital Terrain Model (DTM), the volume of fill was calculated. We considered several surface treatments to protect the embankment from erosion from the velocities of 20-feet per second. Concrete lining was discarded because the reduced friction would dangerously increase the velocity over 30-feet per second. This would impact the channel downstream, causing erosion and the potential for a large jump in the water surface. The velocity is too high for plain riprap and would require d_{50} of 5-feet yielding a section width of 10-feet. Instead, we propose to use grouted riprap with a d_{50} of 2.5-feet and depth of 6.0-feet as the primary solution, with 5-feet wide soil cement as a secondary solution. Both of these solutions need to be protected from piping beneath their grouted riprap sections.

5.1 Construction Costs Pricing

Construction costs were developed using NDOT, CalTrans, RW Means, City of Henderson and City of North Las Vegas costs. The average cost was used resulting in the following unit costs.

1. Channel Excavation	\$8.00/cy
2. Channel Embankment	\$10.00/cy
3. Aggregate Base	\$15.00/sy
4. Filter Fabric	\$2.50/sy
5. Grouted Riprap	\$110.00/cy
6. Soil Cement	\$40.00/sy
7. Concrete Valley Gutter, 6-feet wide	\$52.00/ft

The area of a 1' L x 34' H x 1.5:1 slope is $(62' \times 1') / 9 = 6.9$ sy/ft

The area of a 1' L X 34' H x 3:1 slope is $(108' \times 1') / 9 = 12.0$ sy/ft

The thickness of riprap is estimated to be 10' based upon a velocity of 20 fps. Grouted riprap was estimated to be 6' deep. There will be a toe cutoff with the riprap.



Angel Park Middle Branch Hydraulic Report

Final Report

5.2 Construction Cost Alternative I – Natural Conditions

	<u>QUALITY</u>	<u>UNIT COST</u>	<u>TOTAL</u>
	0.00	0.00	\$ 0.00
TOTAL			\$ 0.00

5.3 Construction Cost Alternative II – 1.5:1 Side Slopes

	<u>QUALITY</u>	<u>UNIT COST</u>	<u>TOTAL</u>
1 Channel Excavation	32,140 cy	\$ 8.00 / cy	\$ 257,120.00
2 Channel Embankment	141,000 cy	\$ 10.00 / cy	\$ 1,410,000.00
3 Rip - Rap	60,000 cy	\$ 110.00 / cy	\$ 6,600,000.00
4 Concrete Valley Gutter	2,800 ft	\$ 52.00 / ft	\$ 482,544.00
5 Contingency at 20%			\$ 1,749,933.00
TOTAL			\$ 10,499,597.00

5.3 Construction Cost Alternative III – 3:1 Side Slopes

	<u>QUALITY</u>	<u>UNIT COST</u>	<u>TOTAL</u>
1 Channel Excavation	63,500 cy	\$ 8.00 / cy	\$ 508,000.00
2 Channel Embankment	77,200 cy	\$ 10.00 / cy	\$ 772,000.00
3 Rip - Rap	112,000 cy	\$ 110.00 / cy	\$ 6,600,000.00
4 Concrete Valley Gutter	2,800 ft	\$ 52.00 / ft	\$ 145,600.00
5 Contingency at 20%			\$ 2,749,120.00
TOTAL			\$ 16,494,720.00



Angel Park Middle Branch Hydraulic Report

Final Report

5.4 Comparison of Alternatives

Alternative III is 157% more expensive than Alternative II. The alternatives are considerably more expensive than Alternative I, which has no cost.

The use of soil cement in place of riprap was analyzed. It is imperative that the Manning's "n" value of the channel banks remain at 0.035 to keep the velocity as low as possible. It may be possible to construct soil cement with rough surfaces, but its ability to resist scour is questionable. For that reason that use of soil cement was discarded.

5.5 Recommendation

It is recommended that the site be improved leaving the natural channel as it is, Alternative I. There have been major storms over the last 20 years and the channel shows no damage. In its original condition, it will not be necessary to construct much in the way of improvements. We recommend installing cable fencing along Stations 12+00 to 15+00 and 26+00 to 29+00 on the south bank, and along Stations 17+00 to 25+00 and 29+00 to 32+00 on the north bank.

The City of Las Vegas is requesting a 20' public access corridor on both sides of the natural channel. That corridor is shown on the plans included in this report. The public access corridor ends at the golf courses on the east side of the site.



Angel Park Middle Branch Hydraulic Report

Final Report

6.0 Summary

This summary separately addresses the recommendations for the existing bank configuration (Alternative I) and Alternative II and Alternative III. The second two alternatives will provide additional developable area along the existing alignment. Straightening the alignment was not considered viable because the increase in slope would increase the velocity in the channel and problems at the south Rampart Boulevard crossing.

For Alternative I, the natural channel, the increase in flow of 6,047 cfs will inundate that portion of the golf course west of Hualapai Way with the water depth at 27' at the entrance to the culverts. The Hualapai Way road surface elevation at the culverts is 2,896.5, 33 feet above the channel entrance invert.

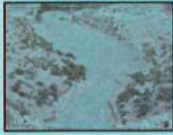
A third culvert should be added to reduce this flow depth. This would require a revision to the headwall at the outlet and widening of the channel between stations 10+00 and 12+50, from 25 feet to 38 feet. An interim recommendation would be to abandon the upstream outlet of the existing 60" RCP drain, reconstruct the manhole in Hualapai Way, and discharge the 60" RCP downstream at about station 12+50. This would allow room for a third culvert south of the existing pair.

The existing channel flows under super critical flow through the project. There is little evidence of erosion through the reach involved with this project. There is evident of caliche throughout the site. This material has stood up well to the storms through the years, including the 1999, 100-year frequency storm event. There is no compelling evidence that channel improvements are required.

Alternative II with 1.5:1 side slopes is intended to reduce the area devoted to the channel. Because of the steep side slopes, the lower 20' will have to be armored with grouted riprap. This alternative would have a 100-foot bottom width and similar depths of flows of up to 5-feet.

Alternative II with 3:1 side slopes is intended to keep the channel accessible. Because of the velocities, grouted riprap protection will be required. This alternative would have a constant bottom width of 100-feet and flow depths less than 5-feet.

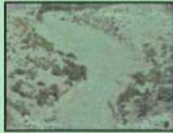
Alternative II and Alternative III add \$10.5 and \$16.5 million in expense to the project respectively and provide little benefit over the existing conditions. They are not recommended.



**Angel Park Middle Branch
Hydraulic Report**

Final Report

APPENDIX



ALTERNATIVE I

HEC-RAS Natural Channel Model Output for 4,000, 5,548 and 6,047 cfs



Angel Park Middle Branch
Hydraulic Report

Final Report

HEC-RAS Natural Channel Model Output for 4,000 cfs

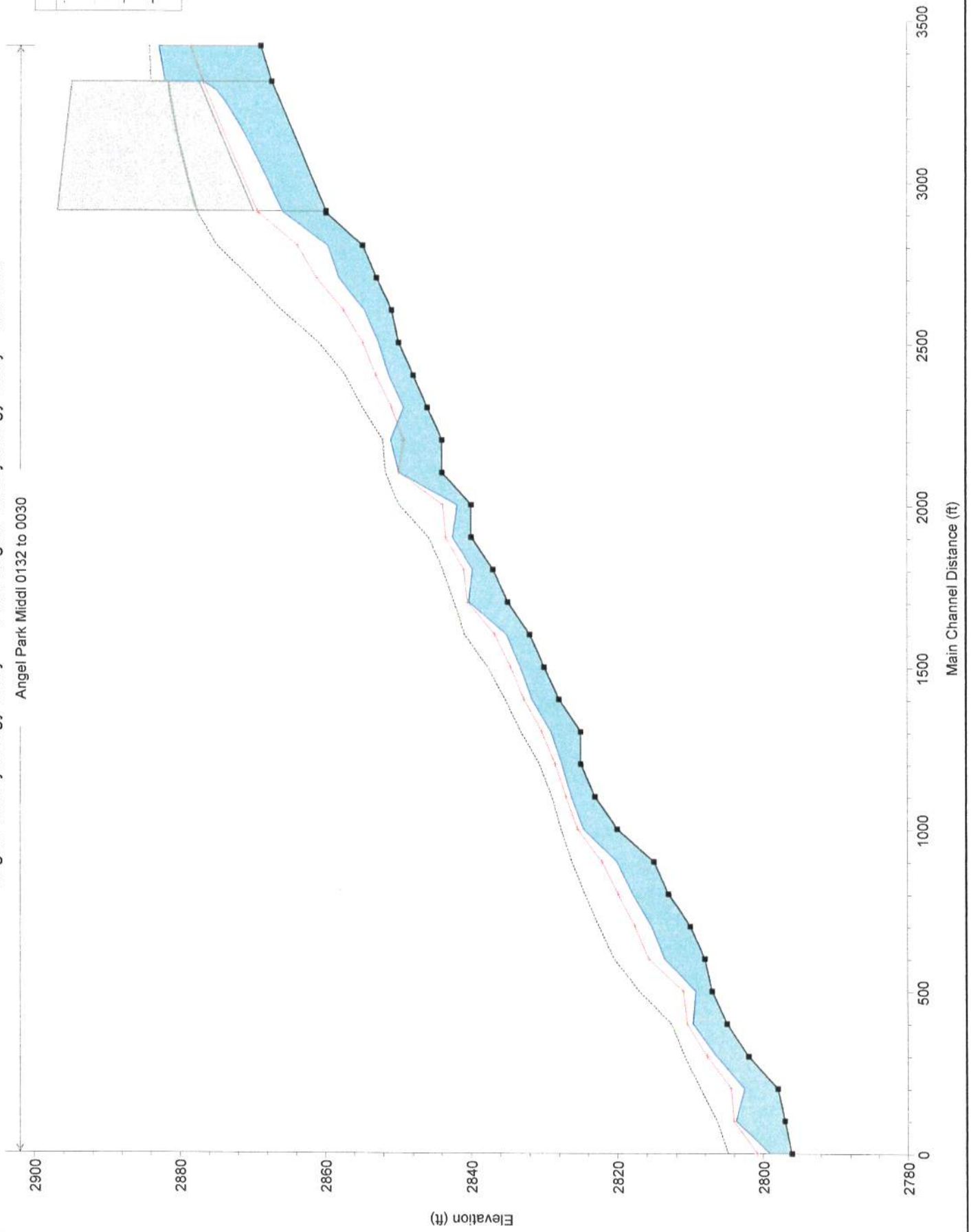
HEC-RAS Plan: Angel Park H River: Angel Park Middl Reach: 0132 to 0030 Profile: PF 1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Cntl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
0132 to 0030	-485	PF 1	4000.00	2869.00	2883.13	2878.64	2884.37	0.000868	10.24	577.40	69.91	0.48
0132 to 0030	-596	PF 1	4000.00	2867.50	2882.28	2876.93	2884.16	0.002343	11.00	363.52	97.41	0.50
0132 to 0030	-900		Culvert									
0132 to 0030	-1005	PF 1	4000.00	2860.00	2865.89	2869.34	2877.73	0.009249	27.62	144.84	24.60	2.01
0132 to 0030	-1100	PF 1	4000.00	2855.00	2859.82	2864.00	2875.05	0.038071	33.08	143.10	37.41	2.66
0132 to 0030	-1200	PF 1	4000.00	2853.00	2858.28	2861.38	2870.44	0.036780	31.06	173.05	61.37	2.57
0132 to 0030	-1300	PF 1	4000.00	2851.00	2854.78	2857.65	2866.17	0.045242	27.86	157.88	58.00	2.71
0132 to 0030	-1400	PF 1	4000.00	2850.00	2852.79	2855.04	2861.02	0.040581	23.73	184.28	76.09	2.50
0132 to 0030	-1500	PF 1	4000.00	2848.00	2851.43	2853.20	2857.31	0.023363	20.67	224.33	78.59	1.97
0132 to 0030	-1600	PF 1	4000.00	2846.00	2849.39	2851.09	2854.99	0.021523	19.67	225.13	77.87	1.88
0132 to 0030	-1700	PF 1	4000.00	2844.00	2851.15	2849.34	2852.15	0.001775	9.30	590.89	117.68	0.61
0132 to 0030	-1800	PF 1	4000.00	2844.00	2850.05	2850.05	2851.79	0.004981	12.82	456.99	130.45	0.98
0132 to 0030	-1900	PF 1	4000.00	2840.00	2842.03	2844.00	2849.98	0.058996	23.12	184.23	100.86	2.86
0132 to 0030	-2000	PF 1	4000.00	2840.00	2842.64	2843.58	2845.82	0.016435	14.55	288.96	119.00	1.56
0132 to 0030	-2100	PF 1	4000.00	2837.00	2839.90	2841.11	2843.88	0.020307	17.24	281.66	127.96	1.78
0132 to 0030	-2200	PF 1	4000.00	2835.00	2840.40	2840.59	2842.31	0.005834	11.71	395.26	148.42	1.01
0132 to 0030	-2300	PF 1	4000.00	2832.00	2835.24	2836.85	2840.92	0.028894	22.11	248.34	111.99	2.17
0132 to 0030	-2400	PF 1	4000.00	2830.00	2833.32	2834.65	2837.77	0.029040	22.53	268.30	109.81	2.18
0132 to 0030	-2500	PF 1	4000.00	2828.00	2831.77	2832.85	2835.31	0.017218	15.38	281.50	126.15	1.63
0132 to 0030	-2600	PF 1	4000.00	2825.00	2829.15	2830.40	2833.17	0.024893	17.71	265.68	112.18	1.93
0132 to 0030	-2700	PF 1	4000.00	2825.00	2827.66	2828.56	2830.65	0.018284	15.43	312.62	135.10	1.67
0132 to 0030	-2800	PF 1	4000.00	2823.00	2826.36	2827.10	2828.96	0.015252	12.99	311.76	138.13	1.49
0132 to 0030	-2900	PF 1	4000.00	2820.00	2824.69	2825.51	2827.69	0.009584	16.30	341.49	105.65	1.33
0132 to 0030	-3000	PF 1	4000.00	2815.00	2820.12	2822.13	2826.20	0.016639	22.76	243.12	71.47	1.77
0132 to 0030	-3100	PF 1	4000.00	2813.00	2817.98	2819.95	2824.41	0.018769	21.85	227.37	75.74	1.83
0132 to 0030	-3200	PF 1	4000.00	2810.00	2815.41	2817.64	2822.45	0.020285	25.22	234.61	75.69	1.96
0132 to 0030	-3300	PF 1	4000.00	2808.00	2813.63	2815.79	2820.44	0.018936	22.59	224.38	74.08	1.85
0132 to 0030	-3400	PF 1	4000.00	2807.00	2809.33	2811.06	2816.97	0.017884	22.21	181.21	117.33	3.14
0132 to 0030	-3500	PF 1	4000.00	2805.00	2809.71	2810.53	2812.64	0.015219	13.76	291.45	113.68	1.51
0132 to 0030	-3600	PF 1	4000.00	2802.00	2806.47	2807.73	2810.82	0.016683	16.77	240.88	74.40	1.60
0132 to 0030	-3700	PF 1	4000.00	2798.00	2802.62	2804.41	2808.62	0.027900	19.67	203.91	72.06	2.03
0132 to 0030	-3800	PF 1	4000.00	2797.00	2803.77	2804.05	2806.39	0.007254	13.01	311.33	75.89	1.10
0132 to 0030	-3900	PF 1	4000.00	2796.00	2799.11	2800.85	2804.83	0.023336	19.35	212.04	71.28	1.93

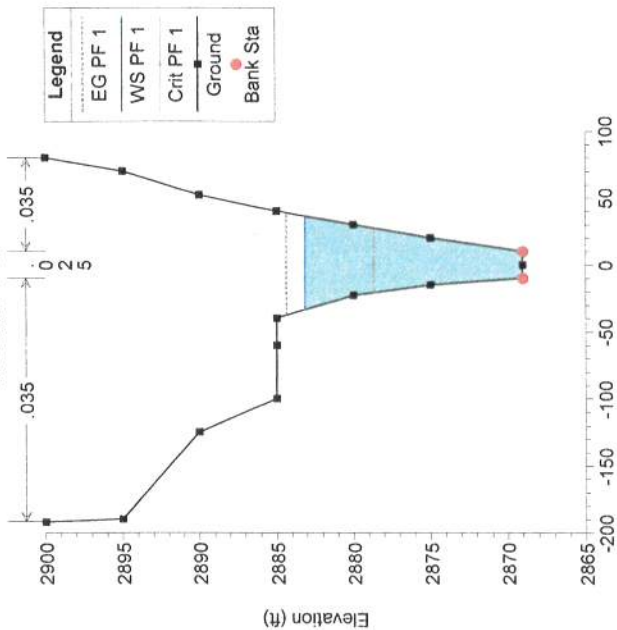
Angel Park Hydrology Study Plan: Angel Park Hydrology Study 8/5/2008

Angel Park Middl 0132 to 0030

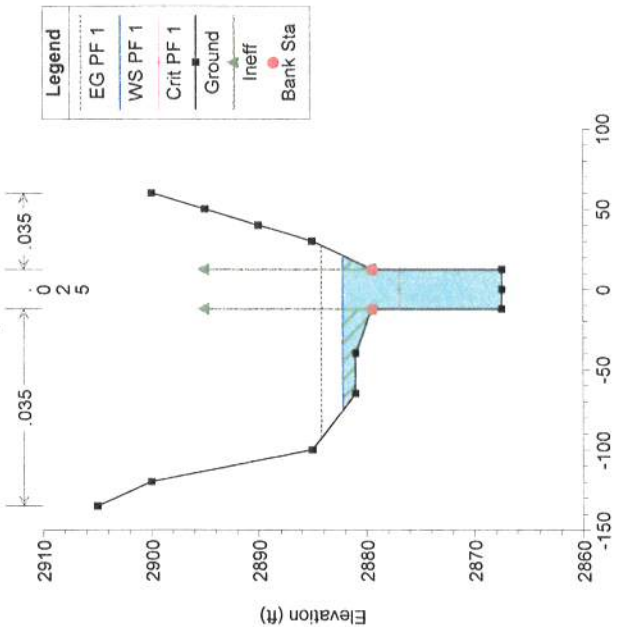
Legend	
EG PF 1	
Crit PF 1	
WS PF 1	
Ground	



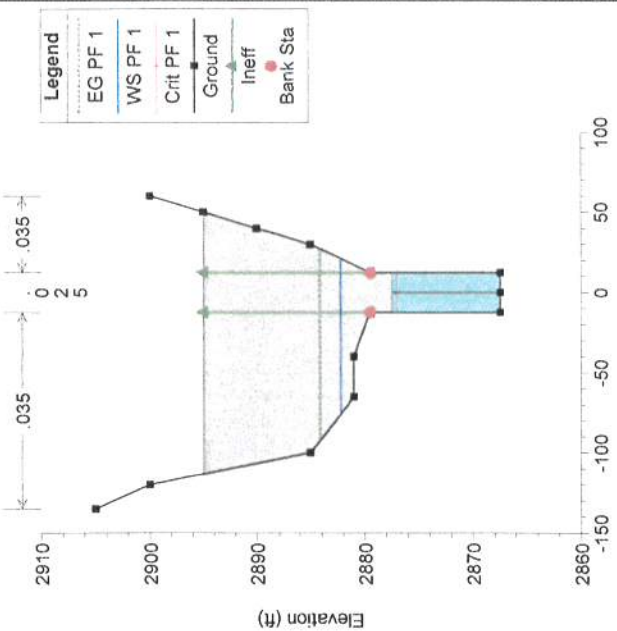
X-Section -4+85



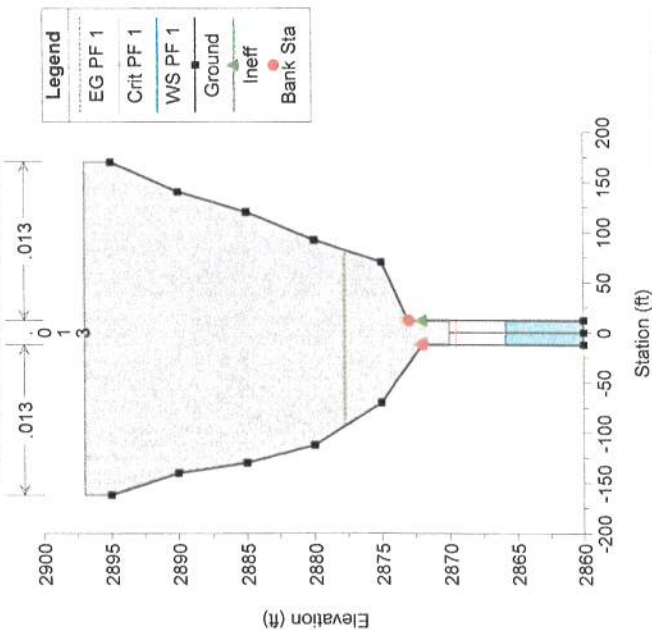
Station -5+95 - Upstream of 2'-18' x 12'



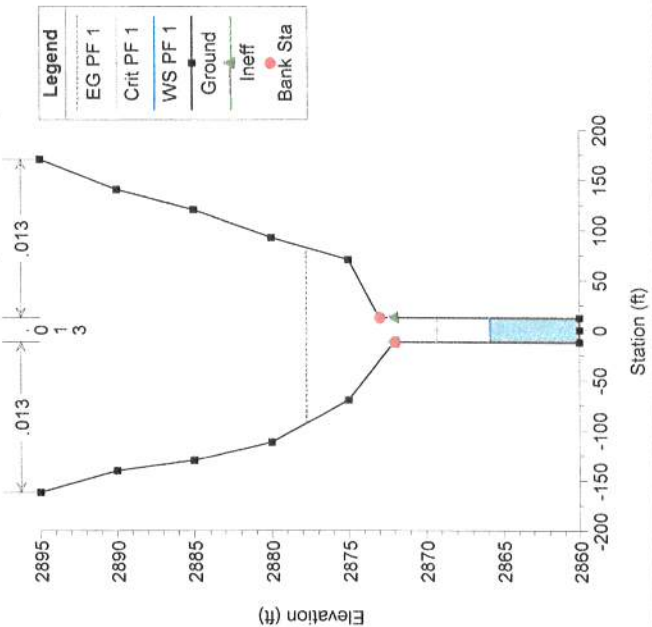
2, 12' x 10' RCB under Hualapai Way



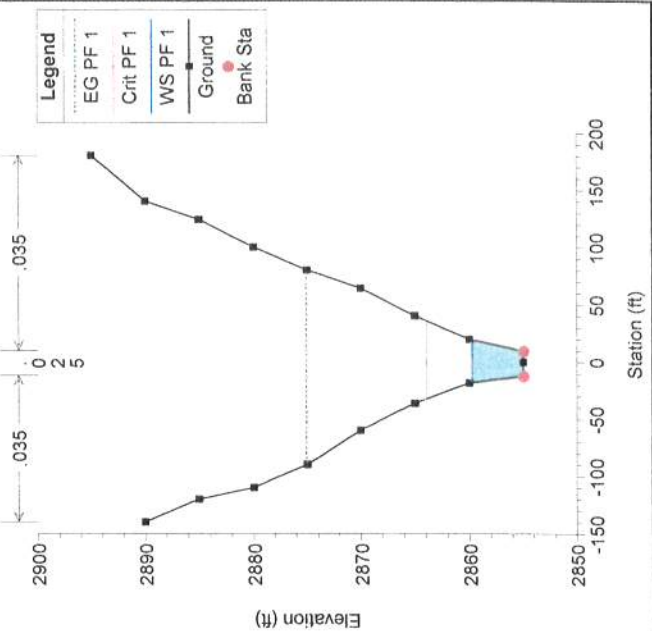
2, 12' x 10' RCB under Hualapai Way



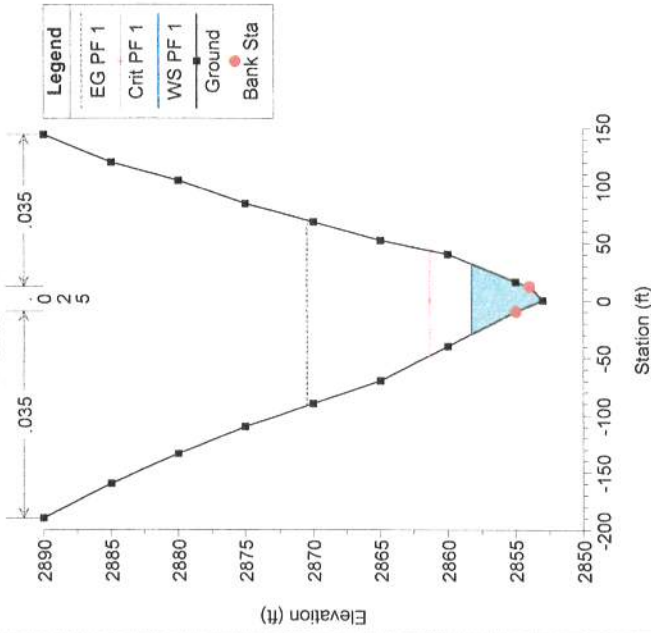
X-Section -10+00 - 2'-12' x 10' culvert, east side of Hualapai



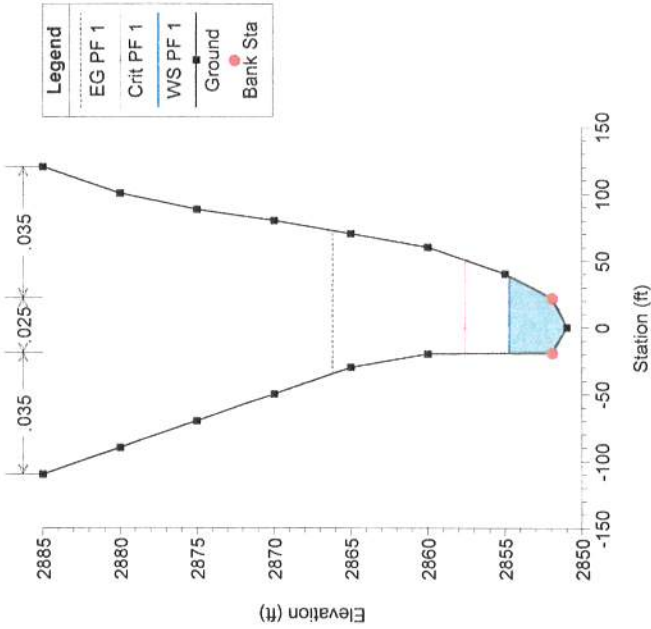
X-Section -11+00



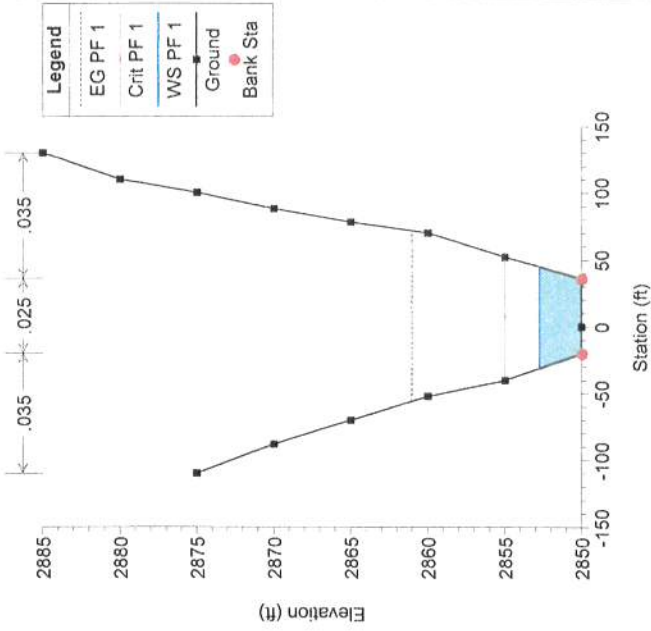
X-Section -12+00



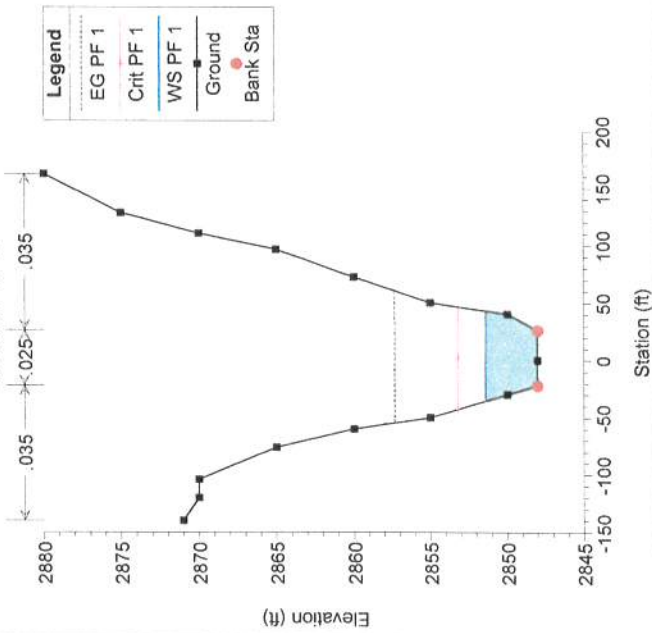
X-Section -13+00



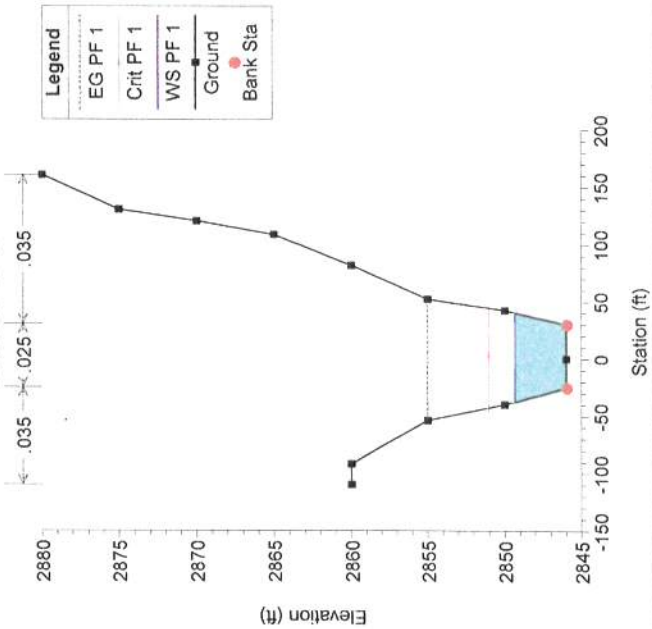
X-Section -14+00



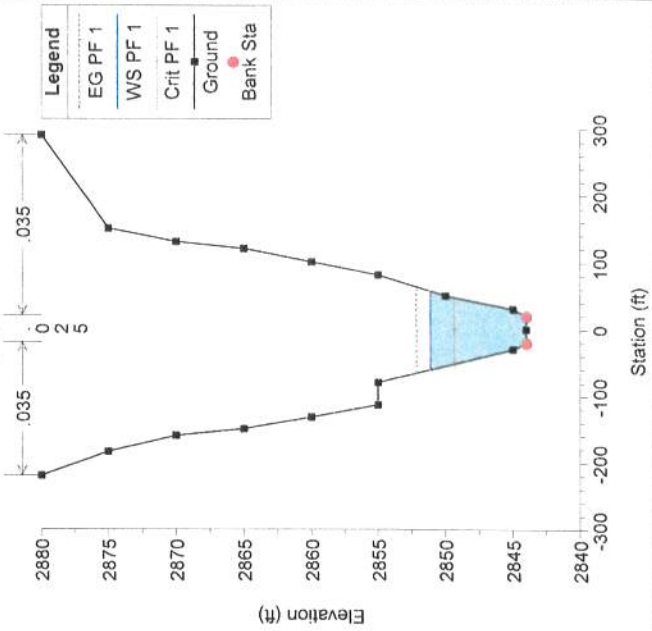
X-Section -15+00

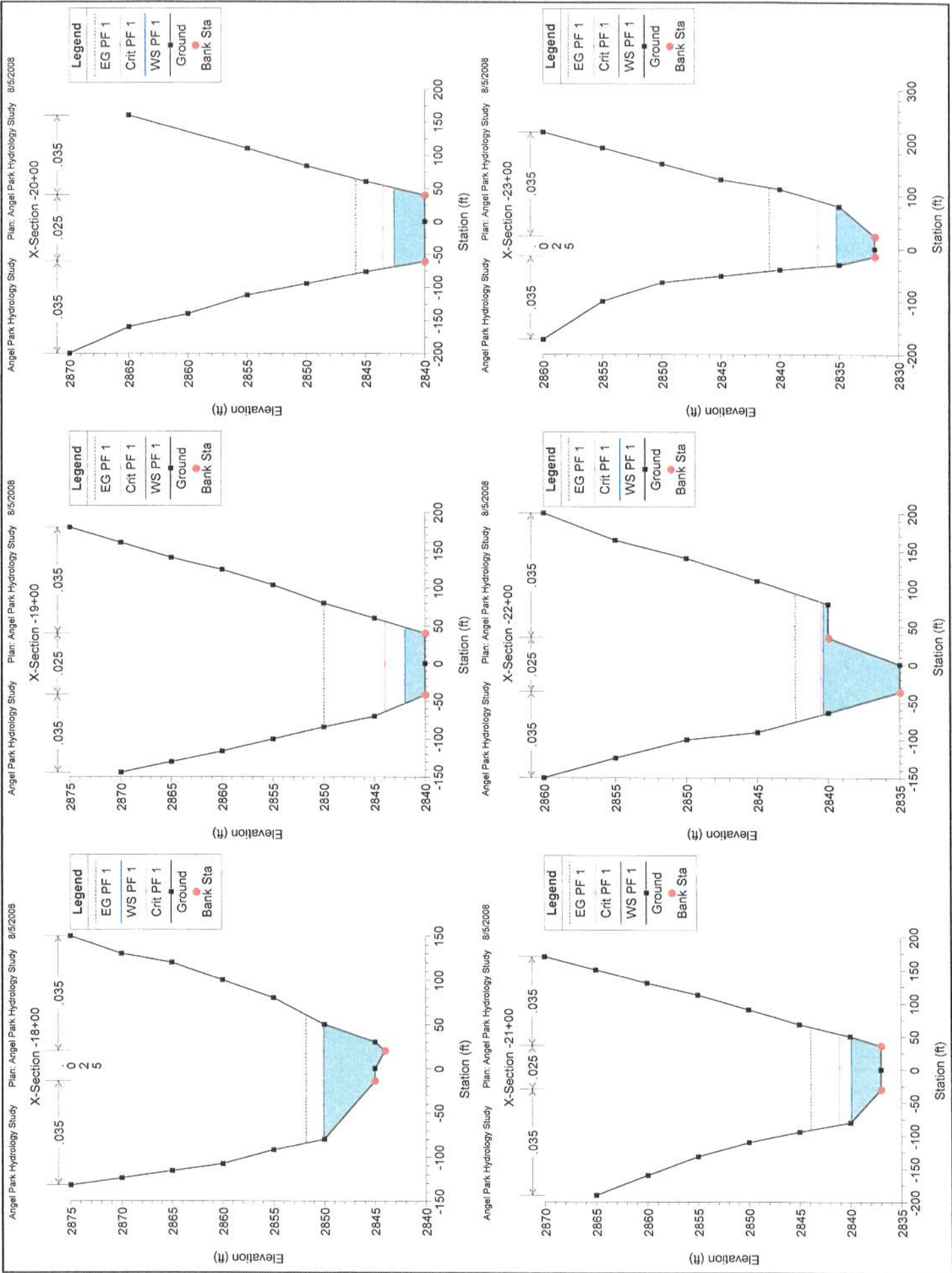


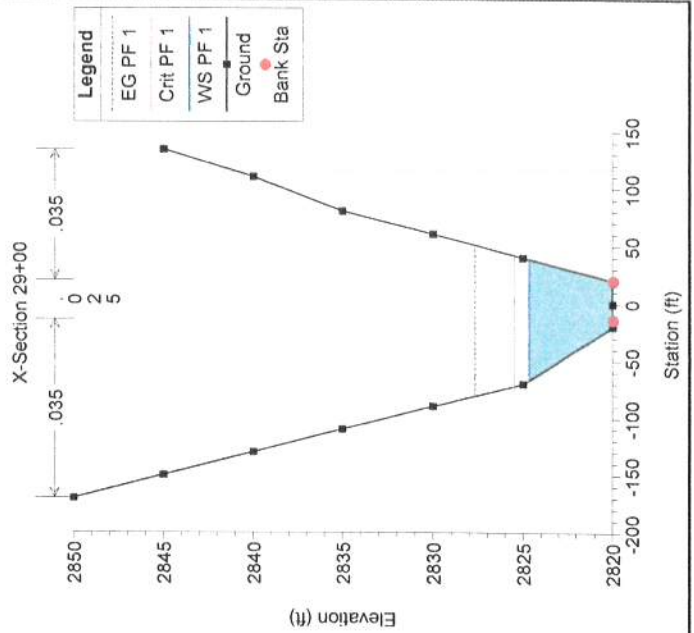
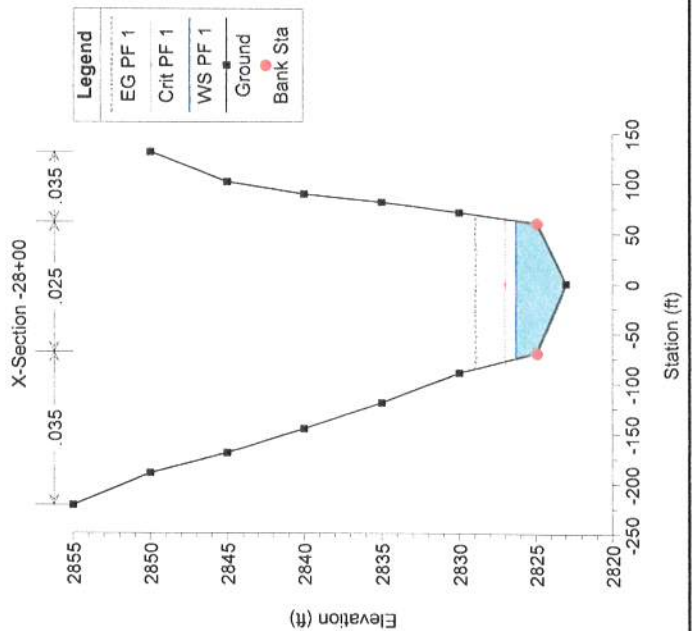
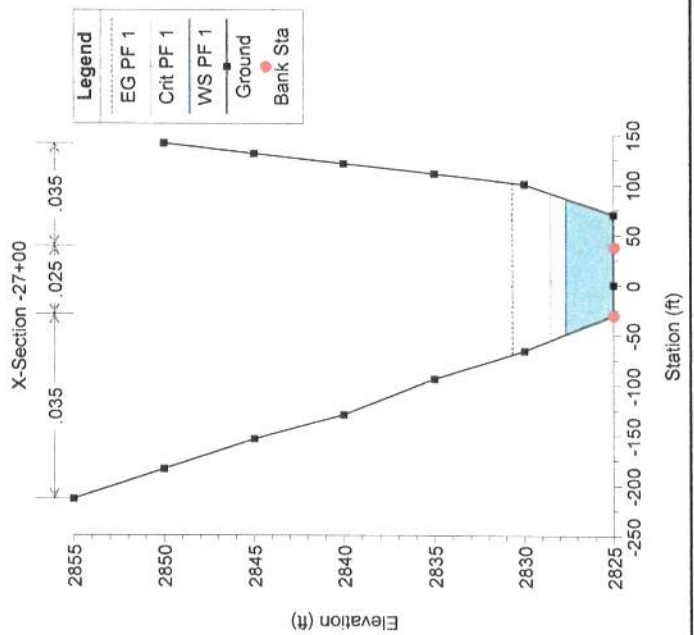
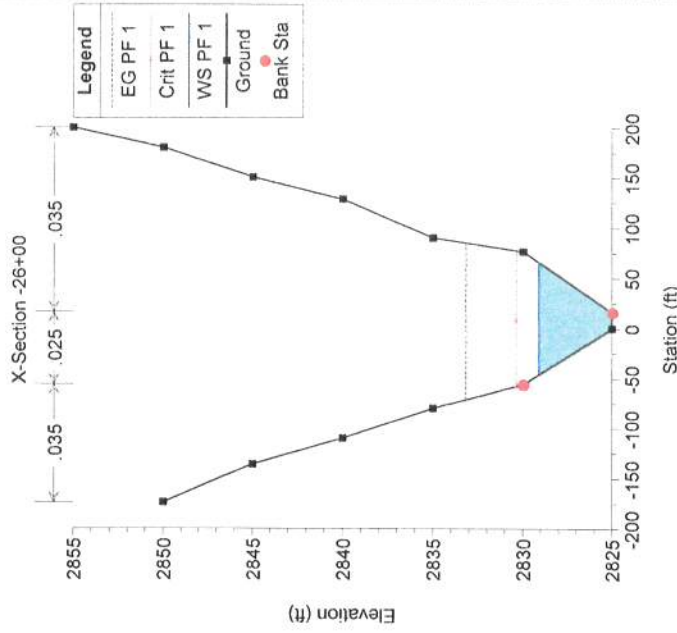
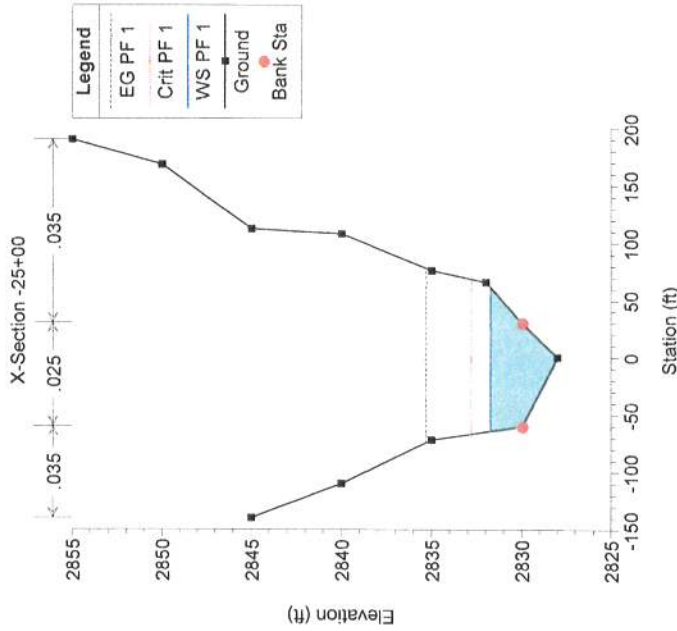
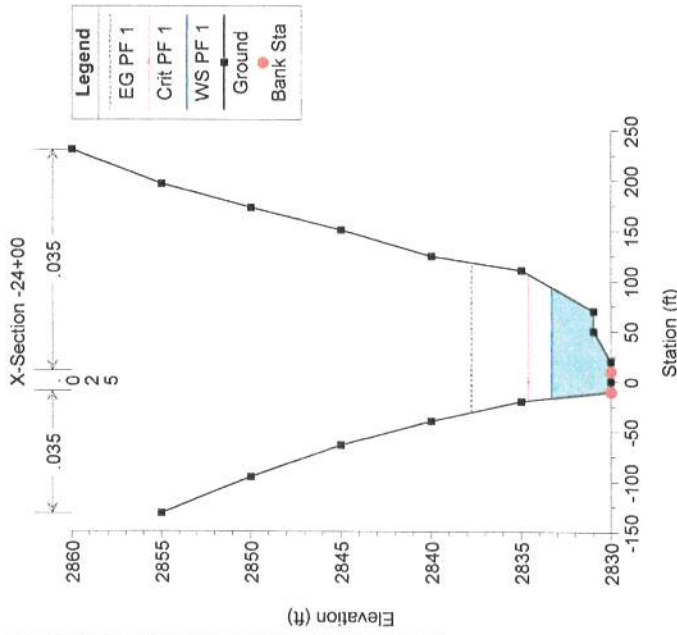
X-Section -16+00

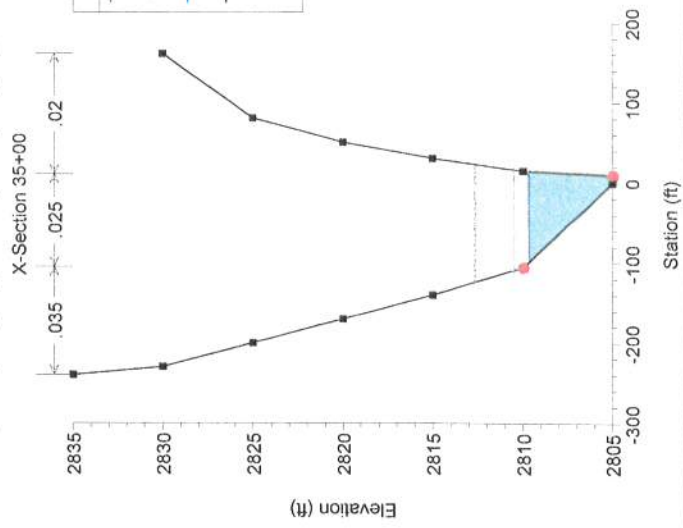
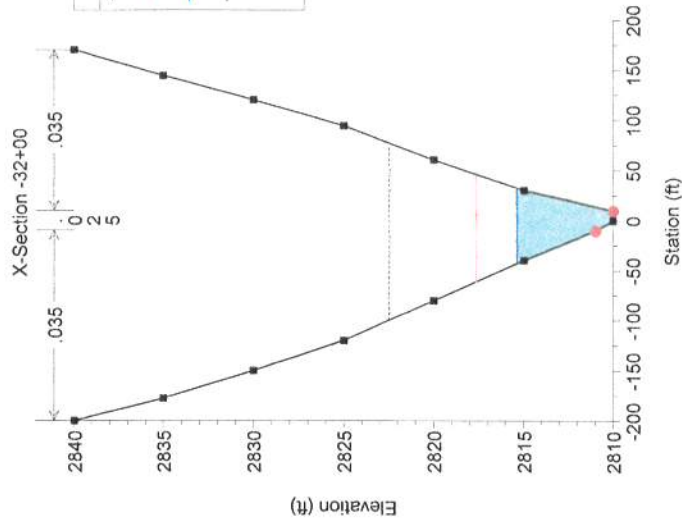
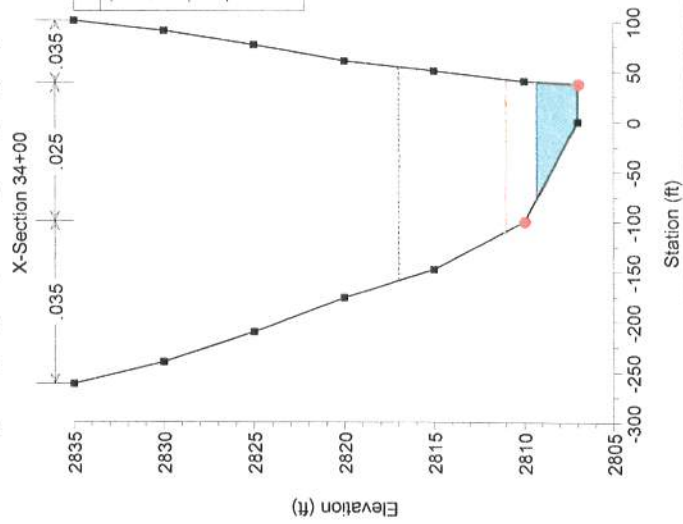
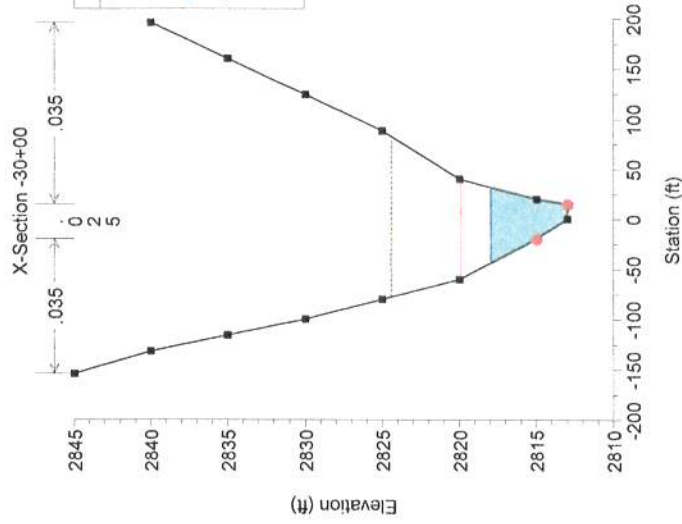
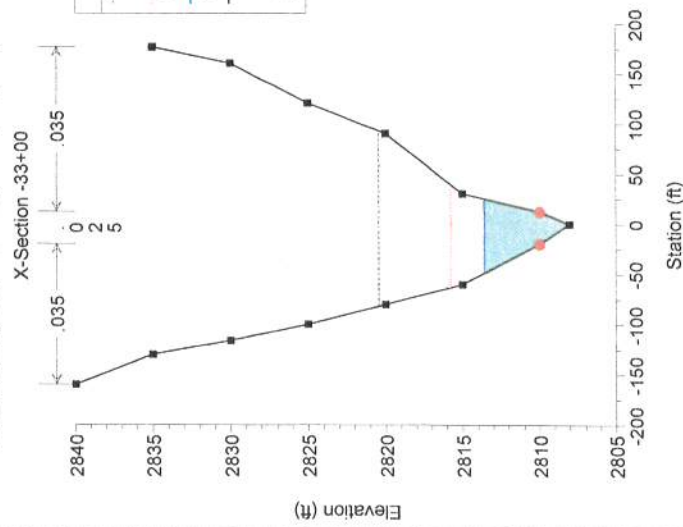
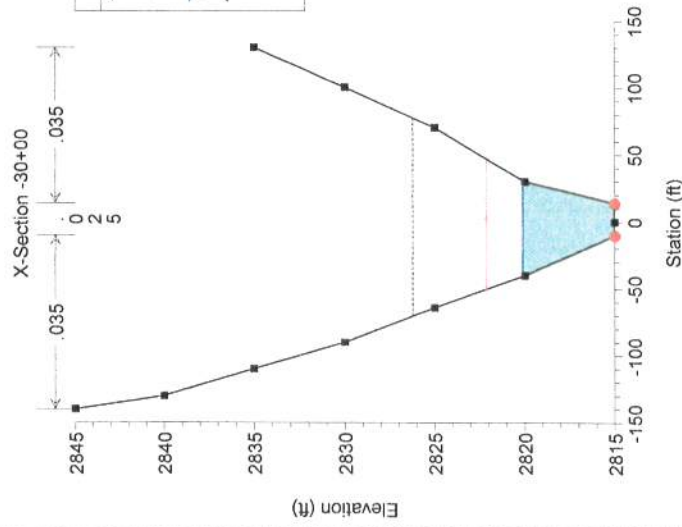


X-Section -17+00

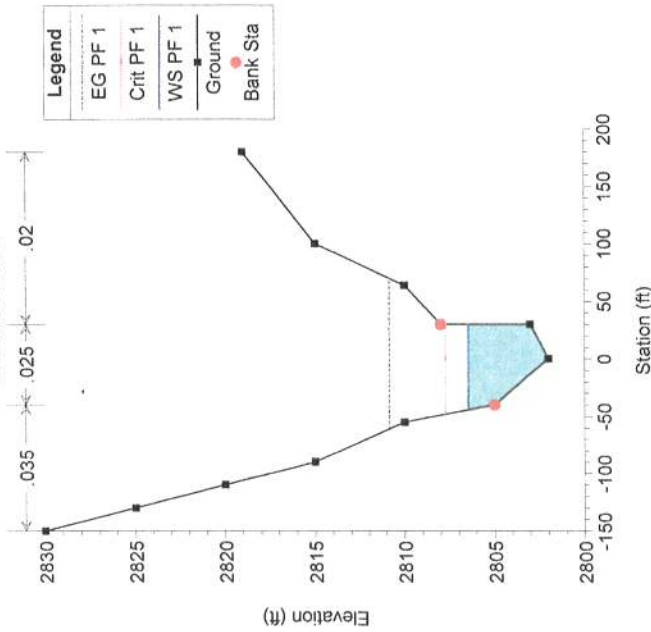




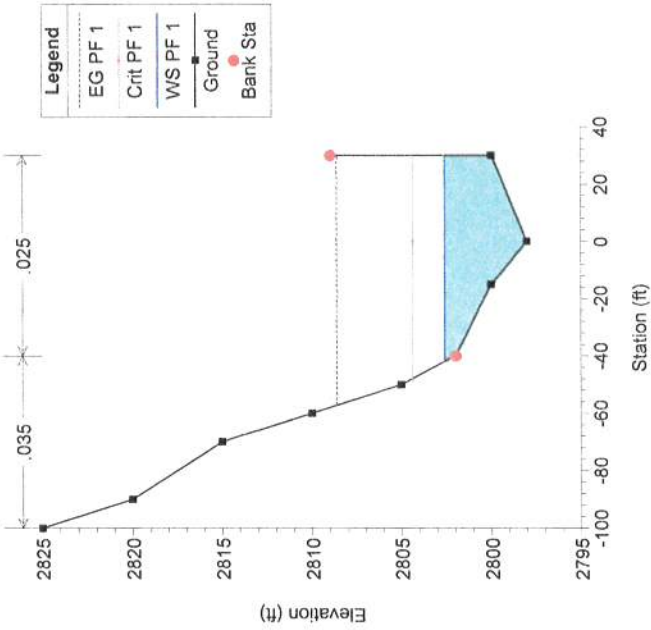




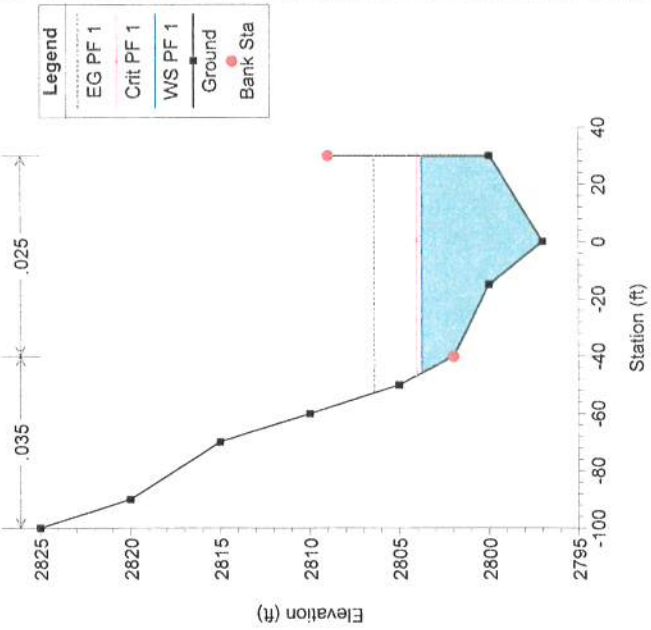
X-Section 36+00



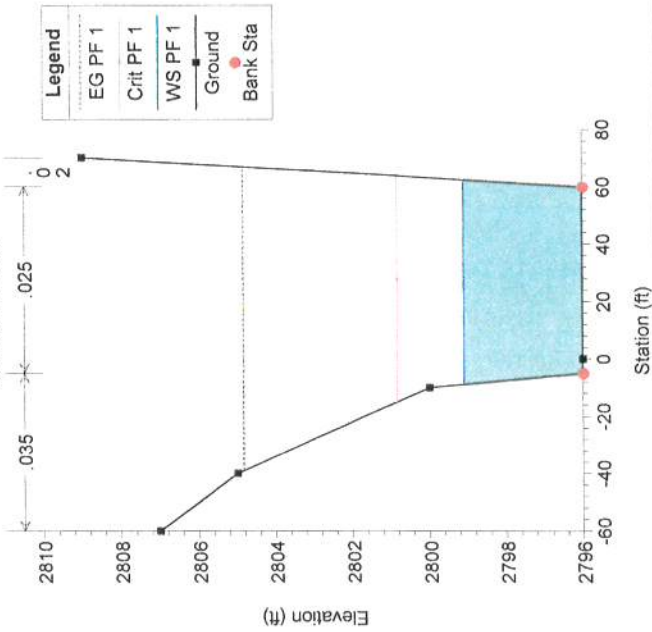
X-Section 37+00



X-Section 38+00



X-Section 39+00





Angel Park Middle Branch
Hydraulic Report

Final Report

HEC-RAS Natural Channel Model Output for 5,548 cfs

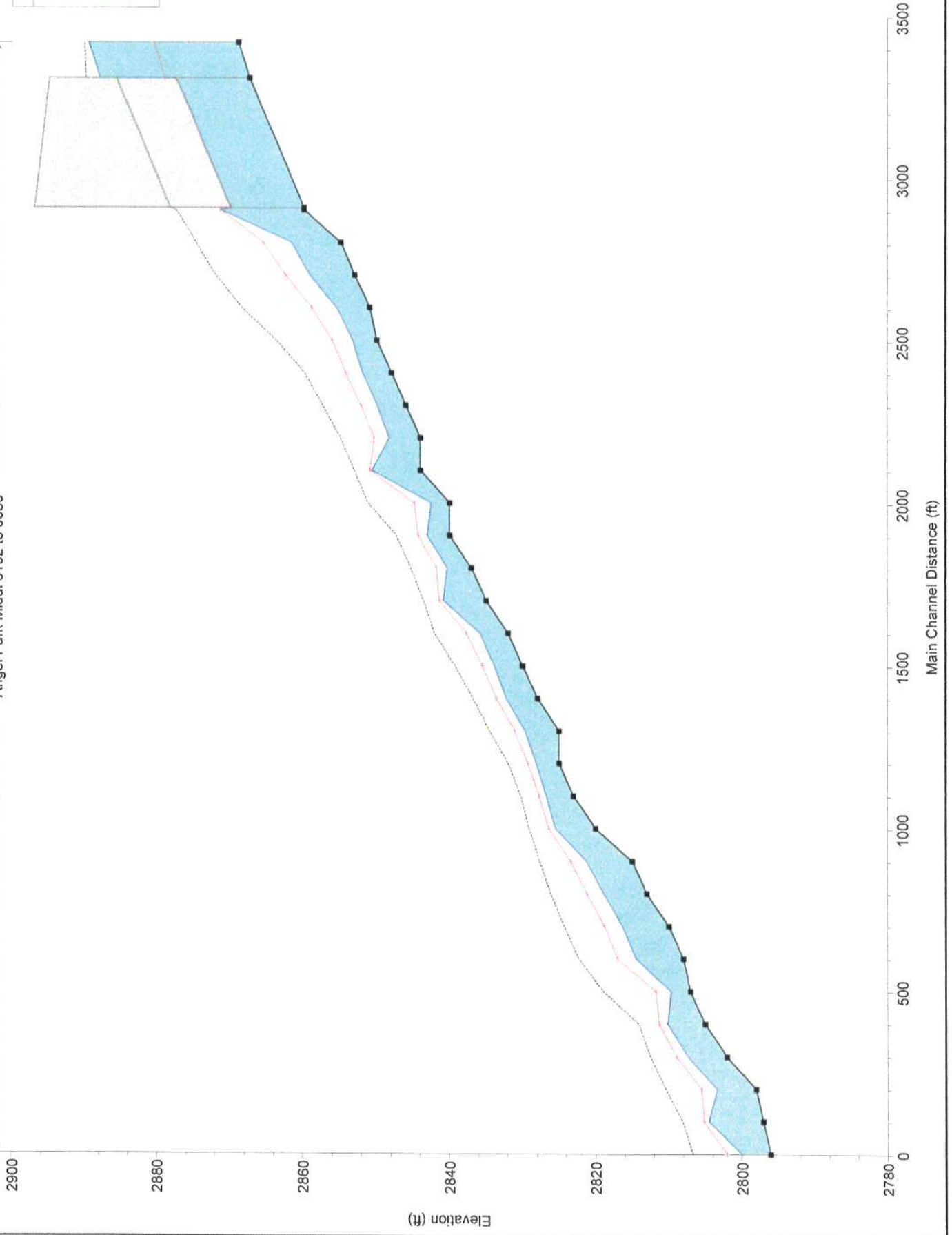
HEC-RAS Plan: Angel Park H River: Angel Park Middl Reach: 0132 to 0030 Profile: PF 1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
0132 to 0030	-485	PF 1	5548.00	2869.00	2889.63	2880.59	2890.13	0.000270	7.34	1445.38	174.28	0.28
0132 to 0030	-595	PF 1	5548.00	2867.50	2888.08	2879.10	2889.95	0.001494	10.96	506.31	140.27	0.43
0132 to 0030	-900	Culvert										
0132 to 0030	-1005	PF 1	5548.00	2860.00	2871.52	2871.52	2877.47	0.002724	19.58	283.29	24.60	1.02
0132 to 0030	-1100	PF 1	5548.00	2855.00	2861.75	2865.67	2874.79	0.021721	31.28	228.00	51.28	2.12
0132 to 0030	-1200	PF 1	5548.00	2853.00	2859.27	2862.59	2872.06	0.031461	32.78	239.50	72.12	2.45
0132 to 0030	-1300	PF 1	5548.00	2851.00	2855.61	2858.98	2868.57	0.038818	30.01	207.93	61.86	2.61
0132 to 0030	-1400	PF 1	5548.00	2850.00	2853.36	2856.16	2863.85	0.040920	26.96	228.58	80.17	2.59
0132 to 0030	-1500	PF 1	5548.00	2848.00	2852.01	2854.34	2859.88	0.025743	24.07	270.74	82.05	2.12
0132 to 0030	-1600	PF 1	5548.00	2846.00	2850.01	2852.23	2857.39	0.022935	22.72	274.74	82.04	2.00
0132 to 0030	-1700	PF 1	5548.00	2844.00	2848.39	2850.43	2855.04	0.021135	23.16	305.06	90.50	1.95
0132 to 0030	-1800	PF 1	5548.00	2844.00	2850.72	2850.97	2853.03	0.005858	15.04	545.94	136.06	1.08
0132 to 0030	-1900	PF 1	5548.00	2840.00	2842.65	2844.94	2851.19	0.044708	24.09	249.49	107.01	2.61
0132 to 0030	-2000	PF 1	5548.00	2840.00	2843.17	2844.42	2847.31	0.019856	16.66	353.38	122.84	1.65
0132 to 0030	-2100	PF 1	5548.00	2837.00	2840.44	2841.91	2845.35	0.020535	19.40	351.62	132.81	1.84
0132 to 0030	-2200	PF 1	5548.00	2835.00	2840.98	2841.52	2843.60	0.006869	13.86	483.28	154.92	1.12
0132 to 0030	-2300	PF 1	5548.00	2832.00	2835.92	2837.74	2842.11	0.025366	23.54	326.80	117.73	2.09
0132 to 0030	-2400	PF 1	5548.00	2830.00	2833.95	2835.60	2839.28	0.028166	24.92	339.68	117.36	2.21
0132 to 0030	-2500	PF 1	5548.00	2828.00	2832.32	2833.64	2836.77	0.017408	17.42	352.25	132.60	1.69
0132 to 0030	-2600	PF 1	5548.00	2825.00	2829.74	2831.16	2834.55	0.025716	19.43	336.59	125.99	2.00
0132 to 0030	-2700	PF 1	5548.00	2825.00	2828.23	2829.36	2831.95	0.017785	17.33	392.27	142.67	1.70
0132 to 0030	-2800	PF 1	5548.00	2823.00	2826.85	2827.83	2830.25	0.015482	14.85	380.44	141.09	1.55
0132 to 0030	-2900	PF 1	5548.00	2820.00	2825.53	2826.47	2829.11	0.009467	18.09	434.90	114.27	1.36
0132 to 0030	-3000	PF 1	5548.00	2815.00	2821.33	2823.42	2827.69	0.013767	23.87	339.51	87.04	1.97
0132 to 0030	-3100	PF 1	5548.00	2813.00	2818.95	2821.26	2826.12	0.016741	23.56	306.48	87.38	1.79
0132 to 0030	-3200	PF 1	5548.00	2810.00	2816.35	2818.85	2824.28	0.019258	27.50	312.64	88.96	1.96
0132 to 0030	-3300	PF 1	5548.00	2808.00	2814.56	2817.06	2822.31	0.017622	24.63	298.61	84.91	1.84
0132 to 0030	-3400	PF 1	5548.00	2807.00	2809.72	2811.77	2818.92	0.079134	24.38	229.03	130.45	3.24
0132 to 0030	-3500	PF 1	5548.00	2805.00	2810.20	2811.37	2814.13	0.017345	15.97	349.05	121.99	1.65
0132 to 0030	-3600	PF 1	5548.00	2802.00	2807.40	2809.02	2812.47	0.014354	18.14	311.78	77.21	1.54
0132 to 0030	-3700	PF 1	5548.00	2798.00	2803.43	2805.52	2810.43	0.023820	21.26	263.52	74.77	1.94
0132 to 0030	-3800	PF 1	5548.00	2797.00	2804.53	2805.20	2808.14	0.008210	15.30	370.16	78.43	1.19
0132 to 0030	-3900	PF 1	5548.00	2796.00	2799.96	2802.04	2806.65	0.019898	20.98	273.16	72.99	1.86

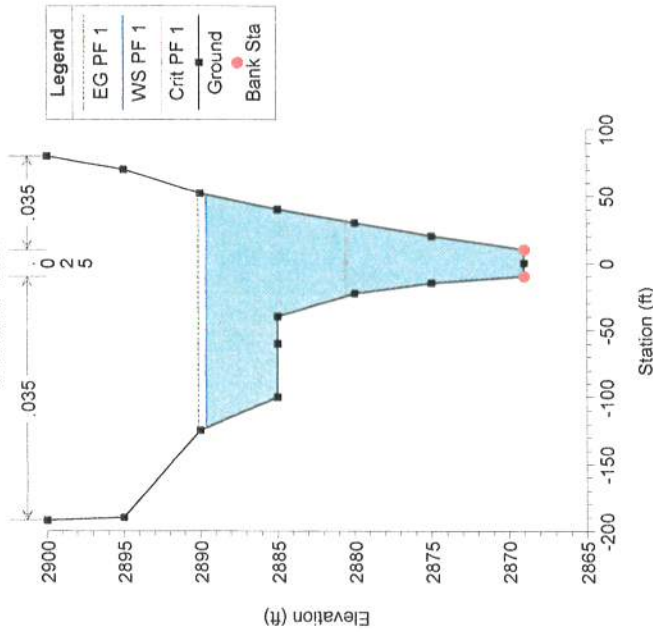
Angel Park Hydrology Study Plan: Angel Park Hydrology Study 8/5/2008

Angel Park Middl 0132 to 0030

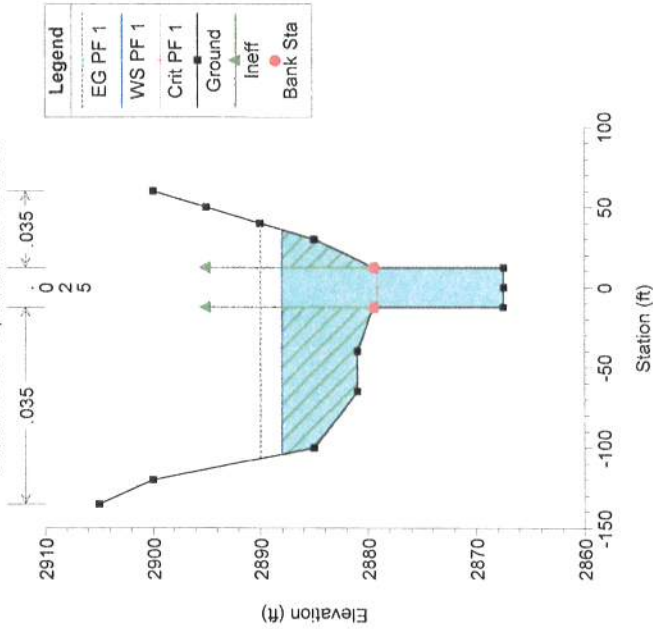
Legend	
EG PF 1	
Crit PF 1	
WS PF 1	
Ground	



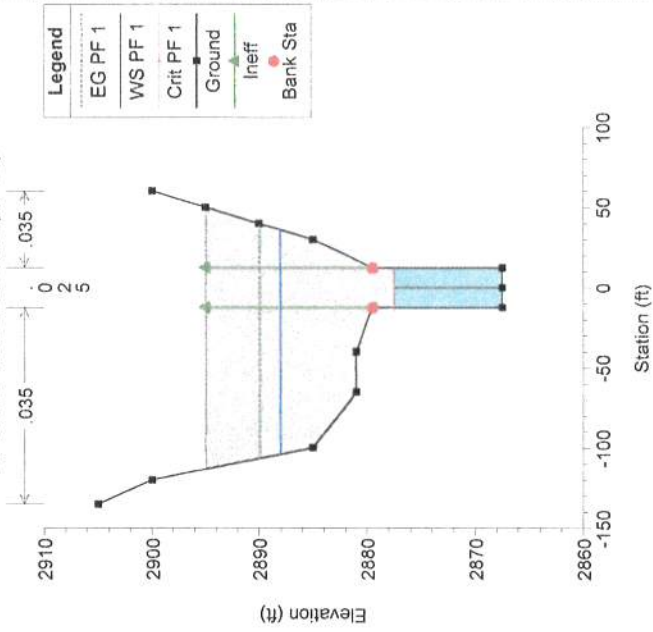
X-Section -4+85



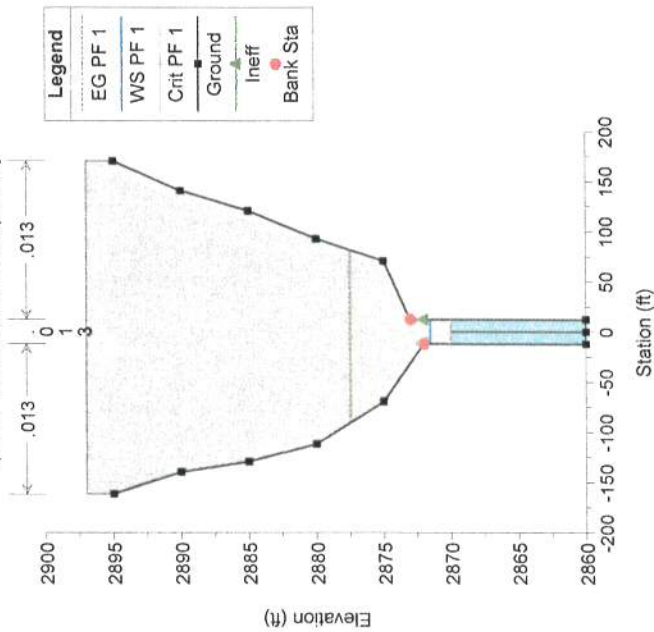
Station -5+95 - Upstream of 2-18' x 12



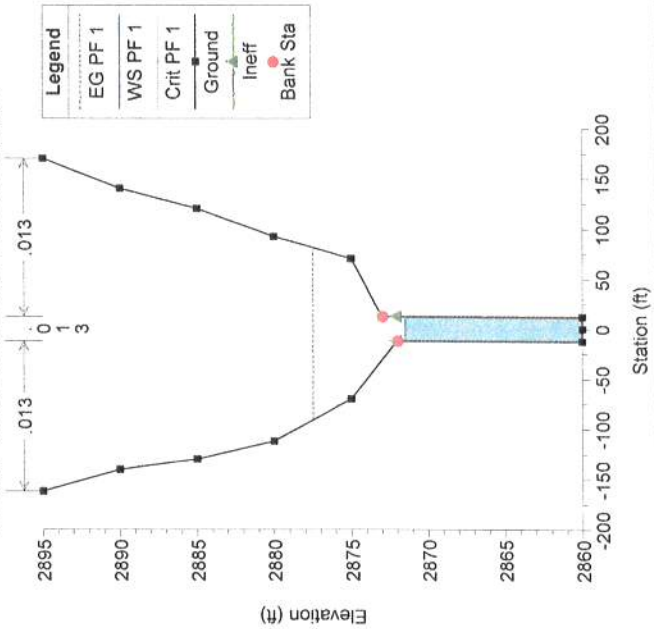
2-12' x 10' RCB under Hualapai Way



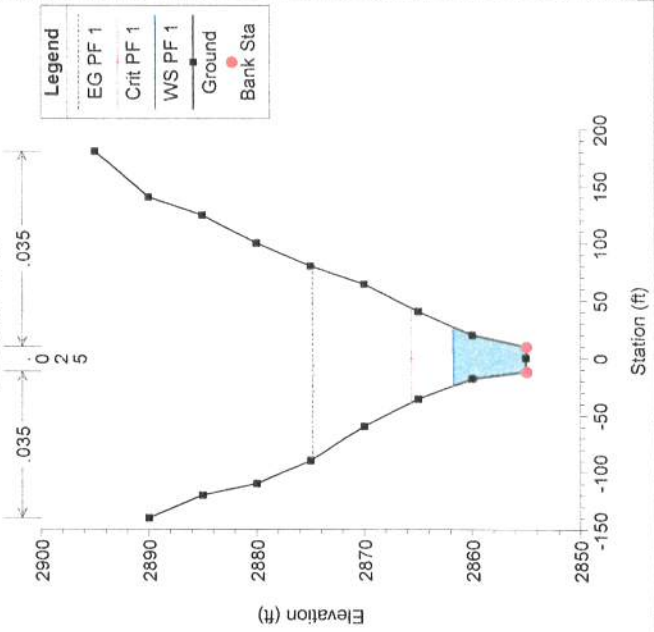
2-12' x 10' RCB under Hualapai Way



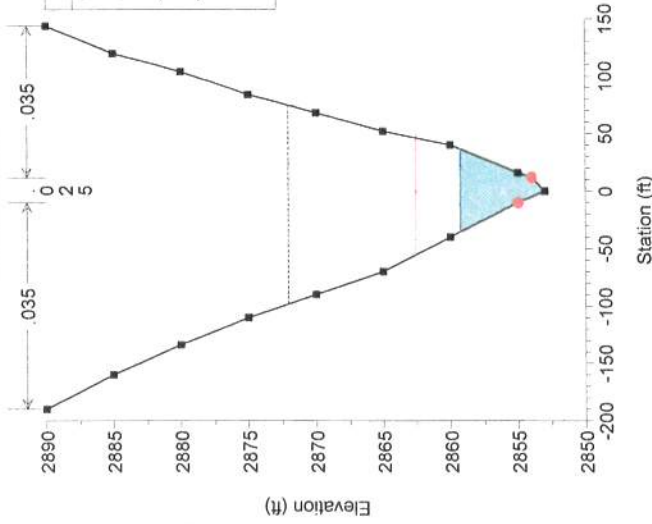
X-Section -10+00 - 2-12' x 10' culvert, east side of Hualapai



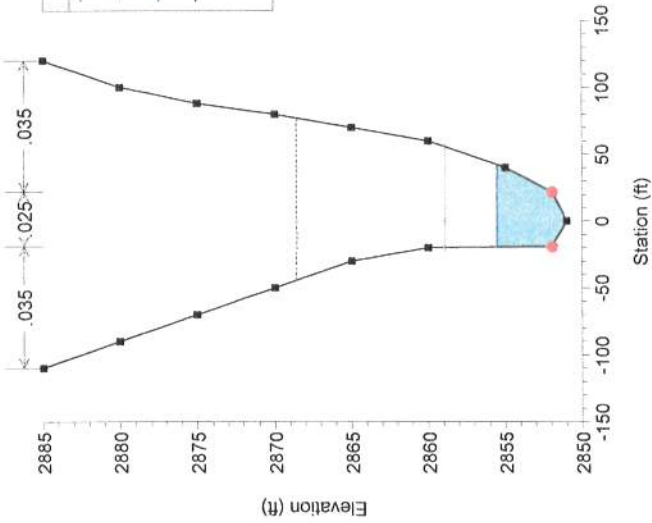
X-Section -11+00



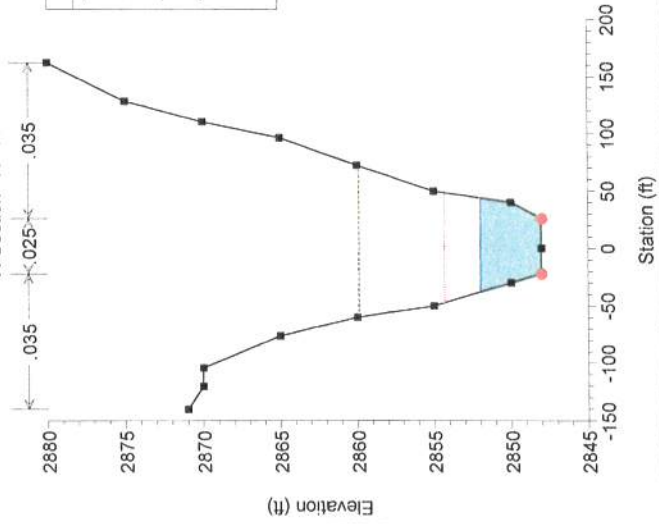
X-Section -12+00



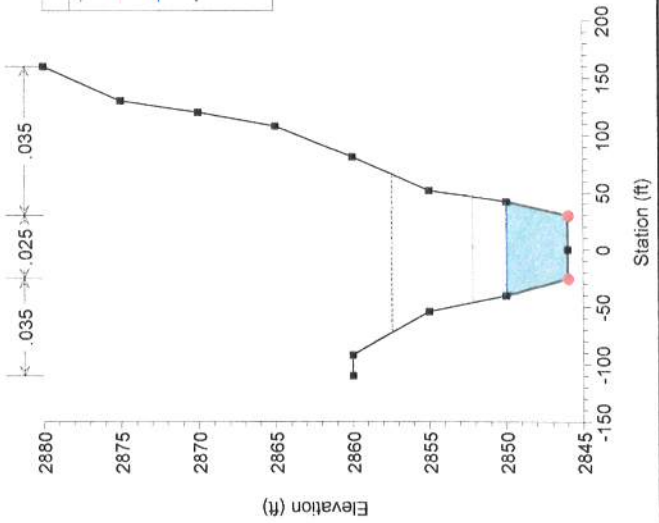
X-Section -13+00



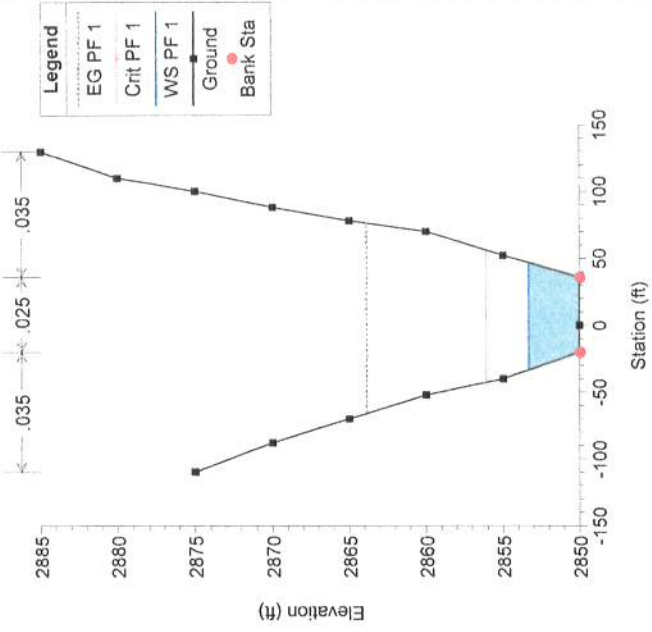
X-Section -15+00



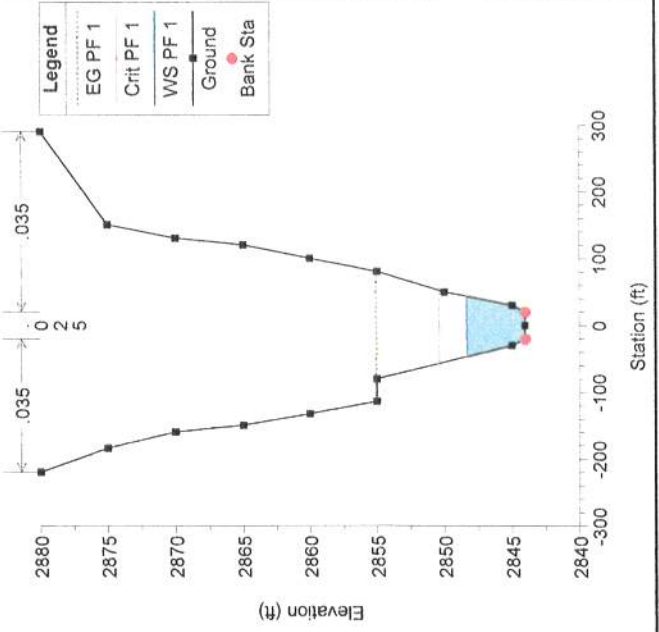
X-Section -16+00



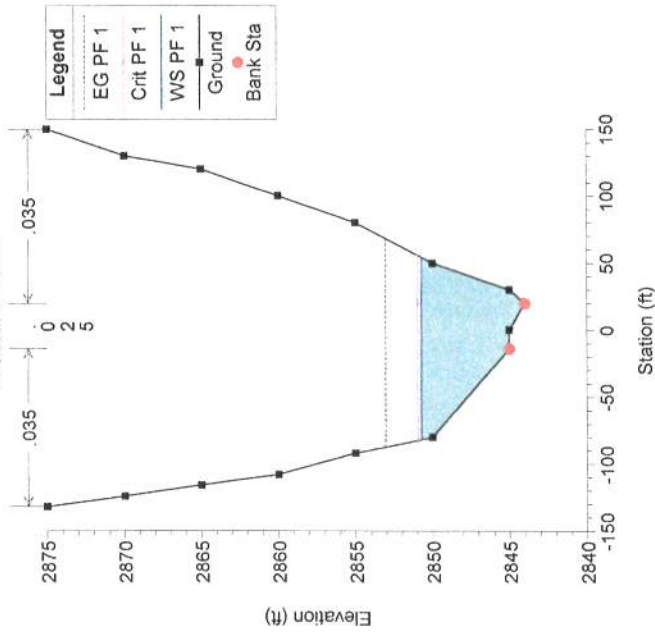
X-Section -14+00



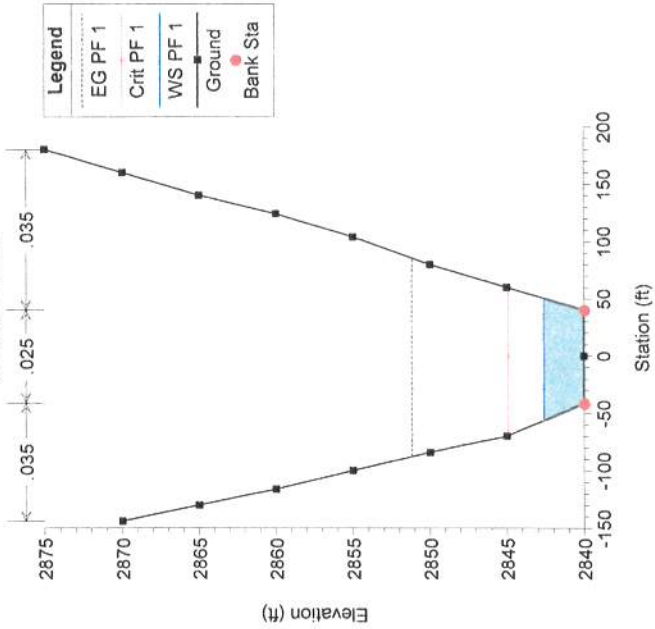
X-Section -17+00



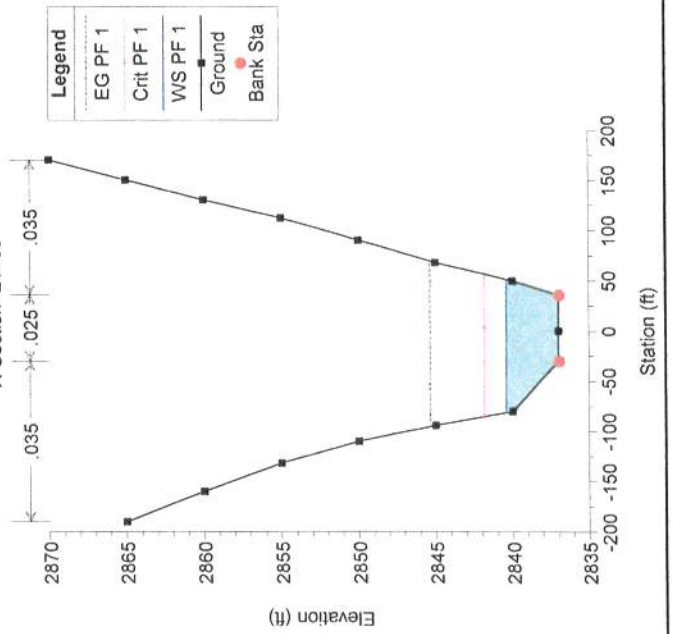
X-Section -18+00



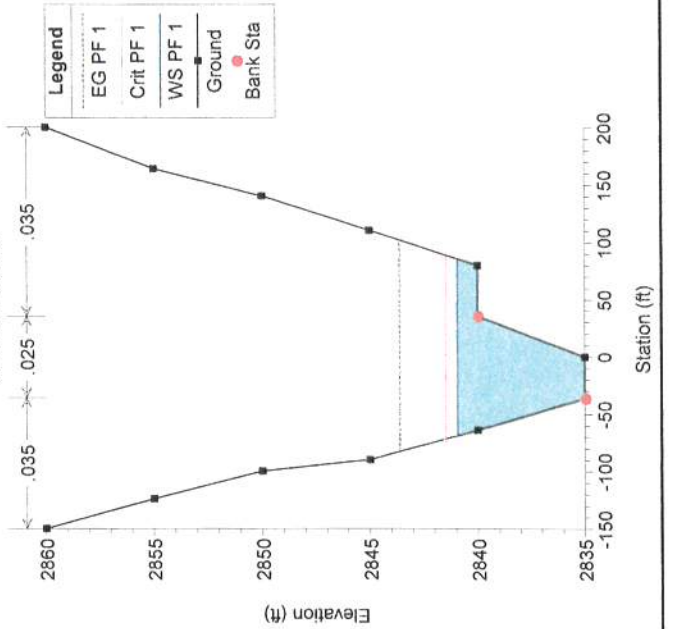
X-Section -19+00



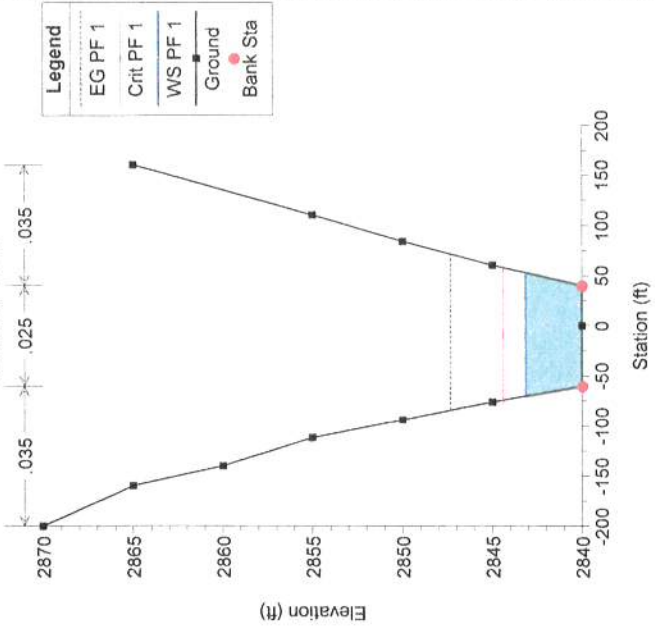
X-Section -21+00



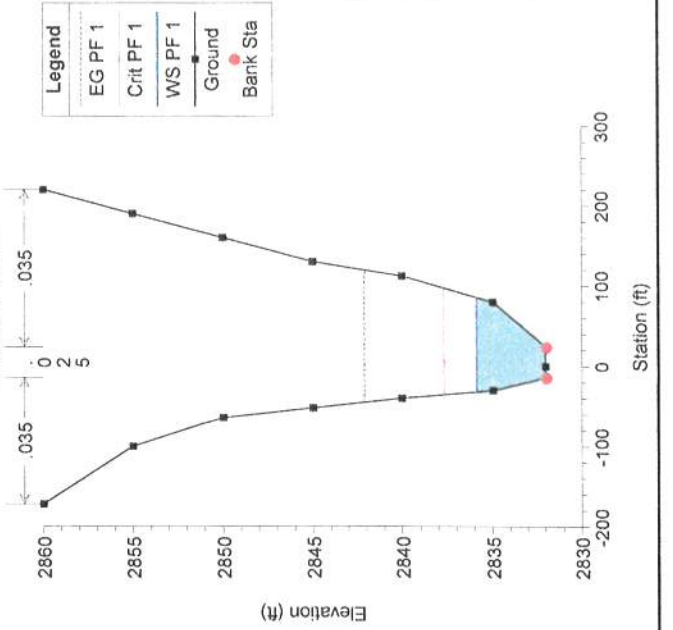
X-Section -22+00

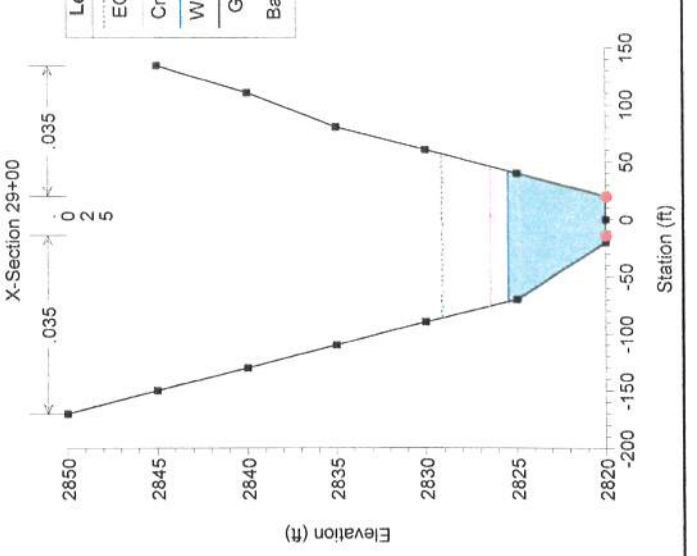
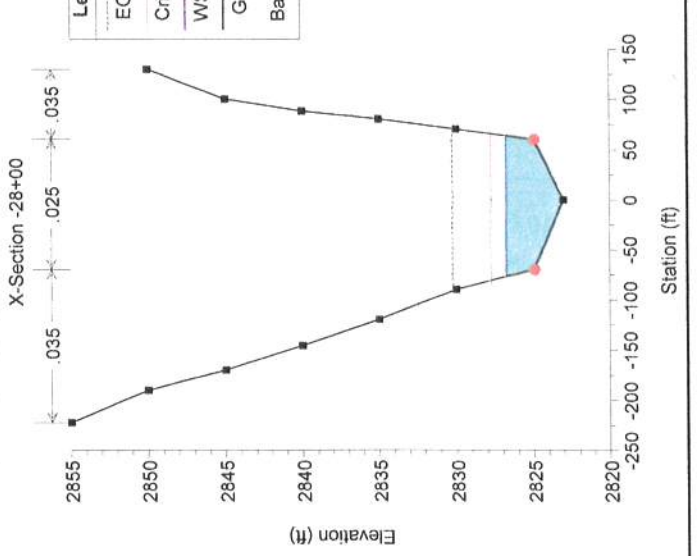
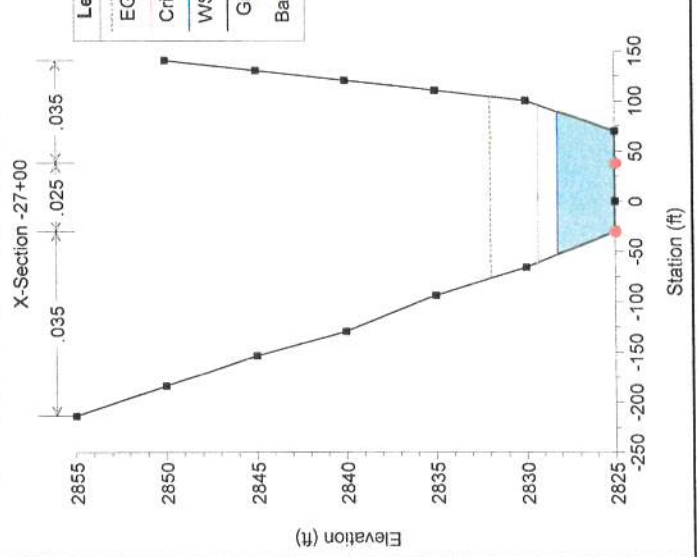
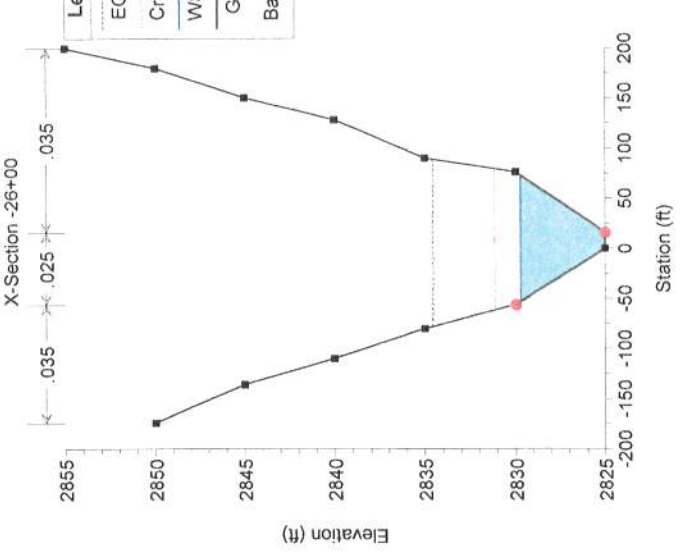
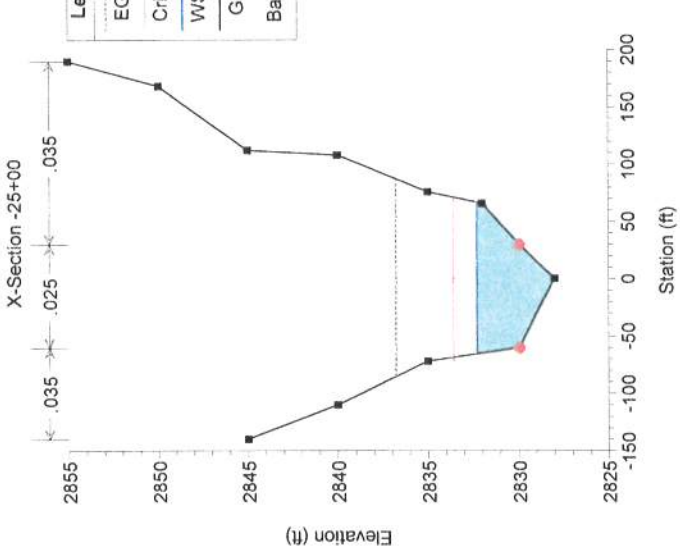
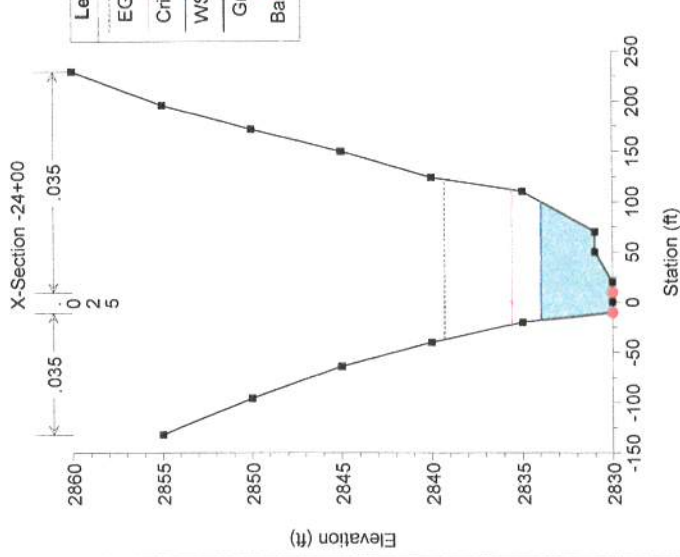


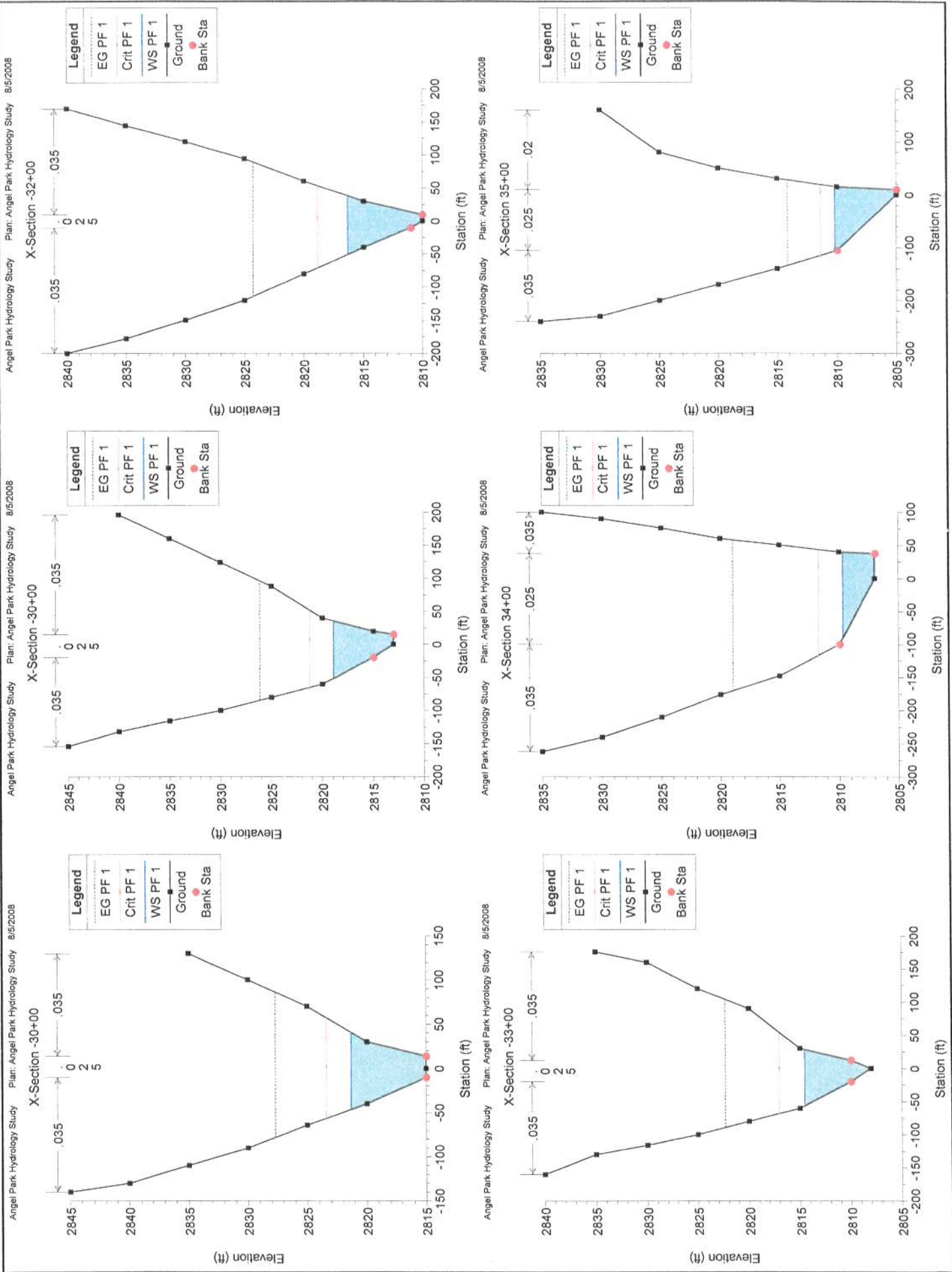
X-Section -20+00



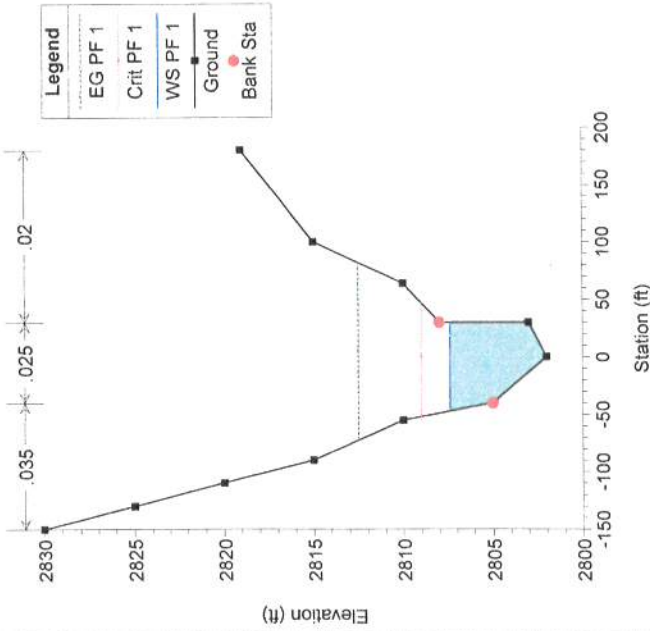
X-Section -23+00



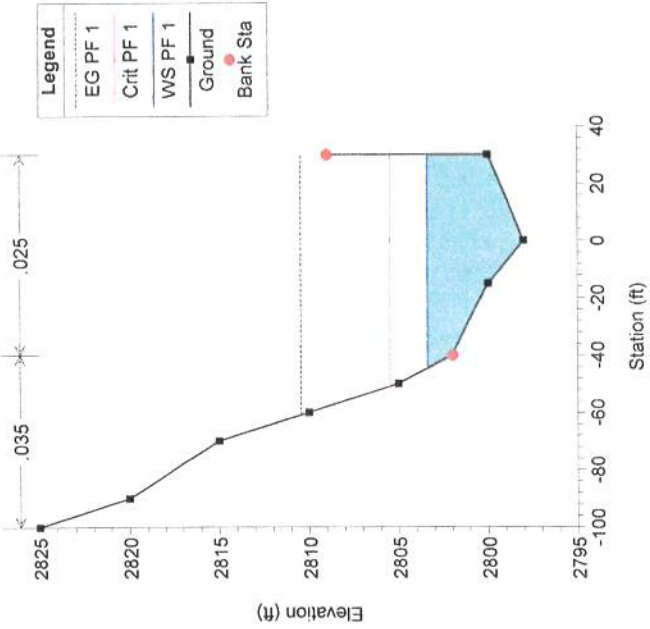




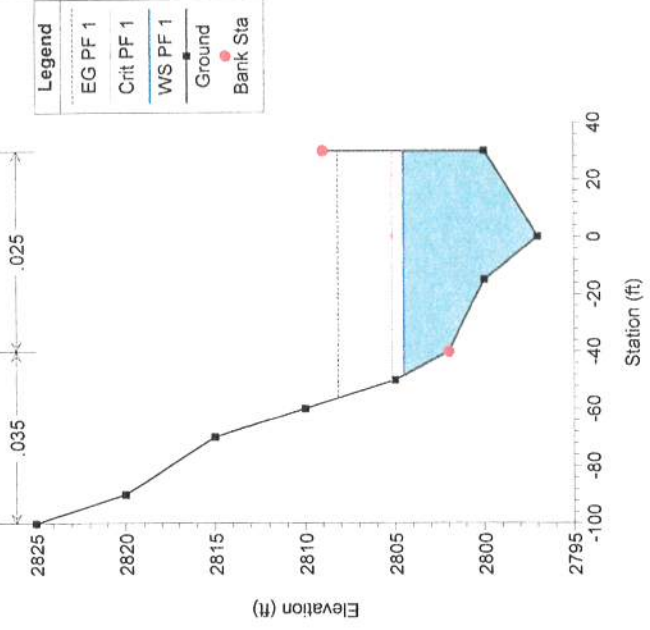
X-Section 36+00



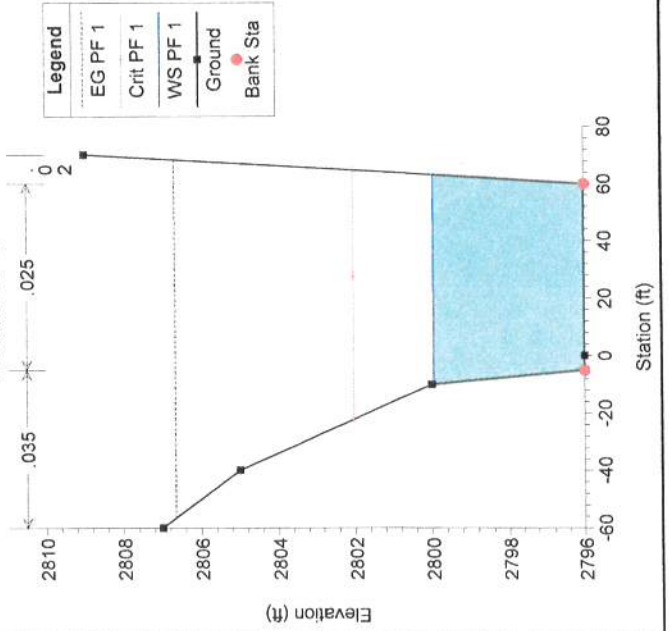
X-Section 37+00



X-Section 38+00



X-Section 39+00





Angel Park Middle Branch
Hydraulic Report

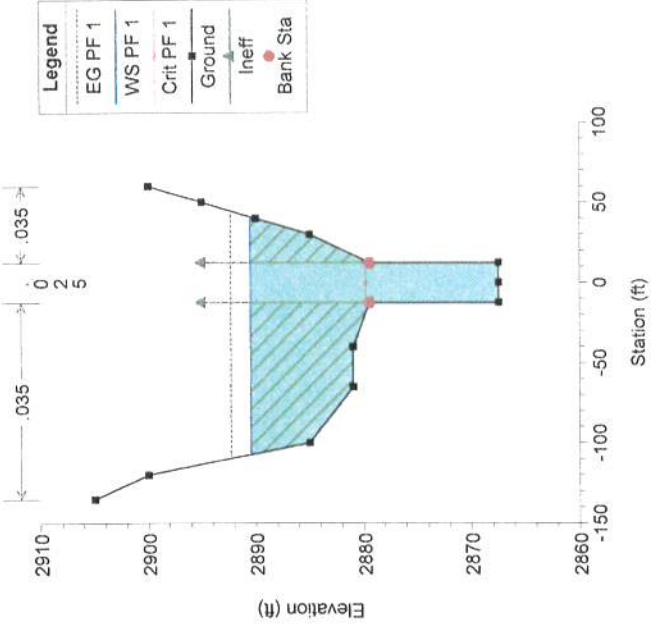
Final Report

HEC-RAS Natural Channel Model Output for 6,047 cfs

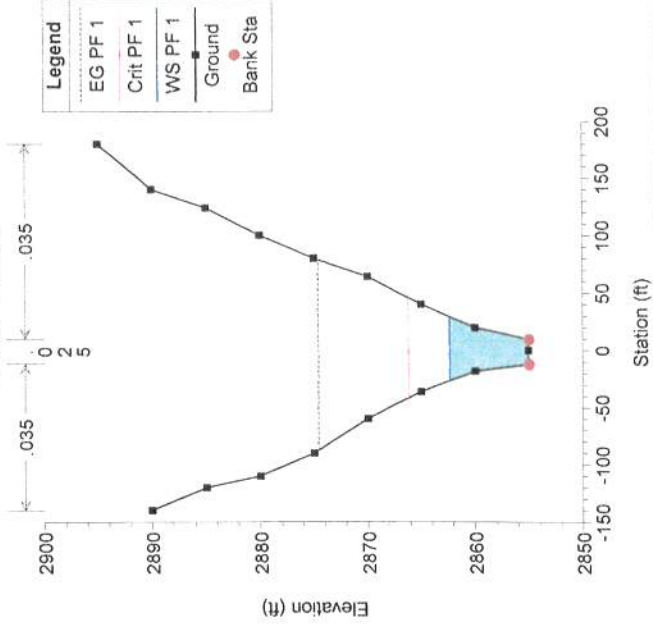
HEC-RAS Plan: Angel Park H River: Angel Park Middl Reach: 0132 to 0030 Profile: PF 1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
0132 to 0030	-485	PF 1	6047.00	2889.00	2892.12	2881.22	2892.47	0.000174	6.37	1922.98	212.23	0.23
0132 to 0030	-595	PF 1	6047.00	2867.50	2890.52	2879.84	2892.29	0.001223	10.68	566.16	148.38	0.39
0132 to 0030	-900		Culvert									
0132 to 0030	-1005	PF 1	6047.00	2860.00	2875.68	2875.68	2877.83	0.000816	12.82	611.36	148.70	0.57
0132 to 0030	-1100	PF 1	6047.00	2855.00	2862.37	2866.20	2874.58	0.018444	30.56	261.12	55.97	1.98
0132 to 0030	-1200	PF 1	6047.00	2853.00	2859.59	2862.96	2872.31	0.029555	32.99	263.21	75.59	2.40
0132 to 0030	-1300	PF 1	6047.00	2851.00	2855.89	2859.33	2869.09	0.036413	30.37	225.41	63.04	2.56
0132 to 0030	-1400	PF 1	6047.00	2850.00	2853.54	2856.47	2864.60	0.040275	27.72	243.52	81.50	2.60
0132 to 0030	-1500	PF 1	6047.00	2848.00	2852.19	2854.68	2860.62	0.026099	24.96	285.70	83.14	2.15
0132 to 0030	-1600	PF 1	6047.00	2846.00	2850.22	2852.54	2858.00	0.022628	23.36	292.46	83.07	2.00
0132 to 0030	-1700	PF 1	6047.00	2844.00	2848.59	2850.77	2855.66	0.021297	23.96	323.35	92.31	1.97
0132 to 0030	-1800	PF 1	6047.00	2844.00	2851.19	2851.19	2853.37	0.005081	14.73	610.98	140.02	1.02
0132 to 0030	-1900	PF 1	6047.00	2840.00	2842.83	2845.21	2851.63	0.042477	24.51	268.54	108.74	2.57
0132 to 0030	-2000	PF 1	6047.00	2840.00	2843.32	2844.68	2847.79	0.017177	17.32	371.27	123.88	1.58
0132 to 0030	-2100	PF 1	6047.00	2837.00	2840.59	2842.15	2845.79	0.020595	20.02	372.41	133.80	1.86
0132 to 0030	-2200	PF 1	6047.00	2835.00	2841.13	2841.77	2843.98	0.007209	14.51	507.58	156.67	1.16
0132 to 0030	-2300	PF 1	6047.00	2832.00	2836.16	2838.00	2842.37	0.023812	23.71	354.71	119.71	2.05
0132 to 0030	-2400	PF 1	6047.00	2830.00	2834.14	2835.87	2839.68	0.027633	25.49	363.15	119.73	2.21
0132 to 0030	-2500	PF 1	6047.00	2828.00	2832.48	2833.89	2837.19	0.017378	17.97	373.85	133.54	1.70
0132 to 0030	-2600	PF 1	6047.00	2825.00	2829.91	2831.42	2834.94	0.025835	19.88	358.74	130.01	2.02
0132 to 0030	-2700	PF 1	6047.00	2825.00	2828.36	2829.60	2832.41	0.018459	18.11	410.46	144.35	1.74
0132 to 0030	-2800	PF 1	6047.00	2823.00	2826.99	2828.05	2830.64	0.015598	15.40	400.58	141.94	1.57
0132 to 0030	-2900	PF 1	6047.00	2820.00	2825.82	2826.76	2829.48	0.009145	18.40	468.13	116.58	1.34
0132 to 0030	-3000	PF 1	6047.00	2815.00	2821.65	2823.78	2828.15	0.013362	24.30	368.05	91.14	1.66
0132 to 0030	-3100	PF 1	6047.00	2813.00	2819.26	2821.62	2826.52	0.015911	23.85	334.49	91.15	1.76
0132 to 0030	-3200	PF 1	6047.00	2810.00	2816.64	2819.21	2824.73	0.018808	28.02	338.57	92.95	1.95
0132 to 0030	-3300	PF 1	6047.00	2808.00	2814.79	2817.41	2822.97	0.017828	25.44	318.21	87.54	1.86
0132 to 0030	-3400	PF 1	6047.00	2807.00	2809.83	2812.00	2819.53	0.080055	25.05	242.98	134.04	3.27
0132 to 0030	-3500	PF 1	6047.00	2805.00	2810.32	2811.64	2814.62	0.017924	16.89	364.43	123.24	1.69
0132 to 0030	-3600	PF 1	6047.00	2802.00	2807.69	2809.43	2812.96	0.013791	18.51	334.04	78.07	1.52
0132 to 0030	-3700	PF 1	6047.00	2798.00	2803.67	2805.87	2810.97	0.022941	21.72	281.86	75.58	1.92
0132 to 0030	-3800	PF 1	6047.00	2797.00	2804.76	2805.53	2808.67	0.008452	15.95	388.07	79.19	1.21
0132 to 0030	-3900	PF 1	6047.00	2796.00	2800.22	2802.40	2807.21	0.019126	21.45	292.12	74.54	1.84

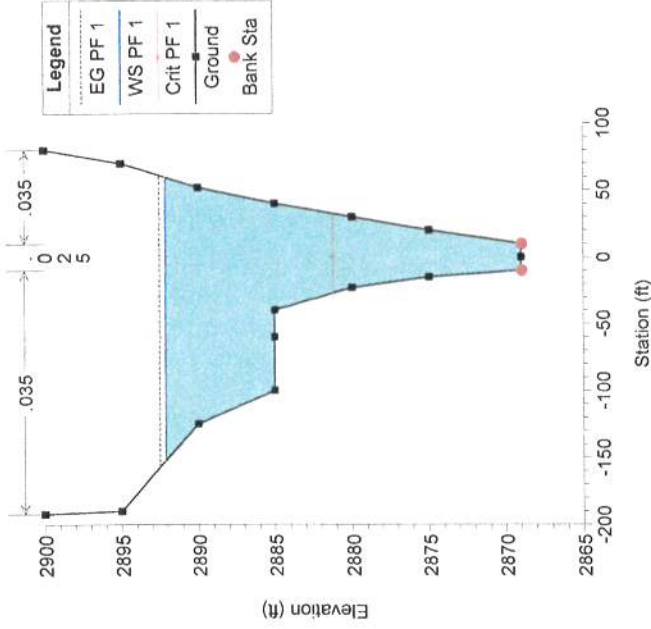
Station -5+95 - Upstream of 2'-18' x 12'



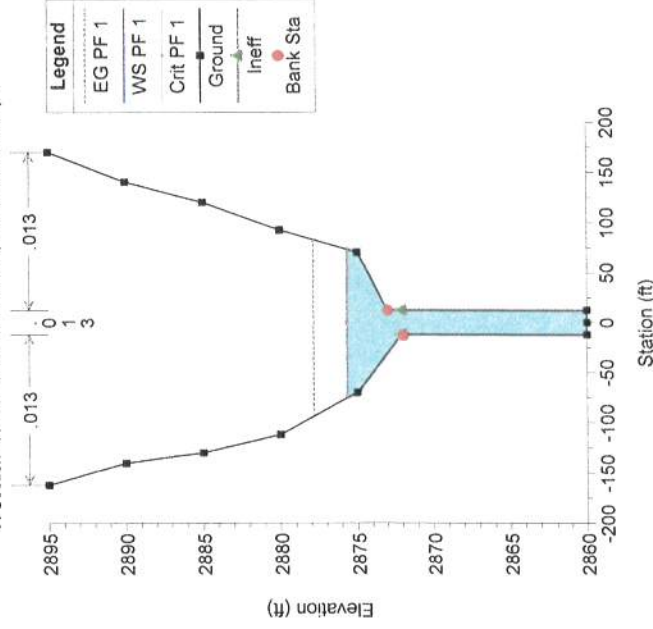
X-Section -11+00



X-Section -4+85

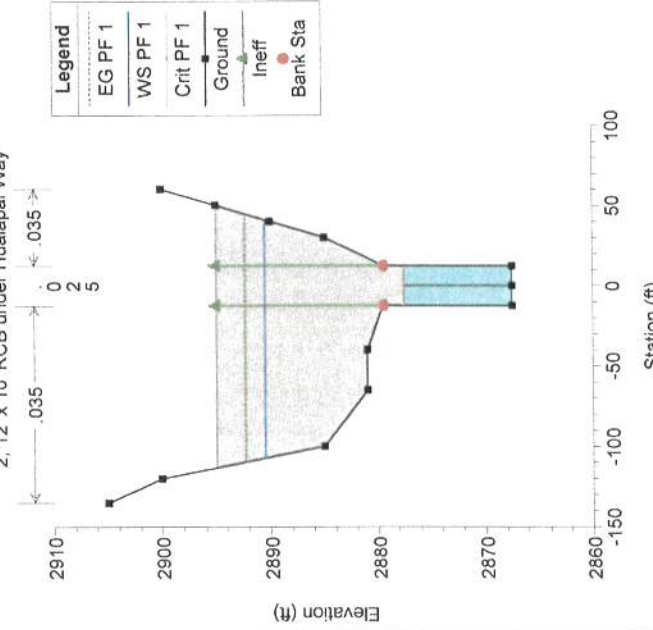


X-Section -10+00 - 2'-12' x 10' culvert, east side of Hualapai



No Data for Plot

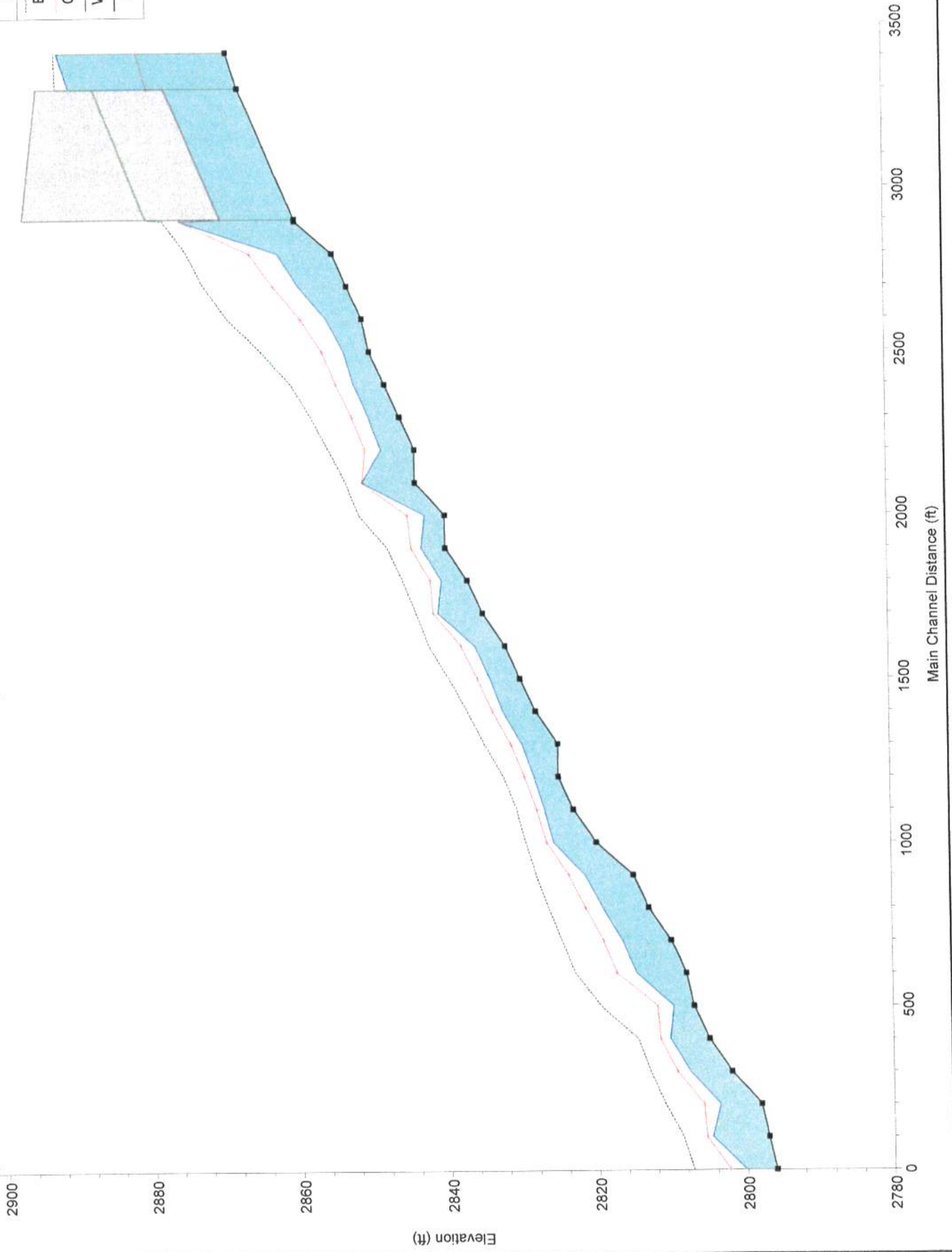
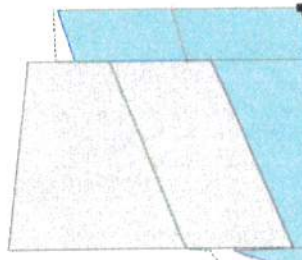
2, 12' x 10' RCB under Hualapai Way

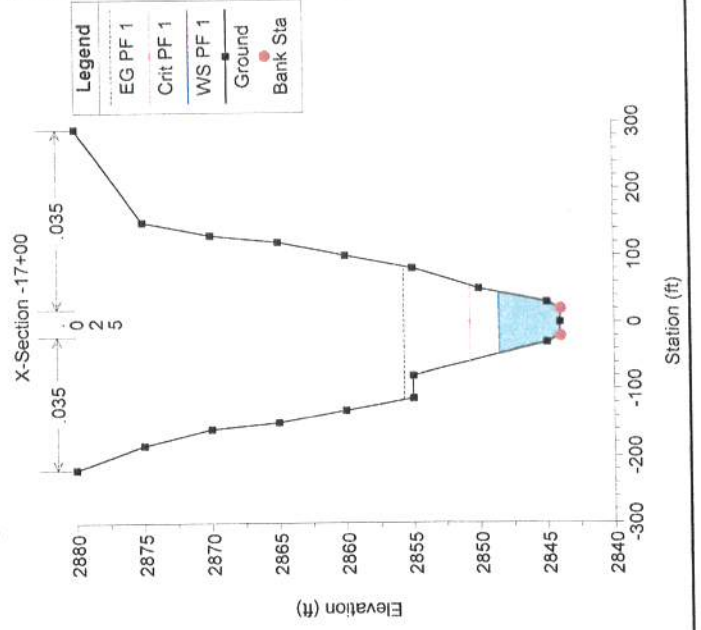
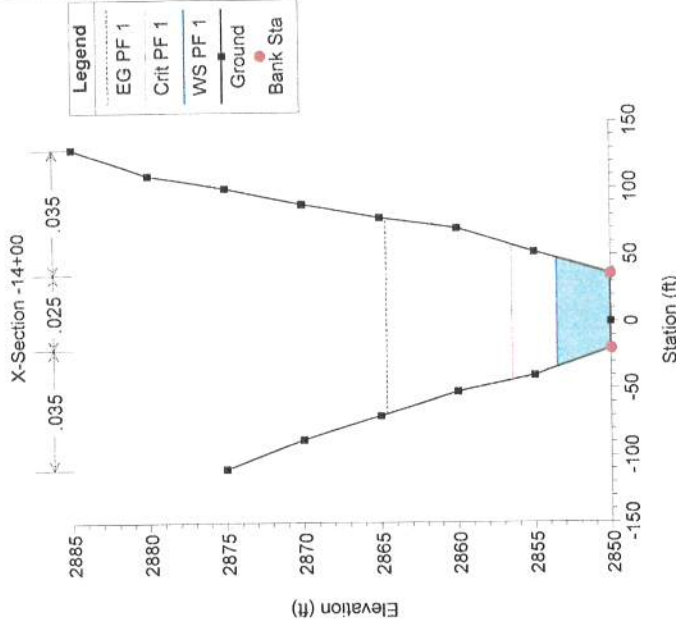
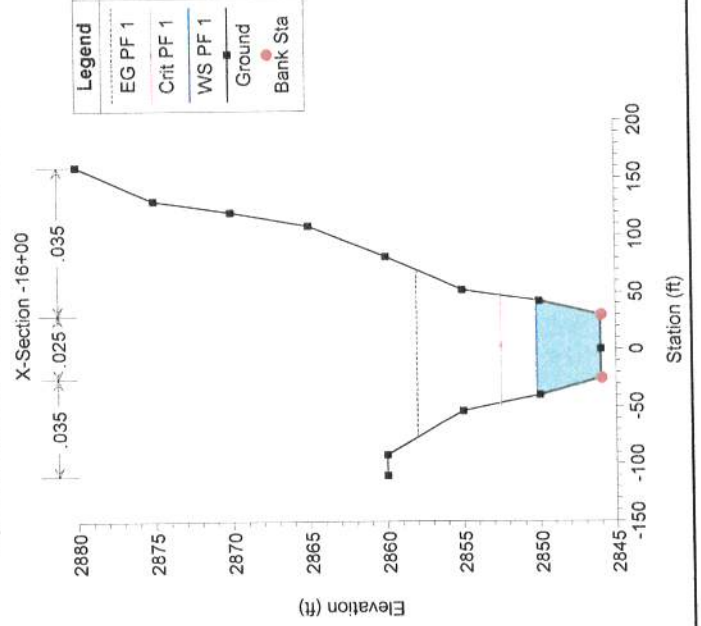
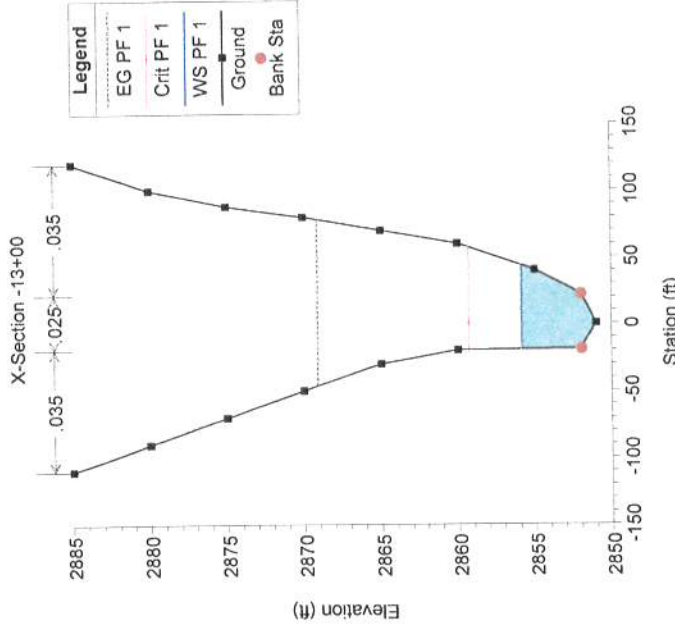
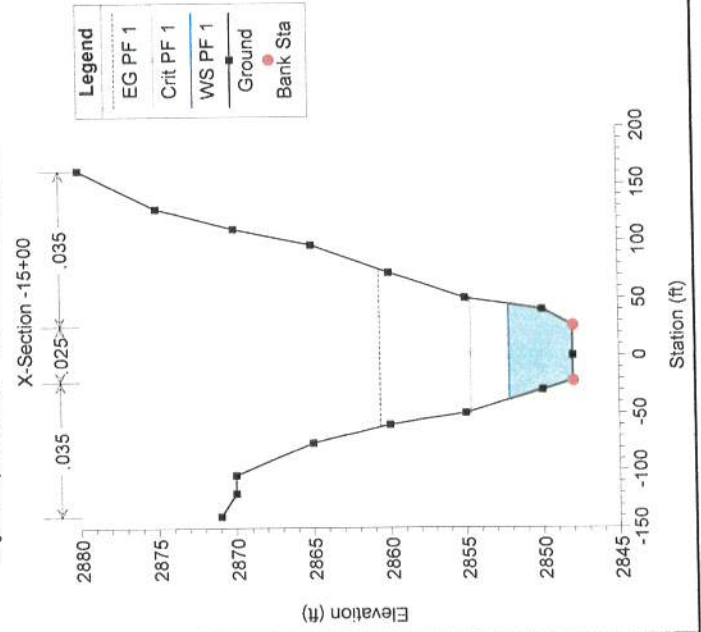
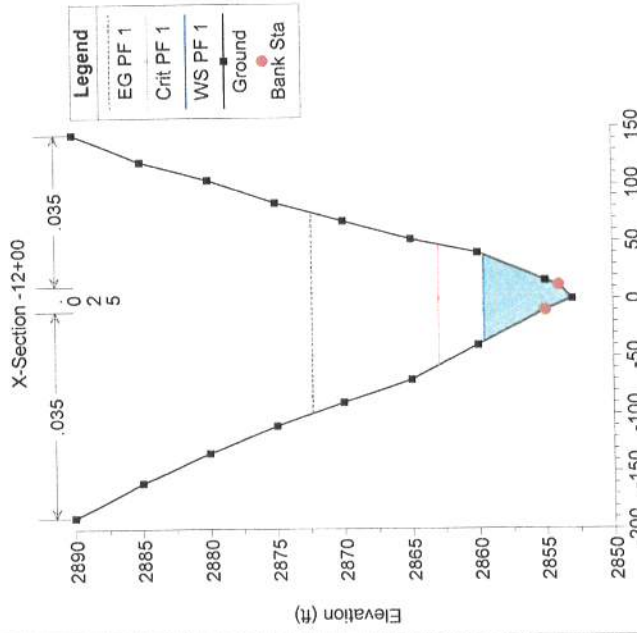


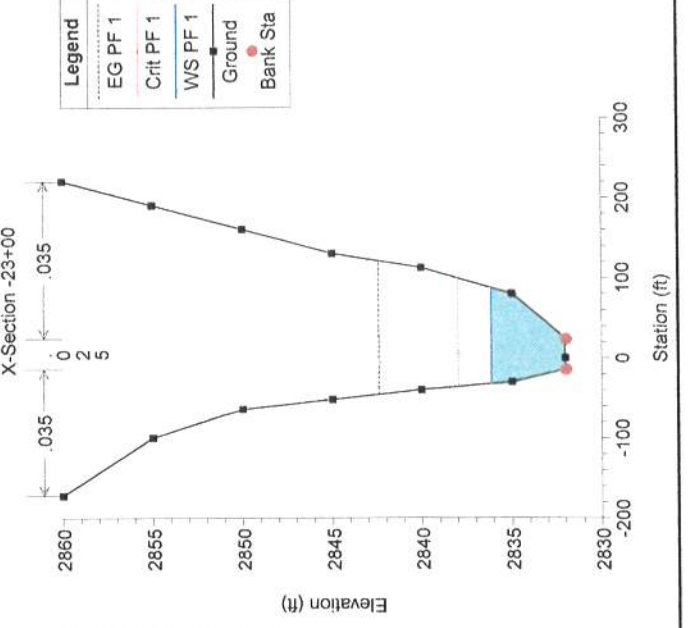
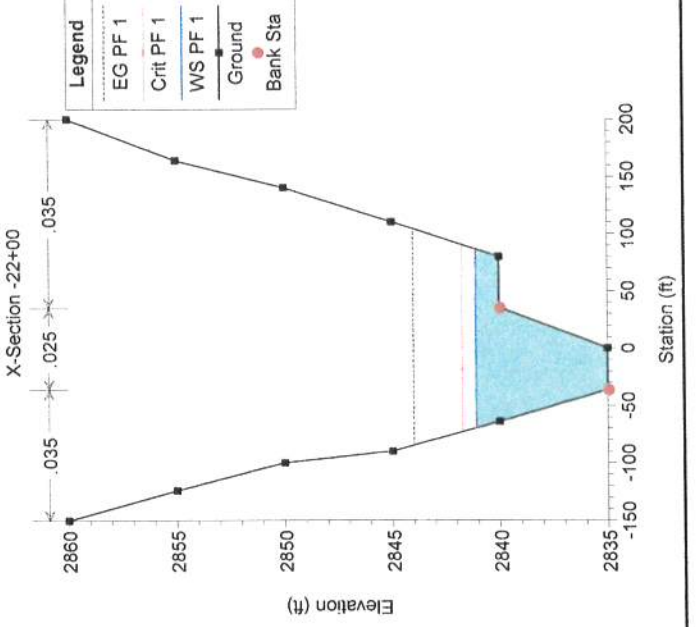
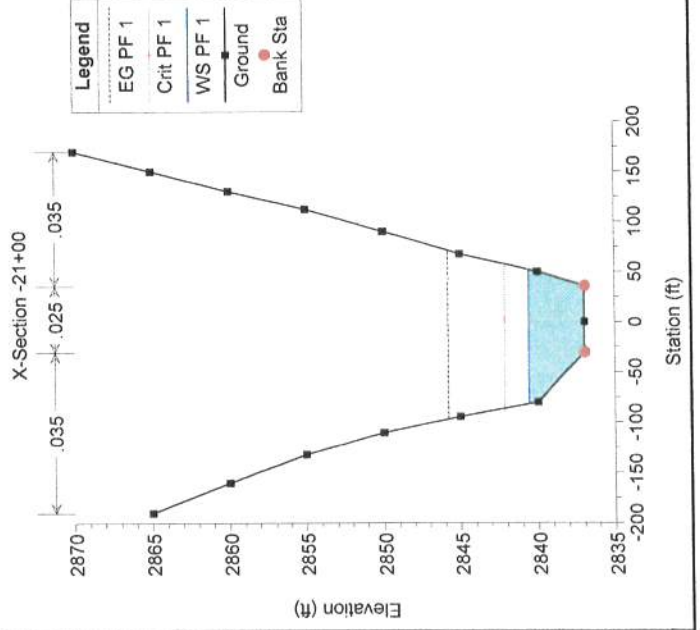
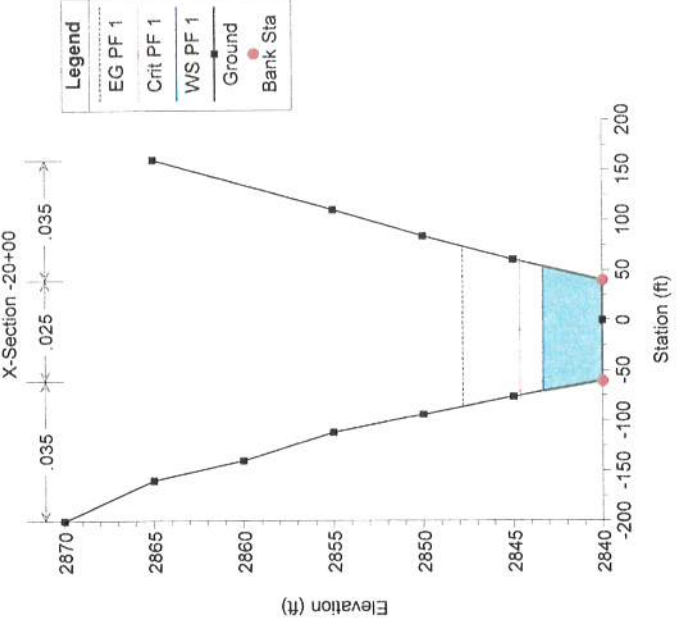
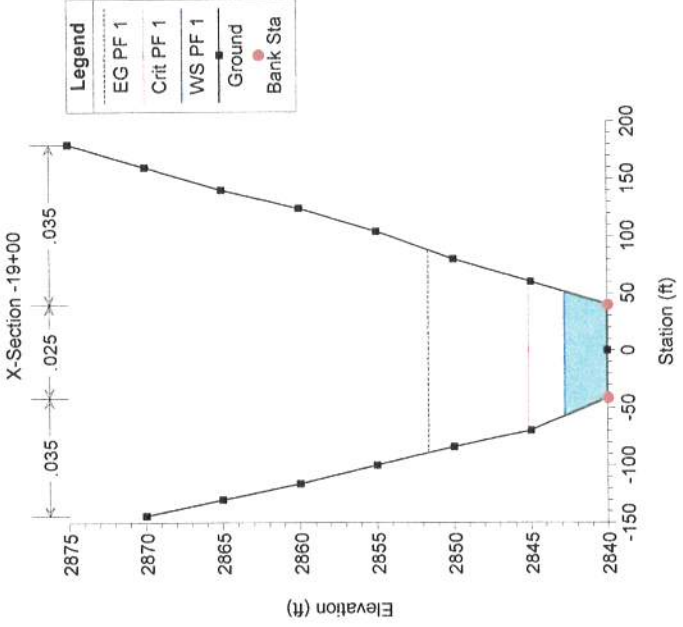
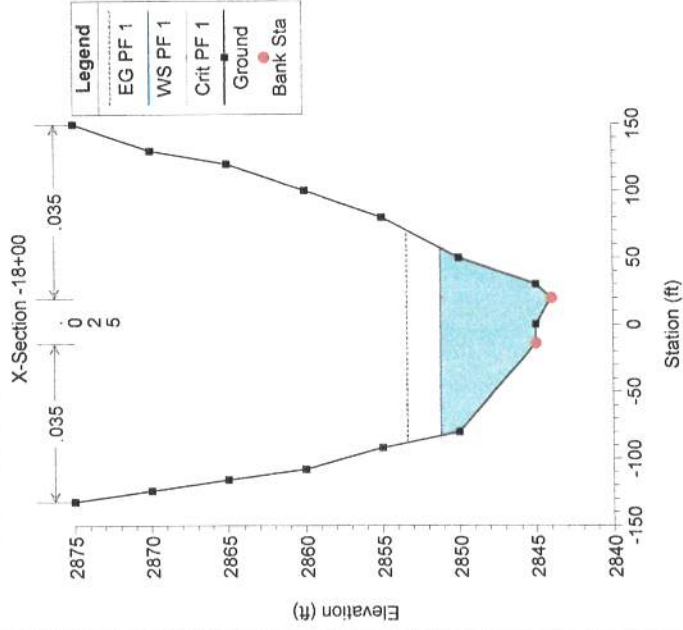
Angel Park Hydrology Study Plan: Angel Park Hydrology Study 8/5/2008

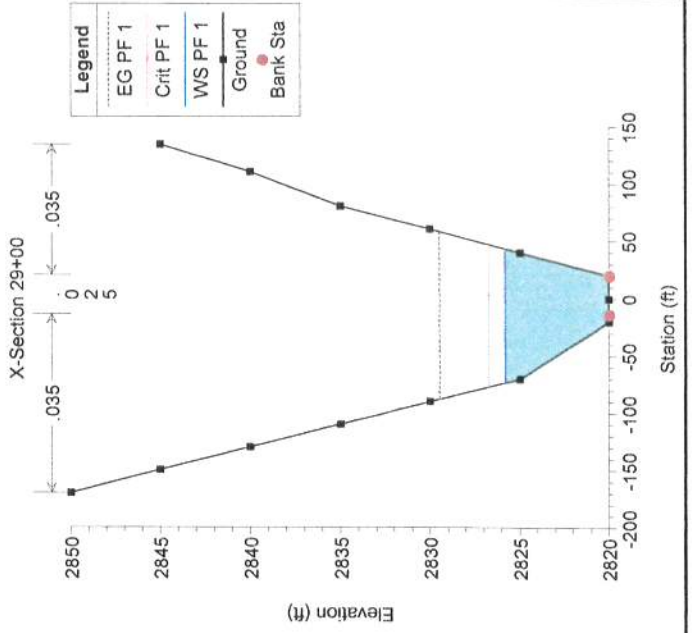
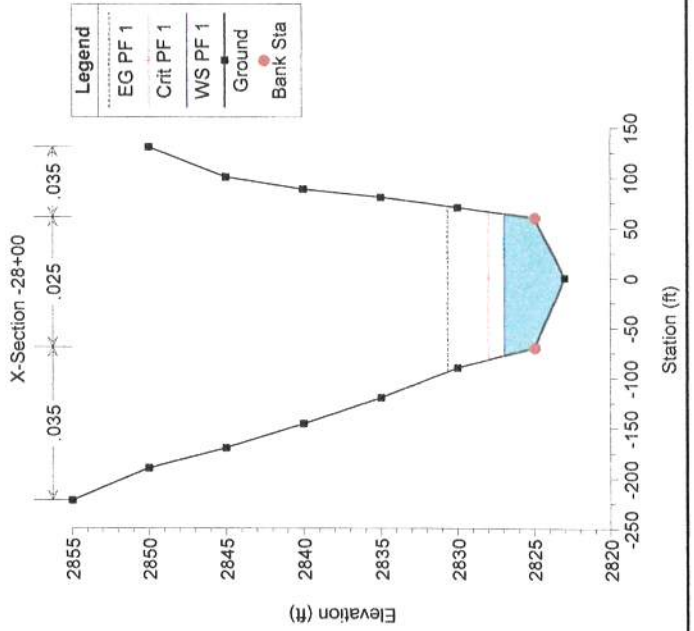
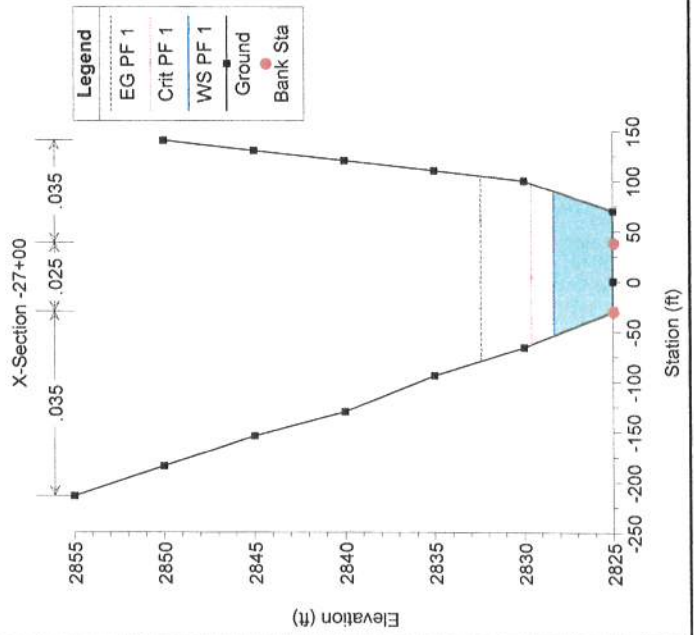
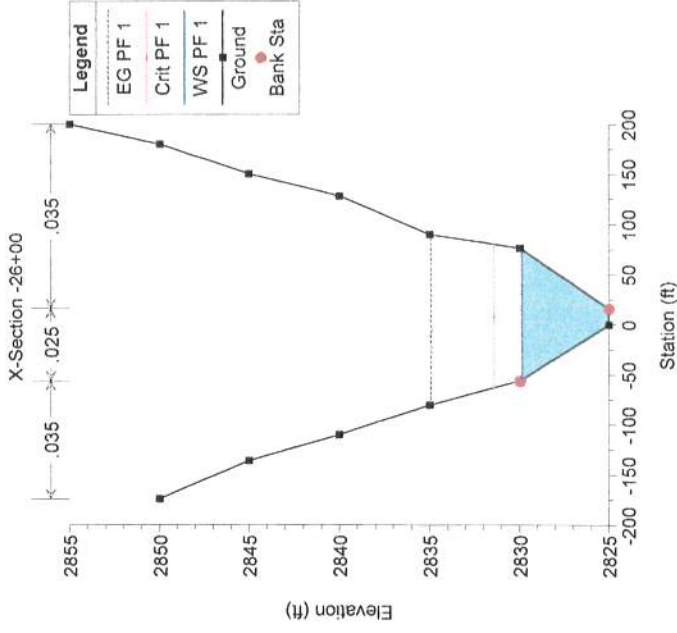
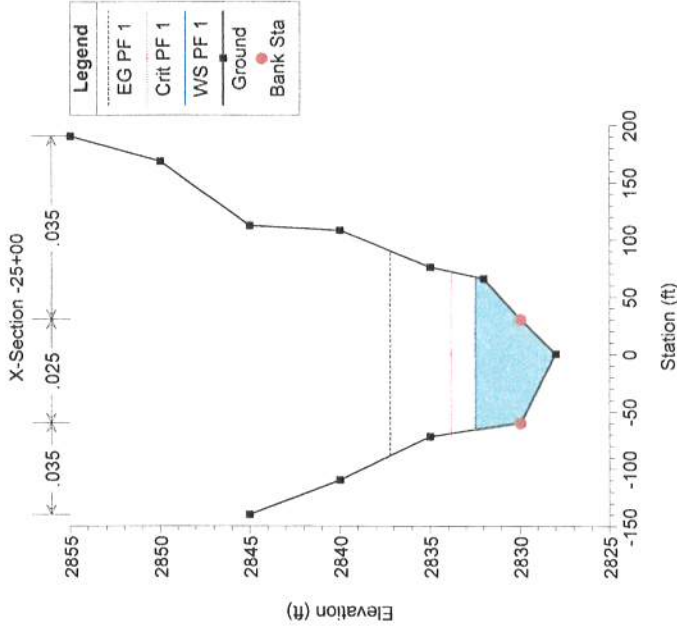
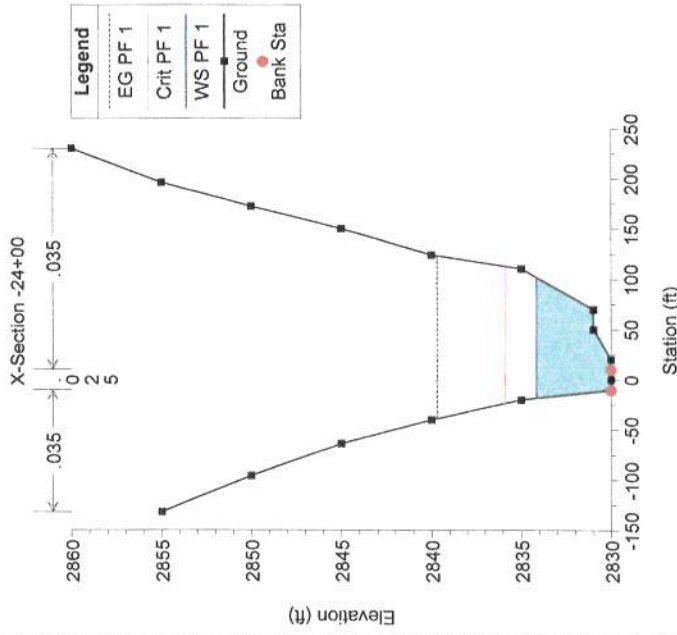
Angel Park Middl 0132 to 0030

Legend	
EG PF 1	
Crit PF 1	
WS PF 1	
Ground	

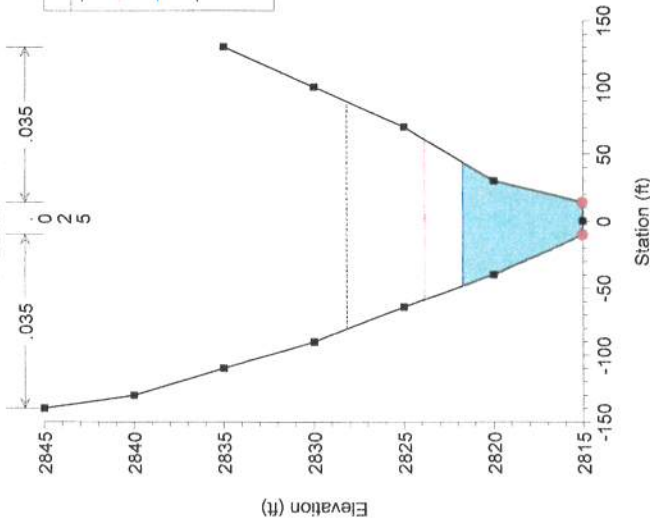




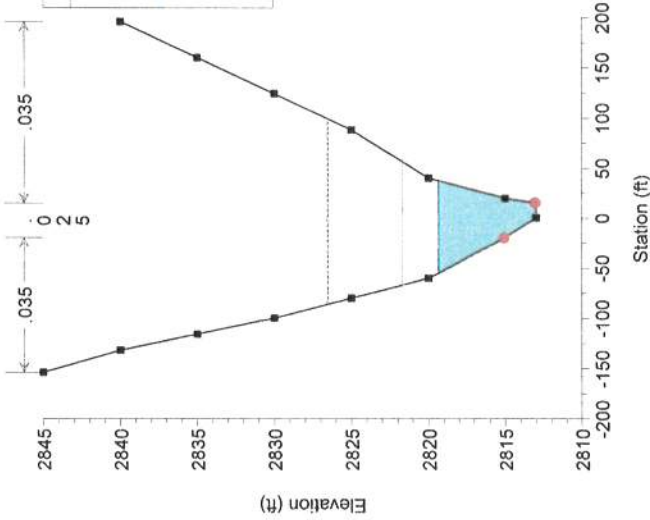




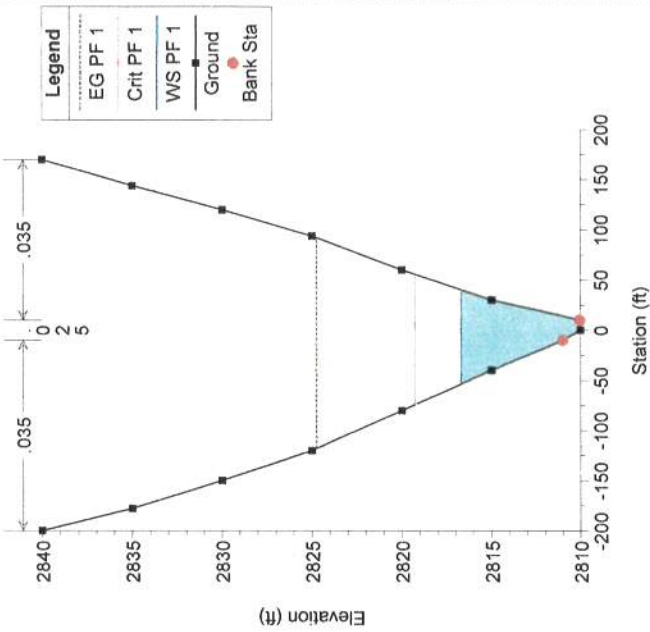
X-Section -30+00



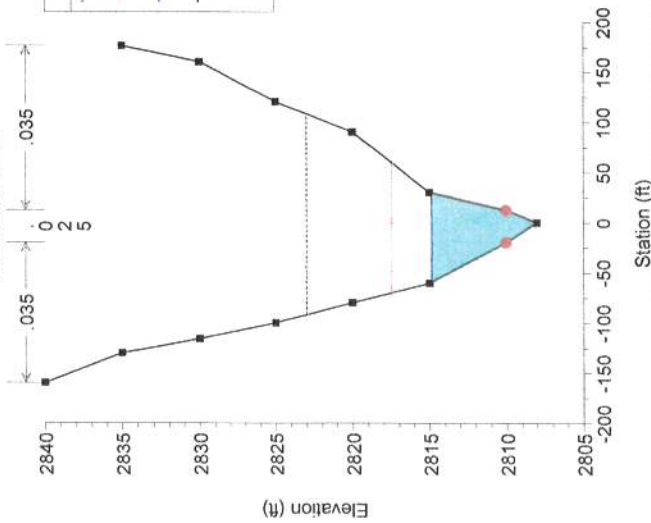
X-Section -30+00



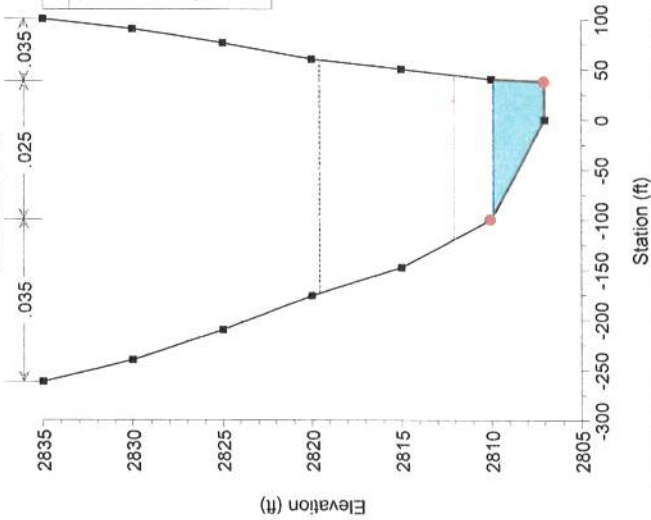
X-Section -32+00



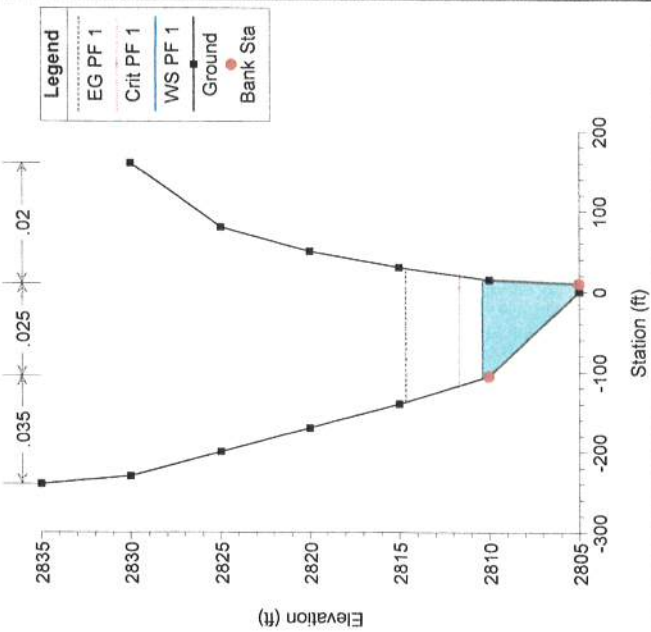
X-Section -33+00



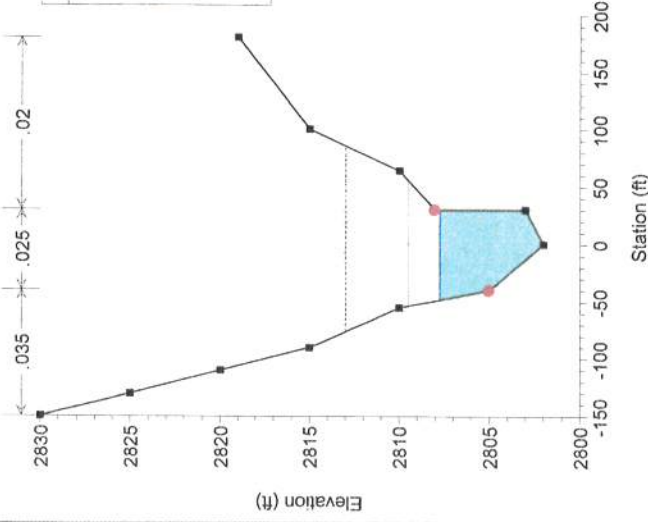
X-Section 34+00



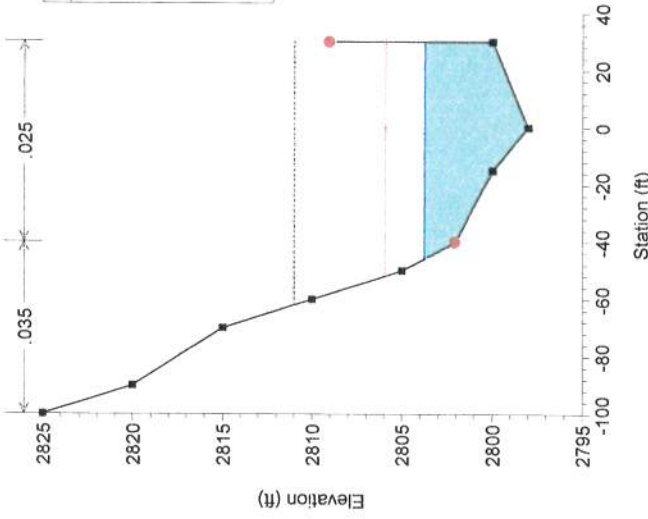
X-Section 35+00



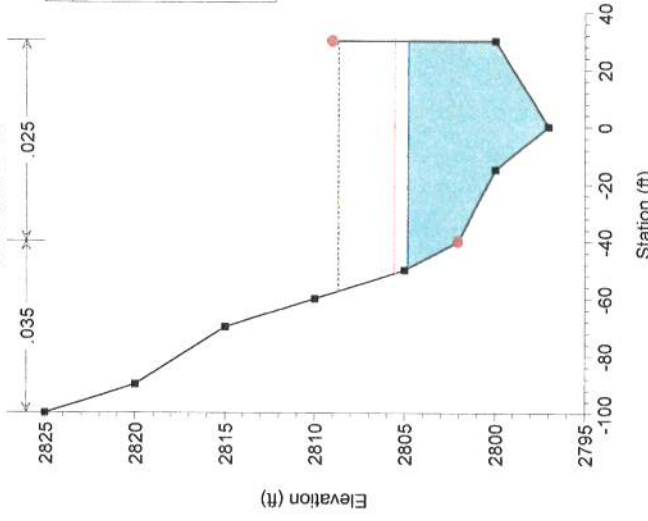
X-Section 36+00



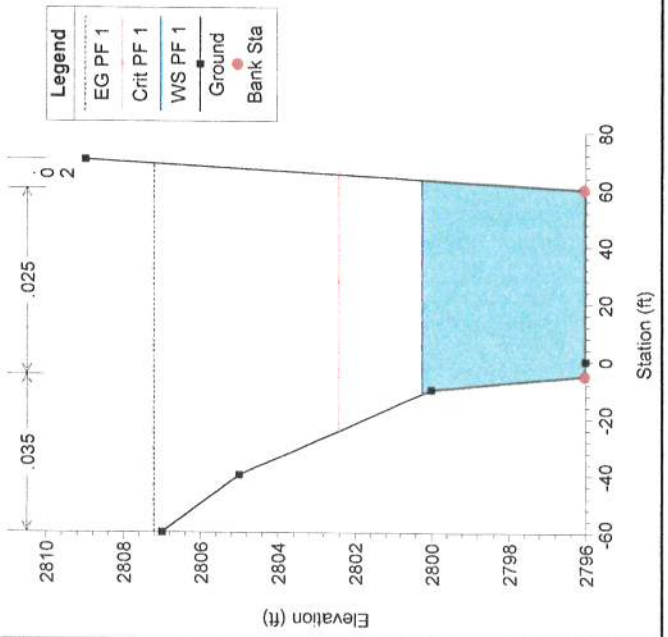
X-Section 37+00

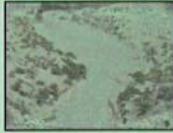


X-Section 38+00



X-Section 39+00





ALTERNATIVE II

HEC-RAS Model Output for 6,047 cfs, 1.5:1 rip rap side slopes

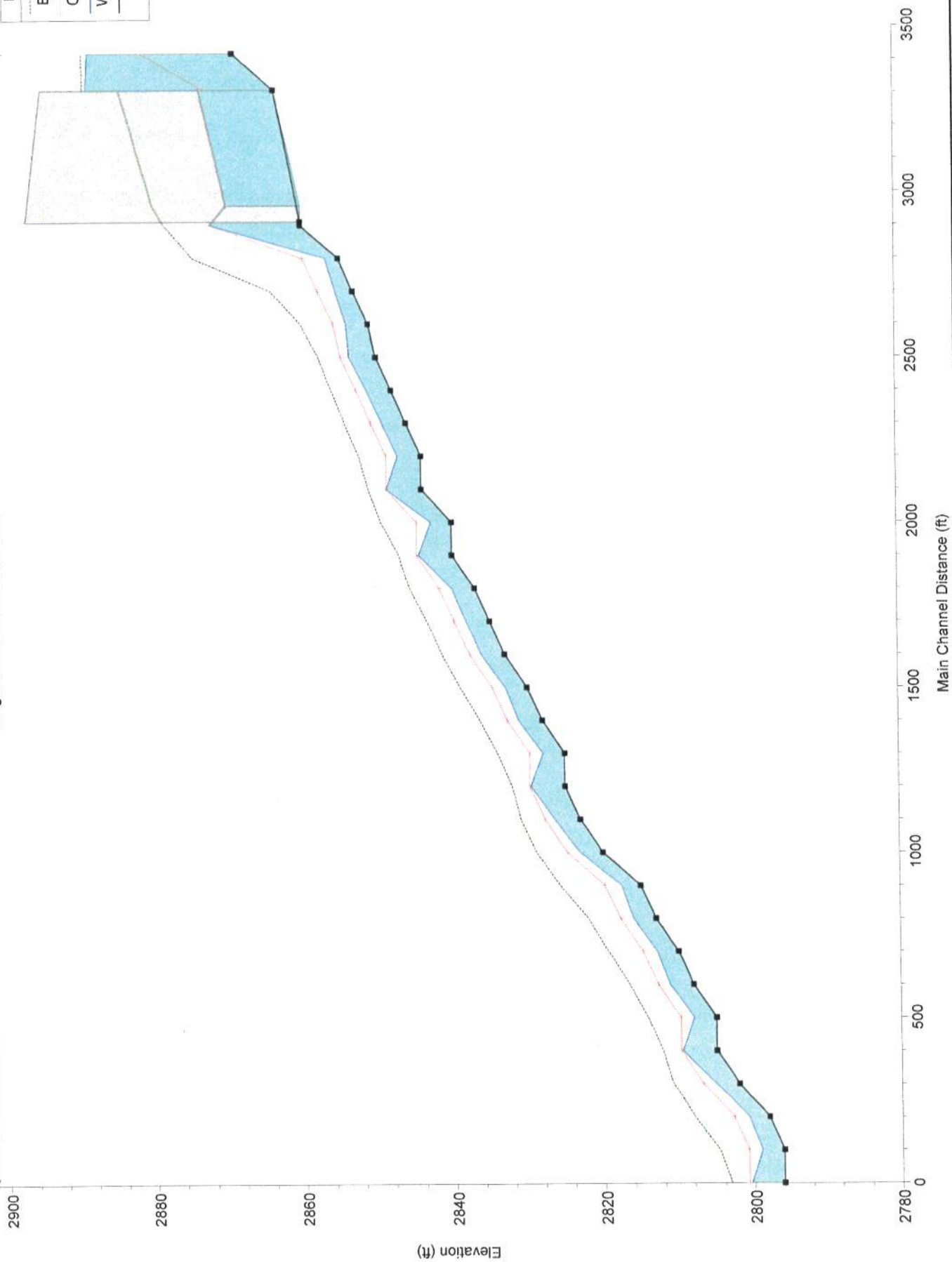
HEC-RAS Plan: Angel Park H River: Angel Park Middel Reach: 0132 to 0030 Profile: PF 1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
0132 to 0030	-485	PF 1	6047.00	2869.00	2888.60	2881.22	2889.38	0.000430	8.96	1268.57	166.60	0.36
0132 to 0030	-595	PF 1	6047.00	2863.50	2888.83	2872.93	2889.24	0.000070	5.58	1635.21	142.75	0.20
0132 to 0030	-900		Culvert									
0132 to 0030	-1005	PF 1	6047.00	2860.00	2872.16	2872.16	2878.30	0.001082	19.89	304.05	136.49	1.00
0132 to 0030	-1100	PF 1	6047.00	2855.00	2856.76	2859.78	2874.47	0.152783	33.92	181.08	105.29	4.50
0132 to 0030	-1200	PF 1	6047.00	2853.00	2855.53	2857.78	2864.06	0.045846	23.60	262.03	107.57	2.62
0132 to 0030	-1300	PF 1	6047.00	2851.00	2853.99	2855.78	2860.02	0.025851	19.85	312.75	108.98	2.02
0132 to 0030	-1400	PF 1	6047.00	2850.00	2853.62	2854.78	2857.70	0.013589	16.34	381.89	110.87	1.51
0132 to 0030	-1500	PF 1	6047.00	2848.00	2851.34	2852.75	2856.03	0.017550	17.59	357.66	114.31	1.70
0132 to 0030	-1600	PF 1	6047.00	2846.00	2849.32	2850.78	2854.20	0.018320	17.89	348.00	109.95	1.73
0132 to 0030	-1700	PF 1	6047.00	2844.00	2847.25	2848.78	2852.35	0.019683	18.28	340.33	109.74	1.79
0132 to 0030	-1800	PF 1	6047.00	2844.00	2848.78	2848.78	2851.07	0.005314	12.30	512.39	114.34	0.99
0132 to 0030	-1900	PF 1	6047.00	2840.00	2842.86	2844.78	2849.49	0.030286	20.82	297.80	108.57	2.17
0132 to 0030	-2000	PF 1	6047.00	2840.00	2844.48	2844.78	2847.10	0.006602	13.13	478.60	113.45	1.09
0132 to 0030	-2100	PF 1	6047.00	2837.00	2840.11	2841.78	2845.68	0.022666	19.07	325.76	109.34	1.91
0132 to 0030	-2200	PF 1	6047.00	2835.00	2838.23	2839.78	2843.38	0.019985	18.36	338.73	109.69	1.80
0132 to 0030	-2300	PF 1	6047.00	2833.00	2836.23	2837.78	2841.38	0.019985	18.36	338.73	109.69	1.80
0132 to 0030	-2400	PF 1	6047.00	2830.00	2833.00	2834.78	2839.02	0.025809	19.84	312.91	108.98	2.02
0132 to 0030	-2500	PF 1	6047.00	2828.00	2831.22	2832.78	2836.41	0.020190	18.42	337.66	109.66	1.81
0132 to 0030	-2600	PF 1	6047.00	2825.00	2827.99	2829.78	2834.04	0.026030	19.89	312.09	108.96	2.03
0132 to 0030	-2700	PF 1	6047.00	2825.00	2829.61	2829.78	2832.08	0.006014	12.77	492.83	113.83	1.05
0132 to 0030	-2800	PF 1	6047.00	2823.00	2826.46	2827.78	2830.94	0.015894	17.13	363.71	110.37	1.62
0132 to 0030	-2900	PF 1	6047.00	2820.00	2823.13	2824.83	2828.86	0.022983	19.26	317.76	103.35	1.92
0132 to 0030	-3000	PF 1	6047.00	2815.00	2817.64	2819.83	2825.69	0.040346	22.81	267.82	102.83	2.47
0132 to 0030	-3100	PF 1	6047.00	2813.00	2816.07	2817.83	2822.03	0.024522	19.64	311.55	103.28	1.98
0132 to 0030	-3200	PF 1	6047.00	2810.00	2812.96	2814.83	2819.37	0.027620	20.35	300.49	103.17	2.09
0132 to 0030	-3300	PF 1	6047.00	2808.00	2811.23	2812.83	2816.59	0.020554	18.63	328.74	103.46	1.83
0132 to 0030	-3400	PF 1	6047.00	2805.00	2808.02	2809.83	2814.16	0.025673	19.91	307.24	103.24	2.02
0132 to 0030	-3500	PF 1	6047.00	2805.00	2809.65	2809.83	2812.21	0.006070	12.89	476.19	104.98	1.05
0132 to 0030	-3600	PF 1	6047.00	2802.00	2805.13	2806.83	2810.82	0.022732	19.18	318.49	103.36	1.91
0132 to 0030	-3700	PF 1	6047.00	2798.00	2800.75	2802.79	2807.95	0.034342	21.64	283.49	105.90	2.30
0132 to 0030	-3800	PF 1	6047.00	2796.00	2799.10	2800.79	2804.74	0.022990	19.17	320.57	106.65	1.92
0132 to 0030	-3900	PF 1	6047.00	2796.00	2800.45	2800.77	2803.14	0.006816	13.27	466.10	109.53	1.11

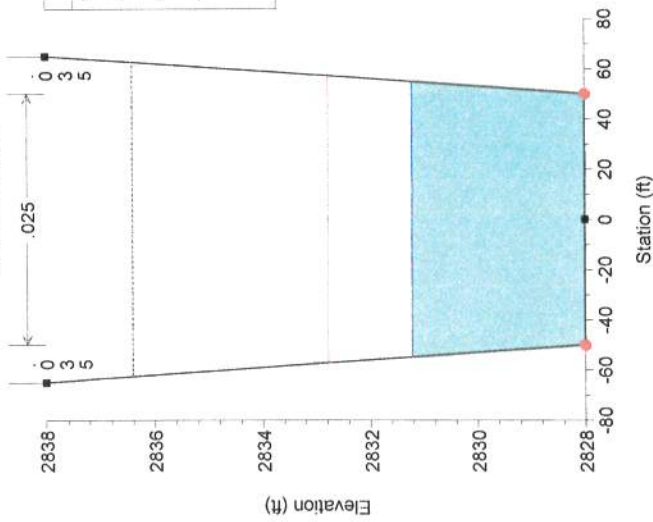
Angel Park Hydrology Study Plan: Angel Park Hydrology Study 6/29/2008

Angel Park Middl 0132 to 0030

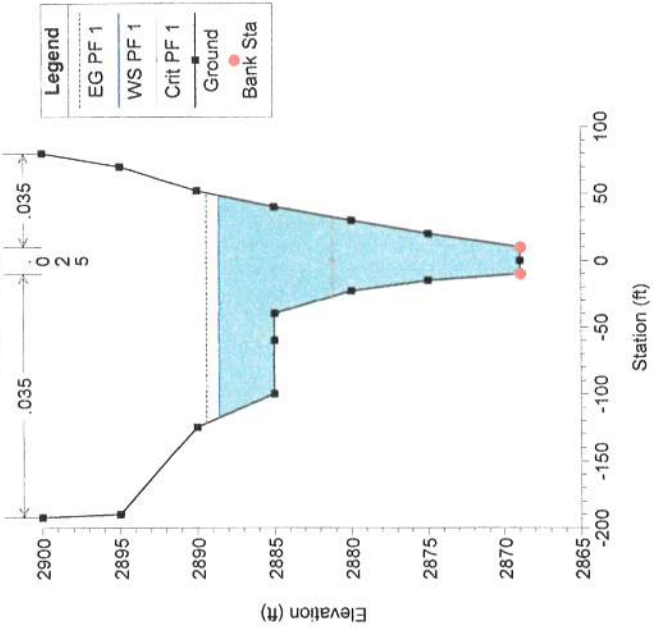
Legend				
EG	PF 1			
Crit	PF 1			
WS	PF 1			
Ground				



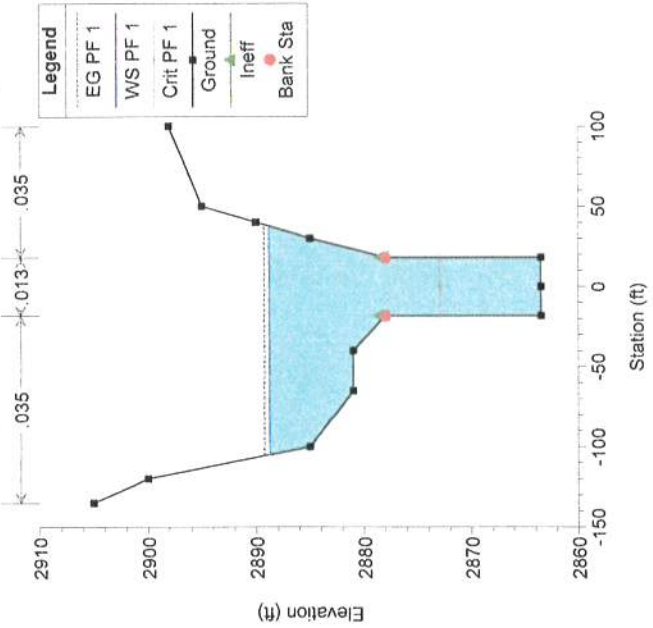
X-Section -25+00



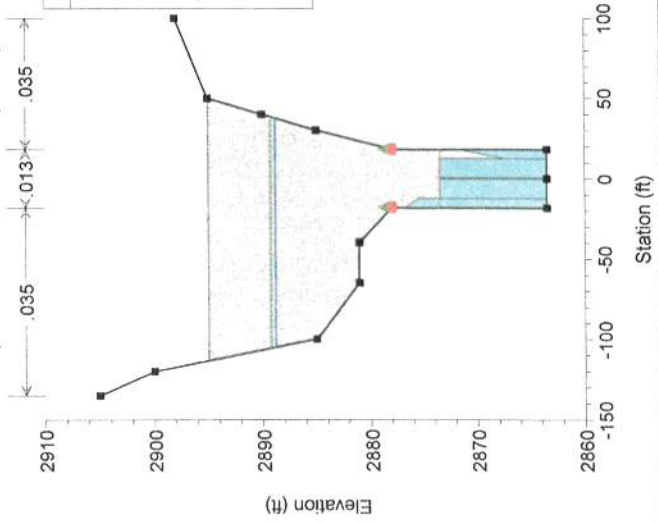
X-Section -4+85



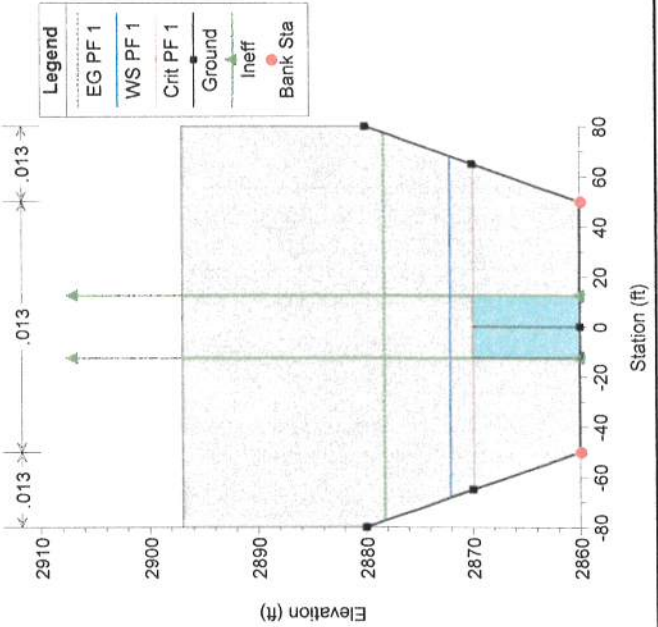
Station -5+95 - Upstream of 2'-18" x 10' RCB, west side of Hualapai



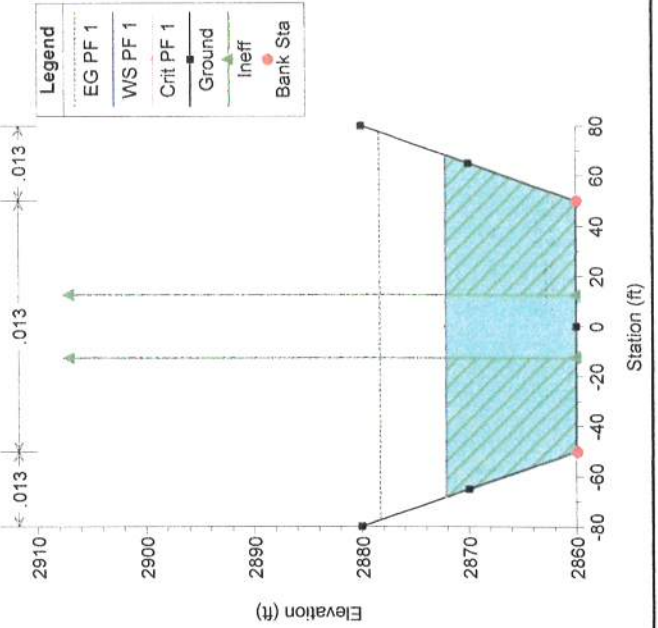
2, 12' x 10' RCB under Hualapai Way



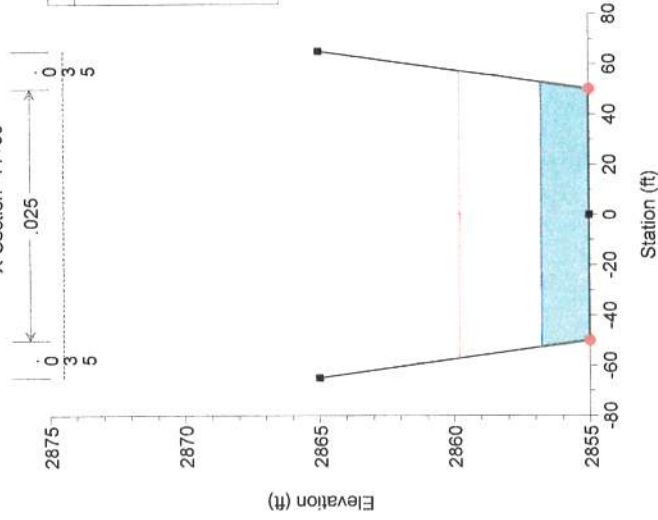
2, 12' x 10' RCB under Hualapai Way



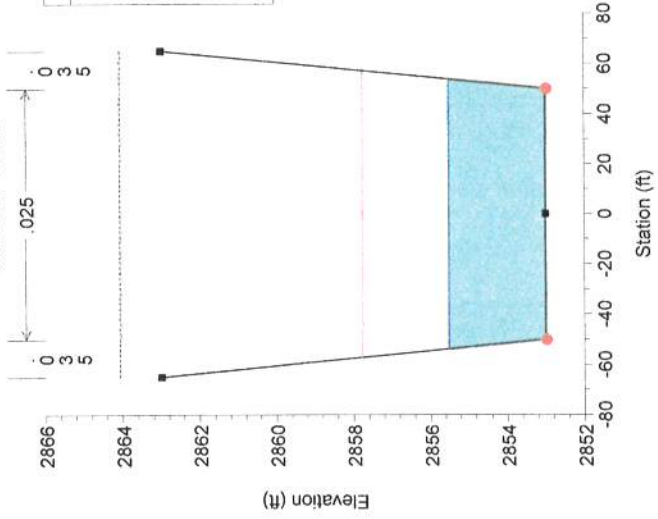
X-Section -10+00 - 2'-12" x 10' culvert, east side of Hualapai



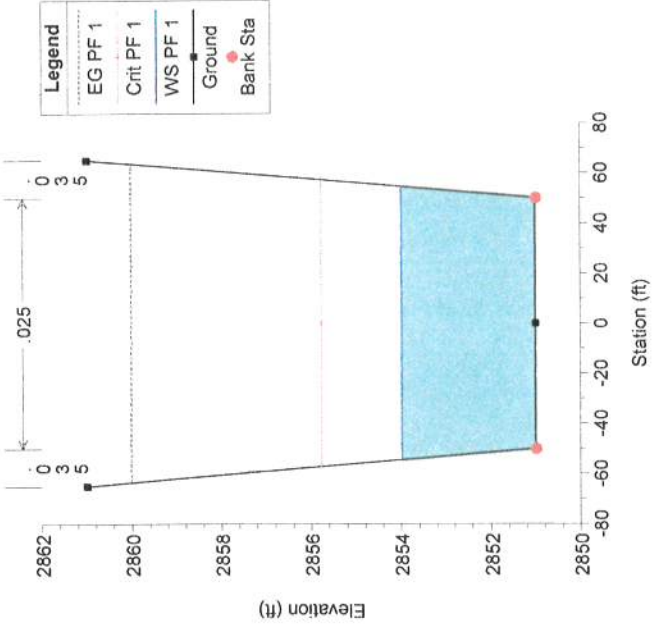
X-Section -11+00



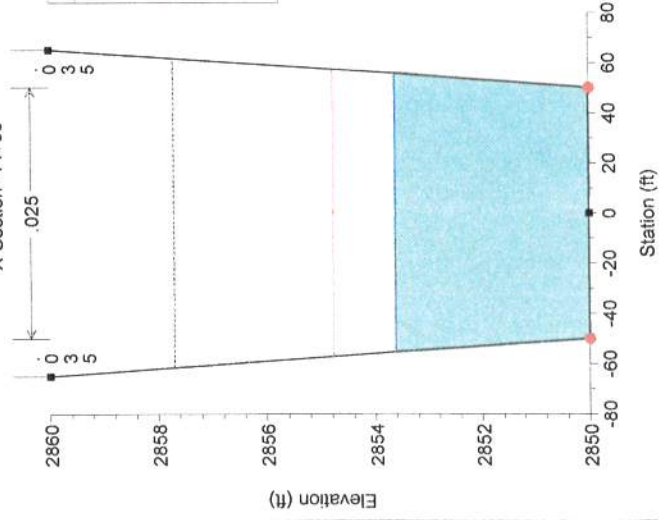
X-Section -12+00



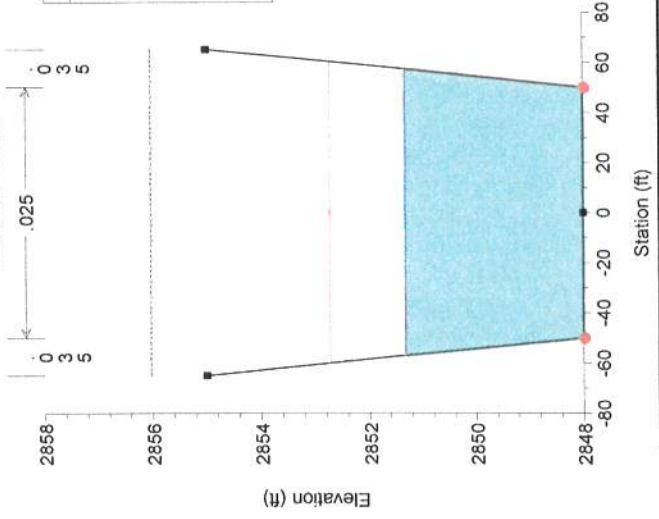
X-Section -13+00



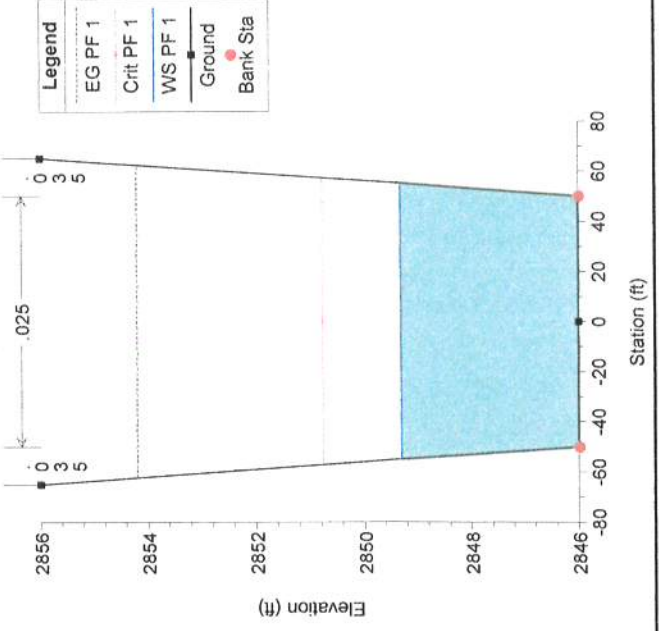
X-Section -14+00



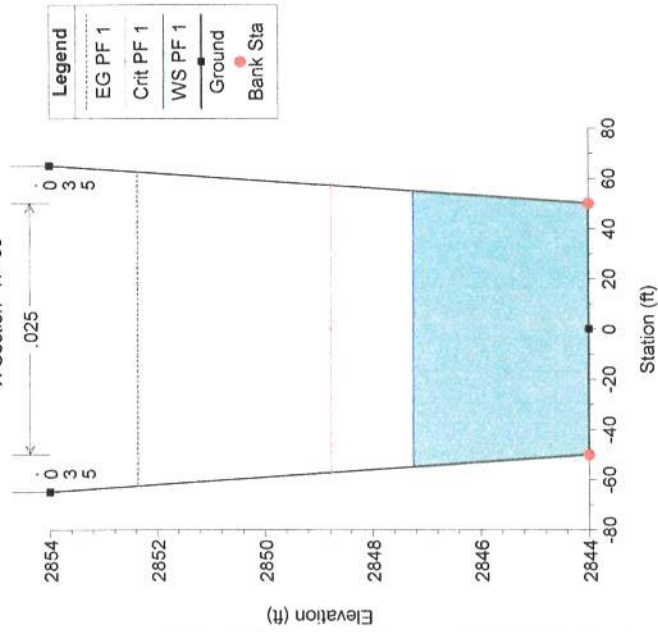
X-Section -15+00



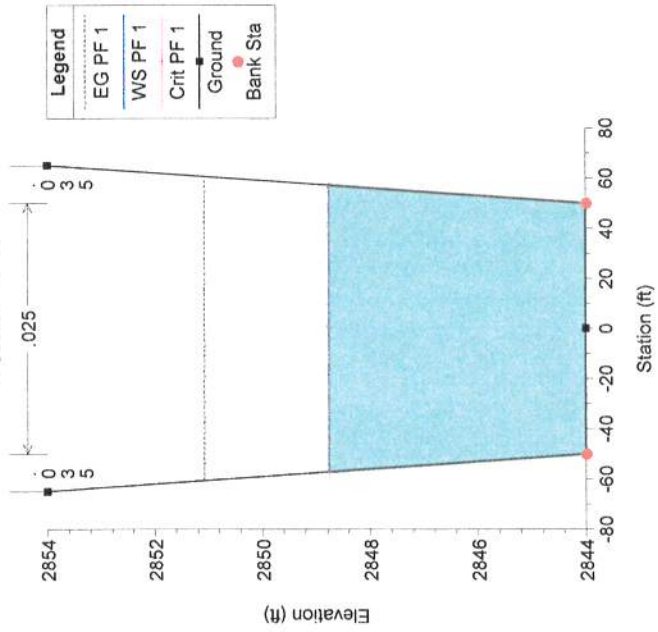
X-Section -16+00



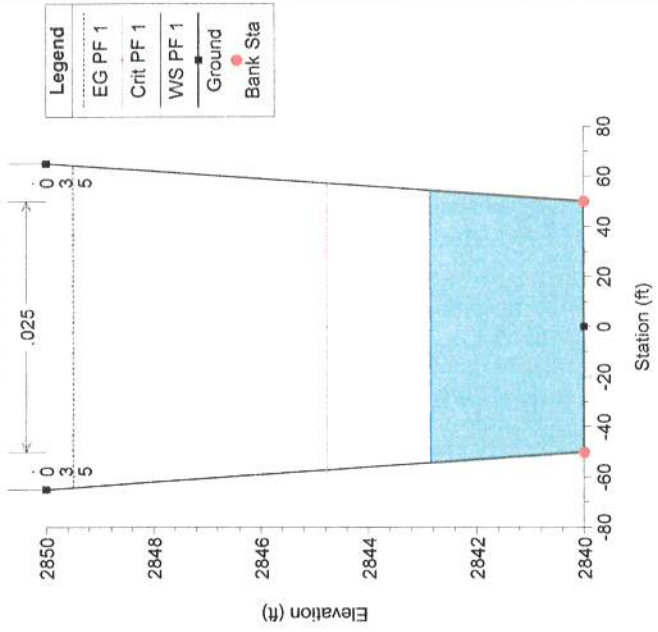
X-Section -17+00



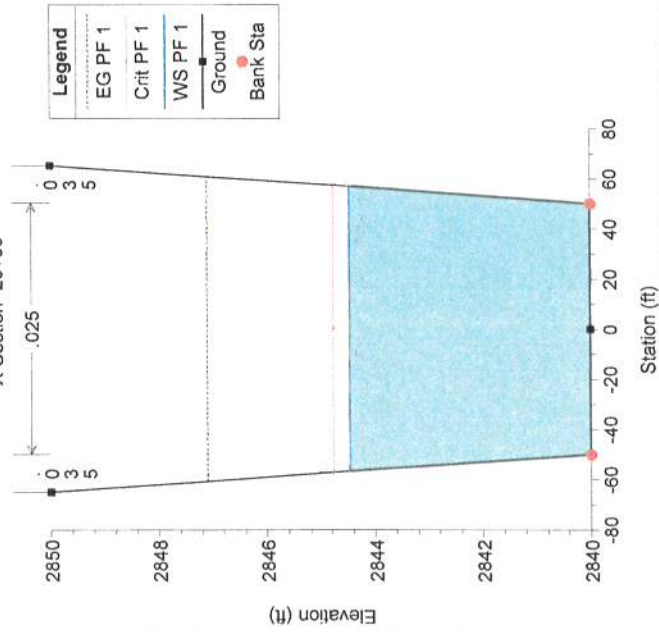
X-Section -18+00



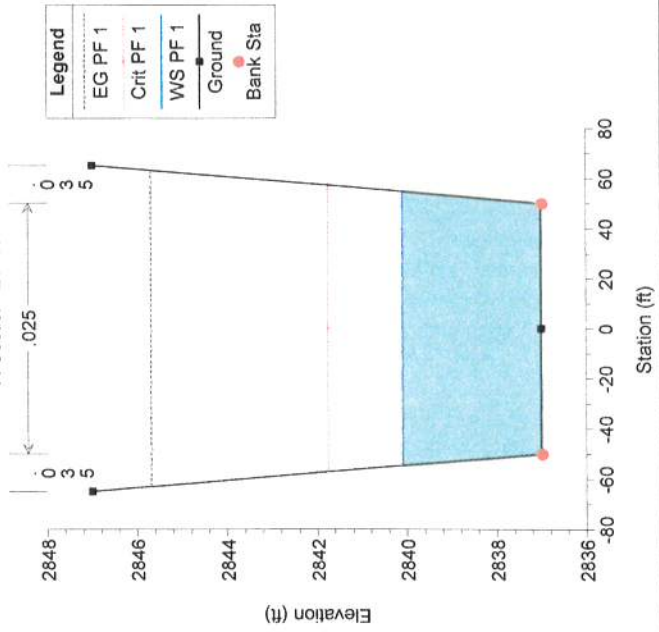
X-Section -19+00



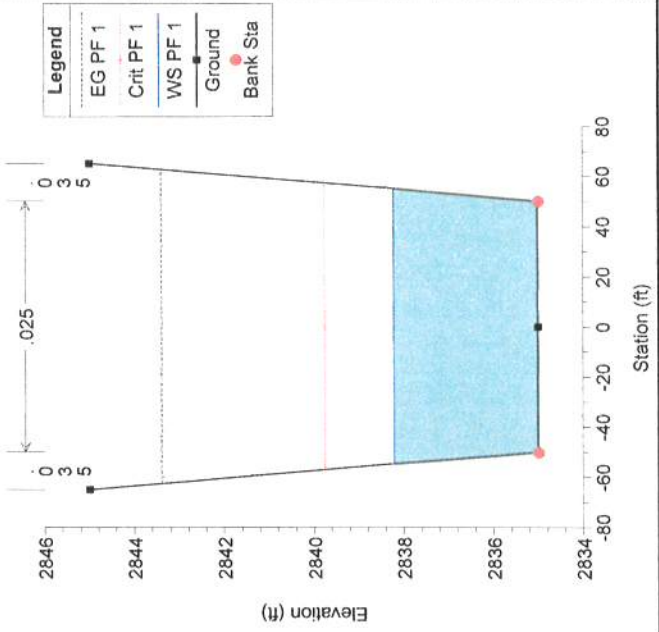
X-Section -20+00



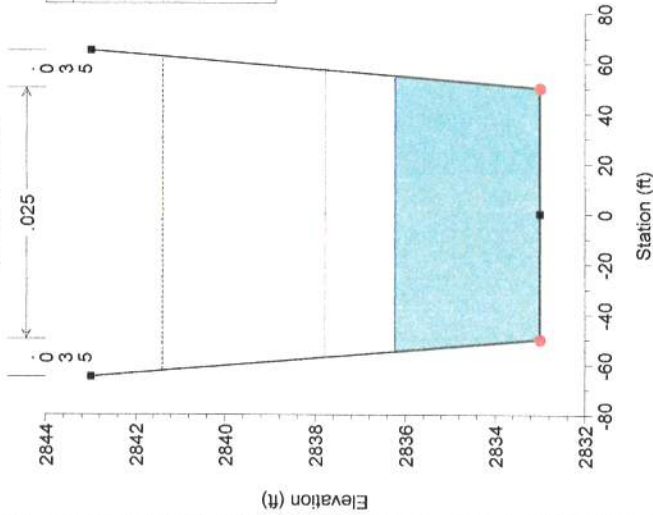
X-Section -21+00



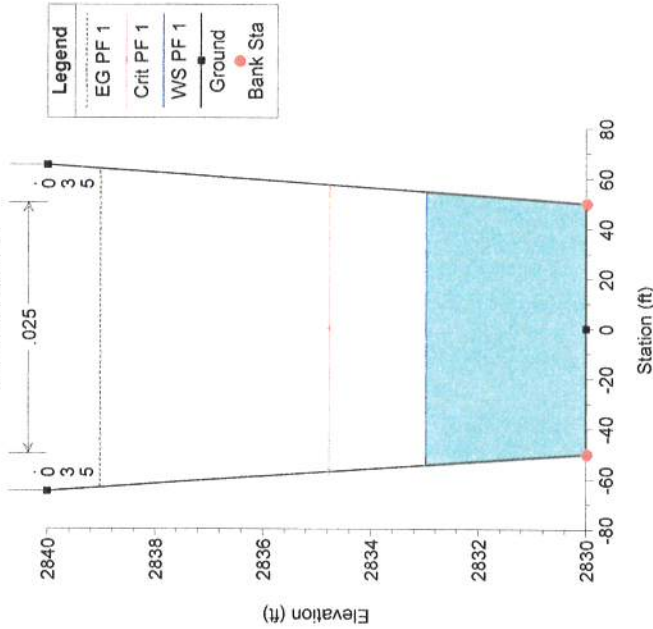
X-Section -22+00



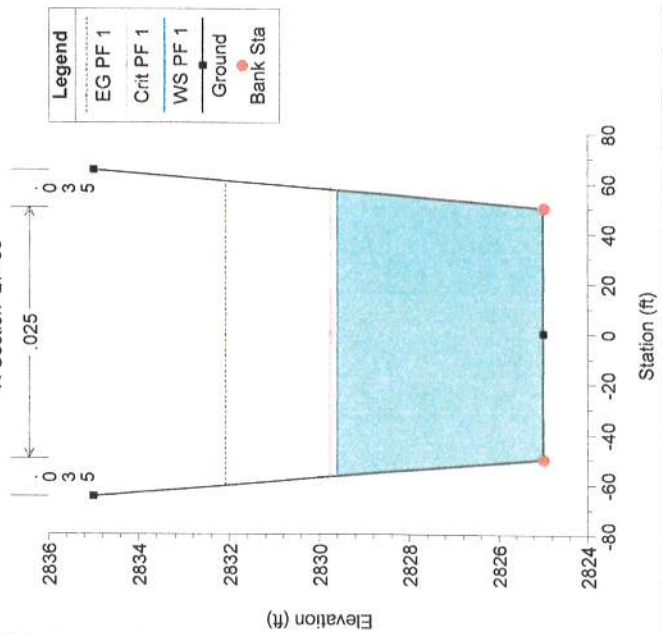
X-Section -23+00



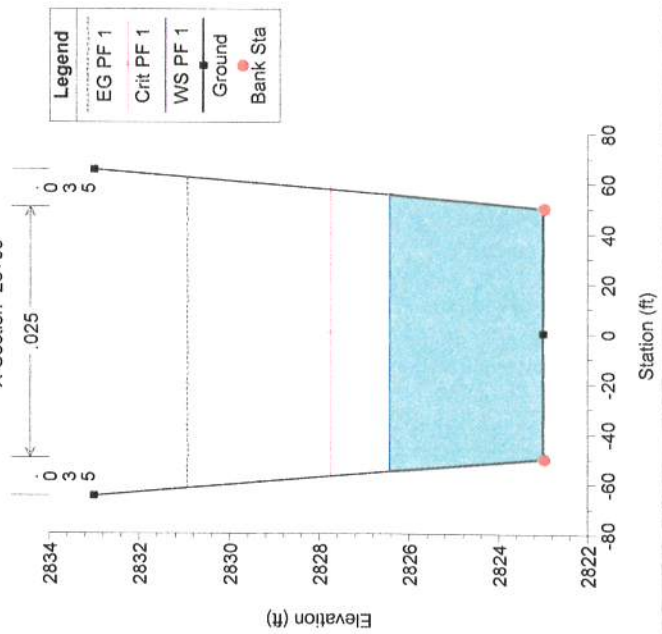
X-Section -24+00



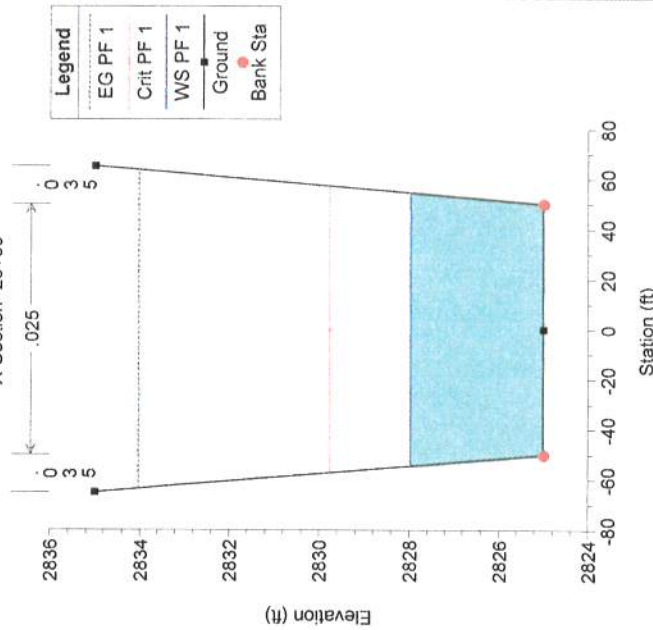
X-Section -27+00



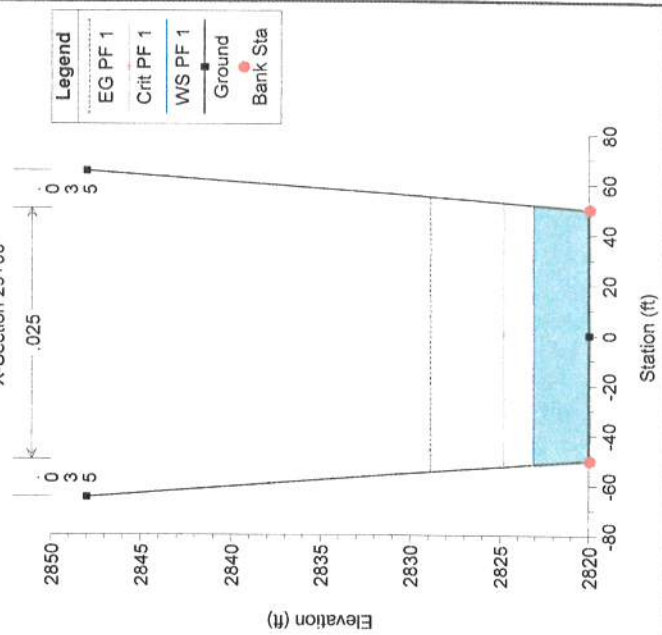
X-Section -28+00



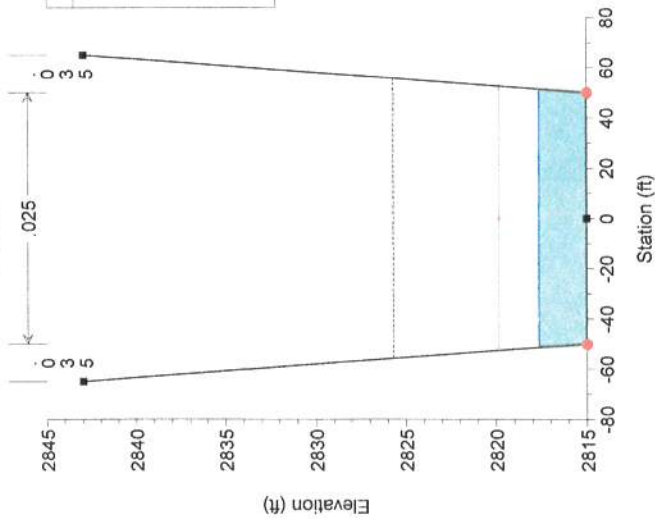
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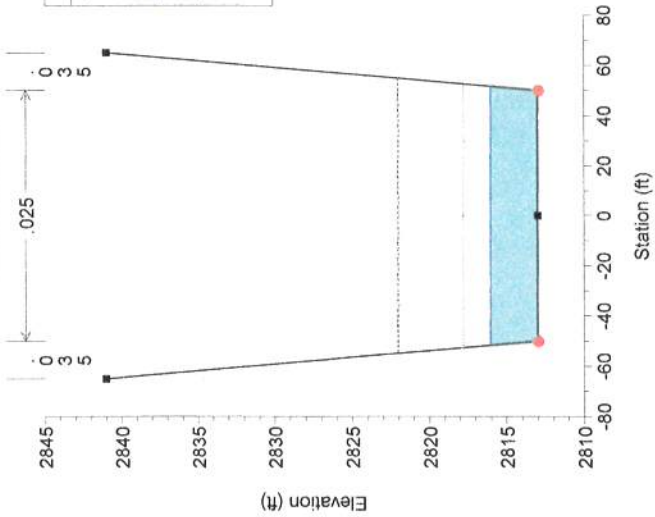
X-Section 29+00



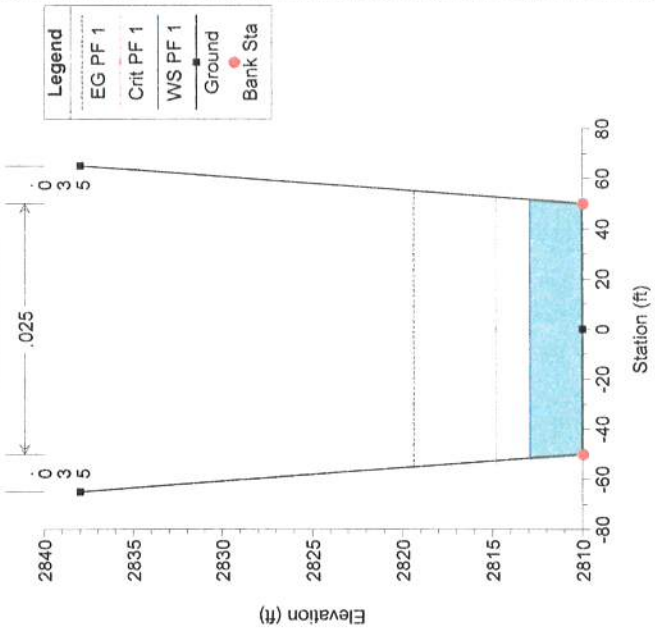
X-Section -30+00



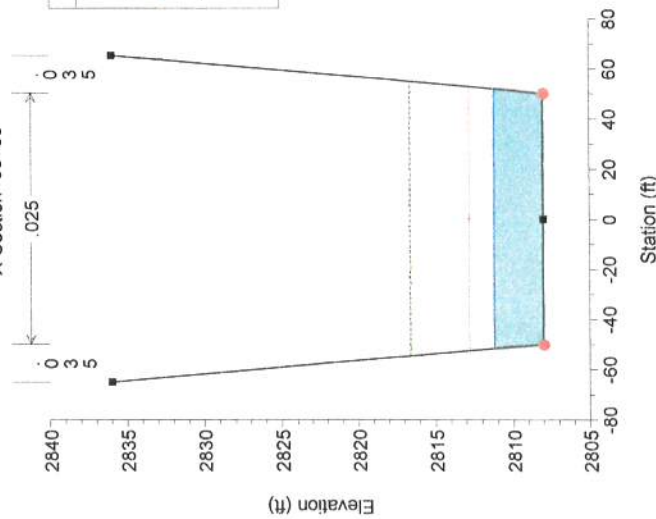
X-Section -30+00



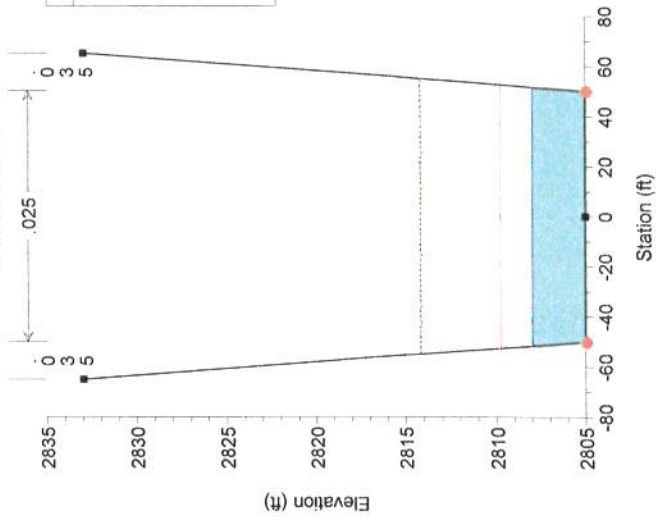
X-Section -32+00



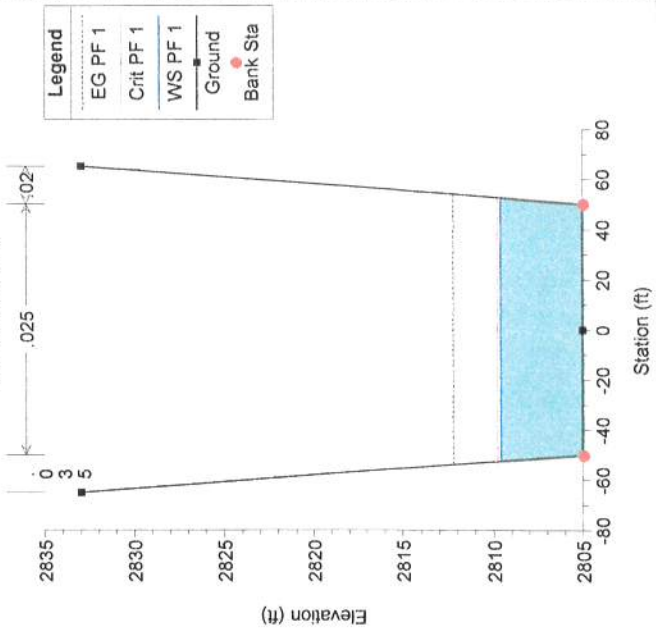
X-Section -33+00



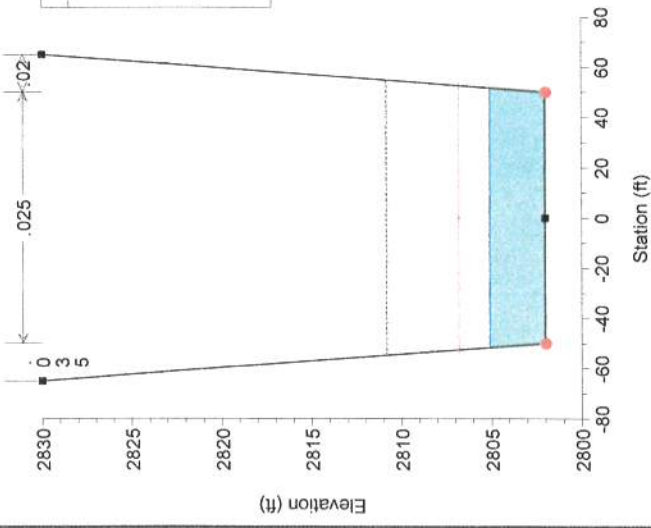
X-Section 34+00



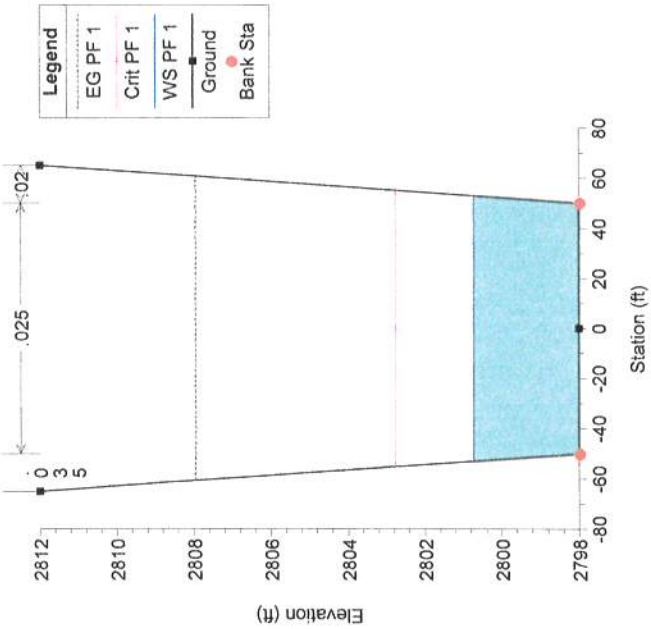
X-Section 35+00



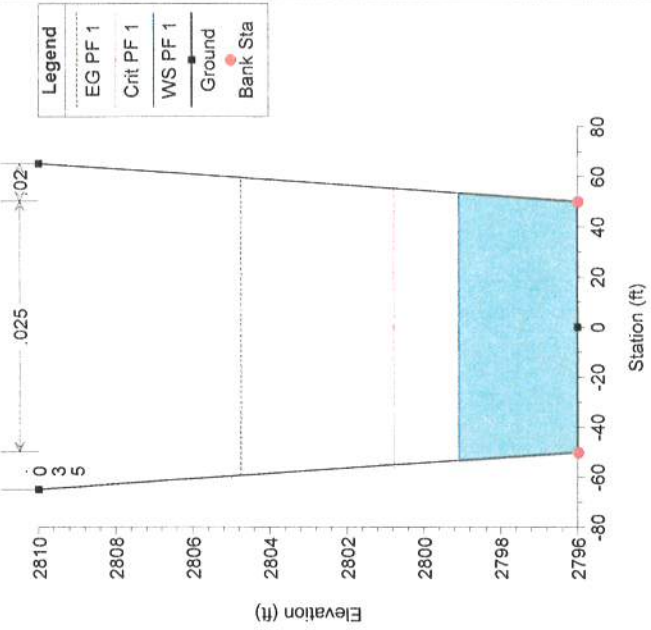
X-Section 36+00



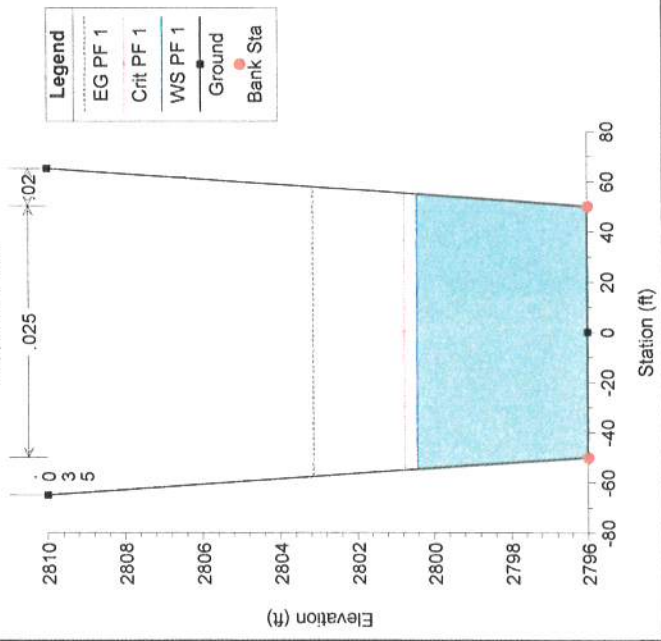
X-Section 37+00



X-Section 38+00



X-Section 39+00





ALTERNATIVE III

HEC-RAS Model Output for 6,047 cfs, 3:1 rip rap side slopes

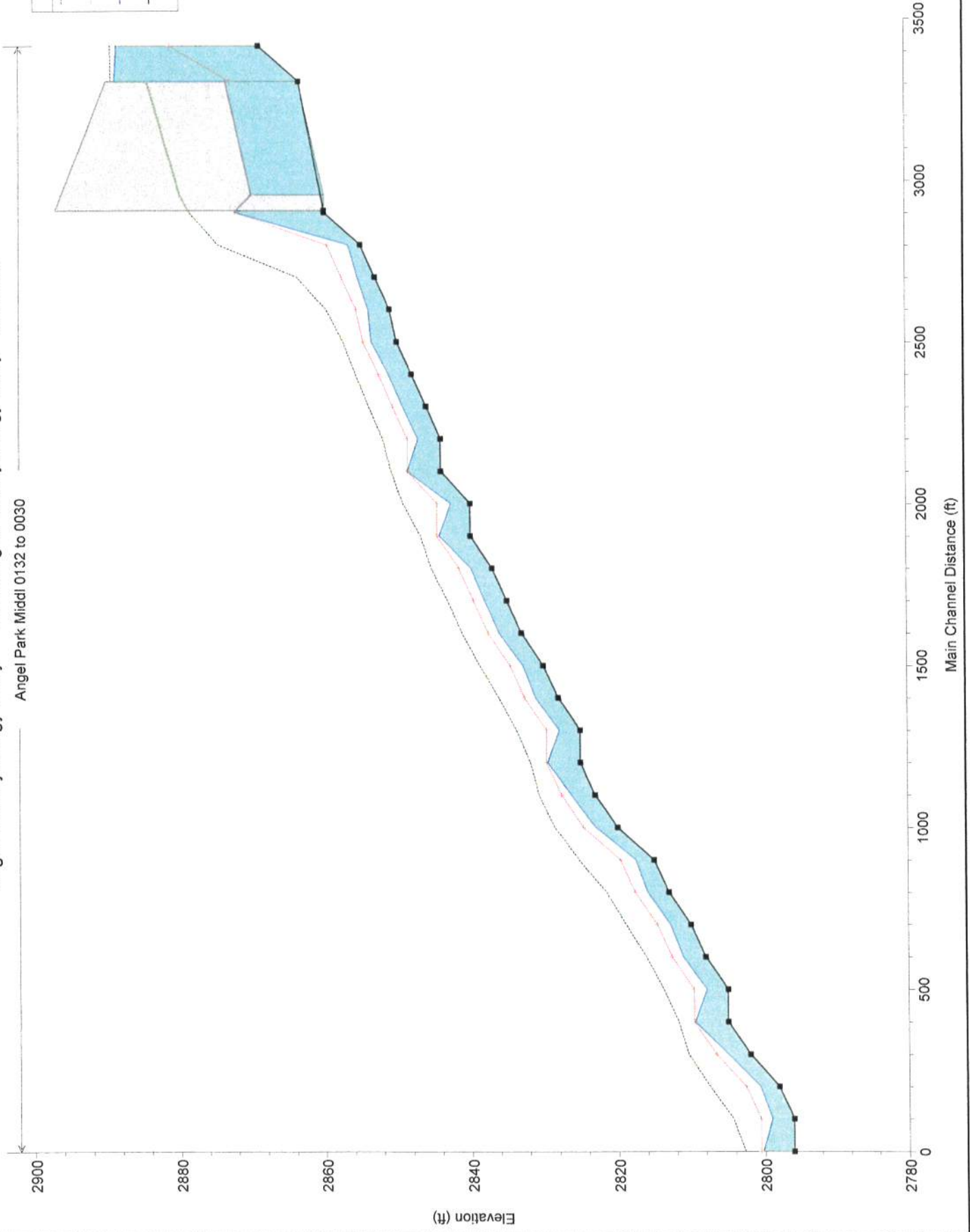
HEC-RAS Plan: Angel Park H River: Angel Park Middl Reach: 0132 to 0030 Profile: PF 1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (%/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
0132 to 0030	-485	PF 1	6047.00	2869.00	2888.60	2881.22	2889.38	0.000430	8.96	1268.66	166.60	0.36
0132 to 0030	-595	PF 1	6047.00	2863.50	2888.83	2872.93	2889.24	0.000070	5.57	1638.10	142.76	0.20
0132 to 0030	-900		Culvert									
0132 to 0030	-1005	PF 1	6047.00	2860.00	2872.29	2872.29	2878.50	0.001979	20.00	302.41	136.88	1.01
0132 to 0030	-1100	PF 1	6047.00	2855.00	2856.71	2859.66	2874.62	0.162803	34.29	179.77	110.26	4.62
0132 to 0030	-1200	PF 1	6047.00	2853.00	2855.47	2857.66	2863.79	0.046843	23.47	264.74	114.79	2.63
0132 to 0030	-1300	PF 1	6047.00	2851.00	2853.93	2855.66	2859.70	0.025937	19.60	318.66	117.58	2.02
0132 to 0030	-1400	PF 1	6047.00	2850.00	2853.54	2854.66	2857.39	0.013527	16.05	391.42	121.23	1.50
0132 to 0030	-1500	PF 1	6047.00	2848.00	2851.20	2852.58	2855.68	0.018160	17.40	364.22	127.45	1.71
0132 to 0030	-1600	PF 1	6047.00	2846.00	2849.27	2850.66	2853.83	0.017729	17.44	359.29	119.63	1.70
0132 to 0030	-1700	PF 1	6047.00	2844.00	2847.21	2848.66	2851.97	0.019037	17.83	351.30	119.23	1.75
0132 to 0030	-1800	PF 1	6047.00	2844.00	2848.66	2848.66	2850.77	0.005202	11.96	531.14	127.96	0.98
0132 to 0030	-1900	PF 1	6047.00	2840.00	2842.79	2844.66	2849.20	0.030754	20.64	302.04	116.72	2.18
0132 to 0030	-2000	PF 1	6047.00	2840.00	2844.33	2844.66	2846.81	0.006734	12.95	488.89	126.96	1.10
0132 to 0030	-2100	PF 1	6047.00	2837.00	2840.04	2841.66	2845.38	0.022867	18.86	331.56	118.23	1.91
0132 to 0030	-2200	PF 1	6047.00	2835.00	2838.13	2839.66	2843.15	0.020775	18.31	341.74	118.75	1.83
0132 to 0030	-2300	PF 1	6047.00	2833.00	2836.13	2837.66	2841.15	0.020775	18.31	341.74	118.75	1.83
0132 to 0030	-2400	PF 1	6047.00	2830.00	2832.91	2834.66	2838.75	0.026395	19.70	316.91	117.49	2.03
0132 to 0030	-2500	PF 1	6047.00	2828.00	2831.15	2832.66	2836.10	0.020263	18.17	344.44	118.88	1.80
0132 to 0030	-2600	PF 1	6047.00	2825.00	2827.92	2829.66	2833.73	0.026168	19.65	317.77	117.53	2.03
0132 to 0030	-2700	PF 1	6047.00	2825.00	2829.51	2829.66	2831.78	0.005824	12.38	512.21	127.07	1.03
0132 to 0030	-2800	PF 1	6047.00	2823.00	2826.37	2827.66	2830.65	0.016043	16.92	370.82	120.21	1.62
0132 to 0030	-2900	PF 1	6047.00	2820.00	2823.00	2824.66	2828.50	0.024003	19.14	326.54	117.98	1.95
0132 to 0030	-3000	PF 1	6047.00	2815.00	2817.56	2819.66	2825.23	0.040960	22.53	276.09	115.38	2.48
0132 to 0030	-3100	PF 1	6047.00	2813.00	2815.98	2817.66	2821.55	0.024470	19.25	324.55	117.86	1.97
0132 to 0030	-3200	PF 1	6047.00	2810.00	2812.88	2814.66	2818.88	0.027663	19.99	312.27	117.25	2.08
0132 to 0030	-3300	PF 1	6047.00	2808.00	2811.14	2812.66	2816.13	0.020514	18.24	343.10	118.82	1.82
0132 to 0030	-3400	PF 1	6047.00	2805.00	2807.92	2809.66	2813.74	0.026304	19.68	317.25	117.50	2.03
0132 to 0030	-3500	PF 1	6047.00	2805.00	2809.54	2809.66	2811.74	0.005600	12.19	515.53	127.23	1.01
0132 to 0030	-3600	PF 1	6047.00	2802.00	2805.01	2806.65	2810.40	0.023245	18.90	328.50	118.08	1.92
0132 to 0030	-3700	PF 1	6047.00	2798.00	2800.70	2802.65	2807.52	0.034065	21.25	291.38	116.17	2.28
0132 to 0030	-3800	PF 1	6047.00	2796.00	2799.03	2800.65	2804.36	0.022917	18.82	329.97	118.15	1.91
0132 to 0030	-3900	PF 1	6047.00	2796.00	2800.36	2800.65	2802.77	0.006467	12.75	492.36	126.13	1.08

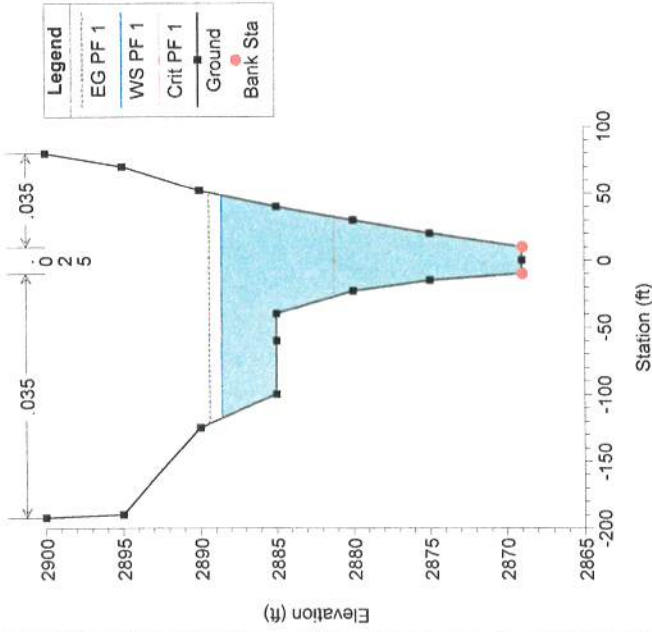
Angel Park Hydrology Study Plan: Angel Park Hydrology Study 8/5/2008

Angel Park Middl 0132 to 0030

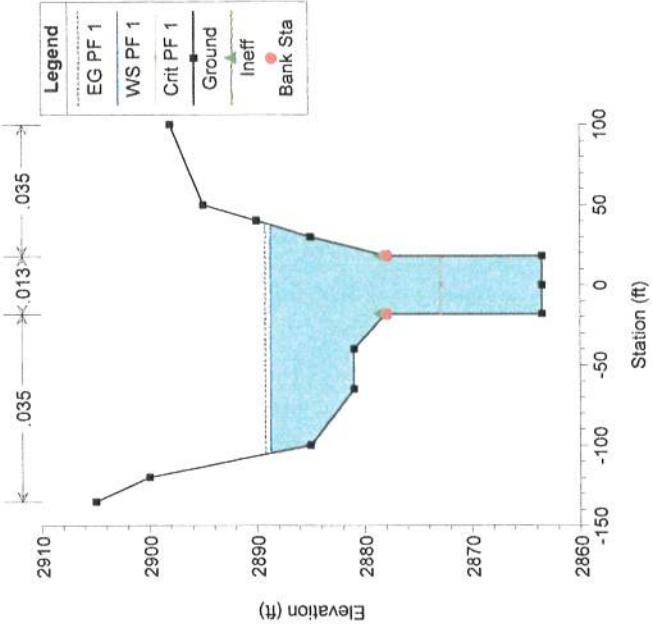
Legend	
EG PF 1	
Crit PF 1	
WS PF 1	
Ground	



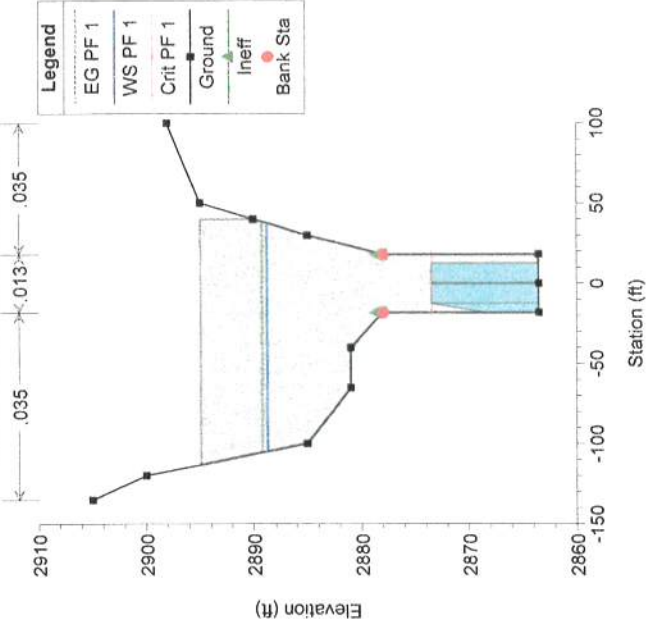
X-Section -4+85



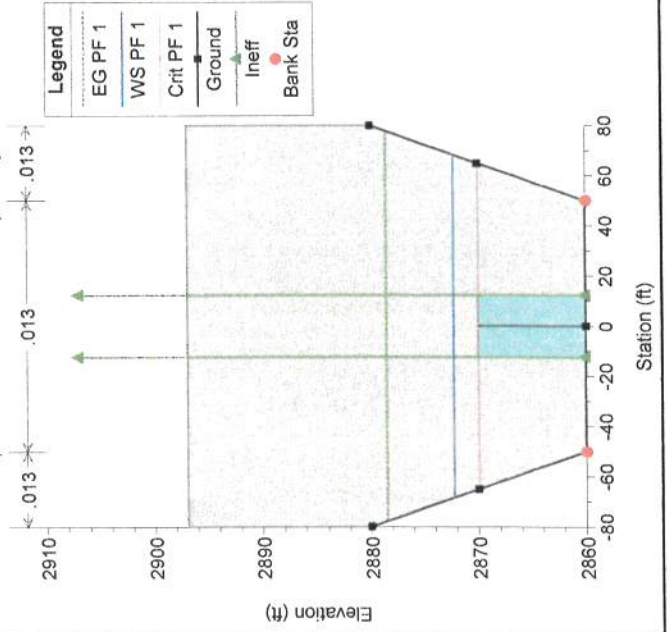
Station -5+95 - Upstream of 2-18' x 10' RBC, west side of Hualapai



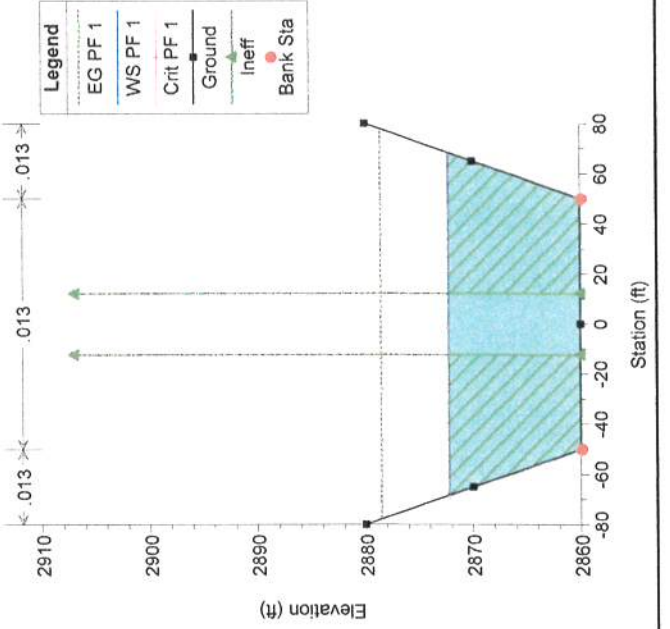
2, 12' x 10' RCB under Hualapai Way



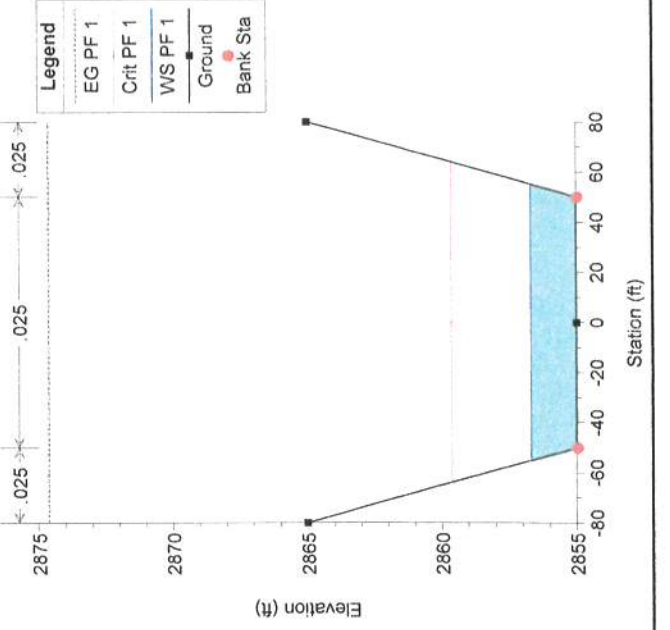
2, 12' x 10' RCB under Hualapai Way



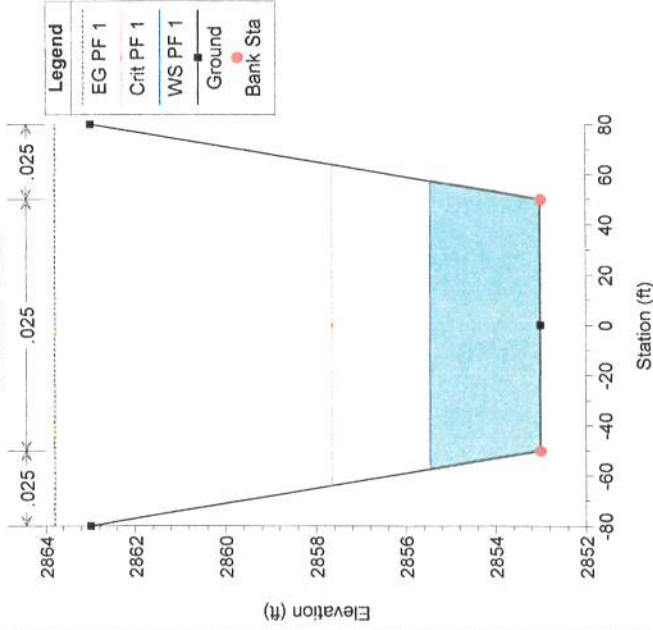
X-Section -10+00 - 2-12' x 10' culvert, east side of Hualapai



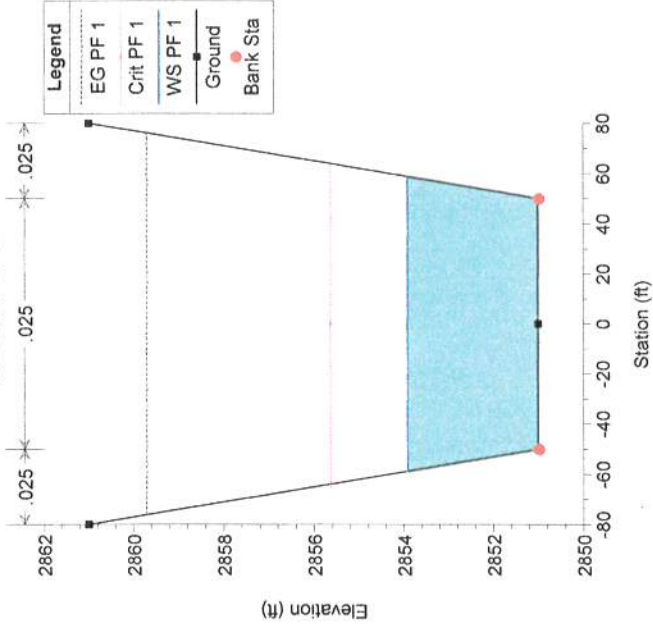
X-Section -11+00



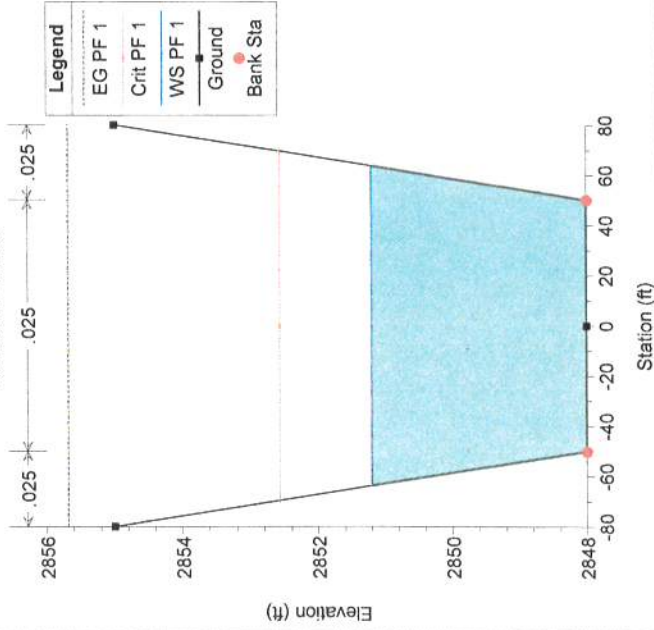
X-Section -12+00



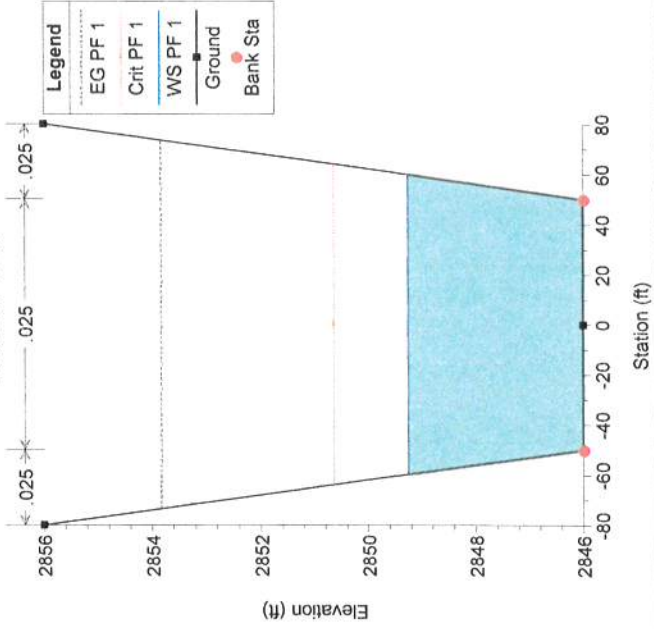
X-Section -13+00



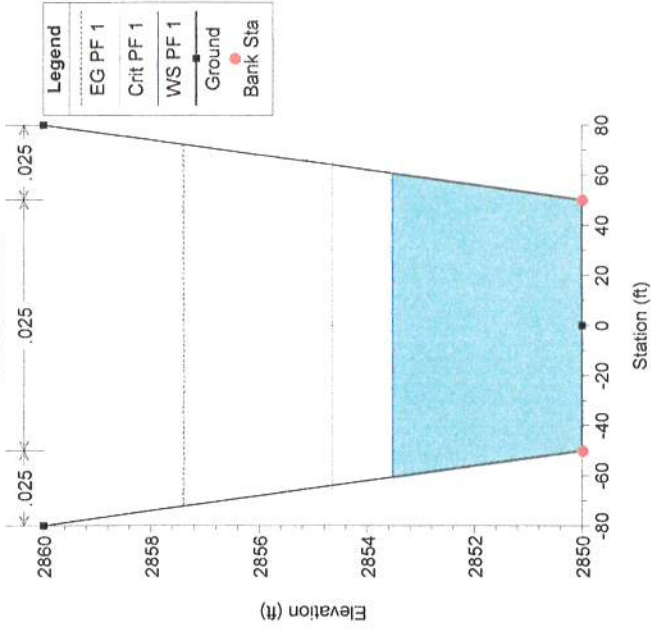
X-Section -15+00



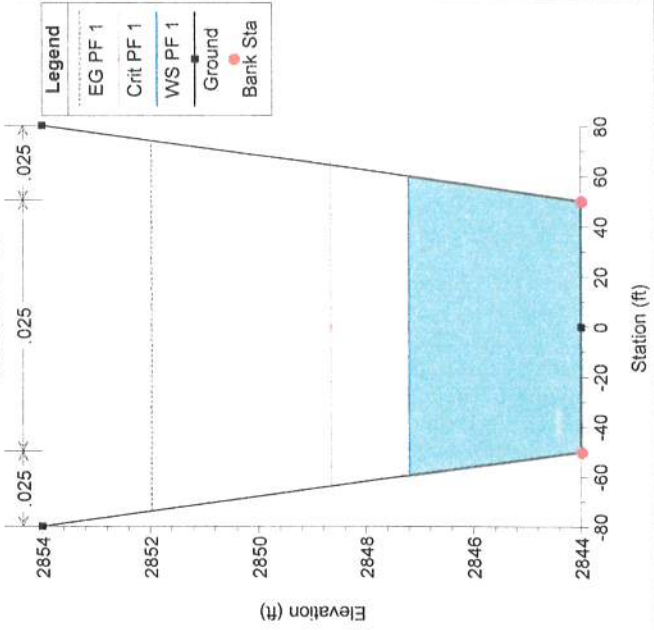
X-Section -16+00



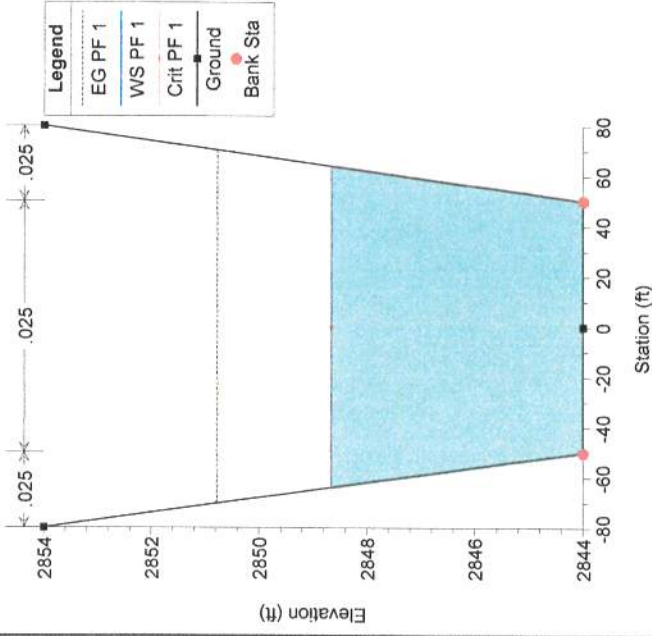
X-Section -14+00



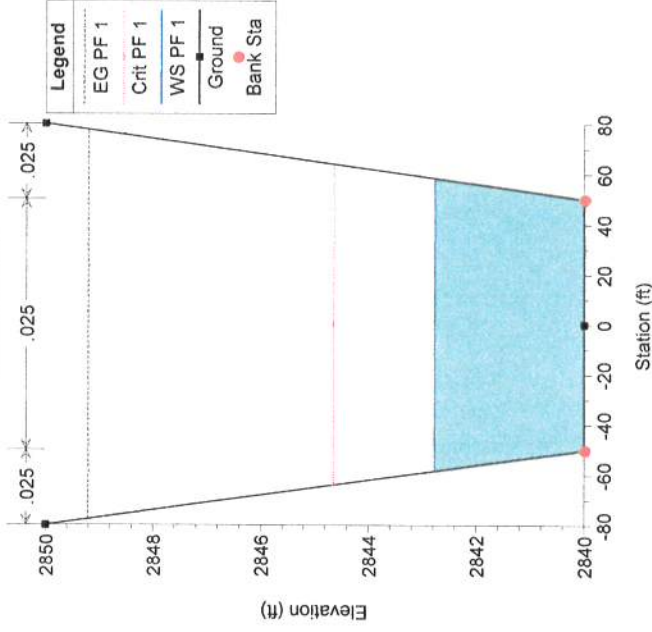
X-Section -17+00



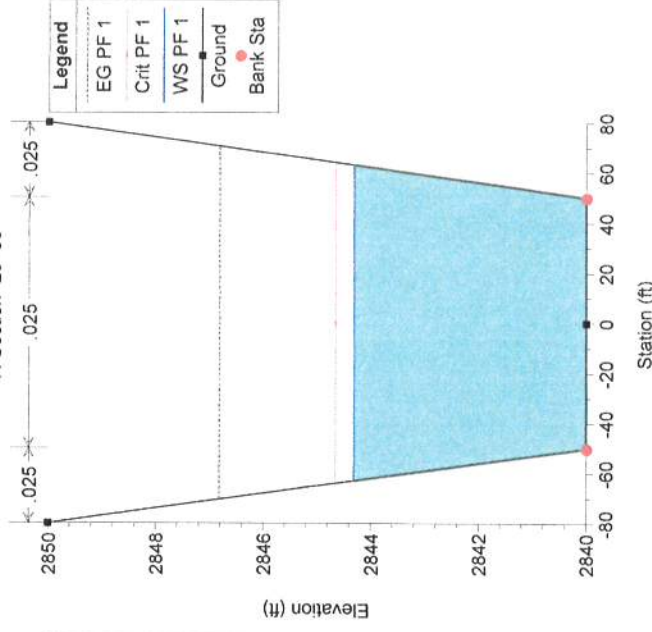
X-Section -18+00



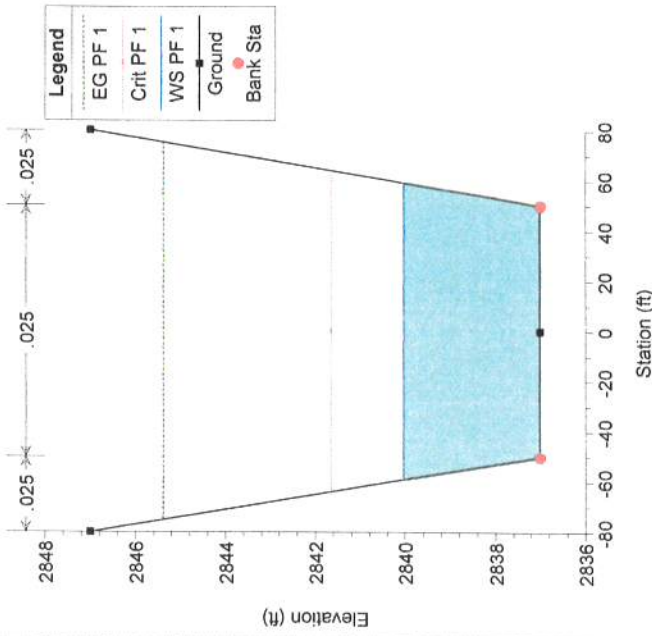
X-Section -19+00



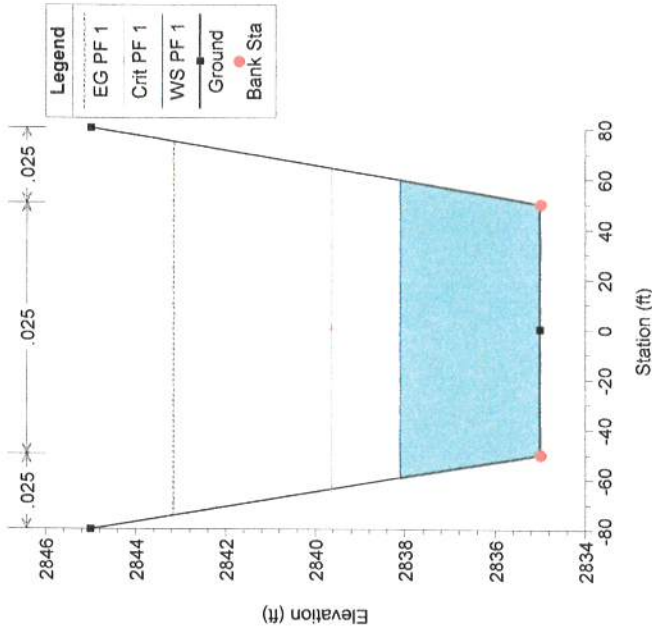
X-Section -20+00



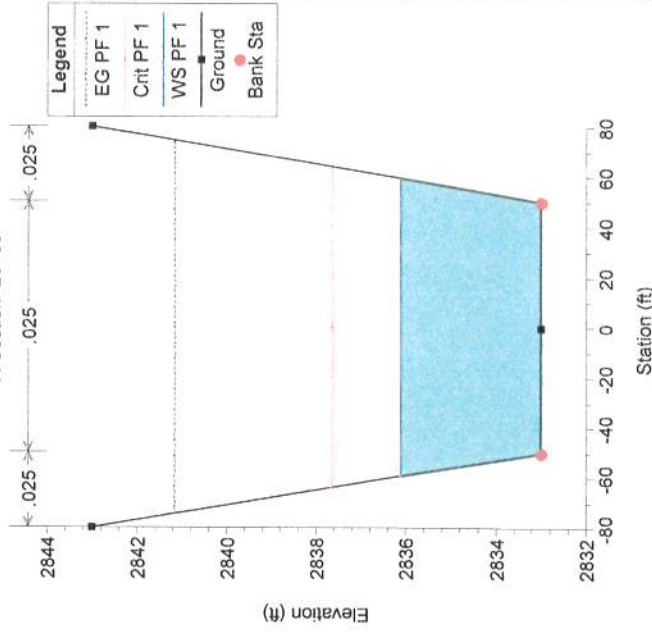
X-Section -21+00



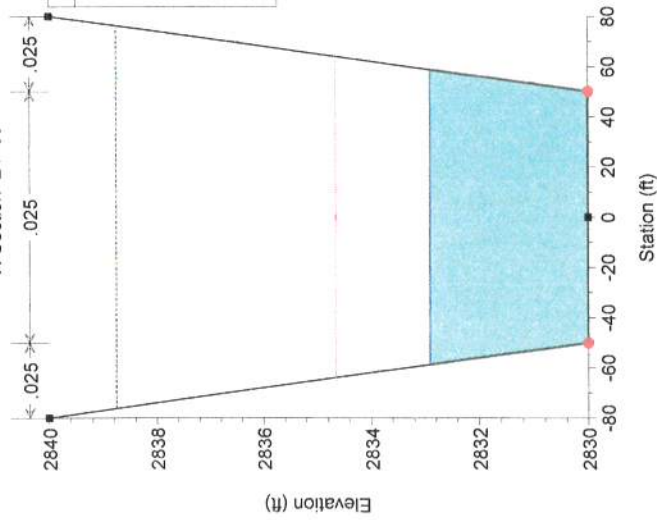
X-Section -22+00



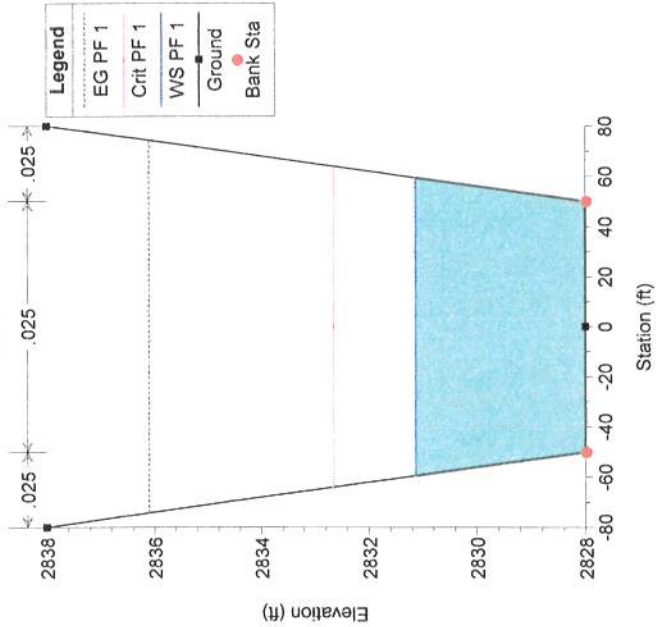
X-Section -23+00



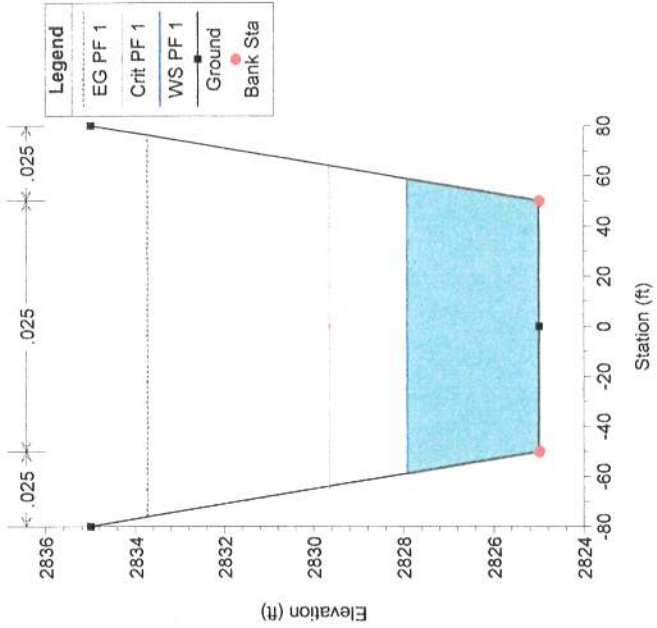
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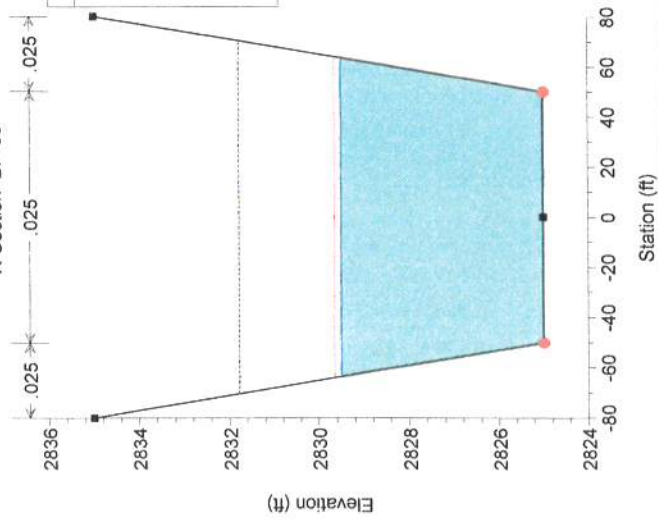
X-Section -25+00



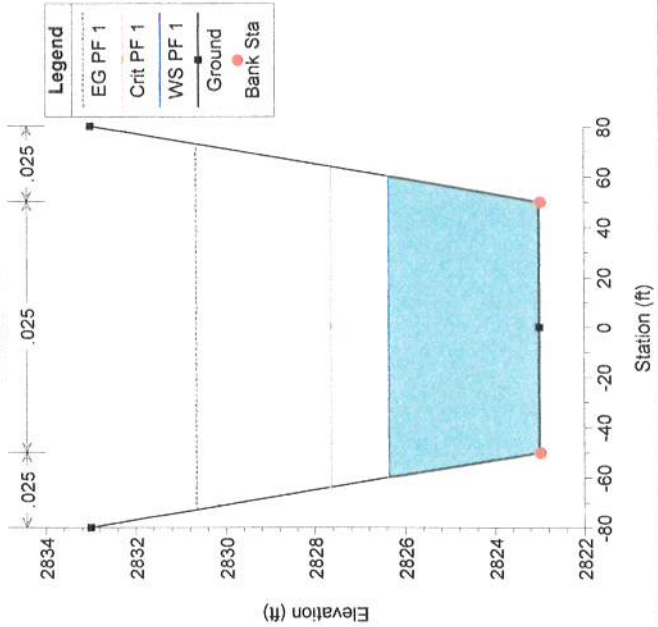
X-Section -26+00



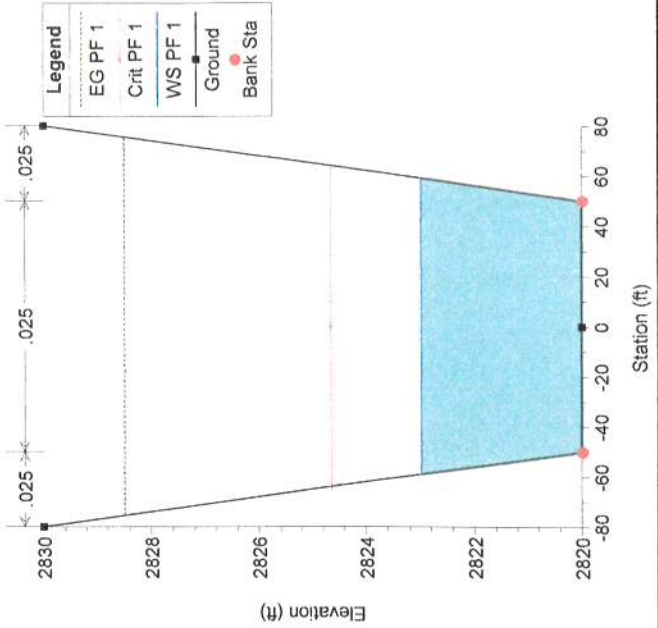
X-Section -27+00



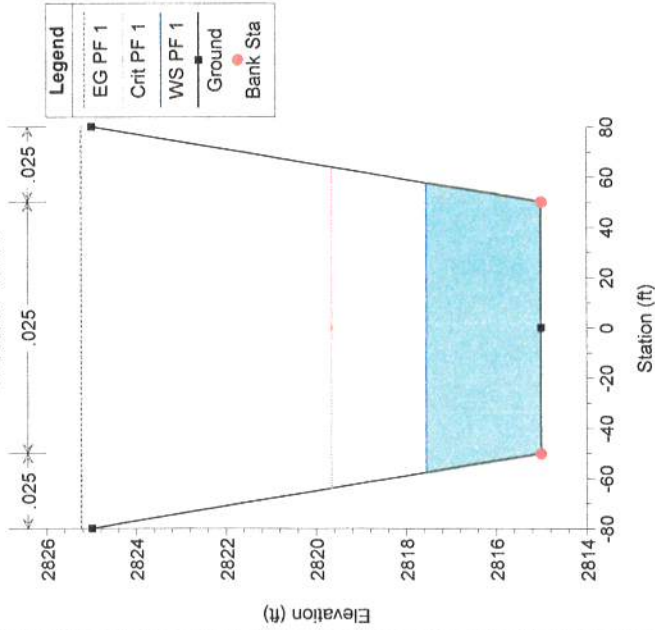
X-Section -28+00



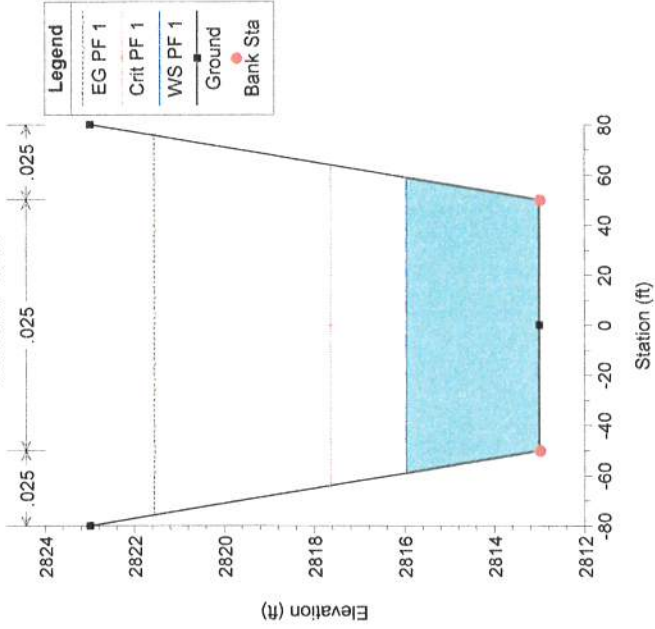
X-Section 29+00



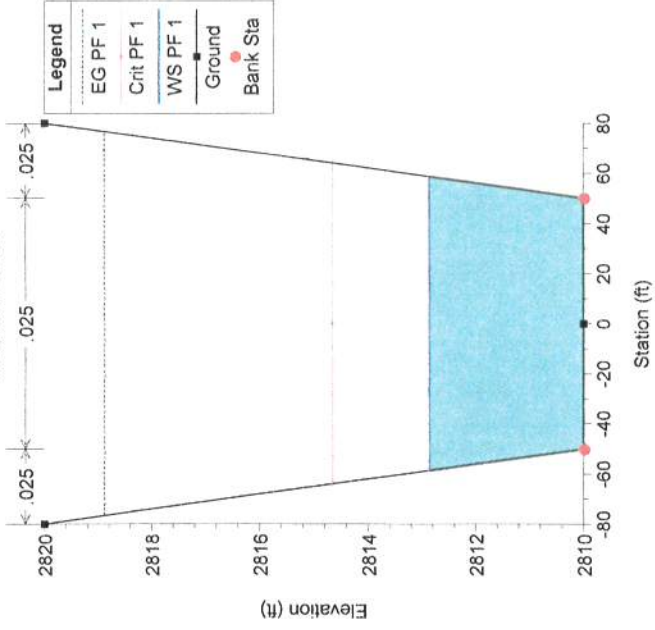
X-Section -30+00



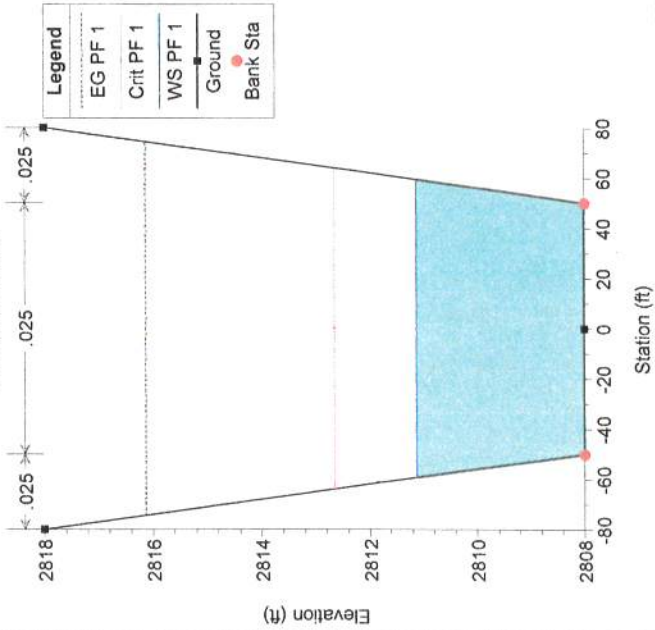
X-Section -30+00



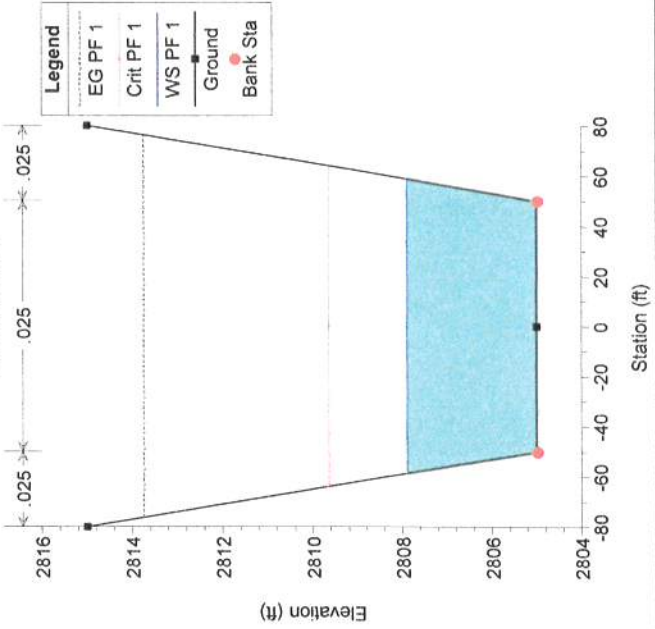
X-Section -32+00



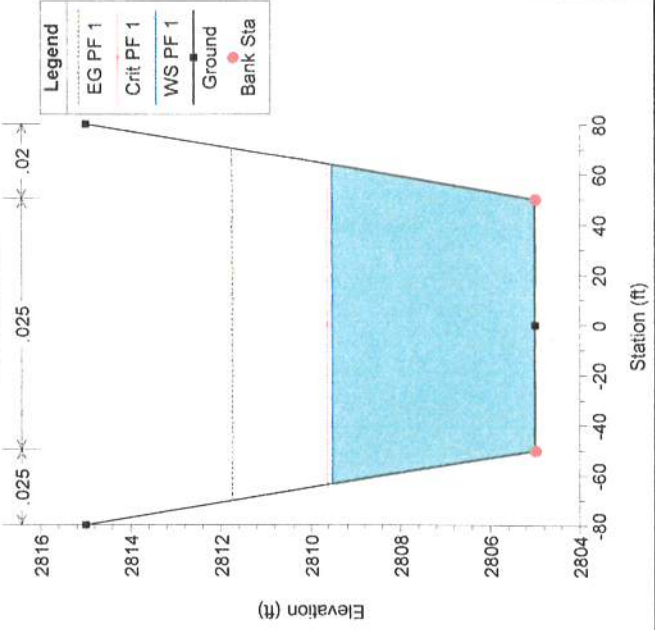
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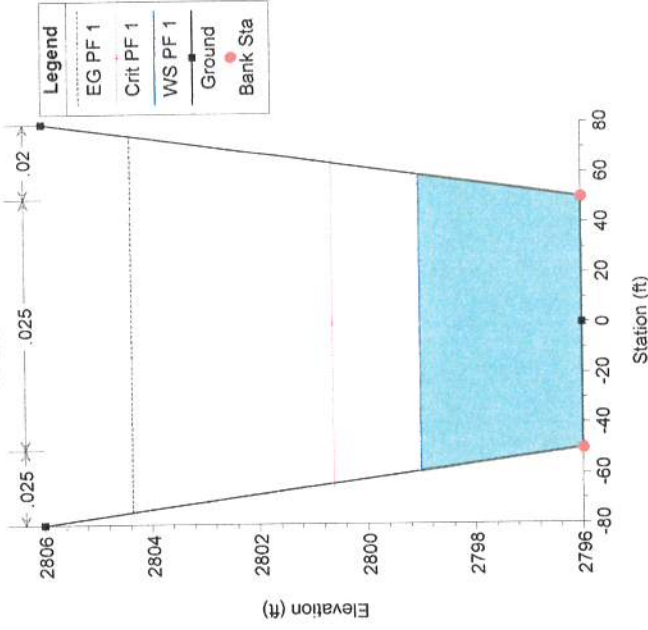
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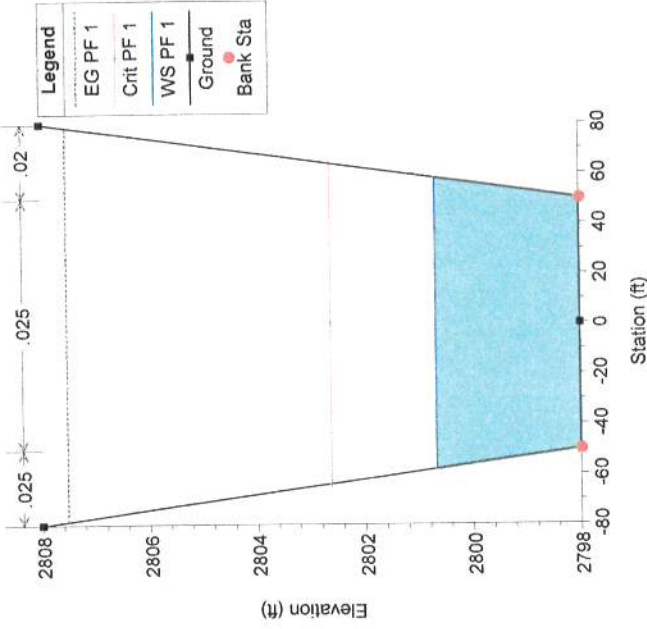
X-Section 35+00



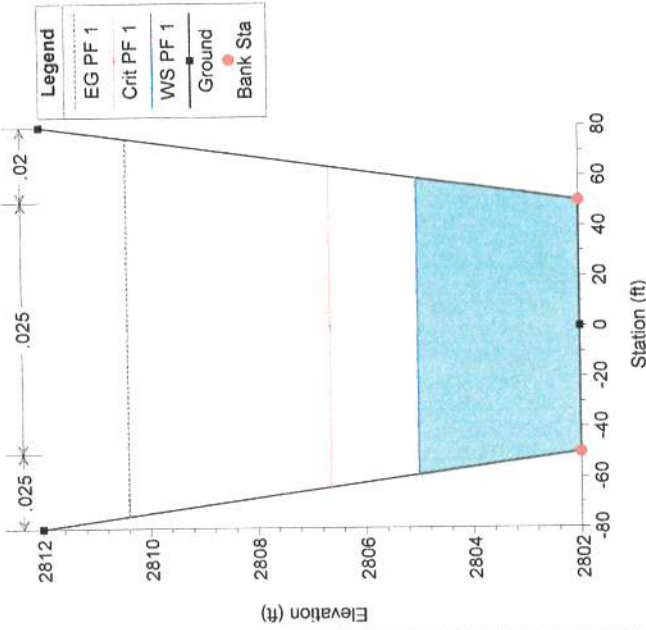
X-Section 38+00



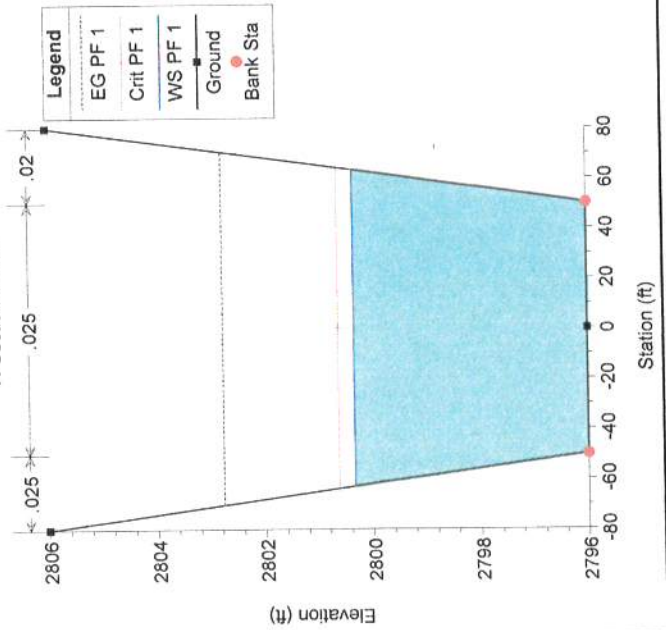
X-Section 37+00

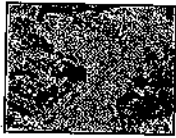


X-Section 36+00

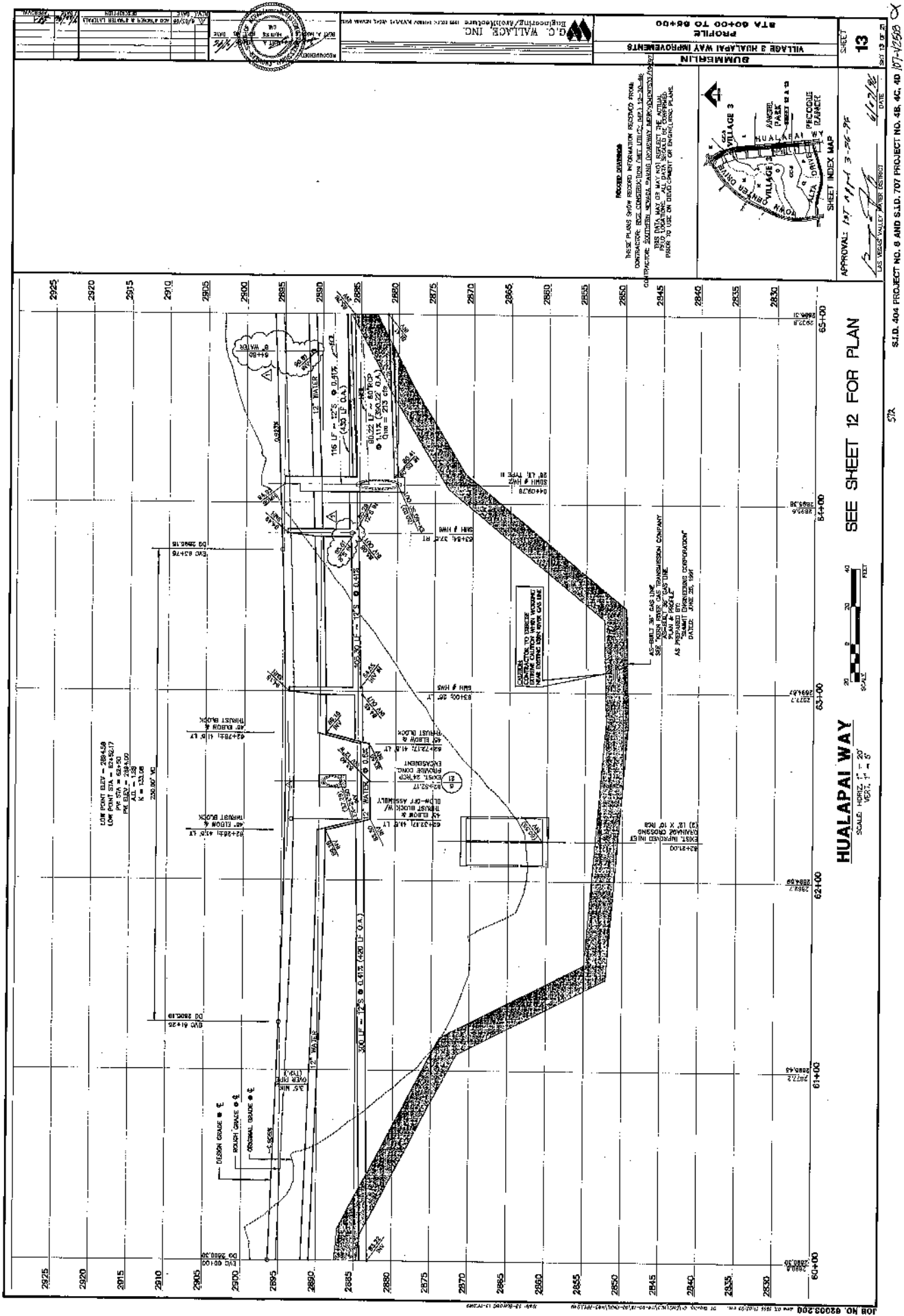


X-Section 39+00





Plans for Nearby Existing Facilities Channel Photographs



100% PROPOSED

80% PROPOSED

20% PROPOSED

EXISTING

DATE: 10/1/88

BY: [Signature]

FOR: [Signature]

100% PROPOSED

80% PROPOSED

20% PROPOSED

EXISTING

DATE: 10/1/88

BY: [Signature]

FOR: [Signature]

100% PROPOSED

80% PROPOSED

20% PROPOSED

EXISTING

DATE: 10/1/88

BY: [Signature]

FOR: [Signature]

100% PROPOSED

80% PROPOSED

20% PROPOSED

EXISTING

DATE: 10/1/88

BY: [Signature]

FOR: [Signature]



PROJECT NO.	15-620-101
DATE	04/21/04
DESIGNED BY	KES
CHECKED BY	7/14/03
DATE	7/14/03
BY	7/14/03

PECCOLE OFFICE BUILDING
UTILITY PLAN & STREETLIGHT



WRIGHT CIVIL ENGINEERS, INC.
100 S. BURNING WOOD, SUITE 200
LAS VEGAS, NEVADA 89102
TEL: (702) 735-7000 FAX: (702) 735-7001
WWW.WRIGHTCIVIL.COM

REV	DATE	BY	DESCRIPTION
1	04/21/04	KES	ISSUED FOR PERMIT

UTILITY NOTE

THE CITY OF LAS VEGAS HAS REVIEWED THIS UTILITY PLAN AND FINDS IT TO BE IN ACCORDANCE WITH THE CITY ENGINEERING DEPARTMENT STANDARDS AND SPECIFICATIONS. THE CITY ENGINEERING DEPARTMENT DOES NOT GUARANTEE THE ACCURACY OF THE INFORMATION PROVIDED HEREON. THE USER OF THIS INFORMATION SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND FOR THE PROTECTION OF THE PUBLIC. THE CITY ENGINEERING DEPARTMENT DOES NOT ASSUME ANY LIABILITY FOR ANY DAMAGE OR INJURY TO PERSONS OR PROPERTY ARISING FROM THE USE OF THIS INFORMATION.

WATER DETAIL

1. 10" CPVC WATER MAIN
2. 8" CPVC WATER MAIN
3. 6" CPVC WATER MAIN
4. 4" CPVC WATER MAIN
5. 3" CPVC WATER MAIN
6. 2" CPVC WATER MAIN
7. 1.5" CPVC WATER MAIN
8. 1" CPVC WATER MAIN
9. 0.75" CPVC WATER MAIN
10. 0.5" CPVC WATER MAIN
11. 0.375" CPVC WATER MAIN
12. 0.25" CPVC WATER MAIN
13. 0.1875" CPVC WATER MAIN
14. 0.125" CPVC WATER MAIN
15. 0.09375" CPVC WATER MAIN
16. 0.0625" CPVC WATER MAIN
17. 0.046875" CPVC WATER MAIN
18. 0.03125" CPVC WATER MAIN
19. 0.0234375" CPVC WATER MAIN
20. 0.015625" CPVC WATER MAIN
21. 0.01171875" CPVC WATER MAIN
22. 0.0078125" CPVC WATER MAIN
23. 0.005859375" CPVC WATER MAIN
24. 0.00390625" CPVC WATER MAIN
25. 0.0029296875" CPVC WATER MAIN
26. 0.001953125" CPVC WATER MAIN
27. 0.00146484375" CPVC WATER MAIN
28. 0.00109375" CPVC WATER MAIN
29. 0.00081953125" CPVC WATER MAIN
30. 0.0006145875" CPVC WATER MAIN
31. 0.0004609375" CPVC WATER MAIN
32. 0.000345703125" CPVC WATER MAIN
33. 0.000259275" CPVC WATER MAIN
34. 0.000194328125" CPVC WATER MAIN
35. 0.0001457421875" CPVC WATER MAIN
36. 0.00010930078125" CPVC WATER MAIN
37. 0.0000819765625" CPVC WATER MAIN
38. 0.00006148125" CPVC WATER MAIN
39. 0.00004609375" CPVC WATER MAIN
40. 0.0000345703125" CPVC WATER MAIN
41. 0.0000259275" CPVC WATER MAIN
42. 0.0000194328125" CPVC WATER MAIN
43. 0.00001457421875" CPVC WATER MAIN
44. 0.000010930078125" CPVC WATER MAIN
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Preliminary Plans, Profiles & Sections

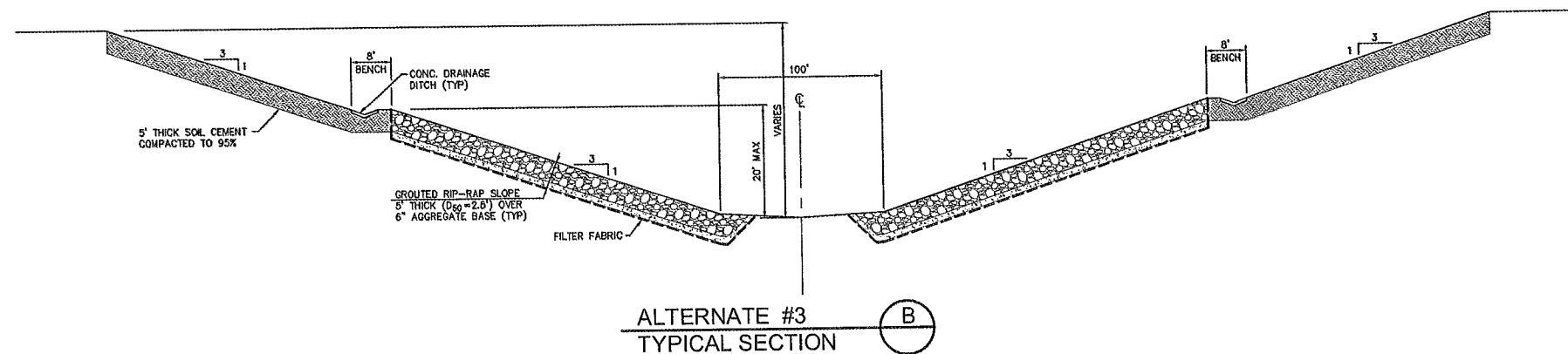
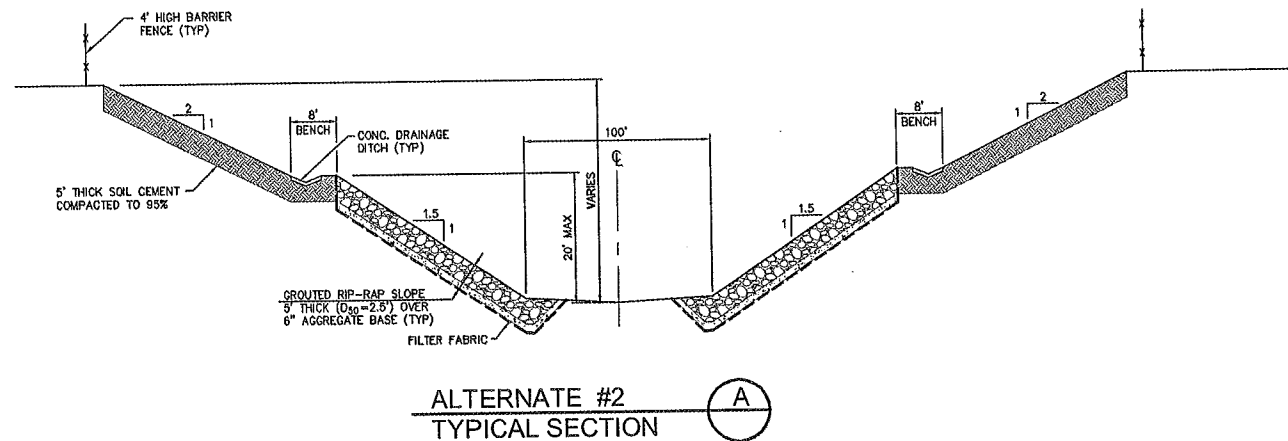
**Alternative I – Natural
Alternative II – 1.5:1 Banks
Alternative III – 3:1 Banks**

CITY OF LAS VEGAS, NEVADA

DEPARTMENT OF PUBLIC WORKS

ANGEL PARK MIDDLE BRANCH

ALTERNATE CHANNEL IMPROVEMENTS



SHEET INDEX

SHT. NO.	DRAWING TITLE
1	COVER SHEET
2	CHANNEL PLAN - ALTERNATE #1
3	CHANNEL PROFILE - ALTERNATE #1
4	CROSS SECTIONS - ALTERNATE #1
5	CROSS SECTIONS - ALTERNATE #1
6	CROSS SECTIONS - ALTERNATE #1
7	CHANNEL PLAN - ALTERNATE #2
8	CHANNEL PROFILE - ALTERNATE #2
9	CROSS SECTIONS - ALTERNATE #2
10	CROSS SECTIONS - ALTERNATE #2
11	CROSS SECTIONS - ALTERNATE #2
12	CHANNEL PLAN - ALTERNATE #3
13	CHANNEL PROFILE - ALTERNATE #3
14	CROSS SECTIONS - ALTERNATE #3
15	CROSS SECTIONS - ALTERNATE #3
16	CROSS SECTIONS - ALTERNATE #3



**BUREAU
VERITAS**

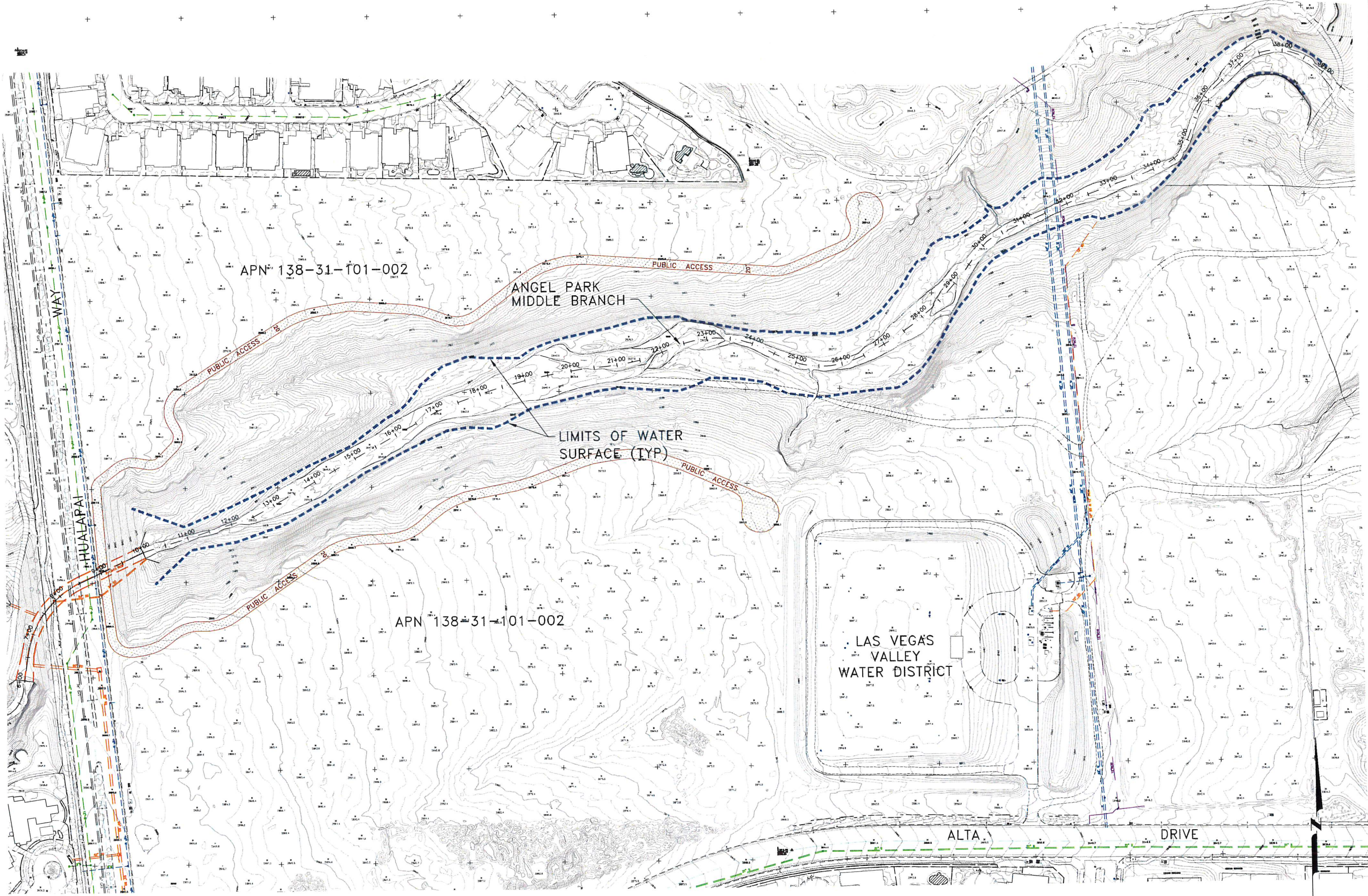
**Bureau Veritas
North America, Inc.**

4840 W. University Ave, Suite A-1
Las Vegas, Nevada 89103
Tel: (702) 252-7866



CITY OF LAS VEGAS - DEPARTMENT OF PUBLIC WORKS - ENGINEERING DIVISION

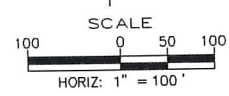
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TITLE SHEET 					
ANGEL PARK MIDDLE BRANCH DRAINAGE STUDY 					
ANGEL PARK 					
SHEET NO. 					
1 					
SHT. 1 OF 16 DWG No. 107V4396 					



Bureau Veritas
North America, Inc.
4840 W. University Ave, Suite A-1
Las Vegas, Nevada 89103-3829
Tel (702) 252-7866

BUILDING FINISHED FLOOR ELEVATIONS TO BE 18" ABOVE THE HIGHEST ADJACENT GRADE AT THE BUILDING FOOTPRINT OR HIGHER. BUILDINGS SHALL ALSO BE 6" ABOVE ANY ADJACENT PAVING AREAS, AND CONFORM TO ALL REQUIREMENTS OF THE "CCRFCD HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL".

NOTE:
FLOW RATE IN ANGEL PARK MIDDLE BRANCH $Q_{100} = 6,047$ cfs



CITY OF LAS VEGAS - DEPARTMENT OF PUBLIC WORKS - ENGINEERING DIVISION

CHANNEL PLAN - ALTERNATE #1

ANGEL PARK MIDDLE BRANCH DRAINAGE STUDY

ANGEL PARK

SHEET NO.

2

SHT. 2 OF 16

REVISIONS

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SCALE: 1" = 50'

DESIGN: DRA / DGR

DRAWN: DGR

CHECKED:

APPROVED:

DATE: 8-7-08

PROJECT NO.

FILE NAME:

PROFESSIONAL ENGINEER - STATE OF NEVADA

DONALD R. ALLISON

Exp: 12/31/08

CIVIL

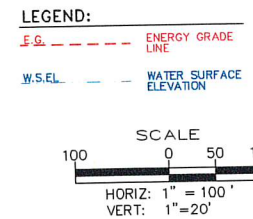
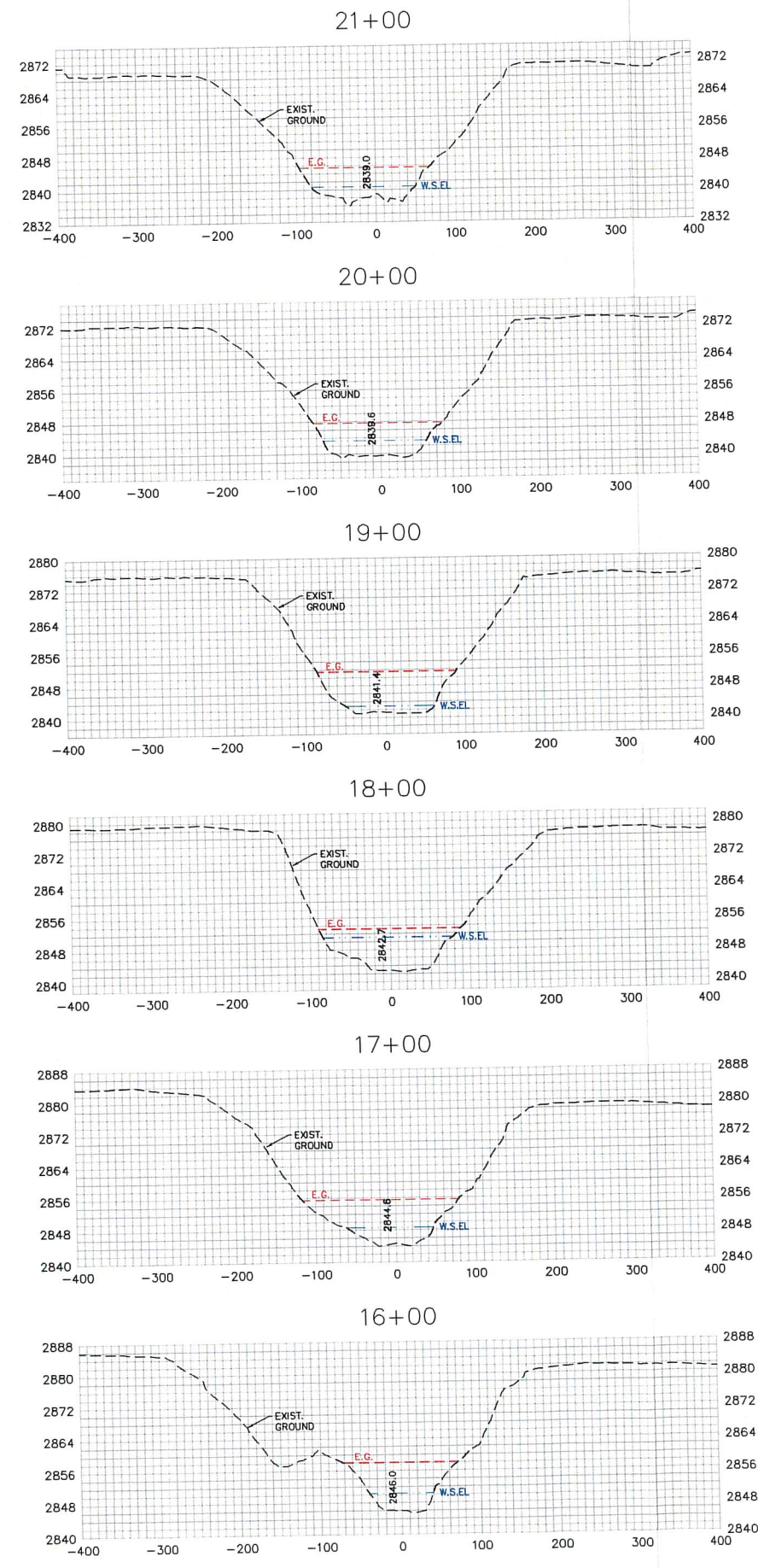
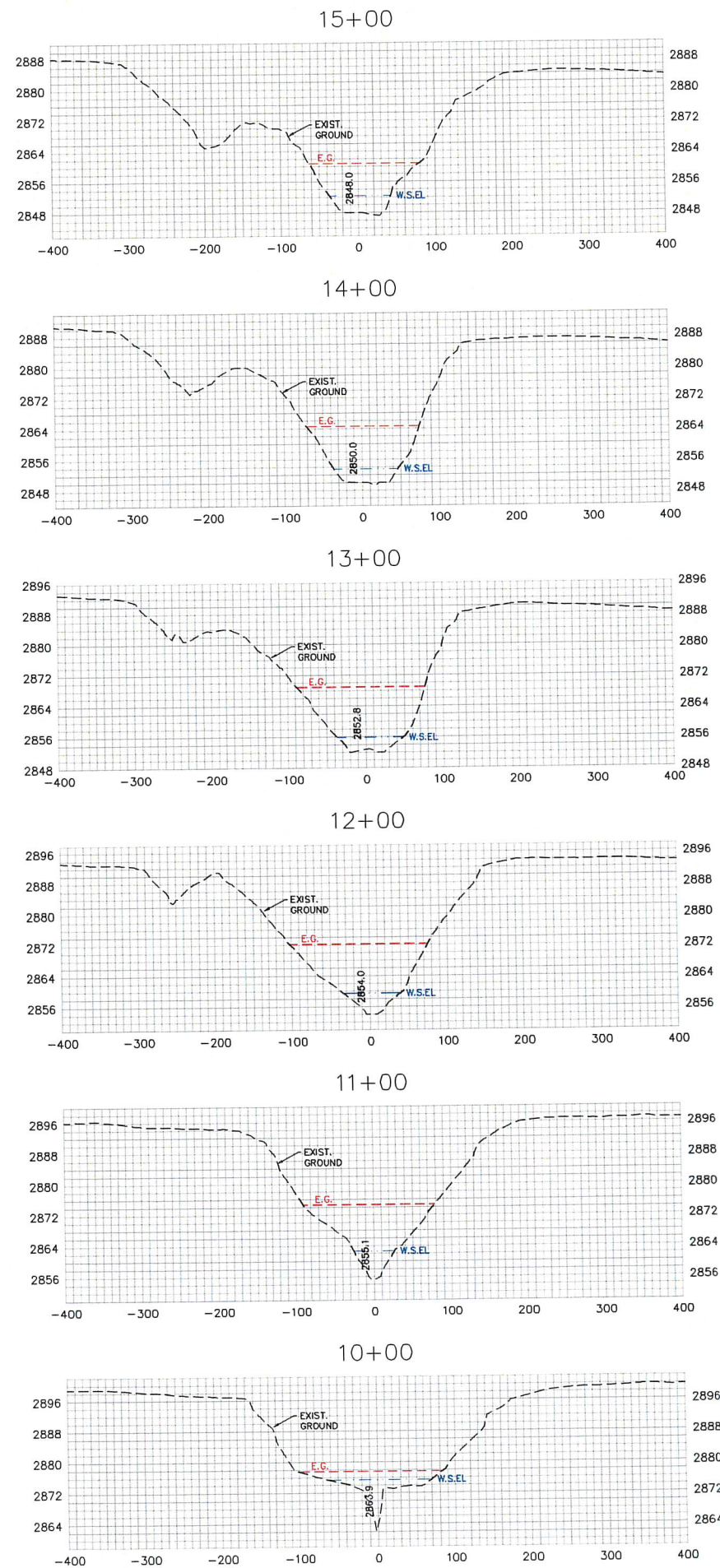
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North America, Inc.**

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Tel. (702) 252-7866



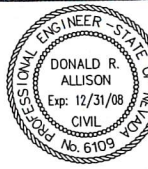
CITY OF LAS VEGAS - DEPARTMENT OF PUBLIC WORKS - ENGINEERING DIVISION

CROSS SECTIONS - ALTERNATE #1

ANGEL PARK MIDDLE BRANCH DRAINAGE STUDY

ANGEL PARK

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CHECKED:
APPROVED:
DATE: 8-7-08

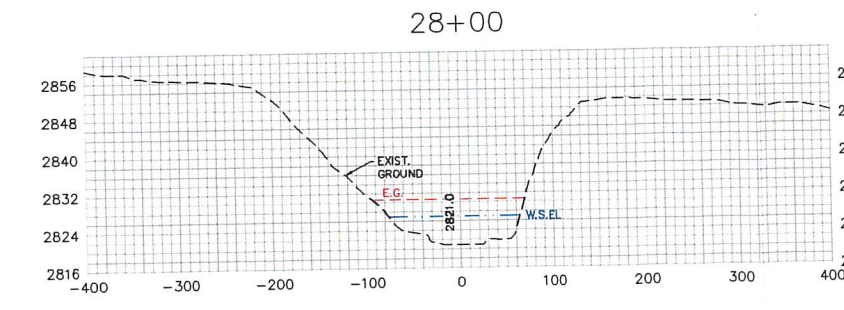
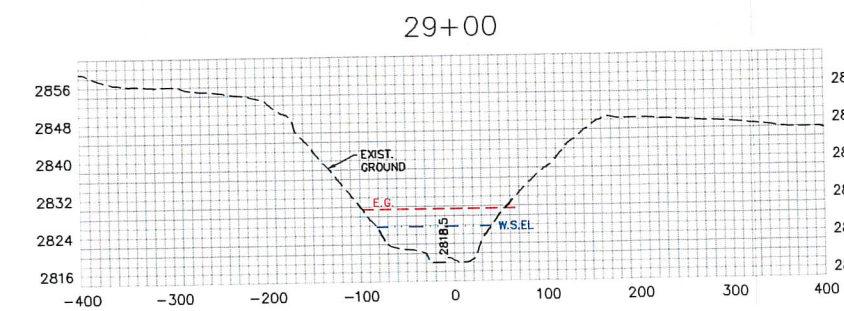
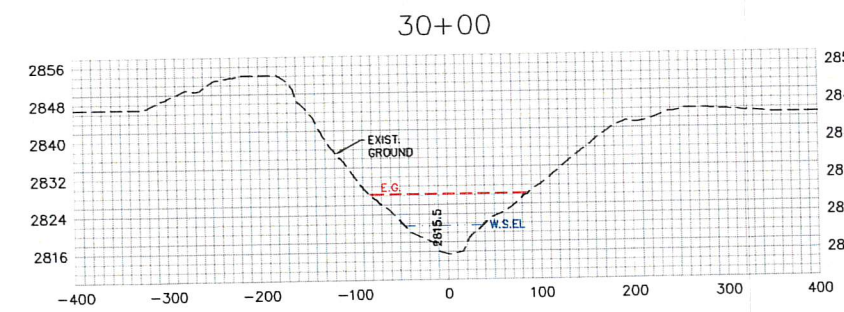
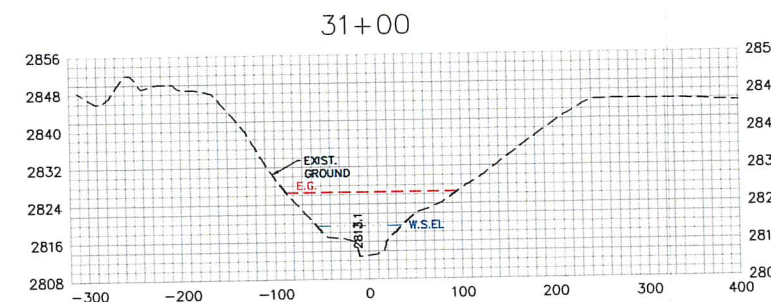
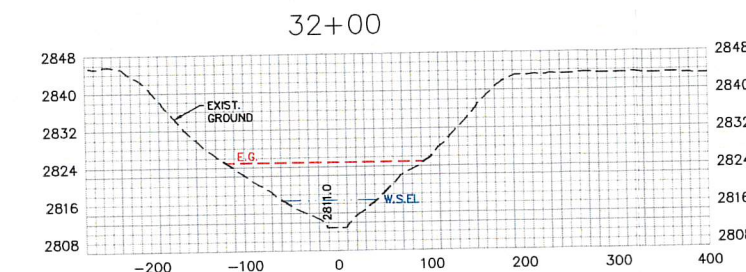
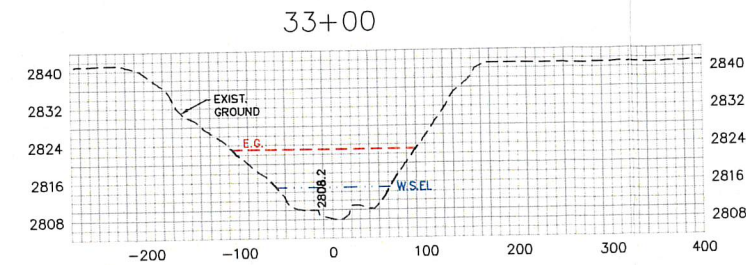
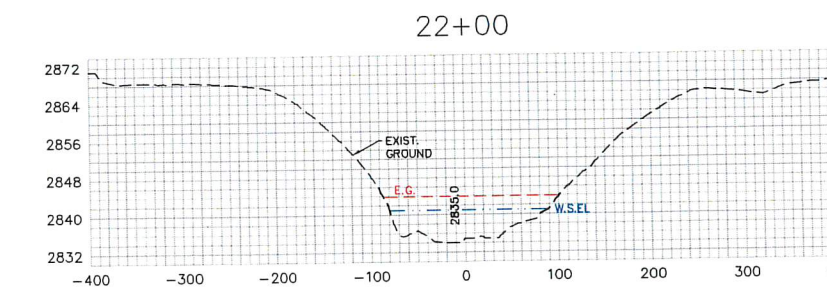
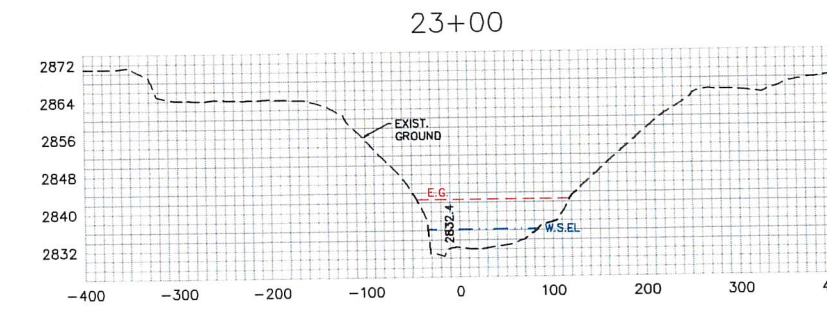
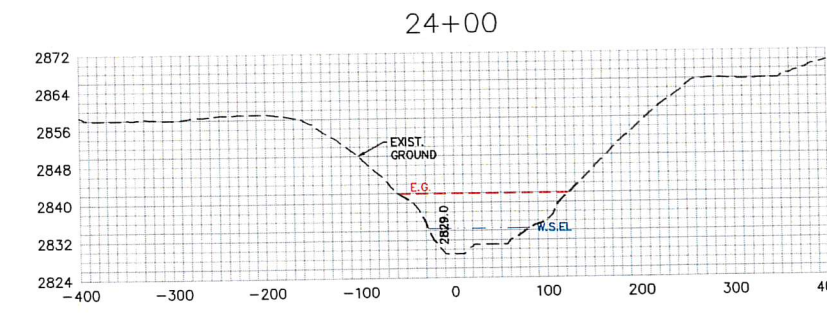
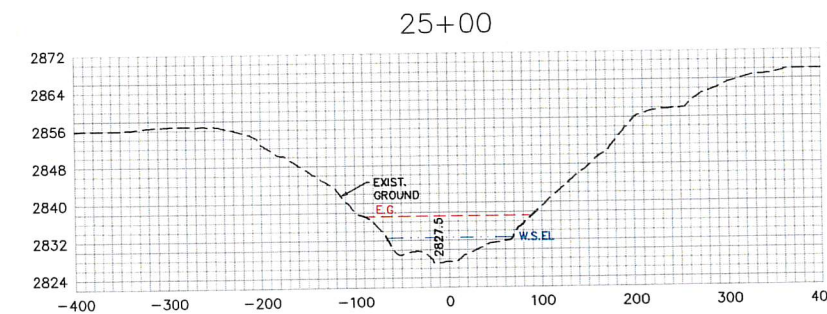
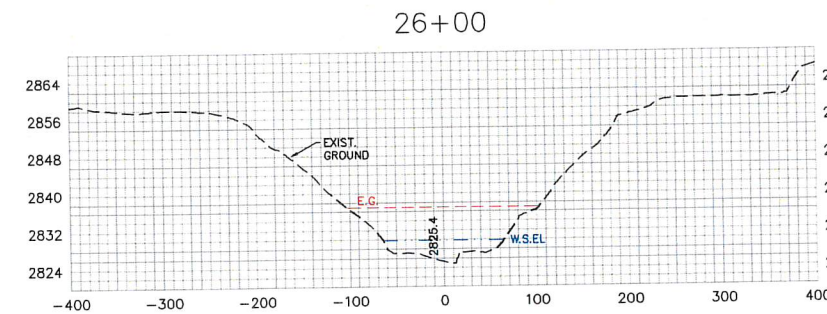
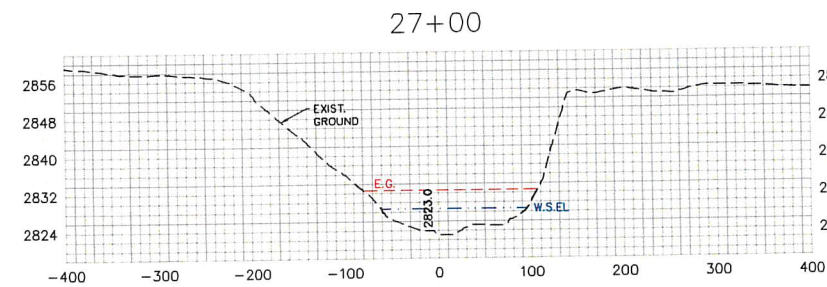


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SHEET NO.

4

SHT. 4 OF 16



LEGEND:

E.G. — — — — — ENERGY GRADE LINE
W.S.E.L. — — — — — WATER SURFACE ELEVATION

W.S.E.L. — — — WATER SURFACE ELEVATION

SCALE

100 0 50 100

HORIZ: 1" = 100'

VERT: 1" = 20'

HORIZ: 1" = 100'
VERT: 1" = 20'

HORIZ: 1" = 100'
VERT: 1" = 20'

(DRAWING TITLE)

CROSS SECTIONS - ALTERNATE #1

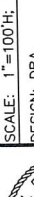
(PROJECT TITLE)

ANGEL PARK MIDDLE BRANCH DRAINAGE STUDY

ANGEL PARK

(LOCATION)

SCALE: 1"=100'H; 1"=20'V
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DRAWN: DGR
CHECKED:
APPROVED:
DATE: 8-7-08



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PROJECT NO:
FILE NAME:

5

SHT. 5 OF 16

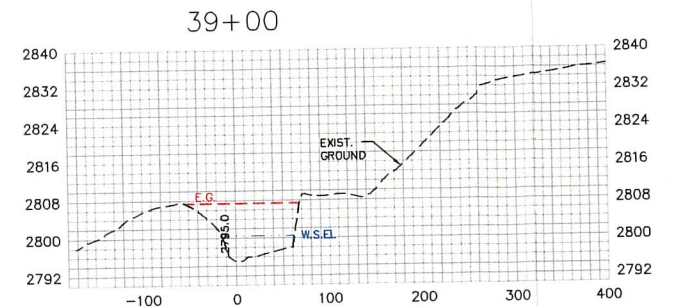
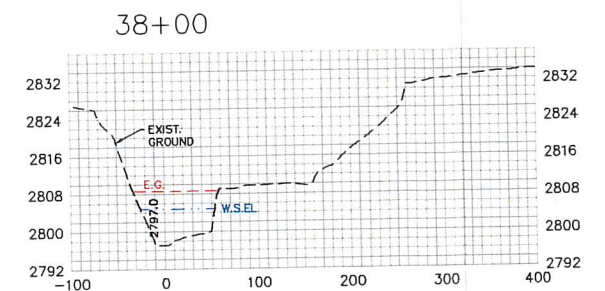
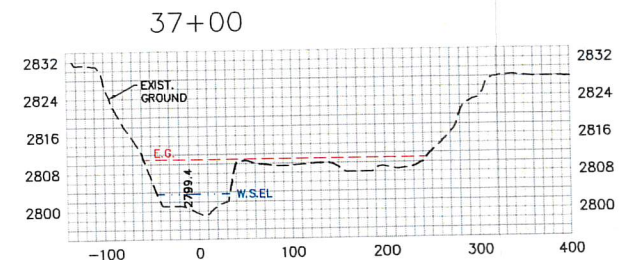
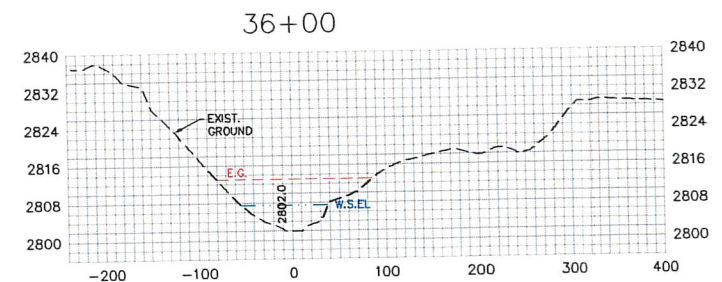
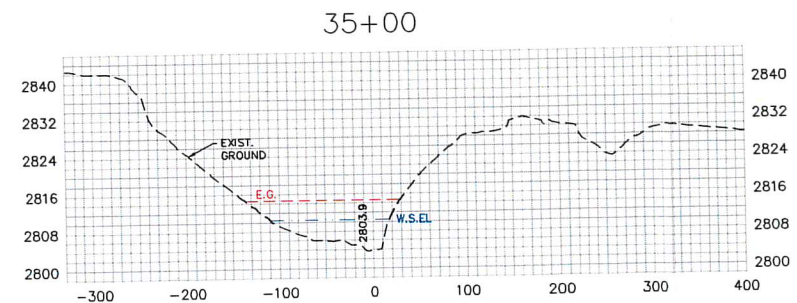
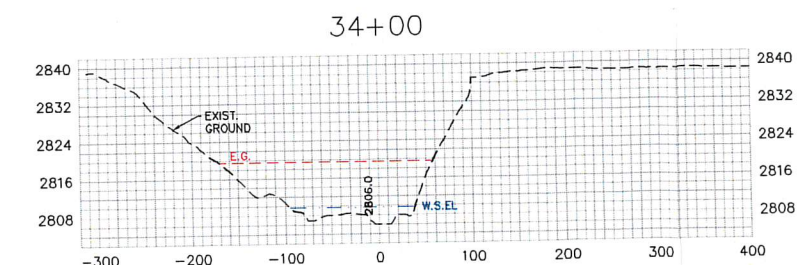
SHEET NO.



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LEGEND:
E.G. --- ENERGY GRADE LINE
W.S.E.L. --- WATER SURFACE ELEVATION

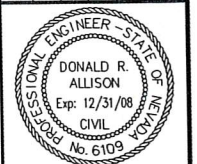
SCALE
100 0 50 100
HORIZ: 1" = 100'
VERT: 1" = 20'

CITY OF LAS VEGAS - DEPARTMENT OF PUBLIC WORKS - ENGINEERING DIVISION

CROSS SECTIONS - ALTERNATE #1

ANGEL PARK MIDDLE BRANCH DRAINAGE STUDY

ANGEL PARK



REVISIONS		NO.	DESCRIPTION	DATE	BY
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SHEET NO.

6

SHT. 6 OF 16

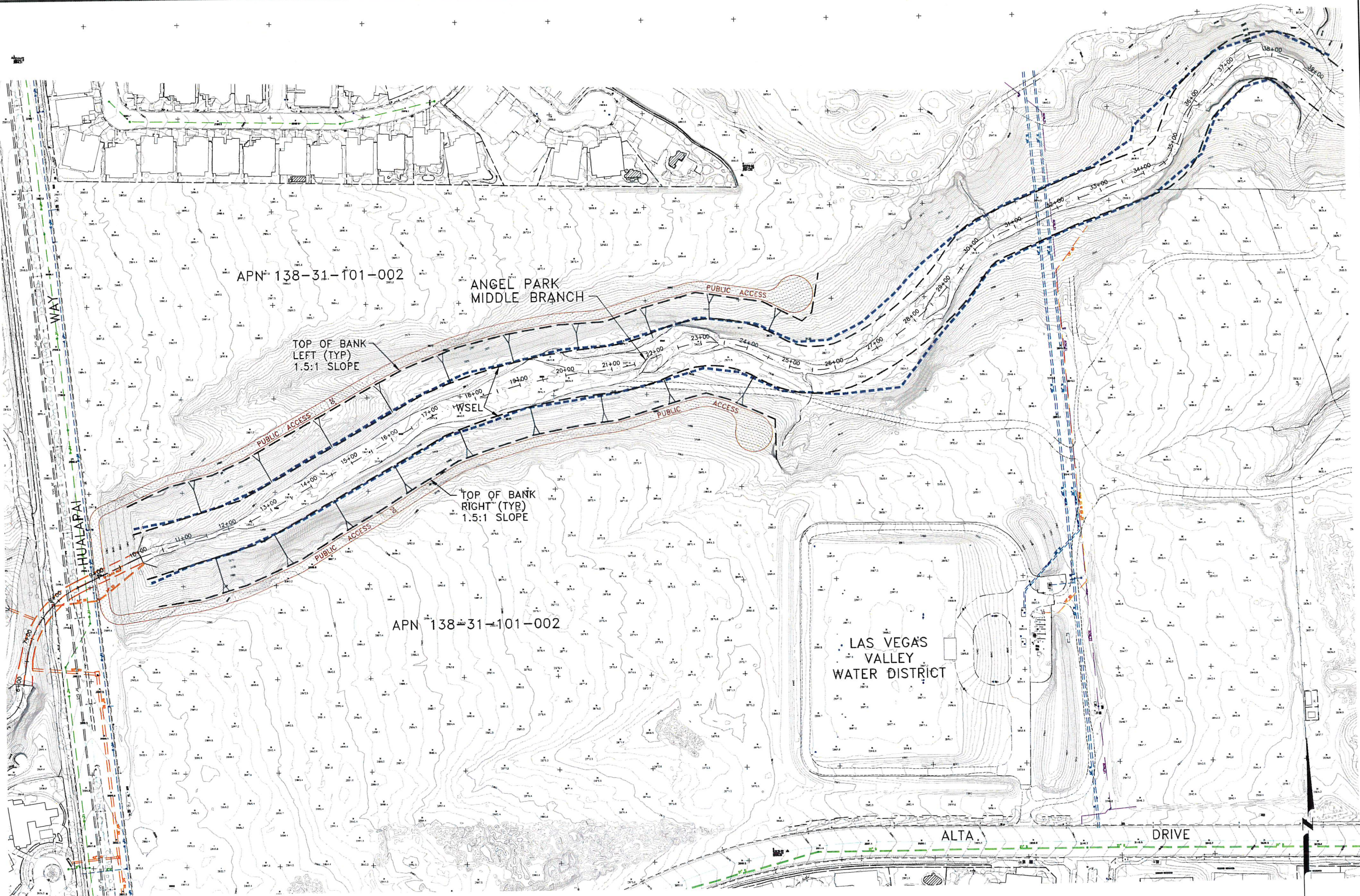
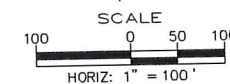


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BUILDING FINISHED FLOOR ELEVATIONS TO BE 18" ABOVE THE HIGHEST ADJACENT GRADE AT THE BUILDING FOOTPRINT OR HIGHER. BUILDINGS SHALL ALSO BE 6" ABOVE ANY ADJACENT PAVING AREAS, AND CONFORM TO ALL REQUIREMENTS OF THE "CCRFCD HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL".

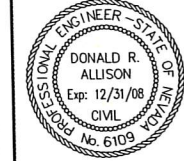
NOTE:

FLOW RATE IN ANGEL PARK MIDDLE BRANCH $Q_{100} = 6,047$ cfs



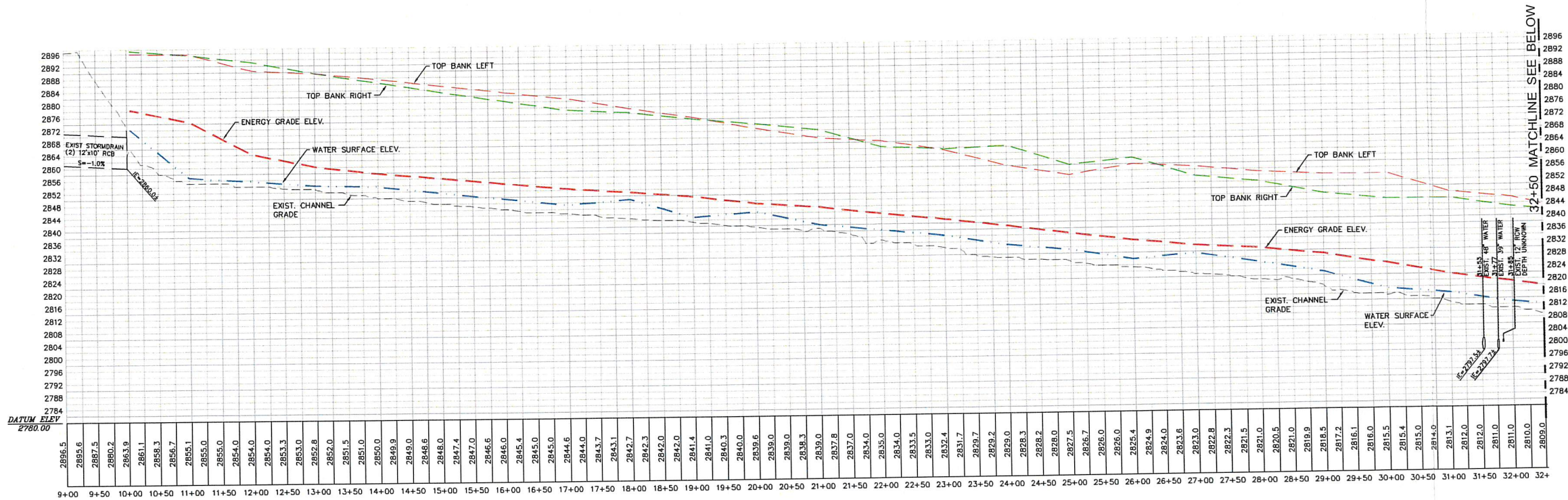
CITY OF LAS VEGAS - DEPARTMENT OF PUBLIC WORKS - ENGINEERING DIVISION

CHANNEL PLAN - ALTERNATE #2		SCALE: 1" = 50'		REVISIONS	
ANGEL PARK MIDDLE BRANCH DRAINAGE STUDY		DESIGN: DRA / DGR		NO. DESCRIPTION DATE BY	
ANGEL PARK		DRAWN: DGR		1 2 3 4 5	
SHEET NO. 7		CHECKED: [Signature]		PROJECT NO. FILE NAME:	
SHT. 7 OF 16		APPROVED: [Signature]		DATE: 8-7-08	



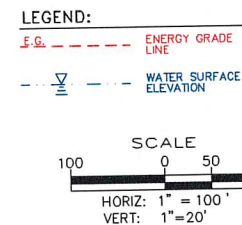
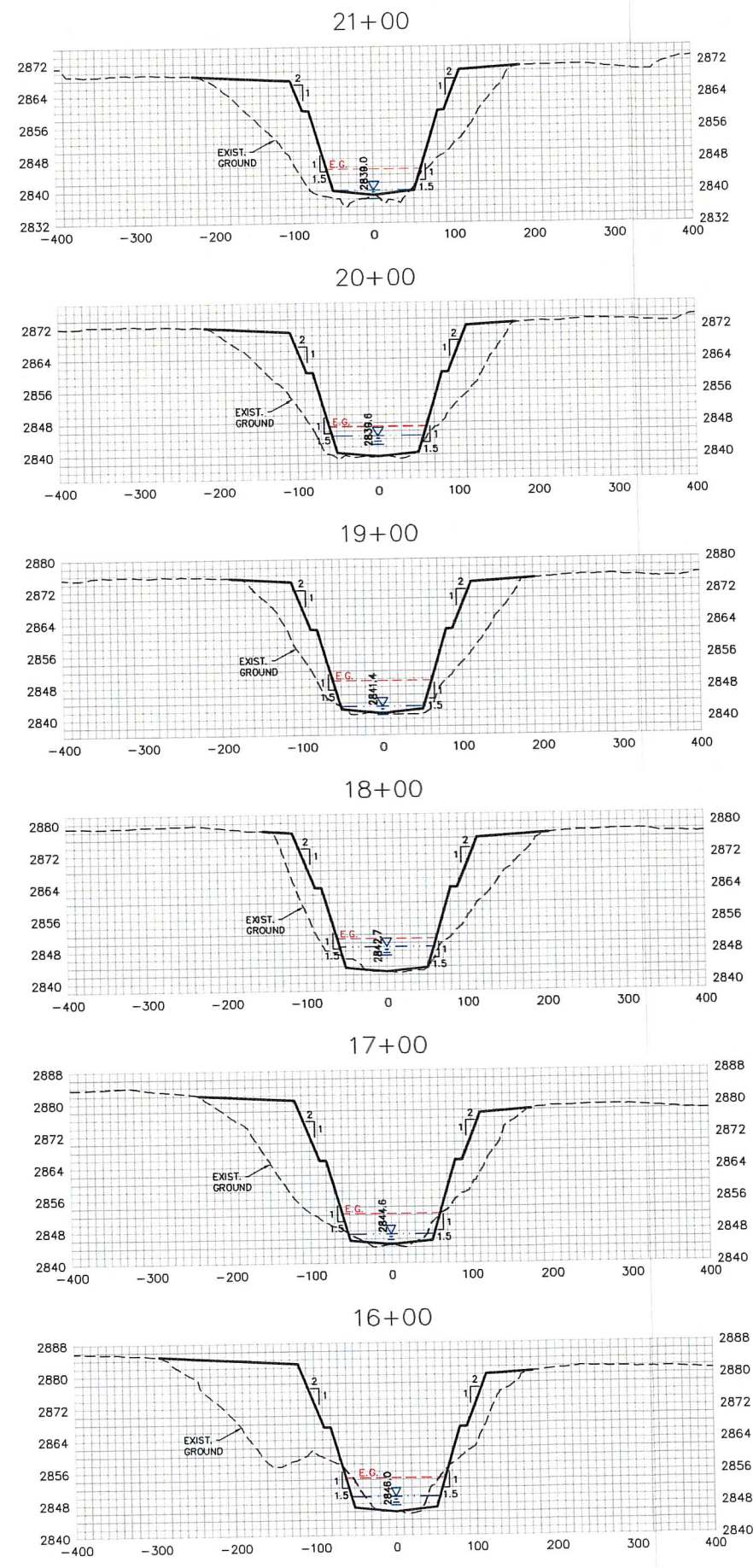
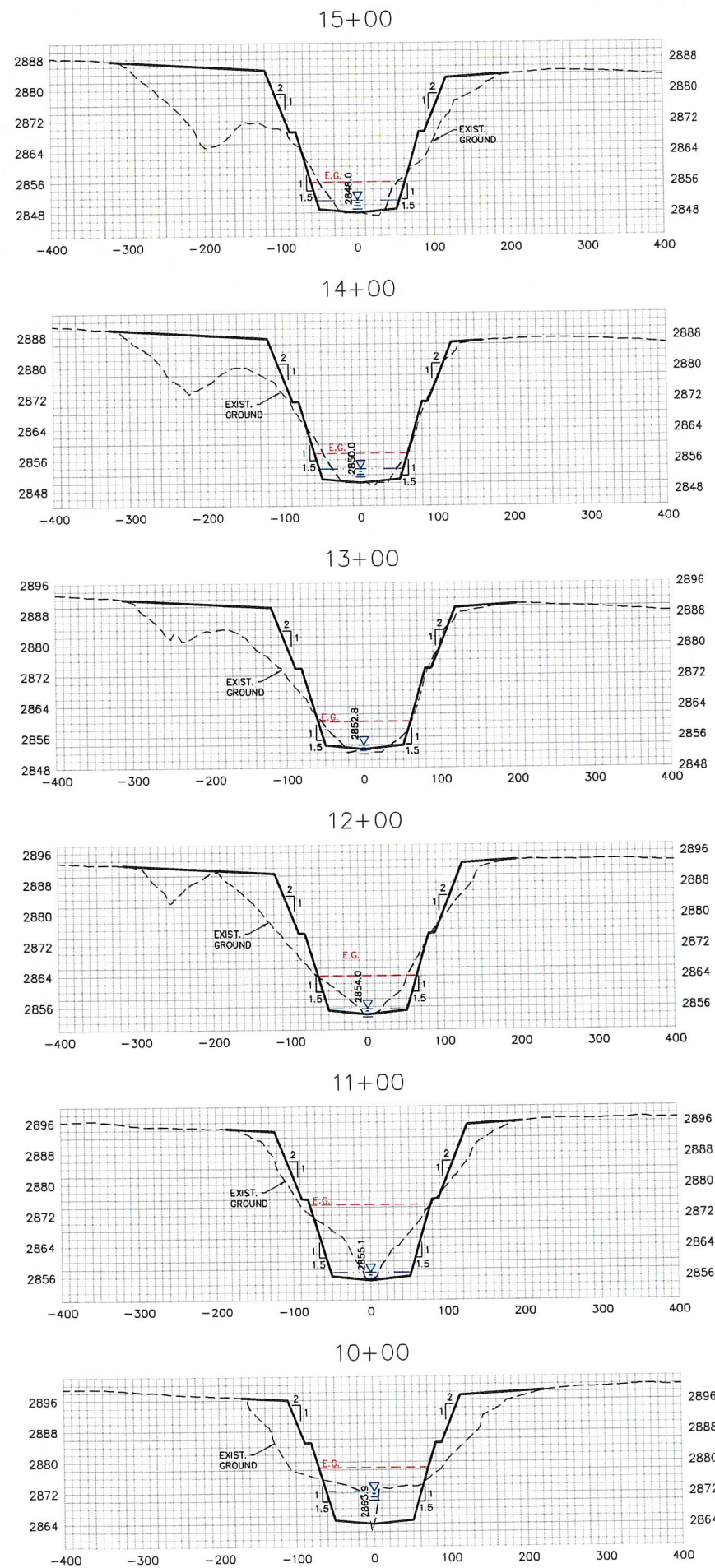


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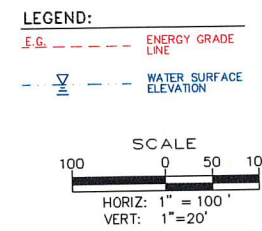
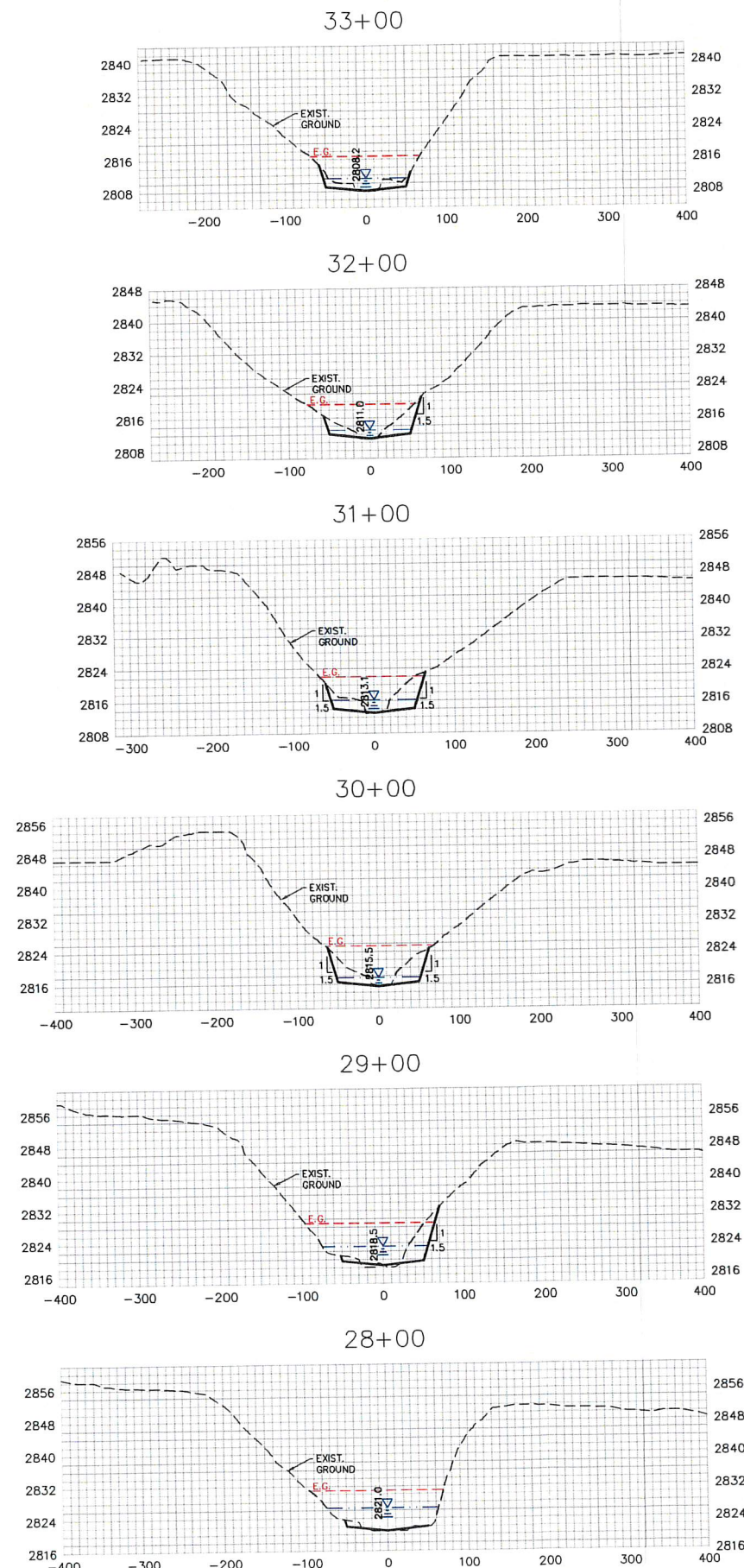
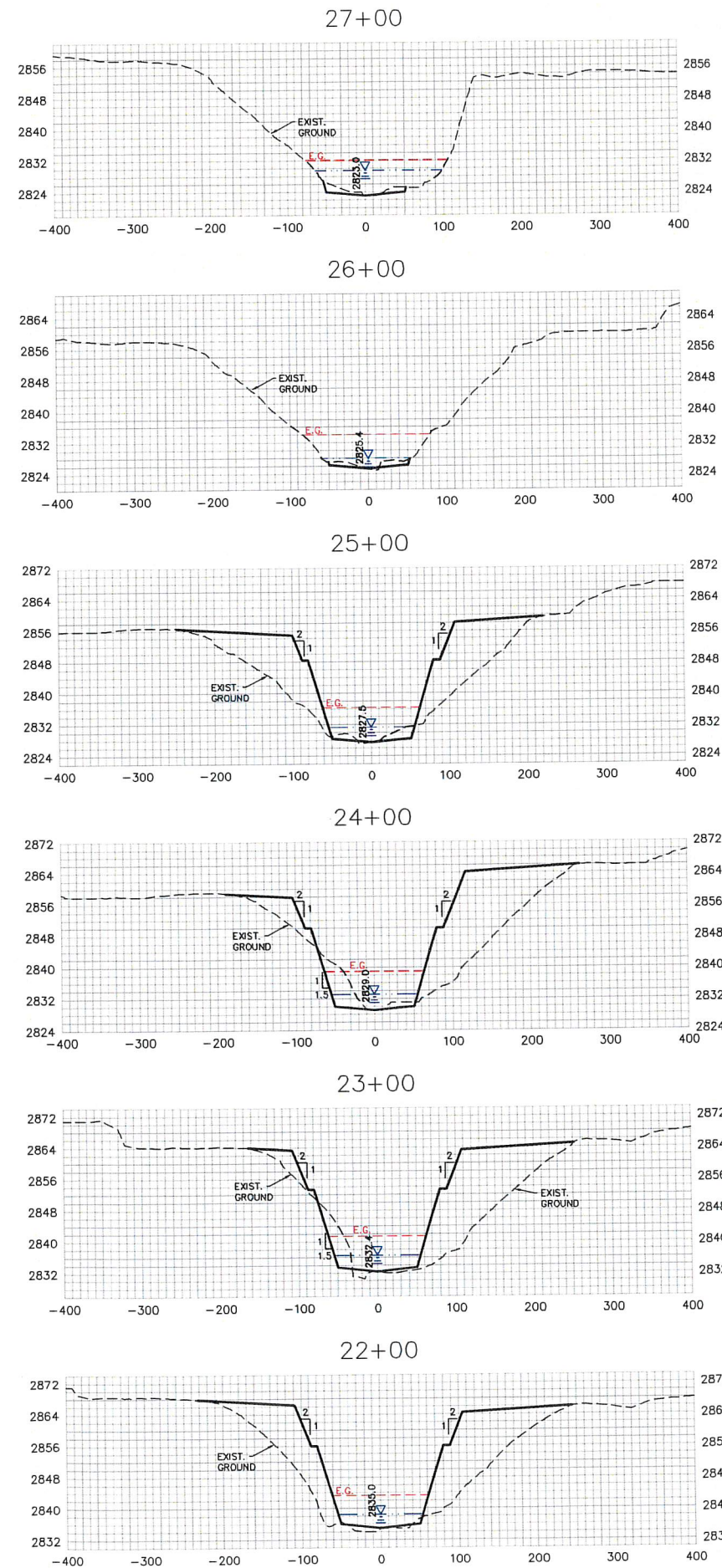


CITY OF LAS VEGAS - DEPARTMENT OF PUBLIC WORKS - ENGINEERING DIVISION

CROSS SECTIONS - ALTERNATE #2		REVISIONS	
ANGEL PARK MIDDLE BRANCH DRAINAGE STUDY		NO.	DATE
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REVISIONS		SCALE: 1"=100'H; 1"=20'V		DESIGN: DRA		DRAWN: DGR		CHECKED:		APPROVED:		PROJECT NO. FILE NAME:	
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CROSS SECTIONS - ALTERNATE #2

ANGEL PARK MIDDLE BRANCH DRAINAGE STUDY

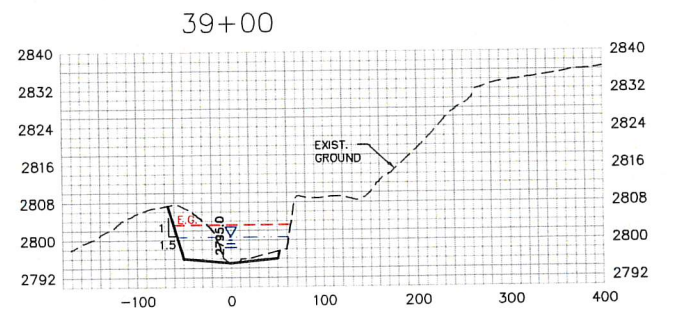
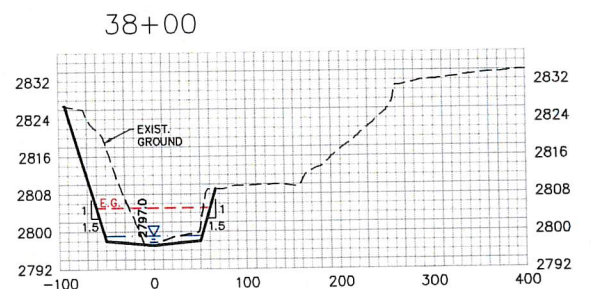
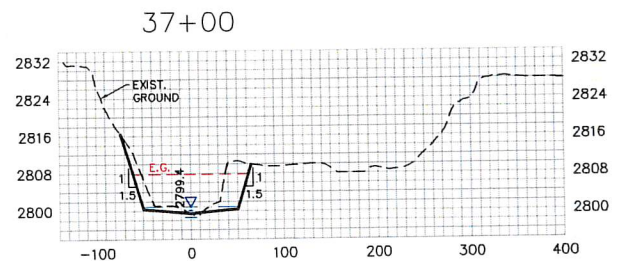
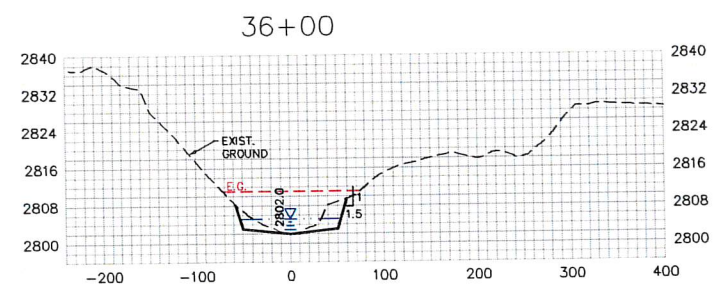
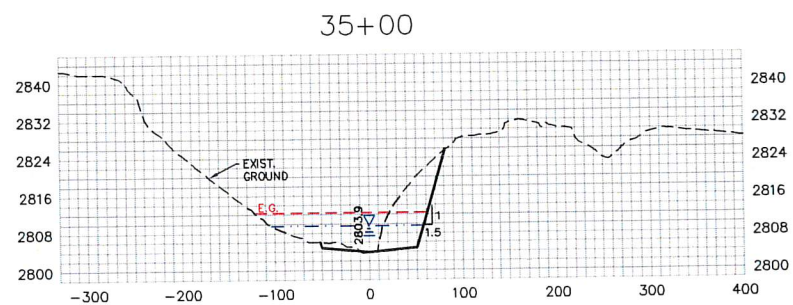
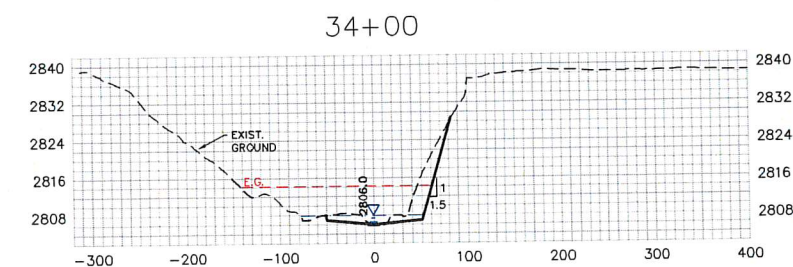
ANGEL PARK

SHEET NO. 10

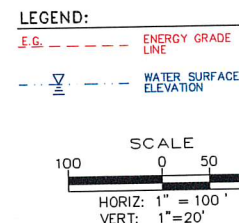
SHT. 10 OF 16



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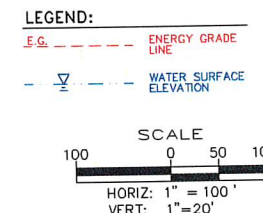
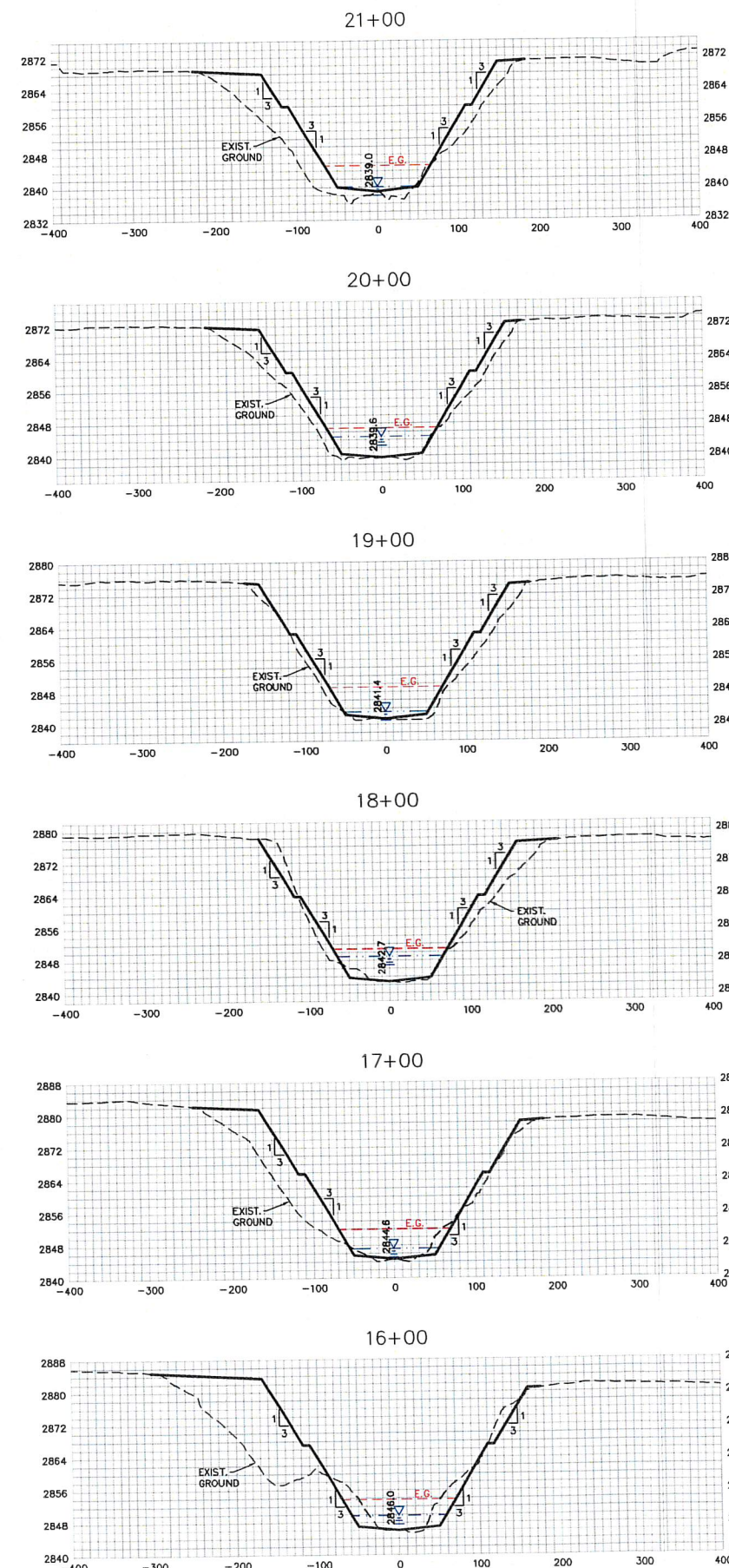
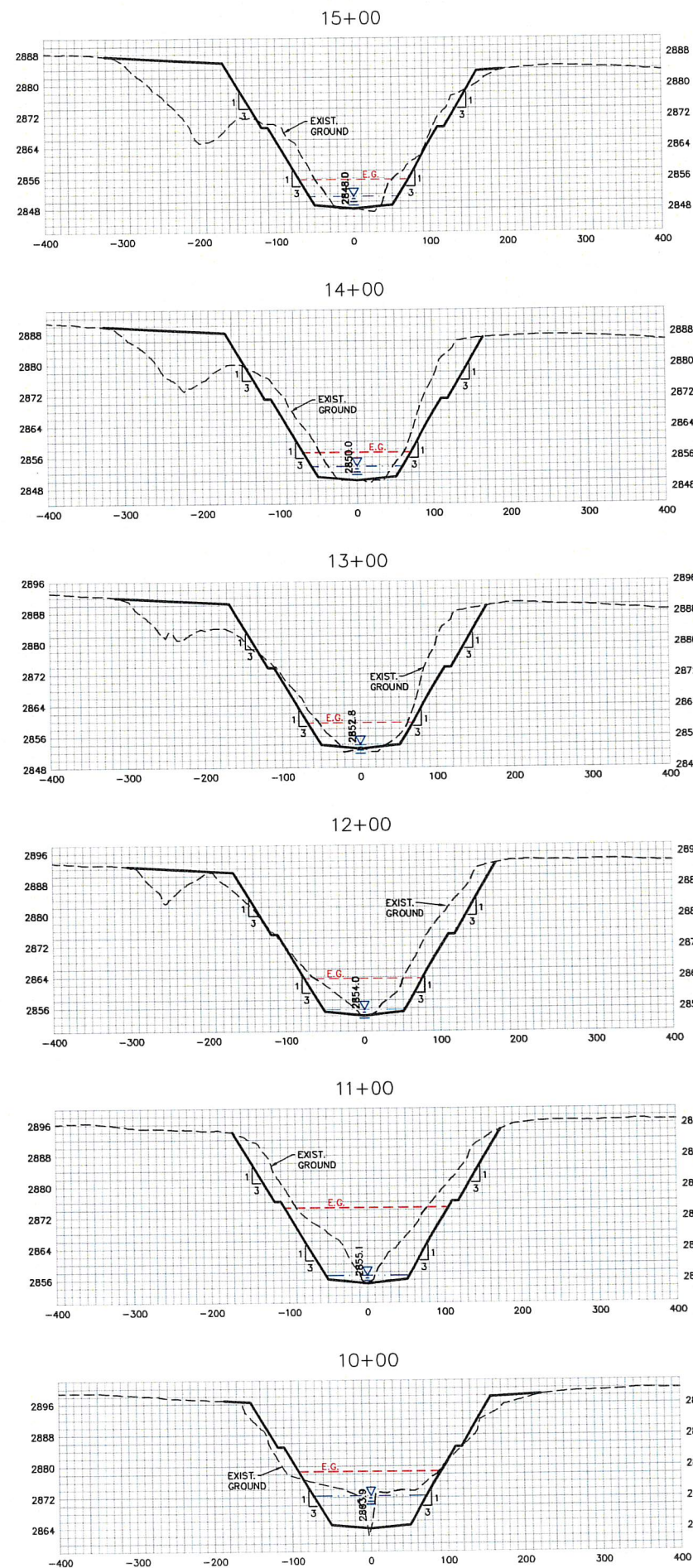
STATION	AREAS Square Feet		VOLUMES Cubic Yards		CUMULATIVE VOLUMES Cubic Yards	
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11+00	906.40	728	2549.09	4366.66	5918.77	8870.36
12+00	470.11	1630	1095.71	6433.33	7014.49	15303.69
13+00	121.58	1844	593.60	7155.56	7608.09	22459.25
14+00	198.97	2020	869.57	9751.85	8477.66	32211.10
15+00	270.60	3246	958.08	12701.85	9435.75	44912.95
16+00	246.77	3613	577.57	12192.59	10013.32	57105.54
17+00	65.12	2971	206.71	9266.67	10220.03	66372.21
18+00	45.81	2033	91.00	7894.44	10311.03	74266.65
19+00	1.46	2230	4.74	8755.56	10315.77	83022.21
20+00	1.10	2498	9.36	9953.70	10325.12	92975.91
21+00	4.18	2877	35.96	11190.74	10361.08	104166.65
22+00	13.43	3166	546.34	10662.96	10907.43	114829.61
23+00	270.69	2592	1437.21	10005.56	12344.64	124835.17
24+00	385.69	2811	890.68	10561.11	13235.32	135396.28
25+00	121.29	2892	401.33	5364.89	13636.64	140761.17
26+00	85.30	5.04	330.04	15.67	13966.68	140776.84
27+00	93.77	3.28	222.23	28.36	14188.91	140805.20
28+00	30.54	11.86	555.79	69.34	14744.70	140874.54
29+00	268.23	25.74	1223.59	47.86	15968.29	140922.40
30+00	371.14	0.21	1279.72	4.02	17248.01	140926.42
31+00	364.95	1.93	1177.49	7.77	18425.50	140934.19
32+00	270.89	2.27	760.13	10.01	19185.63	140944.20
33+00	139.58	3.14	887.24	9.01	20072.87	140953.21
34+00	339.53	1.73	2603.68	6.33	22676.55	140959.54
35+00	681.21	1.66	1666.02	6.58	24342.56	140966.12
36+00	218.44	1.89	1179.16	11.26	25521.73	140977.38
37+00	418.31	4.19	3026.77	9.81	28548.50	140987.19
38+00	1018.77	1.13	3589.51	3.02	32138.01	140990.21
39+00	470.85	0.50	0.00	0.00	32138.01	140990.21



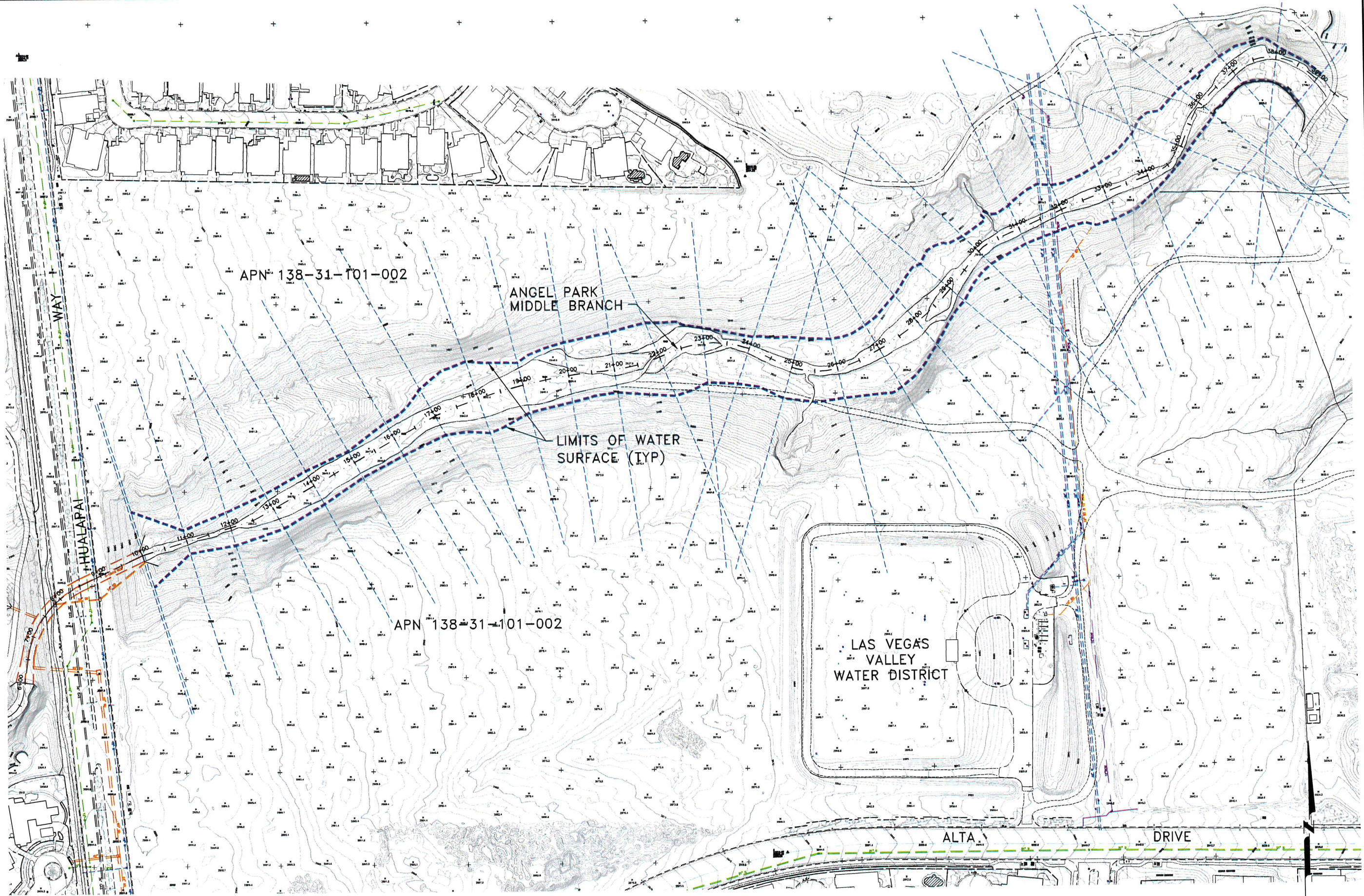
CITY OF LAS VEGAS - DEPARTMENT OF PUBLIC WORKS - ENGINEERING DIVISION	
CROSS SECTIONS - ALTERNATE #2	
ANGEL PARK MIDDLE BRANCH DRAINAGE STUDY	
ANGEL PARK	
SHEET NO. 11	
SHT. 11 OF 16	
REVISIONS	
NO. DESCRIPTION DATE BY	
DESIGN: DRA	
DRAWN: DGR	
CHECKED:	
APPROVED:	
DATE: 8-8-08	
PROJECT NO:	
FILE NAME:	



**Bureau Veritas
North America, Inc.**
4840 W. University Ave., Suite A-1
Las Vegas, Nevada 89103-3829
Tel: (702) 252-7866



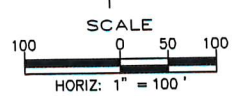
CITY OF LAS VEGAS - DEPARTMENT OF PUBLIC WORKS - ENGINEERING DIVISION	
CROSS SECTIONS - ALTERNATE #3	
ANGEL PARK MIDDLE BRANCH DRAINAGE STUDY	
ANGEL PARK	
SHEET NO. 14	
SHT. 14 OF 16	
PROJECT NO. 8-8-08	
FILE NAME:	
SCALE: 1"=100'H; 1"=20'V	
DESIGN: DRA	
DRAWN: DGR	
CHECKED:	
APPROVED:	
DATE: 8-8-08	
REVISIONS	
NO. DESCRIPTION	
DATE BY	



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BUILDING FINISHED FLOOR ELEVATIONS TO BE 18" ABOVE THE HIGHEST ADJACENT GRADE AT THE BUILDING FOOTPRINT OR HIGHER. BUILDINGS SHALL ALSO BE 6" ABOVE ANY ADJACENT PAVING AREAS, AND CONFORM TO ALL REQUIREMENTS OF THE "CCRFCD HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL".

NOTE:
FLOW RATE IN ANGEL PARK MIDDLE BRANCH $Q_{100} = 6,047$ cfs



CITY OF LAS VEGAS - DEPARTMENT OF PUBLIC WORKS - ENGINEERING DIVISION

CHANNEL CROSS SECTION LOCATION PLAN

ANGEL PARK MIDDLE BRANCH DRAINAGE STUDY

ANGEL PARK

REVISIONS

NO.	DESCRIPTION	DATE	BY
1			
2			
3			
4			
5			

SCALE: 1" = 50'

DESIGN: DRA / DGR

DRAWN: DGR

CHECKED:

APPROVED:

DATE: 6-8-08

PROFESSIONAL ENGINEER - STATE OF NEVADA

DONALD R. ALLISON

Exp: 12/31/08

CIVIL

No. 6109

PROJECT NO:

FILE NAME:

SHEET NO.

1

SHT. 1 OF 1

