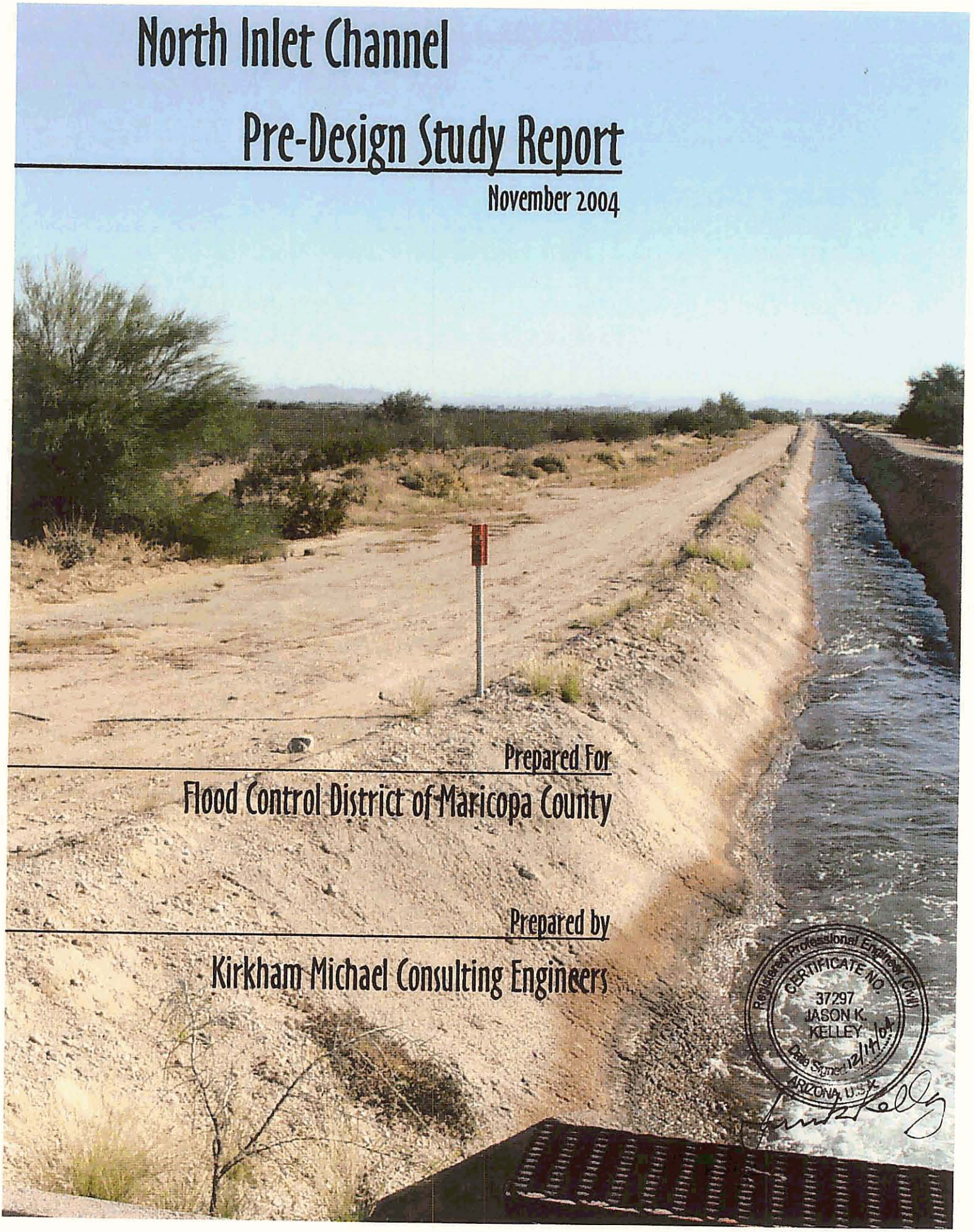
North Inlet Channel

Pre-Design Study Report

November 2004



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1. PROJECT BACKGROUND

1.1 DESCRIPTION

This report addresses the design study on the North Inlet Channel (NIC), a constructed diversion channel to reduce flows in Beardsley Wash. The four design issues addressed in this report are:

- NIC crossings at Olive Avenue, Northern Avenue and the Beardsley Canal
- Design of the NIC, including the amount of flow to be diverted
- Beardsley Wash and FRS #3 Channel bank erosion
- Sediment buildup at Olive Avenue - Beardsley Wash Crossing

The study encompasses a number of alternatives for each design issue, and concludes with a recommended design for each issue.

1.2 PURPOSE

The purpose of this analysis is to recommend a cost-effective design that will prevent Beardsley Wash breakouts at Olive Avenue, Northern Avenue and the Beardsley-Cholla Wash confluence. The design must consist of a supplementary earthen channel (the North Inlet Channel) to run east of the Beardsley Canal, provide enough of a flow diversion to allow a 100-year flow to be contained within the wash floodplain, and provide bank erosion protection at the Beardsley-Cholla Wash confluence and other locations along the canal where necessary. The flows must be diverted east of the canal into the supplementary channel at Olive Avenue and must be diverted back to the west side of the canal at Northern Avenue.

1.3 LOCATION

The project is located in Maricopa County east of the White Tanks Mountains. The site begins just north of Olive Avenue and ends at the Flood Retarding Structure #3 (FRS#3) located south of Northern Avenue. The site runs along the Beardsley Canal, which is located west of Perryville Road. The Sonoran Ridge Estates borders the west edge of the wash just south of Olive Avenue.

1.4 AGENCIES

The Flood Control District of Maricopa County (FCDMC) is the lead agency in this project but additional coordinating agencies include Maricopa County Water Conservancy District No. 1 (MWD), the Natural Resources Conservation Service (NRCS) and the Maricopa County Department of Transportation (MCDOT).

1.5 PREVIOUS STUDIES

There were several previous studies that provided the basis for the analysis included in this report. The studies include:

Level II, Draft Phase II Alternatives Analysis Report, Loop 303 Corridor/White Tanks Area Drainage Master Plan Update, URS, September 2001 -

FIRM Map No. 04013C1590G, Federal Emergency Management Agency, July 2001 -

White Tanks FRS #3 / North Inlet Channel Pre-Design Study Report, Wood Patel & Associates, Inc., July 2002 –

Sonoran Ridge Estates HECRas model

1.6 EXISTING FEATURES

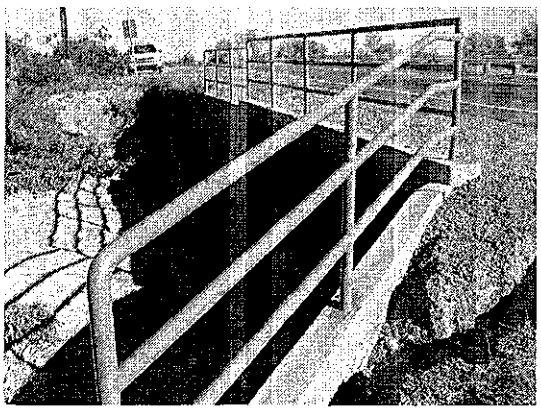
In the current condition, Beardsley Wash does not have the capacity to contain the 100-year storm event flow. Currently, the Beardsley Wash is a densely vegetated natural wash with Sonoran Ridge Estates encroachments between Olive Avenue and Cholla Wash along the west side. The Beardsley Canal runs along the east side of the wash for its entirety and, for the most part, is the boundary restricting the movement of the wash to the east. The low flow channel of the wash is located at the base of the canal maintenance road, but the wash does contain braids that extend along the west side of the wash into the floodplain.

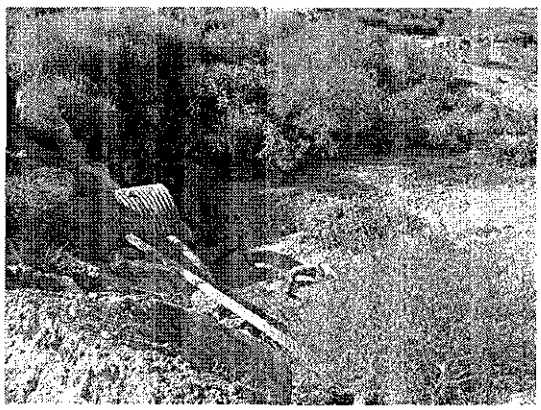
The Beardsley-Waterfall Wash confluence is located on the north side of Olive Avenue and is the cause for overtopping at the Olive Avenue-Beardsley Canal intersection. Cholla Wash converges with Beardsley Wash approximately halfway between Olive and Northern Avenue and is the source for flow overtopping of the canal from Cholla Wash to Northern Avenue.

The MWD currently owns and maintains the Beardsley Canal within a 75-foot right-of-way. The MWD also owns an additional 60-foot right-of-way west of the canal. The Beardsley Canal flow line is located approximately 3-5 feet above the thalweg of the Beardsley Wash. MWD also owns the land located along the east side of the canal between Olive and Northern Avenue, the future site of the NIC. The land the borders the west side of the wash is privately owned

There are existing culverts at both the Northern and Olive Avenue crossings. The Olive Avenue crossing consists of two sets of culverts: one 7-foot and one 8-foot corrugated metal pipe (CMP) and two 10'x6' concrete box culverts. All four culverts are approximately half full of silt and debris caused by the Waterfall Wash confluence just upstream of Olive Avenue. There are two 6-foot CMP culverts located at the Northern Avenue crossing. These CMP culverts do not contain a significant amount sediment. The culverts feed into the start of the FRS#3 earthen channel.

Figure 1 - Inlet of wash culverts at Olive Avenue crossing (left) and Northern Avenue (right)





2. HYDROLOGY

2.1 URS HEC-1 MODEL

Hydrology was provided by the County and was adapted from the Loop 303 Corridor / White Tanks Area Drainage Master Plan Update, URS, September 2001. Original HEC-1 models were provided and peak discharges were obtained along the project corridor (see Appendix A). The peak discharges were modified to reflect the overall project conditions, these included:

- No breakouts over Olive Avenue.
- A controlled diversion of 1600 cfs or 1200 cfs at Olive Avenue into the North Inlet Channel.
- Corresponding reduction in flows routed in Beardsley Canal Wash from Olive Avenue to Cholla Wash.
- Combining of peak flows at Beardsley Canal Wash and Cholla Wash while accounting for timing of hydrograph peaks.
- No breakouts at Northern Avenue.
- Return of the diversion flows (1600 or 1200 cfs) into the FRS#3 channel just downstream of Northern Avenue.

The assumption was made that the diversion flows combine directly with the flows routed in Beardsley Canal Wash from Cholla Wash to Northern Avenue. Flows coming in from areas west of the FRS#3 channel combine with the flows in Beardsley Canal Wash and the diversion flows just north of the FRS#3 structure.

A check was performed in HEC-1 to determine if the 'accounting' methods for mathematically combining the peak flows was accurate. The check showed that the method was within 100 cfs in accounting for the combining of peak flows at Beardsley Canal Wash and Cholla Wash (see Appendix A). The same accounting method was used to approximate the comining of hydrograph peaks downstream of Northern Avenue in the FRS#3 channel.

The peak flows are as follows:

At Olive Avenue – 2655 cfs
Diversion – 1600 cfs or 1200 cfs
Olive Avenue to Cholla Wash in Beardsley Canal – 1055 cfs or 1455 cfs
Cholla Wash – 4868 cfs
Cholla Wash to Northern Avenue in Beardsley Canal – 5539 or 5939
Northern Avenue to 1200 feet south of Northern Avenue in FRS#3 Channel – 7139 cfs
1200 feet south of Northern Avenue to FRS#3 Structure in FRS#3 Channel – 7776 cfs

These flows were used consistently for all inputs into HEC-RAS models for evaluation and design.

3. SITE EVALUATION

3.1 MANNING'S COEFFICIENT

Site visits were performed along Beardsley Canal Wash from Olive Avenue to Cholla Wash to determine existing roughness conditions. The wash was traversed every hundred feet or so and photos were taken along each cross-section of the wash to document the existing conditions. The majority of the study reach consists of a natural sandy-bottom channel with trees and shrubs on the sides. The overbank floodplains consist of normal density desert brush. The 'n' values were estimated for the reach were applied to the original Sonoran Ridge Estates HEC-RAS model along the study reach to right overbank, left overbank and channel, using the Sonoran Ridge Estates Manning's Roughness Coefficients Table in Volume II, Hydraulics, of the Maricopa County Drainage Design Manual. The table contains 'n' values for minimum, normal and maximum tree and shrub density, which were used to more accurately depict the channel with its varying vegetation. Hand-drawn schematics were used to organize photos taken of the study reach and variation of 'n' values along a cross-section of the reach. Small tributaries and wide variation in vegetative density required flexibility in defining the roughness at a given cross-section in the HEC-RAS model. Up to six 'n' values were used per cross-section using the varying 'n' value option in the cross-section editor (see Appendix B).

3.2 SUMMARY OF VEGETATION

The site evaluation provided a list of native foliage located within the wash. The vegetation was primarily Native Mesquite and Blue Palo Verde but included Foothills Palo Verde and Ironwood, and scattered Desert Willow. The vegetation is most dense along the west bank of the Beardsley Canal, in the middle of the channel and to a lesser extent along the west side of the wash.

3.3 SEDIMENT EVALUATION

Sediment buildup is observed at the existing culverts at both Olive Avenue and Northern Avenue. The estimated sediment depths are between 1' to 3' feet. The culverts appear to be functioning at Olive Avenue. The culverts at Northern Avenue have other issues besides sediment problems (i.e. undersizing, debris).

A sediment basin upstream of the proposed North Inlet Channel diversion culvert is not recommended. A basin at this location would cause 'clean water' to travel down existing Beardsley Wash further aggravating the highly erodible channel (due to the ability for 'clean water' to pick up additional silt load from stream banks). The inlet to the diversion structure will be a weir-type structure and will only receive flows with depths over two to three feet. This configuration would prevent a significant portion of the bed load from entering the diversion structure. Some sediment buildup is predicted, yet the required drop inlet to the diversion structure (to get under the canal) would cause it to be 'self-cleaning' and the diversion culvert itself would be steep enough to be 'self cleaning'. Any sediment passing through the diversion structure would tend to fall out after entering the flatter North Inlet Channel (s = 0.00075 '/ft). Cleanout of deposited sediment downstream of the diversion culvert would be needed after one or more large storm events (this would be the case for a sedimentation basin also).Sediment buildup at the Northern Avenue diversion structure would not be a problem due to the non-erosive velocities in the proposed earthen North Inlet Channel (v = 3.5 to 4.0 fps).

4. OLIVE AVENUE FLOW SPLIT ANALYSIS

The amount of flow to be diverted from the Beardsley Wash dictates the design of the North Inlet Channel. The possibility of clearing the Beardsley Wash within the 60' MWD right-of-way could be a cost effective solution to reduce the flow, therefore the width, in the NIC. The Sonoran Ridge HECRas model was updated with more applicable Manning's values for the existing channel and a cleared channel. The amount of flow that must be diverted from the existing and cleared channel was then computed. Additionally, a sensitivity analysis was completed to ensure that any slight change in the existing wash's vegetation would not affect the amount of flow to be diverted.

4.1 EXISTING BEARDSLEY CANAL WASH

The updated SRE HECRas model was run and the depths produced were compared to the Flood Insurance Study (FIS) elevations provided by the FEMA Flood Map of the area. To maintain the existing water surface elevations of the floodplain, it was calculated that approximately 1,600 cfs will have to be diverted to the North Inlet Channel along the east side of the canal. The table below shows the comparison between the FIS and the updated SRE HECRas water line elevations for the existing wash condition. River station 2.159 is at the downstream face of the Olive Avenue culvert.

Table 1-Flow Diversion and FIS, HECRas and SRE Water Elevations for Existing Wash with 1600cfs Diverted Flow

River Station (mi)	FIS[1] Elev. (ft)	HEC Elev. (ft)	HEC - FIS Elev. Difference (ft)
2.159	1276.84	1273.10	-3.74
2.072	1271.44	1271.43	-0.01
1.996	1267.84	1265.71	-2.13
1.920	1265.04	1263.43	-1.61
1.844	1261.84	1259.40	-2.44
1.768	1256.14	1255.96	-0.18
1.692	1253.24	1252.75	-0.49
1.616	1253.04	1250.59	-2.45

[1] *FIS elevation increased by 2.24' to match SRE datum*

4.2 CLEARED BEARDSLEY CANAL WASH

The Manning's values obtained from the site visit were altered to provide a clearing of the channel within the Maricopa Water District 60-foot right-of-way along the west side of the canal. The Manning's n value for the cleared channel in the new HECRas model was 0.022. To maintain the existing water surface elevations of the floodplain, as provided by FEMA, it is calculated that approximately 1,200 cfs will have to be diverted to the North Inlet Channel. The table below shows the comparison between the FIS, altered SRE HECRas and original SRE model (no diversion) water line elevations for the cleared wash condition. Again, river station 2.159 is at the downstream face of the Olive Avenue culvert.

Table 2-Flow Diversion and FIS, HECRas and SRE Water Elevations for Cleared Wash with 1200cfs Diverted Flow

River Station (mi)	FIS[1] Elev. (ft)	HEC Elev. (ft)	HEC - FIS Elev. Difference (ft)
2.159	1276.84	1273.79	-3.05
2.072	1271.44	1271.36	-0.08
1.996	1267.84	1265.59	-2.25
1.920	1265.04	1262.22	-2.82
1.844	1261.84	1260.23	-1.61
1.768	1256.14	1254.83	-1.31
1.692	1253.24	1253.19	-0.05
1.616	1253.04	1250.37	-2.67

[1] FIS elevation increased by 2.24' to match SRE datum

Clearing the wash presents several dilemmas that must be addressed in order to consider this option. First, the responsibility and cost of maintaining the cleared channel must be noted. Additionally, temporary construction easements might need to be obtained from SRE in order to provide adequate space for clearing equipment. SRE owners may be noncompliant to this request because a 'scenic' wash adjacent to their property is being cleared.

The encroachment data utilized in the original Sonoran Ridge Estates HEC-RAS model was maintained in the flow split analyses. It is assumed that this is the most representative information on the future encroachment due to development.

5. NORTH INLET CHANNEL

Although the general design of the NIC was outlined in the scope for this project, the base width and right-of-way dimensions of the channel will change depending on the amount of flow that is to be diverted. Once the flows to be diverted from the channel were estimated, the basic design of the North Inlet Channel could be completed using normal depth calculations and modeled in HEC-RAS. The scope states that the NIC is to be an earthen channel with two 15-foot maintenance roads on each side and of the channel. To prevent erosion the velocity should be no greater than 4 feet per second. The slope of the channel is 0.00075 '/ft and, for aesthetic purposes, the side slopes vary from 4:1 to 8:1 creating a meandering channel bottom of constant width. A freeboard of 2 feet is used to ensure that the banks will not be overtopped if the channel becomes vegetated. Ten or more drop structures are used along the proposed channel to attain the required fall of 40 feet from Olive Avenue to Northern Avenue while maintaining flatter slopes needed to control the velocity and erosive potential of the diverted flow.

5.1 DESIGN FOR EXISTING CHANNEL FLOW SPLIT

Using the 1,600 cfs flow provided by the HECRas model and the limitations provided above, the width of the channel bottom could be no less than 55 feet. In this case, the width of the channel is approximately 150 feet, not including trails and access roads on either side of the channel. The width of the right-of-way, including two 15-foot maintenance roads, is approximately 180.

5.2 DESIGN FOR CLEARED CHANNEL FLOW SPLIT

Using the 1,200 cfs flow provided by the model and the limitations provided above, the bottom width of the channel must be no less than 35 feet. The total channel width is then approximately 130 feet, not including pathways and service roads. Including the including two 15-foot maintenance roads expands the right-of-way to approximately 160 feet.

5.3 DROP STRUCTURES

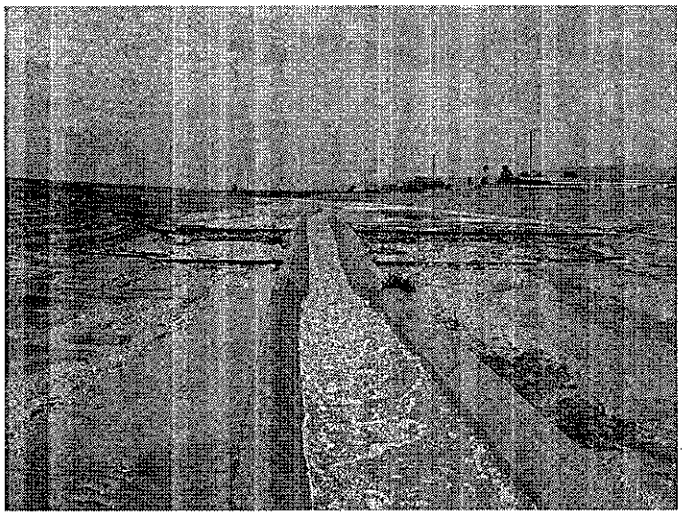
A cursory drop structure analysis was performed in HEC-RAS to determine the hydraulic characteristics of drop structure alternatives. The drop structure analysis shows that a constriction is needed at the crest of each drop structure of at least 50% of the channel width. For example, if the NIC bottom width is 55', a drop structure crest width of 25' would be satisfactory in maintaining upstream headwater elevations and minimizing velocity increases due to draw-down over the drop structure crest. The constriction can be implemented in several ways with the most feasible being a sudden contraction in the channel using earthen fill protected by gabions, rip-rap or concrete. This constriction would narrow the channel bottom up to the drop structure crest thereby minimizing the velocities approaching the crest of the drop. The constriction would be maintained through the drop and then the channel transitioned back to the normal width downstream of the drop (see Appendix F).

5.3.1 SLOPING BURIED CONCRETE

The sloping buried concrete drop structure contains two cutoff walls approximately 15 feet apart with dumped riprap between them. Riprap is also placed upstream and downstream of the cutoff walls: 15 feet in the top apron and 35 feet in the bottom apron. Earthen walls with bank protection would be used to constrict flow horizontally at the structure. A picture of a similar structure is shown below and a conceptual drawing can be found in Appendix F. The drop structures to be used

in the NIC will not have a low-flow concrete channel as seen in the picture below.

Figure 2 - Sloping buried concrete drop structure; taken in Laveen, Arizona



5.3.2 SLOPING GROUTED ROCK

The sloping grouted rock drop structure contains two concrete cutoff walls at the top and bottom of the drop with approximately 55 feet of grouted rock between them. The grouted rock section of the drop structure contains a 15-foot apron at the top, a 15-foot sloping segment and a 25-foot bottom apron. The bottom apron also acts as a stilling basin with a 1-foot sill at its downstream edge, as well as 15 feet of dumped riprap beyond the sill. Earthen walls with bank protection would be used to constrict flow horizontally at the structure. A picture of a similar structure is shown below and a conceptual drawing can be found in Appendix F.

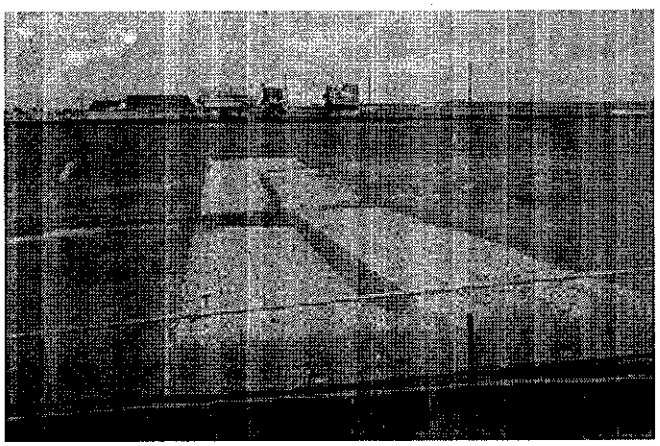
Figure 3 - Sloping grouted rock drop structure; taken at Cherry Creek, Denver, Colorado

5.3.3 VERTICAL GABION

The vertical gabion structure is comprised of gabion mattresses and basket filled with riprap. Mattresses would be used to protect the channel from erosion while the baskets would provide the actual drop. The configuration used for this analysis includes 18' x 6' x 12" mattresses at the top and bottom of the structure (provides 18-33 feet of channel protection as well as 12' x 3' x 3'

baskets for the drop). Earthen walls with bank protection would be used to constrict flow horizontally at the structure. A picture of a similar structure is shown below and a conceptual drawing can be found in Appendix F. Unlike the photograph below, the NIC drop structures will extend up the bank to the 100-year flow line.

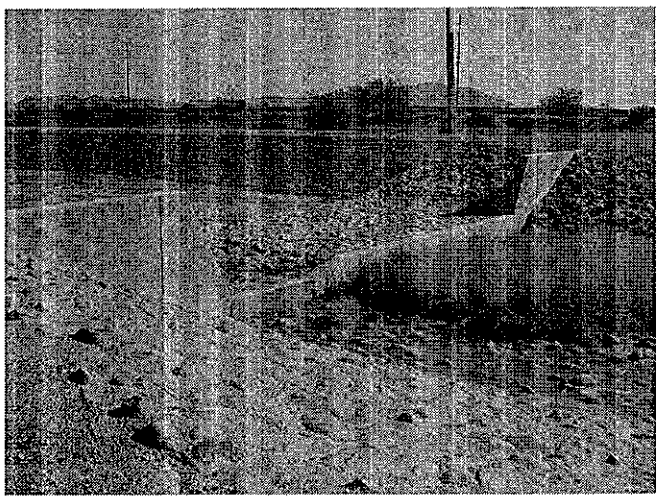
Figure 4 - Vertical gabion drop structure; taken in unknown area



5.3.4 VERTICAL EXPOSED CONCRETE

The vertical exposed concrete drop structure contains two cutoff walls 25 feet apart. The first cutoff wall provides the 3.5' drop and the second cutoff wall provides the downstream sill for the stilling basin. Grouted rock is used in both the 25-foot stilling basin, the 15-foot upstream apron and the 15-foot bottom apron. A picture of a similar structure is shown below and a conceptual drawing can be found in Appendix F. As seen in the picture, concrete walls would be used to constrict flow horizontally at the first cut off wall; the second cutoff wall is not shown in the photograph.

Figure 5 - Vertical exposed concrete drop structure; taken in the Rittenhouse Channel, Queen Creek, Arizona

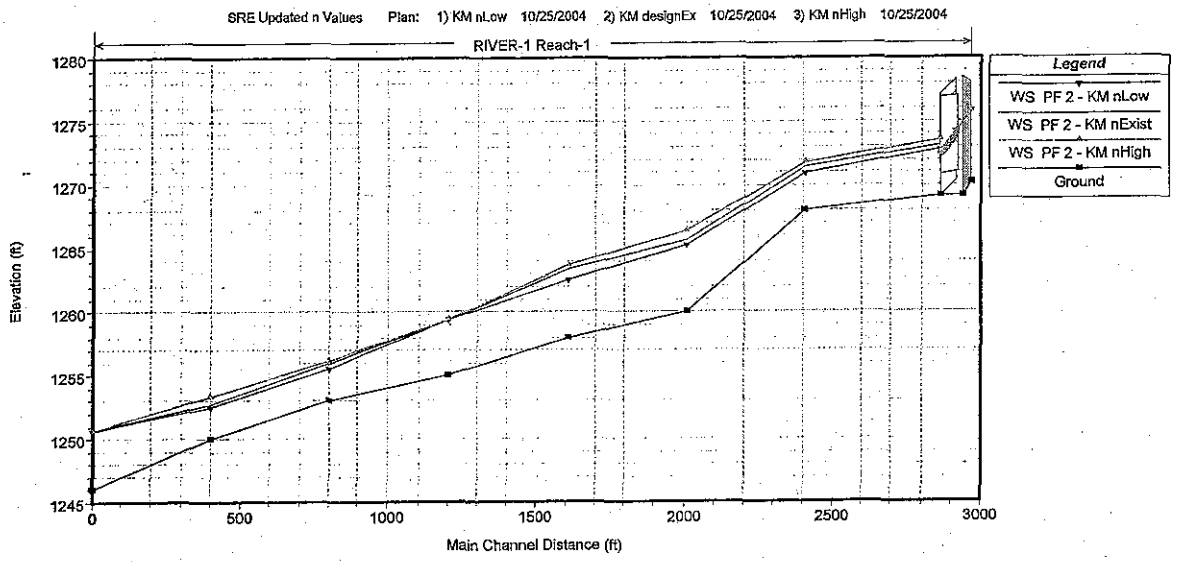


6. 'N' VALUE SENSITIVITY ANALYSIS

6.1 BEARDSLEY WASH

A sensitivity analysis was completed on the Beardsley Wash to ensure that small changes in the vegetation would not affect the performance of either the wash or the channel. The analysis was completed in the SRE HECRas model by altering the 'n' values to characterize increases or decreases in vegetation. The figure below shows that slight increases in vegetation do not increase the water surface elevation significantly.

Figure 6 - HECRas profile of Beardsley Canal Wash, Olive Ave. to Cholla Wash, showing water line for sensitivity analysis with existing 'n' value, low 'n' value and high 'n' value



The weighted 'n' values for the low, existing and high vegetative conditions can be found in Appendix D.

6.2 NORTH INLET CHANNEL

A sensitivity analysis was completed on the North Inlet Channel to ensure that flow would not overtop the banks when the channel vegetation increases or decreases. The Manning's 'n' value for normal channel vegetation is 0.030. The channel condition immediately following construction is characterized by an n value of 0.025 and the condition of an unmaintained channel is described by a 0.035 'n' value. It was concluded that the 2-foot freeboard, which was used in the calculations, provided enough room for the range of conditions at either diversion flow value for the existing channel flow or cleared channel flow (see Appendix F).

7. OLIVE AVENUE DIVERSION STRUCTURE

Listed below are options for aligning the diversion structure at Olive Avenue. These differ in either minimizing culvert length, the number of canal structure replacements/relocations and upstream weir configuration. The alternatives below were compared using a cost analysis and sized based on a diversion flow of 1,600 cfs diverted flow. The 1,600 cfs flow dictates that a minimum of three box culverts measuring 10'x5' are needed. The size of the structure for the 1200 cfs diversion would be nearly the same.

7.1 SHORT CROSSING ALTERNATIVE

A NIC crossing located directly through the Olive Avenue-Beardsley Canal intersection, or the short crossing, allows for a minimization of culvert length but contains many canal structure replacements. This alternative entails that the box culverts measure 220-feet in length and the location requires the removal and replacement of a canal headwall and turnout structure.

7.2 LONG CROSSING ALTERNATIVE

The NIC crossing alternative located just east of the Olive Avenue-Beardsley Canal intersection, or the long crossing, allows for a minimization of canal structure replacements but requires a longer box culvert length. The required 330-foot box culvert is difficult to maintain and may need additional lighting within the culvert. This crossing location does not require canal structure removals.

7.3 MEDIUM CROSSING ALTERNATIVE

The medium crossing is the NIC crossing at, but not directly though, the Olive Avenue – Beardsley Canal intersection. This alternative lies between the short and long crossings and utilizes a culvert length shorter than the long crossing and less canal structure relocations than the short crossing. The location of the crossing does require that a canal turnout structure and headwall must be replaced but the overall culvert length is 240 feet.

7.4 DOUBLE-CROSSING ALTERNATIVE

The double-crossing alternative includes two NIC box culvert crossings that are short and easily maintained. The first box culvert is located perpendicular to the Beardsley Canal and is 160 feet in length. The second box culvert, measuring 110 feet in length, is located perpendicular to Olive Avenue. This alternative does not require canal structure replacements but does include Concrete channel between the two culverts as well as additional inlet and outlet headwalls for the second culvert. The ninety-degree turn needed to cross the canal and Olive Avenue perpendicularly is not hydraulically practical.

8. NORTHERN AVENUE DIVERSION STRUCTURE

There are several North Inlet Channel crossing options at Northern Avenue that minimize either culvert length or the number of canal structure replacements. The alternatives, noted below, were compared using a cost analysis and were designed using the 1,600 cfs diverted flow. The 1,600 cfs flow dictates that a minimum of five 10'x5' box culverts are needed. The sizing of this structure is dependent on channelization in the FRS#3 channel downstream of Northern.

Due to the high tailwater conditions downstream of the Northern Avenue wash crossing, where the North Inlet Channel confluences with the FRS#3 Channel, it was necessary to evaluate lowering and channelizing the FRS#3 Channel. At existing channel elevations and grades, high tailwater exists in the FRS#3 Channel and flow is 'backed up' through the North Inlet Channel (NIC) Diversion Structure at Northern Avenue, causing adverse affects and probable overtopping of the NIC at Northern.

In order to lower the water surface enough to prevent flow from backing up in the NIC, it is estimated that the FRS#3 Channel will have to be expanded to a bottom width of 90 feet, and the upstream section will have to be placed 3 to 4 feet deeper. Also, a large box culvert either with a drop inlet or in a 'broken-back' configuration would be needed to convey the flows in the Beardsley Canal Wash safely under Northern Avenue. The size of this culvert could be as large as an 8-barrel, 12'x8' reinforced concrete box (see Appendix G).

8.1 SHORT CROSSING ALTERNATIVE

The short crossing alternative is located at the Northern Avenue – Beardsley Canal intersection and minimizes culvert length but includes a replacement of both a canal headwall and turnout structure. The length of the culvert measures 300 feet.

8.2 LONG CROSSING ALTERNATIVE

The long crossing alternative is located just east of the Northern Avenue – Beardsley Canal intersection and includes a 500' box culvert and approximately 1500 cubic yards of channelization from the NIC to the culvert inlet. No canal structure relocation is required for this alternative.

8.3 DOUBLE-CROSSING ALTERNATIVE

The double-crossing alternative includes two box culverts, one crossing Northern Avenue perpendicularly and one crossing the canal at approximately a forty-five degree angle. The first culvert measures 50 feet in length, the second measures 250 feet. Over 10,000 c.y. of channelization is required between the two culverts, as well as additional outlet and inlet headwalls for the second culvert. The location of the NIC crossing downstream of the Northern Avenue – Beardsley Canal intersection requires that a canal drop structure and approximately 550 feet of canal must be removed and replaced.

9. NORTHERN AVENUE WASH CROSSING

Even with 1600 cfs diversion at Olive Avenue, overtopping still occurs at the Northern Avenue – Beardsley Wash crossing due to the large flows coming in from Cholla Wash. The 100-year flow in the wash at Northern Avenue is over 5,500 cfs. Two design alternatives to prohibit canal overtopping are noted and compared below. Both alternatives require that the canal road, on the east side of the wash, be built up. A description of the build up is noted below. A grade stabilization structure upstream of the wash crossing would not be necessary because the headwaters caused by a new culvert will back up and slow down the flow in the wash enough to reduce erosion and maintain the current grade. A plan and profile sheet of each crossing option can be found in Appendix E.

9.1 DIP SECTION WITH CULVERT ALTERNATIVE

Including a 15 mph dip crossing at the Northern Avenue – Beardsley Wash intersection allows the culverts at this location to be smaller while passing flow over the dip section. The depth of the dip section is limited by the height of the canal crossing and canal road immediately east of the dip. The alternative balances the dip section and culvert size to provide capacity to pass the 100-year flow. The dip crossing was maximized to minimize the size of the culvert. The minimum culvert size needed is five 10'x6'box culverts. The 100-year water depth would still be nearly 4.5 feet over the dip crossing. In order to maintain the integrity of the crossing, a concrete fjord must protect the roadway above the culvert with riprap protection on exposed areas. This option presents many difficulties: emergency vehicle access is not provided, future ultimate roadway improvements would entail major reconstruction, the flow depths are high and the dip could be a hazard to the steep approach from the east. This alternative is not recommended.

9.2 CULVERTS ONLY ALTERNATIVE

If only box culverts are used to convey the wash flows beneath Northern Avenue, the sizing increases to eight 12'x8'. Minor roadway improvements would most likely need to be completed over the culverts. Channelization downstream of the culvert would be required (see Appendix H). This option seems most feasible and has many benefits. The upstream water surface is lowered to safer levels, thereby reducing the chances of overtopping. It is still recommended to complete canal maintenance road improvements and bank protection approaching Northern Avenue. Also, culvert extension in the future would be feasible if the MCDOT desired ultimate build-out of the roadway (broken-back culvert would be ideal for future extensions). Cost sharing would be justified based on providing and all-weather access, flood control protection and protection of the canal.

9.3 CANAL ROAD IMPROVEMENTS

By providing a large box culvert for a wash crossing at Northern Avenue, the canal road upstream of Northern Avenue will contain the flows so they do not overtop the canal.

10. WASH BANK PROTECTION

Bank protection is needed in the Beardsley Canal Wash to reduce erosion. Protection would be needed between Olive Avenue and Cholla Wash if clearing the channel was a desired alternative for increasing the capacity of Beardsley Canal Wash and reducing the diversion flows. The second reach lies between Cholla Wash and Northern Avenue where the high velocity and volume of flow from Cholla Wash erode the west bank of the wash. Lastly, FRS#3 channel velocities, south of Northern Avenue, must be evaluated and bank protection provided where needed.

10.1 OLIVE AVENUE TO CHOLLA WASH

If the channel were cleared, this reach would need to be protected with a versatile bank lining that would encourage vegetative growth after construction. This report recommends gabion lining as diagramed in the typical section (see Appendix #). A portion of this reach will be protected regardless when the canal maintenance road is raised to provide protection from overtopping at Cholla Wash.

10.2 CHOLLA WASH TO NORTHERN AVENUE

Gabion lining is recommended for this reach also. Buried concrete is one concept previously discussed, this is not recommended due to erosion of the covering soil, protection from undermining or piping and aesthetics.

10.3 NORTHERN AVENUE TO FRS #3

See Section 10.2

11. FRS #3 CHANNEL

11.1 FLOW VELOCITIES

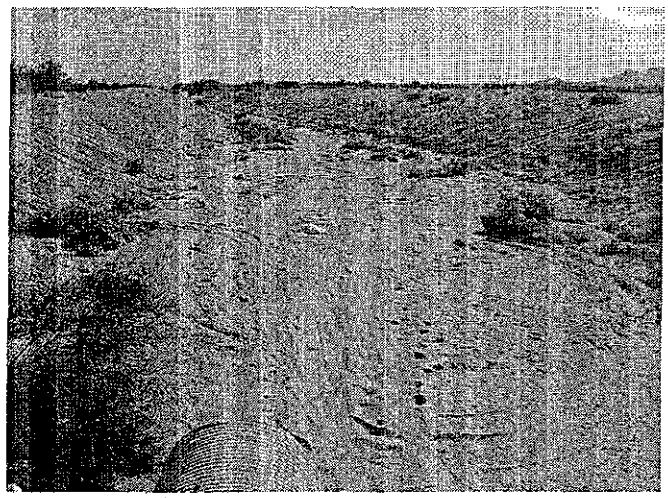
Flow velocities in the FRS#3 channel, south of Northern Avenue, range from 5 fps to over 14 fps near the FRS#3 structure. These velocities are high because the flow rates are now much higher than that previously modeled. The flow rates are high because the project prevents breakouts at Olive Avenue, at Cholla Wash and at Northern Avenue thereby routing all the flows to the FRS#3 structure via this channel.

11.2 BANK PROTECTION

Bank protection is recommended for the FRS #3 channel because of high velocities. Either gabion mattresses or soil cement can be used for bank protection. Keyed-in mattress gabion lining is recommended for this reach, as soil cement requires toe down depths that would increase cost dramatically.

The gabion lining would extend from two feet above the 100-year water surface down to the channel toe and then across the bottom of the channel for 15 to 18 feet. Providing a gabion mattress at the toe would allow for any scour and the flexible lining would conform to the scour conditions along the reach, thereby minimizing maintenance and reconstruction. Bank protection is most likely needed on both sides of this channel from Northern Avenue downstream.

Figure 7- FRS #3 Channel with Northern-Wash intersection CMP outlet



12. COST ESTIMATE SUMMARY

The cost of each alternative or improvement is noted in the table below. An explanation of the costs is summarized in the improvement section below. Complete cost estimation tables can be found in Appendix I. It should be noted that the estimates given in this section are rough and should not be exclusively used in budgeting the project.

Table 3 - Cost Summery per Alternative

North Inlet Channel Alternatives

NIC Diversion Structure at Olive Avenue	Cost
Crossing at Olive/Canal Intersection (Short Crossing)	$449,067
Crossing East of Olive/Canal Intersection (Long Crossing)	$449,850
Two Culverts Perp: To Olive and Canal (Two Crossings)	$1,188,403
Crossing at Olive/Canal Intersection (Medium Crossing)	$434,308

NIC Diversion Structure at Northern Avenue	Cost
Crossing at Northern/Canal Intersection (Short Crossing)	$362,117
Crossing East of Northern/Canal Intersection (Long Crossing)	$333,482
Two Crossings at Northern and Canal (Double Crossing)	$620,548

Beardsley Wash Alternatives

Olive Avenue to Cholla Wash	Cost
Cleared Beardsley Wash, 1200 cfs Diversion (including NIC construction cost)	$4,012,306
Existing Beardsley Wash, 1600 cfs Diversion (including NIC construction cost)	$3,887,897

Cholla Wash to Northern Avenue	Cost
Culvert Crossing at Northern Avenue	$173,265
Maintenace Road Build-Up, includes Cholla Wash confluence protection (Gabion)	$619,667

Northern Avenue to FRS #3	Cost
Lining East Bank (12" Gabion)	$1,641,241
Lining Both Banks (12" Gabion)	$2,942,089

12.1 FLOW SPLIT (CLEARED VS. EXISTING WASH)

Clearing the Beardsley Canal Wash only reduced the diversion flow by 200 cfs. The diversion flow reduction of 200 cfs reduced the NIC width by 20 feet, which therefore reduced the right-of-way acquisition by approximately 2.4 acres, or 11%. The reduction of NIC width also reduced the materials needed for the drop structures, but not enough to offset the cost of bank protection needed along Beardsley Canal Wash after it has been cleared.

12.2 OLIVE AVENUE DIVERSION STRUCTURE

The alternatives described for the Olive Avenue diversion structure were chosen to consider whether replacing canal structures or constructing longer culverts was more cost effective. As seen in the table above, the cost of multiple culverts for the crossing, especially the concrete channel

needed between the culverts to produce a 90-degree turn in the waterway, increased costs dramatically. All of the other alternatives produced similar costs, proving that culvert construction cost, per linear foot, and canal structure replacement balance out. Therefore the crossing should be determined on ease of implementation and maintenance.

12.3 Northern Avenue Diversion Structure

Again in this diversion crossing, it is shown that the double culvert design, including concrete channel between the culverts, is not cost effective. The short and long crossings are similar in cost and should be evaluated on ease of implementation and maintenance.

12.4 Drop Structures

A cost estimate spreadsheet on the alternatives for drop structures is located in Appendix I. The North Inlet Channel construction costs were completed using the cheapest vertical drop structure as calculated in the drop structure spreadsheet. The 1200 cfs NIC was estimated using the Vertical Gabions Drop Structure and the 1600 cfs NIC was estimated using the Vertical Exposed Concrete Drop Structure. The vertical drop structure was used because the cost of a constructing sloping drop structure was far greater than that of a vertical drop.

12.5 Northern Avenue Wash Crossing

The dip-crossing alternative mentioned in the Northern Avenue Wash Crossing section was not considered a viable option, therefore it was not cost estimated. This concludes that the culvert only crossing is the only viable design. The cost of this alternative is noted above. A more detailed cost estimate can be found in Appendix I.

12.6 Wash Bank Protection and Maintenance Road Build-Up

Bank protection along the east bank of the Beardsley Canal Wash was considered only when using Gabion baskets and mattresses. The cost quoted above reflects a gabion wall stretching from Cholla Wash to Northern Avenue providing the dual function of building-up the existing canal maintenance road and providing bank protection. A more complete cost estimate can be found in Appendix I.

12.7 FRS #3 Channel

The velocities experienced in the FRS channel enforce the need for bank protection. Gabion baskets and mattresses provide an economical solution. The bank protection costs noted above include the cost of excavating the channel to ensure that it meets the capacity required to contain the NIC flow and the Beardsley Canal Wash flow. The cost estimate for the bank protection, using both 12-inch and 9-inch gabion mattresses, Beardsley Canal Wash from Northern Avenue to FRS#3 can be found in Appendix I.

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12.5 Northern Avenue Wash Crossing

The dip-crossing alternative mentioned in the Northern Avenue Wash Crossing section was not considered a viable option, therefore it was not cost estimated. This concludes that the culvert only crossing is the only viable design. The cost of this alternative is noted above. A more detailed cost estimate can be found in Appendix I.

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13. RECOMMENDATION

Based on the results of our Value Engineering (VE) session Held on November 9th and 10th, our recommendations for this project include:

Flow Split

The first recommendation is that the existing Beardsley Canal Wash should not be cleared to reduce diverted flows. Therefore 1600 cfs will be the amount of diverted flow. The clearing of the 60-foot right-of-way poses 404 permitting problems, aesthetic dilemmas with regards to the SRE development on the west side of the wash, possible scour issues and a higher concentration of cost.

North Inlet Channel

It was concluded that sloping buried concrete drop structures provided an aesthetic and cost efficient option. The drop structures should contain a slope of 20:1 or less to allow for the possibility for pedestrian and equestrian trails throughout the channel.

Olive Avenue Diversion Structure

The long crossing was chosen for the diversion structure at Olive Avenue. This crossing will not remove any canal structures therefore it will reduce the cost of canal rebuilding and increase the possibility of completing the canal reconstruction within the dry out period.

Northern Avenue Diversion Structure

The long crossing at Northern Avenue was also chosen because it missed canal structures. The placement of this structure must not inhibit the culverts to be placed at the Northern Avenue wash crossing and it must be noted that the structures (the diversion structure and the wash crossing) should not be connected at their southern ends.

Northern Avenue Wash Crossing

The wash crossing is to use culverts only, no dip. This will provide a safe all weather access for property on the west side of the canal, where Northern Avenue is the only access. The canal maintenance road build-up between Cholla Wash and Northern Avenue was abandoned. The raising of the maintenance road at Northern Avenue to prevent breakouts is not recommended. Providing a larger culvert at the Northern Avenue-Beardsley Wash crossing as well as a drop inlet will prevent the breakouts.

Only the Cholla Wash confluence will have bank protection along the east side of the Beardsley Canal Wash. This will ensure that the Cholla Wash flow, which hits the bank almost perpendicularly, does not erode the canal maintenance road any further. The bank will be protected using soil cement.

FRS#3 Channel

The FRS#3 Channel contains high enough velocities that the east bank must be protected. Using soil cement instead of gabion mattresses may reduce the cost of bank protection. Channelization immediately downstream of Northern Avenue was determined necessary to ensure that the diversion structure at Northern Avenue does not become outlet controlled.

APPENDIX A – HYDROLOGY

Included in Appendix A

- URS ADMP HEC-1 Model obtained flows for:
  - Waterfall Wash Confluence
  - Beardsley Canal Wash
  - Cholla Wash

KIRKHAM MICHAEL
CONSULTING ENGINEERS

Job Number

Sheet 1 of

Project NORTH INLET CHANNEL Date 8/25/04

Subject PEAK DISCHARGES FROM URS ADMP HEC-1 MODELS ALONG PROJECT CORRIDOR Designed JKK Checked

L303M1L

AT OLIVE (CP3): 2655 cfs ← USE THIS NUMBER AT OLIVE AVE.

DIVERSION AT OLIVE (DI189): 548 cfs ← OUR NUMBER NEEDS TO BE HERE
(BREAKOUT)

BEARDSLEY CANAL WASH (RCP3): 2038 cfs ← THIS NUMBER WILL CHANGE

CHOLLA WASH (I1CP10): 4868 cfs ← PEAK Q BEFORE COMBINE WITH RCP3

AT NORTHERN AVE (CP10): 6522 cfs ← PEAK Q AT NORTHERN AVE BEFORE BREAKOUT

DIVERSION 1 AT NORTHERN (1DI188): 958 cfs ← FROM URS FLOODPLAIN STUDY BY MIKE R. & BOB D. ON 2-14-02

DIVERSION 2 AT NORTHERN (2DI88): 1596 cfs ←

FLOW IN CHANNEL FROM NORTHERN TO FRS#3 (RCP10): 3822 cfs ← ROUTING AFTER DIVERSIONS AT NORTHERN

FLOW AT FRS#3 (CP12): 4459 cfs ← COMBINED FLOW AT NORTHERN END OF FRS#3

KIRKHAM MICHAEL
CONSULTING ENGINEERS

Job Number _____

Sheet 1 of _____

Project NORTH INLET CHANNEL Date ~~8/25/04~~ 9/04

Subject HEC-1 CHECK PEAK DISCHARGES FROM URS ADMP HEC-1 MODELS ALONG PROJECT CORRIDOR Designed JKK Checked _____

L303M1L

HEC-1 CHECK (DIVERSION WAS 'UPPED' AT OLIVE TO SIMULATE DIVERSION TO NIC — COMBINES COMPARED W/ SUBTRACTION METHOD)

TP AT OLIVE (CP3): 2655 cfs ← USE THIS NUMBER AT OLIVE AVE. JKK

1587 1488

DIVERSION AT OLIVE (DI189): 548 cfs ← OUR NUMBER NEEDS TO BE HERE
(BREAKOUT)

1001 1098

3.08 BEARDSLEY CANAL WASH (RCP3): 2038 cfs ← THIS NUMBER WILL CHANGE

2.75 CHOLLA WASH (I1CP10): 4868 cfs ← PEAK Q BEFORE COMBINE WITH RCP3

5540 5613

20min AT NORTHERN AVE (CP10): 6522 cfs ← PEAK Q AT NORTHERN AVE BEFORE BREAKOUT

DIVERSION 1 AT NORTHERN (1DI188): 958 cfs ← FROM URS FLOODPLAIN STUDY BY MIKE R. & BOB D. ON 2-14-02

DIVERSION 2 AT NORTHERN (2DI88): 1596 cfs ←

2.83 FLOW IN CHANNEL FROM NORTHERN TO FRS#3 (RCP10): 3822 cfs ← ROUTING AFTER DIVERSIONS AT NORTHERN

12.83 FLOW AT FRS#3 (CP12): 4459 cfs ← COMBINED FLOW AT NORTHERN END OF FRS#3

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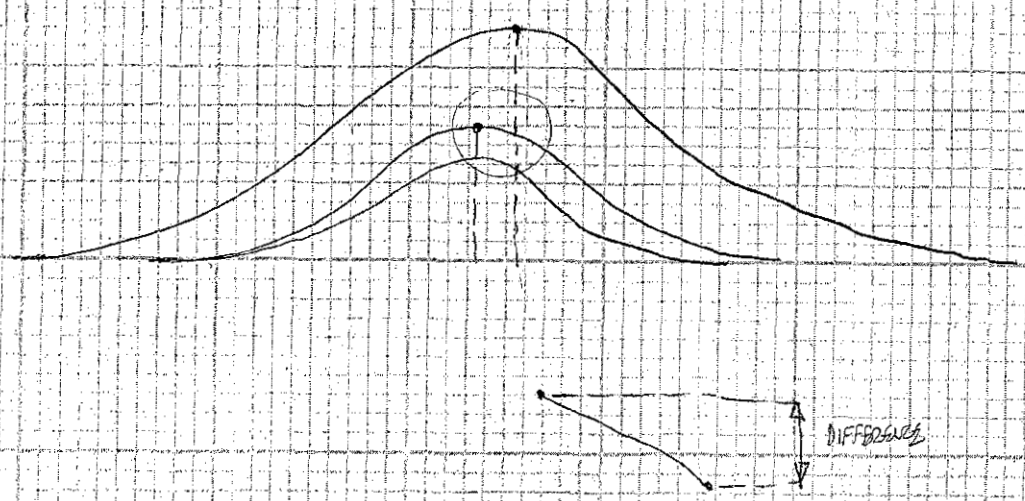


KIRKHAM MICHAEL
CONSULTING ENGINEERS

Job Number

Sheet of

Project NORTH INLET CHANNEL Date 9/13/04

Subject MODELING DISCHARGES BASED ON URS ADMP HEC-1 (L303M1L) Designed JER Checked

PROPOSED PEAK Q INPUTS FOR MODELING PURPOSES BASED ON URS ADMP HEC-1 (L303M1L)

JER.

AT OLIVE 2655 cfs

DIVERSION 1500 cfs

OLIVE TO CHOLLA 1155 cfs

CHOLLA +4868 cfs
6023 -(384)

CHOLLA TO NORTHERN 5639 5755

NORTHERN TO 4000' SOUTH NORTHERN 5639 + 1500 = 7139

SUBBASIN 12 +1214
8353 -(577)

4000' S. OF NORTHERN TO FRS#3 7776

IN HEC-1 MODEL CHOLLA/BEARDSLEY SUM AS FOLLOWS:

2038 + 4868 = 6906
(BEARDSLEY) (CHOLLA) (DIRECT SUMMATION)

6522
(HEC-1 SUMMATION)

384 LESS

IN HEC-1 MODEL BASIN 12/BEARDSLEY SUM AS FOLLOWS:

1214 + 3822 = 5036 (DIRECT SUM)
(SUBBASIN 12) (FLOW FROM NORTHERN)

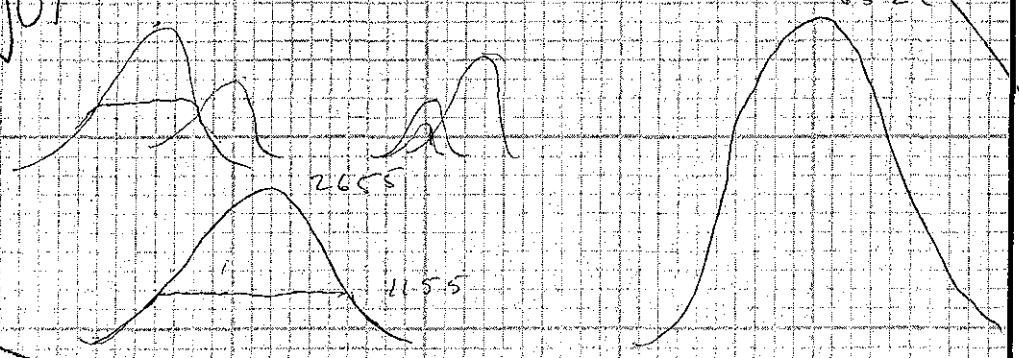
4459 (HEC-1 SUM)

577 LESS

.72 x 1155 = 889 + 4868 = 5755

20 38 = .72
2655

NOT USED



Recommend rounding to nearest hundred.

KIRKHAM MICHAEL
CONSULTING ENGINEERS

Job Number _____

Sheet _____ of _____

Project NORTH INLET CHANNEL Date 9/13/04

Subject MODELING DISCHARGES BASED ON URS ADMP HEC-1 (L303M1L) Designed JAR Checked _____

PROPOSED PEAK Q INPUTS FOR MODELING PURPOSES BASED ON URS ADMP HEC-1 (L303M1L)

AT OLIVE 2655 cfs

DIVERSION 1600 cfs

OLIVE TO CHOLLA 1055 cfs

CHOLLA +4868 cfs
5923 − (384)

CHOLLA TO NORTHERN 5539

NORTHERN TO 1600' SOUTH NORTHERN 5539 + 1600 = 7139

SUBBASIN 12 +1214
8353 − (577)

1600' ~~4000'~~ S. OF NORTHERN TO FRS#3 7776

CORRECT ☒

THIS IS AN ACTUAL DISTANCE BASED ON AERIAL PHOTO (NOT A ROUTING DISTANCE) TO NEXT WASH SOUTH OF NORTHERN (Q IS FOR TOTAL AT SUB-BASIN 12, BUT SHOULD BE APPLIED TO CHANNEL 1600' S. OF NORTHERN) WHICH ENDS AT THE N. END OF FRS#3

IN HEC-1 MODEL CHOLLA/BEARDSLEY SUM AS FOLLOWS:

2038 + 4868 = 6906
(BEARDSLEY) (CHOLLA) (DIRECT SUMMATION)

6522
(HEC-1 SUMMATION)

384 LESS

IN HEC-1 MODEL BASIN 12/BEARDSLEY SUM AS FOLLOWS:

1214 + 3822 = 5036 (DIRECT SUM)
(SUBBASIN 12) (FLOW FROM NORTHERN)

4459 (HEC-1 SUM)

577 LESS

KIRKHAM MICHAEL
CONSULTING ENGINEERS

Job Number

Sheet of

Project Date

Subject Designed Checked

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CP3 :	2689	2655	2665 (!BC2)	2699 (!BC2)
DI189 :	564	548	0	0
RCP3 :	2057	2038	2468	2494
I1CP10 :	4701	4868	4868	4698
CP10 :	6348	6522	6322 (!BC3)	6047 (!BC3)
1DI188 :	931	958	0	0
2DI188 :	1557	1596	0	0
RCP10 :	3698	3822	6426	5786 (!BC4)
CP12 :	4347	4459	6593 (!BC4)	6218

RBC3

URS ADMP File Names (HEC-1 Files)

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ID      TANKS/AGUA FRIA ADMS, Date: October 1991
ID
ID      PER DIRECTION AND BY PROVISION OF THE FCDMC, URS HAS ADDED THE
ID      PROVIDED DIVERT DATA FOR THE EXISTING DIVERSION (PREVIOUSLY
ID      TURNED OFF) AT DI189.
ID
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ID      ***334, 335A, 335, 316 TO REFLECT RELAXED RETENTION REQUIRE-***
ID      ***MENTS ADJACENT TO THE BULLARD CHANNEL S. OF I-10.        ***
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ID     * AS PER FCDMC GIS DATA - 6-27-01 *
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ID      BASINS ARE NOW OFFLINE WITH MULTIPLE BASINS LOCATED WITHIN
ID      LUKE AIR FORCE BASE CRASH ZONE AREA
ID
ID      **ADOT BASIN GEOMETRY REPRESENTS MOST RECENT 2' CONTOURS**
ID      WHITE TANKS AREA DRAINAGE MASTER STUDY *UPDATE*
ID      Original MODEL BY THE WLB Group for FCDMC AS PART OF THE WHITE
ID      TANKS/AGUA FRIA ADMS, Date: October 1991
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ID
ID   THE RESULTS OF THE FLOODPLAIN FLOW SPLIT ANALYSIS
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*    HYDROLOGIC ENGINEERING CENTER     *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
*          (916) 756-1104              *
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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1          ID     LOOP 303 CORRIDOR-WHITE TANKS AREA DRAINAGE MASTER PLAN UPDATE
   2          ID     EXISTING CONDITION HYDROLOGY MODEL 'WITHOUT PROJECTS IN PLACE'
   3          ID
   4          ID     PER DIRECTION AND BY PROVISION OF THE FCDMC, URS HAS ADDED THE
   5          ID     PROVIDED DIVERT DATA FOR THE EXISTING DIVERSION (PREVIOUSLY
   6          ID     TURNED OFF) AT DI189.
   7          ID
   8          ID     THE RESULTS OF THE FLOODPLAIN FLOW SPLIT ANALYSIS
   9          ID     AT PERRYVILLE & 83RD AVE BETWEEN GLENDALE AND BETHANY
  10          ID     HOME ROAD HAVE BEEN INCORPORATED INTO THIS MODEL
  11          ID
  12          ID
  13          ID                                        REVISED BY URS     DATE: 01-14-04
  14          ID                                                           FILE: L303M1L.DAT
  15          ID        NOTES:
  16          ID        1. THIS HEC-1 MODEL CONTAINS THE FOLLOWING SUPER BASINS: WHITE TANKS 3,
  17          ID           2A, 2B, 2C, 2D, 2E, 2F, 2G, 2H, 2I, 2J, 2K, 2 & 3, 4 THRU 26.
  18          ID        2. REVISED TO REFLECT UPDATED SOILS MAPS AND NEW DEVELOPMENT.
  19          ID        3. AVERAGE XKSAT VALUES FOR EACH SUBBASIN WAS RECEIVED FROM FCDMC
  20          ID           GIS DATA AND THEN ADJUSTED FOR VEGETATION, OR LEFT AS ORIGINALLY IN
  21          ID           THE WLB MODEL.
  22          ID        4. FOR NEW DEVELOPMENTS ONLY 80% OF REPORTED PROVIDED RETENTION
  23          ID           WAS INCLUDED IN THIS MODEL (AS A CONSERVATIVE ESTIMATE). RETENTION
  24          ID           CAPACITIES WERE ESTIMATED BY EEC FOR DEVELOPMENTS WITH NO
  25          ID           DRAINAGE REPORTS.
  26          ID        5. REVISED DRAINAGE BOUNDARIES BASED UPON FIELD INSPECTION OF SUN CITY.
  27          ID           GRAND.  COMBINED SEVERAL BASINS TOGETHER TO MAKE NEW BASINS 114 &115.
  28          ID           ALSO REROUTED SUBBASINS 100A, 101, 102A AND 106 TO THE SOUTH TO 113A.
  29          ID        6. CHANNEL ROUTE ALONG REEMS ROAD UPDATED TO REFLECT NEW CONSTRUCTION.
  30          ID        7. REVISED SCS TYPE II RAINFALL DISTRIBUTION FOR THE 24-HOUR GENERAL
  31          ID           STORM.
  32          ID        8. REVISED RAINFALL DEPTH-AREA REDUCTION FACTORS.
  33          ID        9. PSIF WERE ADJUSTED BASED ON THE VALUES OF XKSAT AND WERE EDITED INTO
  34          ID           THE DATA FILE BY THE FCDMC.
  35          ID       10. AVERAGE XKSAT VALUES FOR SUBBASINS WITH BORROW PITS (WHITE TANKS
  36          ID           AREAS #3 & #4) WERE ESTIMATED BY EEC.
              *DIAGRAM
  37          IT       5                    600
  38          IO       5
  39          IN      15
  40          JD    4.03    .001
  41          PC    .000    .002    .005    .008    .011    .014    .017    .020    .023    .026
  42          PC    .029    .032    .035    .038    .041    .044    .048    .052    .056    .060
  43          PC    .064    .068    .072    .076    .080    .085    .090    .095    .100    .105
  44          PC    .110    .115    .120    .126    .133    .140    .147    .155    .163    .172
  45          PC    .181    .191    .203    .218    .236    .257    .283    .387    .663    .707
  46          PC    .735    .758    .776    .791    .804    .815    .825    .834    .842    .849
  47          PC    .856    .863    .869    .875    .881    .887    .893    .898    .903    .908
  48          PC    .913    .918    .922    .926    .930    .934    .938    .942    .946    .950
  49          PC    .953    .956    .959    .962    .965    .968    .971    .974    .977    .980
  50          PC    .983    .986    .989    .992    .995    .998    1.00   1.000   1.000   1.000
  51          JD    3.79      10
  52          JD    3.51      50
  53          JD    3.39     100
  54          JD    3.29     200
              * ***********************************************************************
              * **************THE FOLLOWING SECTION IS WHITE TANKS 3**********************
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WARNING --- ROUTED OUTFLOW (    874.) IS GREATER THAN MAXIMUM OUTFLOW (    860.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (    862.) IS GREATER THAN MAXIMUM OUTFLOW (    860.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (    874.) IS GREATER THAN MAXIMUM OUTFLOW (    860.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (    880.) IS GREATER THAN MAXIMUM OUTFLOW (    860.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (    881.) IS GREATER THAN MAXIMUM OUTFLOW (    860.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (    878.) IS GREATER THAN MAXIMUM OUTFLOW (    860.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (    870.) IS GREATER THAN MAXIMUM OUTFLOW (    860.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (    869.) IS GREATER THAN MAXIMUM OUTFLOW (    860.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (    874.) IS GREATER THAN MAXIMUM OUTFLOW (    860.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (    874.) IS GREATER THAN MAXIMUM OUTFLOW (    860.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (    869.) IS GREATER THAN MAXIMUM OUTFLOW (    860.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (    864.) IS GREATER THAN MAXIMUM OUTFLOW (    860.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (    868.) IS GREATER THAN MAXIMUM OUTFLOW (    860.) IN STORAGE-OUTFLOW TABLE
WARNING --- ROUTED OUTFLOW (    866.) IS GREATER THAN MAXIMUM OUTFLOW (    860.) IN STORAGE-OUTFLOW TABLE
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RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	1	1573.	12.50	222.	61.	30.	1.94		
+	ROUTED TO	RCP1	1386.	12.83	222.	61.	30.	1.94		
+	HYDROGRAPH AT	2	1339.	12.75	237.	66.	32.	1.82		
+	2 COMBINED AT	CP2	2657.	12.75	456.	126.	61.	3.76		
+	ROUTED TO	RCP2	2458.	12.92	455.	126.	61.	3.76		
+	HYDROGRAPH AT	3A	313.	12.33	31.	8.	4.	.29		
+	ROUTED TO	RCP3A	250.	12.50	31.	8.	4.	.29		
+	HYDROGRAPH AT	3	863.	12.33	89.	22.	11.	.81		
+	2 COMBINED AT	I1CP3	1048.	12.42	119.	30.	14.	1.10		
+	2 COMBINED AT	CP3	2655.	12.92	571.	155.	75.	4.86		
+	DIVERSION TO	DI189	548.	12.92	54.	14.	7.	4.86		
+	HYDROGRAPH AT	D3	2107.	12.92	517.	141.	68.	4.86		
+	ROUTED TO	RCP3	2038.	13.08	517.	141.	68.	4.86		
+	HYDROGRAPH AT	4	396.	12.25	36.	10.	5.	.30		
+	HYDROGRAPH AT	5	927.	12.25	86.	23.	11.	.72		
+	2 COMBINED AT	CP5	1315.	12.25	121.	33.	16.	1.02		
+	ROUTED TO	RCP5	1312.	12.25	121.	33.	16.	1.02		
+	HYDROGRAPH AT	6	746.	12.08	52.	14.	7.	.45		
+	2 COMBINED AT	CP6	1854.	12.17	172.	47.	23.	1.47		
	ROUTED TO									

+	RCP6	1784.	12.17	172.	47.	23.	1.47
+ HYDROGRAPH AT	7	494.	12.08	36.	10.	5.	.31
+ 2 COMBINED AT	CP7	2245.	12.17	206.	57.	27.	1.78
+ ROUTED TO	RCP7	1947.	12.33	206.	57.	27.	1.78
+ HYDROGRAPH AT	9	1402.	12.33	161.	44.	21.	1.40
+ 2 COMBINED AT	I1CP9	3324.	12.33	364.	100.	48.	3.18
+ HYDROGRAPH AT	8	890.	12.33	93.	26.	12.	.81
+ 2 COMBINED AT	CP9	4190.	12.33	455.	125.	60.	3.99
+ ROUTED TO	RCP9	3543.	12.75	454.	125.	60.	3.99
+ HYDROGRAPH AT	10	1357.	12.75	237.	62.	30.	2.02
+ 2 COMBINED AT	I1CP10	4868.	12.75	686.	185.	89.	6.01
+ 2 COMBINED AT	CP10	6522.	12.75	1189.	323.	156.	10.87
+ DIVERSION TO	1DI188	958.	12.75	174.	47.	23.	10.87
+ HYDROGRAPH AT	1D10	5564.	12.75	1014.	276.	133.	10.87
+ DIVERSION TO	2DI188	1596.	12.75	215.	54.	26.	10.87
+ HYDROGRAPH AT	2D10	3968.	12.75	799.	222.	107.	10.87
+ ROUTED TO	RCP10	3822.	12.83	799.	222.	107.	10.87
+ HYDROGRAPH AT	12	1214.	12.50	167.	43.	21.	1.38
+ 2 COMBINED AT	CP12	4459.	12.83	953.	261.	126.	12.25
+ ROUTED TO	RCP12	4085.	13.00	952.	261.	126.	12.25
+ HYDROGRAPH AT	11	1559.	12.42	202.	54.	26.	1.56
+ ROUTED TO	RCP11	1268.	12.75	201.	54.	26.	1.56
+ HYDROGRAPH AT	13	1223.	12.42	145.	36.	17.	1.30
+ 2 COMBINED AT	CP13	2062.	12.58	344.	89.	43.	2.86
+ ROUTED TO	RCP13	2035.	12.67	344.	89.	43.	2.86
+ HYDROGRAPH AT	14	1548.	12.33	173.	47.	23.	1.47
+ ROUTED TO	RCP14	1392.	12.58	173.	47.	23.	1.47
+ HYDROGRAPH AT	15	1272.	12.42	149.	40.	19.	1.26
+ 2 COMBINED AT	I1CP15	2485.	12.50	319.	86.	42.	2.73
+ HYDROGRAPH AT	16	1206.	12.42	149.	41.	20.	1.13
+ ROUTED TO	SR16	0.	.00	0.	0.	0.	1.13
+ 2 COMBINED AT	CP15	2485.	12.50	319.	86.	42.	3.90

+	ROUTED TO	RCP15	2108.	12.75	318.	86.	41.	3.90
+	HYDROGRAPH AT	17	1036.	12.33	108.	27.	13.	1.07
+	2 COMBINED AT	I1CP17	2480.	12.67	423.	112.	54.	4.97
+	2 COMBINED AT	CP17	4474.	12.67	761.	200.	96.	7.83
+	ROUTED TO	RCP17	4407.	12.75	761.	200.	96.	7.83
+	HYDROGRAPH AT	WT3	383.	12.50	50.	13.	6.	.44
+	2 COMBINED AT	I1CWT3	4657.	12.75	809.	212.	102.	8.27
+	2 COMBINED AT	CPWT3	7618.	12.92	1684.	453.	218.	20.52
+	ROUTED TO	SRWT3	0.	.00	0.	0.	0.	20.52
+	HYDROGRAPH AT	116	872.	12.33	111.	33.	16.	.66
+	DIVERSION TO	116RET	872.	12.33	93.	25.	12.	.66
+	HYDROGRAPH AT	116OUT	233.	12.67	27.	8.	4.	.66
+	ROUTED TO	R116	110.	13.17	26.	8.	4.	.66
+	HYDROGRAPH AT	117	920.	12.58	158.	47.	23.	.92
+	DIVERSION TO	117RET	920.	12.58	130.	35.	17.	.92
+	HYDROGRAPH AT	117OUT	364.	13.08	41.	12.	6.	.92
+	2 COMBINED AT	CP117	454.	13.08	65.	20.	10.	1.65
+	ROUTED TO	R117	248.	13.67	62.	20.	10.	1.65
+	HYDROGRAPH AT	123	320.	13.00	69.	17.	8.	.44
+	DIVERSION TO	DI134	0.	.00	0.	0.	0.	.44
+	HYDROGRAPH AT	D123	320.	13.00	69.	17.	8.	.44
+	ROUTED TO	R123	293.	13.33	69.	17.	8.	.44
+	HYDROGRAPH AT	124	331.	13.33	89.	22.	11.	.57
+	2 COMBINED AT	CP124	618.	13.33	156.	39.	19.	1.65
+	DIVERSION TO	DI136	296.	13.33	81.	20.	10.	1.65
+	HYDROGRAPH AT	1D124	323.	13.33	76.	19.	9.	1.65
+	DIVERSION TO	DI135	131.	13.33	23.	6.	3.	1.65
+	HYDROGRAPH AT	2D124	191.	13.33	52.	13.	6.	1.65
+	ROUTED TO	R124	178.	13.83	52.	13.	6.	1.65
+	HYDROGRAPH AT	125	934.	12.50	118.	29.	14.	1.00
+	2 COMBINED AT	1I125	930.	12.50	169.	42.	20.	2.01
+	2 COMBINED AT	CP125	924.	12.50	222.	61.	29.	3.66

+	DIVERSION TO	DI137	308.	12.50	74.	21.	10.	3.66
+	HYDROGRAPH AT	1D125	616.	12.50	148.	41.	20.	3.66
+	DIVERSION TO	DI138	308.	12.50	74.	21.	10.	3.66
+	HYDROGRAPH AT	2D125	309.	12.50	74.	20.	10.	3.66
+	ROUTED TO	R125	273.	12.75	73.	20.	10.	3.66
+	HYDROGRAPH AT	118	326.	12.08	42.	14.	7.	.16
+	DIVERSION TO	118RET	321.	12.08	25.	7.	4.	.16
+	HYDROGRAPH AT	118OUT	253.	12.17	23.	7.	3.	.16
+	ROUTED TO	R118	72.	13.83	21.	7.	3.	.16
+	HYDROGRAPH AT	126	1038.	12.50	159.	47.	23.	.95
+	DIVERSION TO	126RET	1038.	12.50	121.	32.	15.	.95
+	HYDROGRAPH AT	126OUT	522.	12.83	51.	15.	7.	.95
+	2 COMBINED AT	1I126	522.	12.83	70.	21.	10.	1.11
+	2 COMBINED AT	CP126	776.	12.83	139.	41.	20.	4.75
+	DIVERSION TO	DI139	776.	12.83	139.	41.	20.	4.75
+	HYDROGRAPH AT	D126	0.	.00	0.	0.	0.	4.75
+	ROUTED TO	R126	0.	.00	0.	0.	0.	4.75
+	HYDROGRAPH AT	100A	173.	12.50	23.	6.	3.	.18
+	ROUTED TO	R100A	145.	13.08	23.	6.	3.	.18
+	HYDROGRAPH AT	102A	462.	12.50	60.	15.	7.	.51
+	2 COMBINED AT	1I102A	462.	12.50	83.	21.	10.	.69
+	HYDROGRAPH AT	101	215.	12.25	20.	5.	2.	.16
+	ROUTED TO	R101	211.	12.25	20.	5.	2.	.16
+	2 COMBINED AT	CP102A	597.	12.42	102.	25.	12.	.75
+	DIVERSION TO	102ART	597.	12.42	61.	15.	7.	.75
+	HYDROGRAPH AT	102AOT	372.	12.83	41.	10.	5.	.75
+	ROUTED TO	R102A	265.	13.42	41.	10.	5.	.75
+	HYDROGRAPH AT	106	712.	12.50	96.	24.	11.	.77
+	DIVERSION TO	106RET	712.	12.50	66.	17.	8.	.77
+	HYDROGRAPH AT	106OUT	413.	12.83	29.	7.	4.	.77
+	2 COMBINED AT	CP106	409.	12.83	68.	17.	8.	1.70
	ROUTED TO							

+	R106	281.	13.83	67.	17.	8.	1.70
+ HYDROGRAPH AT	105	306.	12.25	27.	7.	3.	.21
+ ROUTED TO	R105	264.	12.42	27.	7.	3.	.21
+ HYDROGRAPH AT	112	846.	12.25	99.	29.	14.	.63
+ DIVERSION TO	112RET	846.	12.25	83.	22.	11.	.63
+ HYDROGRAPH AT	112OUT	241.	12.67	23.	7.	3.	.63
+ 2 COMBINED AT	CP112	393.	12.67	48.	13.	6.	.82
+ DIVERSION TO	DI120	131.	12.67	16.	4.	2.	.82
+ HYDROGRAPH AT	1D112	263.	12.67	32.	9.	4.	.82
+ DIVERSION TO	1D121A	131.	12.67	16.	4.	2.	.82
+ HYDROGRAPH AT	2D112	132.	12.67	16.	4.	2.	.82
+ ROUTED TO	R112	77.	13.17	16.	4.	2.	.82
+ HYDROGRAPH AT	113A	772.	12.25	92.	27.	13.	.50
+ DIVERSION TO	113ART	489.	12.08	33.	9.	5.	.50
+ HYDROGRAPH AT	113AOT	772.	12.25	67.	18.	9.	.50
+ 2 COMBINED AT	CP113A	766.	12.25	81.	22.	11.	1.34
+ DIVERSION TO	2D121A	43.	12.25	1.	0.	0.	1.34
+ HYDROGRAPH AT	D113A	723.	12.25	80.	22.	10.	1.34
+ ROUTED TO	R113A	562.	12.50	78.	22.	10.	1.34
+ HYDROGRAPH AT	114	2117.	12.75	423.	125.	60.	2.47
+ DIVERSION TO	114RET	2117.	12.75	365.	97.	47.	2.47
+ HYDROGRAPH AT	114OUT	600.	13.42	92.	28.	13.	2.47
+ 3 COMBINED AT	CP114	860.	13.50	225.	65.	31.	5.26
+ DIVERSION TO	DI122B	597.	13.50	107.	27.	13.	5.26
+ HYDROGRAPH AT	D114	263.	13.50	118.	38.	18.	5.26
+ ROUTED TO	R114	240.	14.00	116.	38.	18.	5.26
+ HYDROGRAPH AT	115	2122.	12.67	408.	121.	58.	2.40
+ DIVERSION TO	115RET	2122.	12.67	369.	99.	47.	2.40
+ HYDROGRAPH AT	115OUT	376.	13.58	71.	23.	11.	2.40
+ 2 COMBINED AT	CP115	513.	13.58	180.	60.	29.	7.59
+ ROUTED TO	R115	428.	14.08	179.	60.	29.	7.59
+ HYDROGRAPH AT	122A	587.	12.25	76.	23.	11.	.38

+	DIVERSION TO	122ART	587.	12.25	57.	15.	7.	.38
+	HYDROGRAPH AT	122AOT	274.	12.50	26.	8.	4.	.38
+	2 COMBINED AT	1I122A	442.	14.08	195.	66.	32.	8.33
+	HYDROGRAPH AT	D114	597.	13.50	107.	27.	13.	5.26
+	ROUTED TO	R114	506.	13.83	107.	27.	13.	5.26
+	HYDROGRAPH AT	122B	734.	12.25	92.	28.	14.	.51
+	DIVERSION TO	122BRT	537.	12.08	41.	12.	6.	.51
+	HYDROGRAPH AT	122BOT	734.	12.25	61.	17.	8.	.51
+	2 COMBINED AT	CP122B	719.	12.25	165.	43.	21.	5.66
+	ROUTED TO	R122B	641.	12.33	165.	43.	21.	5.66
+	2 COMBINED AT	CP122A	911.	14.00	353.	108.	52.	8.49
+	ROUTED TO	1R122A	888.	14.08	350.	108.	52.	8.49
+	ROUTED TO	2R122A	865.	14.42	344.	108.	52.	8.49
+	HYDROGRAPH AT	111	482.	12.08	45.	13.	6.	.26
+	DIVERSION TO	111RET	374.	12.00	23.	6.	3.	.26
+	HYDROGRAPH AT	111OUT	477.	12.17	25.	7.	3.	.26
+	ROUTED TO	R111	271.	12.42	25.	7.	3.	.26
+	HYDROGRAPH AT	104	218.	12.25	19.	5.	2.	.15
+	ROUTED TO	R104	79.	14.75	19.	5.	2.	.15
+	HYDROGRAPH AT	111A	870.	12.25	95.	27.	13.	.61
+	DIVERSION TO	111ART	870.	12.25	95.	27.	13.	.61
+	HYDROGRAPH AT	111AOT	1.	19.75	1.	0.	0.	.61
+	3 COMBINED AT	CP111A	271.	12.42	44.	12.	6.	.97
+	ROUTED TO	R111A	109.	13.92	40.	12.	6.	.97
+	HYDROGRAPH AT	119	544.	13.17	126.	32.	15.	.86
+	DIVERSION TO	DI128	317.	13.17	74.	18.	9.	.86
+	HYDROGRAPH AT	D119	227.	13.17	53.	13.	6.	.86
+	ROUTED TO	R119	204.	13.58	53.	13.	6.	.86
+	HYDROGRAPH AT	119A	296.	13.17	69.	17.	8.	.47
+	2 COMBINED AT	CP119A	439.	13.25	121.	30.	15.	1.26
+	DIVERSION TO	DI130	0.	.00	0.	0.	0.	1.26
+	HYDROGRAPH AT	D119A	439.	13.25	121.	30.	15.	1.26

APPENDIX B – SITE EVALUATION

Included in Appendix B

- Photographs of existing Beardsley Canal Wash
- Maricopa County Manning's Coefficient table
- Beardsley Canal cross-sections with corresponding Manning's Coefficients
- Channel degradation/system sediment balance summary table

Table 6.11
Manning's Roughness Coefficients[1]

Channel Material	Roughness Coefficient (n)		
	Minimum	Normal	Maximum
Corrugated metal	0.021	0.025	0.030
Concrete:			
Trowel finish	0.011	0.013	0.015
Float finish	0.013	0.015	0.016
Unfinished	0.014	0.017	0.020
Shotcrete, good section	0.016	0.019	0.023
Shotcrete, wavy section	0.018	0.022	0.025
Asphalt[2]	0.013	0.016	0.020
Soil cement	0.018	0.020	0.025
Constructed channels with earth or sand bottom			
Clean earth; straight	0.018	0.022	0.025
Earth with grass and weeds	0.020	0.025	0.030
Earth with trees and shrubs	0.024	0.032	0.040
Shotcrete	0.018	0.022	0.025
Soil cement	0.022	0.025	0.028
Concrete	0.017	0.020	0.024
Riprap	0.023	0.032	0.036
Natural channels with sand bottom and sides of:			
Trees and shrubs	0.025	0.035	0.045
Rock	0.024	0.032	0.040
Natural channel with rock bottom	0.040	0.060	0.090
Overbank floodplains:			
Desert brush, normal density	0.040	0.060	0.080
Dense vegetation	0.070	0.100	0.160

(1) From: Simons, Li and Associates, 1988. Adapted from Chow (1959) and Aldridge and Garret (1973).

(2) Use maximum value when cars are present.

KIRKHAM MICHAEL
CONSULTING ENGINEERS

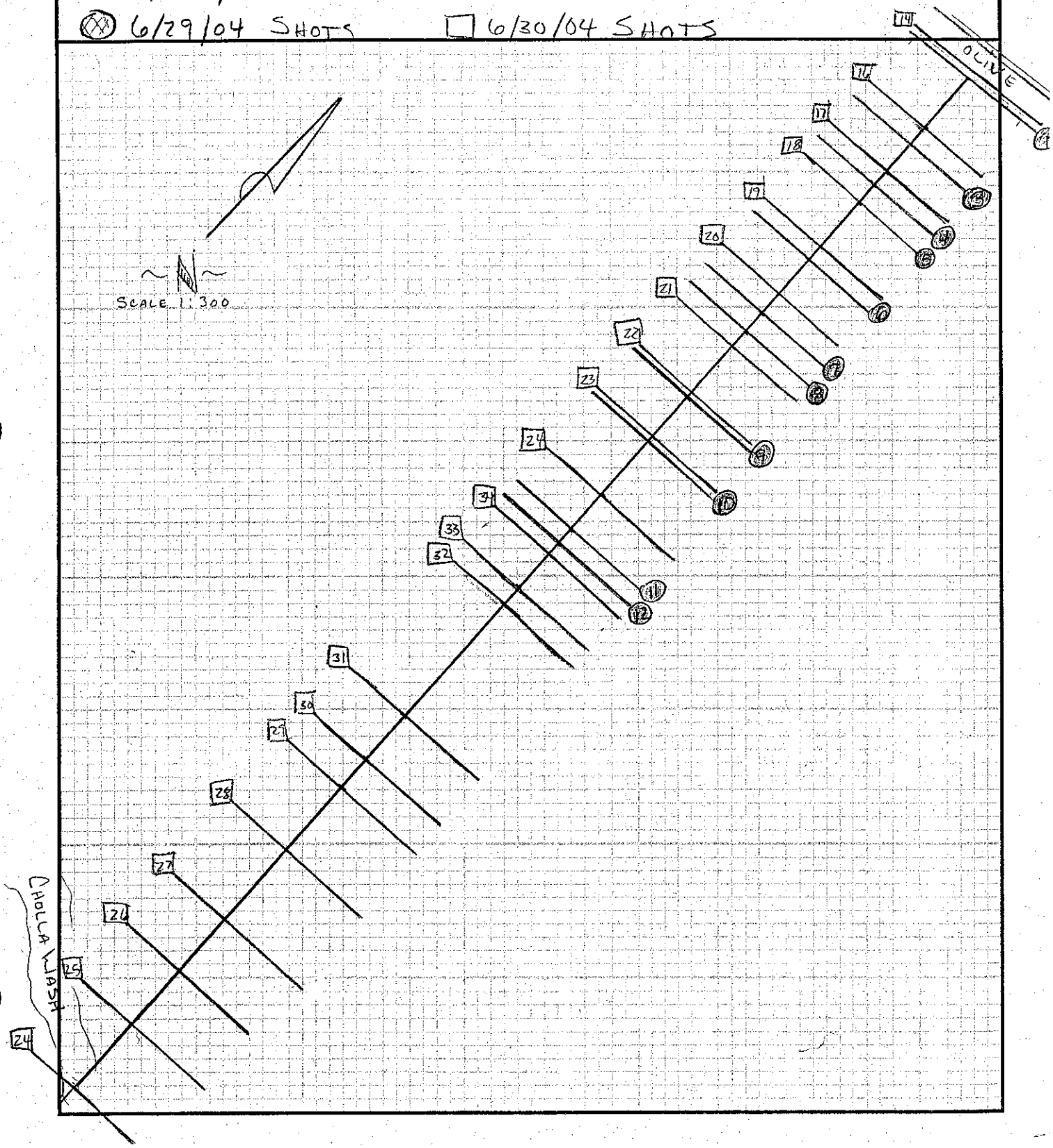
Job Number 0406915

Sheet 1 of 1

Project NORTH INLET CHANNEL Date 7/1/04

Subject WAY POINTS Designed _____ Checked _____

⊗ 6/29/04 SHOTS ☐ 6/30/04 SHOTS



KIRKHAM MICHAEL
CONSULTING ENGINEERS

Job Number 0406915

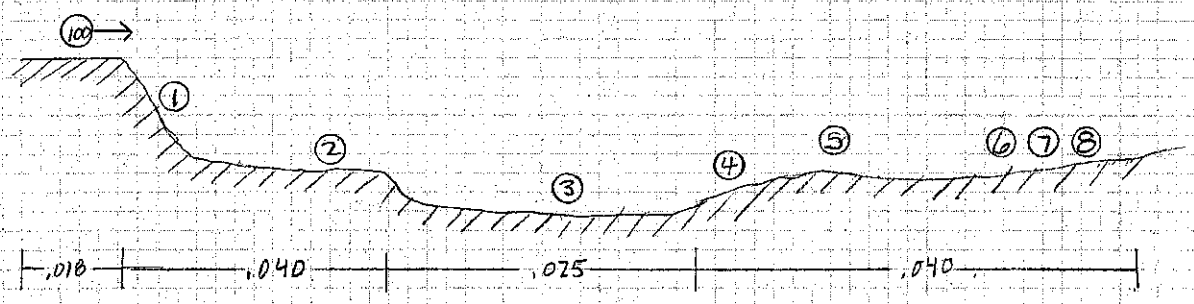
Sheet 1 of 7

Project NORTH INLET CHANNEL Date 7/2/04

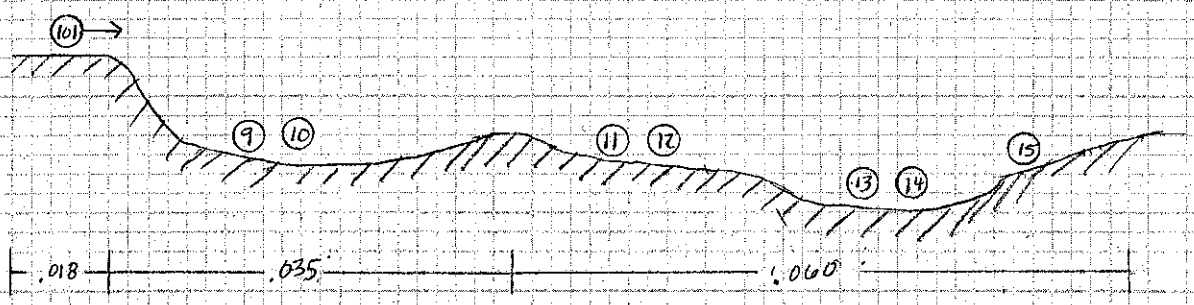
Subject X-SECTIONS W/MANNINGS & PHOTO # Designed _____ Checked _____

(#) - DENOTES PHOTO #, LOOKING DOWNSTREAM |-#-| - DENOTES n VALUE

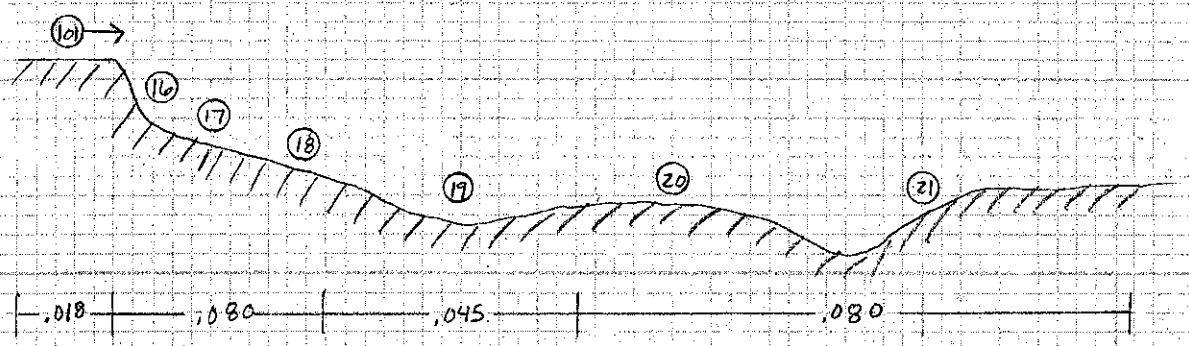
WAYPOINT 1 N-3715004 E-363497



WAYPOINT 2 N-3715028 E-363513



WAYPOINT 3 N-3714934 E-363487



KIRKHAM MICHAEL
CONSULTING ENGINEERS

Job Number 0406915

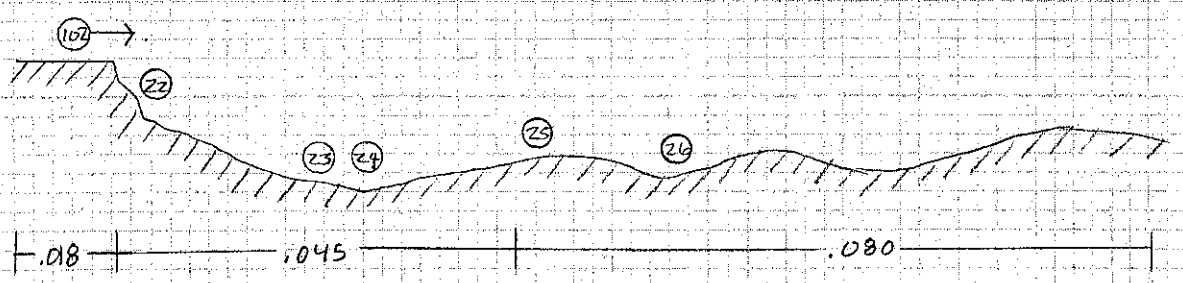
Sheet 2 of 7

Project NORTH INLET CHANNEL Date 7/6/04

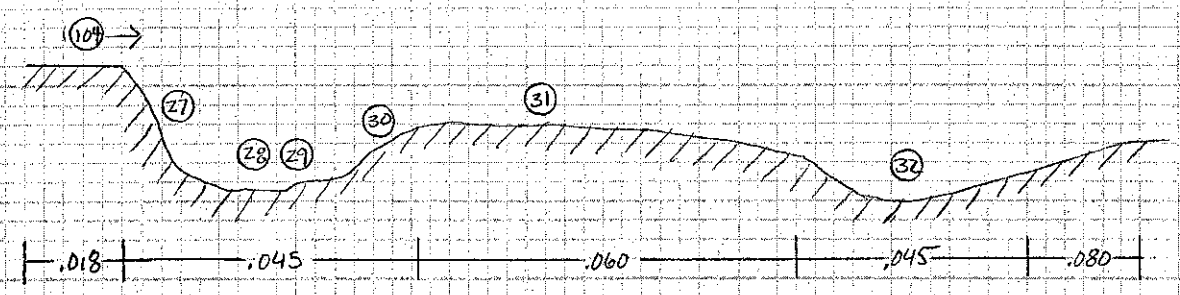
Subject X-SECTIONS / MANNINGS & PHOTO # Designed _____ Checked _____

○ - DENOTES PHOTO #, LOOKING DOWNSTREAM ⊢#⊣ - DENOTES 'n' VALUE

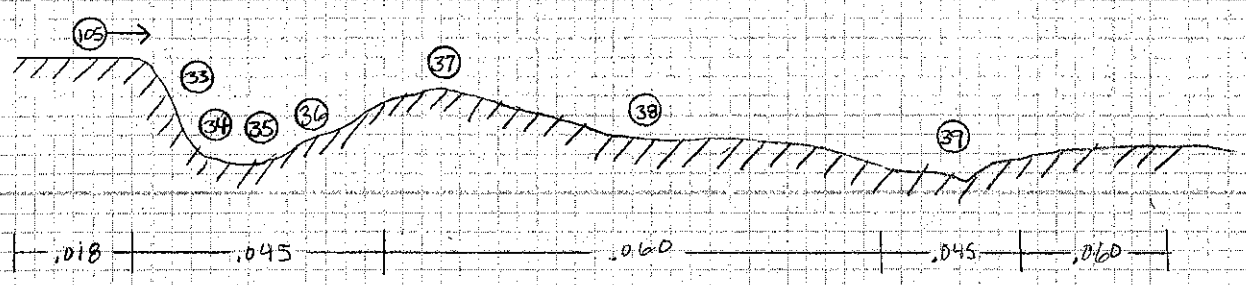
WAYPOINT 4 N-3714906 E-363519



WAYPOINT 5 N-3714886 E-363506



WAYPOINT 6 N-3714838 E-363507



KIRKHAM MICHAEL
CONSULTING ENGINEERS

Job Number 0406915

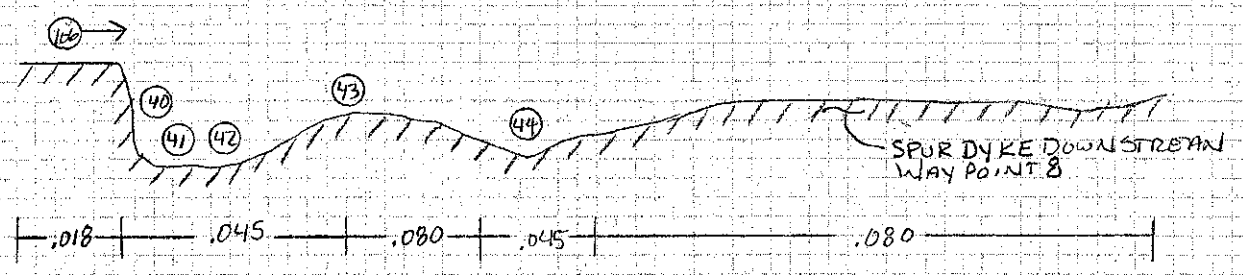
Sheet 3 of 7

Project NORTH INLET CHANNEL Date 7/6/04

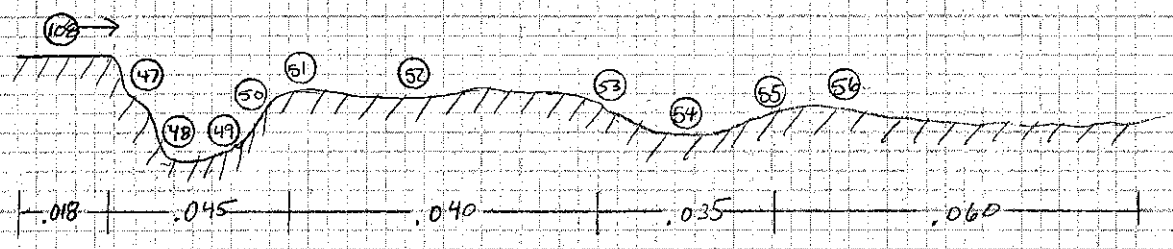
Subject X-SECTIONS/MANNINGS & PHOTO # Designed _____ Checked _____

○ - DENOTES PHOTO #, LOOKING DOWNSTREAM |#| - DENOTES n VALUE

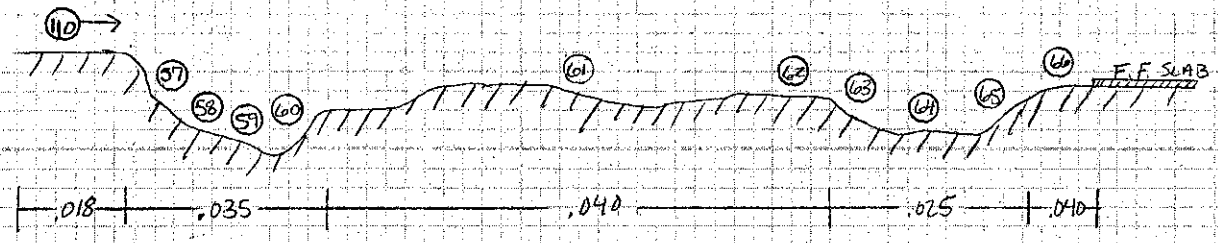
WAYPOINT 7 N-3714790 E-363515



WAYPOINT 9 N-3714713 E-363500



WAYPOINT 10 N-3714671 E-363500



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CONSULTING ENGINEERS

Job Number 0406915

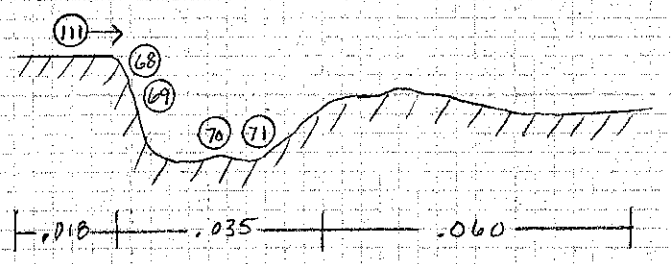
Sheet 4 of 7

Project NORTH CHANNEL INLET Date 7/6/04

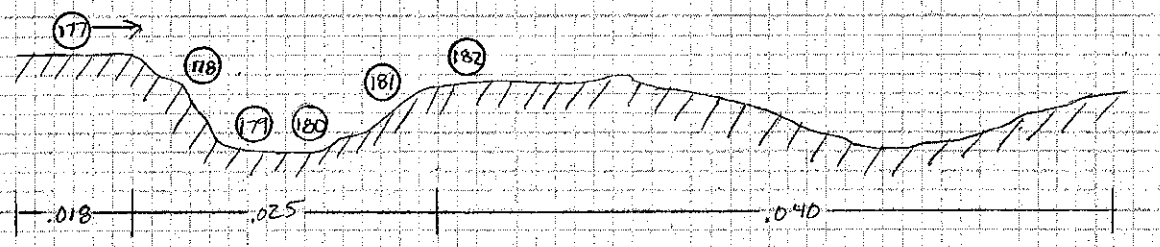
Subject X-SECTIONS / MANNINGS & PHOTO # Designed _____ Checked _____

○ - DENOTES PHOTO #, LOOKING DOWNSTREAM ⊢#⊣ - DENOTES n VALUE

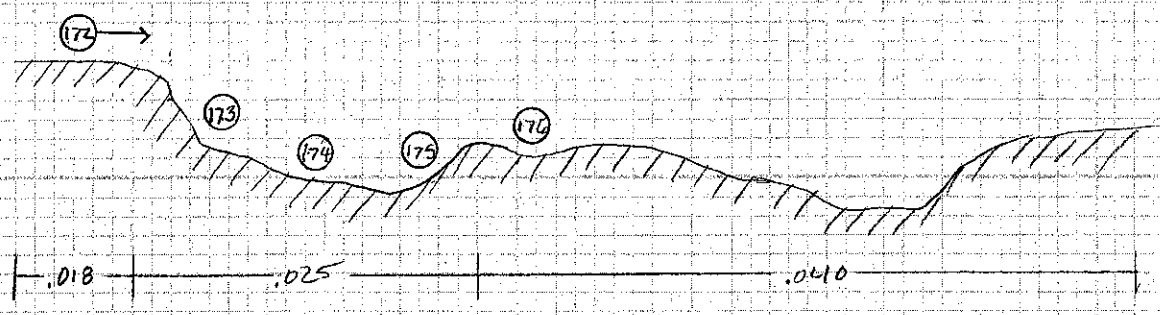
WAYPOINT 11/12 11→N 3714591 E-363481
12→N-3714580 E-363604



WAYPOINT 34 N-3714540 E-363514



WAYPOINT 33 N-3714526 E-363519



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CONSULTING ENGINEERS

Job Number 040 6915

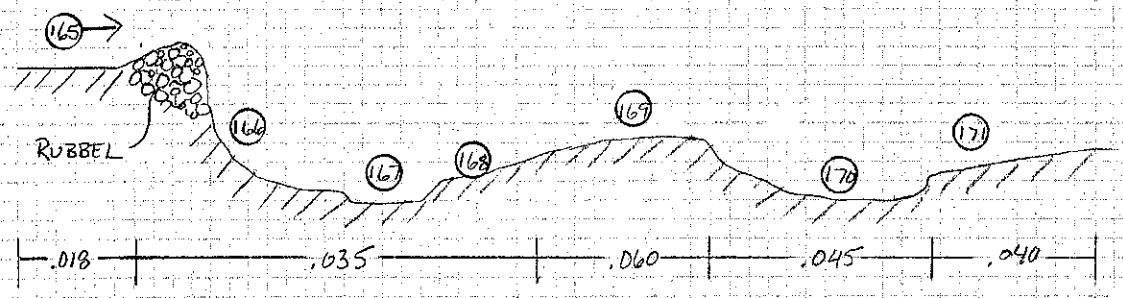
Sheet 5 of 7

Project NORTH INLET CHANNEL Date 7/7/04

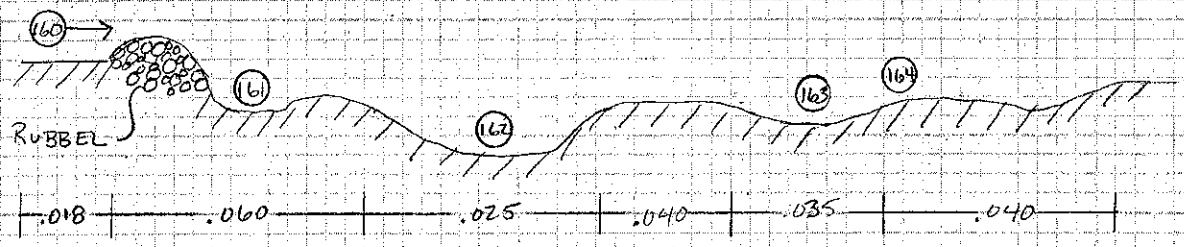
Subject X-SECTIONS/MANNINGS & PHOTO # Designed _____ Checked _____

○ - DENOTES PHOTO #, LOOKING DOWNSTREAM ⊢#⊣ - DENOTES n VALUE

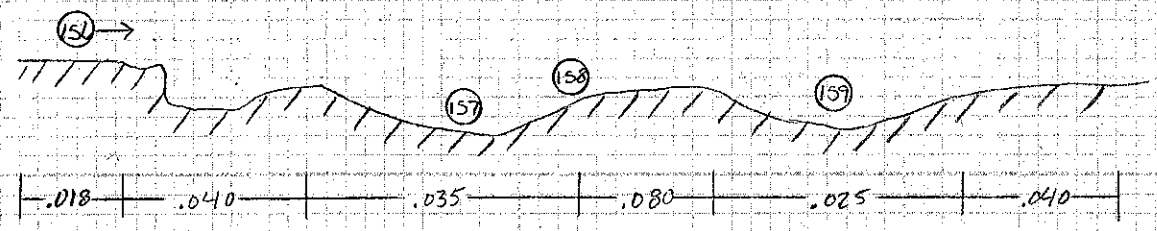
WAYPOINT 37 N - 3714423 E - 363517



WAYPOINT 31 N - 3714385 E - 363516



WAYPOINT 30 N - 3714356 E - 363517



KIRKHAM MICHAEL
CONSULTING ENGINEERS

Job Number 0406915

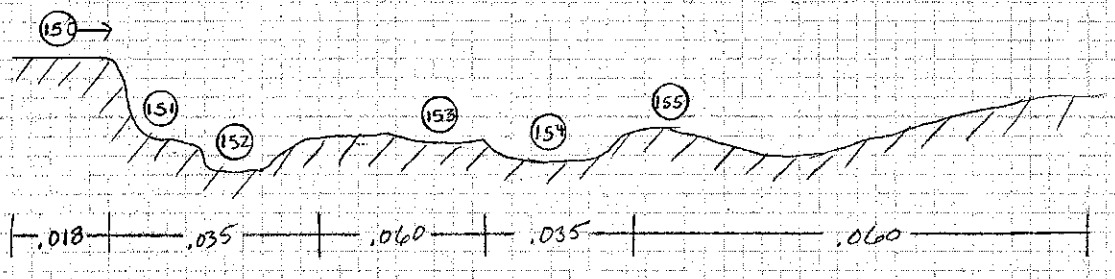
Sheet 6 of 7

Project NORTH INLET CHANNEL Date 7/8/04

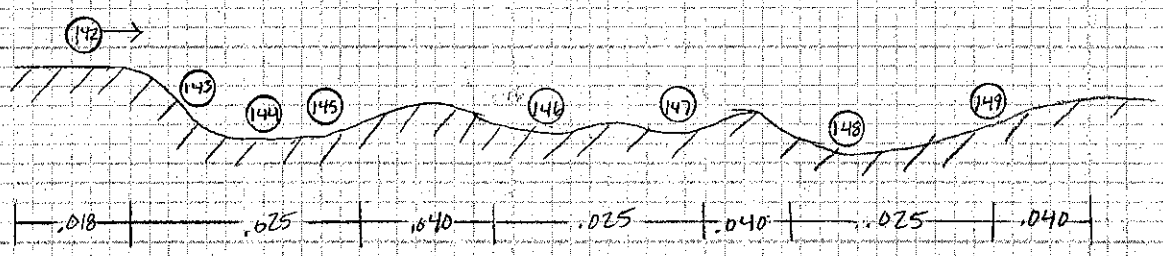
Subject X-SECTIONS/MANNINGS & PHOTO # Designed _____ Checked _____

○ - DENOTES PHOTO #, LOOKING DOWNSTREAM ⊢#⊣ - DENOTES n VALUE

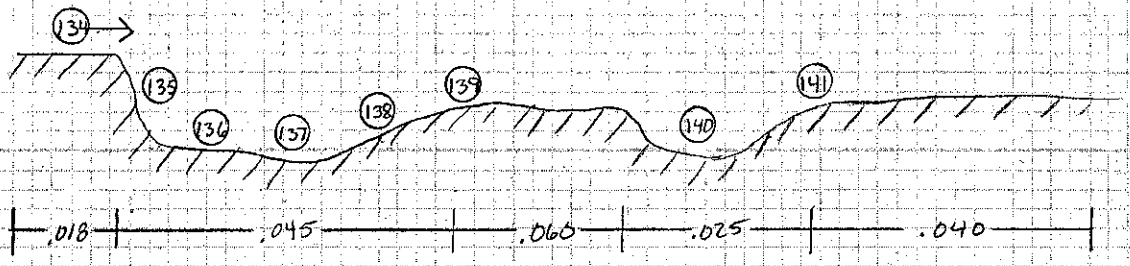
WAYPOINT 29 N-3714302 E-363516



WAYPOINT 28 N-3714238 E-363513



WAYPOINT 27 N-3714191 E-363500



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CONSULTING ENGINEERS

Job Number 0406915

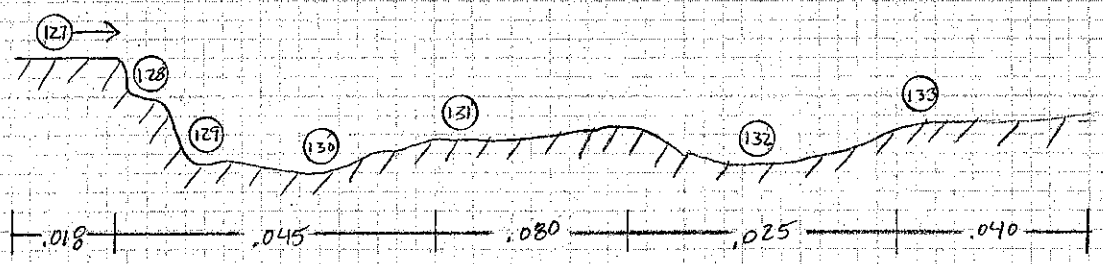
Sheet 7 of 7

Project NORTH INLET CHANNEL Date 7/8/04

Subject X-SECTIONS/MANNINGS & PHOTO # Designed _____ Checked _____

○ - DENOTES PHOTO #, LOOKING DOWNSTREAM ⊢#⊣ - DENOTES n VALUE

WAYPOINT 26 N-3714142 E-363512



WAYPOINT 25 N-3714085 E-363517

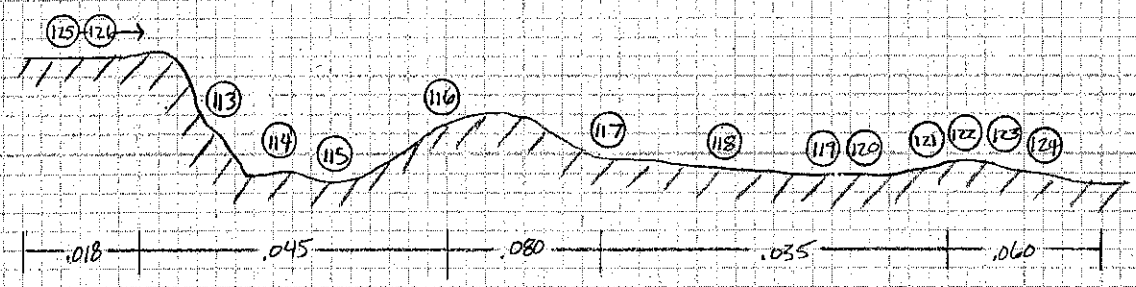


Photo 100

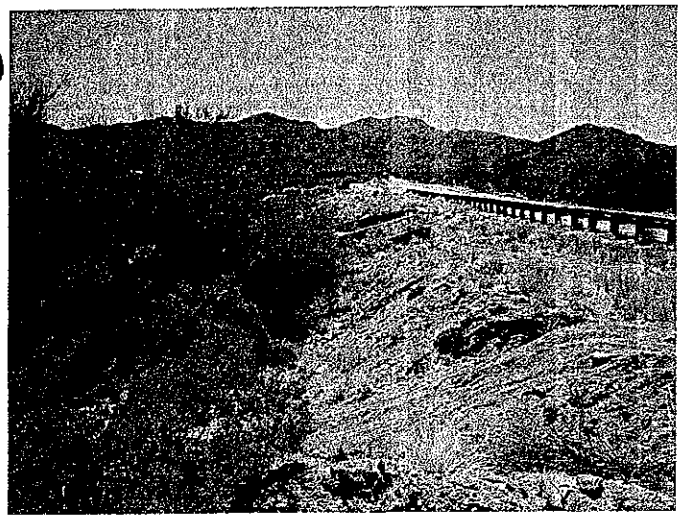


Photo 101

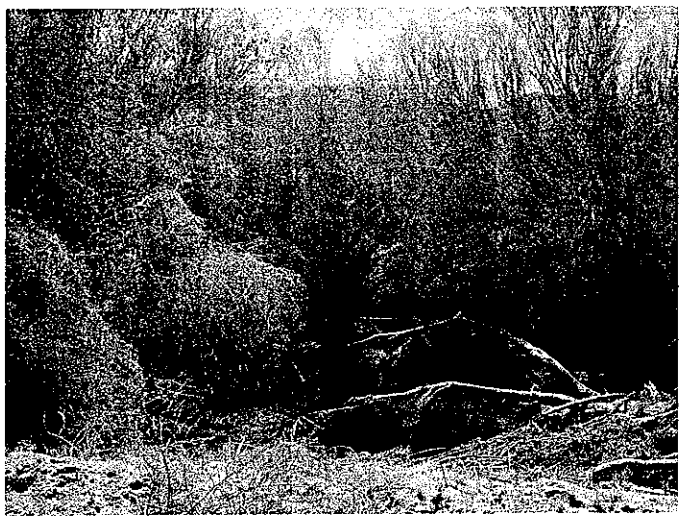


Photo 102

Photo 103

Photo 105

Photo 106

Photo 107

Photo 110

Photo 111

Photo 125

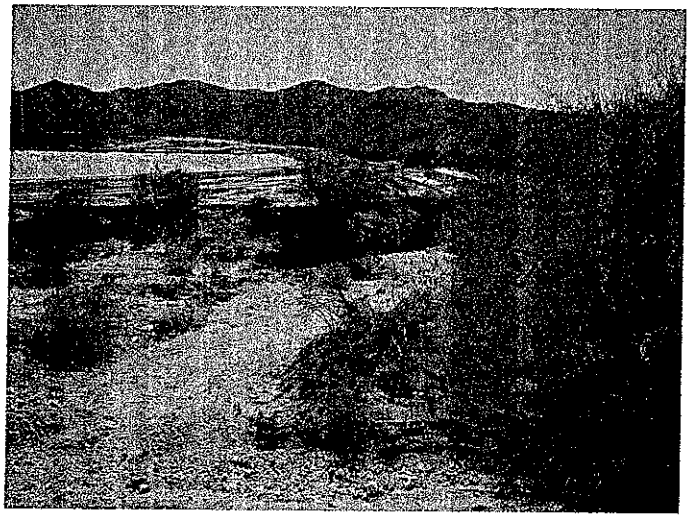


Photo 126

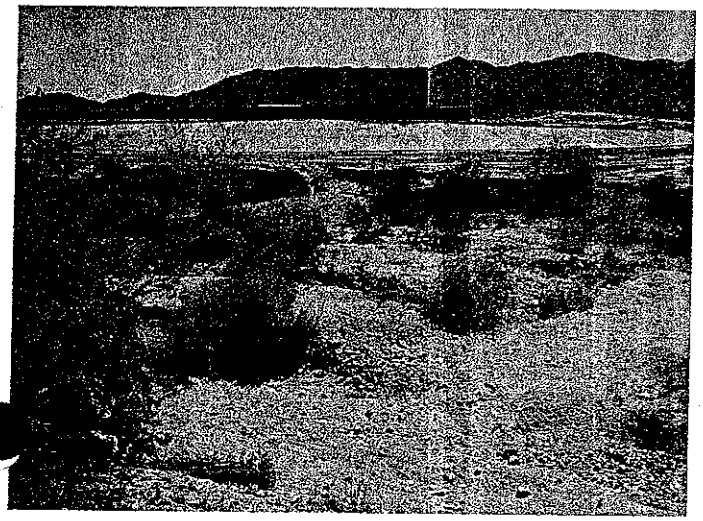


Photo 127

Photo 134

Photo 142

Photo 150

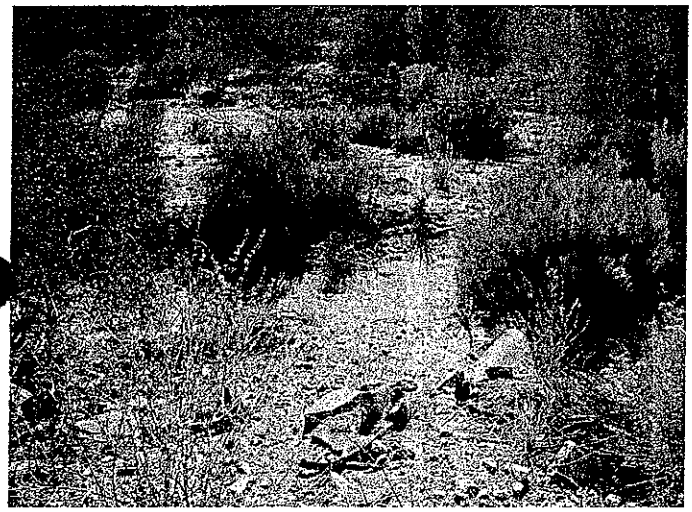


Photo 156

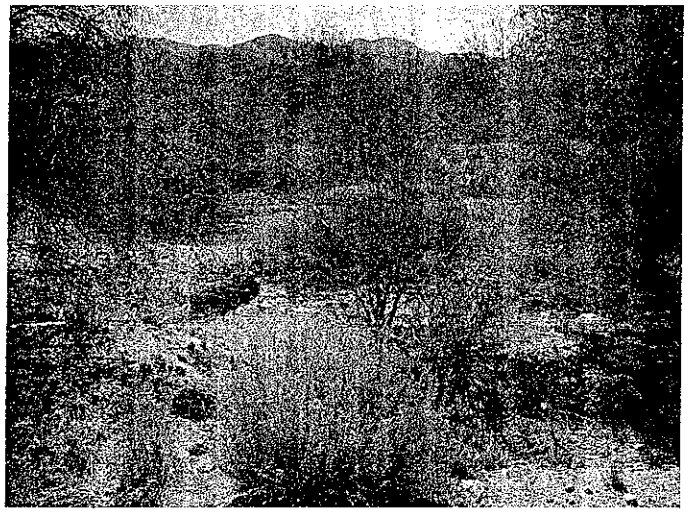


Photo 160

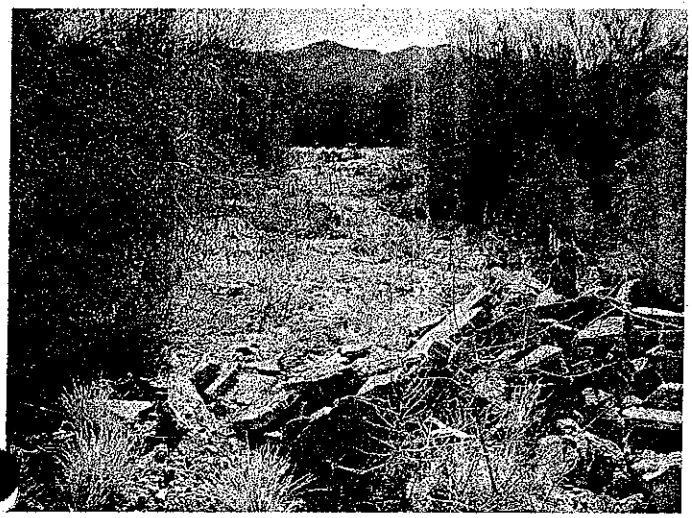


Photo 165

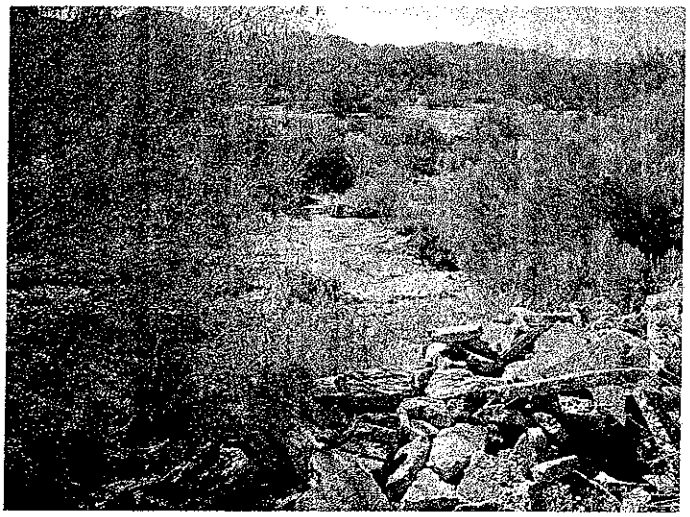


Photo 172

Photo 177

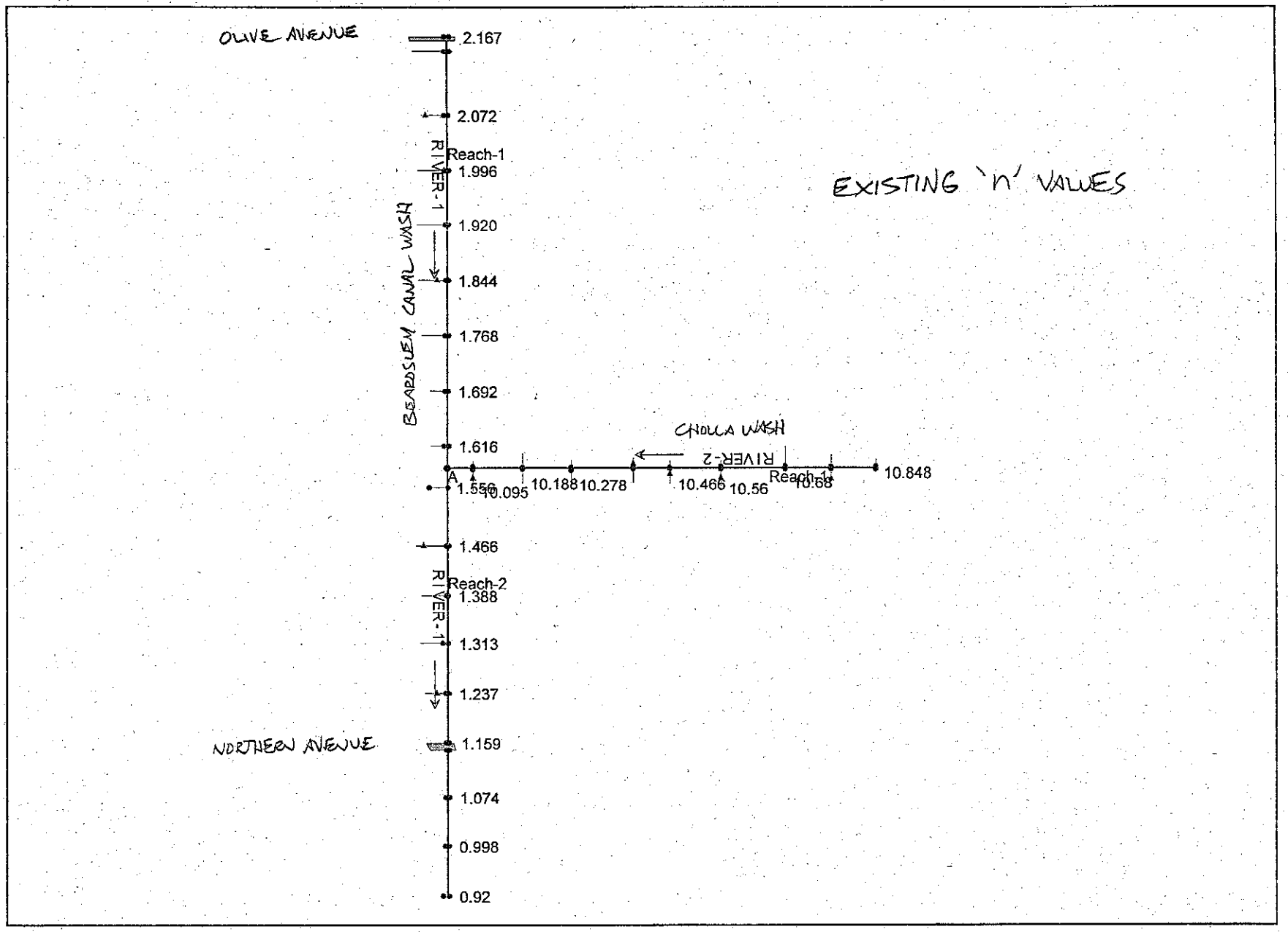
State Standard 5-96 Watercourse System Sediment Balance				
Beardsley Canal Wash and North Inlet Channel Estimated Channel Degradation				
Location on	100-yr Peak	Degradation (ft)		
Channel	Discharge (cfs)	General	Long Term	Total
Olive Ave. (u/s)	2655	3.7	2.3	6.0
Olive Ave. (d/s)	1055	2.5	1.3	3.8
Cholla Wash (before confl.)	4868	4.7	3.3	8.0
Cholla Wash (at BCW)	5539	4.9	3.5	8.4
Northern Ave. (d/s)	7139	5.5	4.1	9.6
1200' d/s of Northern Ave.	7776	5.7	4.3	10.0
North Inlet Channel (div.1)	1600	3.0	1.7	4.7
North Inlet Channel (div.2)	1200	2.7	1.4	4.1

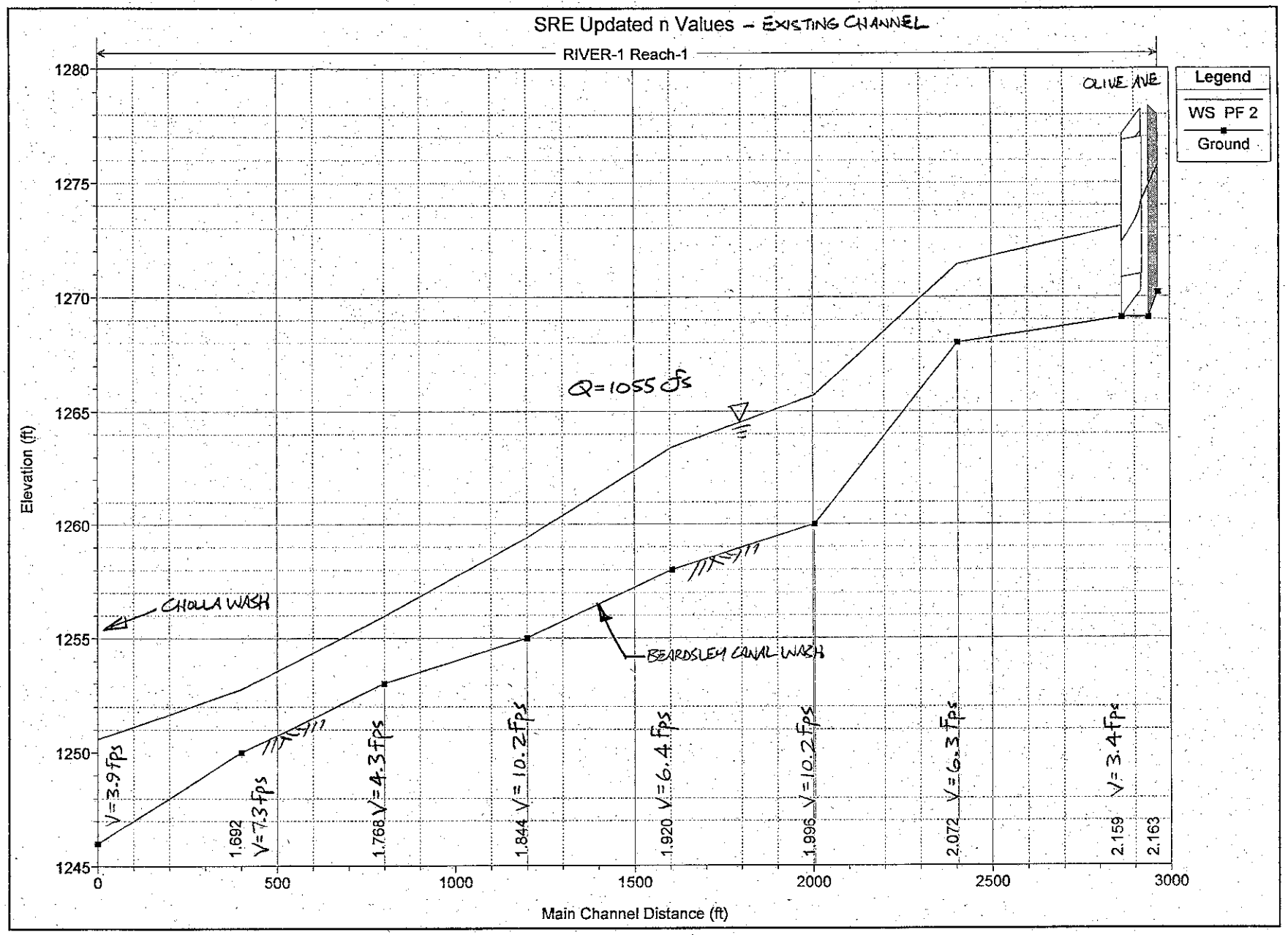
APPENDIX C – HECRAS MODELS

Included in Appendix C

- SRE HECRas Model with altered Manning's coefficients
  - Cross-sections along Beardsley Canal Wash from Olive Avenue to Cholla Wash for cleared and uncleared conditions
  - Profiles of existing flows in Beardsley Canal Wash
- New HECRas Model of Beardsley Canal Wash
  - Cross-sections along Beardsley Canal Wash from Cholla Wash to Northern Avenue
  - Profile of existing flows in Beardsley Canal Wash
  - Data used to create cross-sections

ORIGINAL SONORAN RIDGE ESTATES MODEL
PLAN SCHEMATIC




SRE Updated n Values – EXISTING CHANNEL
RIVER-1 Reach-1
Legend
WS PF 2
Ground
OLIVE AVE
Q=1055 cfs
CHOLLA WASH
BEARDSLEY CANAL WASH
V=3.9fps
1.692 V=7.3fps
1.768 V=4.3fps
1.844 V=10.2fps
1.920 V=6.4fps
1.996 V=10.2fps
2.072 V=6.3fps
2.159 V=3.4fps
2.163
Elevation (ft)
1280
1275
1270
1265
1260
1255
1250
1245
0
500
1000
1500
2000
2500
3000
Main Channel Distance (ft)

ORIGINAL SONDRA[illegible]R ESTATES HEC-RAS MODEL W/ UPDATED 'n' VALUES - EXISTI[illegible]NDITIONS
OLIVE AVE TO CHOLLA WASH
HYDRAULIC DATA

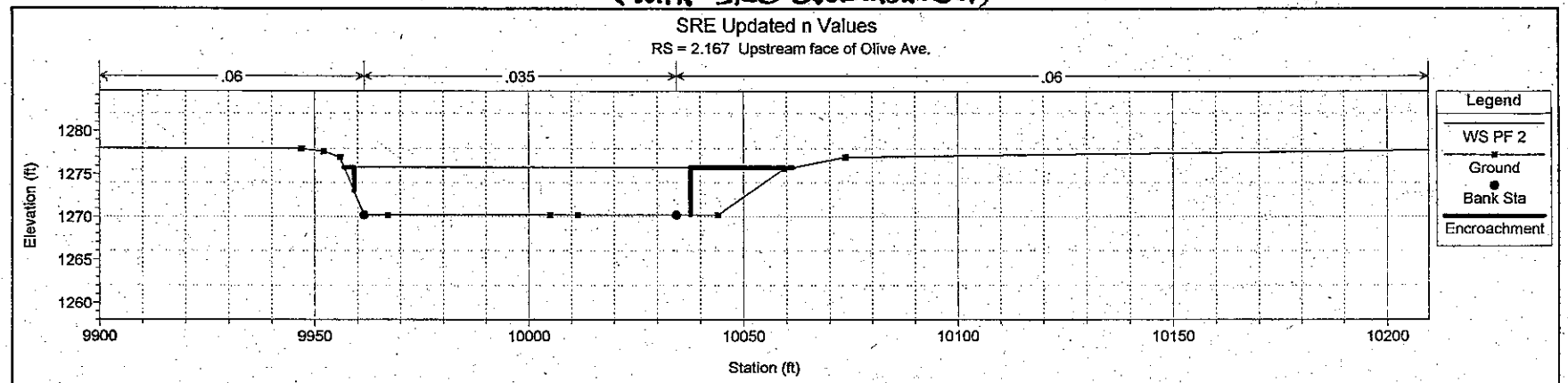
HEC-RAS Plan: KM designEx River: RIVER-1 Reach: Reach-1 Profile: PF 2

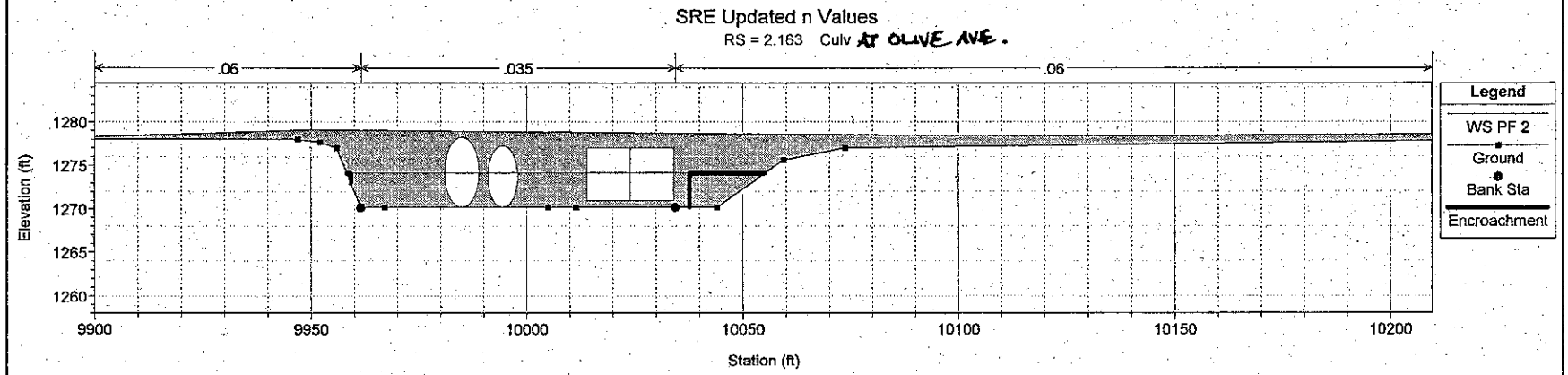
Reach	River Sta	Profile	Q Total	Length Chnl	Mann Wtd Chnl	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)		(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	2.167	PF 2	1055.00	102.00	0.035	1270.20	1275.83	5.63	1271.93	1275.93	0.000351	2.52	439.18	78.54	0.19
Reach-1	2.163		Culvert												
Reach-1	2.159	PF 2	1055.00	460.00	0.035	1269.10	1273.10	4.00		1273.27	0.001072	3.39	313.90	78.54	0.30
Reach-1	2.072	PF 2	1055.00	400.00	0.045	1268.00	1271.43	3.43	1270.87	1272.03	0.010062	6.29	178.28	71.51	0.68
Reach-1	1.996	PF 2	1055.00	400.00	0.035	1260.00	1265.71	5.71	1265.71	1267.32	0.013342	10.17	103.73	32.07	1.00
Reach-1	1.920	PF 2	1055.00	405.00	0.035	1258.00	1263.43	5.43	1261.80	1264.05	0.003571	6.35	166.27	39.02	0.54
Reach-1	1.844	PF 2	1055.00	400.00	0.045	1255.00	1259.40	4.40	1259.40	1261.01	0.022014	10.19	103.52	32.55	1.01
Reach-1	1.768	PF 2	1055.00	400.00	0.035	1253.00	1255.96	2.96	1255.15	1256.15	0.003318	4.33	382.72	193.74	0.49
Reach-1	1.692	PF 2	1055.00	400.00	0.045	1250.00	1252.75	2.75	1252.57	1253.43	0.019790	7.30	167.01	88.95	0.91
Reach-1	1.616	PF 2	1055.00	320.00	0.045	1246.00	1250.59	4.59		1250.79	0.002998	3.86	307.81	103.64	0.38

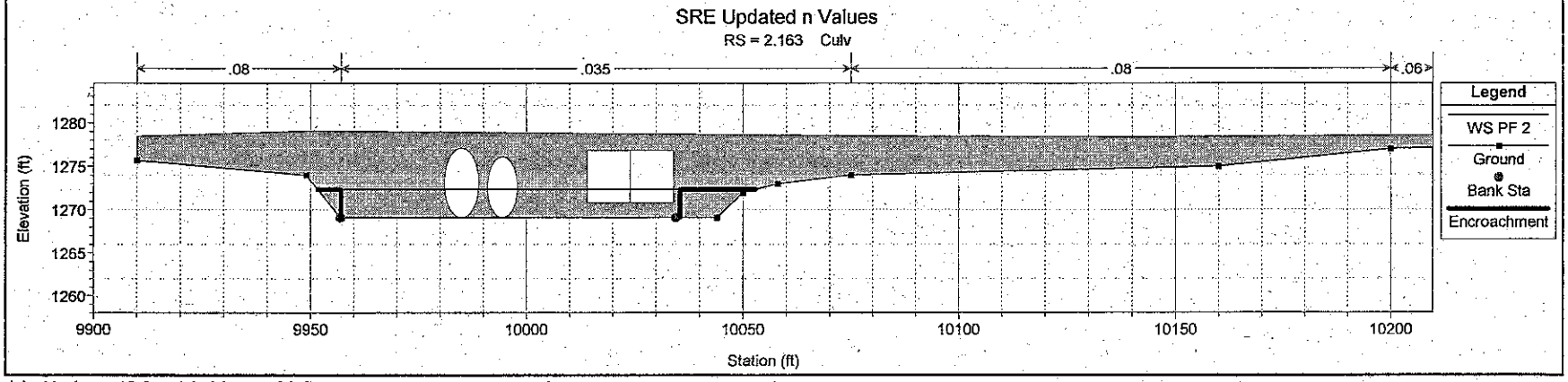
2655 cfs − 1600 cfs DIVERSION TO NIC = 1055 cfs

OLIVE AVE TO CHOLLA WASH
EXISTING CONDITIONS
(WITH SRE ENCROACHMENT)

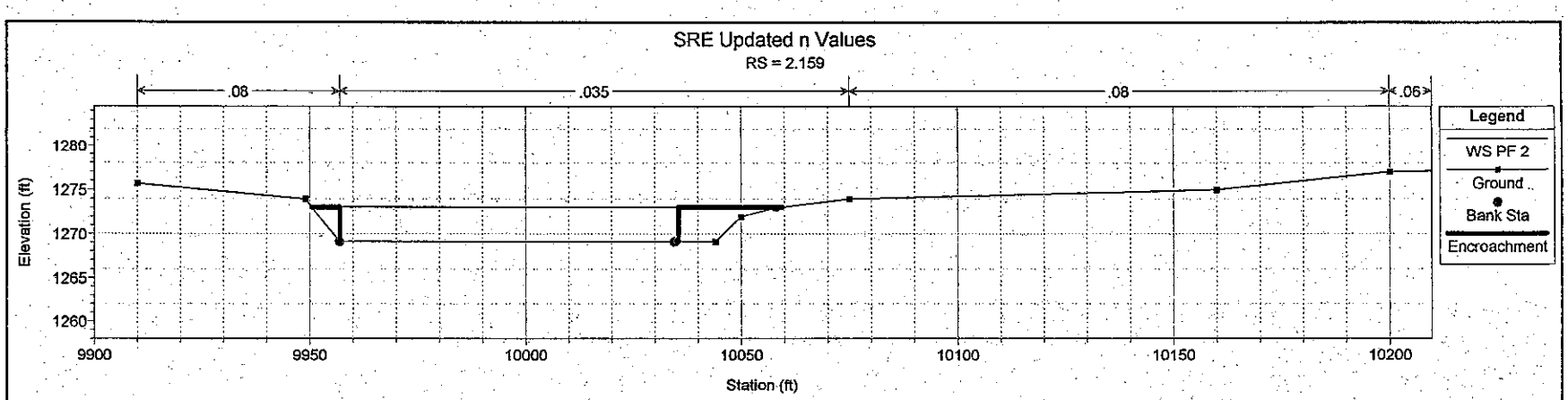
UPDATED 'n' VALUES BASED ON CURRENT VEGETATION CONDITIONS

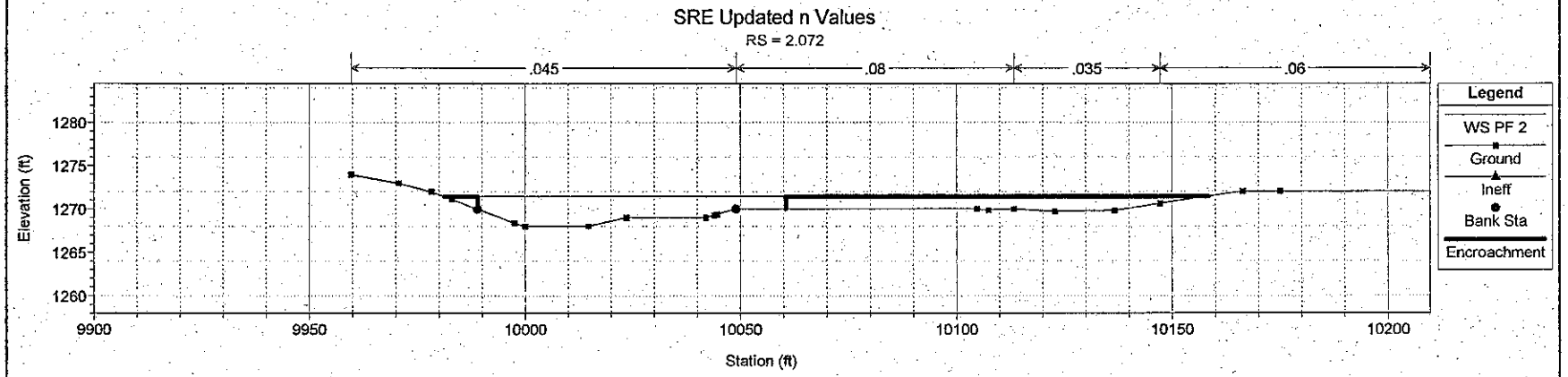


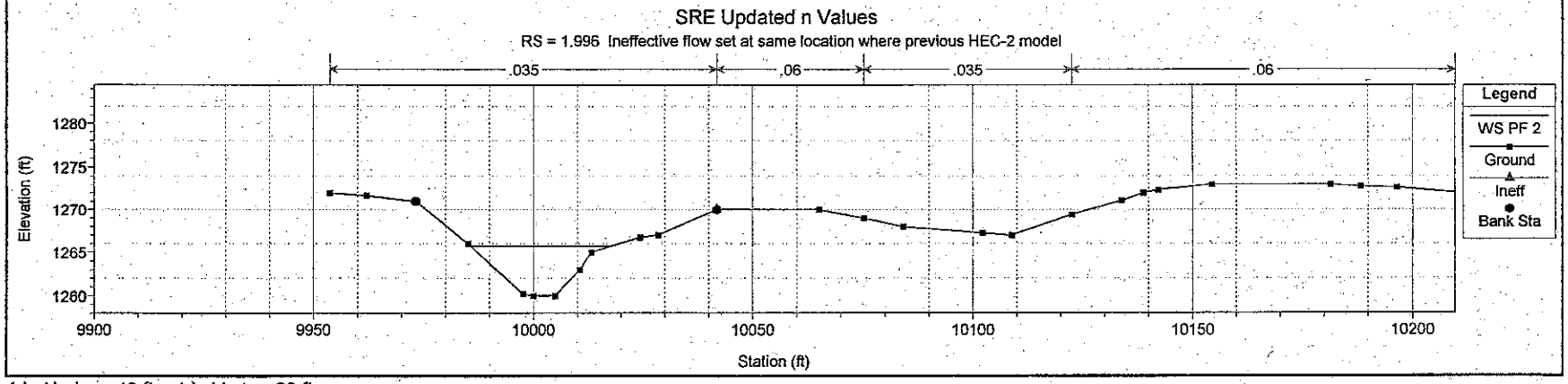




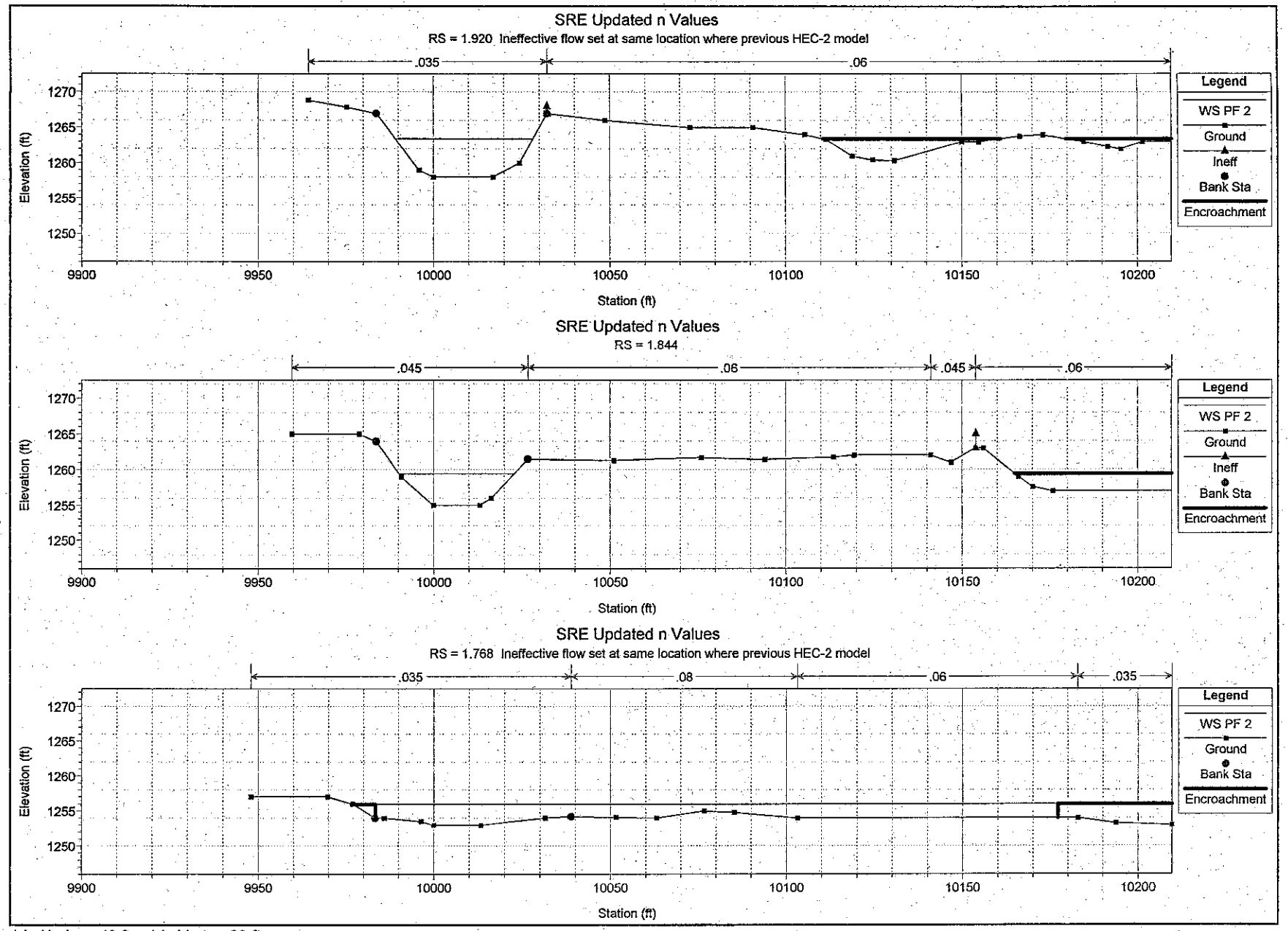
1 in Horiz. = 40 ft 1 in Vert. = 20 ft



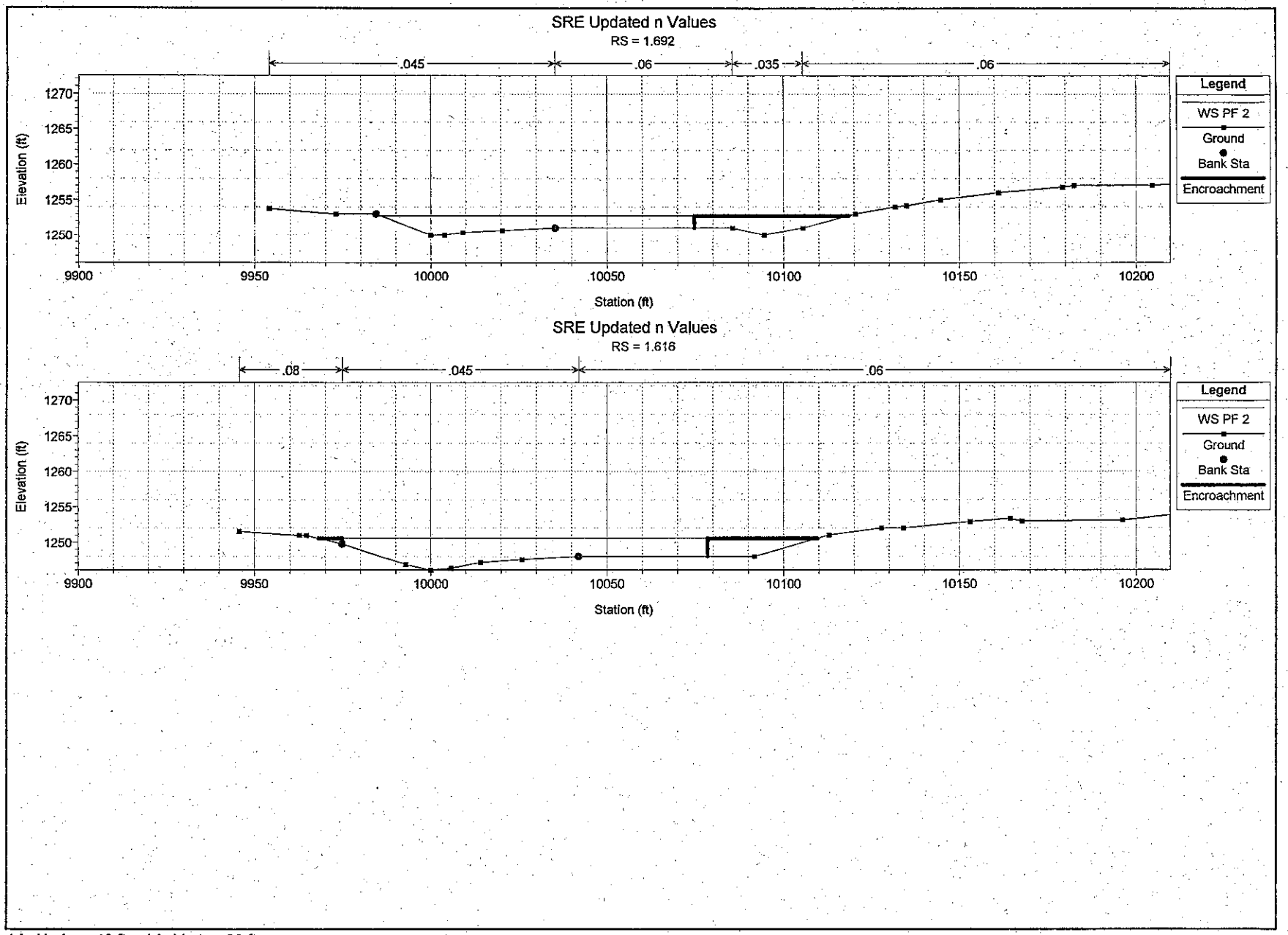




1 in Horiz. = 40 ft 1 in Vert. = 20 ft

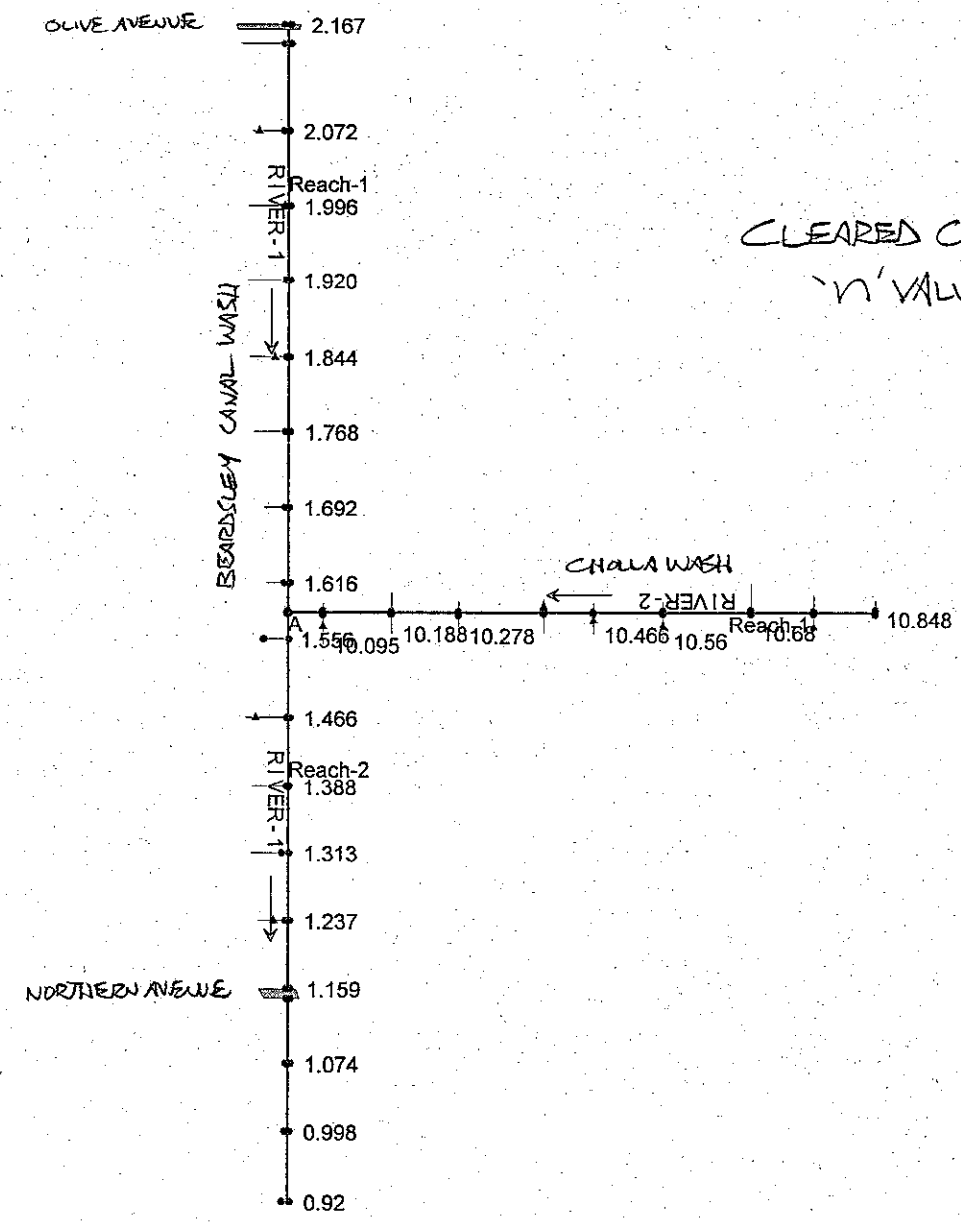


1 in Horiz. = 40 ft 1 in Vert. = 20 ft

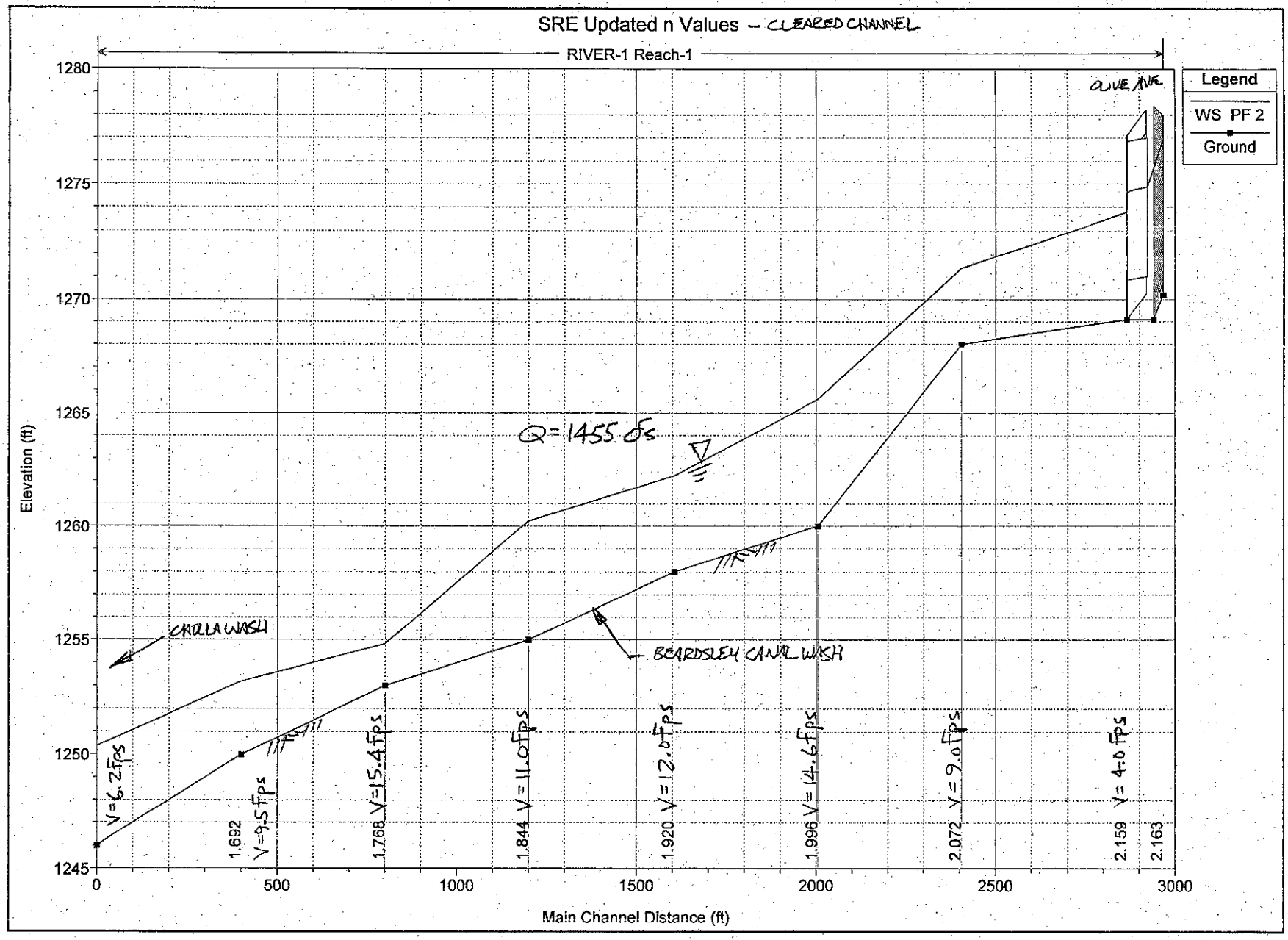


1 in Horiz. = 40 ft 1 in Vert. = 20 ft

ORIGINAL SONORAN RIDGE ESTATES MODEL
PLAN SCHEMATIC



CLEARED CHANNEL
'n' VALUES


SRE Updated n Values – CLEARED CHANNEL
RIVER-1 Reach-1
Legend
WS PF 2
Ground
OLIVE AVE
Q=1455 cfs
CAROLLA WASH
BEARDSLEY CANAL WASH
V=6.2fps
1.692 V=9.5fps
1.768 V=15.4fps
1.844 V=11.0fps
1.920 V=12.0fps
1.996 V=14.6fps
2.072 V=9.0fps
2.159 V=4.0fps
2.163
Elevation (ft)
Main Channel Distance (ft)
1280
1275
1270
1265
1260
1255
1250
1245
0
500
1000
1500
2000
2500
3000

ORIGINAL SONORAN RIDGE ESTATES HEC-RAS MODEL W/ UPDATED 'n' VALUES – 60' CLEAR CHANNEL
OLIVE AVE TO CHOLLA WASH
HYDRAULIC DATA

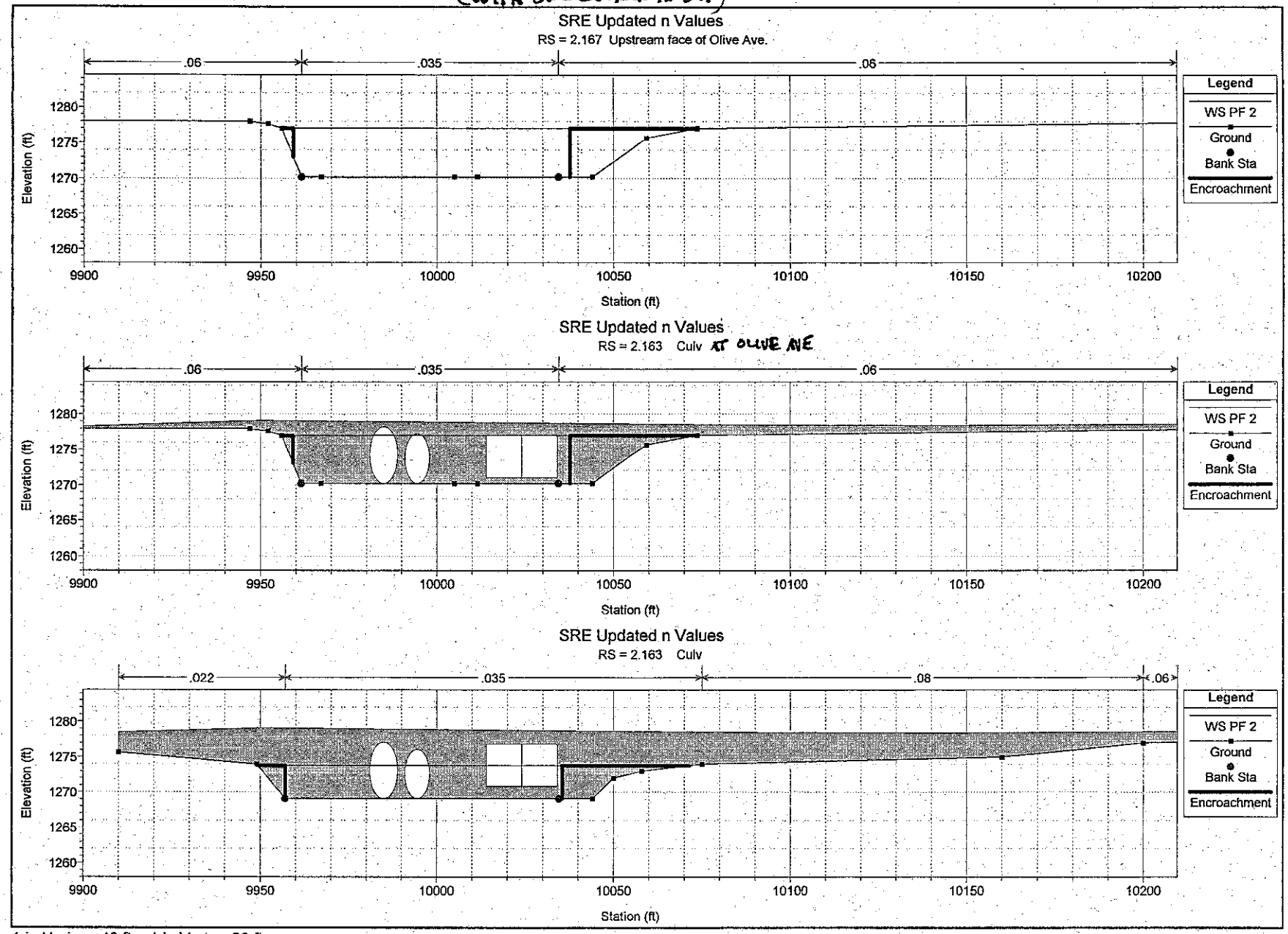
HEC-RAS Plan: ClearDvrsn River: RIVER-1 Reach: Reach-1 Profile: PF 2

Reach	River Sta	Profile	Q Total	Length Chnl	Mann Wtd Chnl	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)		(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	2.167	PF 2	1455.00	102.00	0.035	1270.20	1276.98	6.78	1272.35	1277.11	0.000360	2.89	529.47	78.54	0.20
Reach-1	2.163		Culvert												
Reach-1	2.159	PF 2	1455.00	460.00	0.035	1269.10	1273.79	4.69		1274.03	0.001213	3.98	368.17	78.54	0.32
Reach-1	2.072	PF 2	1455.00	400.00	0.026	1268.00	1271.36	3.36	1271.36	1272.61	0.007269	9.04	173.38	71.51	0.98
Reach-1	1.996	PF 2	1455.00	400.00	0.022	1260.00	1265.59	5.59	1266.68	1268.88	0.010894	14.56	99.93	31.04	1.43
Reach-1	1.920	PF 2	1455.00	405.00	0.026	1258.00	1262.22	4.22	1262.59	1264.46	0.009690	12.03	120.98	35.82	1.15
Reach-1	1.844	PF 2	1455.00	400.00	0.022	1255.00	1260.23	5.23	1260.23	1262.13	0.005044	11.04	131.78	35.31	1.01
Reach-1	1.768	PF 2	1455.00	400.00	0.022	1253.00	1254.83	1.83	1255.61	1257.73	0.036966	15.40	164.56	184.29	2.37
Reach-1	1.692	PF 2	1455.00	400.00	0.025	1250.00	1253.19	3.19	1253.19	1254.33	0.008022	9.49	206.64	90.26	1.09
Reach-1	1.616	PF 2	1455.00	320.00	0.031	1246.00	1250.37	4.37	1249.61	1250.88	0.003951	6.19	284.44	103.64	0.63

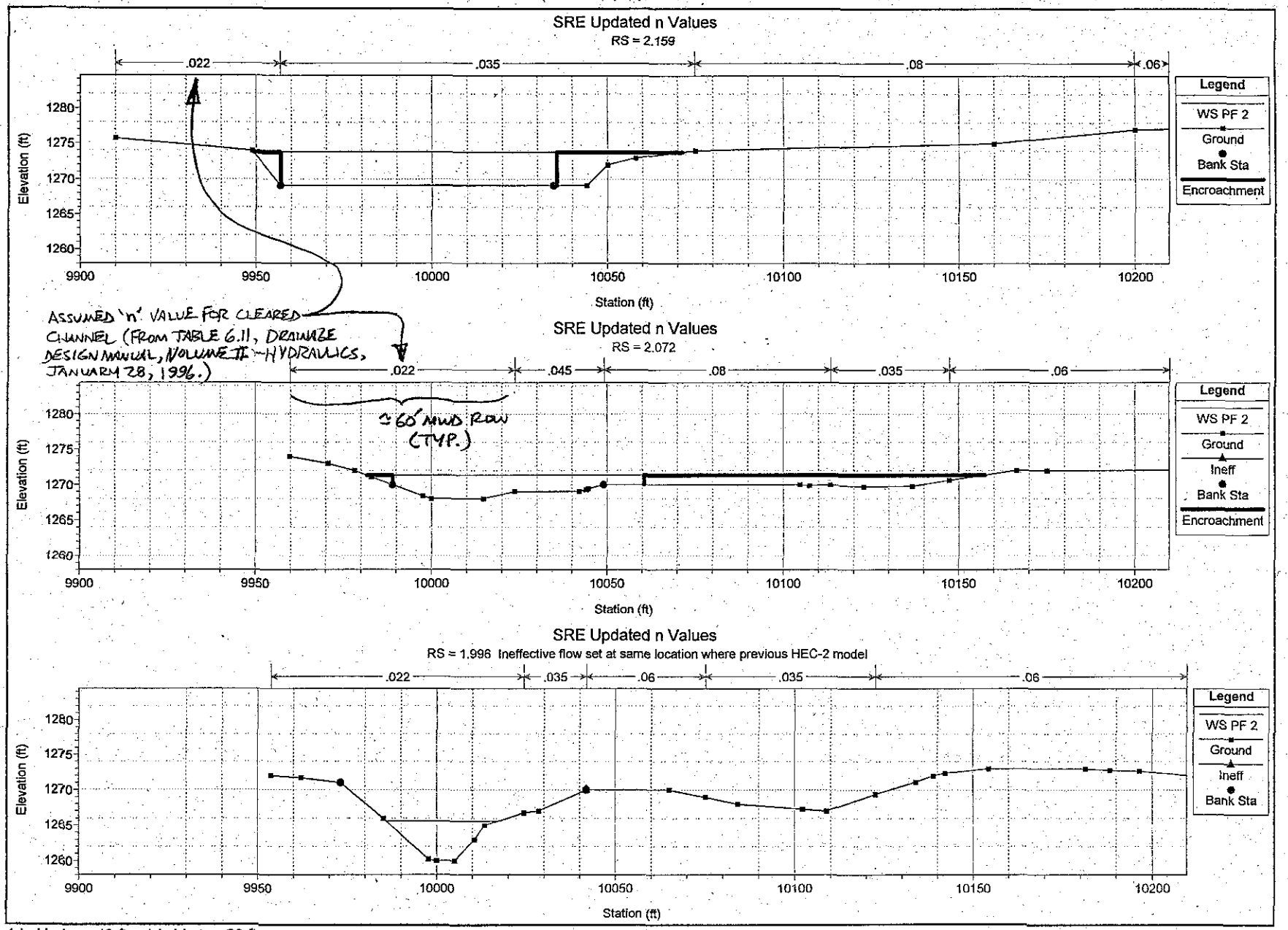
2655 cfs – 1200 cfs DIVERSION TO NIC = 1455 cfs

OLIVE AVE TO CHOLLA WASH
CLEARED CHANNEL
(WITH SRE ENCROACHMENT)

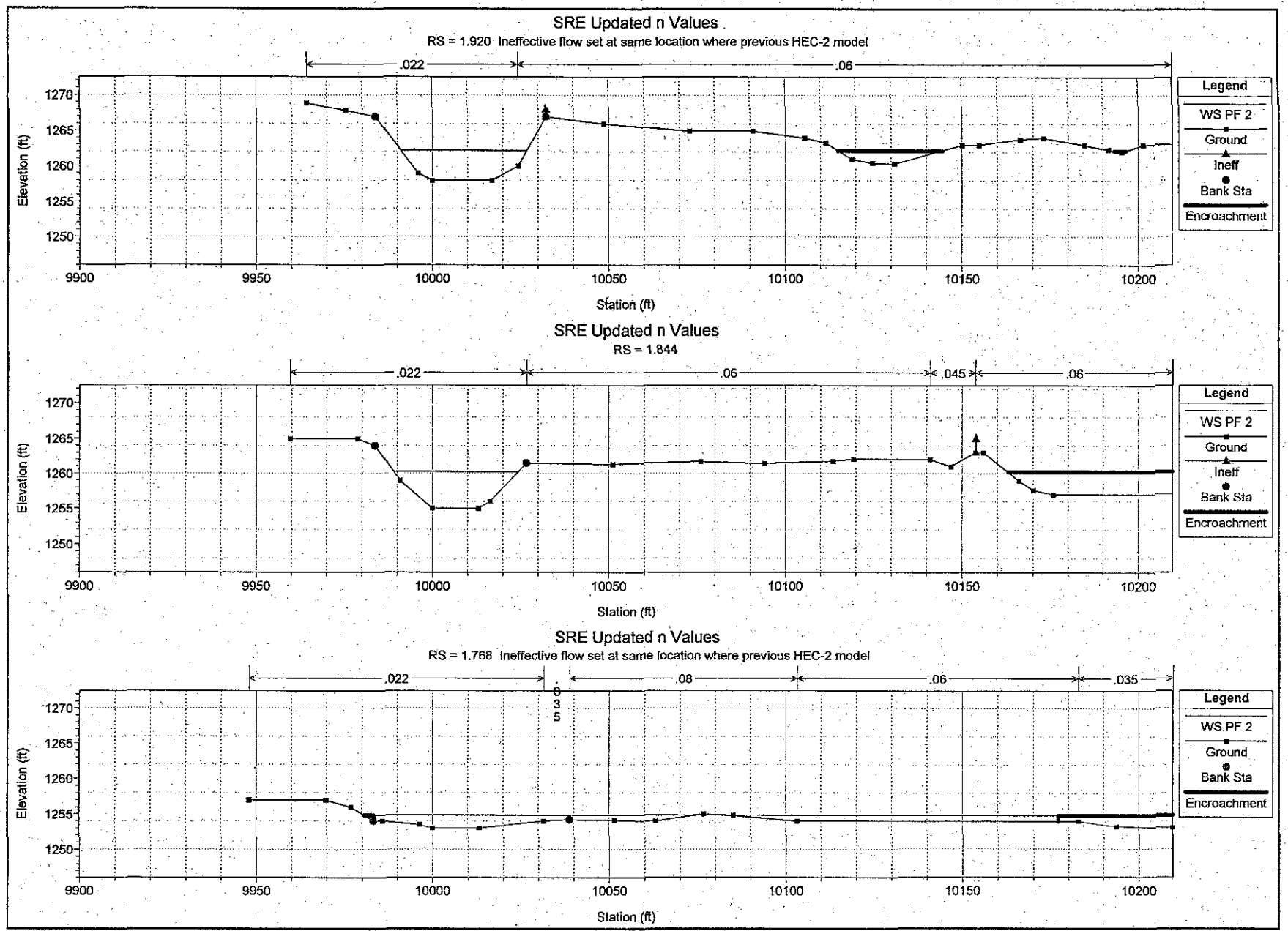
UPDATED 'n' VALUES BASED ON CURRENT
VEGETATION CONDITIONS AND CLEARED 60' MWD ROW



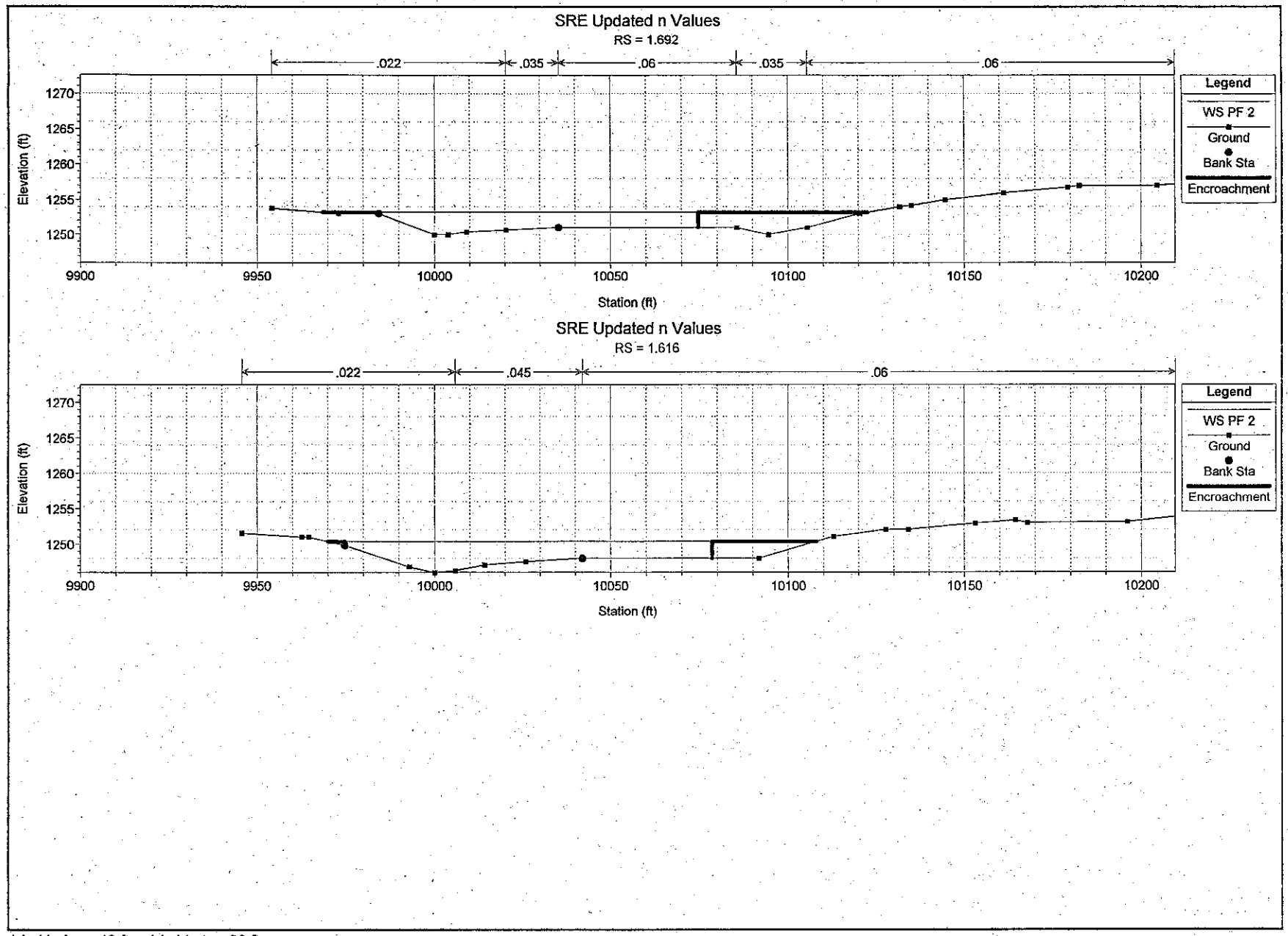
1 in Horiz. = 40 ft 1 in Vert. = 20 ft



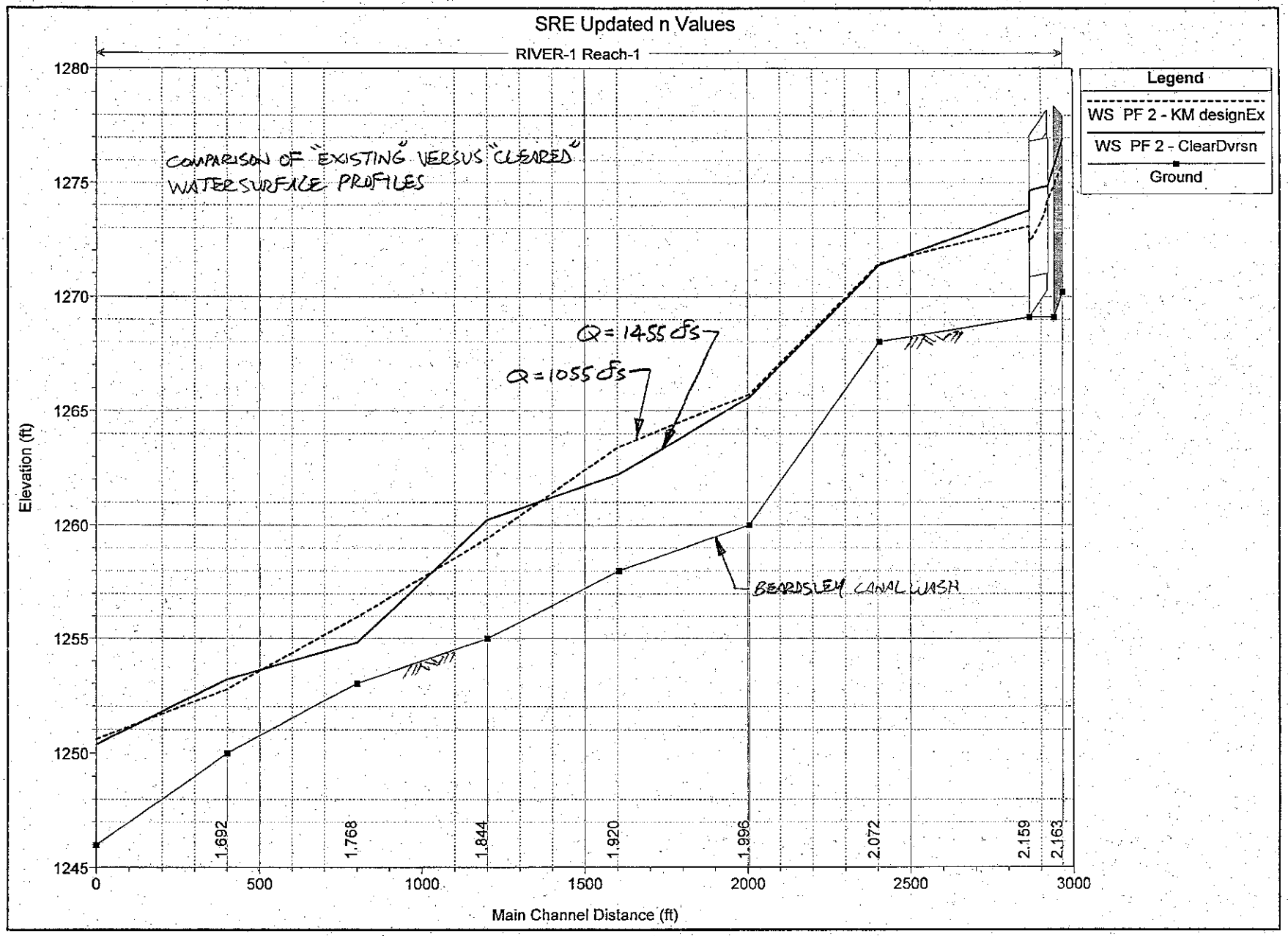
1 in Horiz. = 40 ft 1 in Vert. = 20 ft



1 in Horiz. = 40 ft 1 in Vert. = 20 ft



1 in Horiz. = 40 ft 1 in Vert. = 20 ft

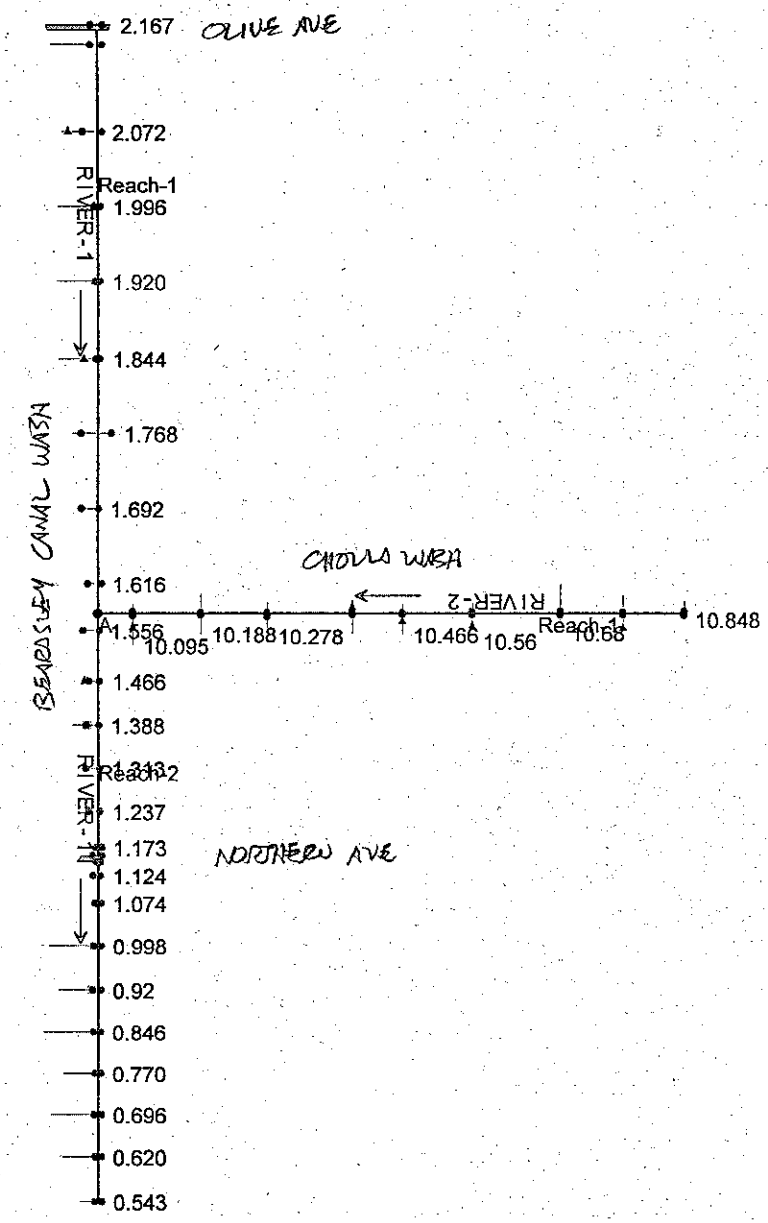

SRE Updated n Values
RIVER-1 Reach-1
Legend
WS PF 2 - KM designEx
WS PF 2 - ClearDvrsn
Ground
COMPARISON OF "EXISTING" VERSUS "CLEARED" WATERSURFACE PROFILES
Q = 1455 cfs
Q = 1055 cfs
BEARDSLEY CANAL WASH
Elevation (ft)
Main Channel Distance (ft)
1280
1275
1270
1265
1260
1255
1250
1245
0
500
1000
1500
2000
2500
3000
1.692
1.768
1.844
1.920
1.996
2.072
2.159
2.163

COMPARISON OF EXISTING VERSUS CLEARED HYDRAULIC DATA

HEC-RAS River: RIVER-1 Reach: Reach-1 Profile: PF 2

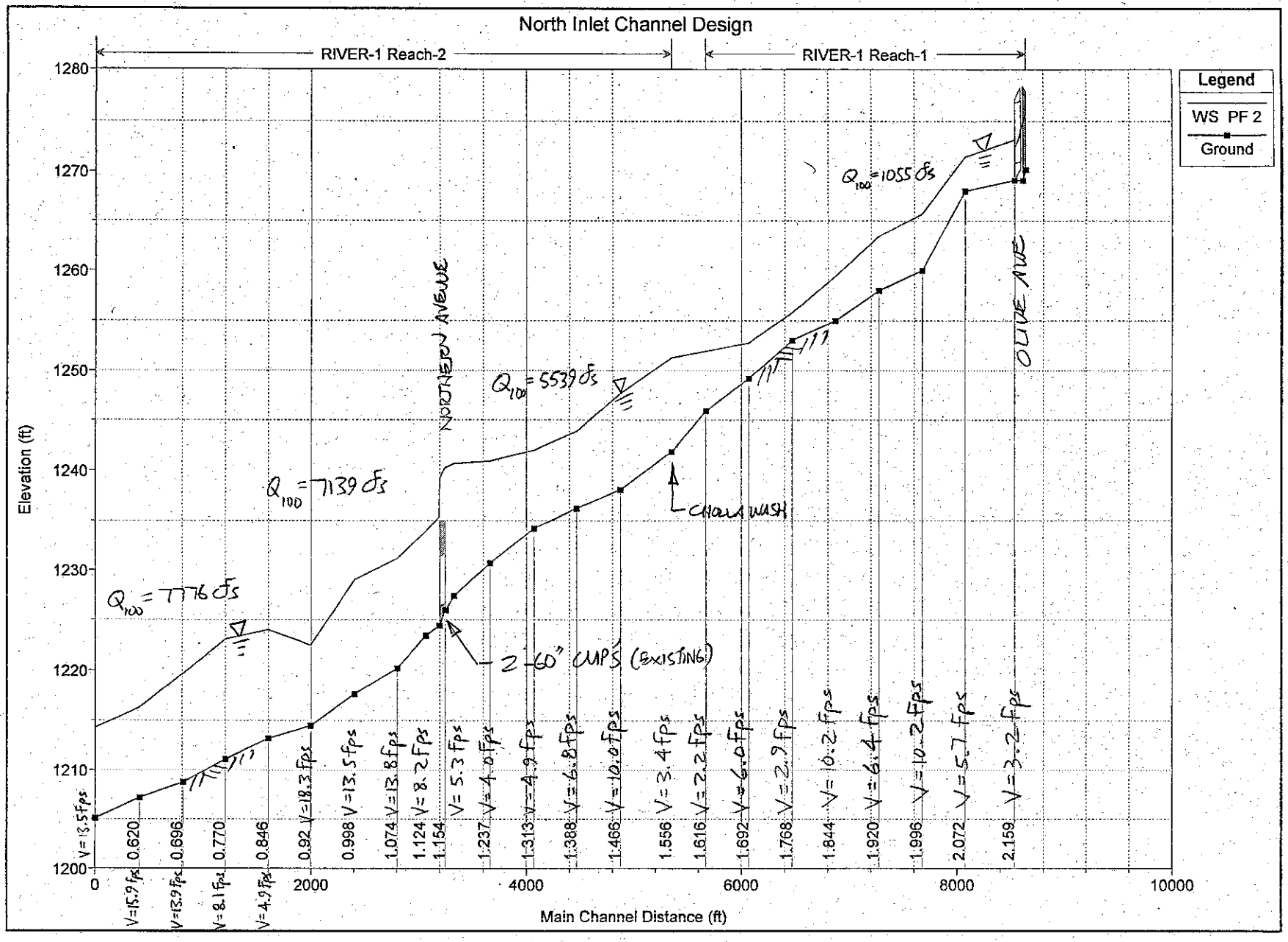
Reach	River Sta	Profile	Plan	Q Total	Length Chnl	Mann Wtd Chnl	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)		(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	2.167	PF 2	ClearDvrsn	1455.00	102.00	0.035	1270.20	1276.98	6.78	1272.35	1277.11	0.000360	2.89	529.47	78.54	0.20
Reach-1	2.167	PF 2	KM designEx	1055.00	102.00	0.035	1270.20	1275.83	5.63	1271.93	1275.93	0.000351	2.52	439.18	78.54	0.19
Reach-1	2.163			Culvert												
Reach-1	2.159	PF 2	ClearDvrsn	1455.00	460.00	0.035	1269.10	1273.79	4.69		1274.03	0.001213	3.98	368.17	78.54	0.32
Reach-1	2.159	PF 2	KM designEx	1055.00	460.00	0.035	1269.10	1273.10	4.00		1273.27	0.001072	3.39	313.90	78.54	0.30
Reach-1	2.072	PF 2	ClearDvrsn	1455.00	400.00	0.026	1268.00	1271.36	3.36	1271.36	1272.61	0.007269	9.04	173.38	71.51	0.98
Reach-1	2.072	PF 2	KM designEx	1055.00	400.00	0.045	1268.00	1271.43	3.43	1270.87	1272.03	0.010062	6.29	178.28	71.51	0.68
Reach-1	1.996	PF 2	ClearDvrsn	1455.00	400.00	0.022	1260.00	1265.59	5.59	1266.68	1268.88	0.010894	14.56	99.93	31.04	1.43
Reach-1	1.996	PF 2	KM designEx	1055.00	400.00	0.035	1260.00	1265.71	5.71	1265.71	1267.32	0.013342	10.17	103.73	32.07	1.00
Reach-1	1.920	PF 2	ClearDvrsn	1455.00	405.00	0.026	1258.00	1262.22	4.22	1262.59	1264.46	0.009690	12.03	120.98	35.82	1.15
Reach-1	1.920	PF 2	KM designEx	1055.00	405.00	0.035	1258.00	1263.43	5.43	1261.80	1264.05	0.003571	6.35	166.27	39.02	0.54
Reach-1	1.844	PF 2	ClearDvrsn	1455.00	400.00	0.022	1255.00	1260.23	5.23	1260.23	1262.13	0.005044	11.04	131.78	35.31	1.01
Reach-1	1.844	PF 2	KM designEx	1055.00	400.00	0.045	1255.00	1259.40	4.40	1259.40	1261.01	0.022014	10.19	103.52	32.55	1.01
Reach-1	1.768	PF 2	ClearDvrsn	1455.00	400.00	0.022	1253.00	1254.83	1.83	1255.61	1257.73	0.036966	15.40	164.56	184.29	2.37
Reach-1	1.768	PF 2	KM designEx	1055.00	400.00	0.035	1253.00	1255.96	2.96	1255.15	1256.15	0.003318	4.33	382.72	193.74	0.49
Reach-1	1.692	PF 2	ClearDvrsn	1455.00	400.00	0.025	1250.00	1253.19	3.19	1253.19	1254.33	0.008022	9.49	206.64	90.26	1.09
Reach-1	1.692	PF 2	KM designEx	1055.00	400.00	0.045	1250.00	1252.75	2.75	1252.57	1253.43	0.019790	7.30	167.01	88.95	0.91
Reach-1	1.616	PF 2	ClearDvrsn	1455.00	320.00	0.031	1246.00	1250.37	4.37	1249.61	1250.88	0.003951	6.19	284.44	103.64	0.63
Reach-1	1.616	PF 2	KM designEx	1055.00	320.00	0.045	1246.00	1250.59	4.59		1250.79	0.002998	3.86	307.81	103.64	0.38

NEW EXISTING CONDITIONS HEC-RAS MODEL



NOTES:

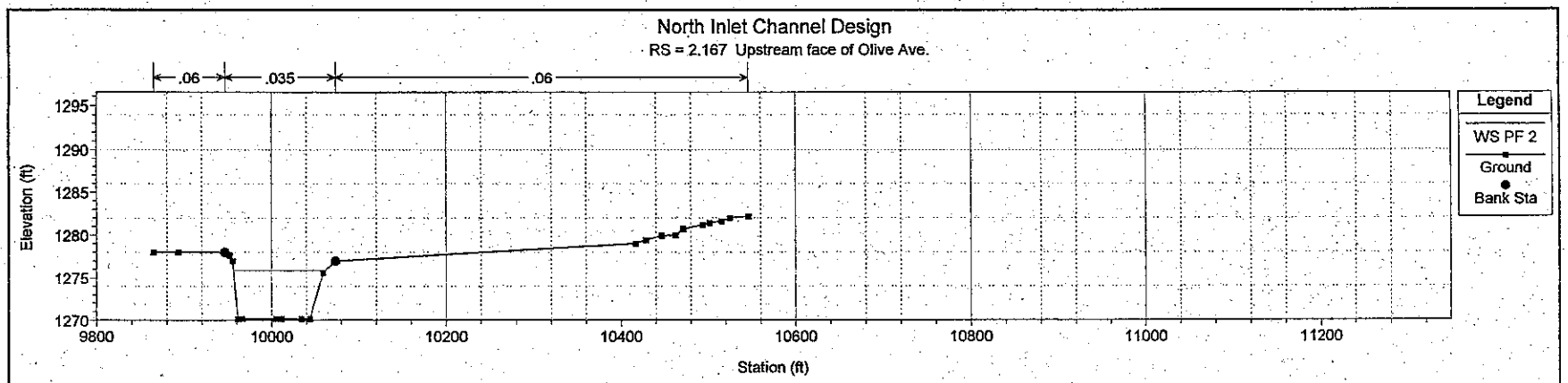
1) UPDATED 'n' VALUES
2) UPDATED CULVERT DATA
3) UPDATED CROSS-SECTION DATA
4) OTHER MINOR CORRECTIONS

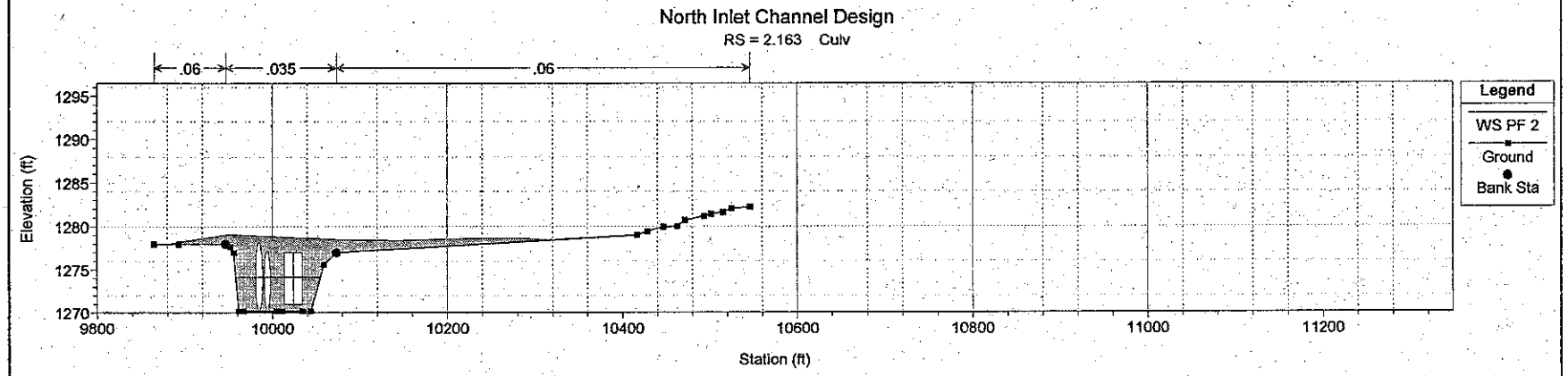

North Inlet Channel Design
RIVER-1 Reach-2
RIVER-1 Reach-1
Legend
WS PF 2
Ground
Elevation (ft)
Main Channel Distance (ft)
1200
1210
1220
1230
1240
1250
1260
1270
1280
0
2000
4000
6000
8000
10000
NORTHERN AVENUE
OLIVE AVE
CHAUA WASH
2-60" CMPS (EXISTING)
Q100 = 7776 cfs
Q100 = 7139 cfs
Q100 = 5539 cfs
Q100 = 1055 cfs
V=15.5 fps
V=15.9 fps
V=13.9 fps
V=8.1 fps
V=4.9 fps
V=18.3 fps
V=13.5 fps
V=13.8 fps
V=8.2 fps
V=5.3 fps
V=4.0 fps
V=4.9 fps
V=6.8 fps
V=10.0 fps
V=3.4 fps
V=2.2 fps
V=6.0 fps
V=2.9 fps
V=10.2 fps
V=6.4 fps
V=10.2 fps
V=5.7 fps
V=3.2 fps
0.620
0.696
0.770
0.846
0.92
0.998
1.074
1.124
1.154
1.237
1.313
1.388
1.466
1.556
1.616
1.692
1.768
1.844
1.920
1.996
2.072
2.159

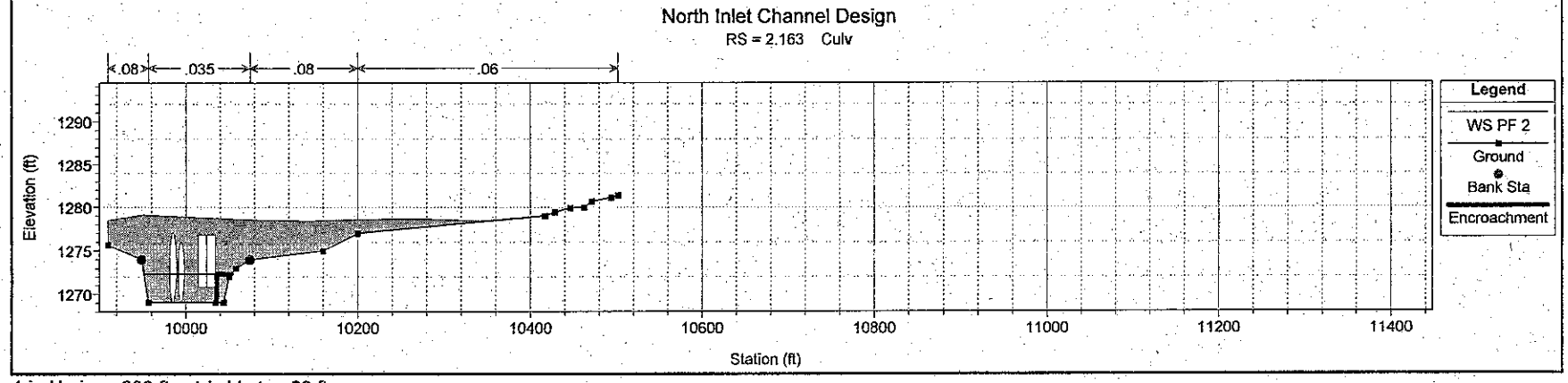
HYDRAULIC DATA

HEC-RAS Plan: KM Dsgn Exst Profile: PF 2

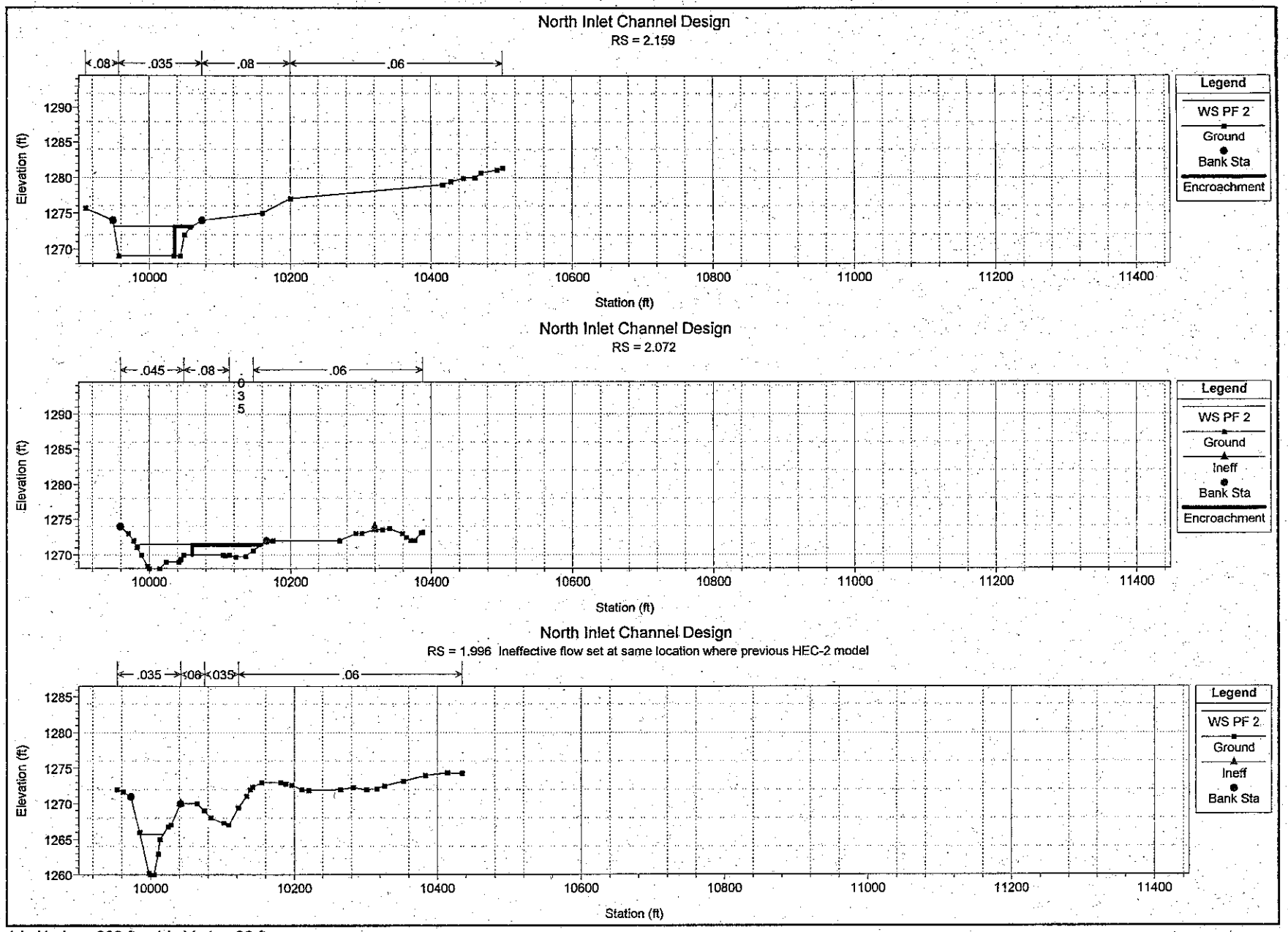
Reach	River Sta	Profile	Q Total	Length Chnl	Mann Wtd Chnl	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)		(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	2.167	PF 2	1055.00	102.00	0.035	1270.20	1275.87	5.67	1271.89	1275.93	0.000271	2.00	526.93	105.08	0.16
Reach-1	2.163		Culvert												
Reach-1	2.159	PF 2	1055.00	460.00	0.040	1269.10	1273.16	4.06		1273.32	0.001268	3.17	332.70	85.18	0.28
Reach-1	2.072	PF 2	1055.00	400.00	0.046	1268.00	1271.47	3.47	1270.83	1271.96	0.009808	5.66	186.56	79.37	0.65
Reach-1	1.996	PF 2	1055.00	400.00	0.035	1260.00	1265.72	5.72	1265.72	1267.32	0.013277	10.15	103.96	32.13	0.99
Reach-1	1.920	PF 2	1055.00	405.00	0.035	1258.00	1263.43	5.42	1261.80	1264.05	0.003573	6.35	166.23	39.02	0.54
Reach-1	1.844	PF 2	1055.00	400.00	0.045	1255.00	1259.40	4.40	1259.40	1261.01	0.021964	10.18	103.60	32.56	1.01
Reach-1	1.768	PF 2	1055.00	400.00	0.048	1253.00	1255.83	2.83	1254.94	1255.96	0.003990	2.91	363.01	199.65	0.38
Reach-1	1.692	PF 2	1055.00	400.00	0.046	1249.20	1252.75	3.55		1253.31	0.012536	6.00	175.83	82.01	0.72
Reach-1	1.616	PF 2	1055.00	320.00	0.059	1245.90	1251.92	6.01		1251.99	0.001281	2.21	477.94	118.52	0.19
Reach-2	1.556	PF 2	5539.00	475.00	0.058	1241.80	1251.27	9.47	1247.49	1251.45	0.001766	3.37	1644.79	294.61	0.25
Reach-2	1.466	PF 2	5539.00	410.00	0.052	1238.10	1247.67	9.57	1247.53	1249.23	0.024184	10.01	553.33	157.81	0.94
Reach-2	1.388	PF 2	5539.00	395.00	0.043	1236.20	1243.87	7.67	1242.75	1244.59	0.006004	6.83	810.75	229.32	0.64
Reach-2	1.313	PF 2	5539.00	405.00	0.060	1234.20	1242.00	7.80		1242.37	0.004812	4.88	1160.81	253.97	0.39
Reach-2	1.237	PF 2	5539.00	335.00	0.056	1230.70	1240.87	10.17		1241.12	0.002037	4.03	1407.45	242.00	0.28
Reach-2	1.173	PF 2	5539.00	75.00	0.047	1227.40	1240.64	13.24		1240.78	0.000523	3.31	1909.43	268.67	0.18
Reach-2	1.159	PF 2	5539.00	60.00	0.038	1226.00	1240.28	14.28	1237.26	1240.69	0.001548	5.25	1157.13	265.00	0.39
Reach-2	1.154		Culvert												
Reach-2	1.148	PF 2	7139.00	125.00	0.026	1224.40	1235.36	10.96	1235.36	1238.66	0.005715	14.58	492.01	83.29	1.00
Reach-2	1.124	PF 2	7139.00	265.00	0.025	1223.40	1233.89	10.49	1230.85	1234.93	0.001385	8.17	873.82	120.18	0.53
Reach-2	1.074	PF 2	7139.00	400.00	0.025	1220.20	1231.16	10.96	1231.09	1234.10	0.005117	13.77	518.42	85.90	0.99
Reach-2	0.998	PF 2	7139.00	410.00	0.027	1217.60	1229.00	11.40	1229.00	1231.85	0.006052	13.54	527.36	92.05	1.00
Reach-2	0.92	PF 2	7139.00	395.00	0.025	1214.50	1222.46	7.96	1224.11	1227.67	0.017447	18.33	389.43	119.70	1.79
Reach-2	0.846	PF 2	7776.00	400.00	0.025	1213.20	1224.01	10.81	1221.77	1224.23	0.000558	4.94	2967.86	781.45	0.34
Reach-2	0.770	PF 2	7776.00	390.00	0.025	1211.10	1223.02	11.92		1223.84	0.001422	8.11	1677.95	538.06	0.54
Reach-2	0.696	PF 2	7776.00	400.00	0.025	1208.80	1219.68	10.88	1219.68	1222.66	0.005272	13.86	561.08	94.91	1.00
Reach-2	0.620	PF 2	7776.00	410.00	0.025	1207.20	1216.27	9.07	1217.52	1220.02	0.007946	15.88	629.12	314.58	1.22
Reach-2	0.543	PF 2	7776.00		0.025	1205.10	1214.30	9.20	1214.64	1216.89	0.005903	13.53	682.25	192.11	1.05



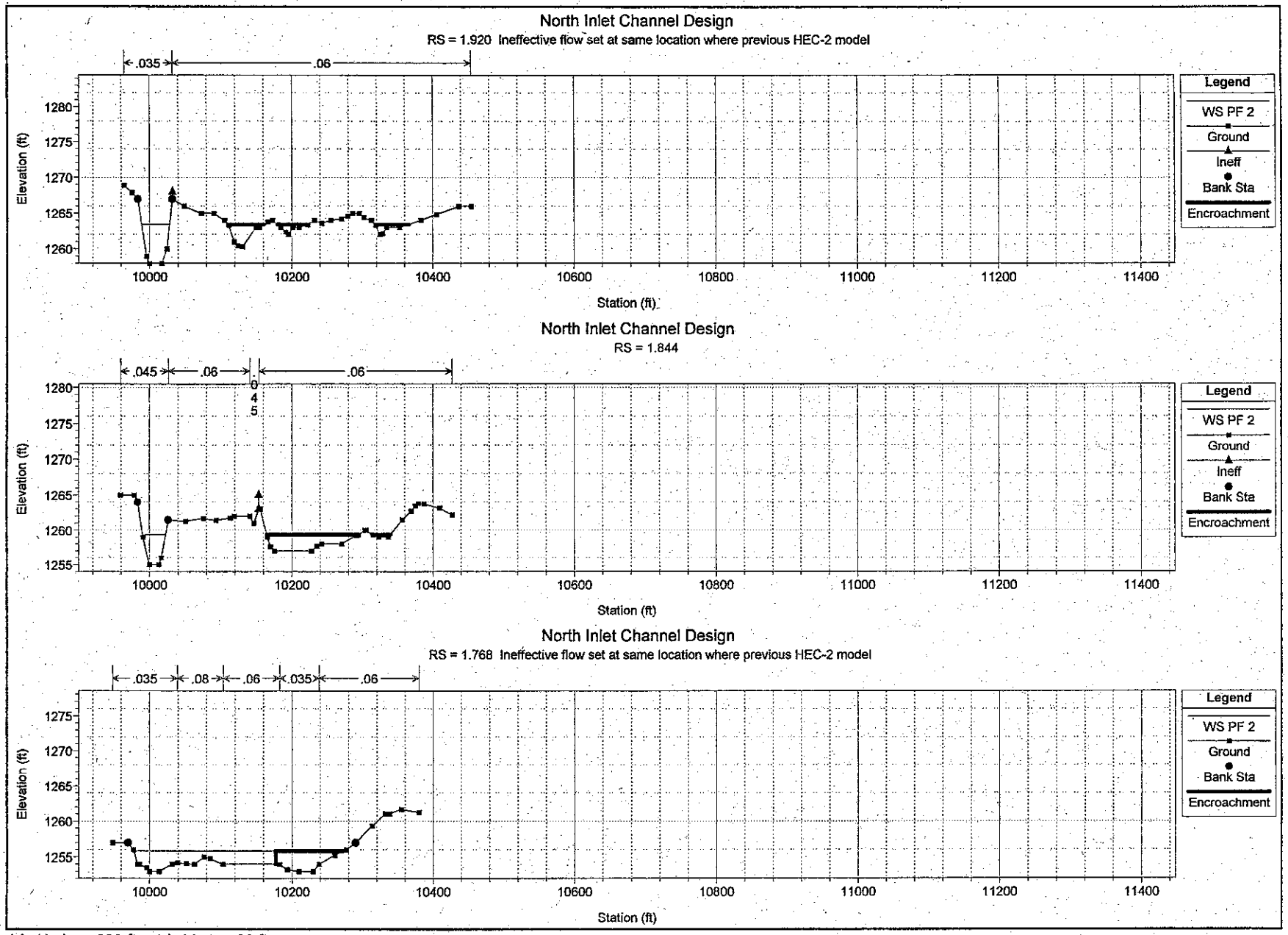




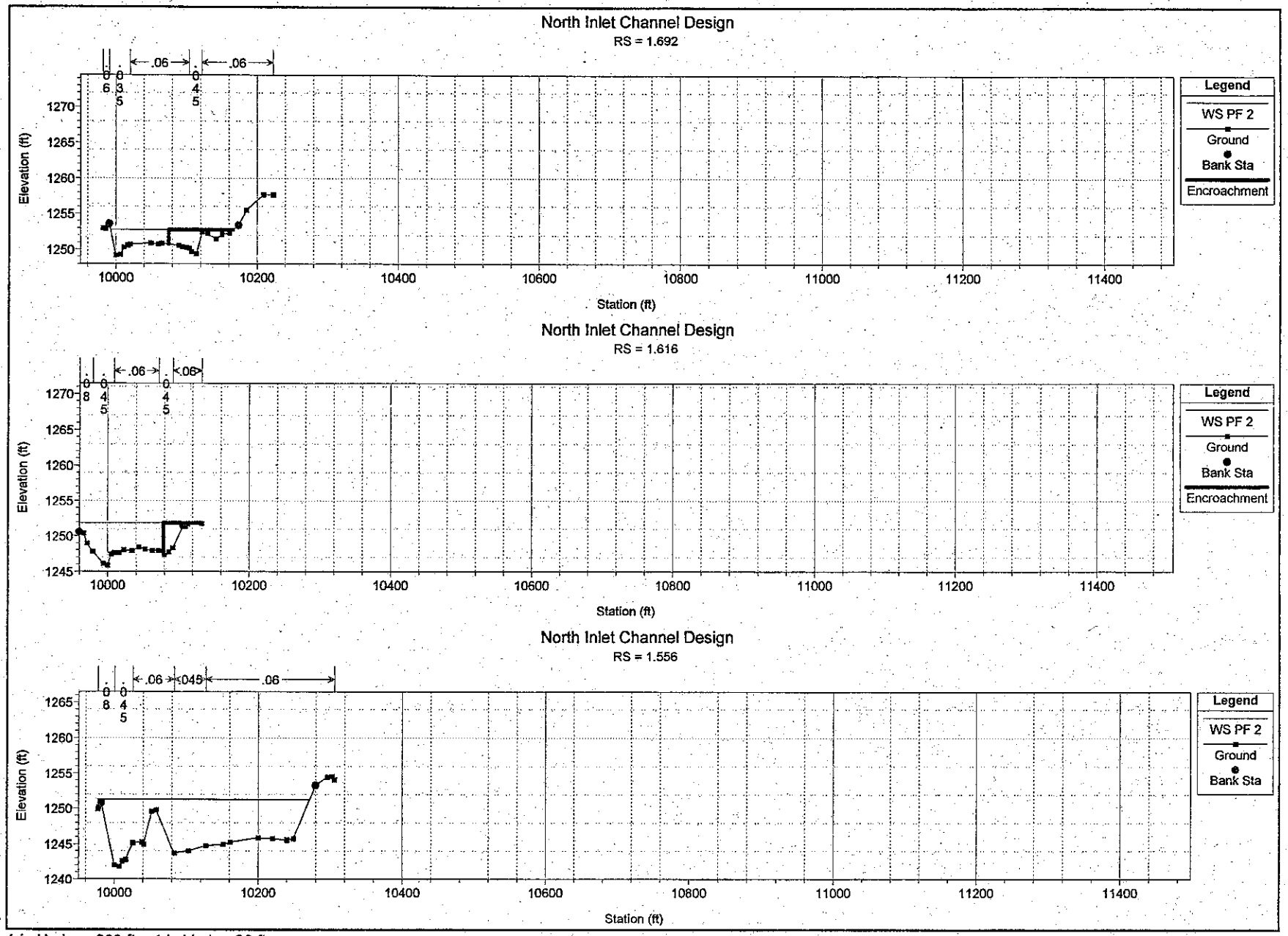
1 in Horiz. = 200 ft 1 in Vert. = 20 ft



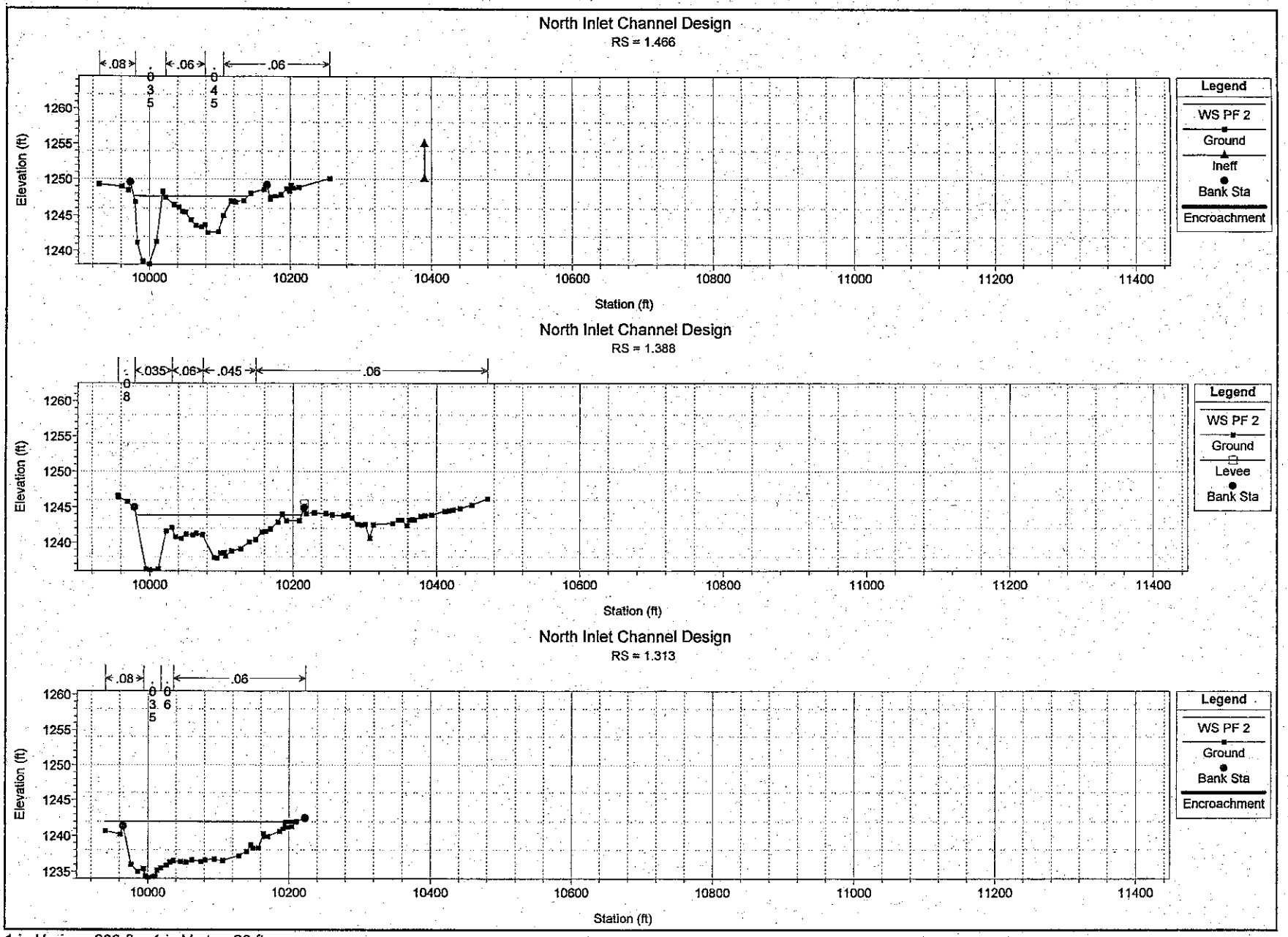
1 in Horiz. = 200 ft . 1 in Vert. = 20 ft



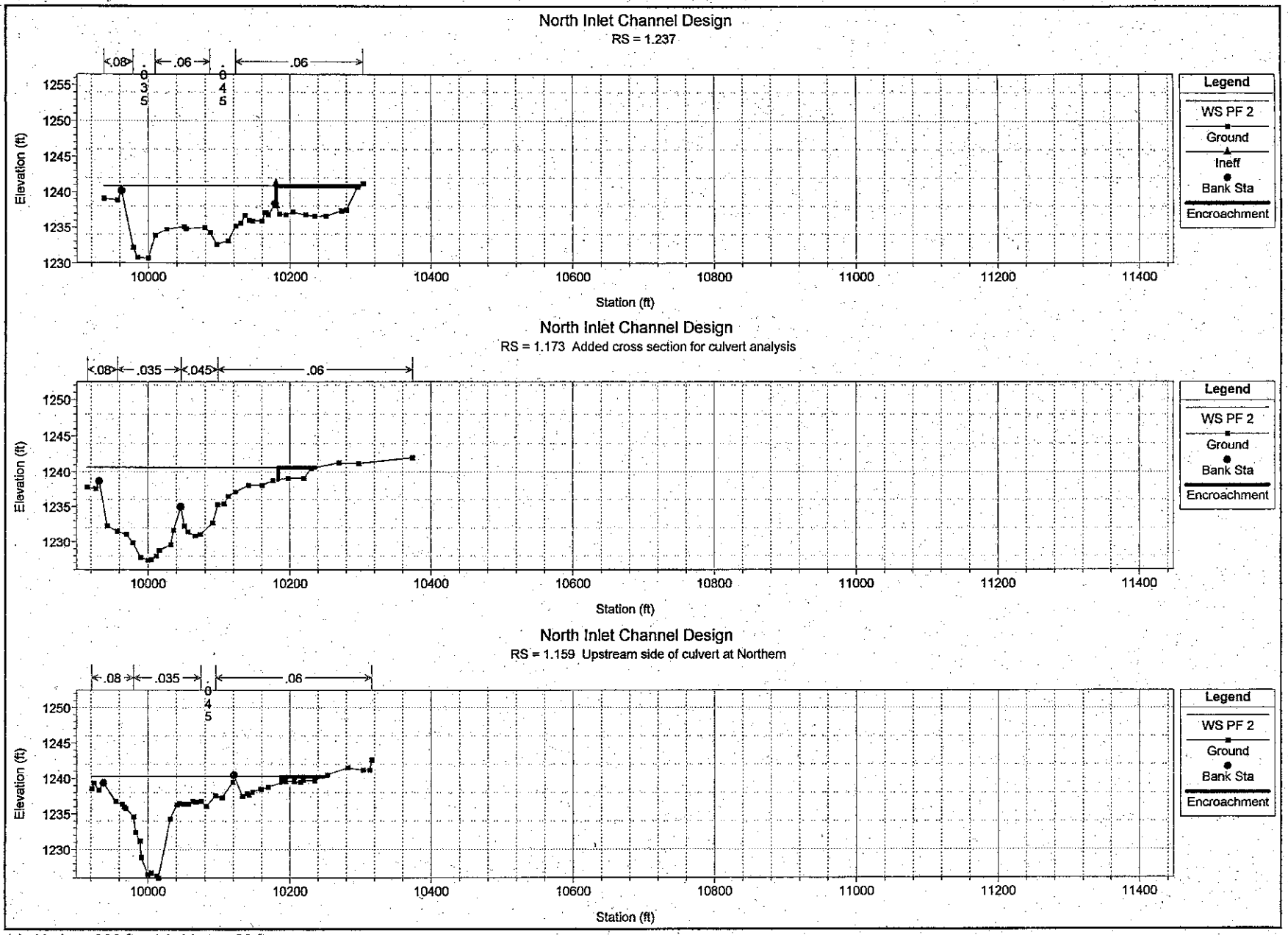
1 in Horiz. = 200 ft 1 in Vert. = 20 ft



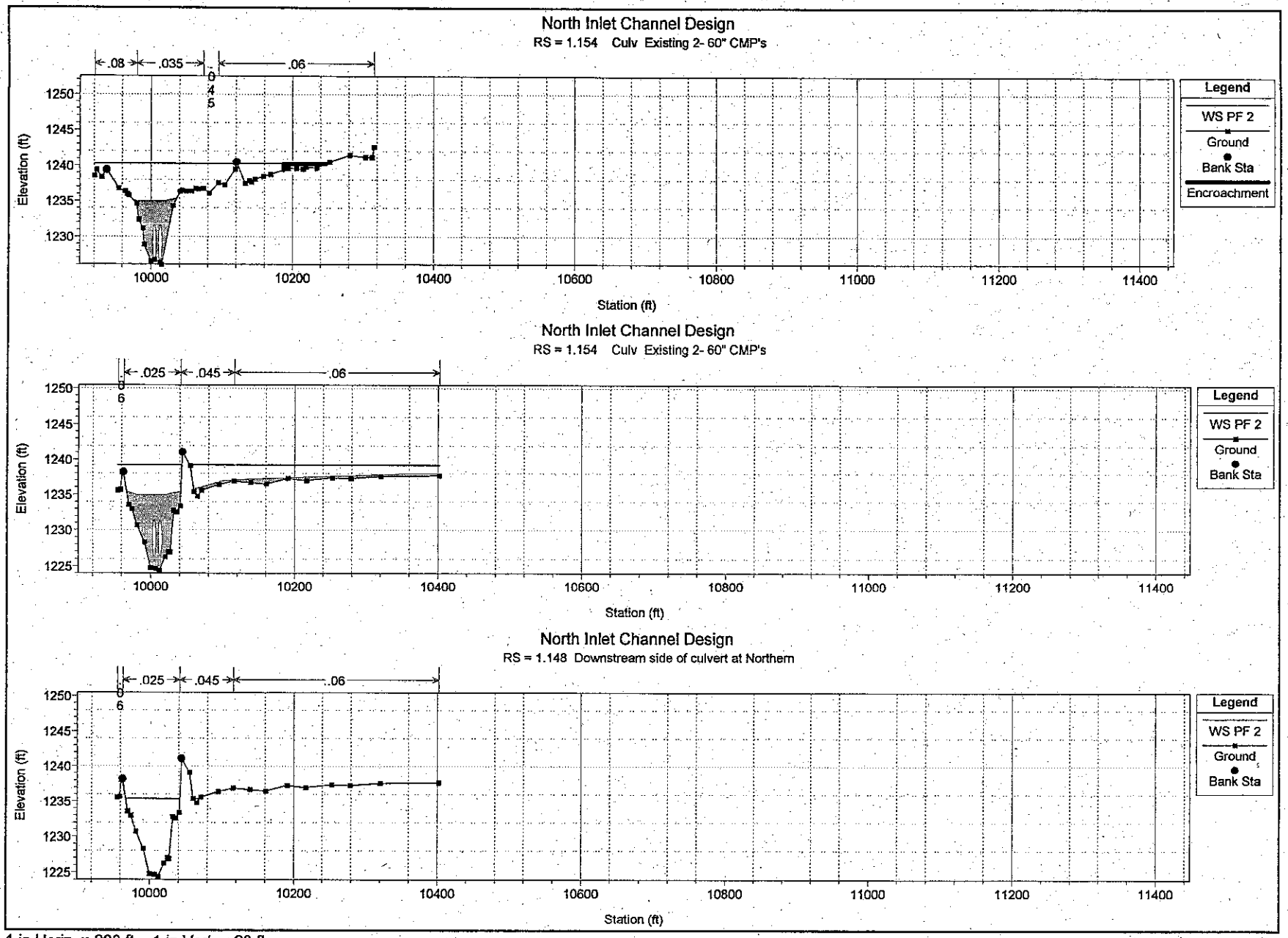
1 in Horiz. = 200 ft 1 in Vert. = 20 ft



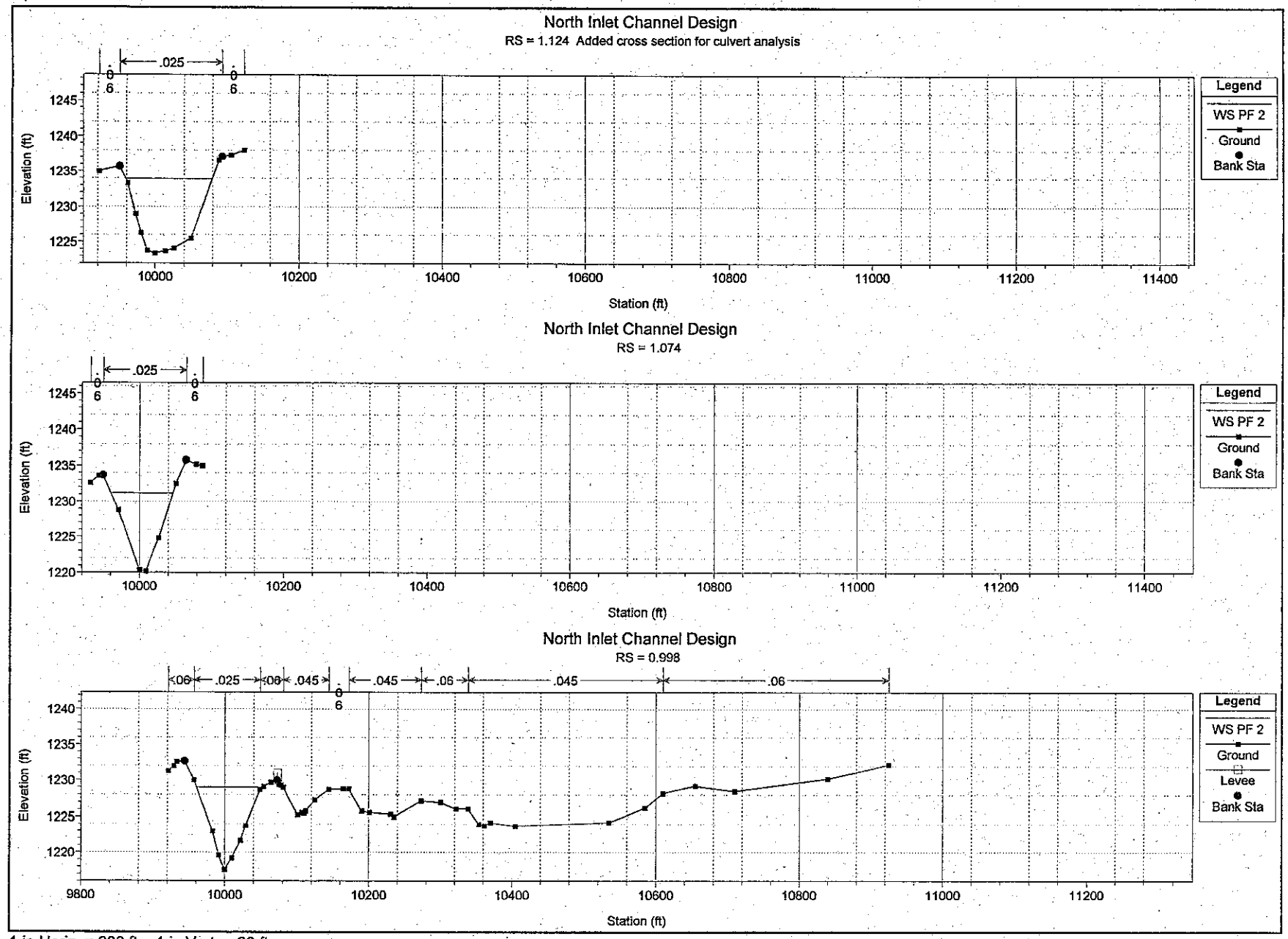
1 in Horiz. = 200 ft 1 in Vert. = 20 ft



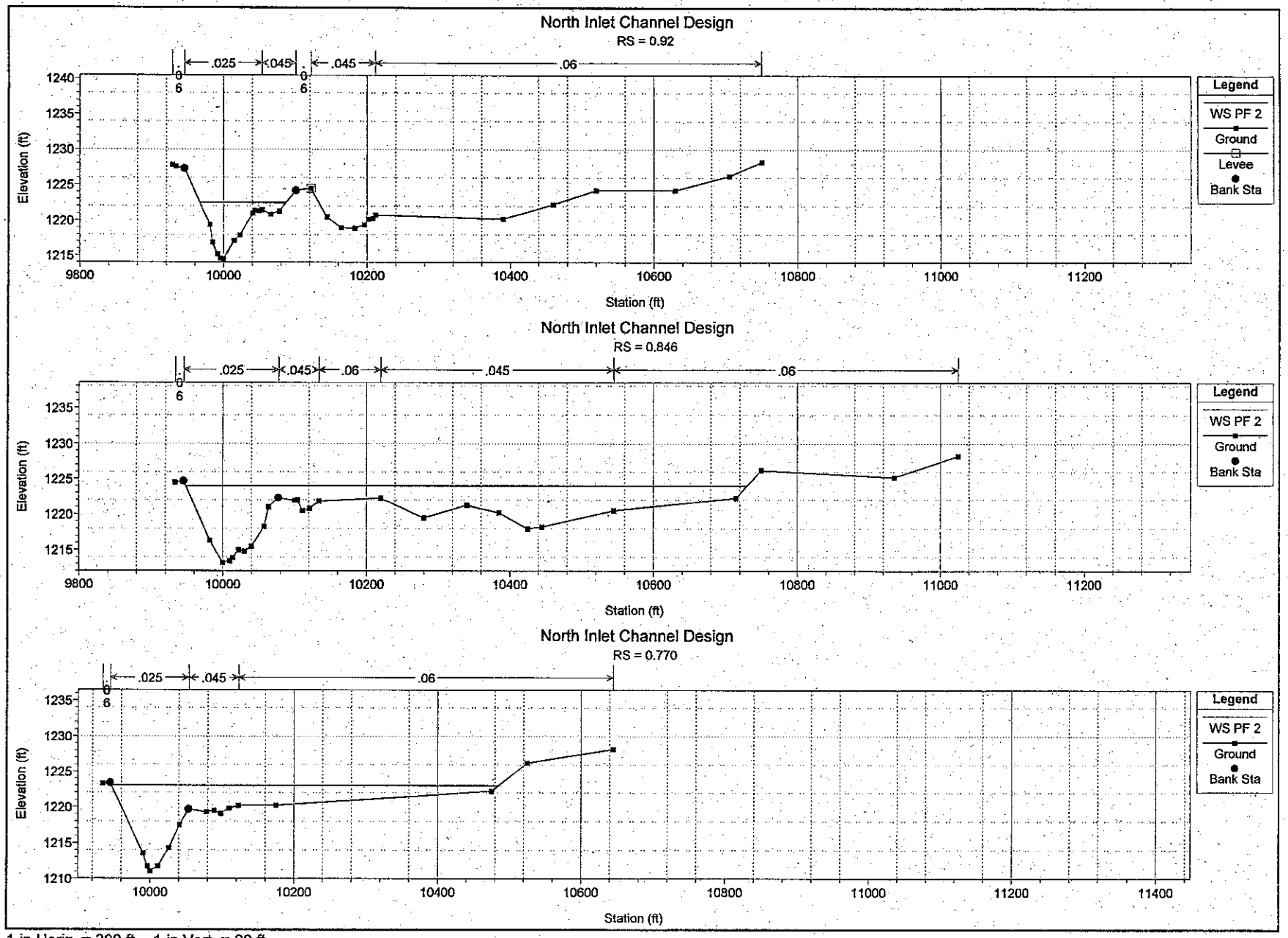
1 in Horiz. = 200 ft 1 in Vert. = 20 ft



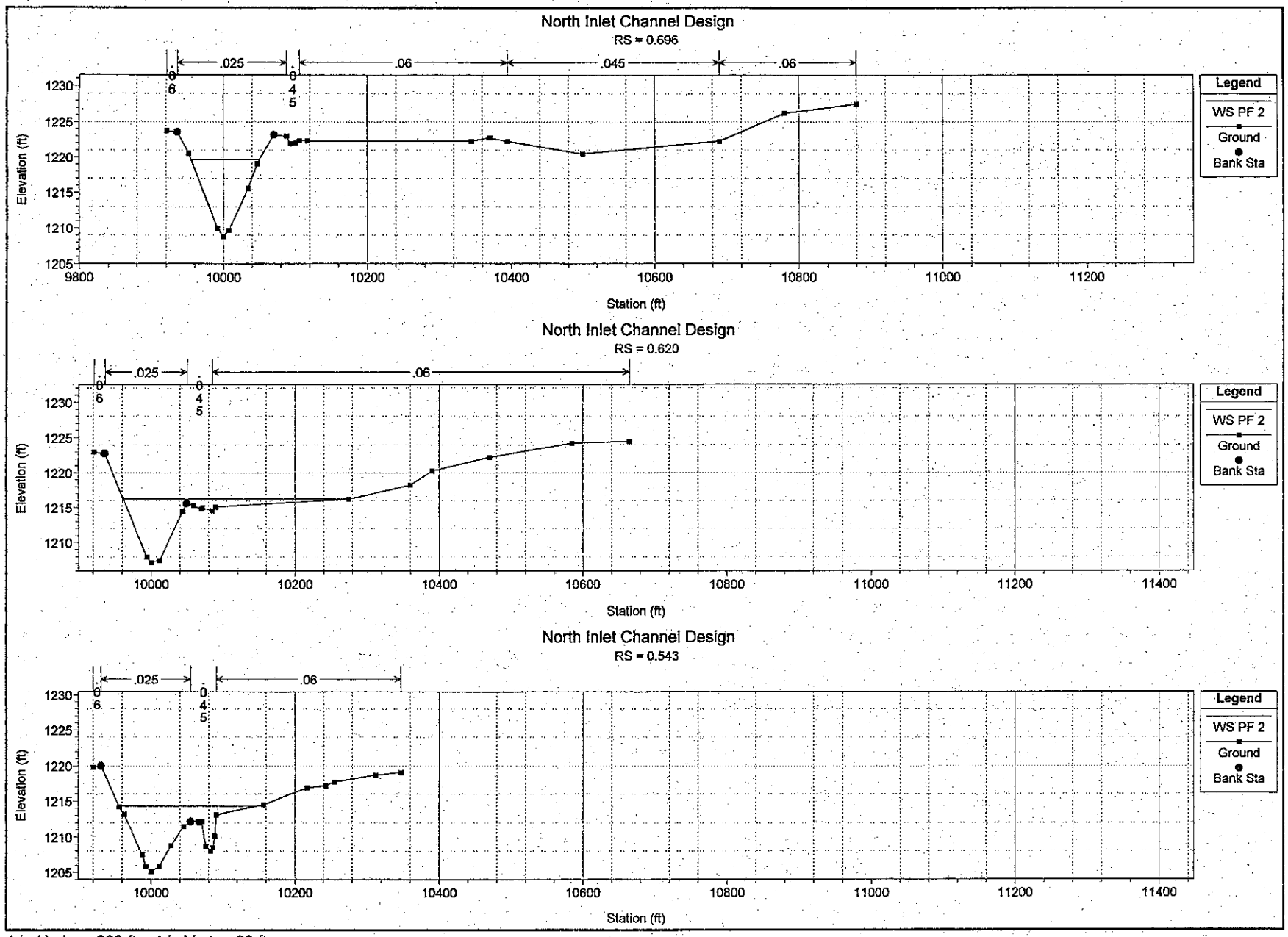
1 in Horiz. = 200 ft 1 in Vert. = 20 ft



1 in Horiz. = 200 ft 1 in Vert. = 20 ft



1 in Horiz. = 200 ft 1 in Vert. = 20 ft

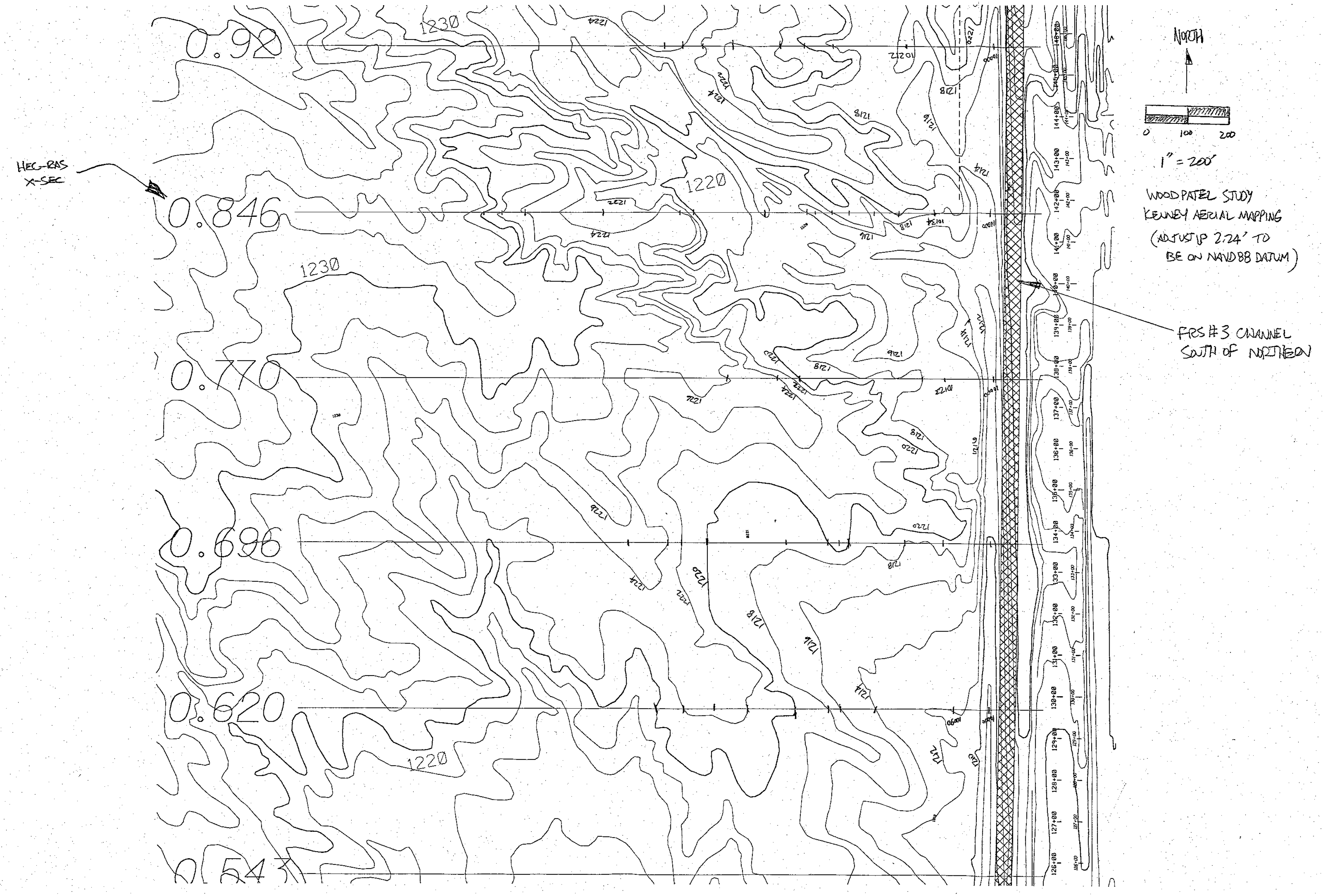


1 in Horiz. = 200 ft 1 in Vert. = 20 ft

From Predesign Study Mapping[1] to Supplement KM Mapping
Downstream of Northern Avenue and West of FRS#3 Channel

HECRAS I.D.	0.998			0.920			0.846			0.770			0.696			0.620		
			ADJ.			ADJ.			ADJ.			ADJ.			ADJ.			ADJ.
	STA	ELEV	ELEV	STA	ELEV	ELEV	STA	ELEV	ELEV	STA	ELEV	ELEV	STA	ELEV	ELEV	STA	ELEV	ELEV
	10000	1218.12	1220.36	10000	1215.50	1217.74	10000	1213.40	1215.64	10000	1211.25	1213.49	10000	1219.00	1221.24	10000	1207.75	1209.99
	10362	1222.25	1224.49	10212	1218.25	1220.49	10134	1218.00	1220.24	10123	1217.25	1219.49	10210	1218.00	1220.24	10090	1212.00	1214.24
	10370	1222.00	1224.24	10390	1218.00	1220.24	10220	1220.00	1222.24	10175	1218.00	1220.24	10345	1220.00	1222.24	10275	1214.00	1216.24
	10405	1221.50	1223.74	10460	1220.00	1222.24	10280	1217.25	1219.49	10475	1220.00	1222.24	10370	1220.50	1222.74	10360	1216.00	1218.24
	10535	1222.00	1224.24	10520	1222.00	1224.24	10340	1219.00	1221.24	10525	1224.00	1226.24	10395	1220.00	1222.24	10390	1218.00	1220.24
	10585	1224.00	1226.24	10630	1222.00	1224.24	10385	1218.00	1220.24	10645	1226.00	1228.24	10500	1218.25	1220.49	10470	1220.00	1222.24
	10610	1226.00	1228.24	10705	1224.00	1226.24	10425	1215.75	1217.99				10690	1220.00	1222.24	10585	1222.00	1224.24
	10655	1227.00	1229.24	10750	1226.00	1228.24	10445	1216.00	1218.24				10780	1224.00	1226.24	10665	1222.25	1224.49
	10710	1226.25	1228.49	10795	1226.25	1228.49	10545	1218.25	1220.49				10880	1225.25	1227.49			
	10840	1228.00	1230.24				10715	1220.00	1222.24									
	10925	1230.00	1232.24				10750	1224.00	1226.24									
							10935	1223.00	1225.24									
							11025	1226.00	1228.24									
							11225	1230.00	1232.24									

[1]From Kenney Aerial Mapping, Wood Patel Predesign Study



HEC-RAS X-SEC
0.92
0.846
0.770
0.696
0.620
0.543
1230
1220
NORTH
0 100 200
1" = 200'
WOODPATEL STUDY
KENNEY AERIAL MAPPING
(ADJUST UP 2.24' TO
BE ON NAVD88 DATUM)
FRS #3 CHANNEL
SOUTH OF NORTHERN

NORTH
0
50
100
1230
1228
1226
1224
1222
1220
1218
00001

X-Sec Data for new HEC-RAS Model

River Sta. 0.543		River Sta. 0.620		River Sta. 0.696		River Sta. 0.770		River Sta. 0.846		River Sta. 0.920	
X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
9920	1219.80	9921	1223.00	9921	1223.80	9934	1223.30	9934	1224.50	9929	1227.80
9931	1220.00	9936	1222.80	9936	1223.60	9945	1223.40	9946	1224.70	9934	1227.60
9956	1214.20	9994	1208.00	9952	1220.60	9990	1213.60	9982	1216.40	9946	1227.30
9963	1213.15	10000	1207.20	9992	1210.00	9996	1211.80	10000	1213.20	9981	1219.40
9988	1207.50	10012	1207.50	10000	1208.80	10000	1211.10	10010	1213.40	9985	1216.90
9993	1205.80	10044	1214.50	10008	1209.70	10011	1211.80	10014	1213.90	9992	1215.20
10000	1205.10	10050	1215.60	10035	1215.60	10026	1214.30	10022	1215.00	9996	1214.60
10011	1205.85	10059	1215.30	10047	1219.10	10041	1217.50	10030	1214.80	10000	1214.50
10028	1208.80	10070	1214.80	10071	1223.20	10054	1219.70	10040	1215.50	10015	1217.10
10045	1211.50	10072	1215.00	10088	1223.00	10078	1219.30	10058	1218.30	10023	1217.90
10055	1212.20	10085	1214.60	10094	1221.90	10089	1219.50	10064	1221.00	10041	1221.00
10065	1212.20	10090	1215.10	10101	1222.00	10098	1219.10	10078	1222.30	10044	1221.40
10067	1212.00			10106	1222.30	10110	1219.80	10100	1221.90	10050	1221.30
10071	1212.20			10117	1222.30	10123	1220.20	10104	1222.00	10054	1221.50
10076	1208.75							10111	1220.50	10066	1220.90
10083	1208.00							10121	1220.80	10078	1221.30
10086	1208.50							10134	1221.80	10101	1224.20
10089	1210.15									10122	1224.50
10091	1213.10									10144	1220.50
10157	1214.50									10164	1219.00
10217	1216.90									10183	1218.90
10243	1217.20		Note:							10196	1219.40
10255	1217.75		Supplementary floodplain data obtained from: →							10202	1220.20
10312	1218.75		Kenney Aerial mapping / Wood Patel Study							10208	1220.30
10347	1219.10	←	for cross-sections 0.543 to 0.920							10212	1220.80

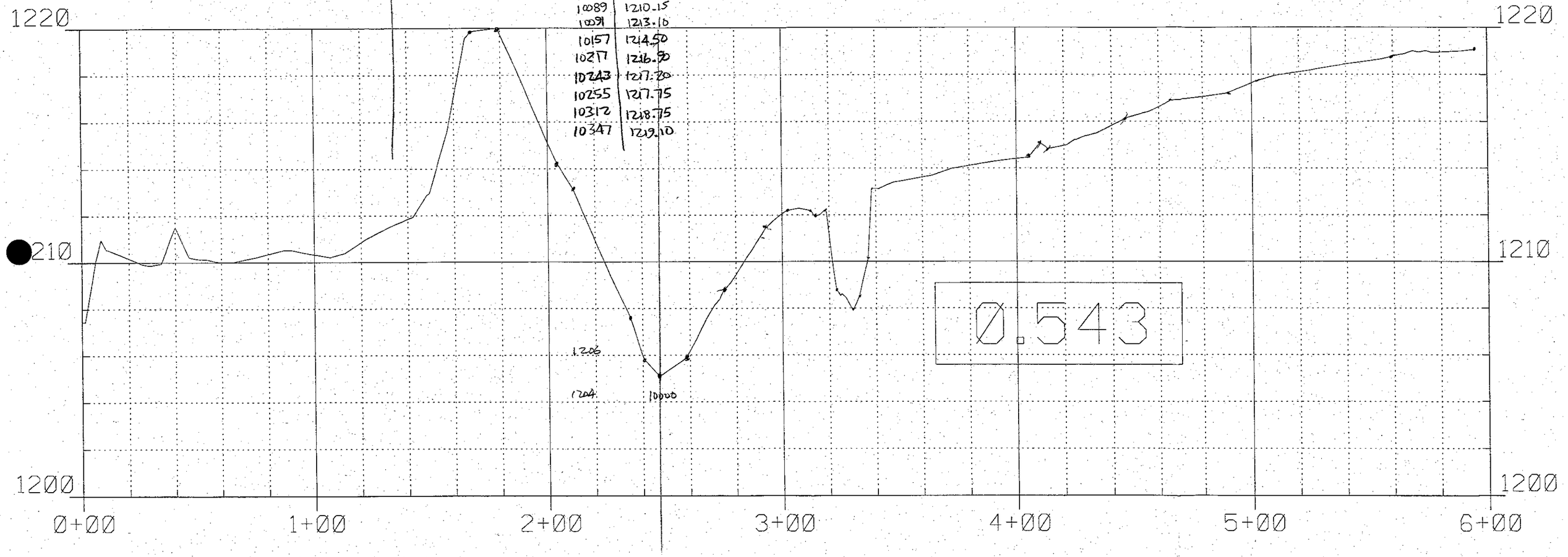
River Sta. 0.998		River Sta. 1.074		River Sta. 1.124		River Sta. 1.148		River Sta. 1.159		River Sta. 1.173		River Sta. 1.237		River Sta. 1.313	
X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
9921	1231.30	9923	1232.60	9922	1235.00	9955	1235.60	9921	1238.60	9915	1237.80	9938	1239.10	9940	1240.70
9929	1232.00	9935	1233.60	9951	1235.70	9959	1235.70	9924	1239.40	9927	1237.60	9957	1238.90	9961	1240.20
9933	1232.60	9941	1233.70	9962	1233.30	9961	1238.10	9931	1238.40	9932	1238.70	9963	1240.20	9965	1241.40
9944	1232.70	9962	1228.80	9973	1229.00	9963	1238.20	9938	1239.40	9943	1232.30	9979	1232.20	9976	1236.00
9957	1230.00	9991	1220.40	9980	1226.30	9970	1233.60	9955	1236.80	9957	1231.60	9985	1230.80	9986	1235.00
9983	1223.00	10000	1220.20	9989	1223.80	9974	1233.00	9964	1236.40	9970	1231.10	10000	1230.70	9994	1235.40
9992	1219.60	10018	1224.80	10000	1223.40	9981	1230.70	9967	1236.00	9979	1229.90	10010	1233.90	9997	1234.40
10000	1217.60	10042	1232.50	10014	1223.70	9992	1228.30	9969	1235.80	9990	1227.80	10026	1234.70	10000	1234.20
10010	1219.20	10056	1235.80	10026	1224.10	10000	1224.80	9980	1234.60	10000	1227.40	10050	1235.10	10007	1234.30
10022	1221.70	10070	1235.20	10050	1225.50	10007	1224.70	9983	1232.40	10005	1227.50	10053	1234.80	10010	1234.40
10029	1223.80	10079	1235.00	10089	1236.60	10012	1224.40	9989	1231.20	10012	1228.00	10079	1235.00	10013	1235.20
10049	1228.70			10094	1237.10	10020	1226.30	9991	1228.90	10016	1228.80	10087	1234.30	10018	1235.50
10054	1229.10			10106	1237.30	10025	1227.00	10000	1226.50	10032	1229.60	10096	1232.60	10026	1235.90
10064	1229.70			10124	1238.00	10027	1226.90	10005	1226.70	10036	1231.70	10112	1233.10	10031	1236.30
10073	1230.00					10032	1232.80	10013	1226.30	10046	1235.00	10123	1235.20	10036	1236.50
10075	1229.40					10036	1232.60	10015	1226.00	10051	1232.30	10130	1235.60	10046	1236.40
10078	1229.30					10041	1233.40	10031	1234.30	10056	1231.50	10136	1236.70	10054	1236.30
10081	1229.00					10044	1241.10	10041	1236.30	10066	1230.90	10142	1236.00	10062	1236.60
10101	1225.30					10055	1239.10	10044	1236.50	10073	1231.10	10147	1235.90	10075	1236.40
10107	1225.60					10060	1235.40	10050	1236.40	10091	1232.70	10160	1235.90	10081	1236.60
10110	1225.50					10065	1234.80	10057	1236.40	10098	1235.30	10164	1237.10	10094	1236.70
10112	1225.80					10071	1235.60	10063	1236.80	10107	1235.40	10166	1237.10	10106	1236.50
10125	1227.30					10095	1236.40	10067	1236.70	10113	1236.50	10169	1236.80	10129	1237.20
10144	1228.70					10116	1236.85	10074	1236.80	10123	1237.10	10179	1238.40	10140	1237.80
10164	1228.80					10139	1236.70	10082	1236.10	10142	1238.10	10185	1236.90	10146	1238.70
10172	1228.80					10161	1236.50	10095	1237.60	10161	1238.10	10194	1236.80	10149	1238.30
10190	1225.80					10191	1237.30	10104	1237.30	10176	1238.80	10204	1237.20	10157	1238.30
10201	1225.60					10217	1237.00	10119	1239.50	10198	1239.10	10222	1236.80	10164	1240.30
10230	1225.40					10253	1237.35	10121	1240.50	10220	1239.10	10235	1236.60	10166	1239.90
10235	1225.00					10279	1237.30	10133	1237.50	10230	1240.50	10251	1236.60	10170	1239.90
10273	1227.20					10321	1237.60	10139	1237.90	10270	1241.30	10273	1237.40	10187	1240.60
10300	1227.00					10402	1237.70	10142	1237.70	10298	1241.20	10280	1237.50	10191	1241.00
10322	1226.10							10147	1238.10	10374	1242.00	10296	1240.70	10199	1241.20
10339	1226.10							10159	1238.50			10304	1241.20	10204	1241.30
10354	1224.00							10169	1238.80					10210	1242.00
10362	1223.80							10194	1239.60					10223	1242.50
								10206	1239.60						
								10215	1239.50						
								10219	1239.80						
								10235	1239.70						
								10253	1240.50						
								10282	1241.50						
								10304	1241.20						
								10313	1241.20						
								10316	1242.60						

X-Sec Data for new HEC-RAS Model

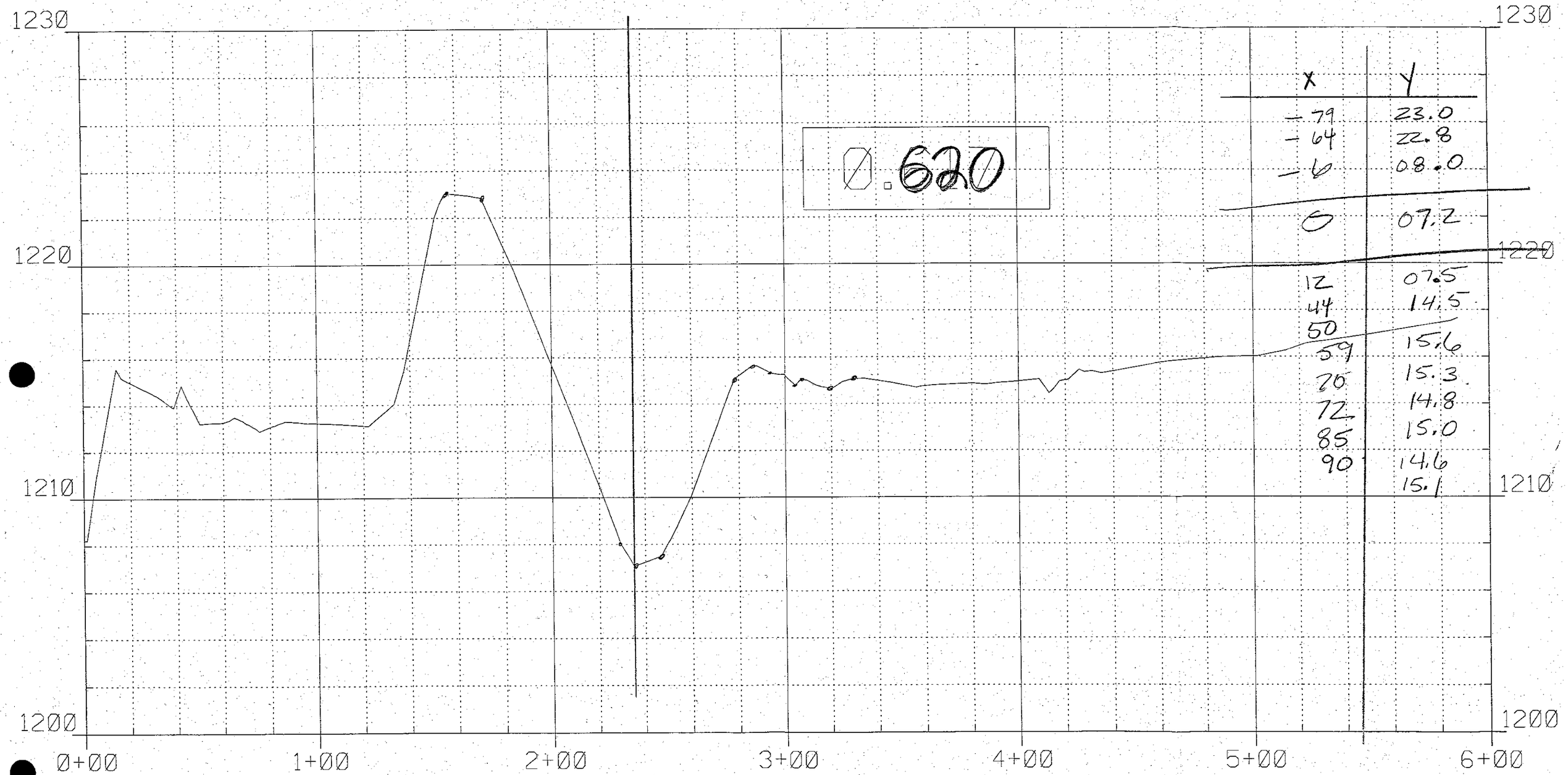
River Sta. 1.388		River Sta. 1.466		River Sta. 1.556		River Sta. 1.616		River Sta. 1.692	
X	Y	X	Y	X	Y	X	Y	X	Y
9943	1238.70	9929	1249.30	9977	1249.90	9960	1250.60	9982	1253.00
9956	1246.60	9961	1249.00	9978	1250.20	9966	1250.40	9986	1252.90
9957	1246.40	9970	1248.50	9982	1250.80	9971	1249.00	9991	1253.60
9969	1245.80	9973	1249.60	10000	1242.00	9979	1247.80	10000	1249.20
9977	1244.90	9980	1246.90	10007	1241.80	9994	1246.10	10007	1249.30
9979	1245.00	9983	1241.20	10011	1242.60	10000	1245.90	10012	1250.30
9995	1236.30	9991	1238.50	10016	1242.80	10005	1247.40	10017	1250.60
10000	1236.20	10000	1238.10	10025	1245.20	10009	1247.60	10020	1250.70
10012	1236.30	10010	1241.30	10038	1245.30	10016	1247.60	10050	1250.90
10023	1241.60	10019	1248.30	10041	1245.00	10023	1248.00	10060	1250.80
10031	1242.10	10023	1247.50	10052	1249.60	10034	1247.90	10065	1250.90
10036	1240.80	10035	1246.50	10058	1249.80	10044	1248.40	10089	1250.60
10044	1240.60	10042	1246.20	10083	1243.70	10053	1248.10	10094	1250.40
10051	1241.20	10047	1245.60	10103	1244.00	10063	1247.90	10100	1250.30
10060	1241.10	10051	1245.50	10127	1244.80	10072	1247.90	10104	1250.20
10065	1241.30	10059	1244.40	10151	1245.00	10080	1247.30	10107	1249.70
10074	1241.10	10066	1243.60	10161	1245.30	10086	1247.70	10114	1249.40
10090	1237.90	10074	1243.40	10200	1245.90	10092	1248.30	10122	1252.40
10094	1237.80	10079	1243.70	10220	1245.80	10107	1251.50	10130	1252.20
10099	1238.50	10083	1242.60	10240	1245.60	10110	1251.40	10142	1251.50
10104	1238.60	10098	1242.70	10249	1245.80	10113	1251.70	10150	1252.10
10106	1238.10	10105	1245.00	10280	1253.30	10133	1251.80	10161	1252.30
10114	1238.80	10116	1247.00	10296	1254.50			10174	1253.40
10127	1239.10	10119	1247.00	10303	1254.60			10185	1255.50
10139	1240.10	10122	1246.90	10306	1254.10			10209	1257.70
10148	1240.40	10134	1247.10					10223	1257.70
10157	1241.50	10144	1248.10						
10162	1241.60	10163	1248.60						
10169	1241.90	10167	1249.20						
10179	1242.90	10172	1247.30						
10185	1244.00	10187	1247.90						
10191	1243.10	10195	1248.70						
10209	1243.10	10199	1248.40						
10216	1244.90	10201	1249.20						
10219	1244.10	10204	1248.80						
10230	1244.20	10212	1248.90						
10246	1244.10	10256	1250.10						
10255	1243.90								
10271	1243.80								
10277	1243.90								
10282	1243.50								
10290	1242.60								
10296	1242.50								
10301	1242.60								
10307	1240.60								
10312	1242.50								
10339	1242.70								
10347	1243.20								
10352	1243.20								
10359	1242.40								
10362	1243.20								
10366	1243.30								
10369	1243.20								
10378	1243.70								
10384	1243.80								
10393	1243.90								
10411	1244.40								
10417	1244.50								
10423	1244.60								
10433	1244.80								
10449	1245.30								
10471	1246.20								

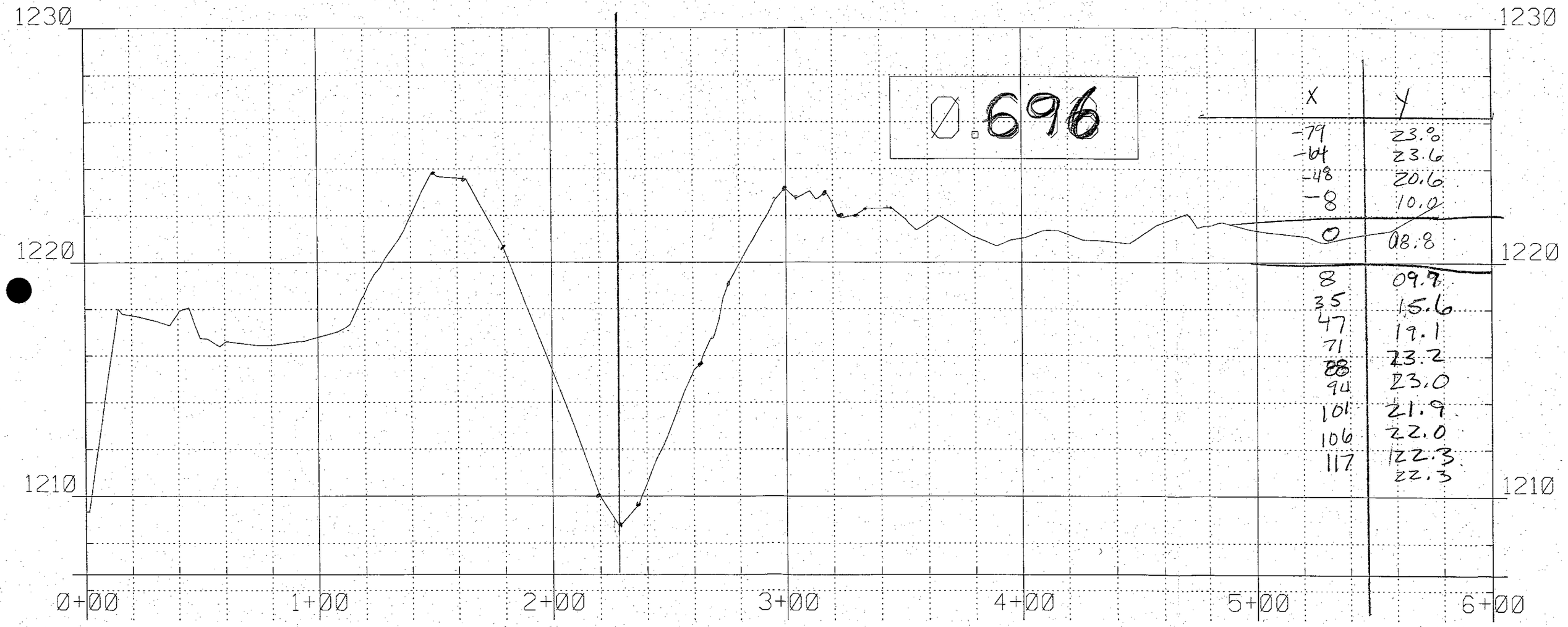
X	Y
-80	1219.80
-69	1220.00
-44	1214.20
-37	1213.15
-12	1207.50
-7	1205.80
10000	1205.10

X	Y
10000	1205.15
10011	1205.85
10028	1208.80
10045	1211.50
10055	1212.20
10065	1212.20
10067	1212.00
10071	1212.20
10076	1208.75
10083	1208.00
10086	1208.50
10089	1210.15
10091	1213.10
10157	1214.50
10217	1216.80
10243	1217.20
10255	1217.75
10312	1218.75
10347	1219.10

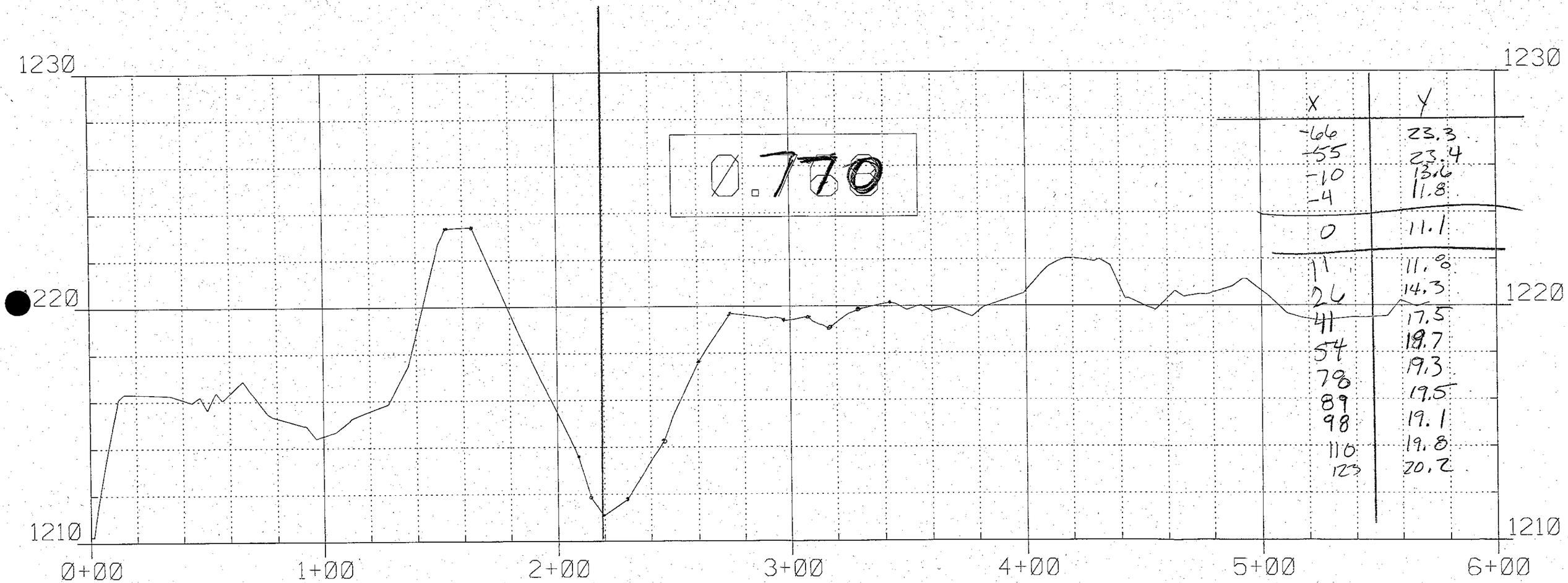


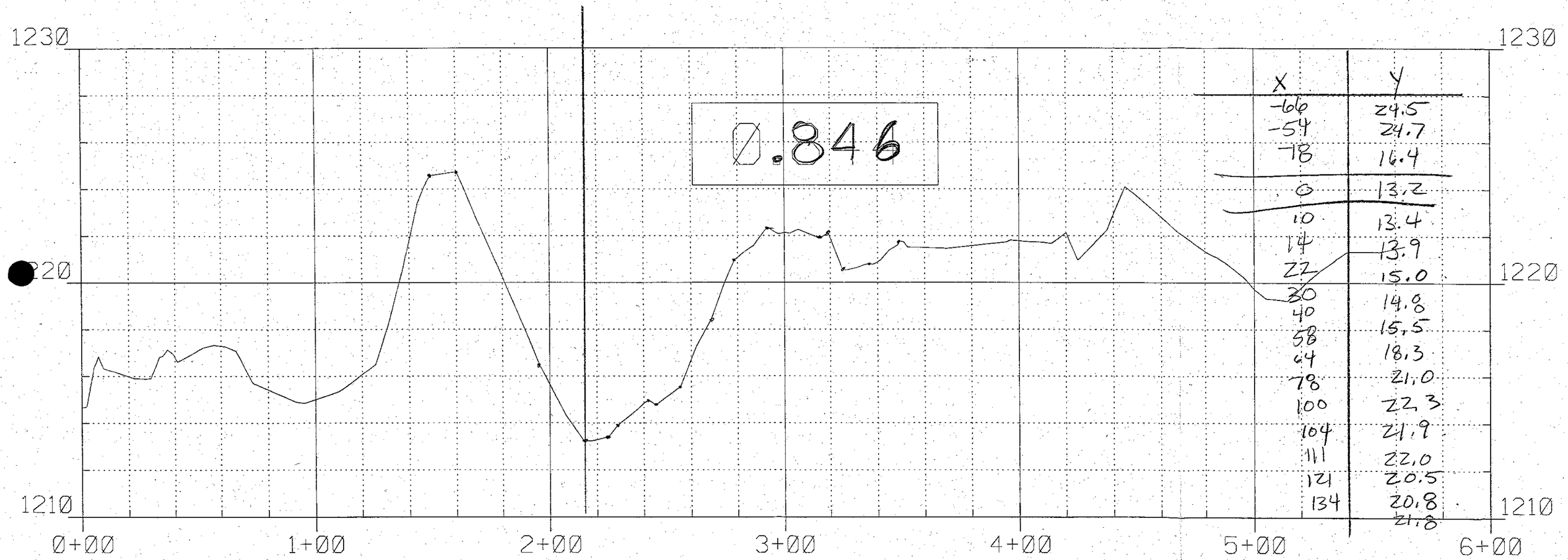
1" = 40'


1230
1220
1210
1200
0+00
1+00
2+00
3+00
4+00
5+00
6+00
0.620
X
Y
-79
23.0
-64
22.8
-6
08.0
0
07.2
12
07.5
44
14.5
50
59
15.6
70
15.3
72
14.8
85
15.0
90
14.6
15.1



X	Y
-79	23.0
-64	23.6
-48	20.6
-8	10.0
0	08.8
8	09.7
35	15.6
47	19.1
71	23.2
88	23.0
94	23.0
101	21.9
106	22.0
117	22.3
	22.3

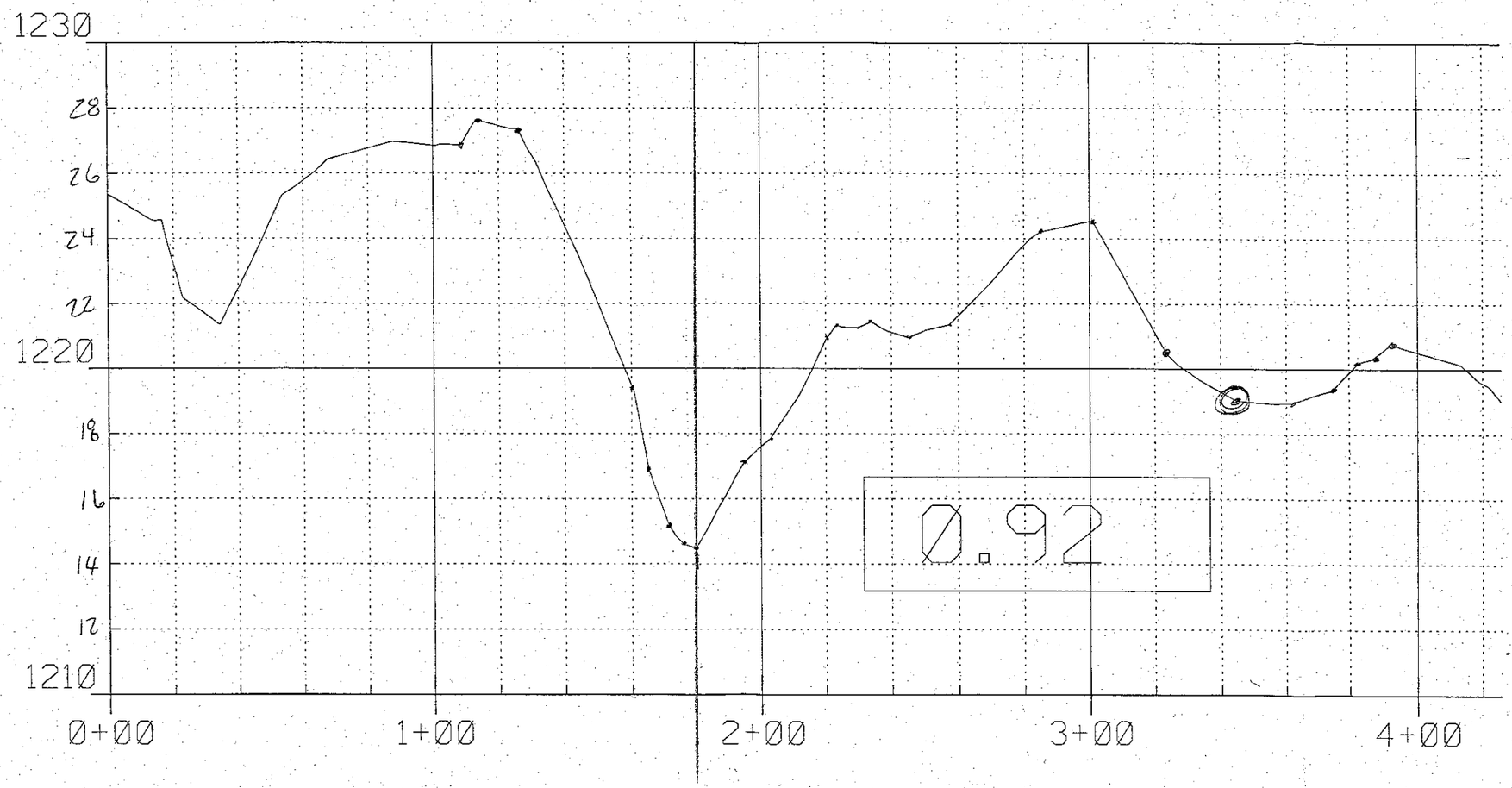

1230
1220
1210
0+00
1+00
2+00
3+00
4+00
5+00
6+00
0.770
X
Y
-66
23.3
-55
23.4
-10
13.6
-4
11.8
0
11.1
11
11.8
26
14.3
41
17.5
54
19.7
78
19.3
89
19.5
98
19.1
110
19.8
123
20.2



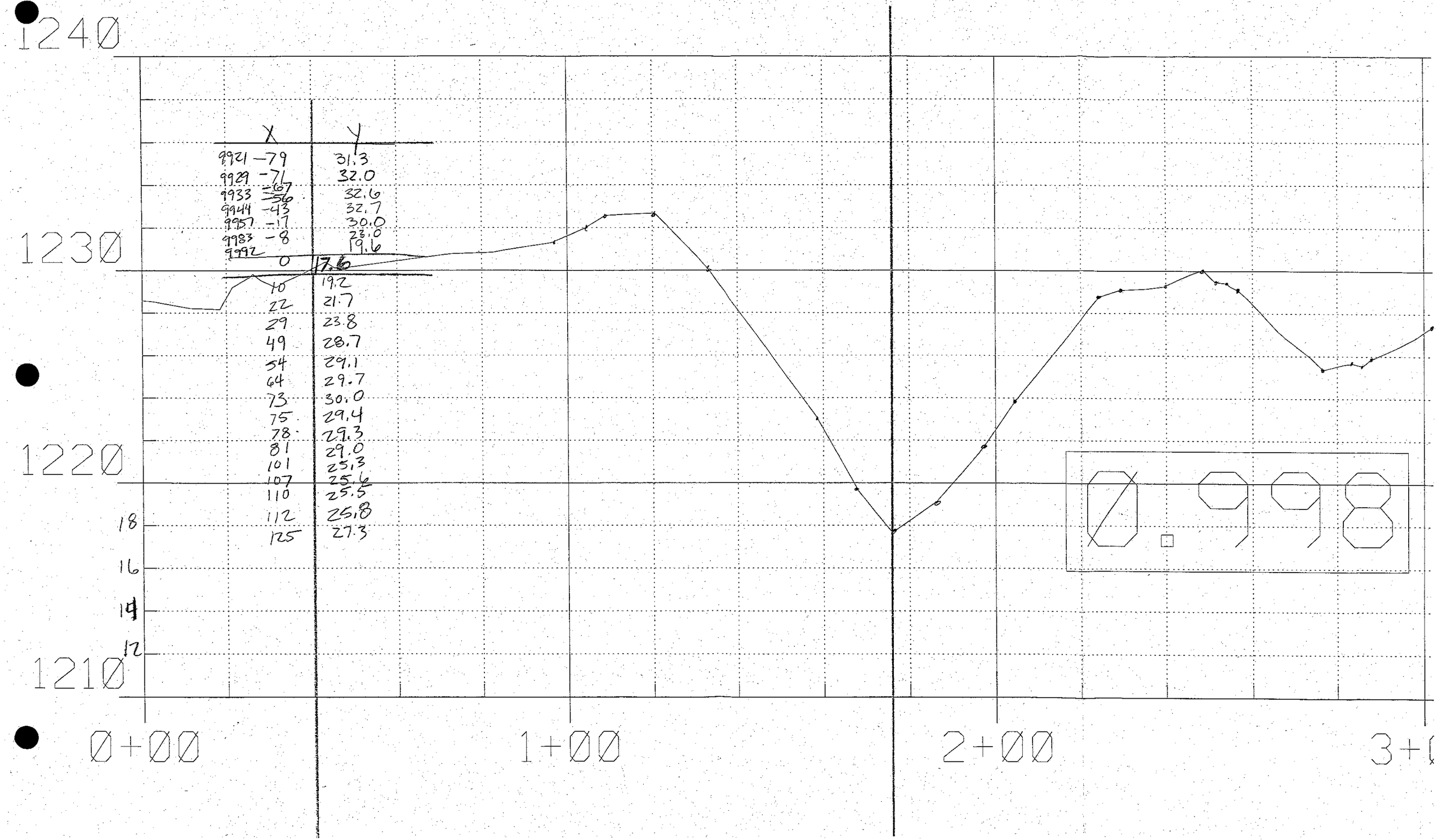
X	Y
-66	24.5
-54	24.7
-18	16.4
0	13.2
10	13.4
14	13.9
22	15.0
30	14.8
40	15.5
58	18.3
64	21.0
78	22.3
100	21.9
104	22.0
111	20.5
121	20.8
134	21.8

1.40
1.4

DONE

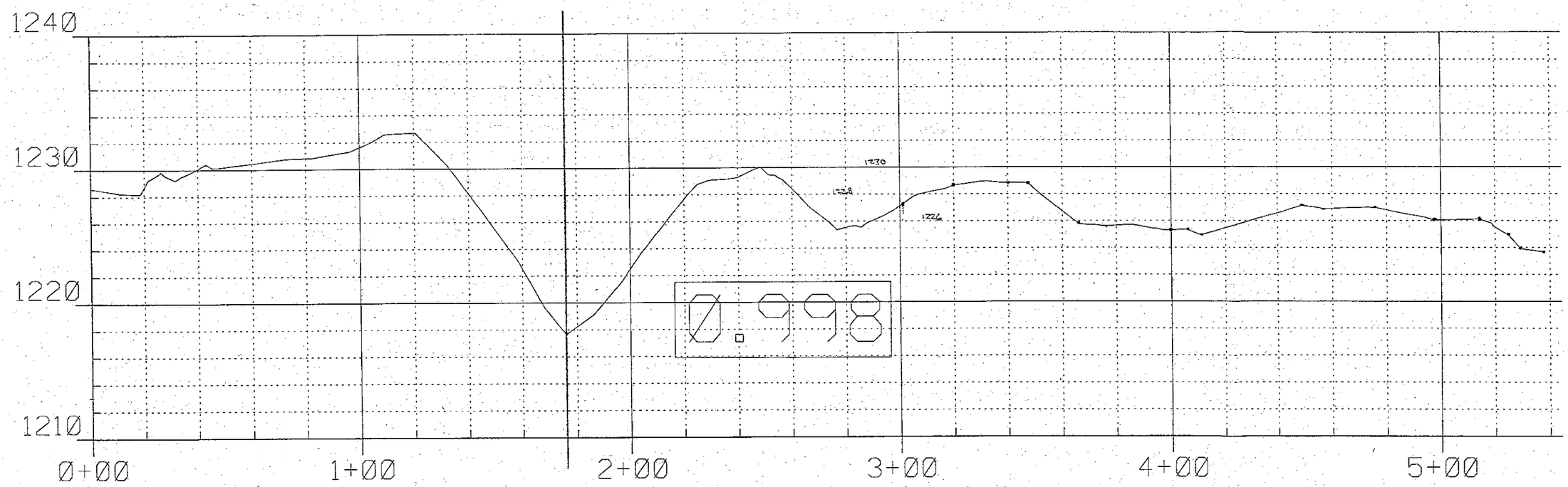


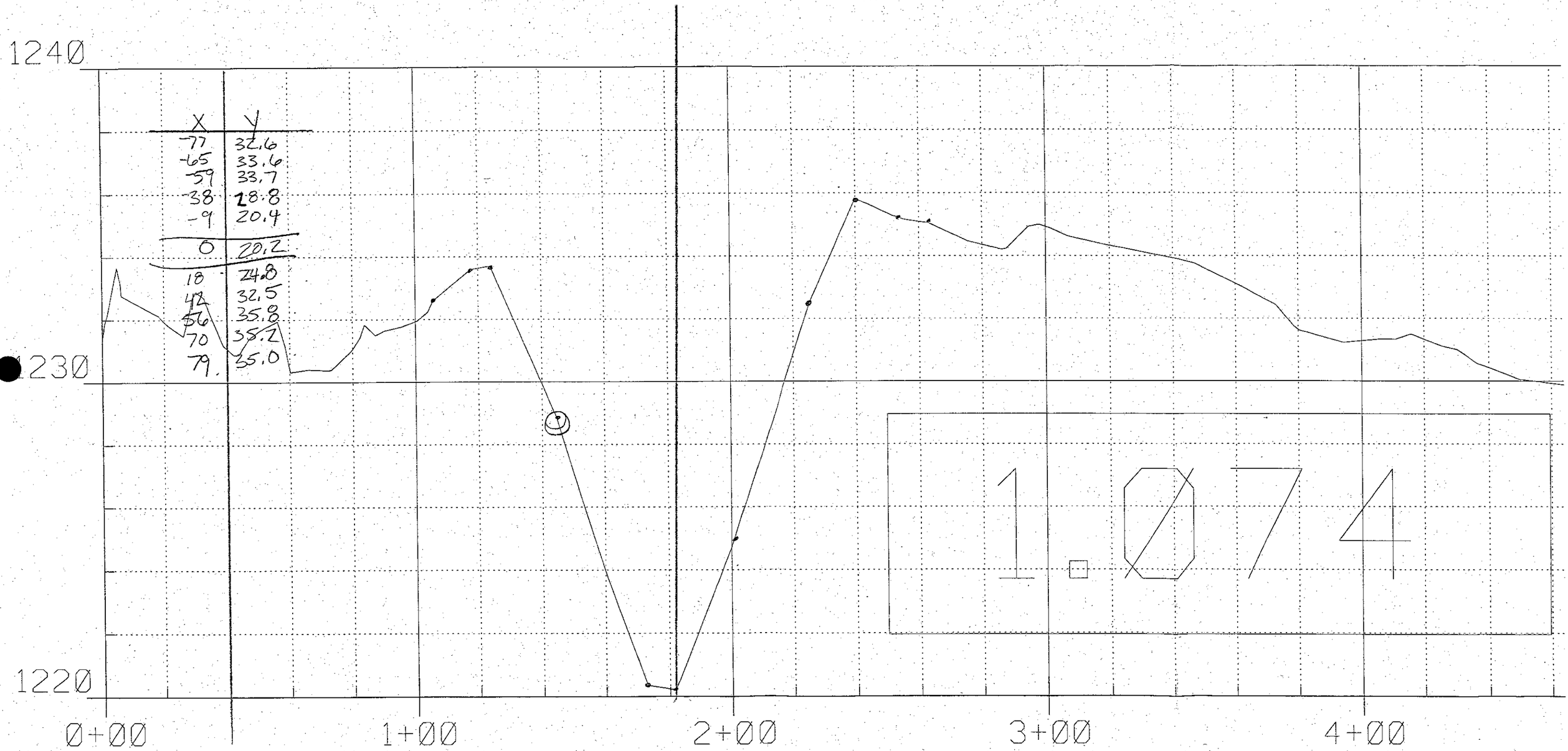
X	Y
-71	27.8
-66	27.6
9946 -54	27.3
9981 -19	19.4
9985 -15	16.9
9992 -8	15.2
9996 -4	14.6
10,000 0	14.5
15	17.1
23	17.9
41	21.0
44	21.4
50	21.3
54	21.5
66	20.9
78	21.3
101	24.2
122	24.5
144	20.5
164 150	19.0
183	18.9
196	19.4
202	20.2
208	20.3
212	20.8



X	Y
9921 −79	31.3
9929 −71	32.0
9933 −67	32.6
9944 −56	32.7
9957 −43	30.0
9983 −17	23.0
9992 −8	19.6
0	17.6
10	19.2
22	21.7
29	23.8
49	28.7
54	29.1
64	29.7
73	30.0
75	29.4
78	29.3
81	29.0
101	25.3
107	25.6
110	25.5
112	25.8
125	27.3

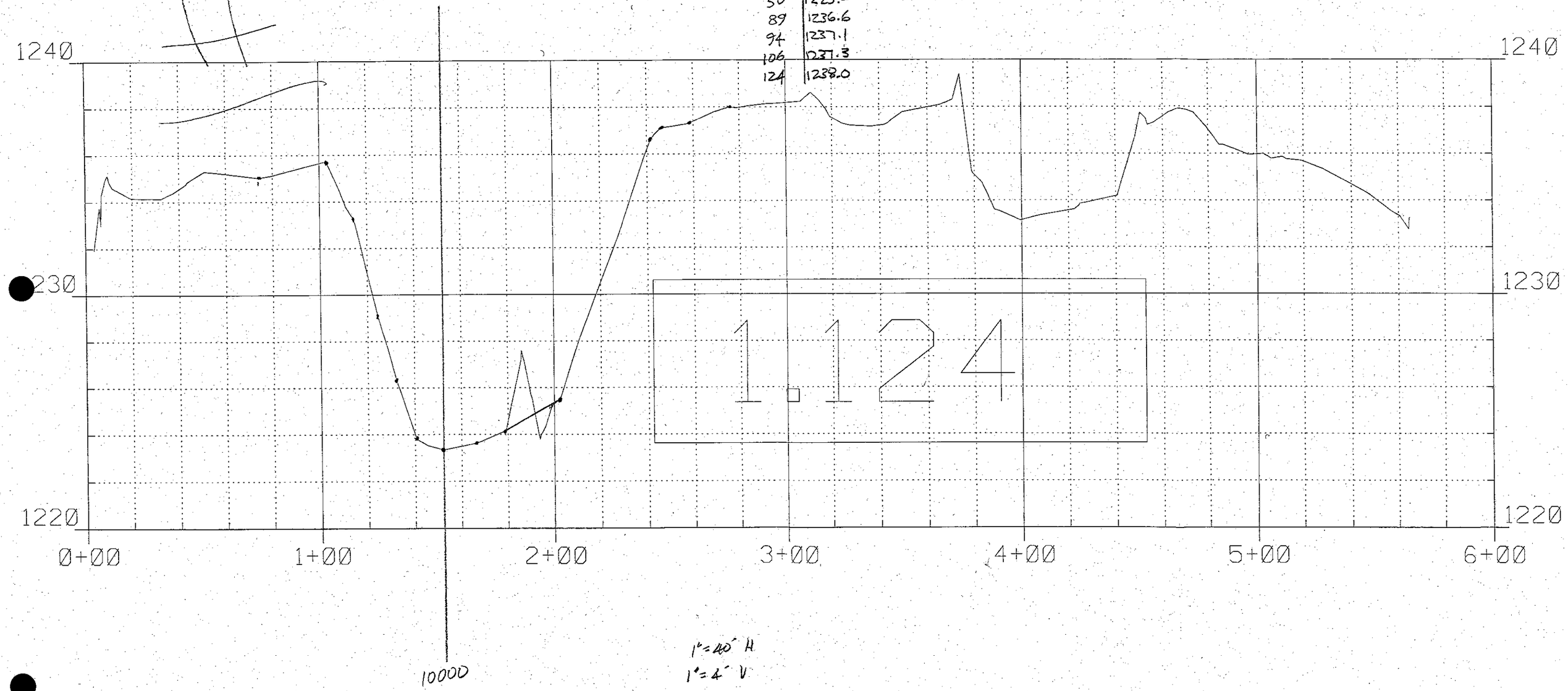
X	Y
10144	1228.70
10164	1228.80
10172	1228.80
10190	1225.80
10201	1225.60
10230	1225.40
10235	1225.00
10273	1227.20
10300	1227.00
10322	1226.10
10339	1226.10
10354	1224.00
10362	1223.80

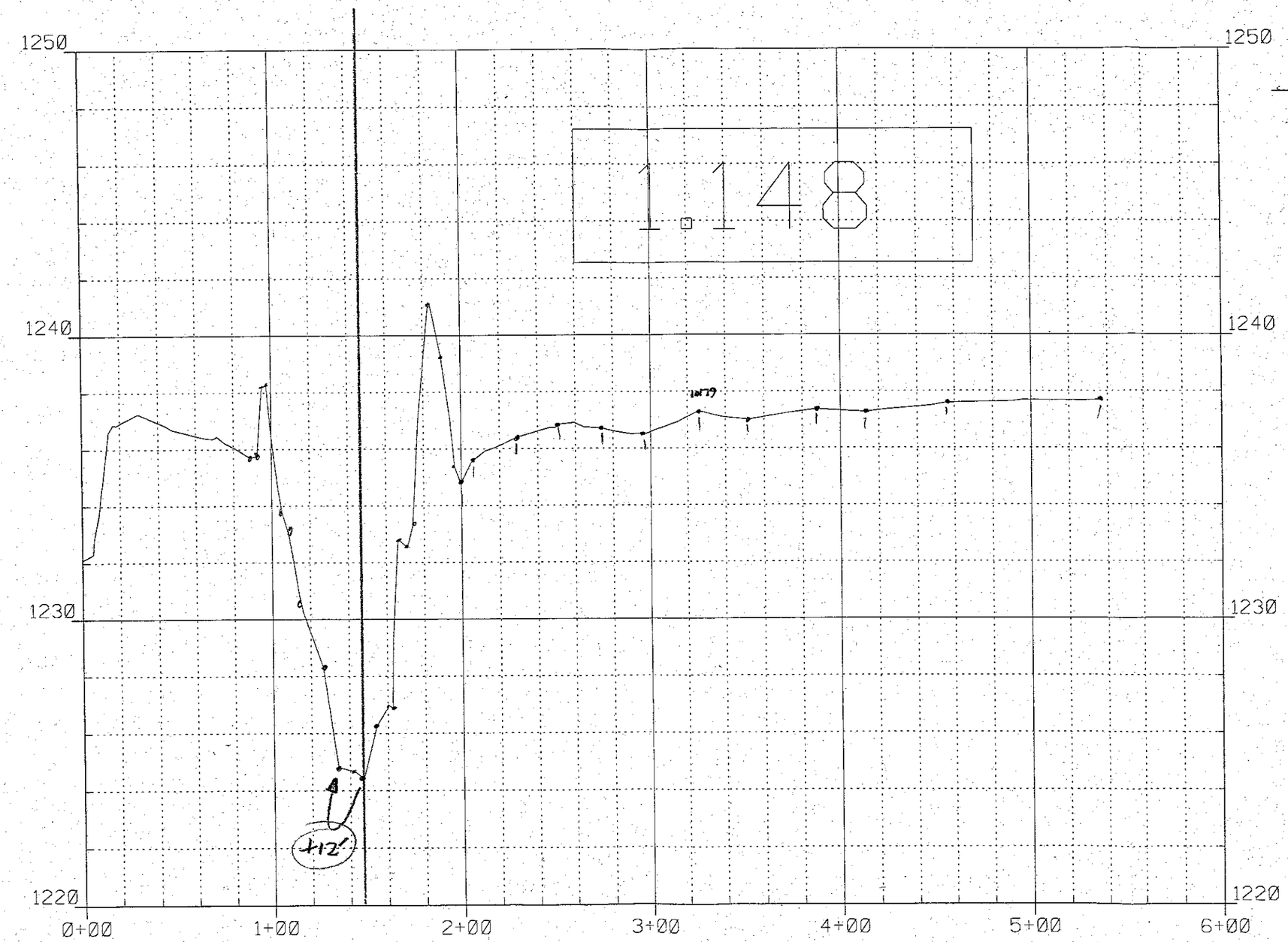




X	Y
-77	32.6
-65	33.6
-59	33.7
-38	28.8
-9	20.4
0	20.2
18	24.8
42	32.5
56	35.8
70	35.2
79	35.0

x	y
-78	1235.0
-49	1235.7
-38	1233.3
-27	1229.0
-20	1226.3
-11	1223.8
0	1223.4
14	1223.7
26	1224.1
50	1225.5
89	1236.6
94	1237.1
106	1237.3
124	1238.0



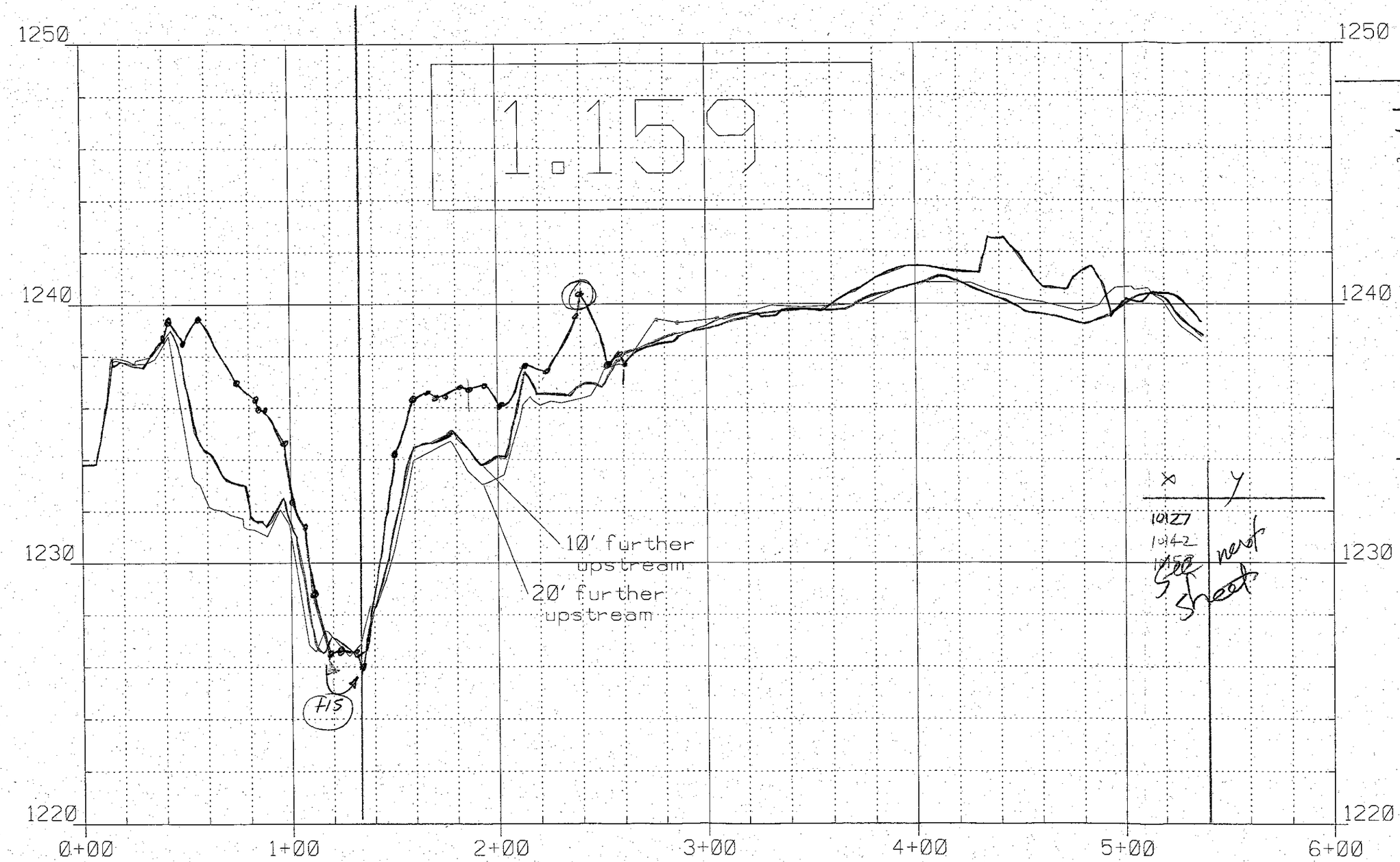


1"=4' V
1"=60' H

+12 feet

X	Y
-57	35.6
-53	35.7
-51	38.1
-49	38.2
-42	33.6
-38	33.0
-31	30.7
-20	28.3
-12	24.8
-5	24.7
0	24.4
8	26.3
13	27.0
15	26.9
20	32.8
24	32.6
29	33.4
32	41.1
43	39.1
48	35.4

10053	1234.8
10059	1235.6
10083	1236.4
10104	1236.85
10127	1236.70
10149	1236.50
10179	1237.30
10205	1237.00
10241	1237.35
10267	1237.30
10309	1237.60
10390	1237.70



1"=50' H
1"=4' V

+15

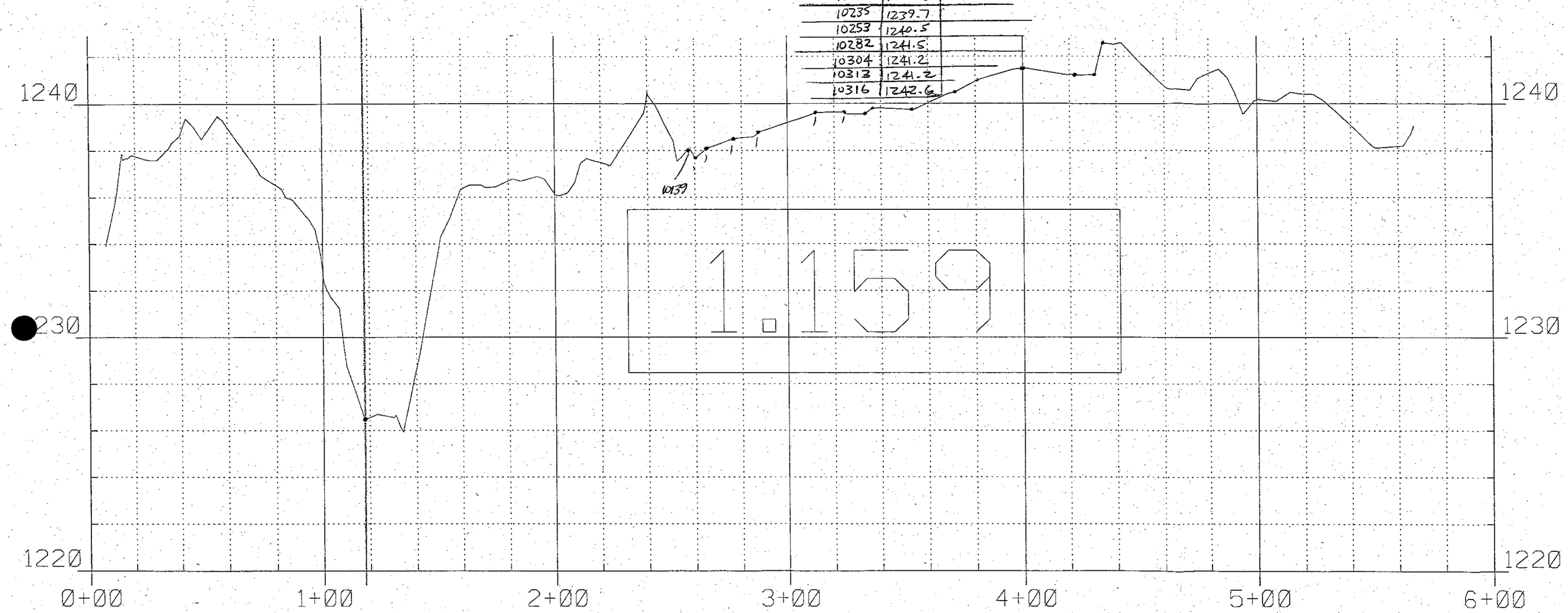
X	Y
-94	38.6
-91	39.4
-84	38.4
-77	39.4
-60	36.8
-51	36.4
-40	36.0
-46	35.8
-35	34.6
-32	32.4
-26	31.2
-24	28.9
-15	26.5
-10	26.7
-2	26.3
0	26.0
16	34.3
26	36.3
29	36.5
35	36.4
42	36.4
48	36.0
52	36.7
59	36.0
67	36.1
80	37.6
89	37.3
104	39.5
106	40.5
118	37.5
124	37.9

X	Y
10127	
10142	
10158	

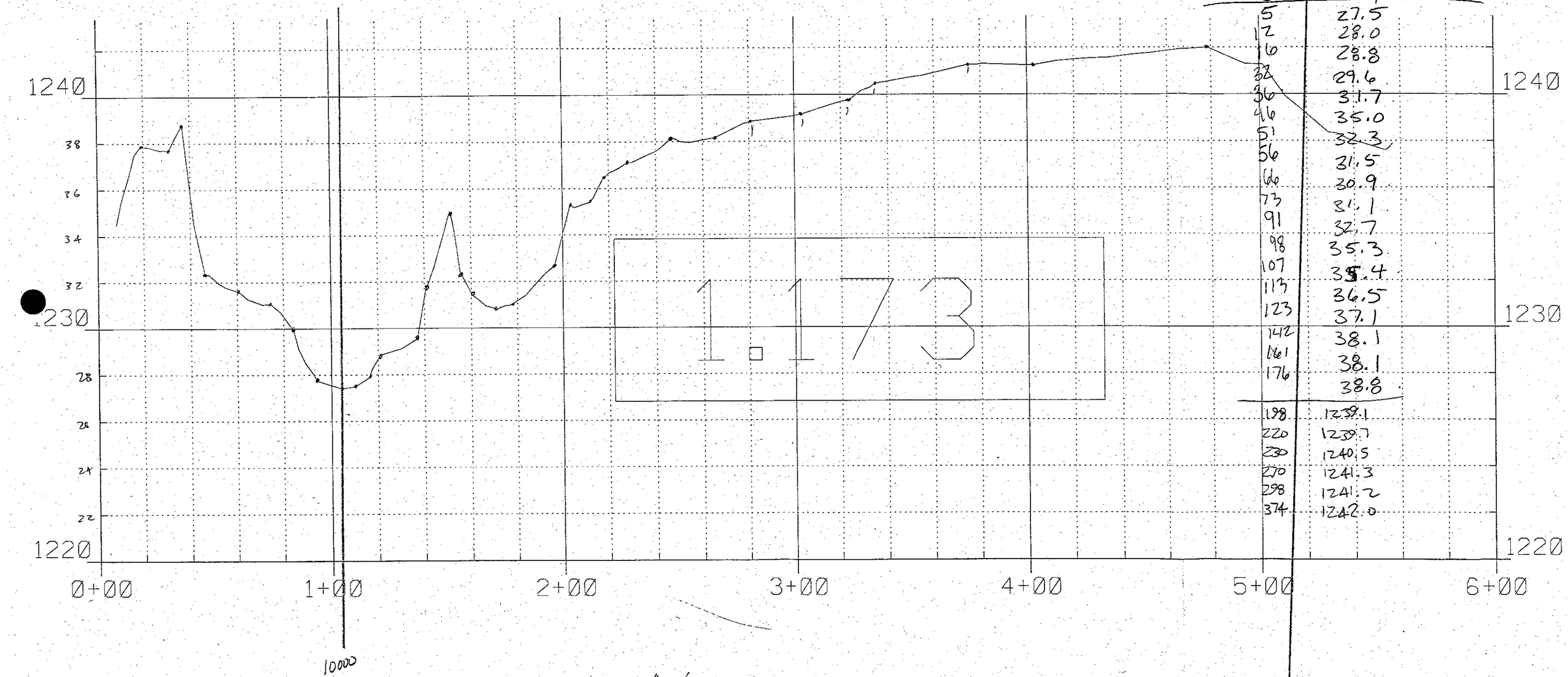
See next sheet

= 10139

X	Y
10142	1237.7
10147	1238.1
10159	1238.5
10169	1238.8
10194	1239.6
10206	1239.6
10215	1239.5
10219	1239.8
10235	1239.7
10253	1240.5
10282	1241.5
10304	1241.2
10313	1241.2
10316	1242.6

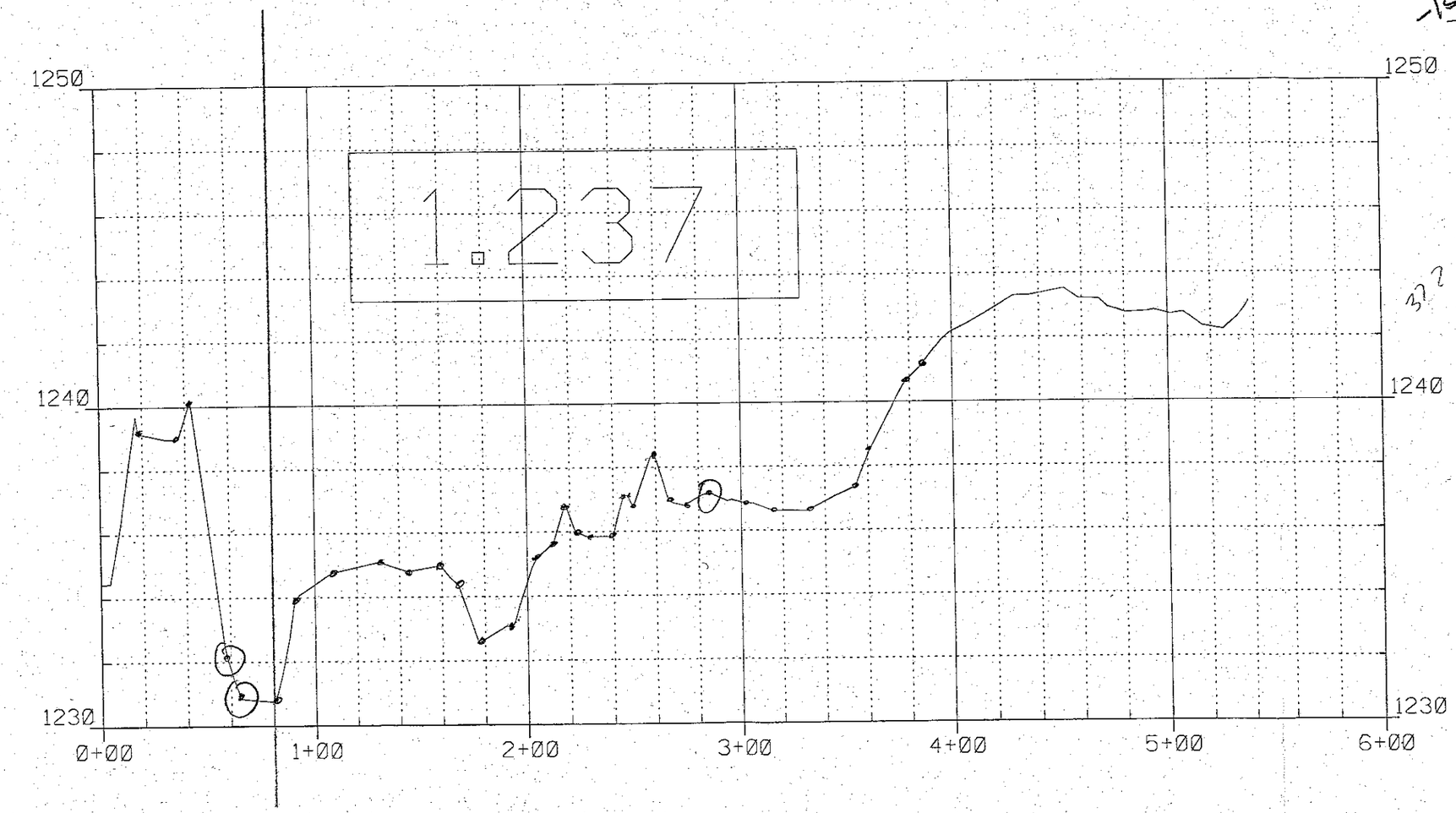


1"=40' #4'

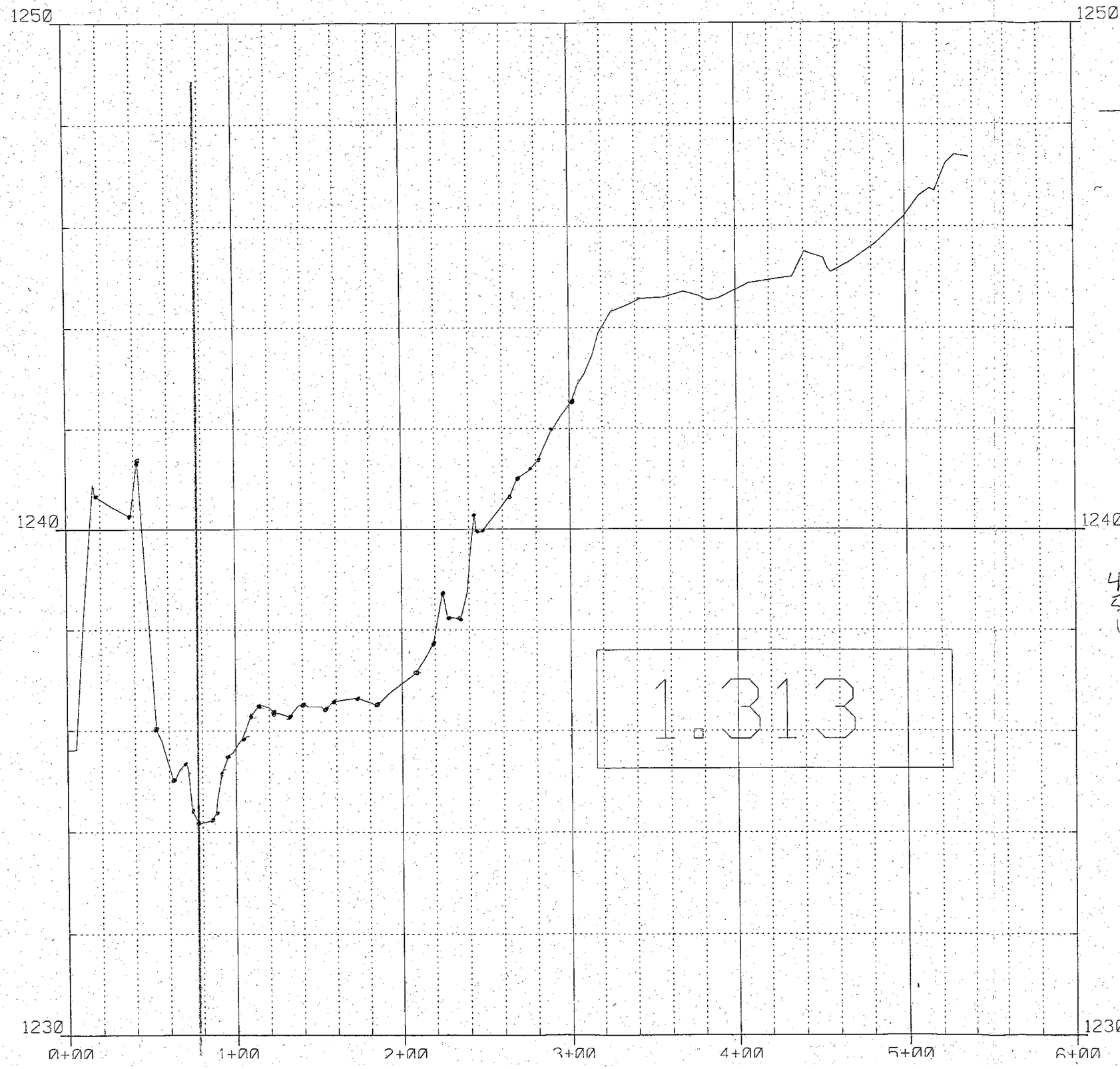


X	Y
~~-70~~85	37.8
-73	37.6
-68	38.7
-57	32.3
-43	31.6
-30	31.1
-21	29.9
-10	27.8
0	27.4
5	27.5
12	28.0
16	28.8
32	29.6
36	31.7
46	35.0
51	32.3
56	31.5
66	30.9
73	31.1
91	32.7
98	35.3
107	35.4
113	36.5
123	37.1
142	38.1
161	38.1
176	38.8
188	1239.1
220	1239.7
230	1240.5
270	1241.3
298	1241.2
374	1242.0

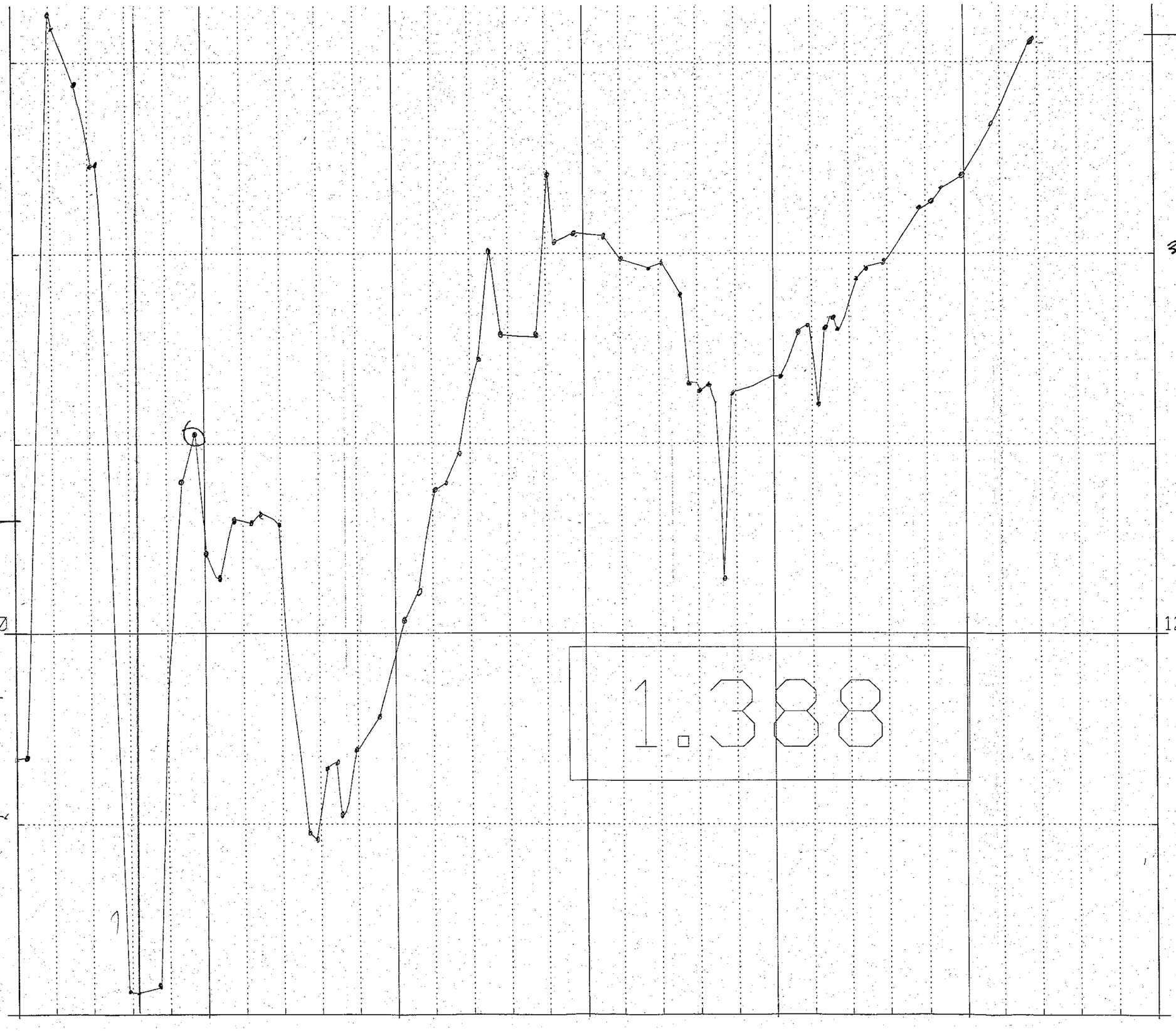
1"=40' H
1"=4' V



X	Y
-62	39.1
-43	38.9
-37	40.2
-31	32.2
-25	30.8
0	30.7
10	33.9
26	34.7
50	35.1
53	34.8
79	35.0
87	34.3
96	32.6
112	33.1
123	35.2
130	35.6
136	36.7
142	36.0
147	35.9
160	35.9
164	37.1
166	37.1
169	36.8
179	38.4
185	36.9
194	36.8
204	37.6
222	36.8
235	36.6
251	36.6
273	37.4
280	37.5
296	40.7
304	41.2



X	Y
-60	40.7
-39	40.2
-35	41.4
-24	36.0
-14	35.0
-6	35.4
-3	34.4
0	34.2
7	34.3
10	34.4
13	35.2
18	35.5
26	35.9
31	36.3
36	36.5
46	36.4
54	36.3
62	36.6
75	36.9
81	36.6
94	36.7
106	36.5
129	37.2
140	37.8
146	38.7
149	38.3
157	38.3
164	40.3
166	39.9
170	39.9
187	40.6
191	41.0
199	41.2
204	41.3
210	42.0
223	42.5



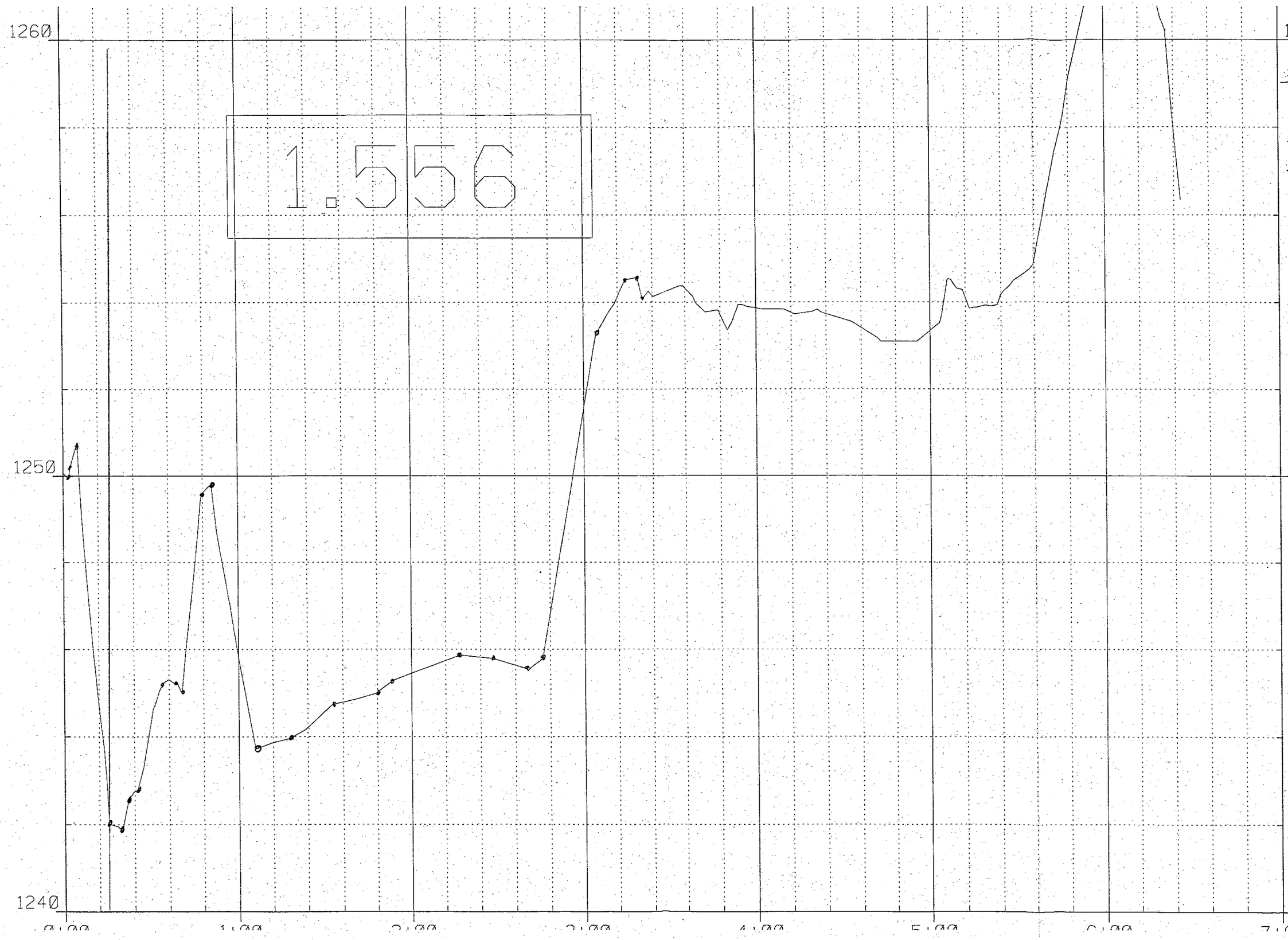
X	Y
-57	38.7
-44	46.6
-43	46.4
-31	45.0
-23	44.9
-21	45.0
-5	36.3
0	36.2
12	36.3
23	41.6
26	42.1
36	40.8
44	40.6
51	41.2
60	41.1
65	41.3
74	41.1
90	37.9
94	37.8
99	38.5
104	38.6
106	38.1
114	38.8
127	39.1
139	40.1
148	40.4
157	41.5
162	41.6
169	41.9
179	42.9
185	44.0
191	43.1
209	43.1
216	44.9
219	44.1
230	44.2
246	44.1
255	43.9
271	43.8
277	43.0
282	43.5
290	42.6
296	42.5
301	42.6
307	40.6
312	42.5
339	42.7
	43.2
	43.2
	41.4

31 ← 26

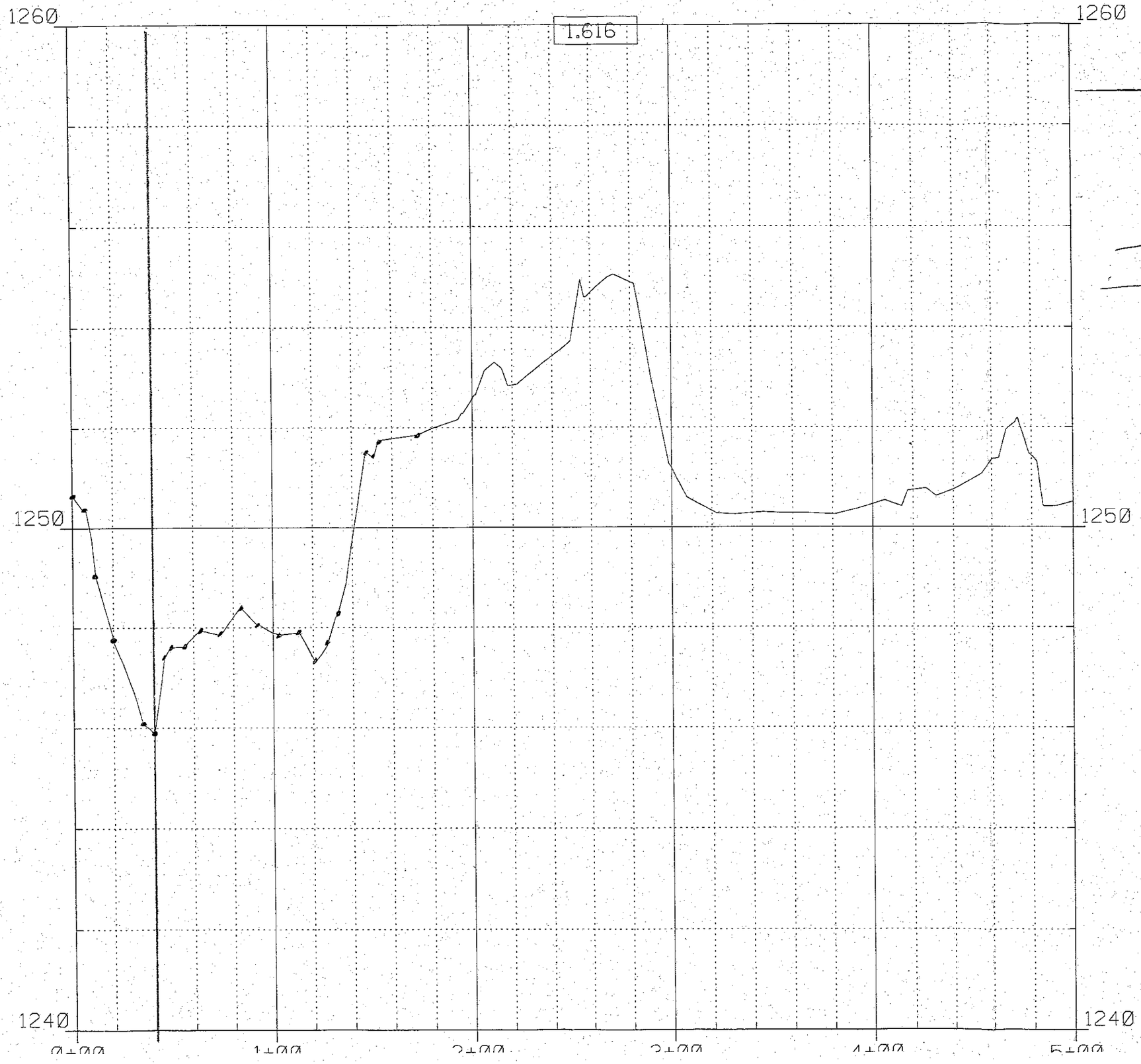
Y	X
352	43.3
359	43.2
362	43.7
364a	43.8
36.9	43.9
37.8	44.9
38.4	44.5
393	44.6
401	44.0
417	45.3
423	46.2
433	
449	
471	

12 19 29

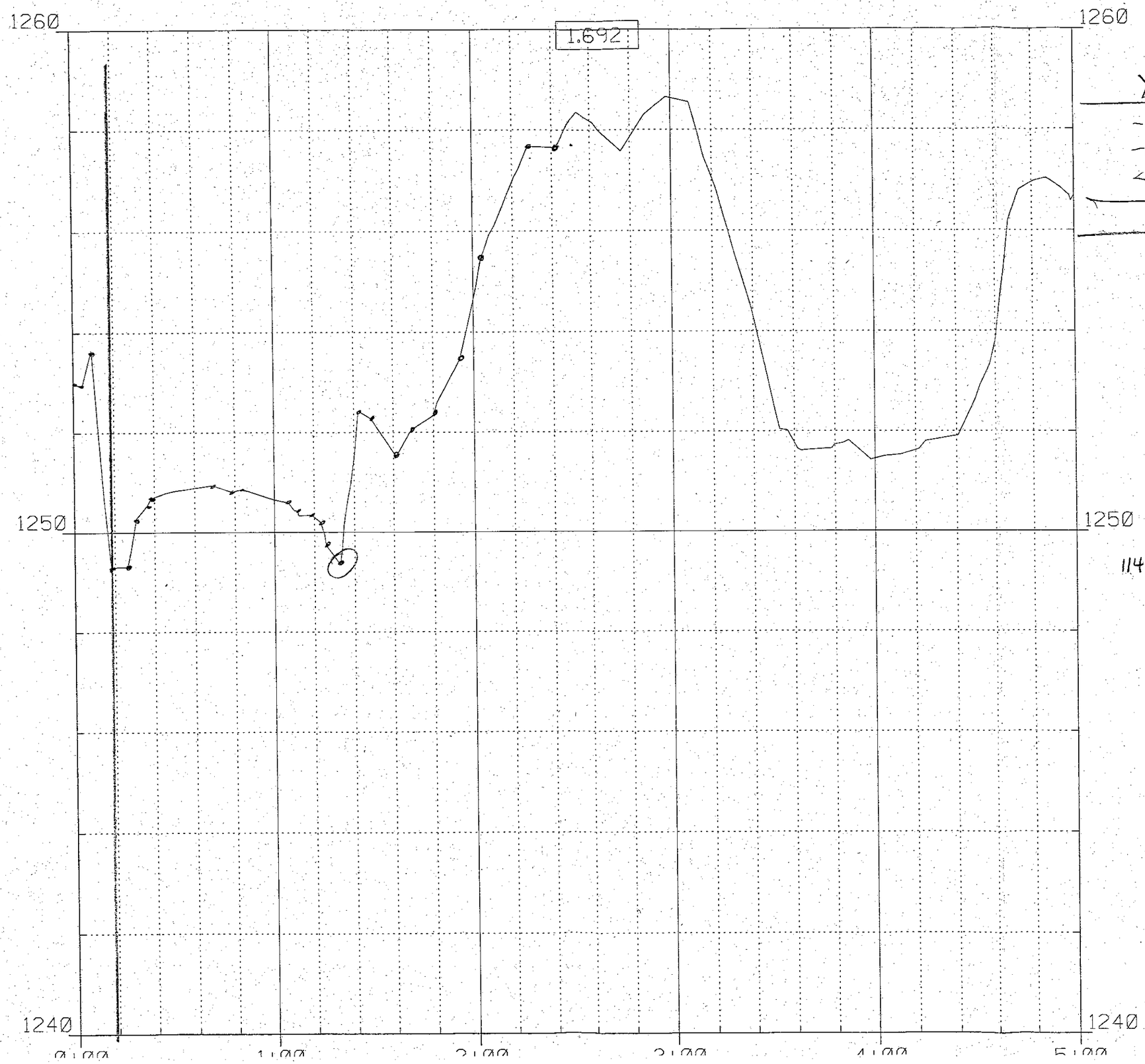
X	Y
-71	49.3
-39	49.0
-30	48.5
-27	49.6
-20	46.9
-17	41.2
-9	38.5
0	38.1
10	41.3
19	48.3
23	47.5
35	46.5
42	46.2
47	45.6
51	45.5
59	44.4
66	43.6
74	43.4
79	43.7
83	42.6
98	42.7
105	45.0
116	47.0
119	47.0
144	46.9
163	47.1
167	48.1
172	48.6
187	47.3
195	47.9
199	48.7
201	48.4
204	49.2
212	48.8
256	48.9
	50.1



X	Y
-23	49.
-22	50
-18	50
0	4[illegible]
7	41.
11	42.
16	42.
25	45
38	45
41	45
52	49.
58	49.
83	43.
103	44.
[illegible]	44.
127	45
151	45
161	45
200	45
220	45
240	45
249	53.
280	54.
296	54
303	54
306	

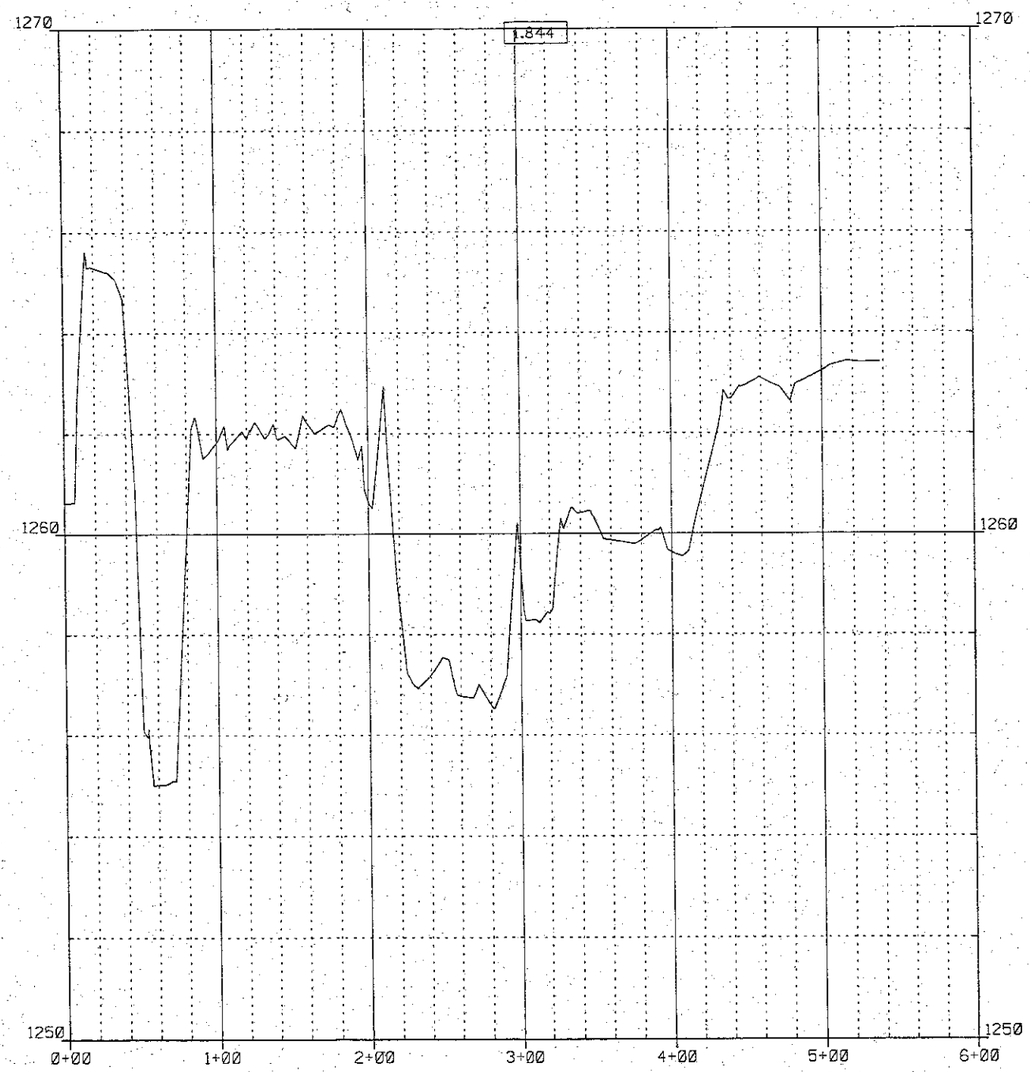


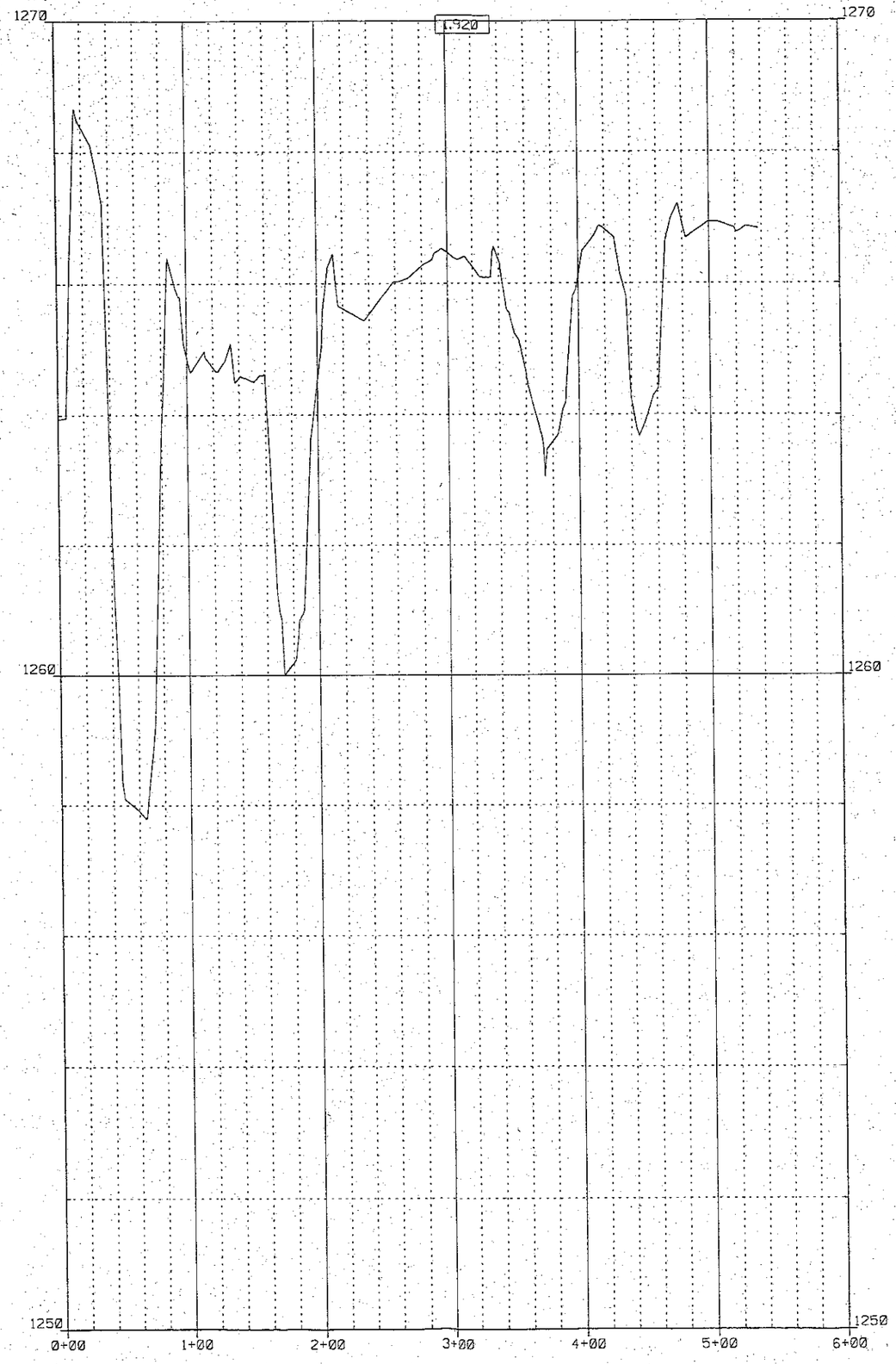
X	Y
-40	1250.6
-34	1250.4
-29	1249.0
-21	1247.8
-6	1246.1
0	1245.9
5	47.4
9	47.6
16	48.0
23	47.9
34	48.4
44	48.1
53	47.9
63	47.9
72	47.3
80	47.8
86	48.3
92	51.5
107	51.4
110	51.7
113	51.8
133	



X	Y
-18	53.0
-14	52.9
-9	53.6
0	49.2
7	49.3
12	50.3
17	50.6
20	50.7
50	50.9
60	50.8
65	50.9
89	50.6
94	50.4
100	50.3
104	50.2
107	49.7
114 ← 119	49.4
122	52.4
130	52.2
142	51.5
150	52.1
161	52.3
179	53.4
185	55.5
209	57.7
223	57.7

1260
1250
1240
6+00
5+00
4+00
3+00
2+00
1+00
0+00
1.768


1270
1.844
1270
1260
1260
1250
1250
0+00
1+00
2+00
3+00
4+00
5+00
6+00


1270
1.920
1270
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1260
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1250
0+00
1+00
2+00
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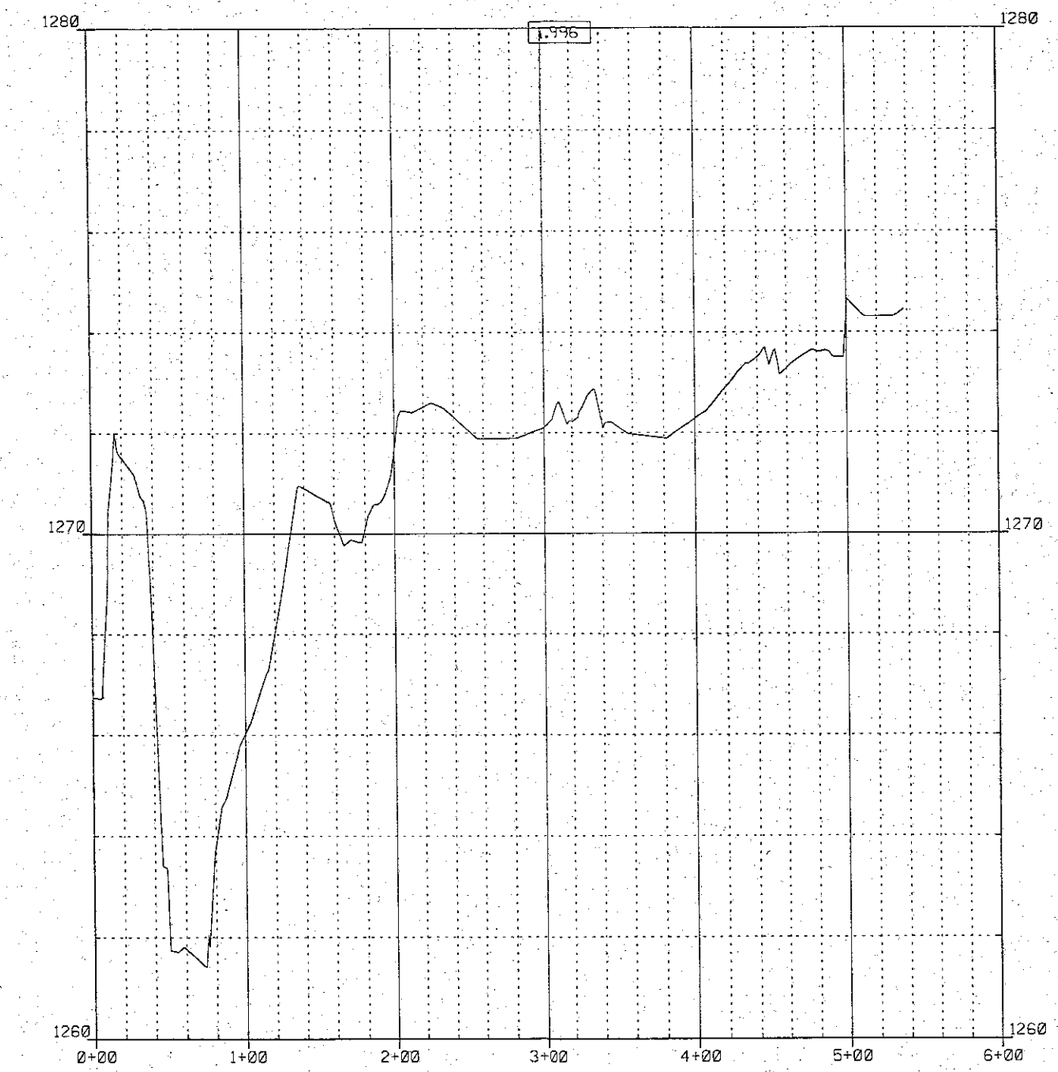
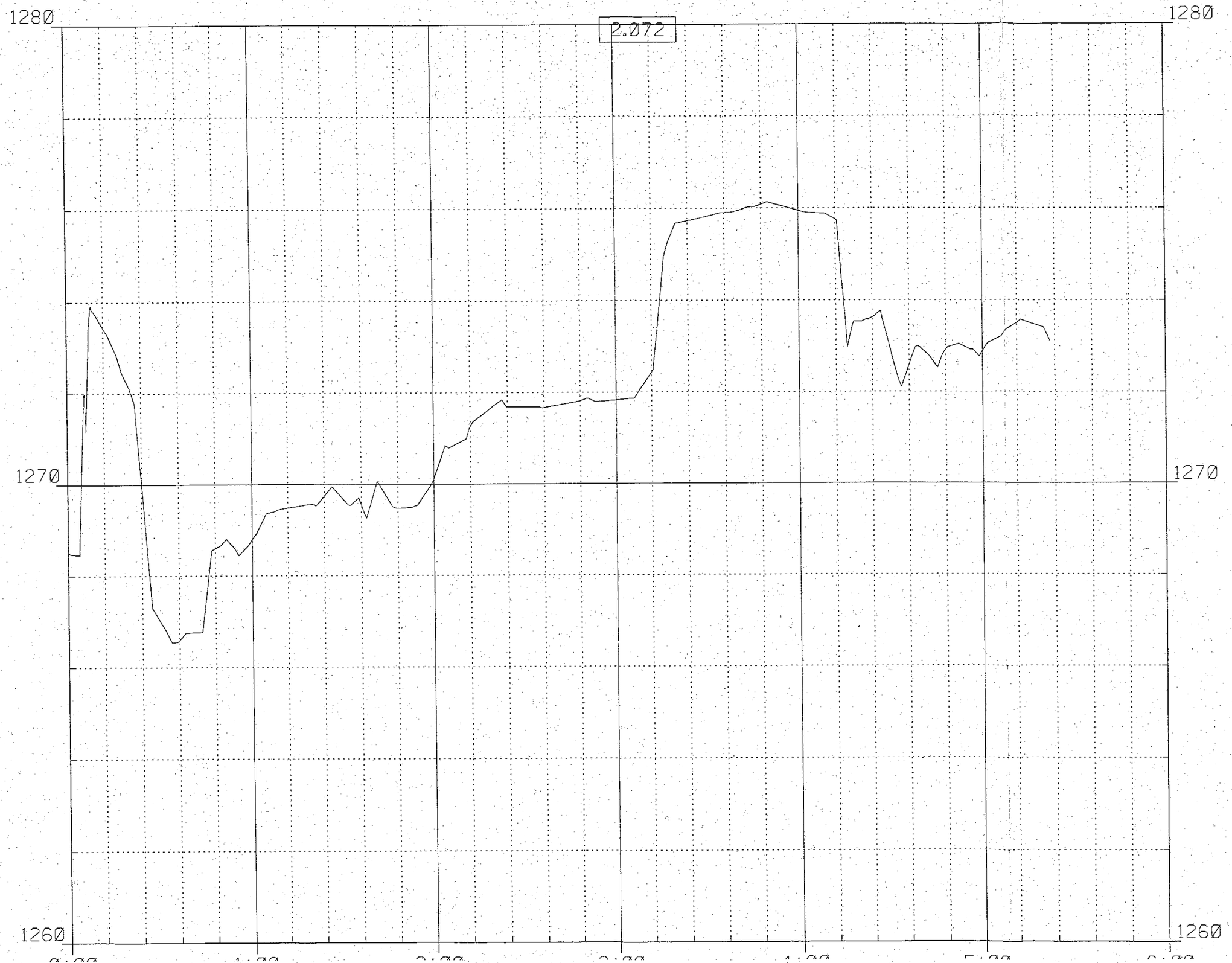
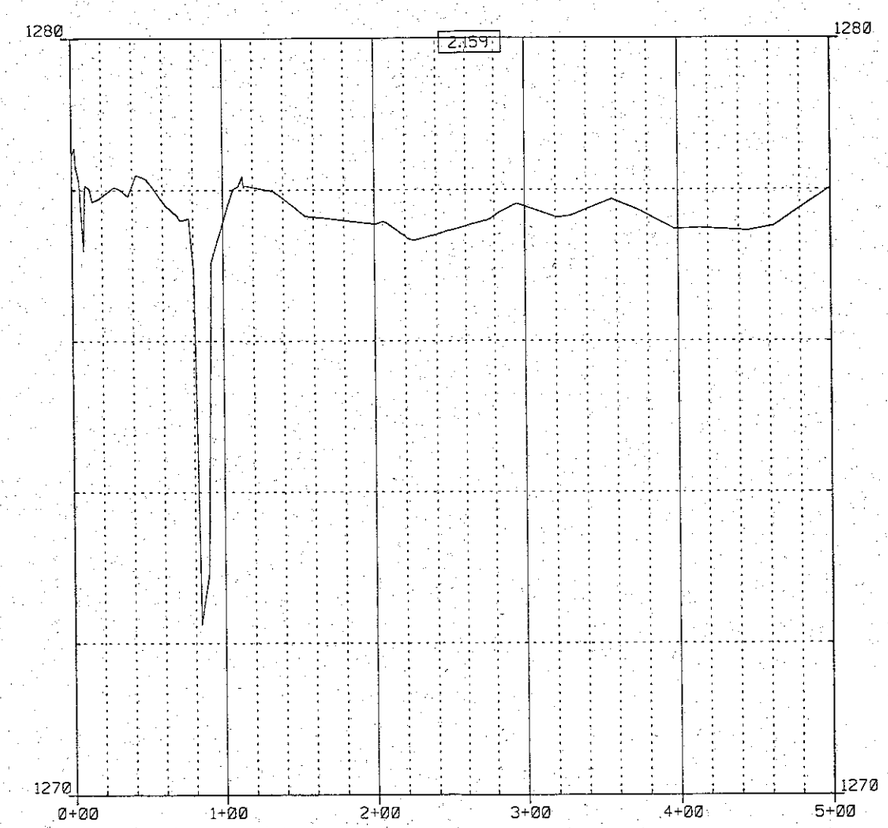
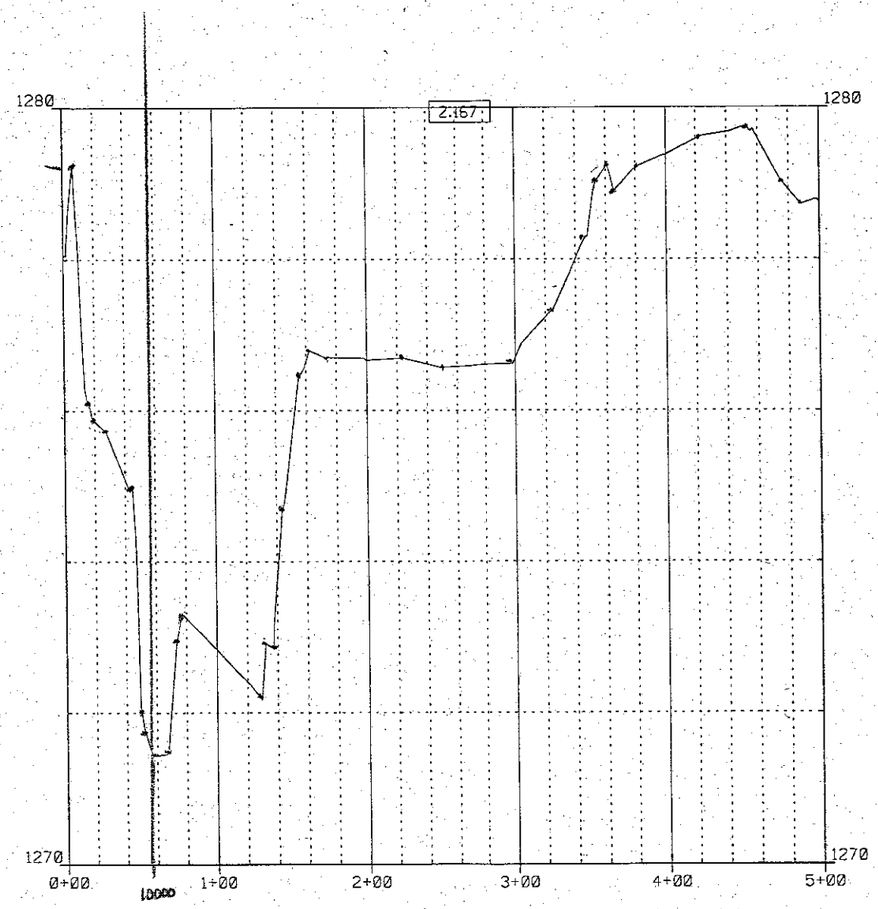
4+00
5+00
6+00

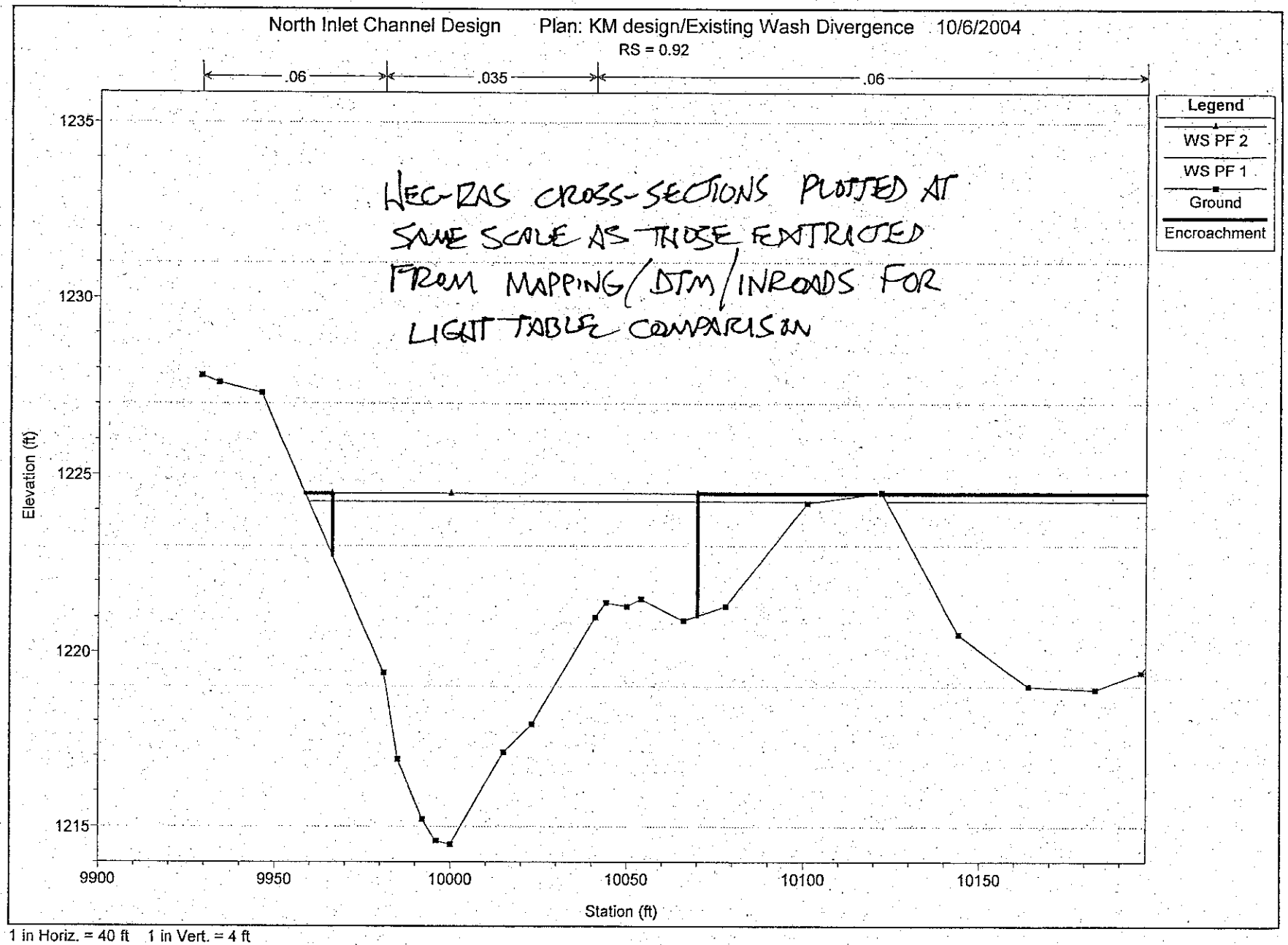

1280
1.996
1280
1270
1270
1260
1260
0+00
1+00
2+00
3+00
4+00
5+00
6+00


1280
2.072
1280
1270
1270
1260
1260

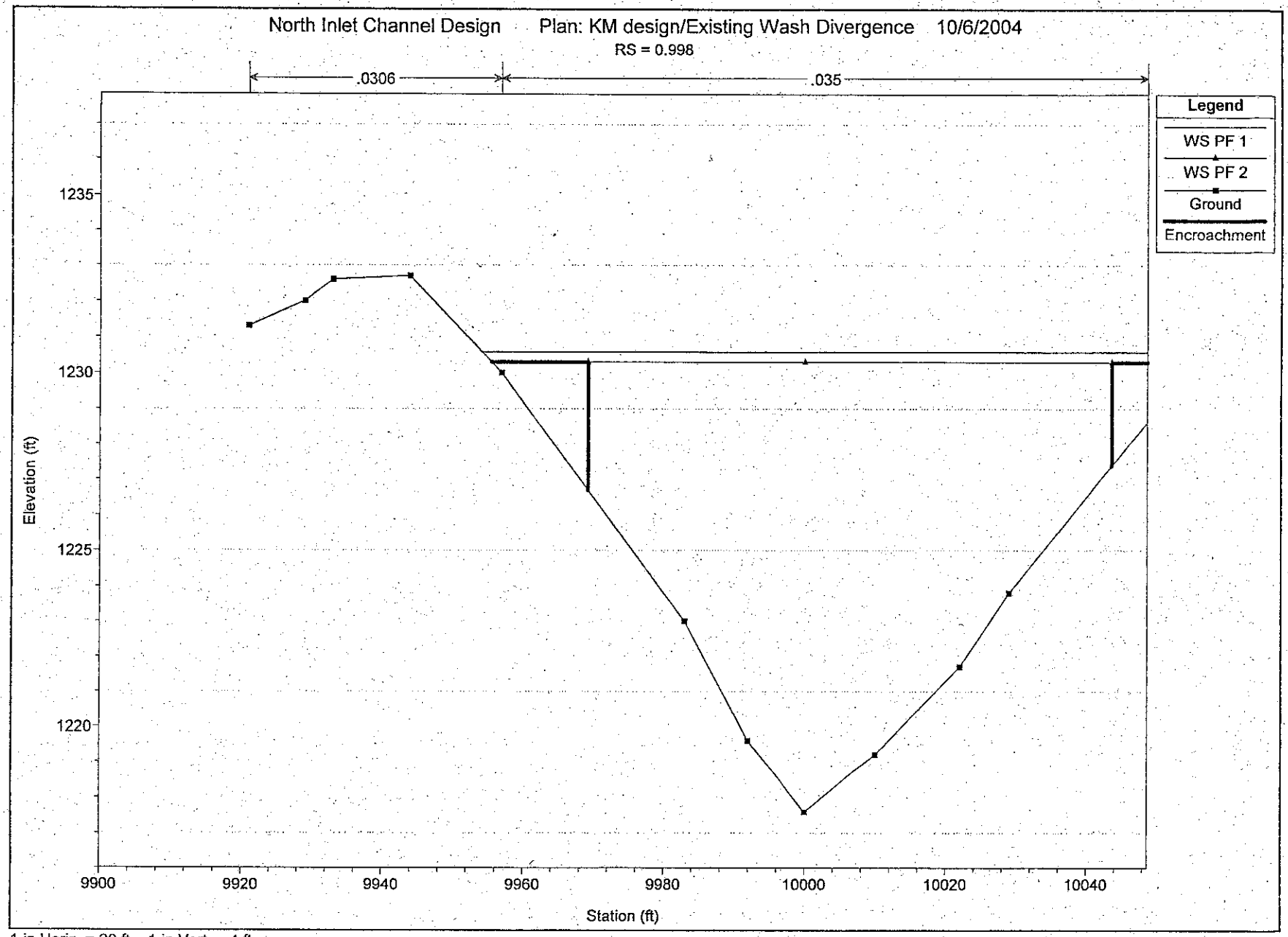

1280
2.59
1280
1270
1270
0+00
1+00
2+00
3+00
4+00
5+00

X	Y
9850	

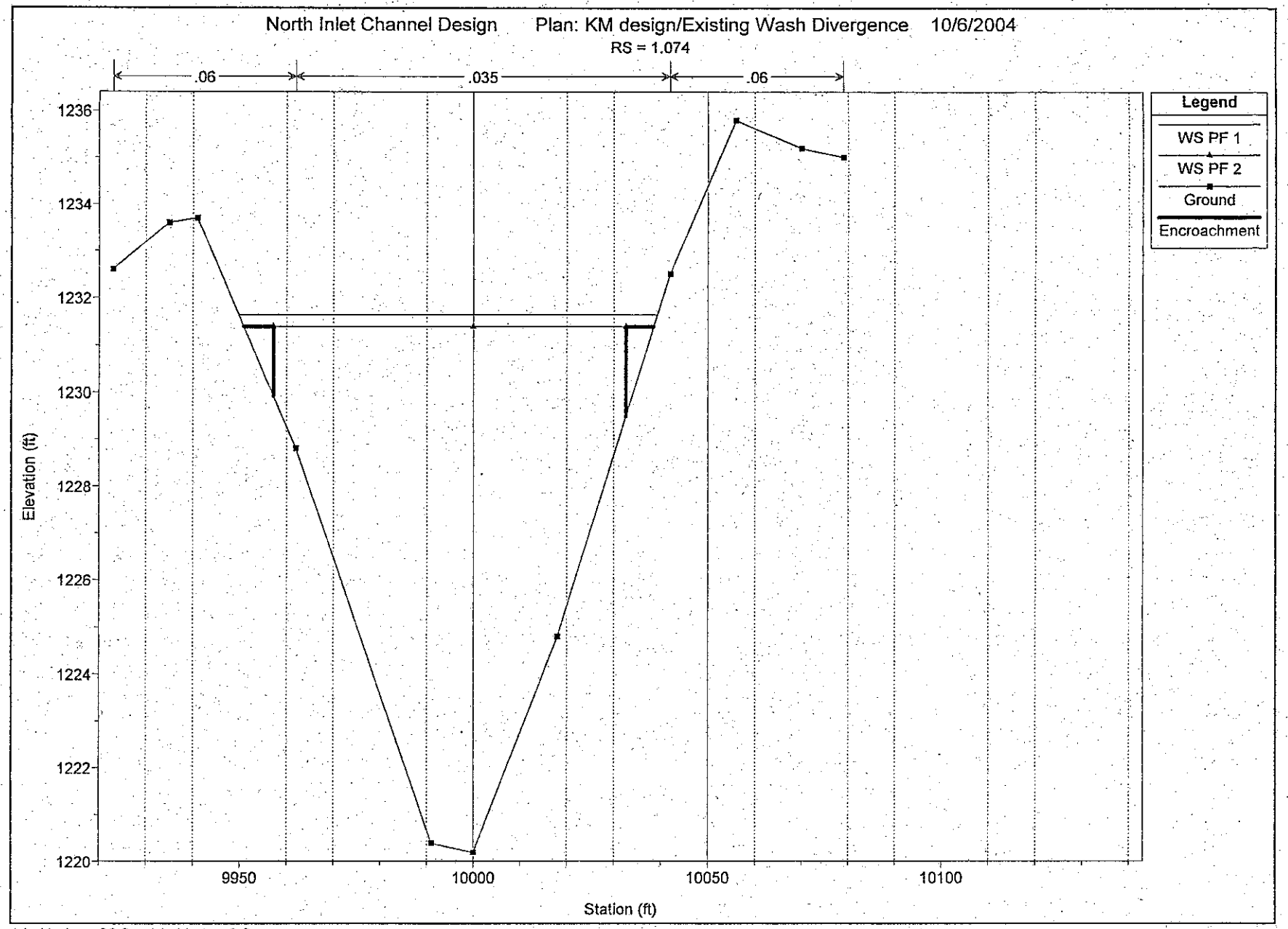




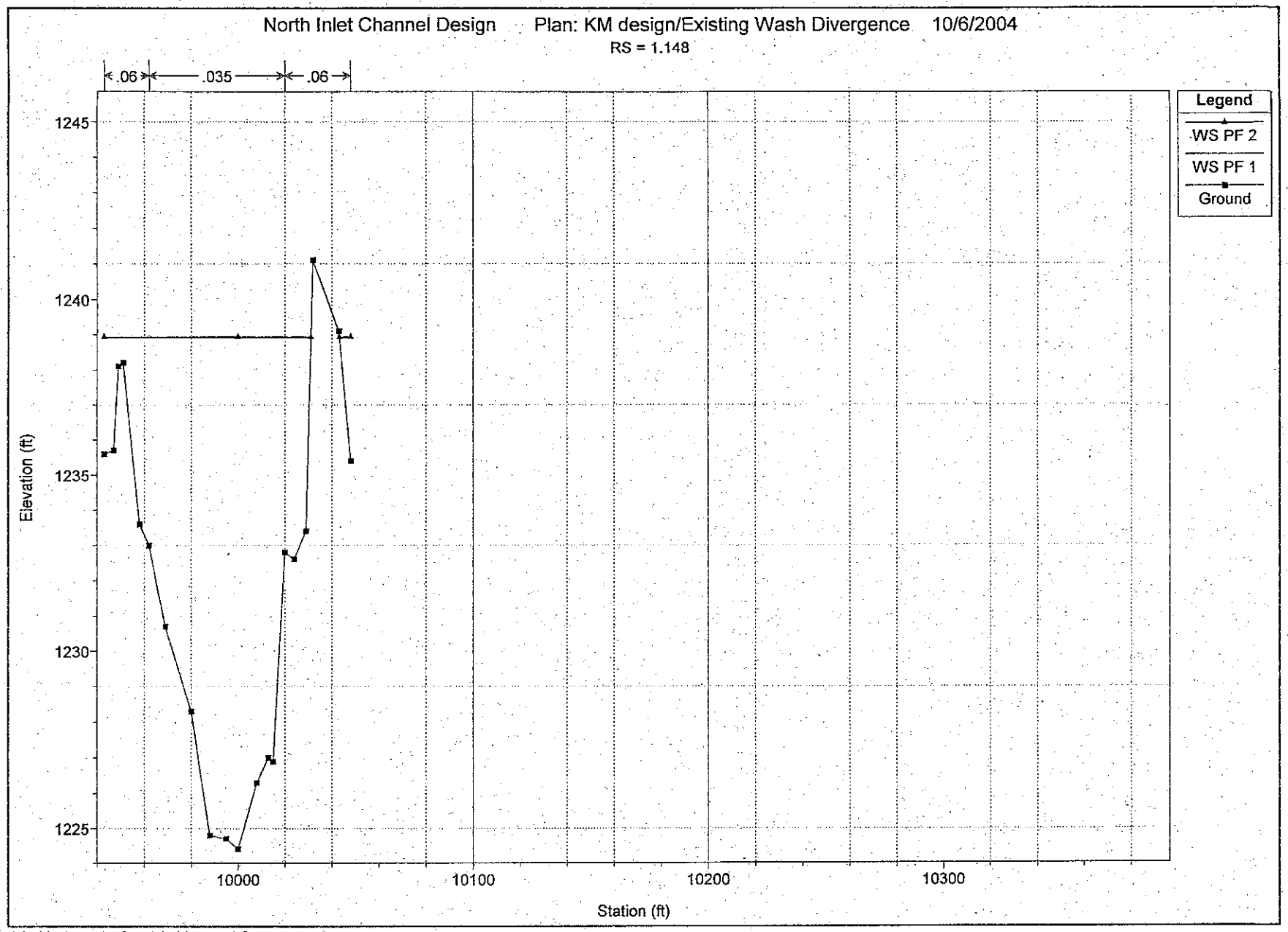
1 in Horiz. = 40 ft 1 in Vert. = 4 ft



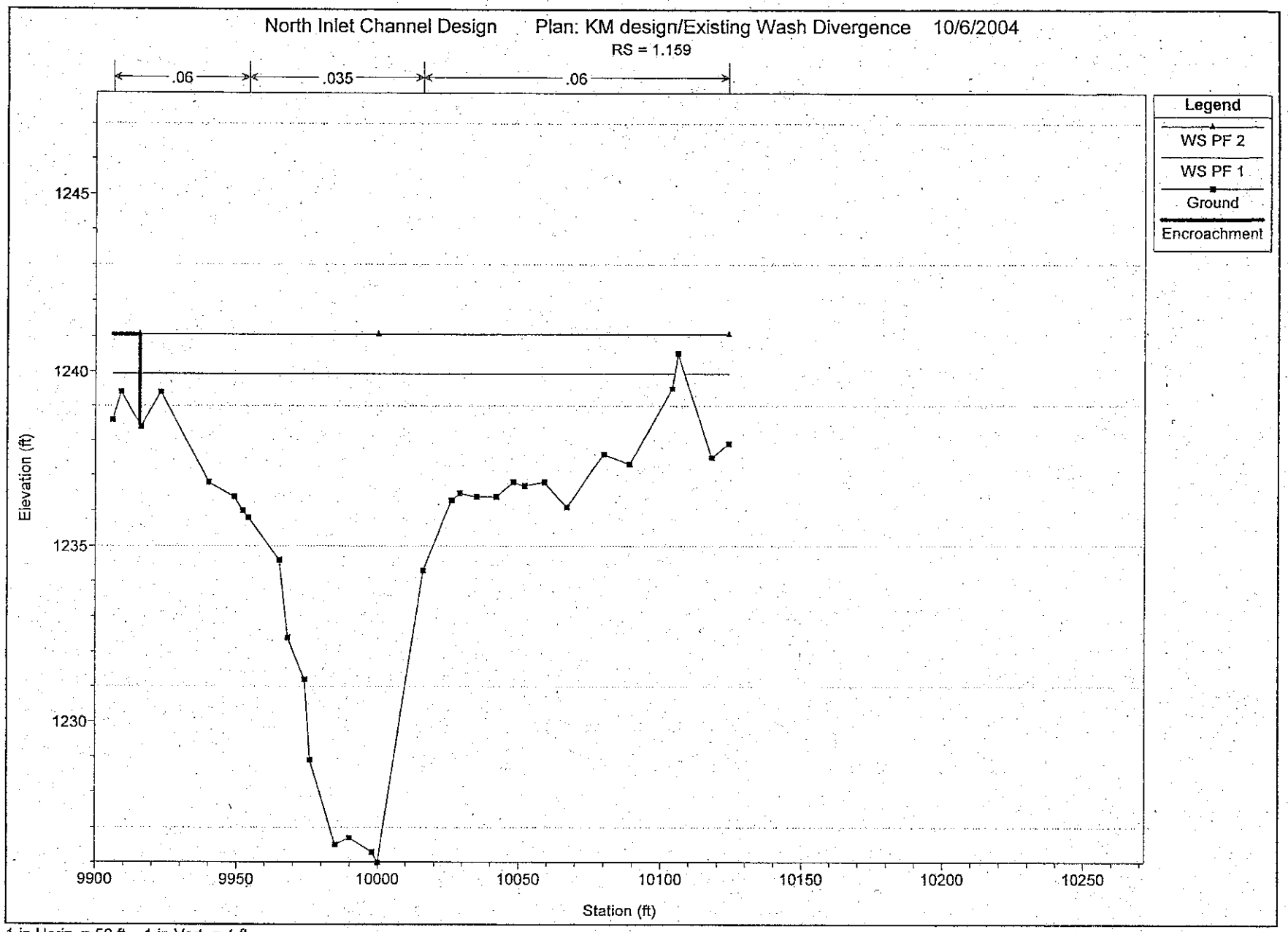
1 in Horiz. = 20 ft 1 in Vert. = 4 ft



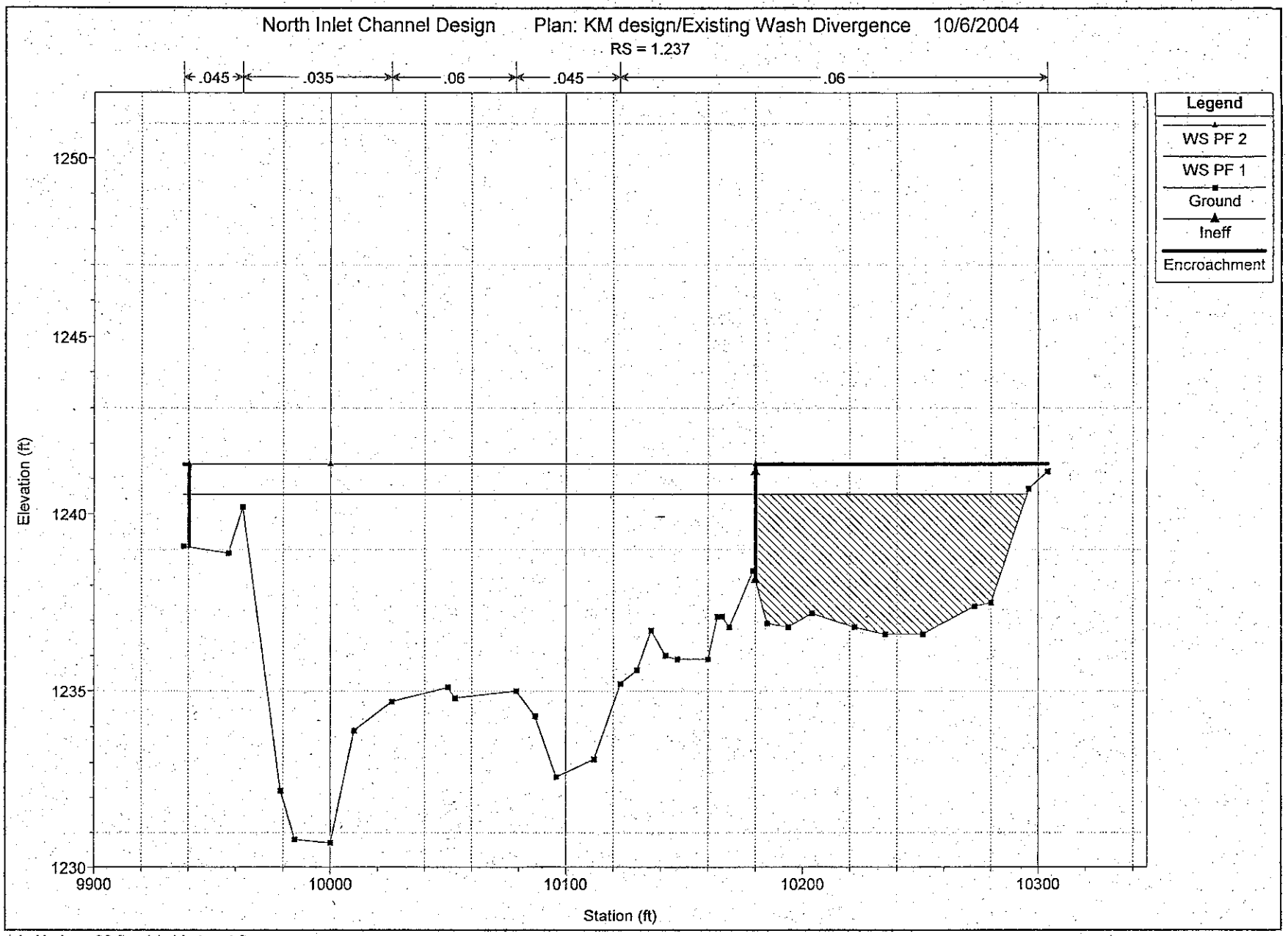
1 in Horiz. = 30 ft 1 in Vert. = 3 ft



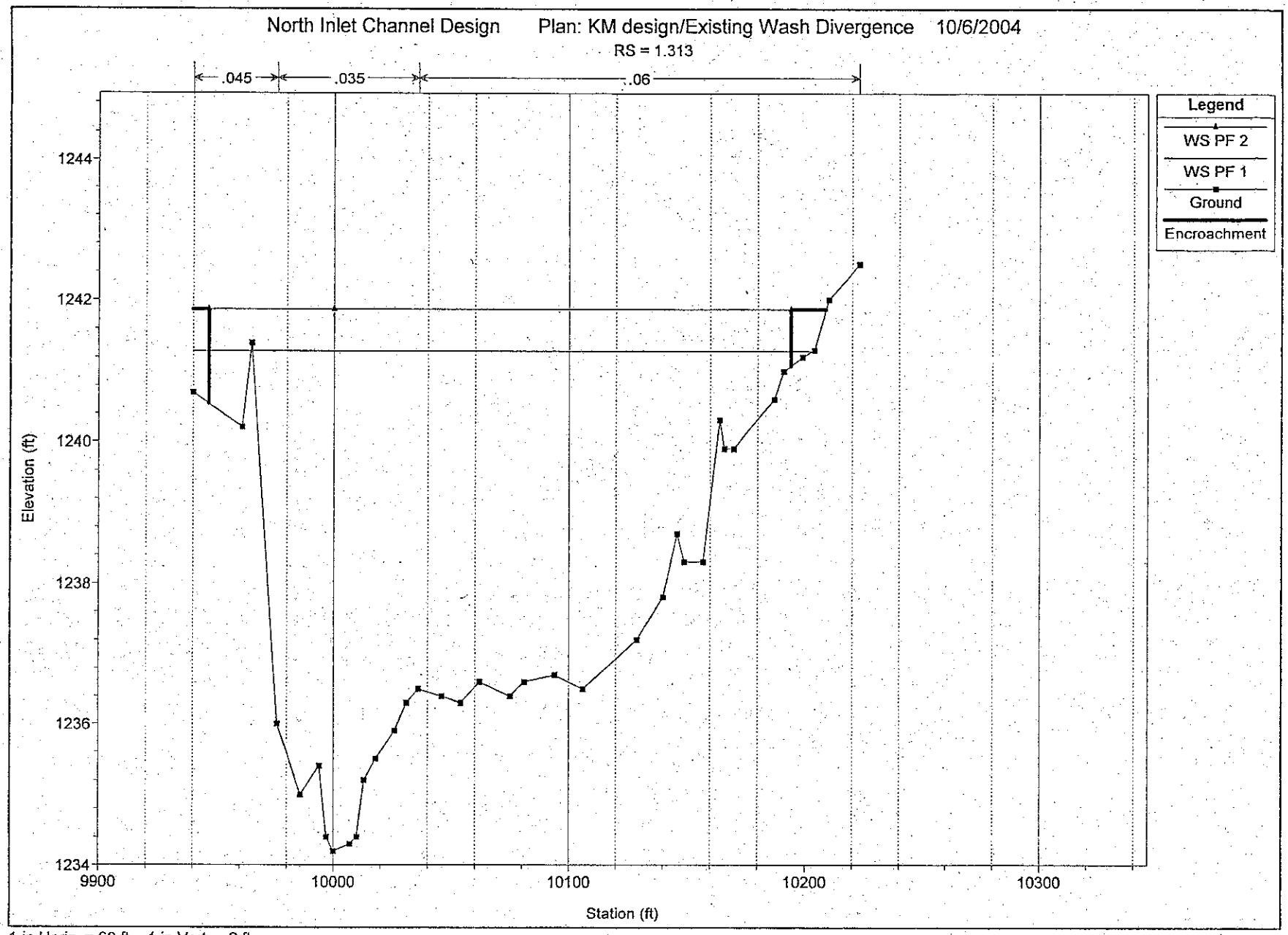
1 in Horiz. = 60 ft 1 in Vert. = 4 ft



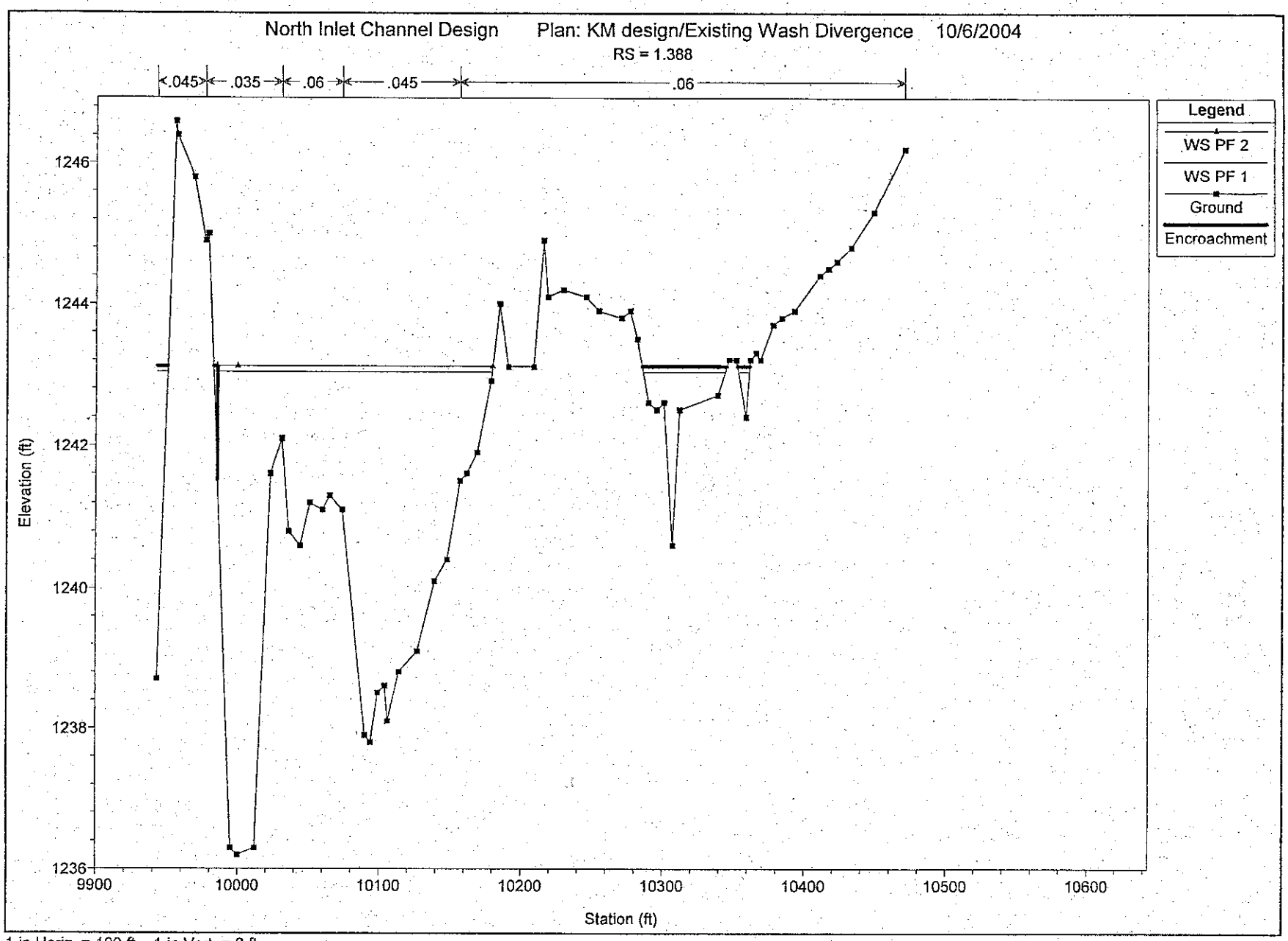
1 in Horiz. = 50 ft 1 in Vert. = 4 ft



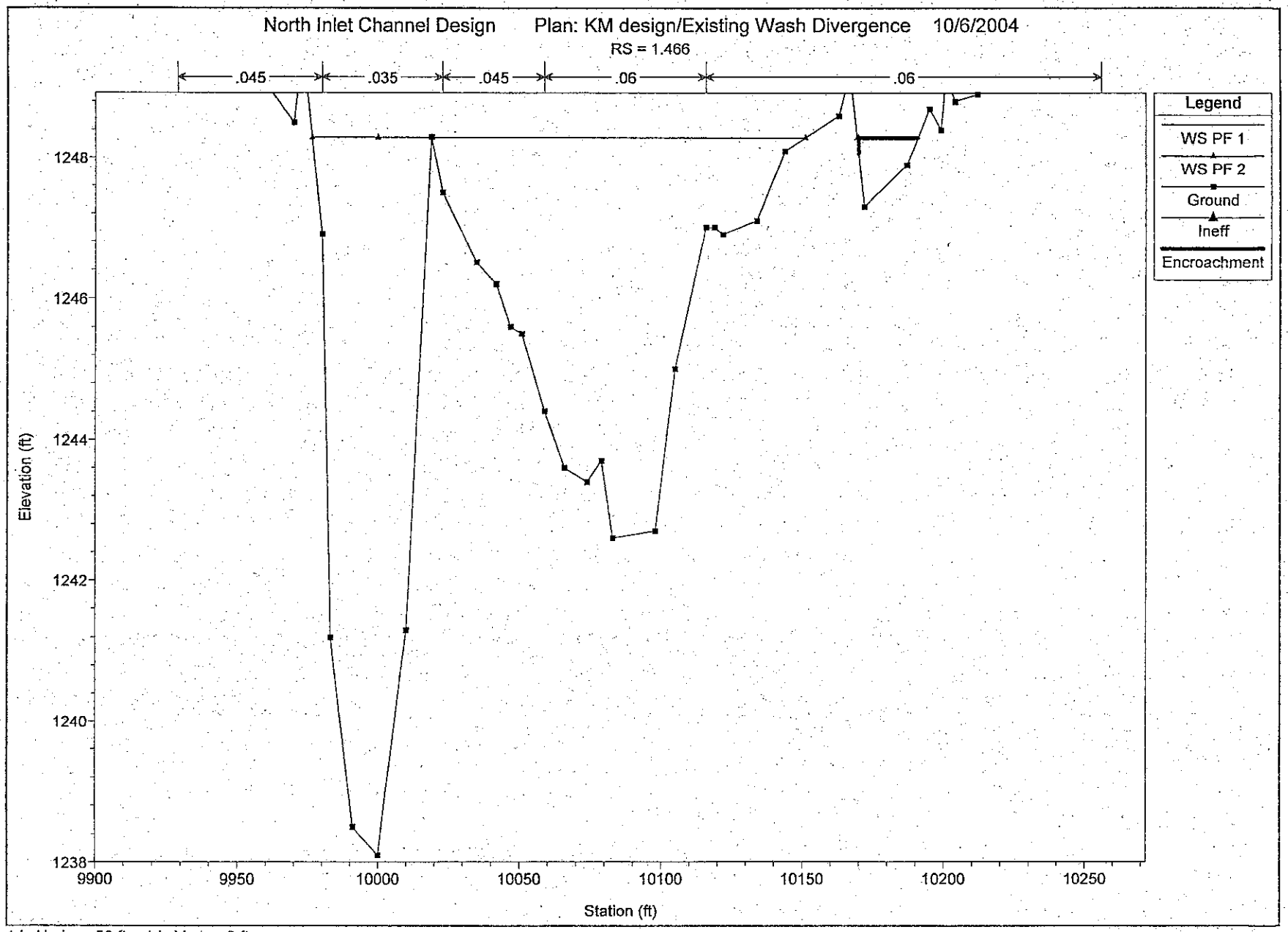
1 in Horiz. = 60 ft 1 in Vert. = 4 ft



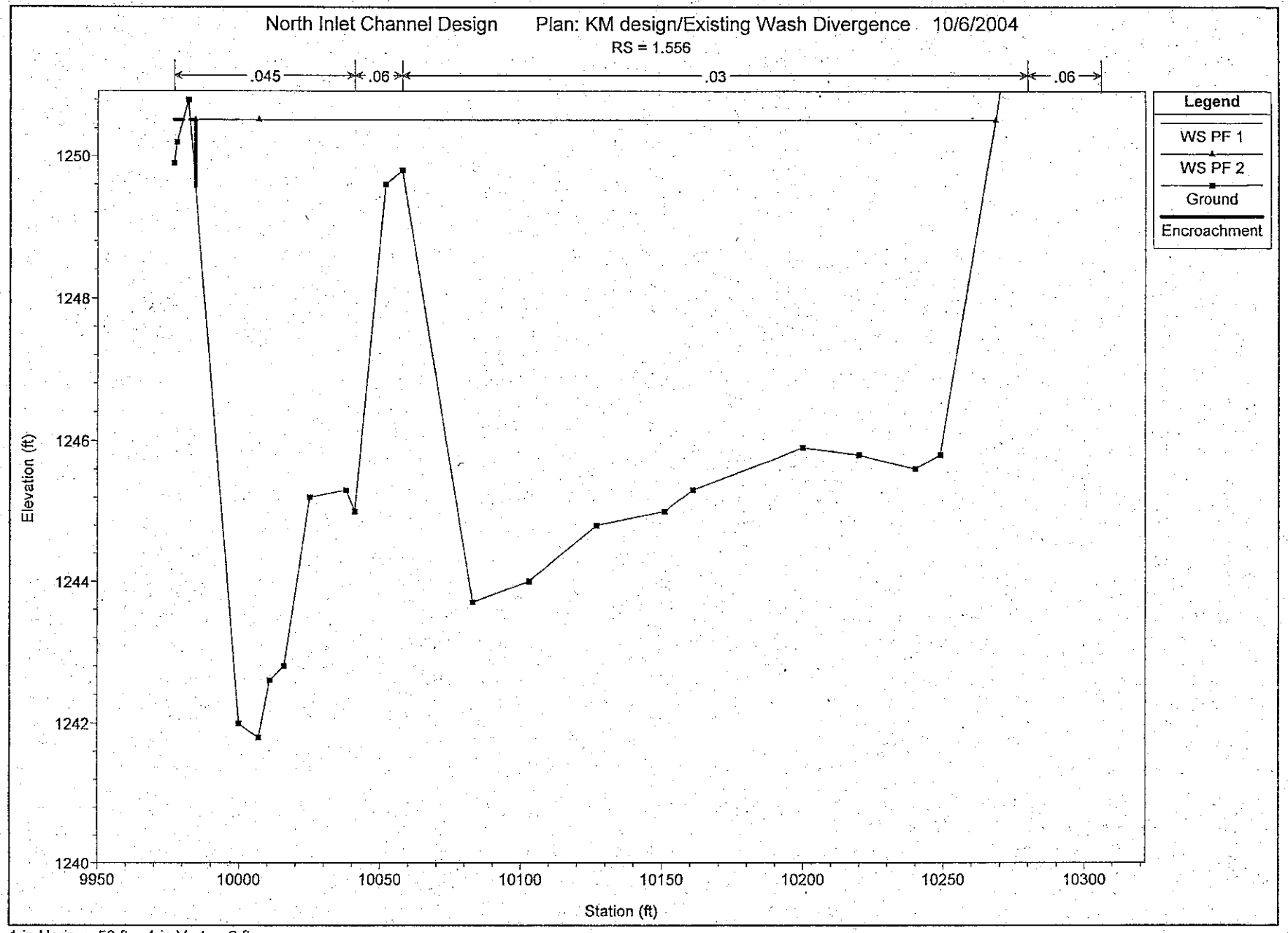
1 in Horiz. = 60 ft 1 in Vert. = 2 ft



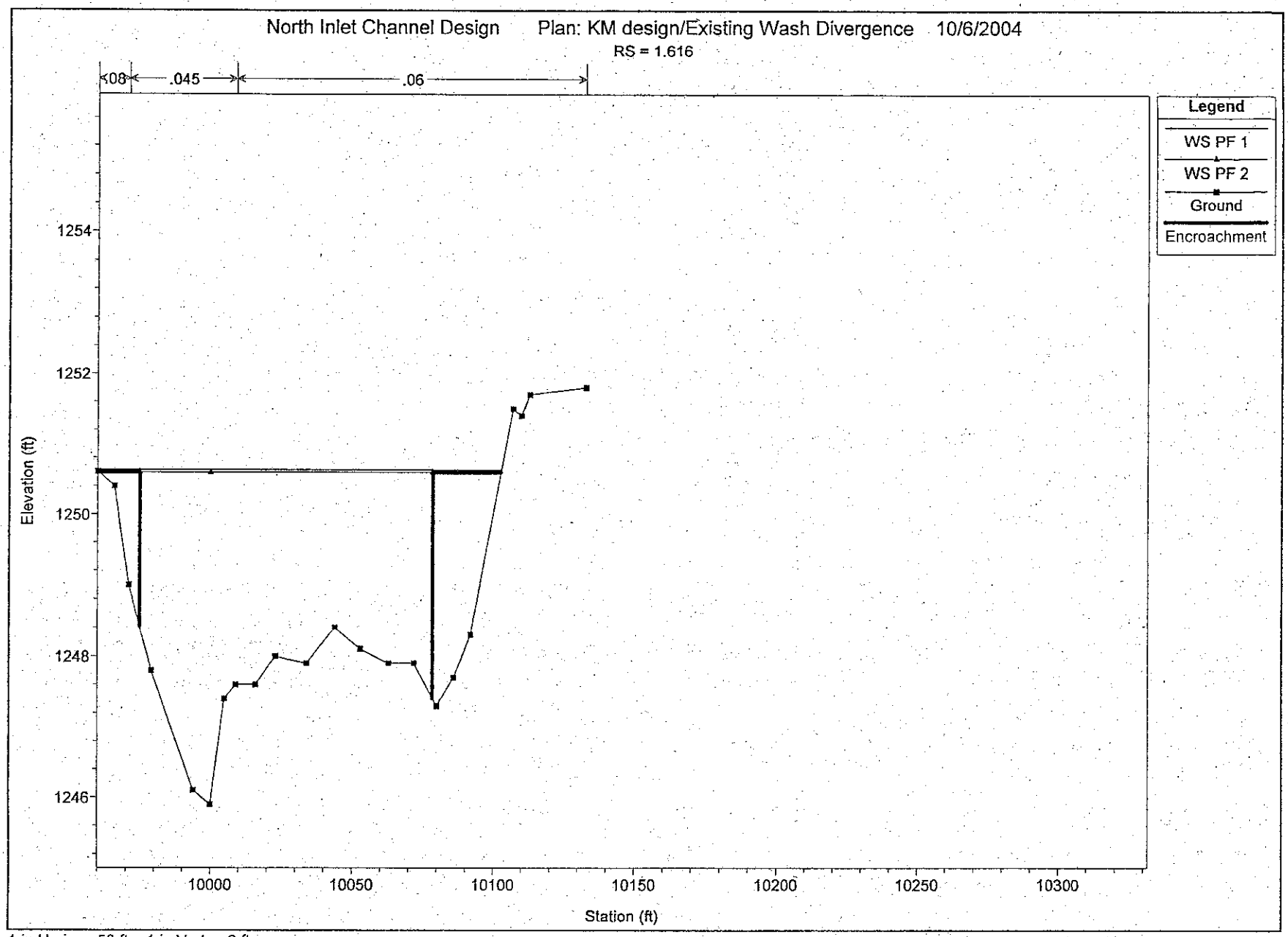
1 in Horiz. = 100 ft 1 in Vert. = 2 ft



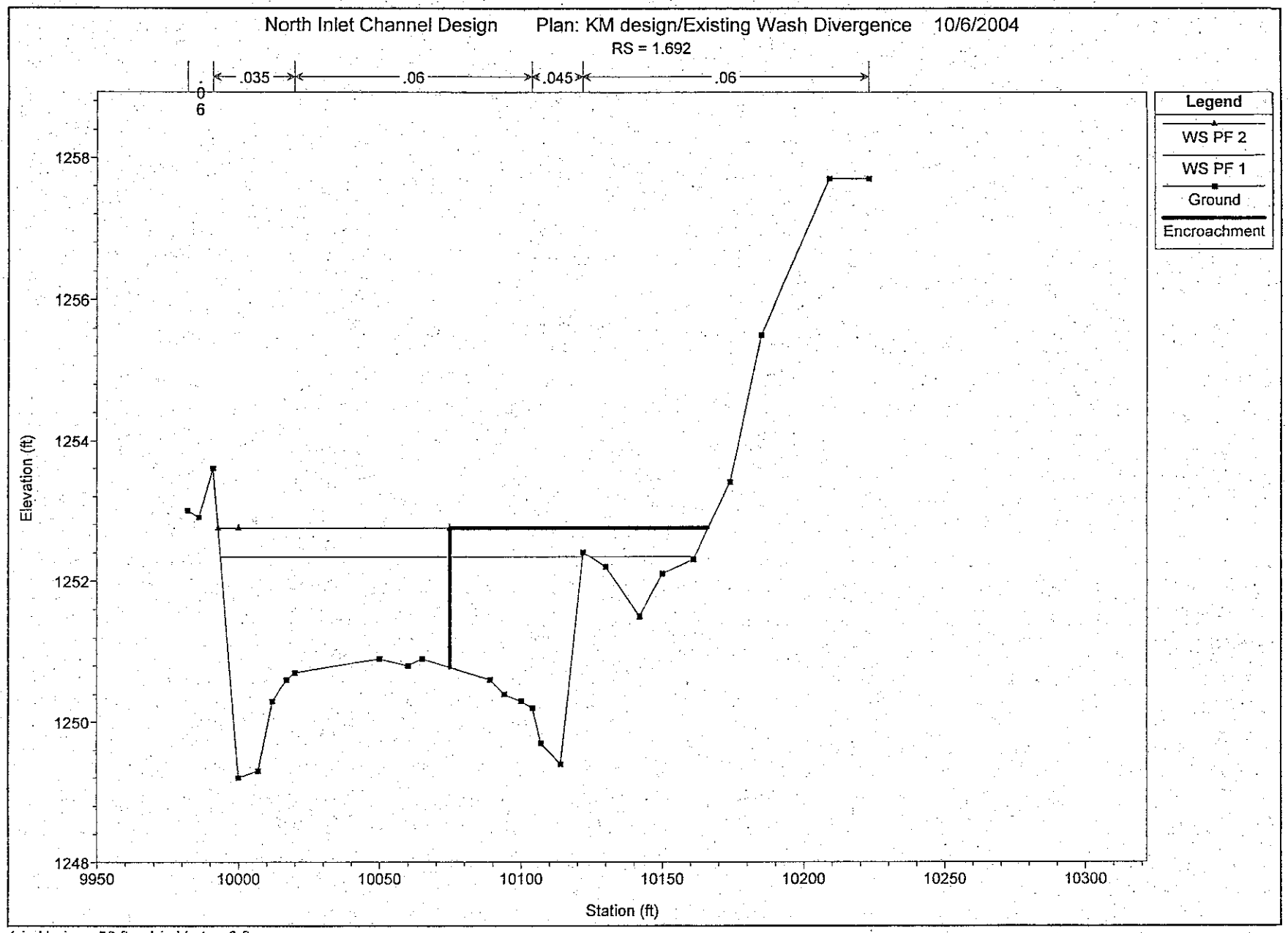
1 in Horiz. = 50 ft 1 in Vert. = 2 ft



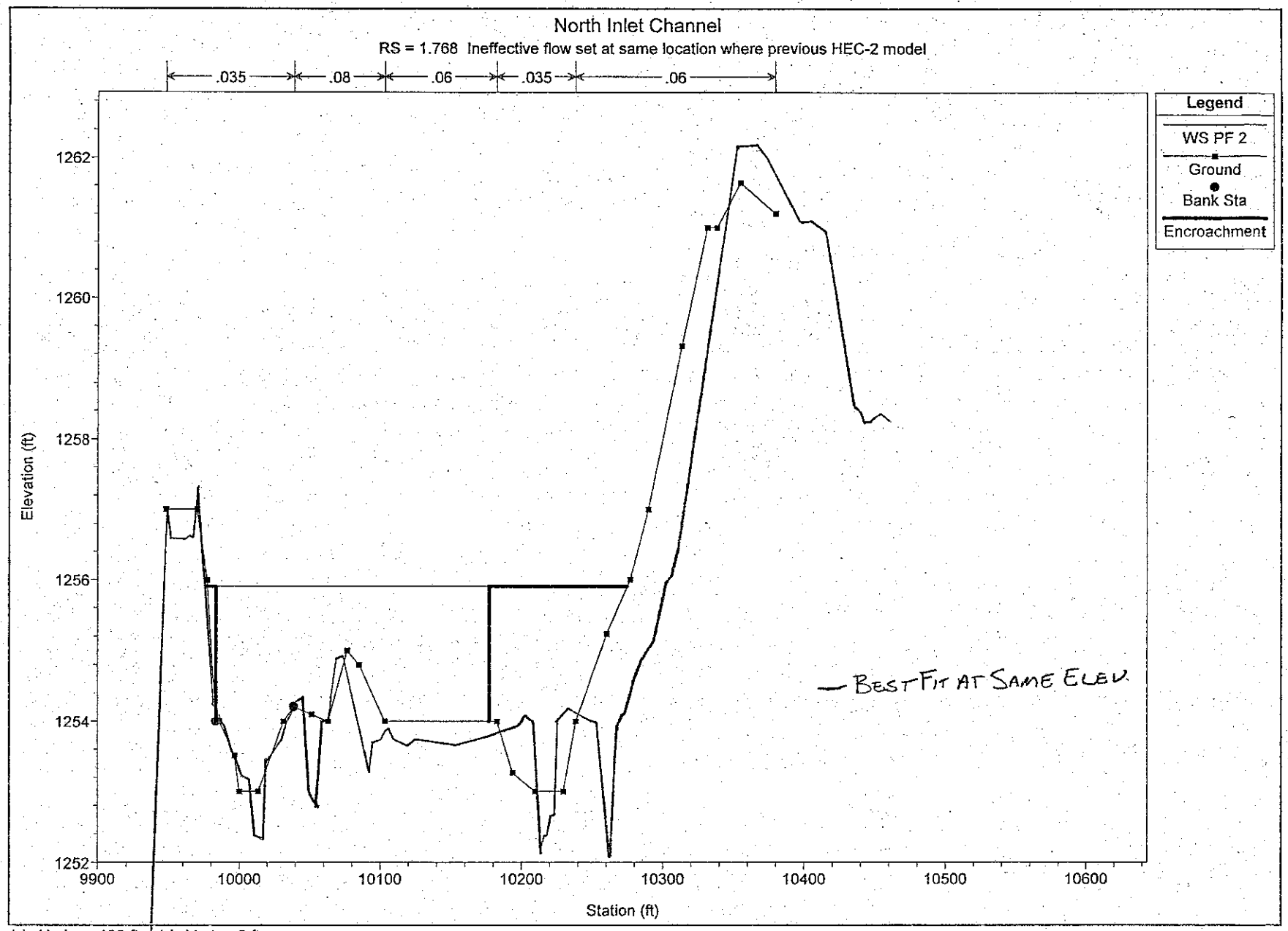
1 in Horiz. = 50 ft 1 in Vert. = 2 ft

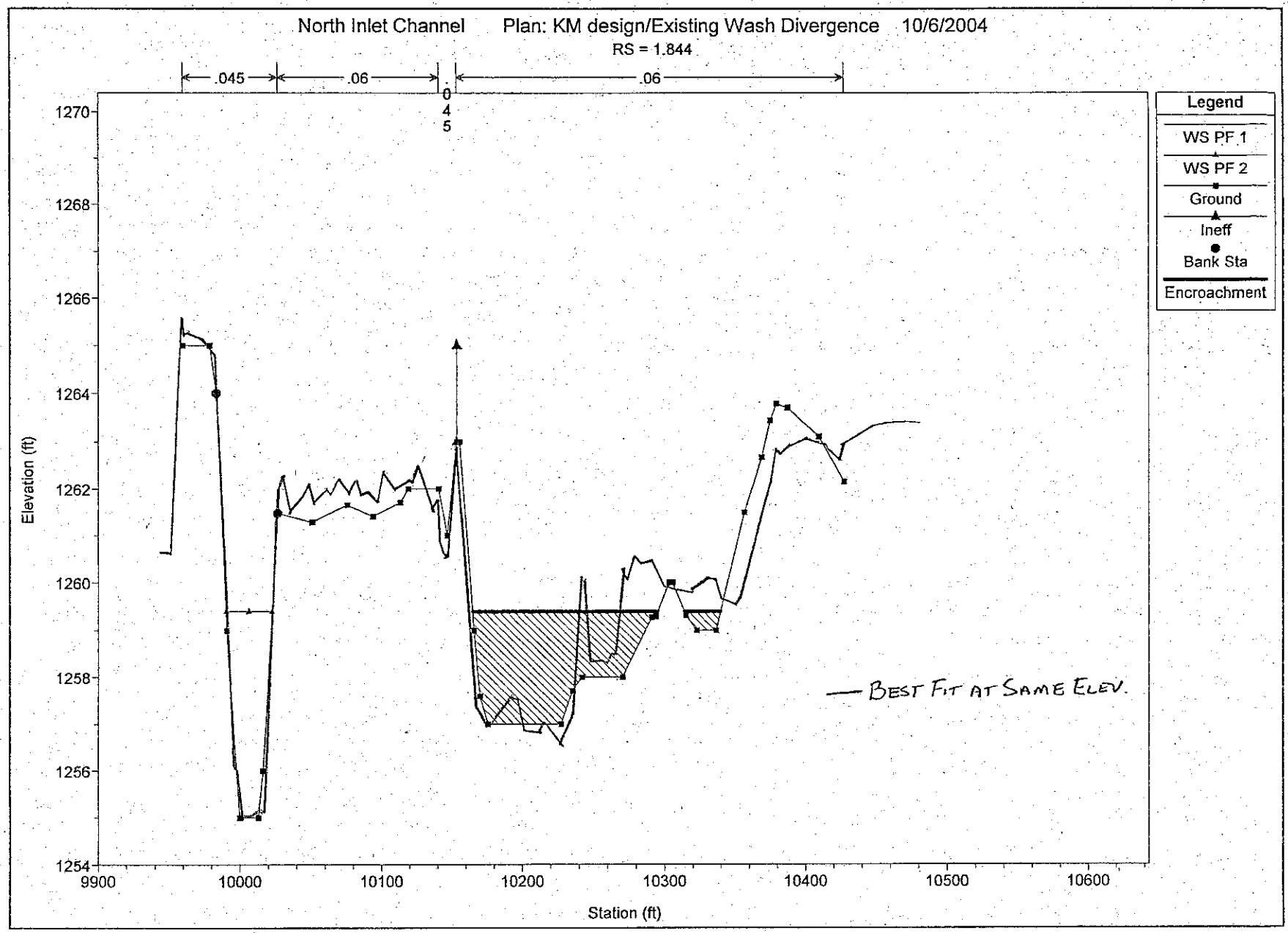


1 in Horiz. = 50 ft 1 in Vert. = 2 ft

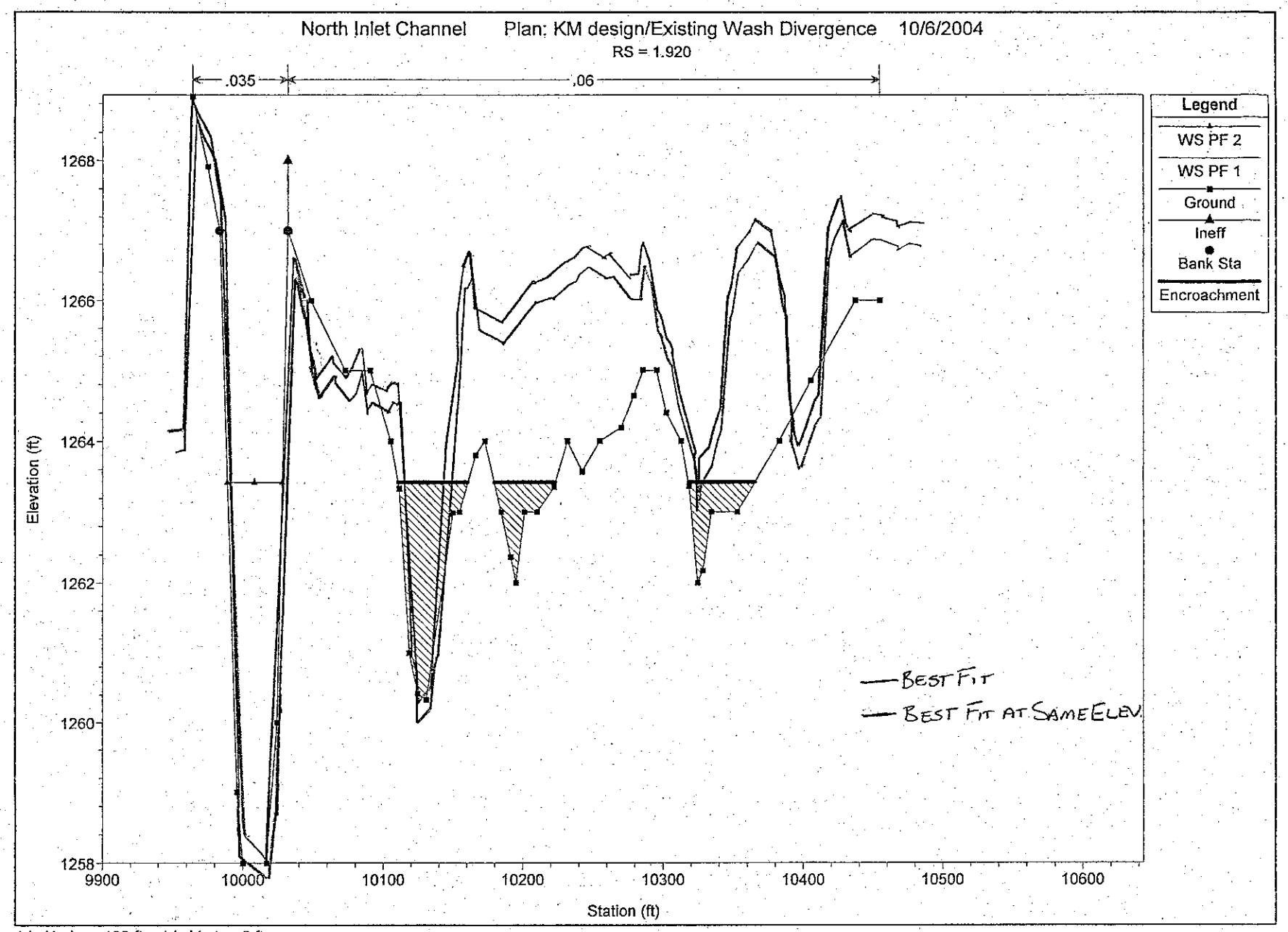


1 in Horiz. = 50 ft 1 in Vert. = 2 ft

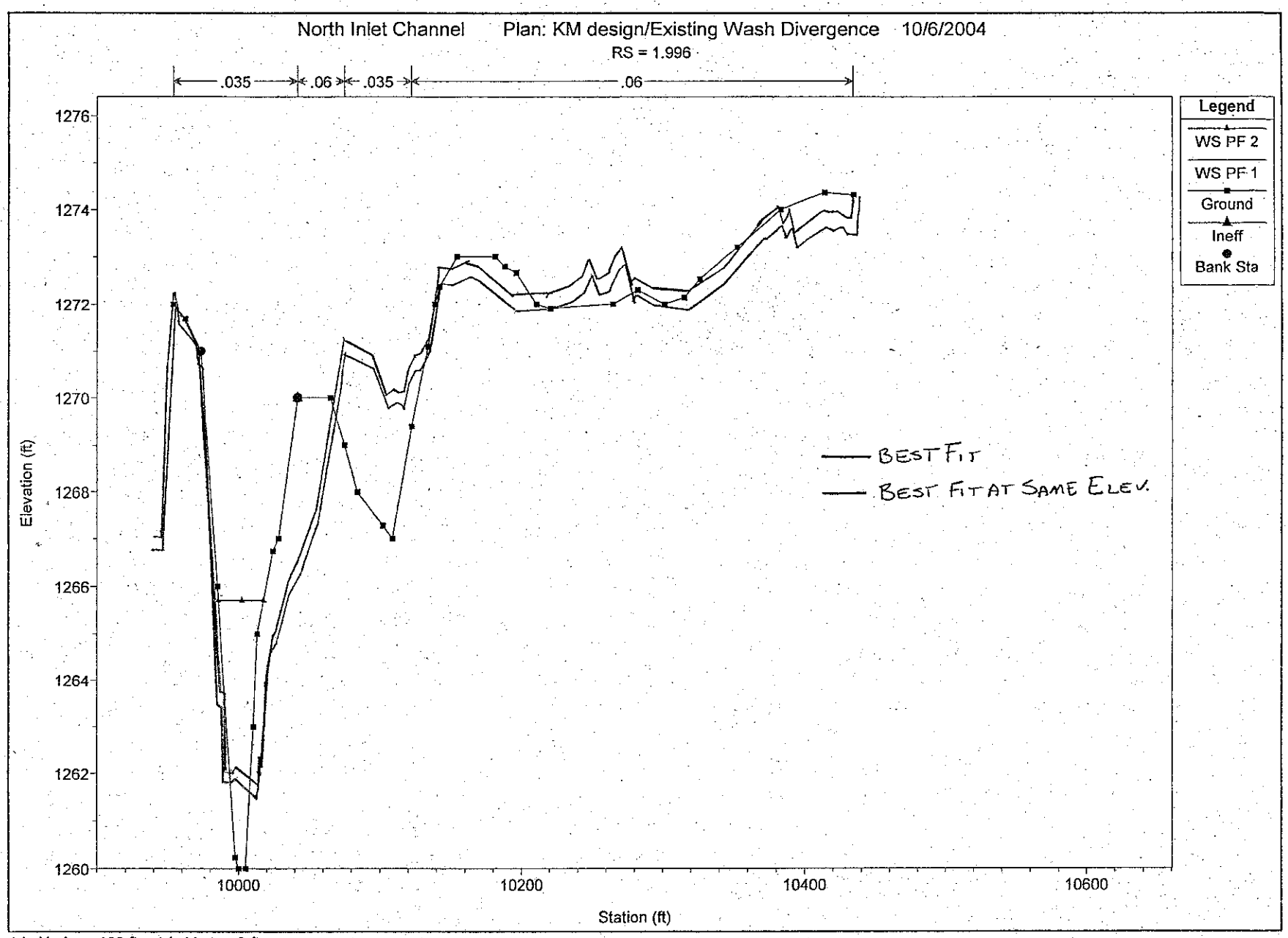

North Inlet Channel
RS = 1.768 Ineffective flow set at same location where previous HEC-2 model
.035
.08
.06
.035
.06
Legend
WS PF 2
Ground
Bank Sta
Encroachment
Elevation (ft)
1262
1260
1258
1256
1254
1252
9900
10000
10100
10200
10300
10400
10500
10600
Station (ft)
— BEST FIT AT SAME ELEV.
1 in Horiz. = 100 ft
1 in Vert. = 2 ft



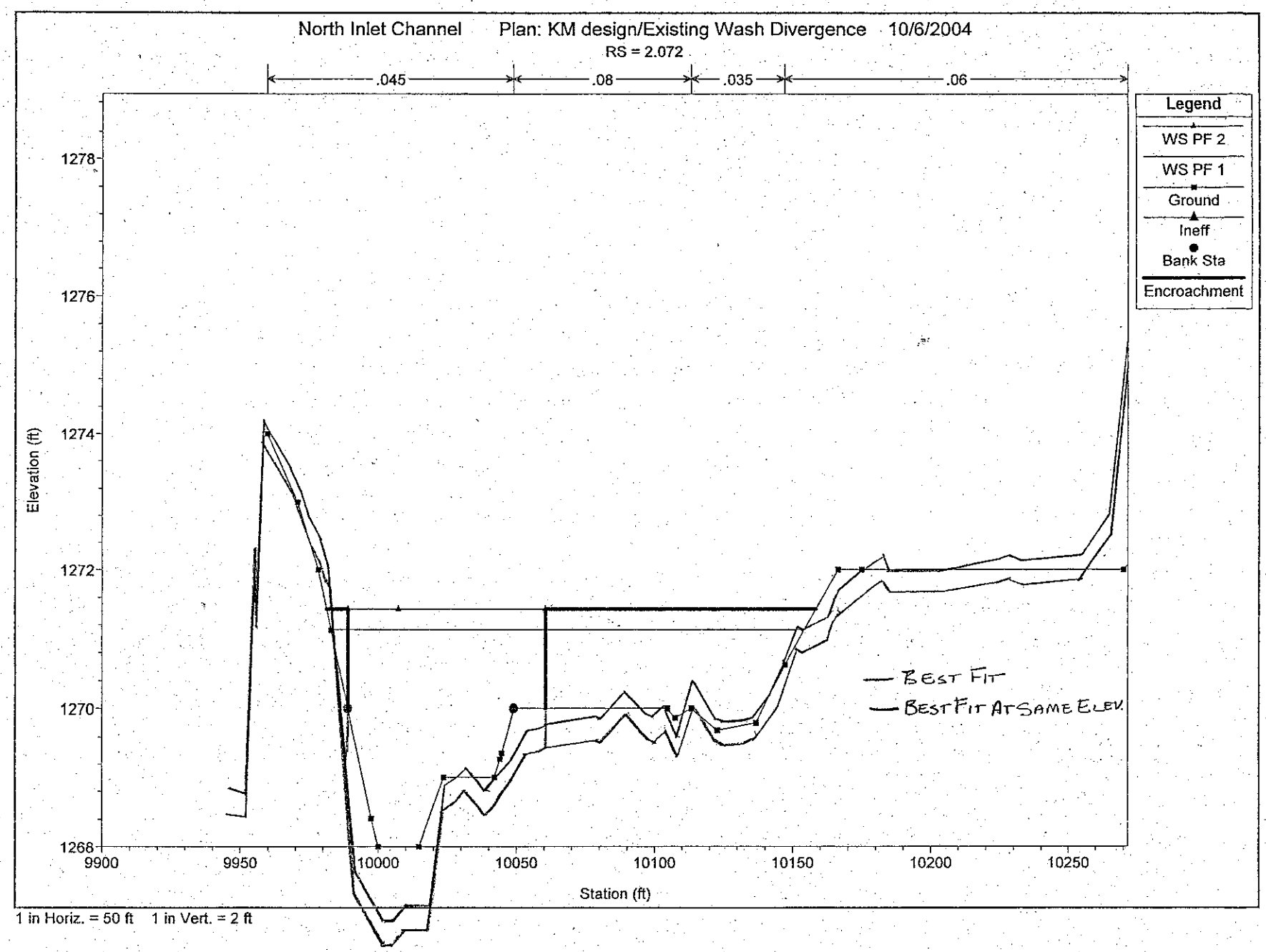
1 in Horiz. = 100 ft 1 in Vert. = 3 ft

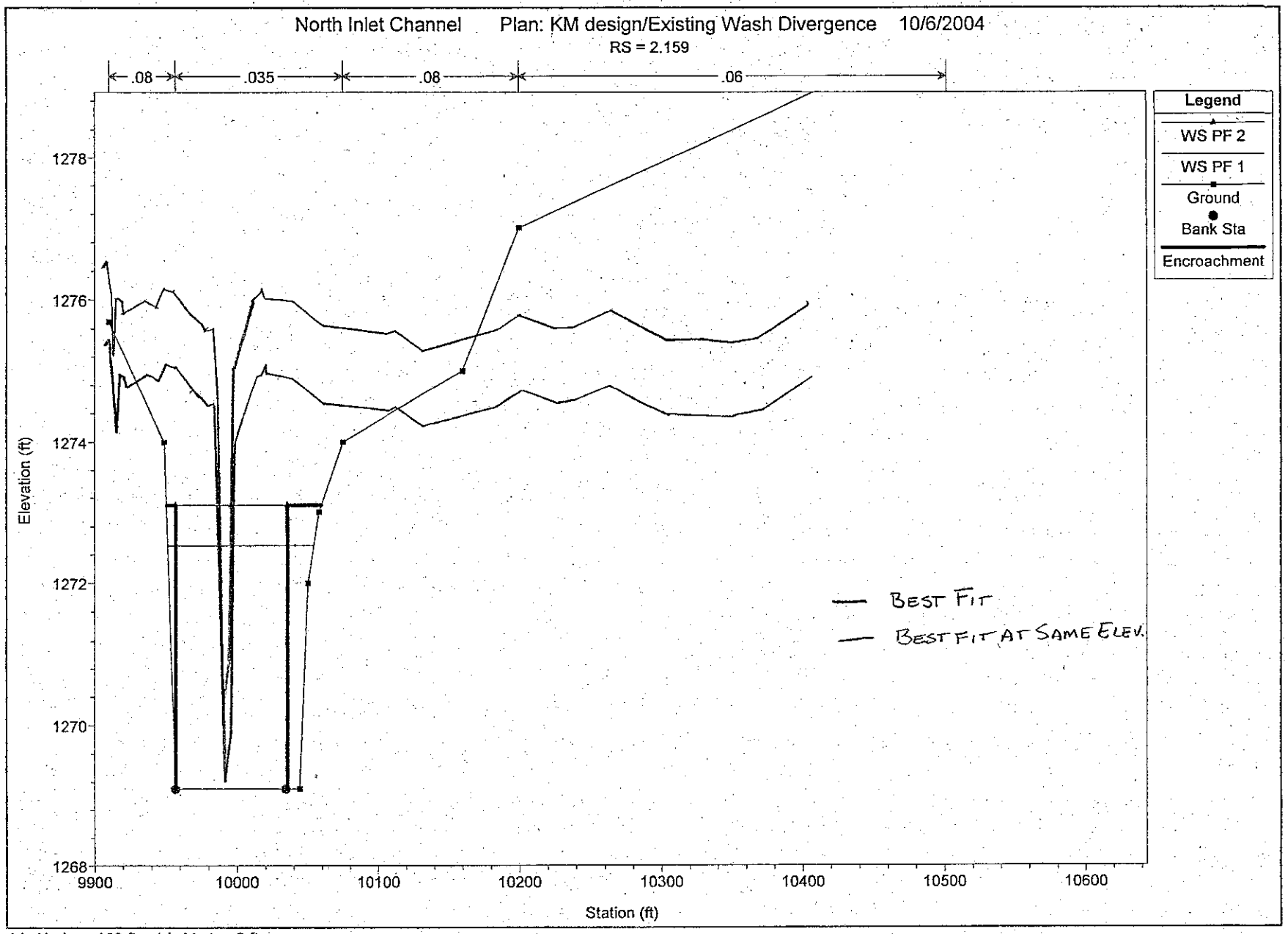


1 in Horiz. = 100 ft 1 in Vert. = 2 ft

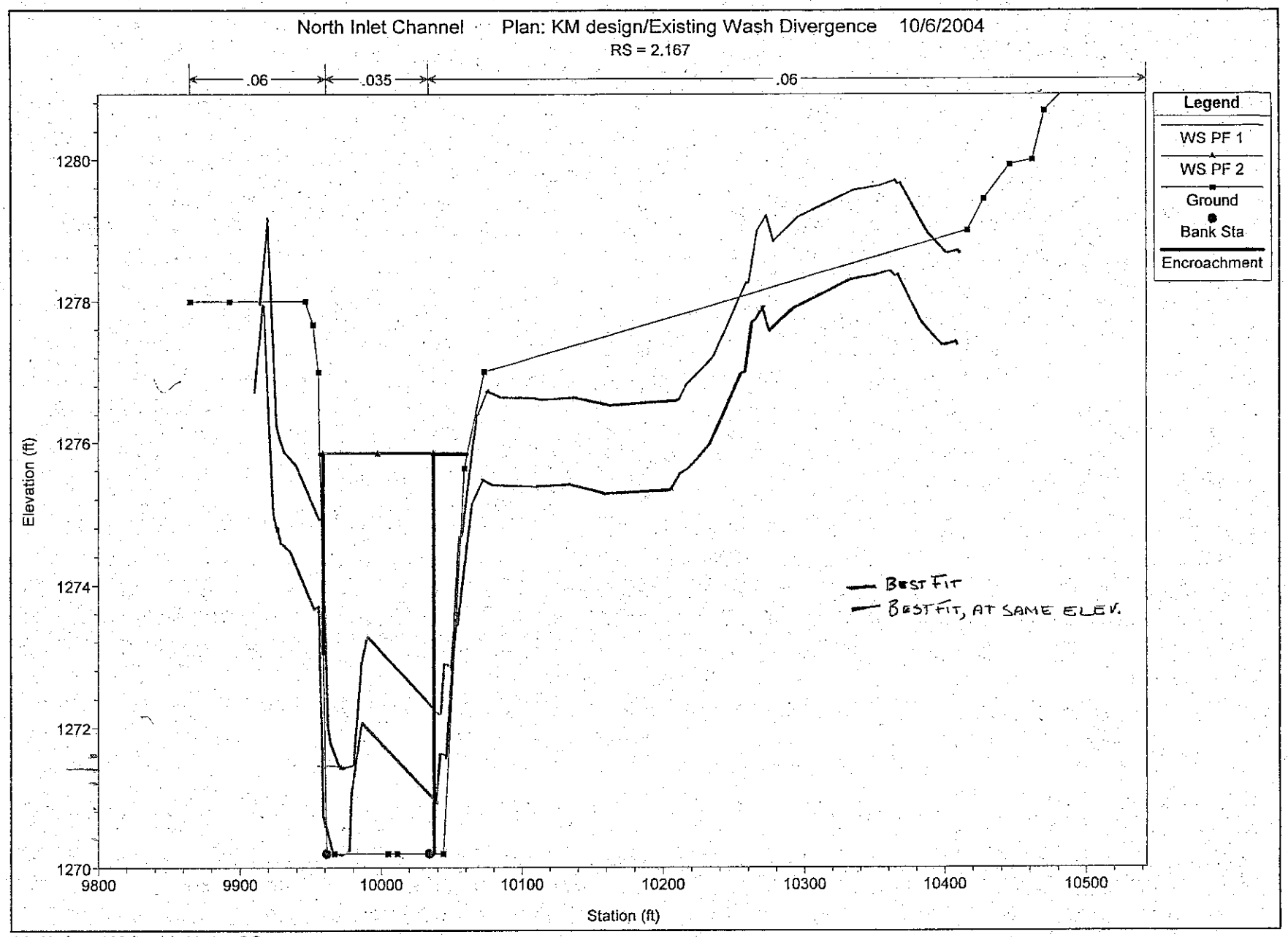


1 in Horiz. = 100 ft 1 in Vert. = 3 ft


North Inlet Channel Plan: KM design/Existing Wash Divergence 10/6/2004
RS = 2.072
.045
.08
.035
.06
Legend
WS PF 2
WS PF 1
Ground
Ineff
Bank Sta
Encroachment
Elevation (ft)
1278
1276
1274
1272
1270
1268
9900
9950
10000
10050
10100
10150
10200
10250
Station (ft)
BEST FIT
BEST FIT AT SAME ELEV.
1 in Horiz. = 50 ft 1 in Vert. = 2 ft



1 in Horiz. = 100 ft 1 in Vert. = 2 ft



1 in Horiz. = 100 ft 1 in Vert. = 2 ft

APPENDIX D – FLOW SPLIT ANALYSIS

Included in Appendix D

- FIRM maps of Beardsley Canal Wash
- Flood Profiles of Beardsley Canal Wash
- Diversion flow calculation spreadsheets, based on SRE HECRas iterative evaluation of flow split
- HECRas profile of Beardsley Canal Wash water elevation for cleared and uncleared diversion flows
- Sensitivity Analysis water elevation profile
- CulvertMaster capacity evaluation for existing culverts under Olive Avenue

HEC-AS WSE vs. FEMA Floodplain BFE from Olive Avanue to Cholla Wash
(Existing Channel)

Flow Divergence for Existing Channel

River Station (mi)	Flow (cfs)	Diversion to NIC (cfs)	FIS[1] Elev. (ft)	SRE Elev. (ft)	HEC-RAS Elev. (ft)	HEC - SRE Elev. Diffrence (ft)	HEC - FIS Elev. Diffrence (ft)
2.159	2655	0	1276.84	1274.38	1275.74	1.36	-1.1
2.072	2655	0	1271.44	1272.71	1273.54	0.83	2.1
1.996	2655	0	1267.84	1268.71	1268.72	0.01	0.9
1.920	2655	0	1265.04	1265.03	1265.61	0.58	0.6
1.844	2655	0	1261.84	1262.73	1262.83	0.10	1.0
1.768	2655	0	1256.14	1256.87	1257.66	0.79	1.5
1.692	2655	0	1253.24	1254.26	1255.57	1.31	2.3
1.616	2655	0	1253.04	1250.25	1250.47	0.22	-2.6
2.159	1655	1000	1276.84	1274.38	1274.21	-0.17	-2.6
2.072	1655	1000	1271.44	1272.71	1272.39	-0.32	1.0
1.996	1655	1000	1267.84	1268.71	1267.13	-1.58	-0.7
1.920	1655	1000	1265.04	1265.03	1264.86	-0.17	-0.2
1.844	1655	1000	1261.84	1262.73	1260.63	-2.10	-1.2
1.768	1655	1000	1256.14	1256.87	1256.52	-0.35	0.4
1.692	1655	1000	1253.24	1254.26	1254.36	0.10	1.1
1.616	1655	1000	1253.04	1250.25	1249.87	-0.38	-3.2
2.159	1055	1600	1276.84	1274.38	1273.10	-1.28	-3.7
2.072	1055	1600	1271.44	1272.71	1271.43	-1.28	0.0
1.996	1055	1600	1267.84	1268.71	1265.71	-3.00	-2.1
1.920	1055	1600	1265.04	1265.03	1263.43	-1.60	-1.6
1.844	1055	1600	1261.84	1262.73	1259.40	-3.33	-2.4
1.768	1055	1600	1256.14	1256.87	1255.96	-0.91	-0.2
1.692	1055	1600	1253.24	1254.26	1252.75	-1.51	-0.5
1.616	1055	1600	1253.04	1250.25	1250.59	0.34	-2.5

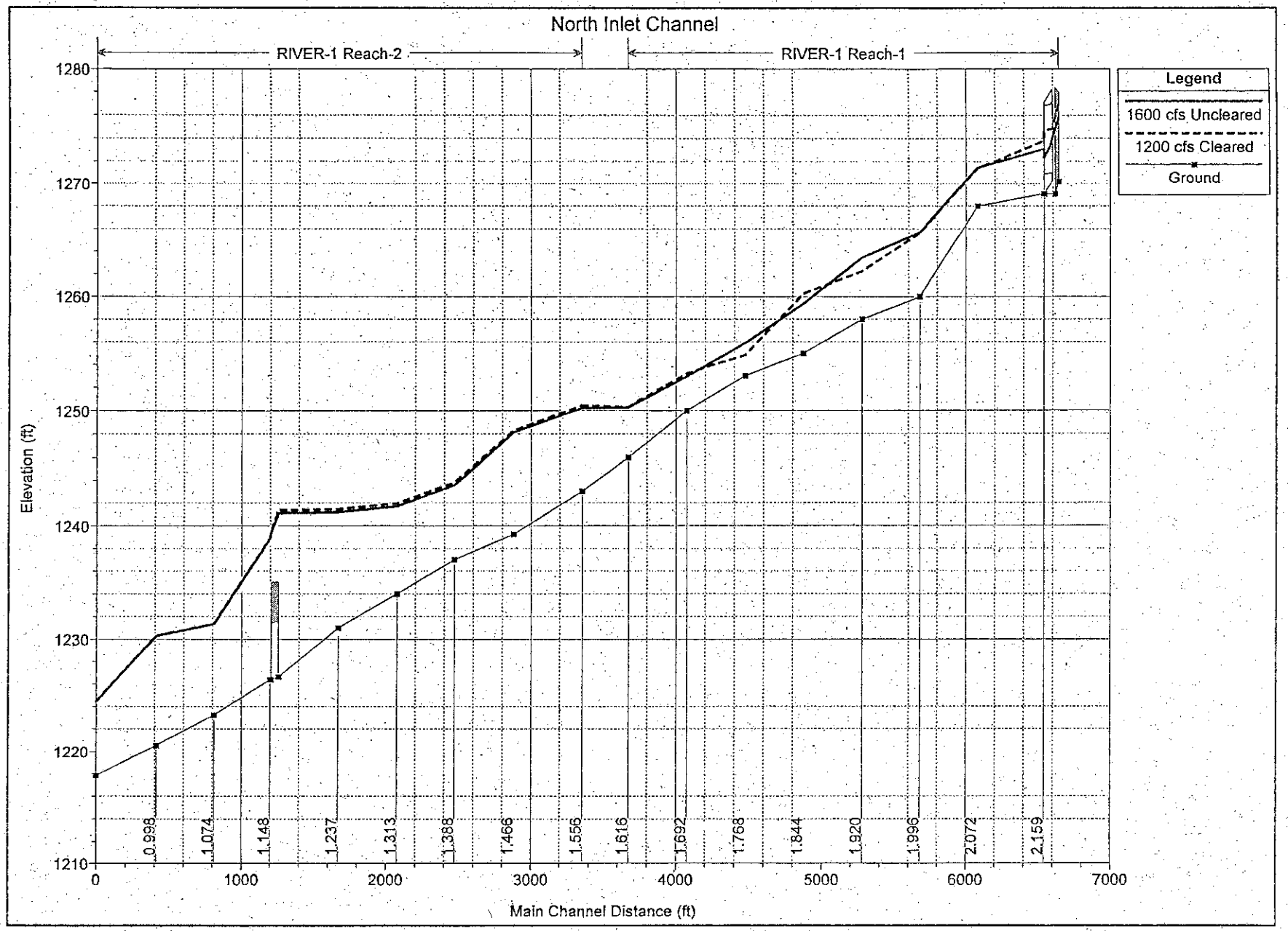
[1] FIS elevation increased by 2.24' to match SRE datum

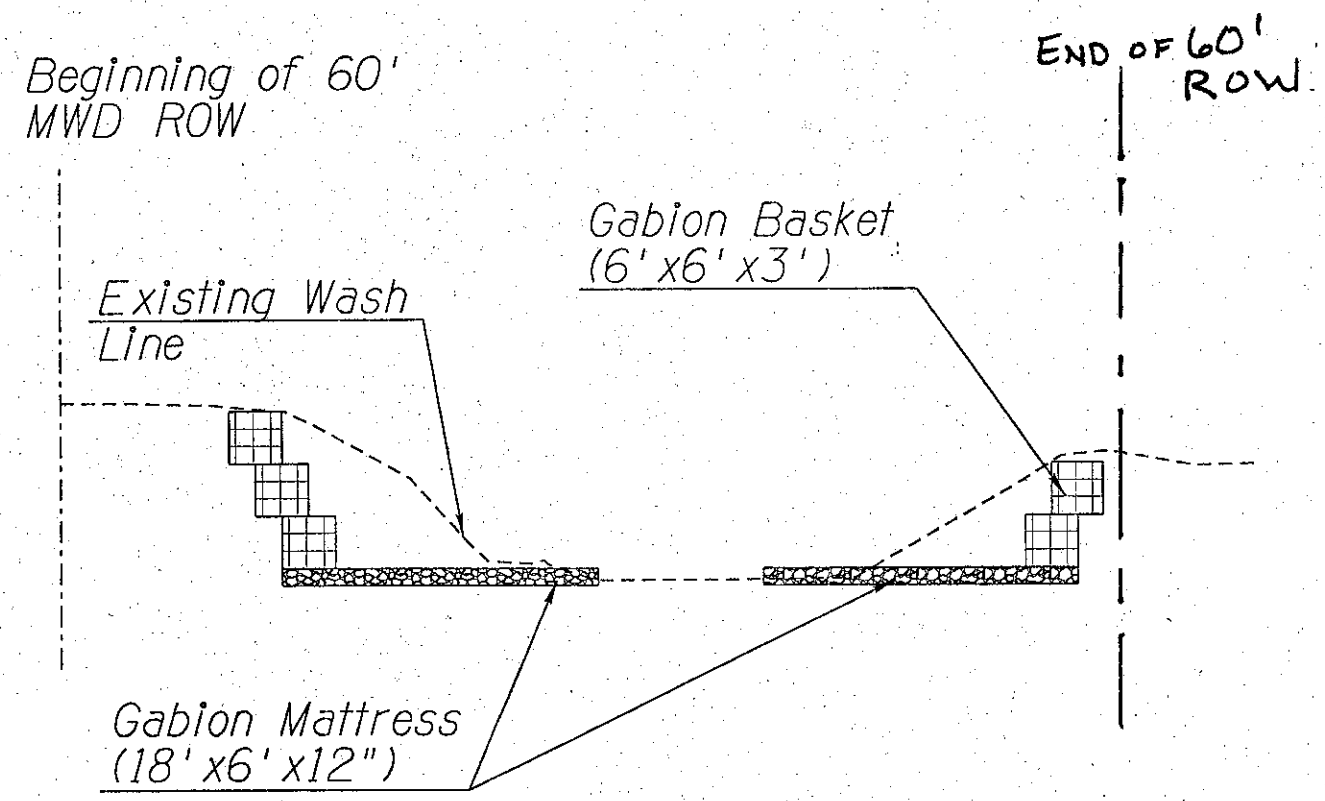
HEC-RAS WSE vs. FEMA Floodplain BFE for reach from Olive Avenue to Cholla Wash
(60' ROW Cleared Channel)

Flow Diversion for Cleared Channel

River Station (mi)	Flow (cfs)	Diversion to NIC (cfs)	FIS[1] Elev. (ft)	SRE Elev. (ft)	HEC-RAS Elev. (ft)	HEC - SRE Elev. Diffrence (ft)	HEC - FIS Elev. Diffrence (ft)
2.159	2655	0	1276.84	1274.38	1275.68	1.30	-1.2
2.072	2655	0	1271.44	1272.71	1272.60	-0.11	1.2
1.996	2655	0	1267.84	1268.71	1268.55	-0.16	0.7
1.920	2655	0	1265.04	1265.03	1264.49	-0.54	-0.5
1.844	2655	0	1261.84	1262.73	1262.78	0.05	0.9
1.768	2655	0	1256.14	1256.87	1257.21	0.34	1.1
1.692	2655	0	1253.24	1254.26	1254.33	0.07	1.1
1.616	2655	0	1253.04	1250.25	1250.60	0.35	-2.4
2.159	1655	1000	1276.84	1274.38	1274.14	-0.24	-2.7
2.072	1655	1000	1271.44	1272.71	1271.58	-1.13	0.1
1.996	1655	1000	1267.84	1268.71	1267.13	-1.58	-0.7
1.920	1655	1000	1265.04	1265.03	1263.20	-1.83	-1.8
1.844	1655	1000	1261.84	1262.73	1260.63	-2.10	-1.2
1.768	1655	1000	1256.14	1256.87	1256.17	-0.70	0.0
1.692	1655	1000	1253.24	1254.26	1253.40	-0.86	0.2
1.616	1655	1000	1253.04	1250.25	1249.79	-0.46	-3.3
2.159	1505	1200	1276.84	1274.38	1273.79	-0.59	-3.0
2.072	1505	1200	1271.44	1272.71	1271.36	-1.35	-0.1
1.996	1505	1200	1267.84	1268.71	1265.59	-3.12	-2.3
1.920	1505	1200	1265.04	1265.03	1262.22	-2.81	-2.8
1.844	1505	1200	1261.84	1262.73	1260.23	-2.50	-1.6
1.768	1505	1200	1256.14	1256.87	1254.83	-2.04	-1.3
1.692	1505	1200	1253.24	1254.26	1253.19	-1.07	0.0
1.616	1505	1200	1253.04	1250.25	1250.37	0.12	-2.7

[1] FIS elevation increased by 2.24' to match SRE datum

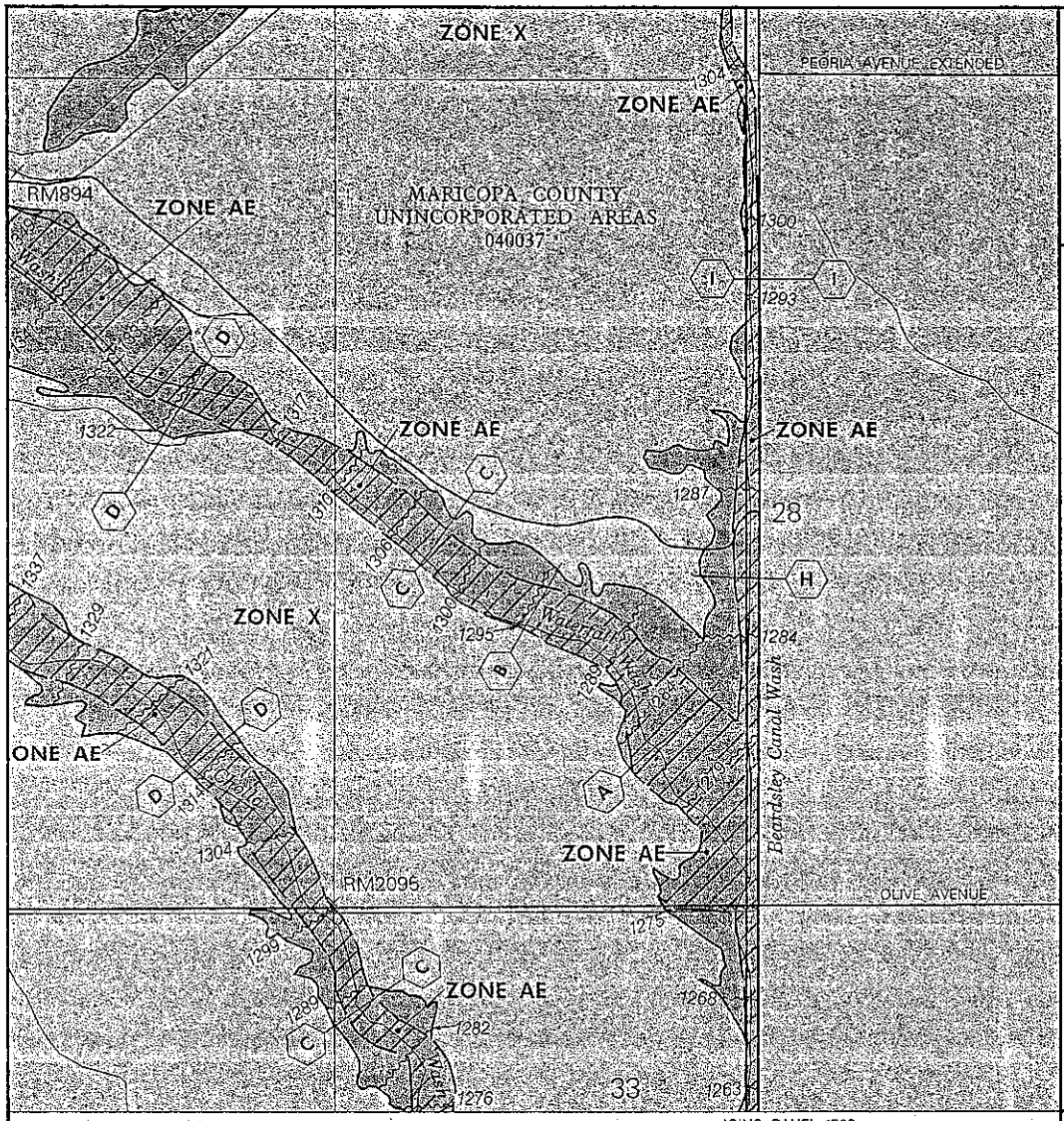

North Inlet Channel
RIVER-1 Reach-2
RIVER-1 Reach-1
Legend
1600 cfs Uncleared
1200 cfs Cleared
Ground
Elevation (ft)
1280
1270
1260
1250
1240
1230
1220
1210
0
1000
2000
3000
4000
5000
6000
7000
Main Channel Distance (ft)
0.998
1.074
1.148
1.237
1.313
1.388
1.466
1.556
1.616
1.692
1.768
1.844
1.920
1.996
2.072
2.159



KIRKHAM MICHAEL
CONSULTING ENGINEERS

Cleared Channel Bank Protection
Typical Section
(Looking Downstream)

PROJ. NO. North Channel Inlet
DATE 11-04
SHEET _ OF _



APPROXIMATE SCALE IN FEET

1000 0 1000

FIRM

FLOOD INSURANCE RATE MAP

MARICOPA COUNTY, ARIZONA AND INCORPORATED AREAS

PANEL 1580 OF 4350

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS: COMMUNITY	NUMBER	PANEL	SUFFIX
GLENDALE, CITY OF	040045	1580	G
MARICOPA COUNTY, UNINCORPORATED AREAS	040037	1580	G
SURPRISE, CITY OF	040053	1580	G

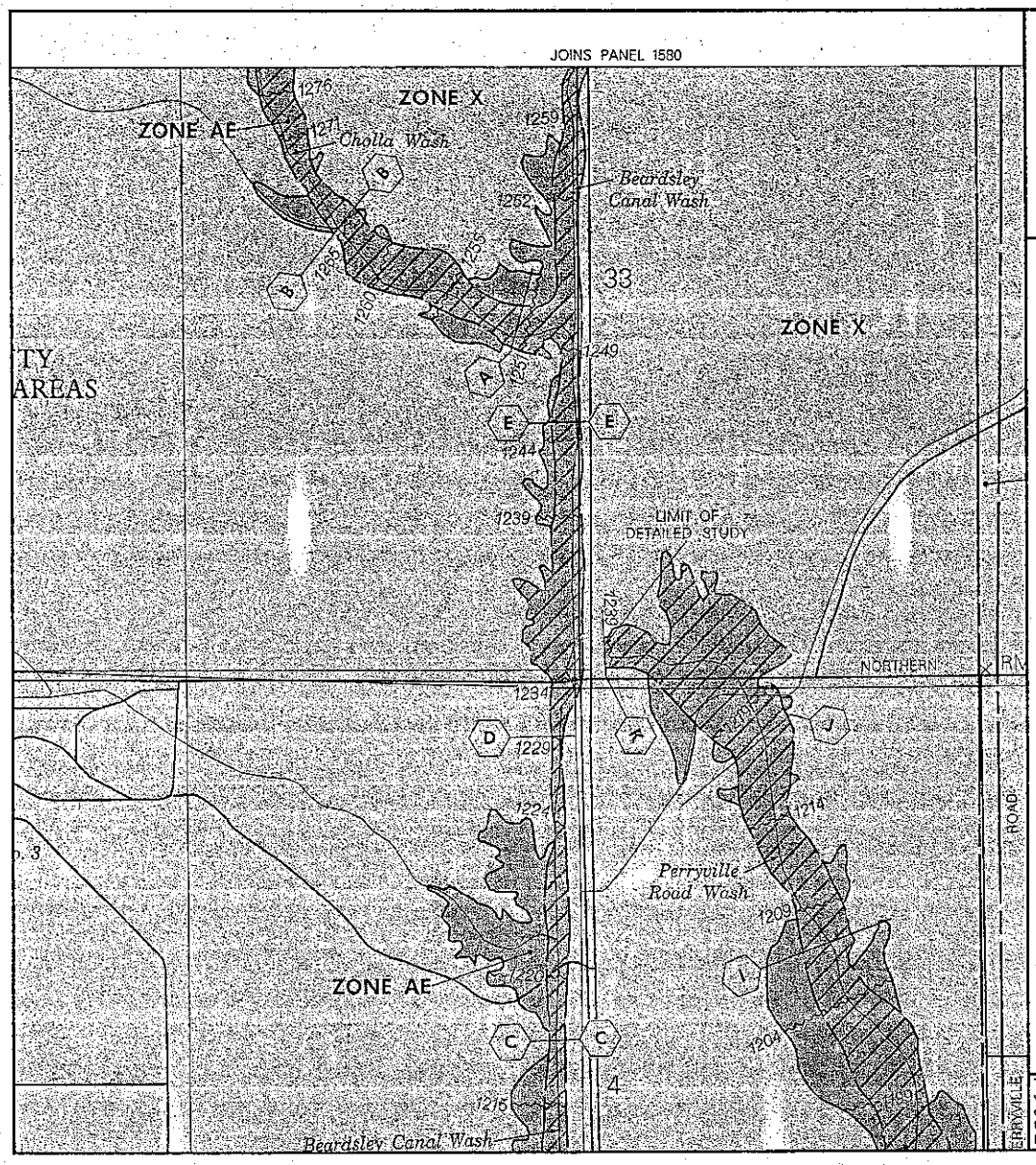
MAP NUMBER 04013C1580 G

MAP REVISED: JULY 19, 2001

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

FEMA FLOODPLAIN COMPARISON



APPROXIMATE SCALE IN FEET

1000 0 1000

FIRM

FLOOD INSURANCE RATE MAP

MARICOPA COUNTY, ARIZONA AND INCORPORATED AREAS

PANEL 1590 OF 4350

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
GLENDALE, CITY OF	040045	1590	G
GOODYEAR, CITY OF	040046	1590	G
MARICOPA, COUNTY UNINCORPORATED AREAS	040037	1590	G

MAP NUMBER 04013C1590 G

MAP REVISED: JULY 19, 2001

Federal Emergency Management Agency

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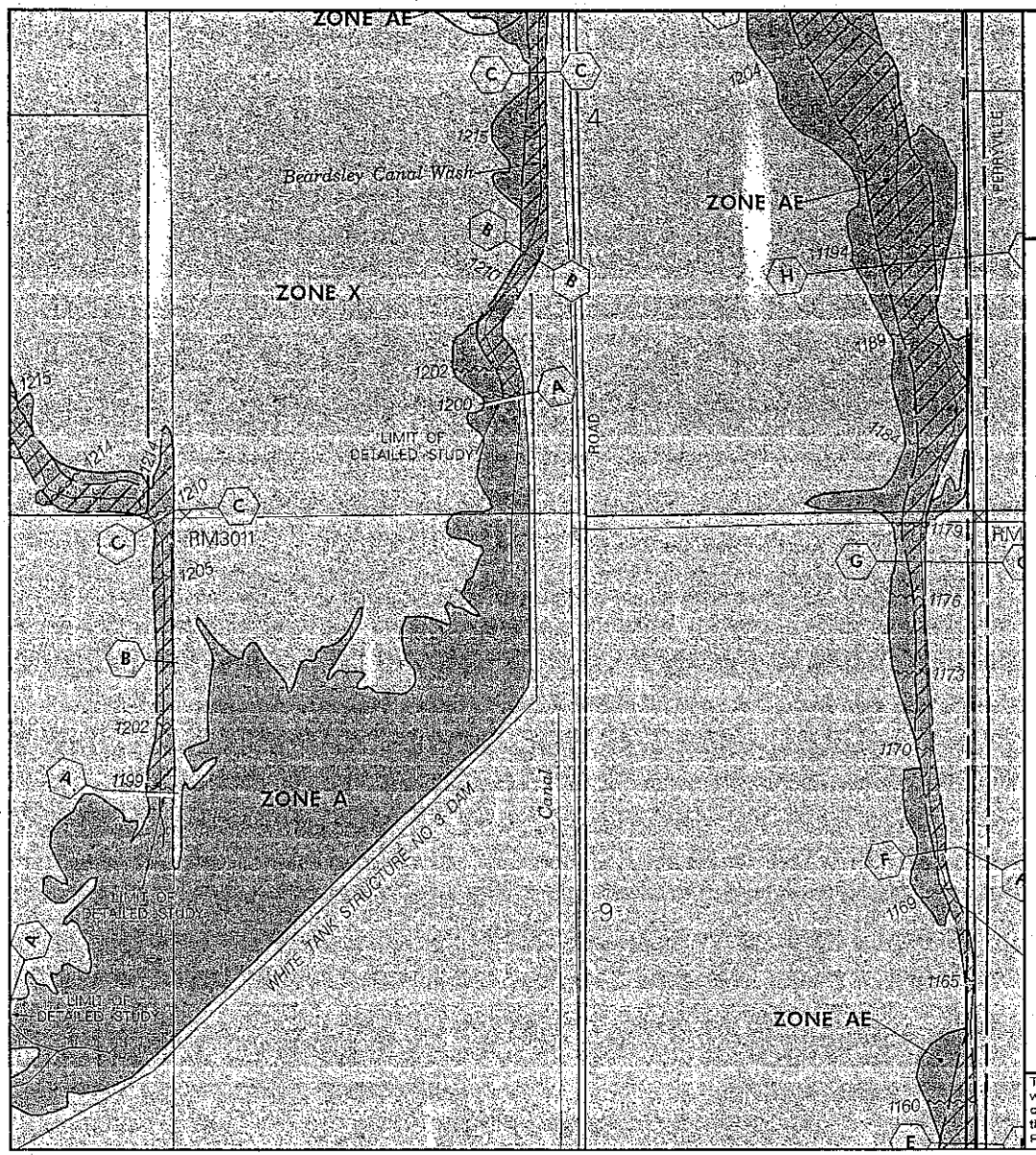


APPROXIMATE SCALE IN FEET

1000 0 1000

FIRM

FLOOD INSURANCE RATE MAP

MARICOPA COUNTY, ARIZONA AND INCORPORATED AREAS

PANEL 1590 OF 4350

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
GLENDALE, CITY OF	040045	1590	G
GOODYEAR, CITY OF	040046	1590	G
MARICOPA COUNTY, UNINCORPORATED AREAS	040037	1590	G

MAP NUMBER
04013C1590 G

MAP REVISED:
JULY 19, 2001

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

KIRKHAM MICHAEL
CONSULTING ENGINEERS

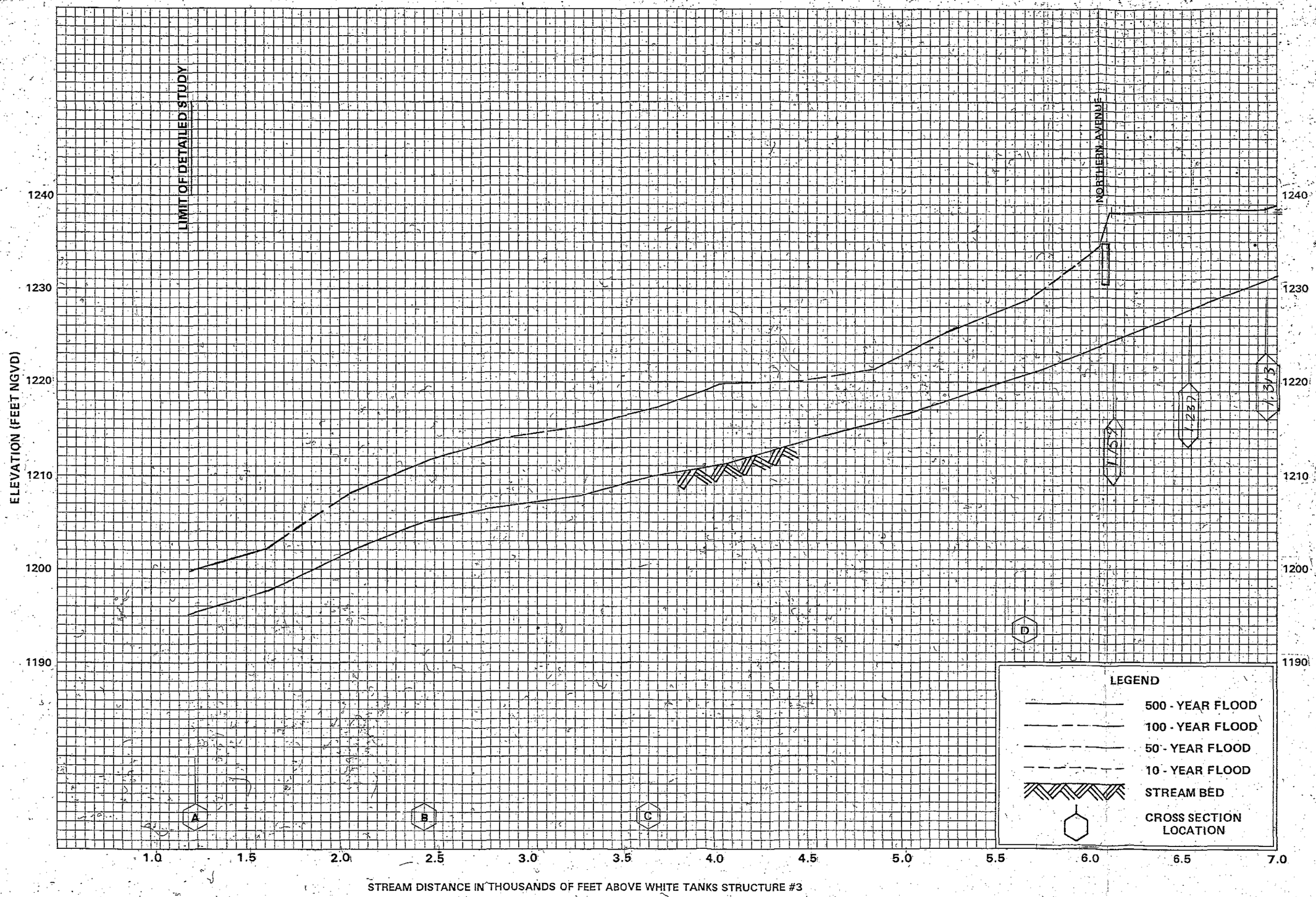
Job Number

Sheet of

Project NORTH INLET CHANNEL Date 8/18/04

Subject BEARDSLEY WASH BASE FLOOD ELEVATIONS FROM FIRM PANELS 580 & 1590 Designed JDL Checked

LOCATION	BFE	FIRM PANEL	MAP NUMBER
OLIVE AVE	1275	1580 OF 4350	04013C1580 G
600' S. OF OLIVE	1268	"	"
1175' S. OF OLIVE	1263	"	"
1650' S. OF OLIVE	1259	1590 OF 4350	04013C1590 G
2200' S. OF OLIVE	1252	"	"
3200' S OF OLIVE (CHOLLA WASH)	1249	"	"
3775' S. OF OLIVE	1244	"	"
4275' S. OF OLIVE	1239	"	"
5350' S. OF OLIVE (NORTHERN)	1234	"	"



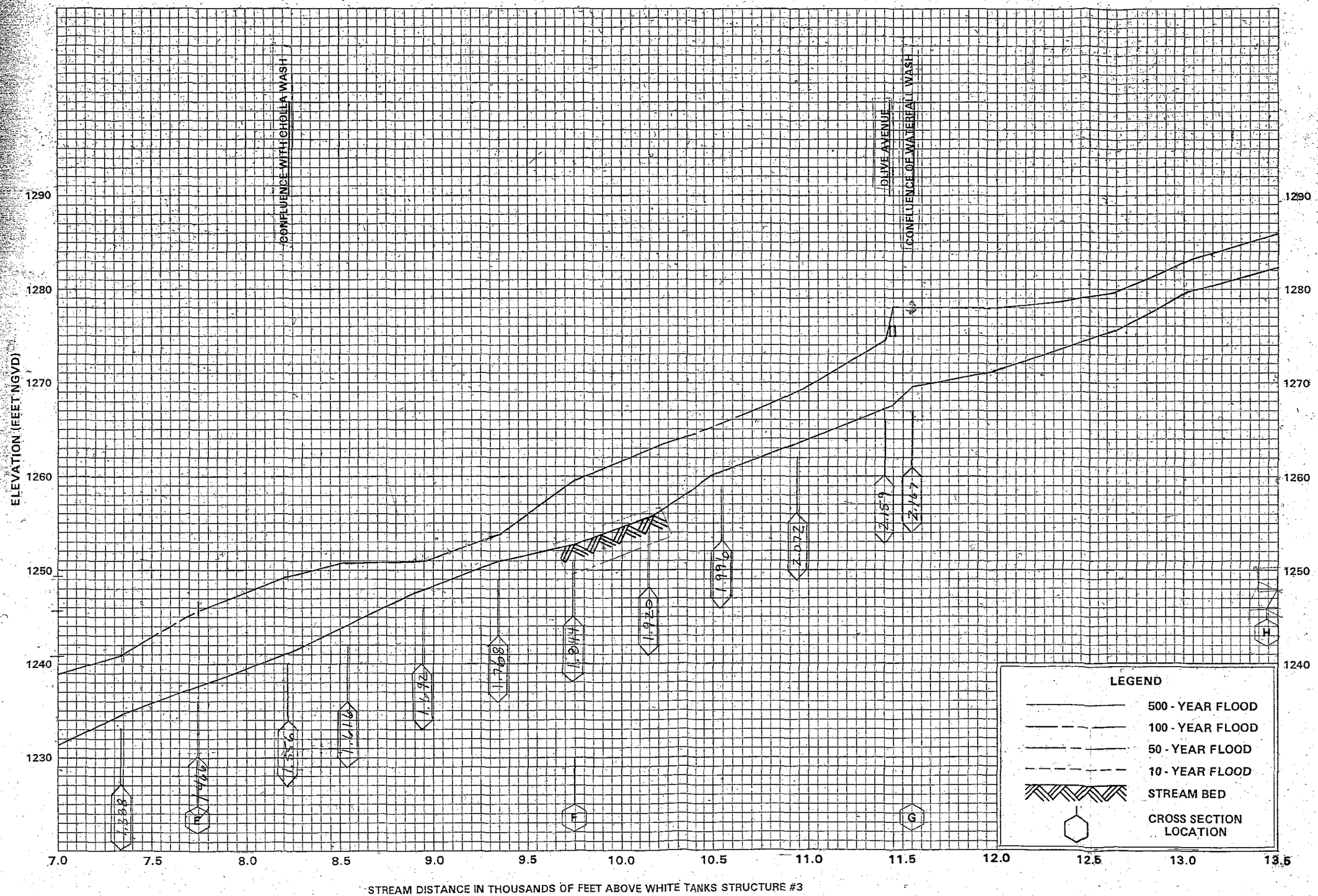
FLOOD PROFILES

BEARDSLEY CANAL WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARICOPA COUNTY, AZ
AND INCORPORATED AREAS

610P



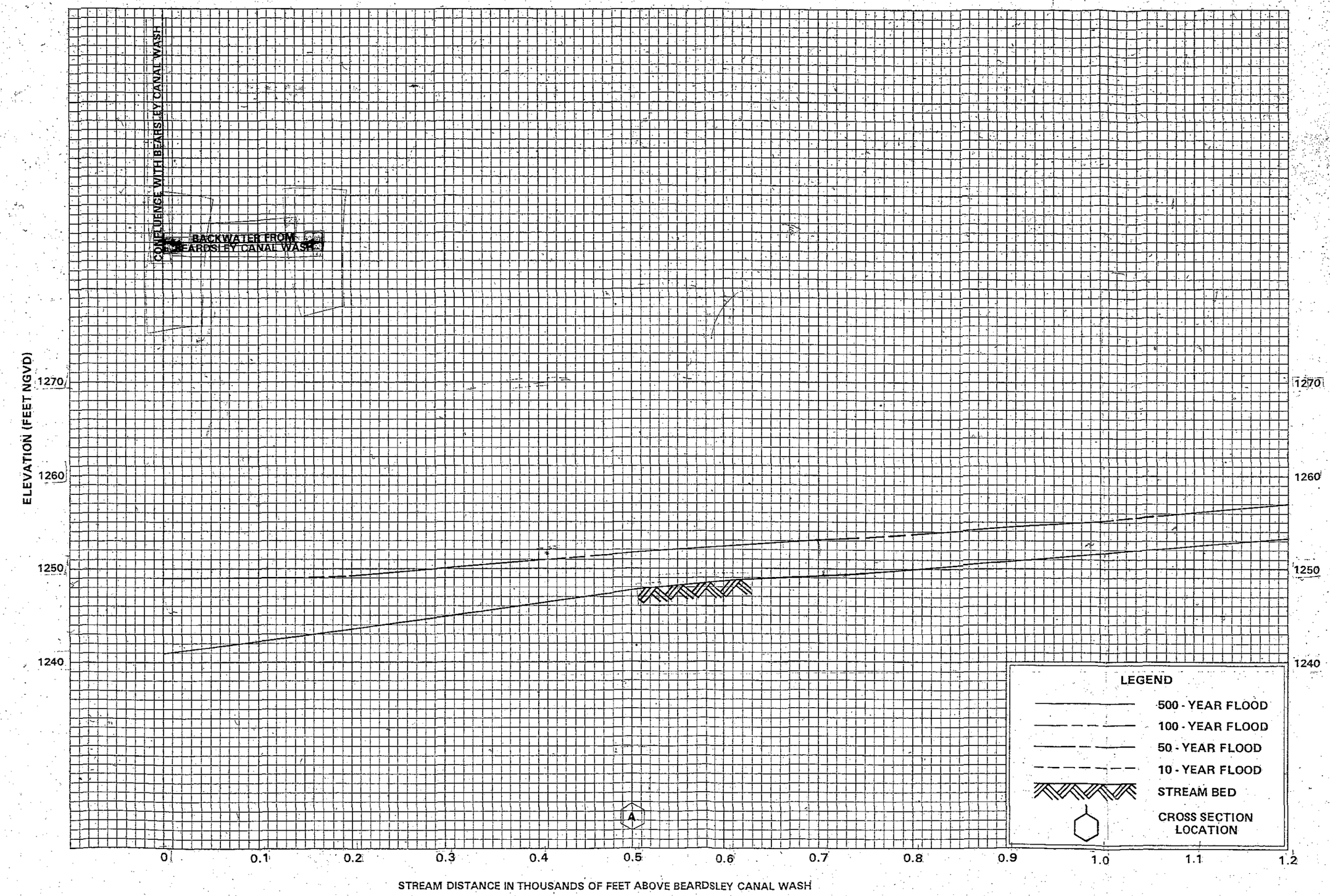
FLOOD PROFILES

BEARDSLEY CANAL WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARICOPA COUNTY, AZ
AND INCORPORATED AREAS

611P



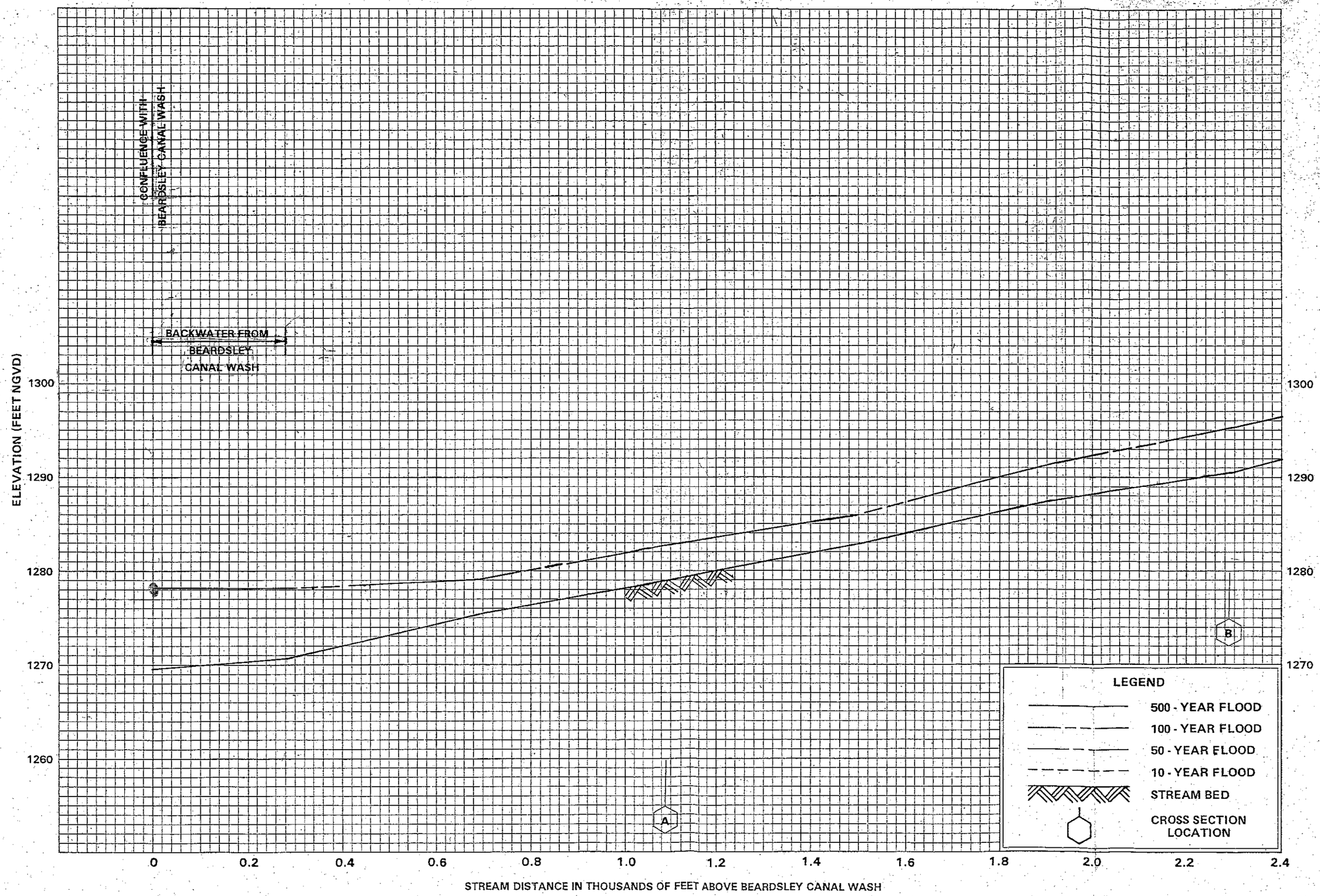
FLOOD PROFILES

CHOLLA WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARICOPA COUNTY, AZ
AND INCORPORATED AREAS

650P



FLOOD PROFILES

WATERFALL WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARICOPA COUNTY, AZ
AND INCORPORATED AREAS

823P

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE (FEET)
					FLOODING SOURCE			
Beardsley Canal Wash								
A	0.231	158	457	9.7	1,200.0	1,200.0	1,200.3	0.3
B	0.465	118	424	9.7	1,211.4	1,211.4	1,211.4	0.0
C	0.696	92	371	11.1	1,217.2	1,217.2	1,217.2	0.0
D	1.074	75	353	10.4	1,229.0	1,229.0	1,229.0	0.0
E	1.466	173	533	9.6	1,245.5	1,245.5	1,245.7	0.2
F	1.844	75	212	9.7	1,259.4	1,259.4	1,259.4	0.0
G	2.186	608	1,952	1.2	1,278.1	1,278.1	1,278.1	0.0
H	2.553	108	224	4.4	1,285.7	1,285.7	1,286.2	0.5
I	2.907	64	97	7.3	1,294.6	1,294.6	1,294.6	0.0
J	3.301	54	69	4.3	1,308.6	1,308.6	1,308.6	0.0
K	3.678	37	69	2.1	1,321.7	1,321.7	1,321.7	0.0

[1]Miles Above White Tanks Structure #3

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE (FEET)
					FLOODING SOURCE			
Cholla Wash								
A	0.095	285	877	4.3	1,251.5	1,251.5	1,251.7	0.2
B	0.373	265	572	6.7	1,265.1	1,265.1	1,265.1	0.0
C	0.765	230	596	6.4	1,288.6	1,288.6	1,288.7	0.1
D	1.138	315	701	5.4	1,314.0	1,314.0	1,314.0	0.0
E	1.509	449	737	4.8	1,343.6	1,343.6	1,343.7	0.1
F	1.886	335	576	6.1	1,382.4	1,382.4	1,382.7	0.3
G	2.250	113	357	9.1	1,433.5	1,433.5	1,433.5	0.0
H	2.727	94	339	9.5	1,505.9	1,505.9	1,505.9	0.0
I	3.116	149	389	8.3	1,580.0	1,580.0	1,580.0	0.0
J	3.508	85	333	9.7	1,660.5	1,660.5	1,660.5	0.0
K	3.587	80	297	10.9	1,675.8	1,675.8	1,675.8	0.0
L	3.956	87	264	9.6	1,770.6	1,770.6	1,770.6	0.0
M	4.242	83	280	9.0	1,843.1	1,843.1	1,843.1	0.0

[1]Miles Above Confluence With Beardsley Canal Wash

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARICOPA COUNTY, AZ
AND INCORPORATED AREAS

FLOODWAY DATA

CHOLLA WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE (FEET)
					FLOODING SOURCE			
Waterfall Wash								
A	0.206	675	890	2.5	1,282.7	1,282.7	1,283.4	0.7
B	0.434	301	477	4.7	1,295.0	1,295.0	1,295.3	0.3
C	0.585	275	457	4.9	1,303.0	1,303.0	1,303.8	0.8
D	0.873	343	433	5.3	1,321.2	1,321.2	1,321.2	0.0
E	1.352	297	319	7.2	1,358.7	1,358.7	1,358.7	0.0
F	1.706	88	241	9.5	1,388.7	1,388.7	1,388.8	0.1
G	2.083	57	214	10.7	1,422.3	1,422.3	1,422.3	0.0
H	2.551	74	202	9.0	1,468.9	1,468.9	1,468.9	0.0
I	3.030	95	216	8.4	1,525.0	1,525.0	1,525.0	0.0
J	3.555	61	183	9.9	1,646.1	1,646.1	1,646.1	0.0

[1]Miles Above Confluence With Beardsley Canal Wash

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARICOPA COUNTY, AZ
AND INCORPORATED AREAS

FLOODWAY DATA

WATERFALL WASH

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Tributary A					
Upstream of confluence with Star Wash	--[1]	--[1]	--[1]	8,700	--[1]
Upstream of confluence with Tributary B	--[1]	--[1]	--[1]	6,000	--[1]
Tributary B					
Upstream of confluence with Star Wash	--[1]	--[1]	--[1]	4,000	--[1]
Tributary C					
Upstream of confluence with Star Wash	--[1]	--[1]	--[1]	2,600	--[1]
Tributary D					
Upstream of confluence with Star Wash	--[1]	--[1]	--[1]	3,300	--[1]
Upstream of confluence with Tributary E	--[1]	--[1]	--[1]	2,000	--[1]
Tributary E					
Upstream of confluence with Star Wash	--[1]	--[1]	--[1]	3,000	--[1]
Beardsley Canal Wash					
Downstream of Northern Avenue	10.87	--[1]	--[1]	3,655	--[1]
Upstream of Northern Avenue	10.87	--[1]	--[1]	5,141	--[1]
At the confluence with Cholla Wash	6.01	--[1]	--[1]	3,816	--[1]
Downstream of Olive Avenue	4.86	--[1]	--[1]	1,755	--[1]
Upstream of Olive Avenue	4.86	--[1]	--[1]	2,245	--[1]
At Peoria Avenue	0.29	--[1]	--[1]	296	--[1]
Cholla Wash					
At the confluence with Beardsley Canal Wash	6.01	--[1]	--[1]	3,816	--[1]
At the confluence with North Fork Cholla Wash	3.99	--[1]	--[1]	3,227	--[1]
Upstream of the confluence with North Fork Cholla Wash	3.18	--[1]	--[1]	2,527	--[1]

[1]Not Computed

Table 3. Summary of Discharges (Cont'd)

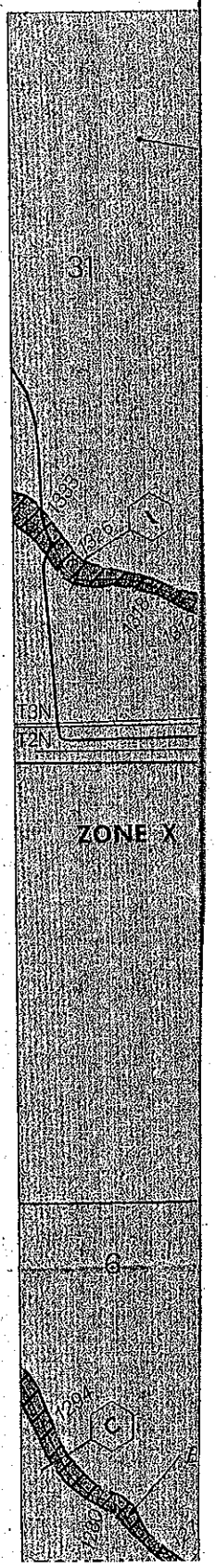
Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
North Fork Cholla Wash					
Upstream of the confluence with Cholla Wash	0.81	--[1]	--[1]	704	--[1]
Waterfall Wash					
At the confluence with Beardsley Canal Wash	4.86	--[1]	--[1]	2,245	--[1]
White Tanks #3 Wash					
At White Tanks Structure #3	2.86	--[1]	--[1]	1,743	--[1]
Bedrock Wash					
At White Tanks Structure #3	4.93	--[1]	--[1]	1,738	--[1]
At the confluence with North Fork Bedrock Wash	3.86	--[1]	--[1]	1,920	--[1]
North Fork Bedrock Wash					
At 0.15 miles upstream of the confluence with Bedrock Wash	2.1	--[1]	--[1]	1,560	--[1]
Jackrabbit Trail Wash					
At Interstate 10	17.43	--[1]	--[1]	1,186	--[1]
At McDowell Road Culverts	17.43	--[1]	--[1]	1,186	--[1]
At Thomas Road	2.07	--[1]	--[1]	1,105	--[1]
At At Indian School Road	1.36	--[1]	--[1]	726	--[1]
At Camelback Road	0.43	--[1]	--[1]	221	--[1]
At Medlock Drive	0.22	--[1]	--[1]	187	--[1]
Tuthill Dike Wash					
Downstream of Interstate 10	13.90	--[1]	--[1]	4,061	--[1]
Upstream of Interstate 10	13.90	--[1]	--[1]	5,503	--[1]
At McDowell Road and the confluence with Bulldozer Wash	14.56	--[1]	--[1]	6,601	--[1]

[1]Not Computed

FROM PANEL 1580

ELEVATION REFERENCE MARKS

REFERENCE MARK	ELEVATION (FEET NGVD)	DESCRIPTION OF LOCATION
RM3008	1218.83	Chiseled square in concrete base electrical transformer W5C 363 at southeast corner of intersection of Perryville Road and Northern Avenue, near southeast corner section 33, T3N, R2W.
RM3009	1182.66	1-+-inch iron pin in pothole, Perryville Road and Glendale Avenue, southeast corner section 4, T2N, R2W.
RM3010	1264.23	National Geodetic Survey benchmark - stainless-steel rod encased in pipe and stamped L475 1981 0.7 mile west of Beardsley Canal along Northern Avenue, q 1050 feet west of northeast corner section 5, T2N, R2W.
RM3011	1213.89	Iron pin at centerline intersection of Glendale Avenue and Jackrabbit Trail, southeast corner section 5, T2N, R2W.
RM3021	1262.08	Inverted aluminum cap at southwest corner of section 17, southwest corner section 17, T2N, R2W.
RM3022	1153.06	1-inch iron pipe flush with pavement, Perryville and Bethany Home Roads, southeast corner section 9, T2N, R2W.
RM3023	1185.68	40d nail in west face of power pole on east side of Jackrabbit Trail approximately 1000 feet south of Medlock Drive, near southeast corner section 17, T2N, R2W.
RM3035	1132.41	Iron rod flush with pavement, Perryville and Camelback Roads, southeast corner section 16, T2N, R2W.



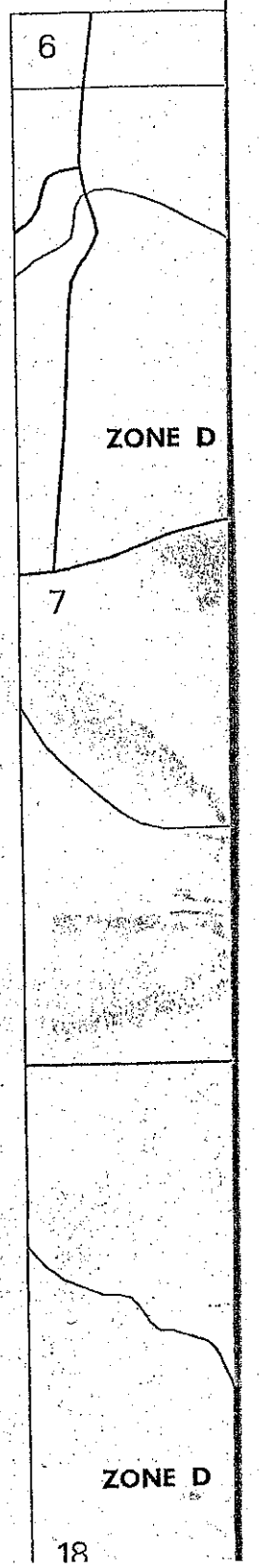
A B

FROM PANEL 1590

112°30'00"
33°37'30"

ELEVATION REFERENCE MARKS

REFERENCE MARK	ELEVATION (FEET NGVD)	DESCRIPTION OF LOCATION
RM894	1360.94	Brass cap in concrete on top of McMicken Dam, stamped 40.
RM895	1361.36	Brass cap in concrete on top of McMicken Dam, stamped 65.
RM896	1361.27	Brass cap in concrete on top of McMicken Dam, stamped 90.
RM897	1361.38	Brass cap in concrete on top of McMicken Dam, stamped 115.
RM898	1361.34	Brass cap in concrete on top of McMicken Dam, stamped 140.
RM899	1361.27	Brass cap in concrete on top of McMicken Dam, stamped 165.
RM900	1360.98	Brass cap in concrete on top of McMicken Dam, stamped 190.
RM901	1361.05	Brass cap in concrete on top of McMicken Dam, stamped 215.
RM2095	1299.40	1-inch pipe in handhole at centerline intersection of Jackrabbit Trail and Olive Avenue, northwest corner section 33, T3N, R2W.
RM2096	1280.02	Chiseled X on top concrete ditch southwest corner of intersection Perryville Road and Peoria Avenue, near southeast corner section 21, T3N, R2W.



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2

Culvert Designer/Analyzer Report
Olive Ave (existing)

Analysis Component			
Storm Event	Design	Discharge	1,055.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	1,055.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	1,273.10 ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-96 inch Circular	216.80 cfs	1,276.06 ft	8.63 ft/s
Culvert-2	1-84 inch Circular	195.92 cfs	1,276.06 ft	8.62 ft/s
Culvert-3	2-10 x 6 ft Box	642.30 cfs	1,276.06 ft	10.11 ft/s
Weir	Roadway (Constant Elevation)	0.00 cfs	1,276.06 ft	N/A
Total	----------	1,055.02 cfs	1,276.06 ft	N/A

Culvert Designer/Analyzer Report
Olive Ave (existing)

Component:Culvert-1

Culvert Summary					
Computed Headwater Elev	1,276.06	ft	Discharge	216.80	cfs
Inlet Control HW Elev.	1,275.41	ft	Tailwater Elevation	1,273.10	ft
Outlet Control HW Elev.	1,276.06	ft	Control Type	Entrance Control	
Headwater Depth/Height	0.73				

Grades					
Upstream Invert	1,270.24	ft	Downstream Invert	1,269.10	ft
Length	54.00	ft	Constructed Slope	0.021111	ft/ft

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	4.00	ft
Slope Type	Steep		Normal Depth	3.02	ft
Flow Regime	N/A		Critical Depth	3.69	ft
Velocity Downstream	8.63	ft/s	Critical Slope	0.010158	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	8.00	ft
Section Size	96 inch		Rise	8.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	1,276.06	ft	Upstream Velocity Head	1.42	ft
Ke	0.50		Entrance Loss	0.71	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,275.41	ft	Flow Control	Unsubmerged	
Inlet Type	Headwall		Area Full	50.3	ft^2
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Olive Ave (existing)

Component:Culvert-2

Culvert Summary			
Computed Headwater Elev	1,276.06 ft	Discharge	195.92 cfs
Inlet Control HW Elev.	1,275.47 ft	Tailwater Elevation	1,273.10 ft
Outlet Control HW Elev.	1,276.06 ft	Control Type	Entrance Control
Headwater Depth/Height	0.83		

Grades			
Upstream Invert	1,270.24 ft	Downstream Invert	1,269.10 ft
Length	54.00 ft	Constructed Slope	0.021111 ft/ft

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	4.00 ft
Slope Type	Steep	Normal Depth	3.03 ft
Flow Regime	N/A	Critical Depth	3.65 ft
Velocity Downstream	8.62 ft/s	Critical Slope	0.011151 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	7.00 ft
Section Size	84 inch	Rise	7.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	1,276.06 ft	Upstream Velocity Head	1.45 ft
Ke	0.50	Entrance Loss	0.73 ft

Inlet Control Properties			
Inlet Control HW Elev.	1,275.47 ft	Flow Control	Unsubmerged
Inlet Type	Headwall	Area Full	38.5 ft²
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

Culvert Designer/Analyzer Report
Olive Ave (existing)

Component:Culvert-3

Culvert Summary					
Computed Headwater Elev	1,276.06	ft	Discharge	642.30	cfs
Inlet Control HW Elev.	1,276.00	ft	Tailwater Elevation	1,273.10	ft
Outlet Control HW Elev.	1,276.06	ft	Control Type	Outlet Control	
Headwater Depth/Height	0.84				

Grades					
Upstream Invert	1,271.00	ft	Downstream Invert	1,270.85	ft
Length	57.00	ft	Constructed Slope	0.002632	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	3.18	ft
Slope Type	Mild		Normal Depth	3.42	ft
Flow Regime	Subcritical		Critical Depth	3.18	ft
Velocity Downstream	10.11	ft/s	Critical Slope	0.003228	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	10.00	ft
Section Size	10 x 6 ft		Rise	6.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1,276.06	ft	Upstream Velocity Head	1.42	ft
Ke	0.20		Entrance Loss	0.28	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,276.00	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	120.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Designer/Analyzer Report
Olive Ave (existing)

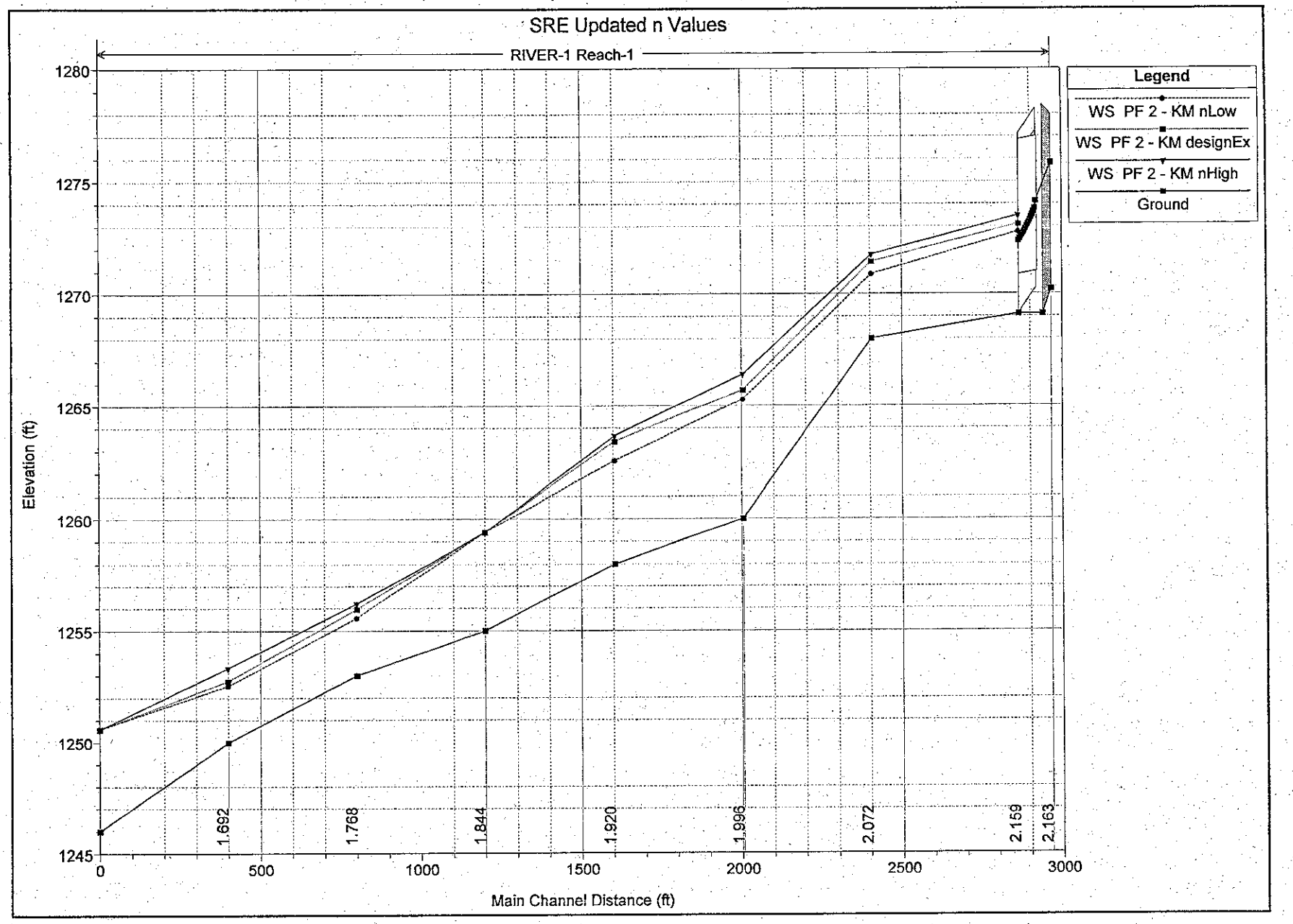
Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)

Discharge	0.00	cfs	Allowable HW Elevation	1,276.06	ft
Roadway Width	24.00	ft	Overtopping Coefficient	2.90	US
Length	340.00	ft	Crest Elevation	1,278.00	ft
Headwater Elevation	N/A	ft	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (ft)	Elev. (ft)
0.00	1,278.00
340.00	1,278.00

'n' VALUE SENSITIVITY ANALYSIS FOR
BEARDSLEY CANAL WASH FROM OLIVE TO CHOLLA



'n' VALUE SENSITIVITY ANALYSIS FOR
BEARDSLEY CANAL WASH FROM OLIVE TO CHOLLA
HYDRAULIC DATA

HEC-RAS River: RIVER-1 Reach: Reach-1 Profile: PF 2

Reach	River Sta	Profile	Plan	Q Total	Length Chnl	Mann Wtd Chnl	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)		(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	2.167	PF 2	KM nLow	1055.00	102.00	0.035	1270.20	1275.83	5.63	1271.93	1275.93	0.000351	2.52	439.18	78.54	0.19
Reach-1	2.167	PF 2	KM designEx	1055.00	102.00	0.035	1270.20	1275.83	5.63	1271.93	1275.93	0.000351	2.52	439.18	78.54	0.19
Reach-1	2.167	PF 2	KM nHigh	1055.00	102.00	0.035	1270.20	1275.83	5.63	1271.93	1275.93	0.000351	2.52	439.18	78.54	0.19
Reach-1	2.163			Culvert												
Reach-1	2.159	PF 2	KM nLow	1055.00	460.00	0.025	1269.10	1272.76	3.65		1272.97	0.000733	3.70	287.03	78.54	0.34
Reach-1	2.159	PF 2	KM designEx	1055.00	460.00	0.035	1269.10	1273.10	4.00		1273.27	0.001072	3.39	313.90	78.54	0.30
Reach-1	2.159	PF 2	KM nHigh	1055.00	460.00	0.045	1269.10	1273.48	4.38		1273.63	0.001312	3.09	344.23	78.54	0.26
Reach-1	2.072	PF 2	KM nLow	1055.00	400.00	0.035	1268.00	1270.86	2.86	1270.86	1271.85	0.013492	8.06	137.78	71.51	0.97
Reach-1	2.072	PF 2	KM designEx	1055.00	400.00	0.045	1268.00	1271.43	3.43	1270.87	1272.03	0.010062	6.29	178.28	71.51	0.68
Reach-1	2.072	PF 2	KM nHigh	1055.00	400.00	0.055	1268.00	1271.75	3.75	1270.87	1272.22	0.010371	5.61	200.90	71.51	0.57
Reach-1	1.996	PF 2	KM nLow	1055.00	400.00	0.025	1260.00	1265.29	5.29	1265.71	1267.37	0.009045	11.59	91.06	28.50	1.14
Reach-1	1.996	PF 2	KM designEx	1055.00	400.00	0.035	1260.00	1265.71	5.71	1265.71	1267.32	0.013342	10.17	103.73	32.07	1.00
Reach-1	1.996	PF 2	KM nHigh	1055.00	400.00	0.045	1260.00	1266.42	6.42	1265.71	1267.46	0.013431	8.19	128.74	38.22	0.79
Reach-1	1.920	PF 2	KM nLow	1055.00	405.00	0.025	1258.00	1262.56	4.56	1261.80	1263.53	0.003448	7.91	133.45	36.73	0.73
Reach-1	1.920	PF 2	KM designEx	1055.00	405.00	0.035	1258.00	1263.43	5.43	1261.80	1264.05	0.003571	6.35	166.27	39.02	0.54
Reach-1	1.920	PF 2	KM nHigh	1055.00	405.00	0.045	1258.00	1263.67	5.67	1261.80	1264.23	0.005007	5.99	176.05	39.68	0.50
Reach-1	1.844	PF 2	KM nLow	1055.00	400.00	0.035	1255.00	1259.40	4.40	1259.40	1261.01	0.013316	10.19	103.52	32.55	1.01
Reach-1	1.844	PF 2	KM designEx	1055.00	400.00	0.045	1255.00	1259.40	4.40	1259.40	1261.01	0.022014	10.19	103.52	32.55	1.01
Reach-1	1.844	PF 2	KM nHigh	1055.00	400.00	0.035	1255.00	1259.40	4.40	1259.40	1261.01	0.013287	10.18	103.60	32.56	1.01
Reach-1	1.768	PF 2	KM nLow	1055.00	400.00	0.025	1253.00	1255.57	2.57	1255.15	1255.86	0.003227	5.35	306.33	193.74	0.66
Reach-1	1.768	PF 2	KM designEx	1055.00	400.00	0.035	1253.00	1255.96	2.96	1255.15	1256.15	0.003318	4.33	382.72	193.74	0.49
Reach-1	1.768	PF 2	KM nHigh	1055.00	400.00	0.045	1253.00	1256.21	3.21	1255.16	1256.35	0.003884	3.88	430.04	193.74	0.42
Reach-1	1.692	PF 2	KM nLow	1055.00	400.00	0.035	1250.00	1252.53	2.53	1252.53	1253.36	0.015853	7.90	147.63	87.81	1.04
Reach-1	1.692	PF 2	KM designEx	1055.00	400.00	0.045	1250.00	1252.75	2.75	1252.57	1253.43	0.019790	7.30	167.01	88.95	0.91
Reach-1	1.692	PF 2	KM nHigh	1055.00	400.00	0.055	1250.00	1253.35	3.35		1253.75	0.012794	5.63	221.26	90.26	0.62
Reach-1	1.616	PF 2	KM nLow	1055.00	320.00	0.035	1246.00	1250.59	4.59	1249.13	1250.79	0.001685	3.72	308.02	103.64	0.37
Reach-1	1.616	PF 2	KM designEx	1055.00	320.00	0.045	1246.00	1250.59	4.59		1250.79	0.002998	3.86	307.81	103.64	0.38
Reach-1	1.616	PF 2	KM nHigh	1055.00	320.00	0.055	1246.00	1250.59	4.59		1250.80	0.004655	3.94	307.64	103.64	0.39

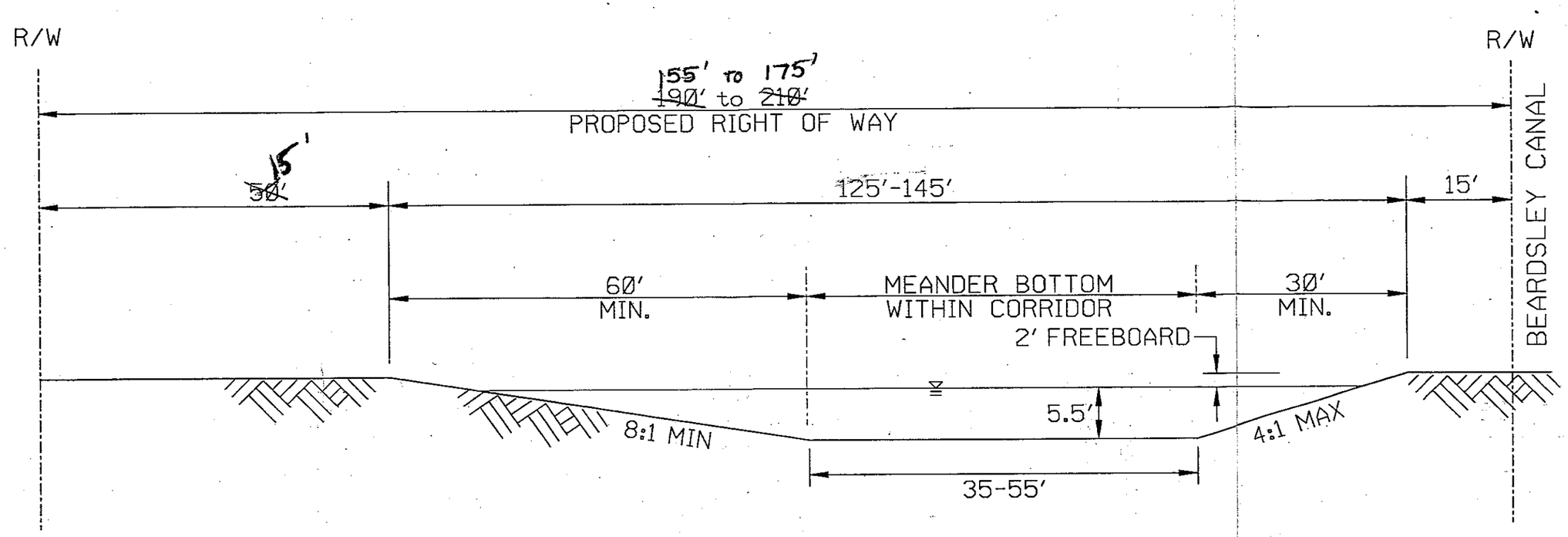
n' Value Sensitivity Analysis for Reach from Olive Avenue to Cholla Wash							
High							
	River Station	Frctn (n/K)	n #1	n #2	n #3	n #4	n #5
1	2.167	n	0.06	0.035	0.06		
2	2.163	Culvert					
3	2.159	n	0.1	0.045	0.1	0.08	
4	2.072	n	0.055	0.1	0.045	0.08	
5	1.996	n	0.045	0.08	0.045	0.08	
6	1.92	n	0.045	0.08			
7	1.844	n	0.035	0.08	0.055	0.08	
8	1.768	n	0.045	0.1	0.08	0.045	0.08
9	1.692	n	0.055	0.08	0.045	0.08	
10	1.616	n	0.1	0.055	0.08		
Low							
	River Station	Frctn (n/K)	n #1	n #2	n #3	n #4	n #5
1	2.167	n	0.06	0.035	0.06		
2	2.163	Culvert					
3	2.159	n	0.06	0.025	0.06	0.04	
4	2.072	n	0.035	0.06	0.025	0.04	
5	1.996	n	0.025	0.04	0.025	0.04	
6	1.92	n	0.025	0.04			
7	1.844	n	0.035	0.04	0.035	0.04	
8	1.768	n	0.025	0.06	0.04	0.025	0.04
9	1.692	n	0.035	0.04	0.025	0.04	
10	1.616	n	0.06	0.035	0.04		

	n' Values for Reach from Olive Avenue to Cholla Wash							
	Cleared							
		River Station	Frctn (n/K)	n #1	n #2	n #3	n #4	n #5	n #6
	1	2.167	n	0.06	0.035	0.06			
	2	2.163	Culvert						
	3	2.159	n	0.022	0.035	0.08	0.06		
	4	2.072	n	0.022	0.045	0.08	0.035	0.06	
	5	1.996	n	0.022	0.035	0.06	0.035	0.06	
	6	1.92	n	0.022	0.06				
	7	1.844	n	0.022	0.06	0.045	0.06		
	8	1.768	n	0.022	0.035	0.08	0.06	0.035	0.06
	9	1.692	n	0.022	0.035	0.06	0.035	0.06	
	10	1.616	n	0.022	0.045	0.06			
	Existing								
		River Station	Frctn (n/K)	n #1	n #2	n #3	n #4	n #5	
	1	2.167	n	0.06	0.035	0.06			
	2	2.163	Culvert						
	3	2.159	n	0.08	0.035	0.08	0.06		
	4	2.072	n	0.045	0.08	0.035	0.06		
	5	1.996	n	0.035	0.06	0.035	0.06		
	6	1.92	n	0.035	0.06				
	7	1.844	n	0.045	0.06	0.045	0.06		
	8	1.768	n	0.035	0.08	0.06	0.035	0.06	
	9	1.692	n	0.045	0.06	0.035	0.06		
	10	1.616	n	0.08	0.045	0.06			

APPENDIX E – DIVERSION STRUCTURE ANALYSIS

Included in Appendix E

- CulvertMaster culvert sizing for both uncleared and cleared diversion flows
  - Diversion structure performance curve, headwater vs. depth
  - ADOT standard drawing of culvert and wings
- Weir design and quantity calculations
  - Sharp crested weir
  - Broad crested weir
- Olive Avenue Crossing Alternatives
  - Plan and profile of crossing
  - Design and quantity calculations
- Northern Avenue Crossing Alternatives
  - Plan and profile of crossing
  - CulvertMaster culvert design



NORTH INLET CHANNEL
ON EAST SIDE OF BEARDSLEY CANAL
NORTHERN AVE TO OLIVE AVE
(Looking Downstream)

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

	NAME	DATE
DESIGNED		
DRAWN		
CHECKED		

FRS #3 NORTH INLET CHANNEL

SHEET ___ OF ___

Rectangular Channel at Olive Ave. Double Crossing
Worksheet for Rectangular Channel

Project Description	
Worksheet	Rectangular Channel
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.005000	ft/ft
Bottom Width	35.00	ft
Discharge	1,600.00	cfs

Results		
Depth	3.01	ft
Flow Area	105.5	ft²
Wetted Perimeter	41.03	ft
Top Width	35.00	ft
Critical Depth	4.02	ft
Critical Slope	0.002040	ft/ft
Velocity	15.17	ft/s
Velocity Head	3.58	ft
Specific Energy	6.59	ft
Froude Number	1.54	
Flow Type	Supercritical	

Trapazoidal Channel at Olive Ave. Double Crossing
Worksheet for Trapezoidal Channel

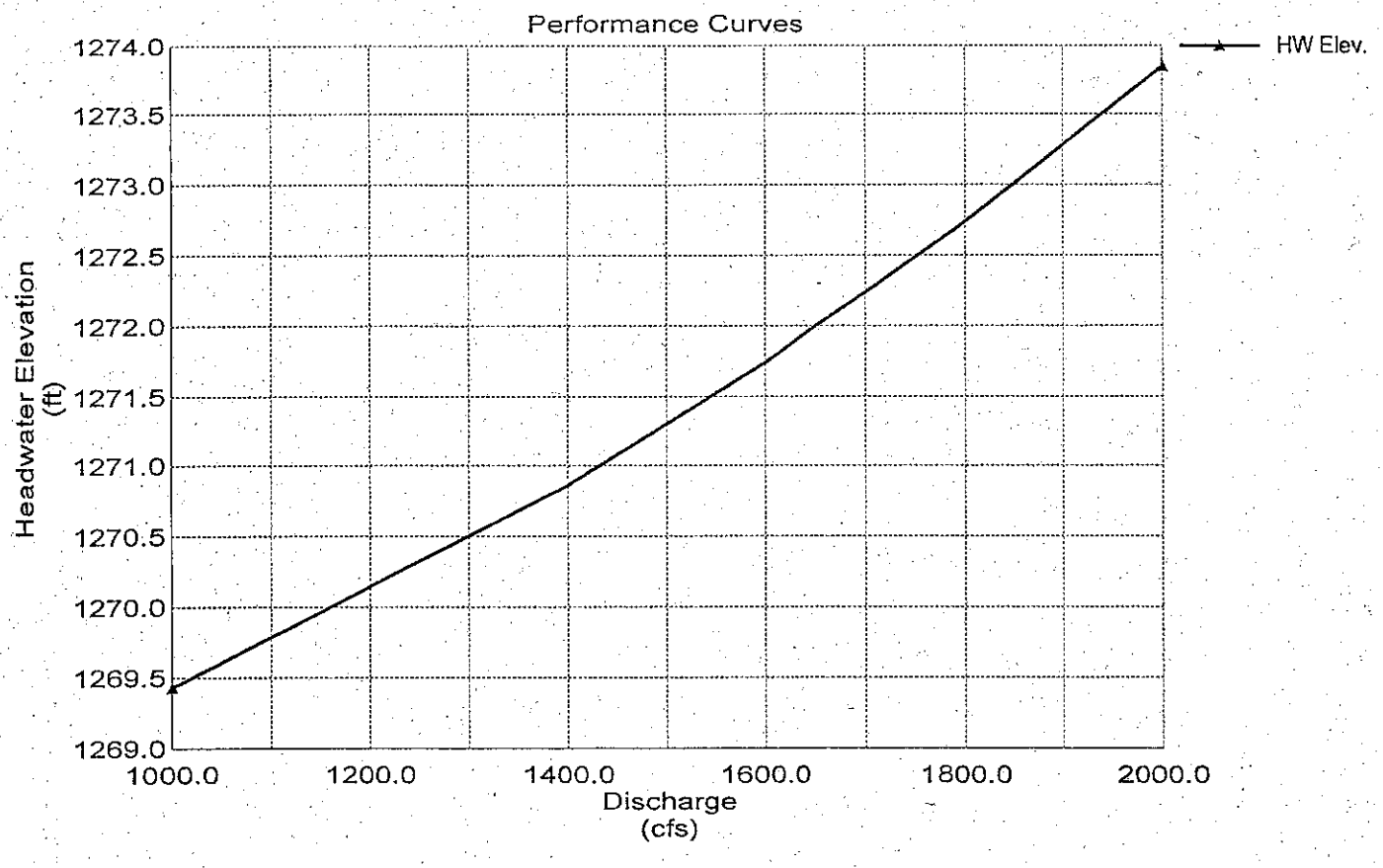
Project Description	
Worksheet	Trapezoidal Channel
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.005000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	35.00	ft
Discharge	1,600.00	cfs

Results		
Depth	2.76	ft
Flow Area	111.7	ft²
Wetted Perimeter	47.33	ft
Top Width	46.03	ft
Critical Depth	3.73	ft
Critical Slope	0.001755	ft/ft
Velocity	14.33	ft/s
Velocity Head	3.19	ft
Specific Energy	5.95	ft
Froude Number	1.62	
Flow Type	Supercritical	

Performance Curves Report
Olive Ave (Diversion Structure)

Range Data:				
	Minimum	Maximum	Increment	
Discharge	1,000.00	2,000.00	200.00	cfs



Culvert Designer/Analyzer Report
Olive Ave (Diversion Structure)

Analysis Component			
Storm Event	Check	Discharge	1,200.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	1,600.00 cfs	Check Discharge	1,200.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	1,268.00 ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-4	3-10 x 5 ft Box	1,199.82 cfs	1,270.15 ft	8.00 ft/s
Weir	Roadway (Constant Elevation)	0.00 cfs	1,270.15 ft	N/A
Total	————	1,199.82 cfs	1,270.15 ft	N/A

Culvert Designer/Analyzer Report
Olive Ave (Diversion Structure)

Component:Culvert-4

Culvert Summary					
Computed Headwater Elev	1,270.07	ft	Discharge	1,199.82	cfs
Inlet Control HW Elev.	1,269.85	ft	Tailwater Elevation	1,268.00	ft
Outlet Control HW Elev.	1,270.07	ft	Control Type	Outlet Control	
Headwater Depth/Height	1.21				

Grades					
Upstream Invert	1,264.00	ft	Downstream Invert	1,262.86	ft
Length	368.00	ft	Constructed Slope	0.003098	ft/ft

Hydraulic Profile					
Profile	CompositePressureProfileM1		Depth, Downstream	5.14	ft
Slope Type	N/A		Normal Depth	3.77	ft
Flow Regime	Subcritical		Critical Depth	3.68	ft
Velocity Downstream	8.00	ft/s	Critical Slope	0.003327	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	10.00	ft
Section Size	10 x 5 ft		Rise	5.00	ft
Number Sections	3				

Outlet Control Properties					
Outlet Control HW Elev.	1,270.07	ft	Upstream Velocity Head	1.11	ft
Ke	0.20		Entrance Loss	0.22	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,269.85	ft	Flow Control	Transition	
Inlet Type	90° headwall w 45° bevels		Area Full	150.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Designer/Analyzer Report
Olive Ave (Diversion Structure)

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)					
Discharge	0.00	cfs	Allowable HW Elevation	1,270.15	ft
Roadway Width	24.00	ft	Overtopping Coefficient	2.90	US
Length	340.00	ft	Crest Elevation	1,278.00	ft
Headwater Elevation	N/A	ft	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (ft)	Elev. (ft)
0.00	1,278.00
340.00	1,278.00

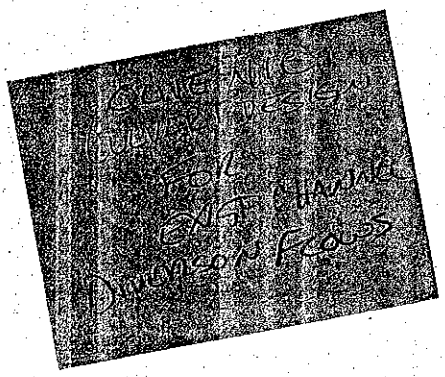
Culvert Designer/Analyzer Report
Olive Ave (Diversion Structure)

Analysis Component			
Storm Event	Design	Discharge	1,600.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	1,600.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	1,268.00 ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-4	3-10 x 5 ft Box	1,600.11 cfs	1,271.74 ft	10.67 ft/s
Weir	Roadway (Constant Elevation)	0.00 cfs	1,271.74 ft	N/A
Total	————	1,600.11 cfs	1,271.74 ft	N/A



Culvert Designer/Analyzer Report
Olive Ave (Diversion Structure)

Component:Culvert-4

Culvert Summary					
Computed Headwater Elev	1,271.74	ft	Discharge	1,600.11	cfs
Inlet Control HW Elev.	1,271.67	ft	Tailwater Elevation	1,268.00	ft
Outlet Control HW Elev.	1,271.74	ft	Control Type	Outlet Control	
Headwater Depth/Height	1.55				

Grades					
Upstream Invert	1,264.00	ft	Downstream Invert	1,262.86	ft
Length	368.00	ft	Constructed Slope	0.003098	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	5.14	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	4.46	ft
Velocity Downstream	10.67	ft/s	Critical Slope	0.003500	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	10.00	ft
Section Size	10 x 5 ft		Rise	5.00	ft
Number Sections	3				

Outlet Control Properties					
Outlet Control HW Elev.	1,271.74	ft	Upstream Velocity Head	1.77	ft
Ke	0.20		Entrance Loss	0.35	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,271.67	ft	Flow Control	Submerged	
Inlet Type	90° headwall w 45° bevels		Area Full	150.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

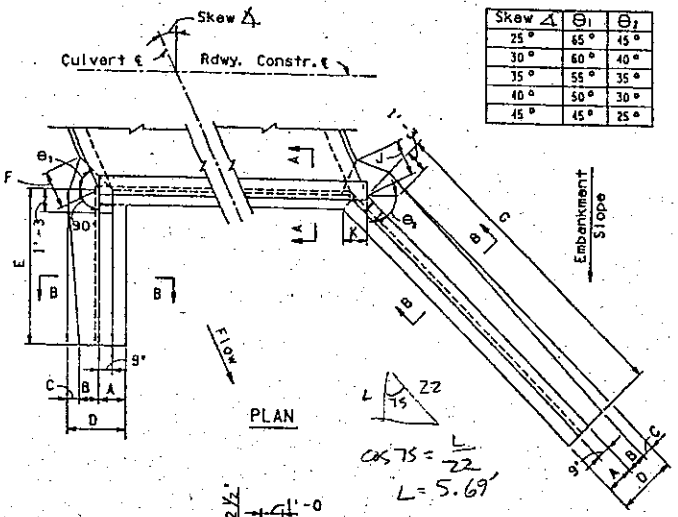
Culvert Designer/Analyzer Report
Olive Ave (Diversion Structure)

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)					
Discharge	0.00	cfs	Allowable HW Elevation	1,271.74	ft
Roadway Width	24.00	ft	Overtopping Coefficient	2.90	US
Length	340.00	ft	Crest Elevation	1,278.00	ft
Headwater Elevation	N/A	ft	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (ft)	Elev. (ft)
0.00	1,278.00
340.00	1,278.00

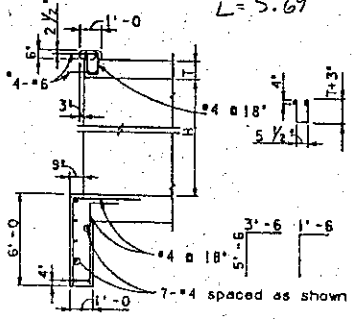
Skew Δ	θ_1	θ_2
25°	65°	45°
30°	60°	40°
35°	55°	35°
40°	50°	30°
45°	45°	25°



2 : 1 Slope	Skew Δ	25°					30°					35°					40°					45°				
	Height H	3'	4'	5'	6'	7'	3'	4'	5'	6'	7'	3'	4'	5'	6'	7'	3'	4'	5'	6'	7'	3'	4'	5'	6'	7'
Dimensions	A	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6
	B	9"	1'-0	1'-1	1'-2	1'-3	9"	1'-0	1'-1	1'-2	1'-3	9"	1'-0	1'-1	1'-2	1'-3	9"	1'-0	1'-1	1'-2	1'-3	9"	1'-0	1'-1	1'-2	1'-3
	C	6"	9"	1'-3	1'-8	2'-1	7"	10"	1'-3	1'-9	2'-2	7"	11"	1'-4	1'-10	2'-3	8"	11"	1'-5	1'-10	2'-4	8"	1'-0	1'-6	1'-11	2'-5
	D	2'-9	3'-3	3'-10	4'-4	4'-10	2'-10	3'-4	3'-10	4'-5	4'-11	2'-10	3'-5	3'-11	4'-6	5'-0	2'-11	3'-5	4'-0	4'-6	5'-1	2'-11	3'-6	4'-1	4'-7	5'-2
	E	6'-0	7'-6	8'-6	10'-0	11'-6	5'-6	7'-0	8'-0	9'-6	11'-0	5'-6	6'-6	8'-0	9'-0	10'-6	5'-0	6'-6	7'-6	8'-6	10'-0	5'-0	6'-0	7'-0	8'-6	9'-6
	F	1'-4	2'-0	2'-9	3'-5	4'-1	1'-6	2'-2	2'-11	3'-8	4'-4	1'-7	2'-4	3'-1	3'-10	4'-7	1'-8	2'-5	3'-3	3'-11	4'-9	1'-8	2'-6	3'-4	4'-1	4'-10
	G	8'-0	10'-0	11'-6	13'-6	15'-6	8'-6	10'-6	12'-6	14'-6	16'-6	9'-0	11'-0	13'-6	15'-6	17'-6	10'-0	12'-0	14'-6	17'-0	19'-6	10'-6	13'-6	16'-0	18'-6	21'-0
	J	1'-3	1'-11	2'-8	3'-4	4'-0	1'-5	2'-0	2'-8	3'-5	4'-1	1'-5	2'-2	2'-9	3'-6	4'-2	1'-6	2'-2	2'-11	3'-6	4'-3	1'-6	2'-3	3'-0	3'-8	4'-5
	K	1'-4½	1'-4½	1'-4½	1'-4½	1'-4½	1'-5¼	1'-5¼	1'-5¼	1'-5¼	1'-5¼	1'-6½	1'-6½	1'-6½	1'-6½	1'-6½	1'-8¾	1'-8¾	1'-8¾	1'-8¾	1'-8¾	1'-11½	1'-11½	1'-11½	1'-11½	1'-11½
	L	1'-1	1'-4	1'-10	2'-1	2'-4	1'-4	1'-7	2'-1	2'-4	2'-7	1'-4	1'-10	2'-1	2'-7	2'-10	1'-7	1'-10	2'-4	2'-10	3'-1	1'-7	2'-1	2'-7	2'-10	3'-4
	M	1'-3	1'-6	2'-0	2'-3	2'-7	1'-4	1'-8	2'-1	2'-5	2'-9	1'-6	1'-11	2'-2	2'-7	3'-1	1'-7	2'-1	2'-5	2'-10	3'-2	1'-10	2'-3	2'-8	3'-2	3'-8

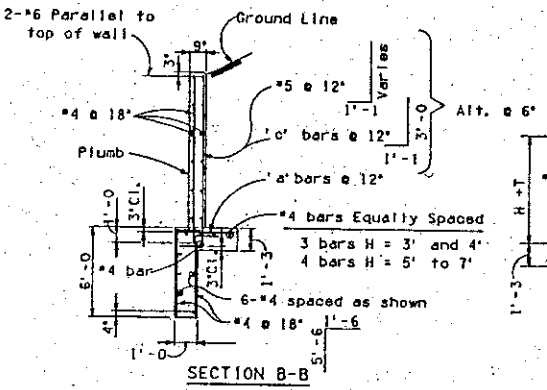
4 : 1 Slope	Skew Δ	25°					30°					35°					40°					45°				
	Height H	3'	4'	5'	6'	7'	3'	4'	5'	6'	7'	3'	4'	5'	6'	7'	3'	4'	5'	6'	7'	3'	4'	5'	6'	7'
Dimensions	A	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6
	B	9"	1'-0	1'-1	1'-2	1'-3	9"	1'-0	1'-1	1'-2	1'-3	9"	1'-0	1'-1	1'-2	1'-3	9"	1'-0	1'-1	1'-2	1'-4	9"	1'-0	1'-1	1'-3	1'-7
	C	4"	7"	1'-0	1'-5	1'-10	4"	7"	1'-0	1'-5	1'-10	4"	7"	1'-0	1'-5	1'-10	4"	7"	1'-0	1'-5	1'-9	4"	7"	1'-0	1'-5	1'-7
	D	2'-7	3'-1	3'-7	4'-1	4'-7	2'-7	3'-1	3'-7	4'-1	4'-7	2'-7	3'-1	3'-7	4'-1	4'-7	2'-7	3'-1	3'-7	4'-1	4'-7	2'-7	3'-1	3'-7	4'-2	4'-8
	E	9'-0	11'-0	13'-6	15'-6	17'-6	8'-6	10'-6	12'-6	14'-6	16'-6	7'-6	9'-6	11'-6	13'-6	15'-0	7'-0	9'-0	10'-6	12'-6	14'-0	7'-0	8'-6	10'-0	12'-0	13'-6
	F	1'-2	1'-10	2'-5	3'-1	3'-9	1'-2	1'-10	2'-6	3'-3	3'-11	1'-2	1'-11	2'-7	3'-3	4'-0	1'-3	1'-11	2'-7	3'-4	4'-0	1'-3	1'-11	2'-8	3'-6	4'-2
	G	12'-0	14'-6	17'-6	20'-6	23'-6	12'-6	15'-6	18'-6	21'-6	24'-6	13'-0	16'-0	19'-6	22'-6	25'-6	14'-0	17'-0	20'-6	24'-0	27'-6	15'-0	18'-6	22'-0	25'-6	29'-0
	J	1'-1	1'-9	2'-4	3'-0	3'-8	1'-1	1'-9	2'-4	3'-0	3'-8	1'-1	1'-9	2'-4	3'-0	3'-8	1'-1	1'-9	2'-4	3'-0	3'-8	1'-1	1'-9	2'-4	3'-1	3'-9
	K	1'-4½	1'-4½	1'-4½	1'-4½	1'-4½	1'-5¼	1'-5¼	1'-5¼	1'-5¼	1'-5¼	1'-6½	1'-6½	1'-6½	1'-6½	1'-6½	1'-8¾	1'-8¾	1'-8¾	1'-8¾	1'-8¾	1'-11½	1'-11½	1'-11½	1'-11½	1'-11½
	L	1'-10	2'-4	2'-8	3'-2	3'-8	1'-11	2'-5	2'-11	3'-5	3'-11	2'-2	2'-8	3'-2	3'-8	4'-4	2'-4	2'-10	3'-5	3'-11	4'-7	2'-4	2'-11	3'-7	4'-1	4'-8
	M	1'-11	2'-6	3'-0	3'-5	3'-11	2'-1	2'-7	3'-1	3'-7	4'-2	2'-2	2'-9	3'-3	3'-10	4'-5	2'-4	2'-11	3'-6	4'-1	4'-8	2'-6	3'-1	3'-9	4'-4	5'-0

6 : 1 Slope	Skew Δ	25°					30°					35°					40°					45°				
	Height H	3'	4'	5'	6'	7'	3'	4'	5'	6'	7'	3'	4'	5'	6'	7'	3'	4'	5'	6'	7'	3'	4'	5'	6'	7'
Dimensions	A	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6	1'-6
	B	9"	1'-0	1'-1	1'-2	1'-4	9"	1'-0	1'-1	1'-2	1'-6	9"	1'-0	1'-1	1'-3	1'-7	9"	1'-0	1'-1	1'-4	1'-8	9"	1'-0	1'-2	1'-6	1'-10
	C	3"	6"	11"	1'-4	1'-8	3"	6"	11"	1'-4	1'-8	3"	6"	11"	1'-3	1'-5	3"	6"	11"	1'-2	1'-4	3"	6"	10"	1'-0	1'-2
	D	2'-6	3'-0	3'-6	4'-0	4'-6	2'-6	3'-0	3'-6	4'-0	4'-6	2'-6	3'-0	3'-6	4'-0	4'-6	2'-6	3'-0	3'-6	4'-0	4'-6	2'-6	3'-0	3'-6	4'-0	4'-6
	E	11'-0	13'-6	16'-0	19'-0	21'-6	10'-0	12'-6	14'-6	17'-0	19'-6	9'-0	11'-6	13'-6	15'-6	18'-0	8'-6	10'-6	12'-6	14'-6	16'-6	8'-0	10'-0	12'-0	13'-6	15'-6
	F	1'-0	1'-8	2'-4	3'-0	3'-8	1'-1	1'-9	2'-5	3'-1	3'-9	1'-1	1'-9	2'-6	3'-2	3'-10	1'-1	1'-10	2'-6	3'-3	3'-11	1'-1	1'-10	2'-6	3'-3	3'-11
	G	14'-0	17'-6	21'-0	24'-6	28'-0	14'-6	18'-6	22'-0	25'-6	29'-0	15'-6	19'-0	23'-0	26'-6	30'-6	16'-0	20'-0	24'-0	28'-0	32'-0	17'-0	21'-0	25'-0	29'-6	33'-6
	J	1'-0	1'-7	2'-3	2'-11	3'-6	1'-0	1'-7	2'-3	2'-11	3'-6	1'-0	1'-7	2'-3	2'-11	3'-6	1'-0	1'-7	2'-3	2'-11	3'-6	1'-0	1'-7	2'-3	2'-11	3'-6
	K	1'-4½	1'-4½	1'-4½	1'-4½	1'-4½	1'-5¼	1'-5¼	1'-5¼	1'-5¼	1'-5¼	1'-6½	1'-6½	1'-6½	1'-6½	1'-6½	1'-8¾	1'-8¾	1'-8¾	1'-8¾	1'-8¾	1'-11½	1'-11½	1'-11½	1'-11½	1'-11½
	L	2'-3	2'-10	3'-5	3'-11	4'-6	2'-5	3'-0	3'-8	4'-3	4'-10	2'-7	3'-2	3'-10	4'-6	5'-1	2'-8	3'-4	4'-0	4'-8	5'-4	2'-9	3'-5	4'-1	4'-10	5'-6
	M	2'-5	3'-0	3'-7	4'-2	4'-9	2'-6	3'-1	3'-8	4'-4	4'-11	2'-7	3'-3	3'-10	4'-6	5'-2	2'-9	3'-5	4'-1	4'-9	5'-5	2'-10	3'-7	4'-4	5'-0	5'-8

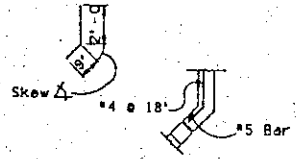


*Use 4-*7 for 10' spans with 35° to 45° skews.

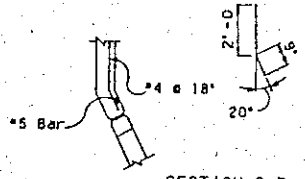
SECTION A-A



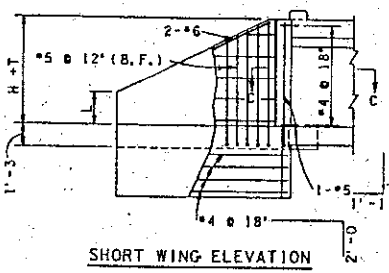
SECTION B-B



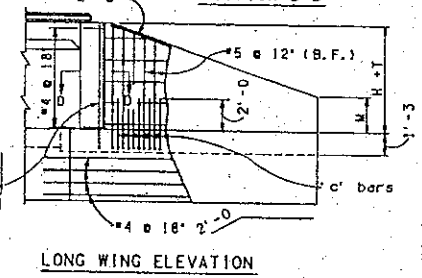
SECTION C-C



SECTION D-D



SHORT WING ELEVATION



LONG WING ELEVATION

'c' Bars Long Wingwall	Skew Δ	2 : 1 Slope	4 : 1 Slope
H = 7'	25°	3 - *5	3 - *5
	30°	3 - *5	3 - *5
	35°	4 - *5	4 - *5
	40°	4 - *5	4 - *5
	45°	5 - *5	4 - *5

'a' Bars	Height H	Short Wing	Long Wing
	3'	*4	*4
	4'	*4	*4
	5'	*4	*4
	6'	*4	*5
	7'	*4	*5

NOTE 1:

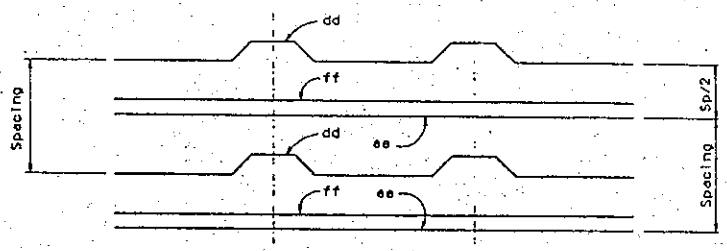
For General Notes and Miscellaneous Details see B-01.10.
For Headwall Quantities see B-05.10, B-05.20 and B-05.30.

DESIGN APPROVED	ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION STANDARD DRAWINGS		REVISION 7-88
APPROVED FOR DISTRIBUTION	OUTLET WINGS CULVERT HEIGHT 3' to 7' SKEW 25° to 45°		STANDARD NO. 8-04.50

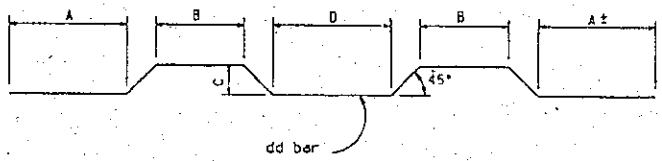
TABLE NO. I
0'-10' FILL

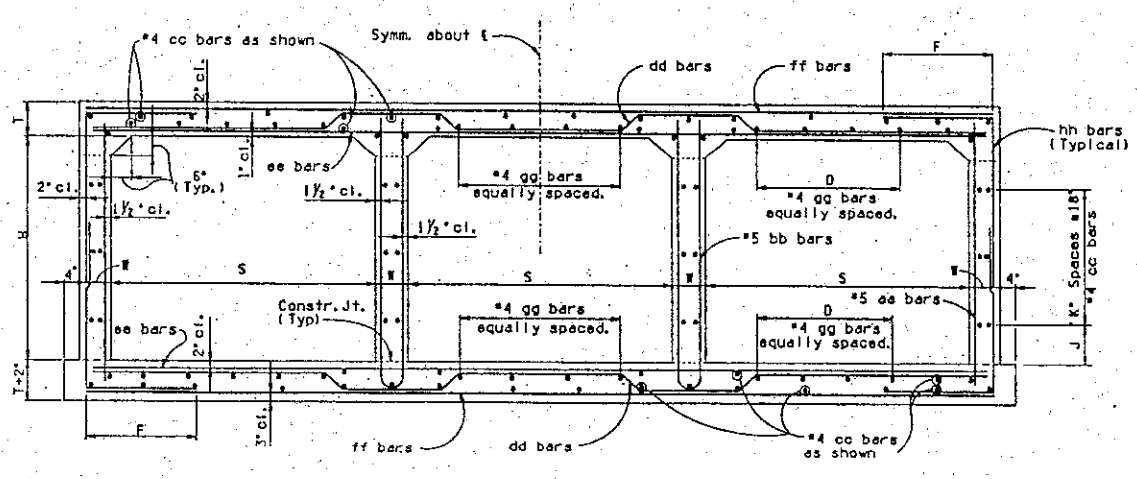
Span "S"	Height "H"	Top Slab "T"	Wall Ts "W"	aa Spacing	aa Length	bb Spacing	bb Length	cc Number +	dd Bar Size	dd Spacing	dd Length	dd A	dd B	dd C	dd D	ee Bar Size	ee Spacing	ee Length	ff Bar Size	ff Spacing	ff Length	gg Number +	hh Bar Size	hh Spacing	hh Length	hh F
6'	3'	9½"	8"	12"	4'-4	12"	8'-9	68	5	14"	20'-2	4'-7	2'-7	6½"	3'-1	5	14"	20'-3	5	14"	20'-3	30	4	7"	5'-1	2'-5
	4'	9½"	8"	12"	5'-4	12"	10'-9	76	5	14"	20'-2	4'-7	2'-7	6½"	3'-1	5	14"	20'-3	5	14"	20'-3	30	4	7"	5'-7	2'-5
	5'	9½"	8"	12"	6'-4	12"	12'-9	76	5	14"	20'-2	4'-7	2'-7	6½"	3'-1	5	14"	20'-3	5	14"	20'-3	30	4	7"	6'-1	2'-5
	6'	9½"	8"	12"	7'-4	12"	14'-9	84	5	14"	20'-2	4'-7	2'-7	6½"	3'-1	5	14"	20'-3	5	14"	20'-3	30	4	7"	6'-7	2'-5
	7'	9½"	8"	12"	8'-4	12"	16'-9	92	5	13"	20'-2	4'-7	2'-7	6½"	3'-1	5	13"	20'-3	5	13"	20'-3	30	4	6½"	7'-1	2'-5
8'	3'	9½"	9"	12"	4'-4	12"	8'-9	68	6	14"	26'-4	6'-1	3'-8	6½"	4'-2	6	14"	26'-7	6	14"	26'-7	36	6	7"	5'-6	2'-6
	4'	9½"	9"	12"	5'-4	12"	10'-9	76	6	14"	26'-4	6'-1	3'-8	6½"	4'-2	6	14"	26'-7	6	14"	26'-7	36	6	7"	6'-0	2'-6
	5'	9½"	9"	12"	6'-4	12"	12'-9	76	6	14"	26'-4	6'-1	3'-8	6½"	4'-2	6	14"	26'-7	6	14"	26'-7	36	6	7"	6'-6	2'-6
	6'	9½"	9"	12"	7'-4	12"	14'-9	84	6	14"	26'-4	6'-1	3'-8	6½"	4'-2	6	14"	26'-7	6	14"	26'-7	36	6	7"	7'-0	2'-6
	7'	9½"	9"	12"	8'-4	12"	16'-9	92	6	13"	26'-4	6'-1	3'-8	6½"	4'-2	6	13"	26'-7	6	13"	26'-7	36	5	6½"	7'-5	2'-6
	8'	9½"	9"	12"	9'-4	12"	18'-9	92	6	13"	26'-4	6'-1	3'-8	6½"	4'-2	6	13"	26'-7	6	13"	26'-7	36	6	6½"	8'-0	2'-6
10'	3'	10½"	11"	12"	4'-6	12"	9'-2	68	7	17"	32'-9	7'-7	4'-8	7½"	5'-2	6	17"	33'-3	7	17"	33'-3	66	6	8½"	6'-1	3'-0
	4'	10½"	11"	12"	5'-6	12"	11'-2	76	7	17"	32'-9	7'-7	4'-8	7½"	5'-2	6	17"	33'-3	7	17"	33'-3	66	6	8½"	6'-7	3'-0
	5'	10½"	11"	12"	6'-6	12"	13'-2	76	6	12"	32'-9	7'-7	4'-8	7½"	5'-2	5	12"	33'-3	6	12"	33'-3	66	5	6"	6'-8	2'-8
	6'	10½"	11"	12"	7'-6	12"	15'-2	84	6	12"	32'-9	7'-7	4'-8	7½"	5'-2	5	12"	33'-3	6	12"	33'-3	66	5	6"	7'-2	2'-8
	7'	10½"	11"	12"	8'-6	12"	17'-2	92	7	15"	32'-9	7'-7	4'-8	7½"	5'-2	5	15"	33'-3	7	15"	33'-3	66	6	7½"	7'-9	2'-8
	8'	10½"	11"	12"	9'-6	12"	19'-2	92	7	15"	32'-9	7'-7	4'-8	7½"	5'-2	5	15"	33'-3	7	15"	33'-3	66	6	7½"	8'-3	2'-8
	9'	10½"	11"	12"	10'-6	12"	21'-2	100	7	15"	32'-9	7'-7	4'-8	7½"	5'-2	6	15"	33'-3	7	15"	33'-3	66	6	7½"	8'-9	2'-8
	10'	10½"	11"	12"	11'-6	12"	23'-2	108	7	14"	32'-9	7'-7	4'-8	7½"	5'-2	5	14"	33'-3	7	14"	33'-3	66	6	7"	9'-3	2'-8
12'	8'	12½"	13"	12"	9'-10	12"	20'-0	92	7	13"	39'-4	9'-1	5'-6	9½"	6'-2	5	13"	39'-11	7	13"	39'-11	78	6	6½"	8'-7	2'-10
	9'	12½"	13"	12"	10'-10	12"	22'-0	100	6	16"	39'-4	9'-1	5'-6	9½"	6'-2	5	16"	39'-11	8	16"	39'-11	78	6	8"	9'-1	2'-10
	10'	12½"	13"	12"	11'-10	12"	24'-0	108	6	16"	39'-4	9'-1	5'-6	9½"	6'-2	5	16"	39'-11	8	16"	39'-11	78	6	8"	9'-7	2'-10
	11'	12½"	13"	12"	12'-10	12"	26'-0	108	7	12"	39'-4	9'-1	5'-6	9½"	6'-2	4	12"	39'-11	7	12"	39'-11	78	6	6"	10'-1	2'-10
	12'	12½"	13"	12"	13'-10	12"	28'-0	116	7	12"	39'-4	9'-1	5'-6	9½"	6'-2	5	12"	39'-11	7	12"	39'-11	78	6	6"	10'-8	2'-10

+ Total number of bars in the cross-section.



REINFORCING BAR PLACING DIAGRAM

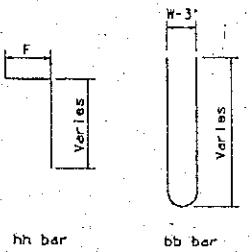




TYPICAL SECTION

NOTE:
Reinforcing shown is for placement location only.
Use the appropriate table to determine the reinforcing requirements.

Height "H"	"J" Dim.	"K" Spaces
3'	9"	1
4'	3'	2
5'	12'	2
6'	9"	3
7'	3'	4
8'	12'	4
9'	9"	5
10'	3'	6
11'	12'	6
12'	9"	7



BENDS

NOTE:
See B-02.35 for Tables II thru V.
See B-01.10 for General Notes and Miscellaneous Details.
See B-02.70 for Quantities.

	DESIGN APPROVED	ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION STANDARD DRAWINGS	REVISION 4-92
	APPROVED FOR ESTABLISHMENT	TRIPLE BARREL BOX CULVERT	STANDARD NO. B-02.30

Weir Calculations

$Q = CLH^{3/2}$ where Q = Total flow over the weir

C = Coefficient of discharge

L = Effective length of weir

H = Difference between energy upstream and crest

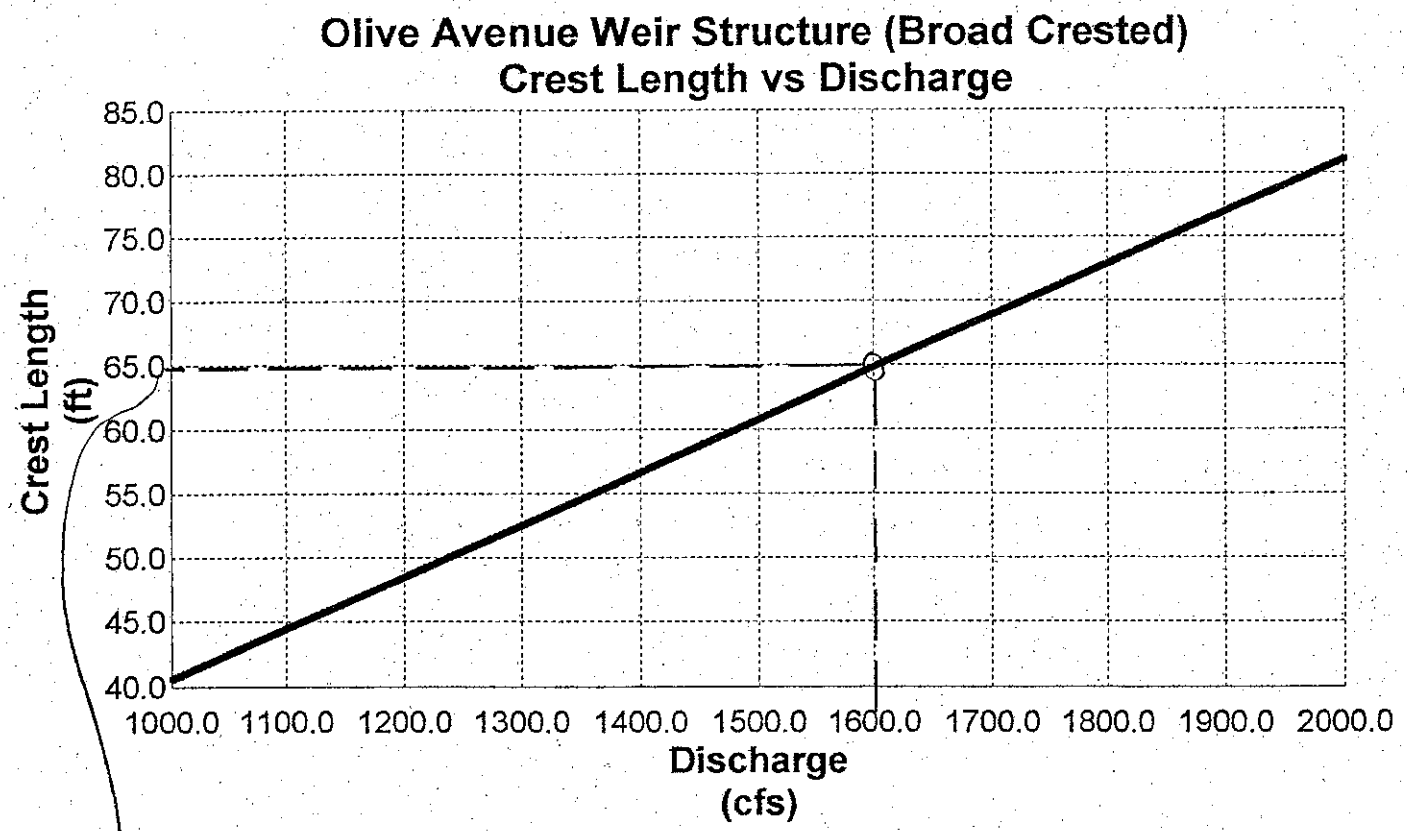
C =	**2.75**	**3.00**		**2.75**	**3.00**		**2.75**	**3.00**		**2.75**	**3.00**
H =	**4.0**	**4.0**		**3.0**	**3.0**		**2.0**	**2.0**		**1.0**	**1.0**
Q (diversion into NIC)	**L**	**L**		**L**	**L**		**L**	**L**		**L**	**L**
1000	46	42		70	65		129	118		364	334
1100	50	46		77	71		142	130		400	367
1200	55	50		84	77		155	142		437	400
1300	60	55		91	84		168	154		473	434
1400	64	59		98	90		180	165		510	467
1500	69	63		105	97		193	177		546	500
1600	**73**	**67**		**112**	**103**		**206**	**189**		**582**	**534**
1700	78	71		119	110		219	201		619	567
1800	82	75		126	116		232	213		655	600
1900	87	80		133	122		245	224		691	634
2000	91	84		140	129		258	236		728	667

Curve
Plotted Curves for Broad Crested Weir

Project Description	
Worksheet	Olive Avenue Weir Structure (Broad Crested)
Type	Broad Crested Weir
Solve For	Crest Length

Input Data		
Headwater Elevation	1,276.00	ft
Crest Elevation	1,272.00	ft
Tailwater Elevation	1,271.74	ft
Crest Surface Type	Paved	
Crest Breadth	5.00	ft

Attribute	Minimum	Maximum	Increment
Discharge (cfs)	1,000.00	2,000.00	200.00



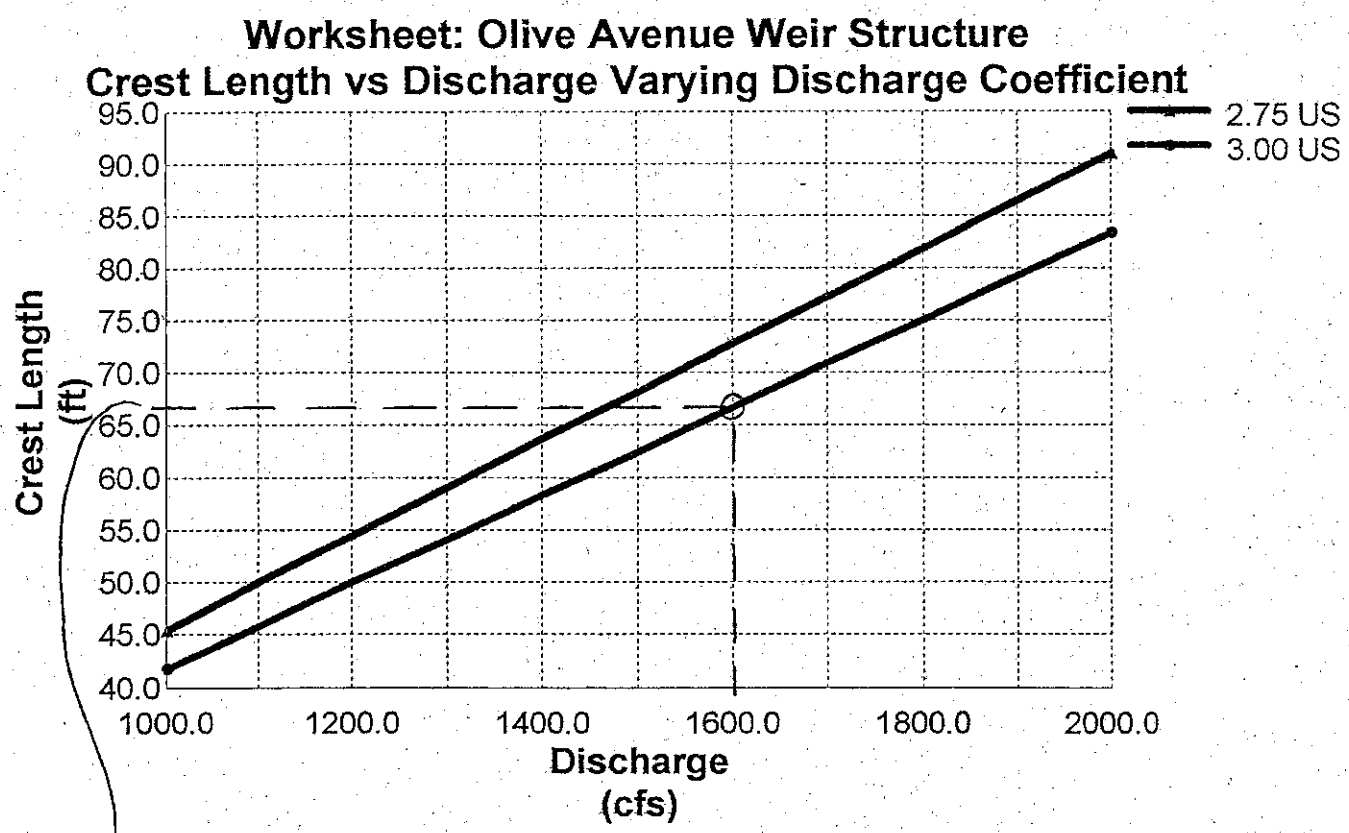
L = 65.6'

Olive Ave Weir Structure
Plotted Curves for Generic Weir

Project Description	
Worksheet	Olive Avenue Weir Structure
Type	Generic Weir
Solve For	Crest Length

Input Data	
Headwater Elevation	1,276.00 ft
Crest Elevation	1,272.00 ft

Attribute	Minimum	Maximum	Increment
Discharge (cfs)	1,000.00	2,000.00	100.00
Discharge Coefficient (US)	2.75	3.00	0.25



L = 66.0'

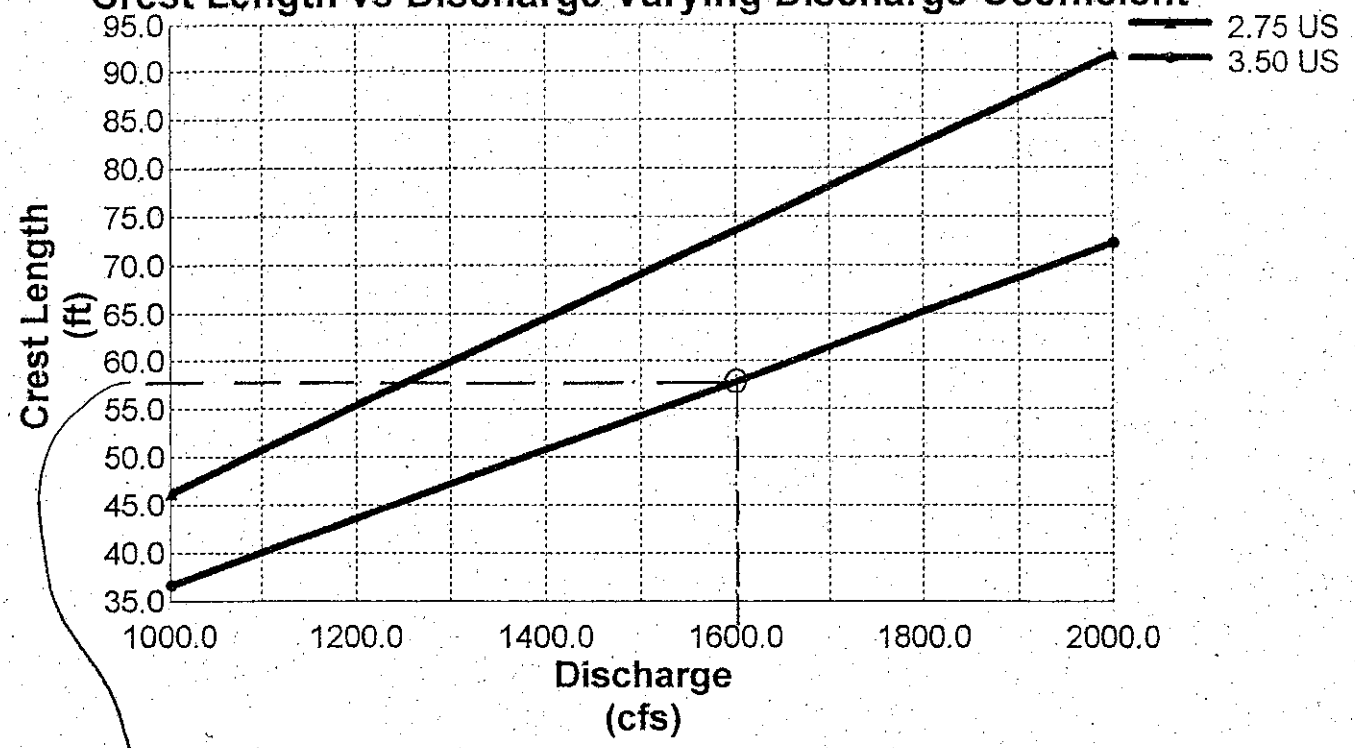
Plotted Curves for Sharp Crested Rectangular Weir

Project Description	
Worksheet	Olive Avenue Weir Structure (Sharp Crested Rectangular)
Type	Sharp Crested Rectangular Weir
Solve For	Crest Length

Input Data	
Headwater Elevation	1,276.00 ft
Crest Elevation	1,272.00 ft
Tailwater Elevation	1,271.74 ft
Number of Contractions	2

Attribute	Minimum	Maximum	Increment
Discharge (cfs)	1,000.00	2,000.00	200.00
Discharge Coefficient (US)	2.75	3.50	0.75

Worksheet: Olive Avenue Weir Structure (Sharp Crested Rectangular)
Crest Length vs Discharge Varying Discharge Coefficient



L ≐ 58.0'

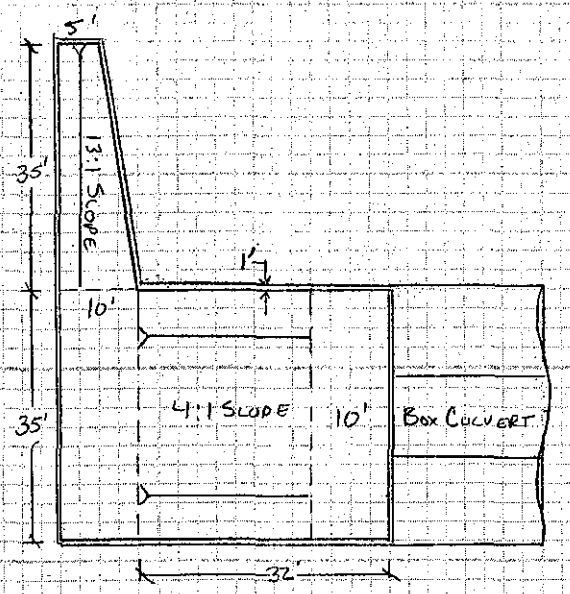
KIRKHAM MICHAEL
CONSULTING ENGINEERS

Job Number _____

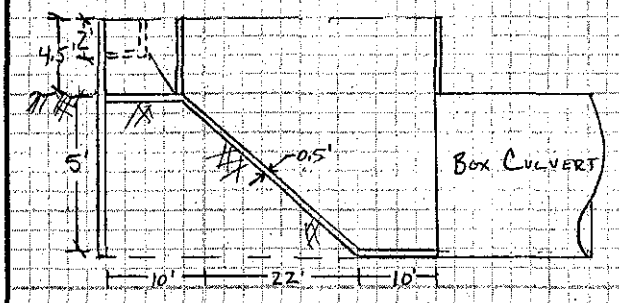
Sheet 1 of 1

Project NORTH INLET CHANNEL Date 10/1/04

Subject LATERAL WEIR LAYOUT & QTY. Designed ACC Checked _____



WEIR PLAN VIEW
N.T.S.



WEIR PROFILE VIEW
N.T.S.

WING

BASE AREA = (35' · 5')(0.5') + (½ 5' · 35')(0.5') + (10' × 35')(0.5')
= 306 CF

WALL AREA = (70' · 2')1' + (10' · 2')(1') + (35' · 35')(1')
= 318 CF

STEM WALL AREA = (70')(1')(5')
= 350 CF

TOTAL WING AREA = 974 CF

BASIN

SLOPE AREA = (35' · 22.5')(0.5')
= 394 CF

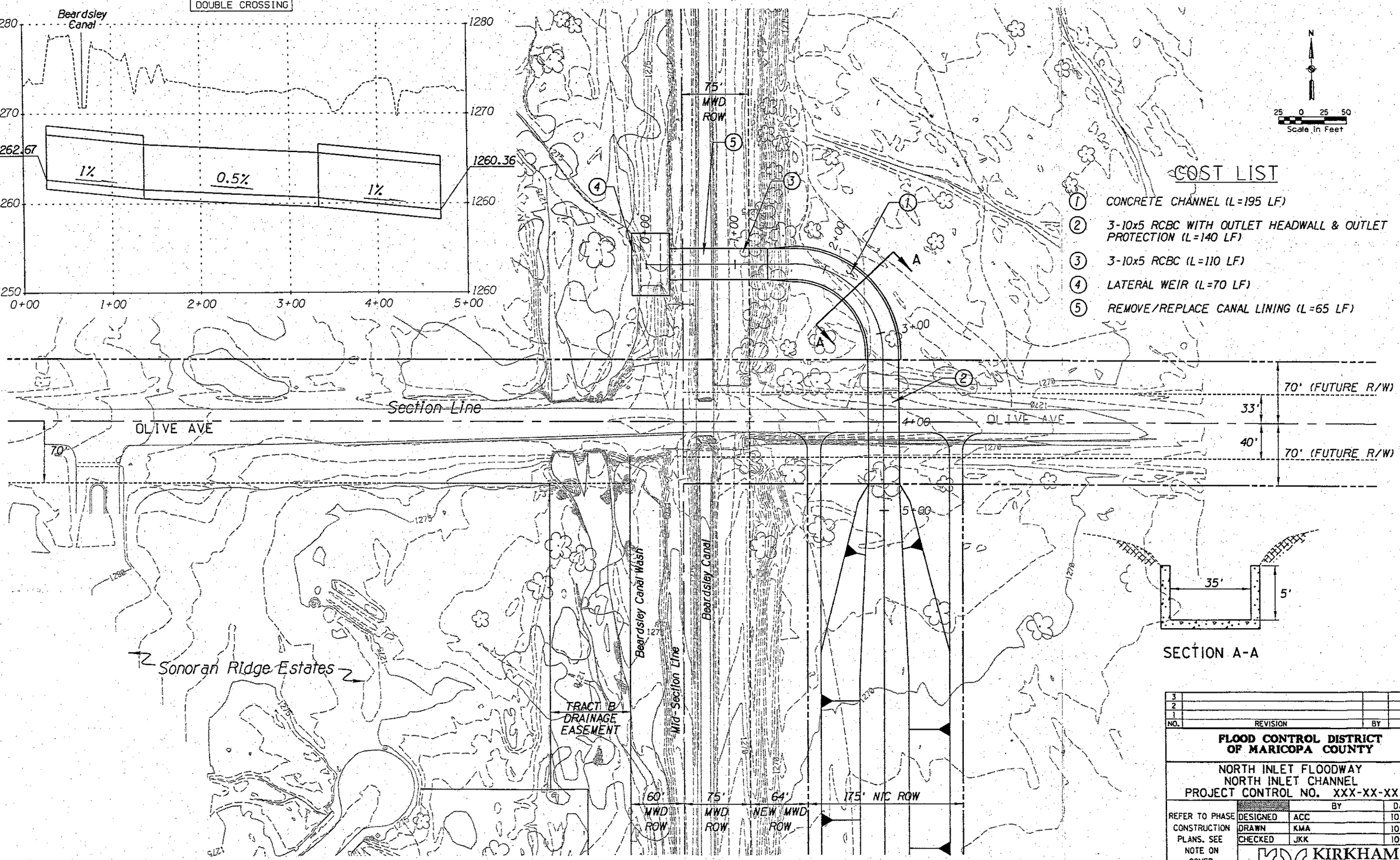
BASE AREA = (10' · 35')(0.5')
= 175 CF

HEADWALL AREA = (2' · 35')(1')
= 70 CF

SIDE WALL AREA = (2)[(4.5' · 32')(1') + (10' · 5')(1') + (½ · 22' · 5')(1)]
= 498 CF

TOTAL BASIN AREA = 1137 CF

TOTAL WEIR AREA = 2111 CF
= 78 CY



COST LIST

1. CONCRETE CHANNEL (L=195 LF)
2. 3-10x5 RCBC WITH OUTLET HEADWALL & OUTLET PROTECTION (L=140 LF)
3. 3-10x5 RCBC (L=110 LF)
4. LATERAL WEIR (L=70 LF)
5. REMOVE/REPLACE CANAL LINING (L=65 LF)

SECTION A-A

OLIVE AVE DOUBLE CULVERT CROSSING

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NORTH INLET FLOODWAY
NORTH INLET CHANNEL
PROJECT CONTROL NO. XXX-XX-XX

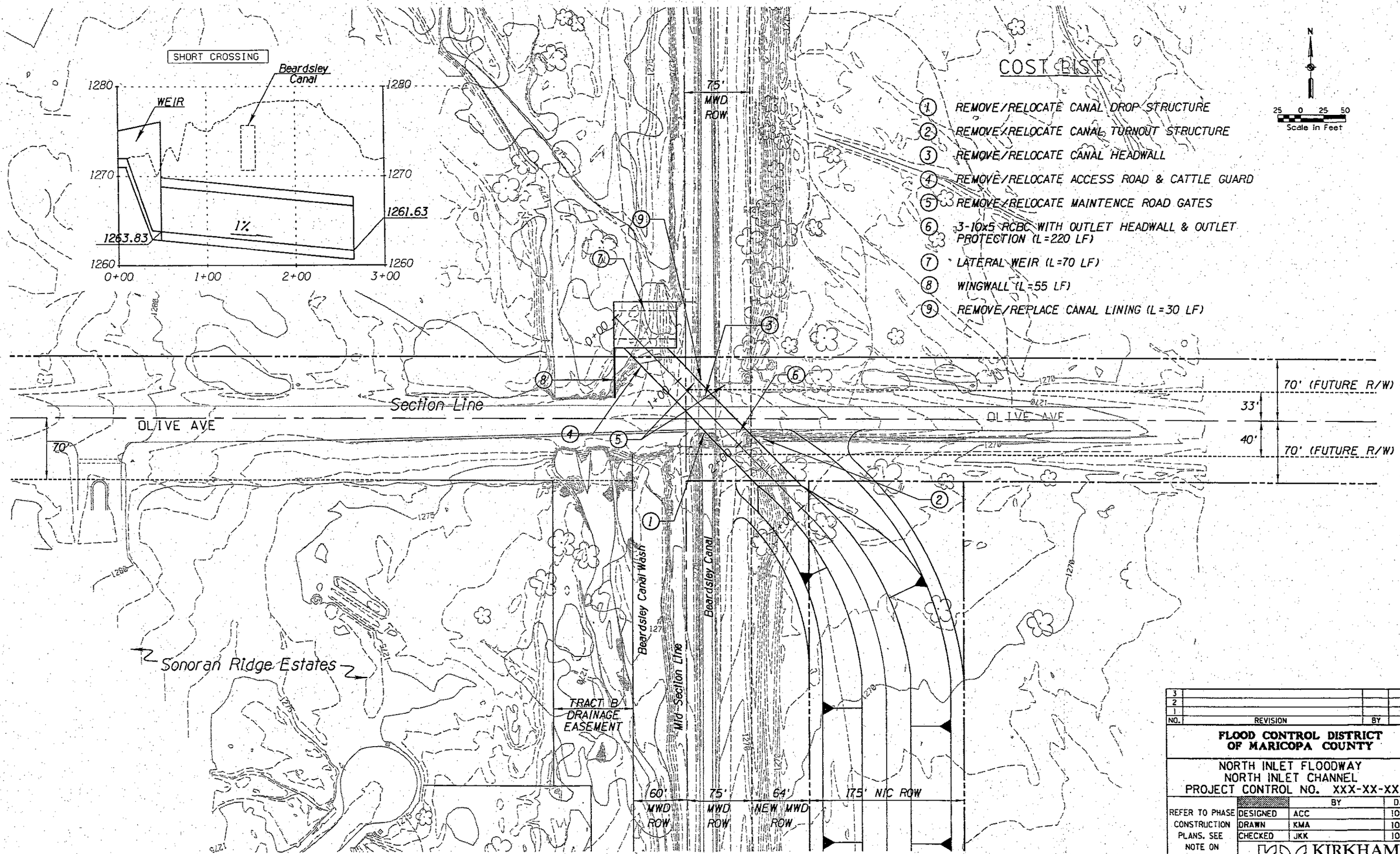
		BY	DATE
REFER TO PHASE CONSTRUCTION PLANS. SEE NOTE ON COVER	DESIGNED	ACC	10/04
	DRAWN	KMA	10/04
	CHECKED	JKK	10/04

KIRKHAM MICHAEL

DRAWING NO.

SHEET OF

$450 K



OLIVE AVENUE SHORT CULVERT CROSSING

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

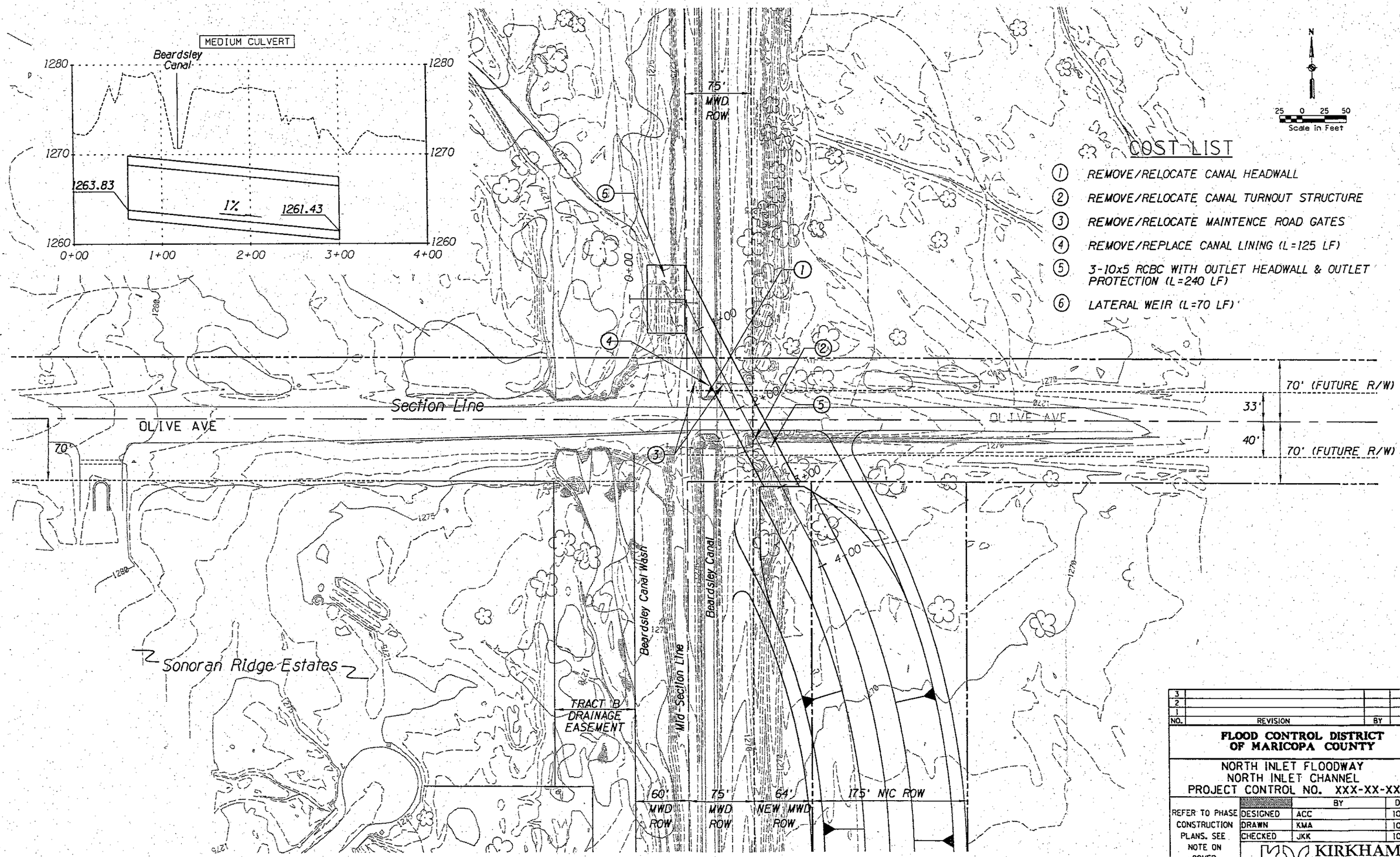
NORTH INLET FLOODWAY
NORTH INLET CHANNEL
PROJECT CONTROL NO. XXX-XX-XX

		BY	DATE
REFER TO PHASE CONSTRUCTION PLANS. SEE NOTE ON COVER	DESIGNED	ACC	10/04
	DRAWN	KMA	10/04
	CHECKED	JKK	10/04

KIRKHAM MICHAEL

DRAWING NO. | SHEET OF

#430 K



COST LIST

1. REMOVE/RELOCATE CANAL HEADWALL
2. REMOVE/RELOCATE CANAL TURNOUT STRUCTURE
3. REMOVE/RELOCATE MAINTENCE ROAD GATES
4. REMOVE/REPLACE CANAL LINING (L=125 LF)
5. 3-10x5 RCBC WITH OUTLET HEADWALL & OUTLET PROTECTION (L=240 LF)
6. LATERAL WEIR (L=70 LF)

OLIVE AVENUE MEDIUM CULVERT CROSSING

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

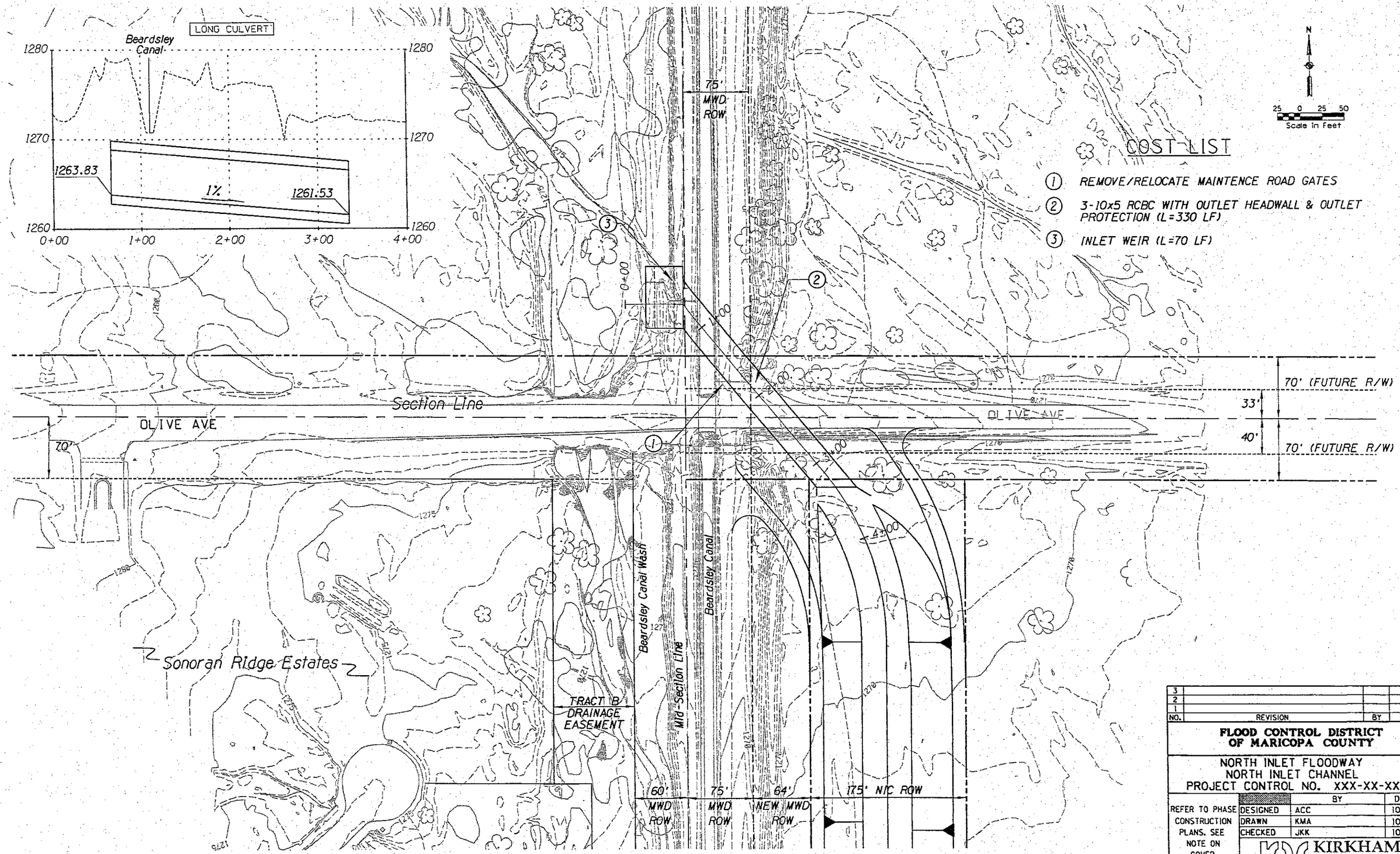
NORTH INLET FLOODWAY
NORTH INLET CHANNEL
PROJECT CONTROL NO. XXX-XX-XX

		BY	DATE
REFER TO PHASE CONSTRUCTION PLANS. SEE NOTE ON COVER	DESIGNED	ACC	10/04
	DRAWN	KMA	10/04
	CHECKED	JKK	10/04

KIRKHAM MICHAEL

DRAWING NO. | SHEET OF

#450.00



OLIVE AVENUE LONG CULVERT CROSSING

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NORTH INLET FLOODWAY
NORTH INLET CHANNEL
PROJECT CONTROL NO. XXX-XX-XX

		BY	DATE
REFER TO PHASE CONSTRUCTION PLANS. SEE NOTE ON COVER	DESIGNED	ACC	10/04
	DRAWN	KMA	10/04
	CHECKED	JKK	10/04

KIRKHAM MICHAEL

DRAWING NO.

SHEET OF

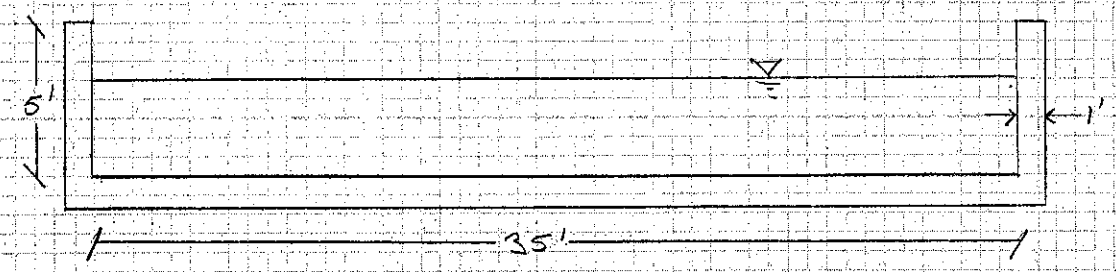
KIRKHAM MICHAEL
CONSULTING ENGINEERS

Job Number

Sheet 1 of 1

Project N/C - Olive Ave Double Crossing Date 10/27/04

Subject Rect. Channel Layout & Quantity Designed ACC Checked



LENGTH FROM CULVERT TO CULVERT = 194.11'

X SECT AREA = (35')(1') + (5')(1') 2
= 350 SQFT

VOLUME = 350 SQFT · 194.11' = 67939 CFT
= 2516 C.Y.

Culvert Designer/Analyzer Report
Northern Ave (1600 cfs diversion)
NIC DIVERSION STRUCTURE

Peak Discharge Method: User-Specified			
Design Discharge	1,600.00 cfs	Check Discharge	0.00 cfs

Grades Model: Inverts			
Invert Upstream	1,223.00 ft	Invert Downstream	1,220.00 ft
Length	250.00 ft	Slope	0.012000 ft/ft
Drop	3.00 ft		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	1,227.27 ft

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	5-10 x 5 ft Box	1,600.00 cfs	1,228.45 ft	

Culvert Designer/Analyzer Report
Northern Ave (1600 cfs diversion)

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elev	1,228.45	ft	Discharge	1,600.00	cfs
Headwater Depth/Height	1.09		Tailwater Elevation	1,227.27	ft
Inlet Control HW Elev.	1,227.99	ft	Control Type	Outlet Control	
Outlet Control HW Elev.	1,228.45	ft			

Grades					
Upstream Invert	1,223.00	ft	Downstream Invert	1,220.00	ft
Length	250.00	ft	Constructed Slope	0.012000	ft/ft

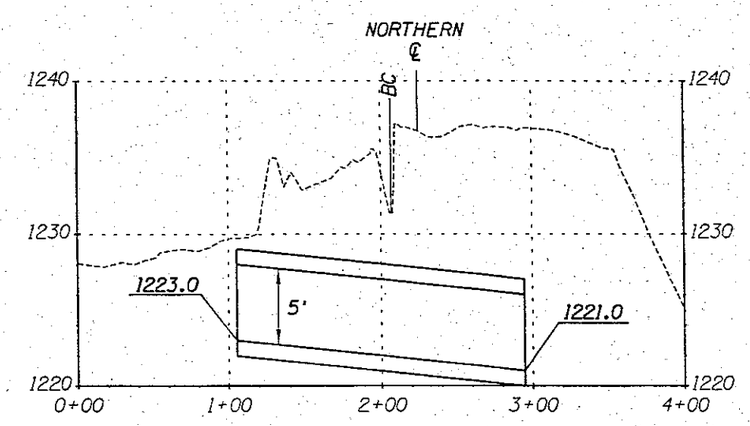
Hydraulic Profile					
Profile	CompositePressureProfileS1		Depth, Downstream	7.27	ft
Slope Type	N/A		Normal Depth	2.01	ft
Flow Regime	Subcritical		Critical Depth	3.17	ft
Velocity Downstream	6.40	ft/s	Critical Slope	0.003226	ft/ft

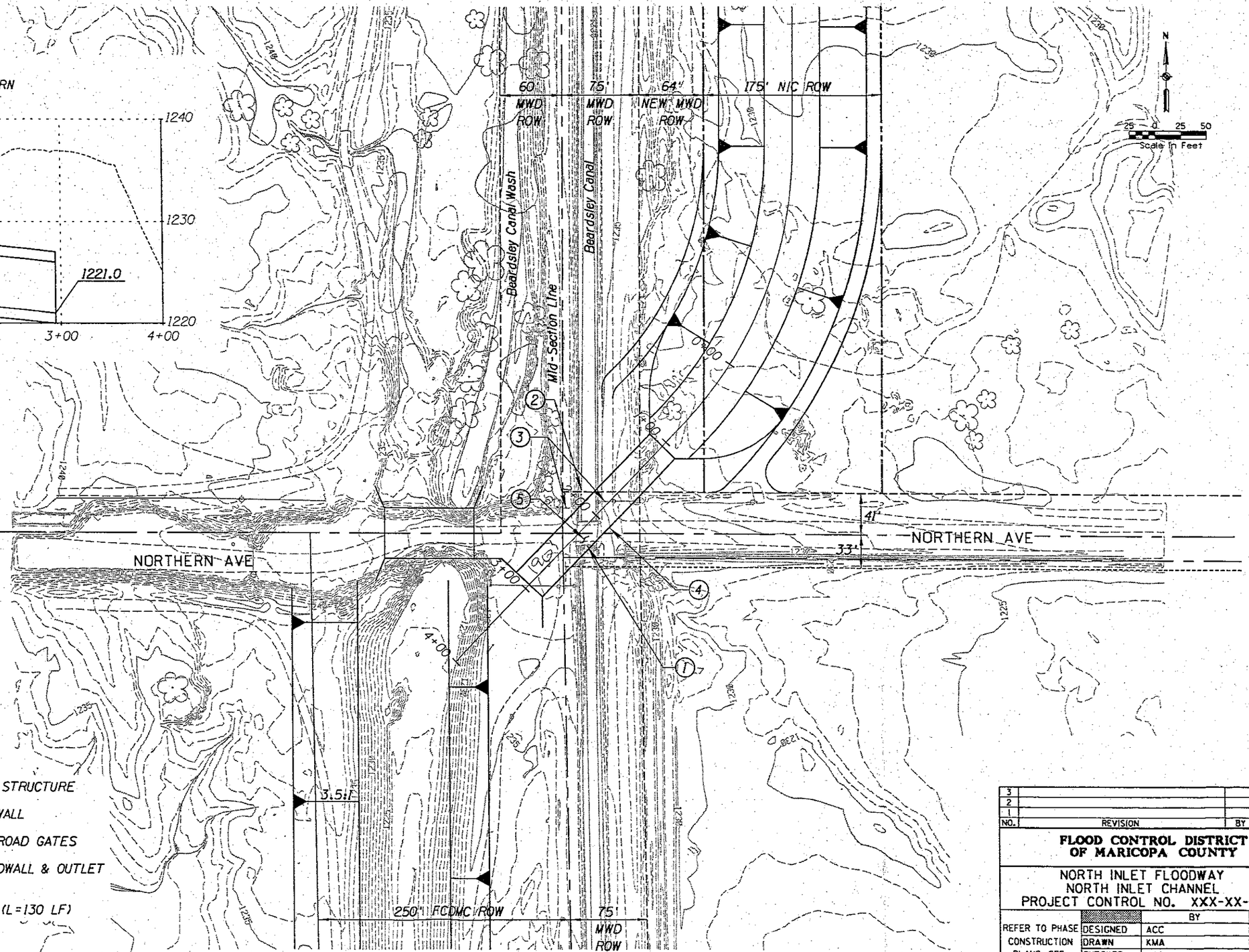
Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	10.00	ft
Section Size	10 x 5 ft		Rise	5.00	ft
Number Sections	5				

Outlet Control Properties					
Outlet Control HW Elev.	1,228.45	ft	Upstream Velocity Head	0.78	ft
Ke	0.20		Entrance Loss	0.16	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,227.99	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	250.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

$490 K





COST LIST

1. REMOVE/RELOCATE CANAL DROP STRUCTURE
2. REMOVE/RELOCATE CANAL HEADWALL
3. REMOVE/RELOCATE MAINTENCE ROAD GATES
4. 3-10x5 RCBC WITH OUTLET HEADWALL & OUTLET PROTECTION (L=200 LF)
5. REMOVE/REPLACE CANAL LINING (L=130 LF)

SHORT CULVERT CROSSING

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NORTH INLET FLOODWAY
NORTH INLET CHANNEL
PROJECT CONTROL NO. XXX-XX-XX

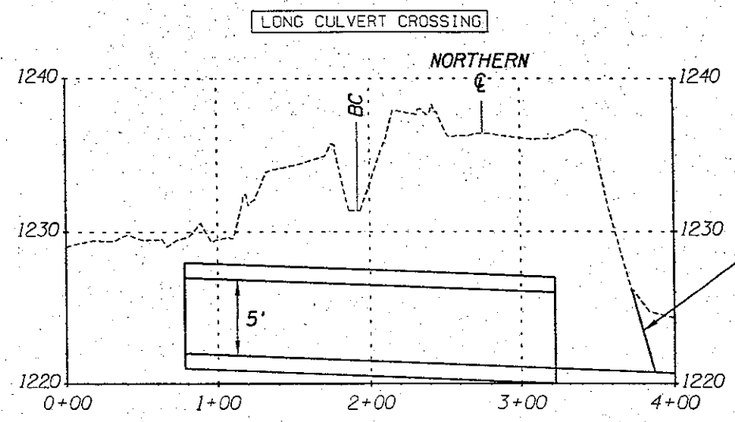
REFER TO PHASE CONSTRUCTION PLANS. SEE NOTE ON COVER

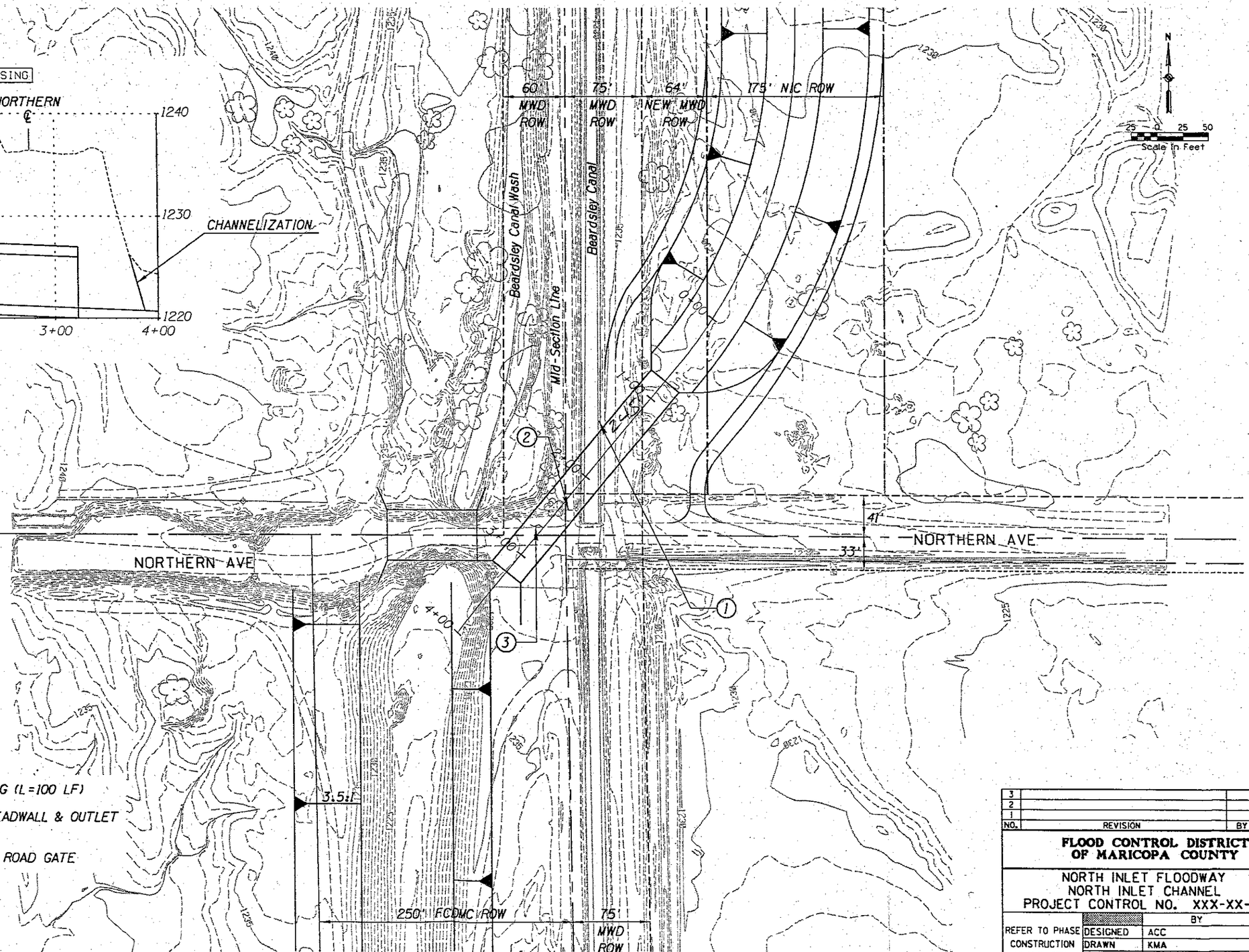
	BY	DATE
DESIGNED	ACC	10/04
DRAWN	KMA	10/04
CHECKED	JKK	10/04

KIRKHAM MICHAEL

DRAWING NO. | SHEET OF

#560 K





COST LIST

1. REMOVE/REPLACE CANAL LINING (L=100 LF)
2. 3-10x5 RCBC WITH OUTLET HEADWALL & OUTLET PROTECTION (L=140 LF)
3. REMOVE/REPLACE MAINTENCE ROAD GATE

LONG CULVERT CROSSING

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NORTH INLET FLOODWAY
NORTH INLET CHANNEL
PROJECT CONTROL NO. XXX-XX-XX

REFER TO PHASE CONSTRUCTION PLANS. SEE NOTE ON COVER

	BY	DATE
DESIGNED	ACC	10/04
DRAWN	KMA	10/04
CHECKED	JKK	10/04

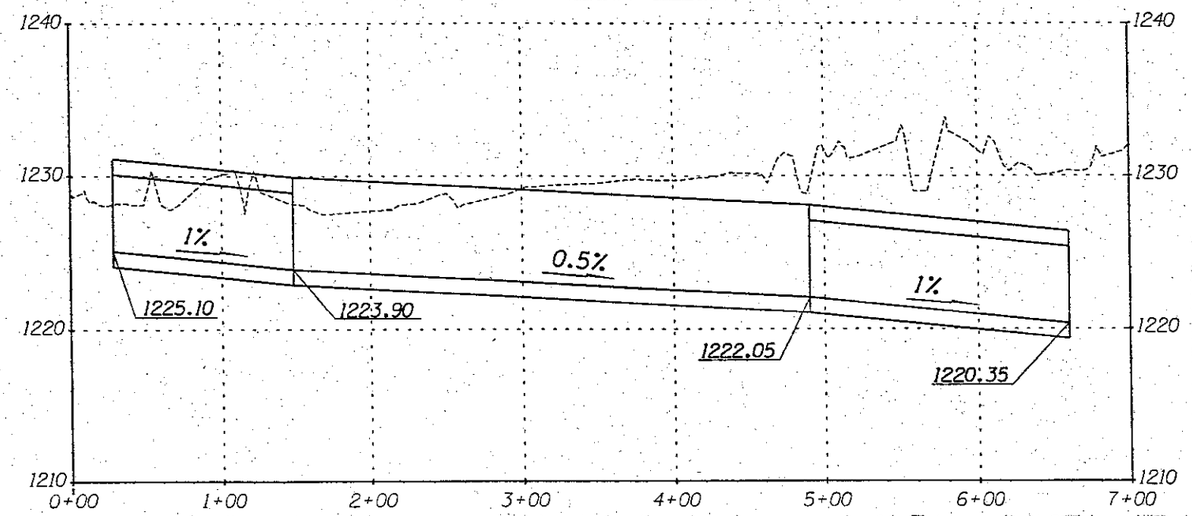
KIRKHAM MICHAEL

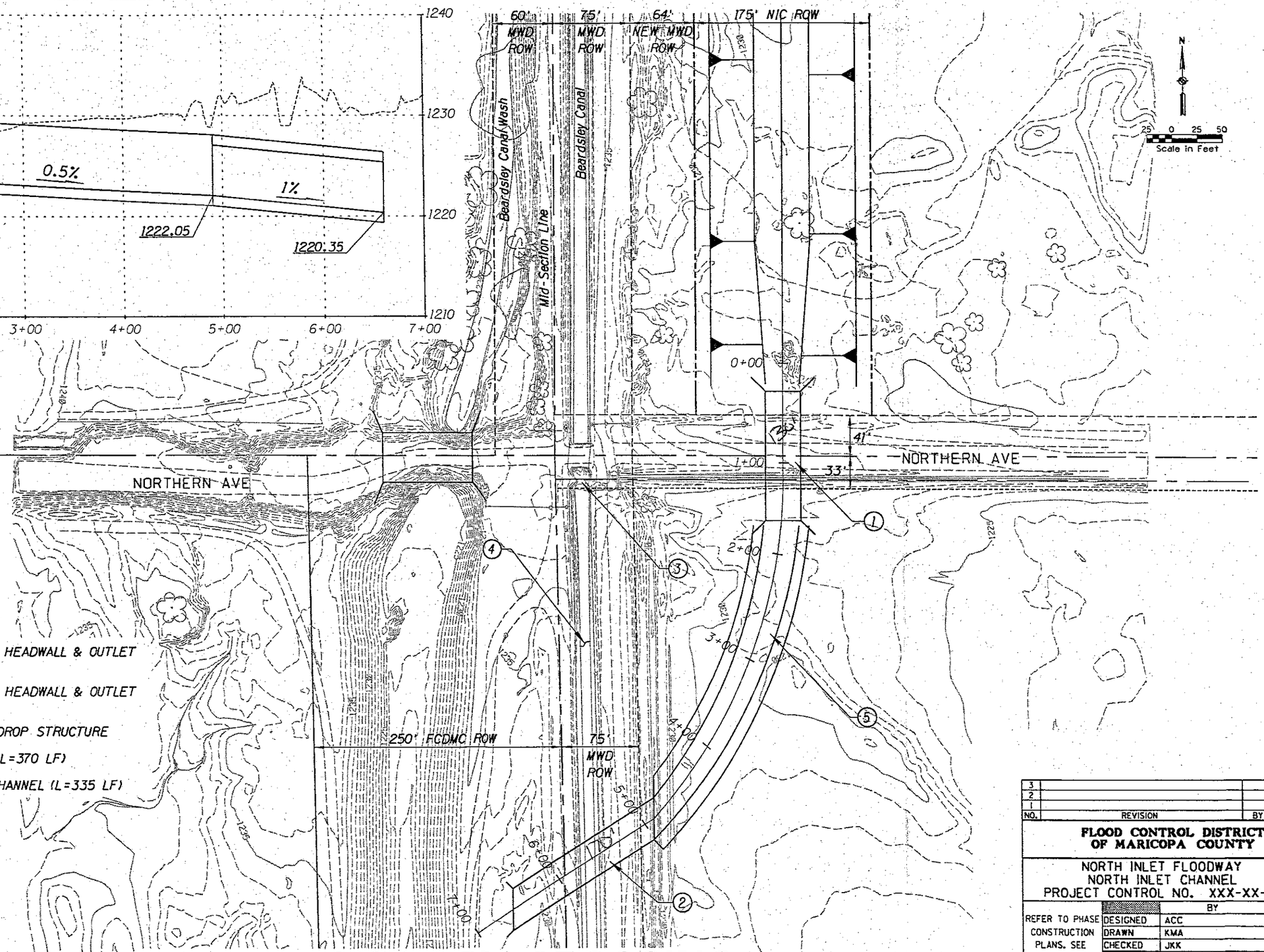
DRAWING NO.

SHEET OF

#830 K

DOUBLE CULVERT CROSSING





COST LIST

1. 3-10x5 RCBC WITH OUTLET HEADWALL & OUTLET PROTECTION (L=120 LF)
2. 3-10x5 RCBC WITH OUTLET HEADWALL & OUTLET PROTECTION (L=170 LF)
3. REMOVE/RELOCATE CANAL DROP STRUCTURE
4. REMOVE/REPLACE CANAL (L=370 LF)
5. RECTANGULAR CONCRETE CHANNEL (L=335 LF)

DOUBLE CULVERT CROSSING

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NORTH INLET FLOODWAY
NORTH INLET CHANNEL
PROJECT CONTROL NO. XXX-XX-XX

		BY	DATE
REFER TO PHASE CONSTRUCTION PLANS. SEE NOTE ON COVER	DESIGNED	ACC	10/04
	DRAWN	KMA	10/04
	CHECKED	JKK	10/04

KIRKHAM MICHAEL

DRAWING NO. | SHEET OF

APPENDIX F – NORTH INLET CHANNEL ANALYSIS

Included in Appendix F

- Cross-section of North Inlet Channel general design
- HECRas rating curve for depth vs. bottom width
- End-Area volume report for NIC designed for uncleared and cleared diversion flows
- Sensitivity Analysis - HECRas rating curve for depth vs. bottom width at varying 'n' values
- Drop structure
    - Conceptual drawings and material estimates
    - HECRas vertical drop structure analysis

End-Area Volume Report

Original Surface: EG-3
Design Surface: dirt

Cut Factor: 1.000000
Fill Factor: 1.000000

Cut: 198603.7 cu yd → SM 200,000 cy
Fill: 1.6 cu yd
Net: 198602.1 cu yd

55' W. to
Channel
Bottom

End-Area Volume Report

N'C CALCS.

Original Surface: EG-3
Design Surface: dirt

Cut Factor: 1.000000
Fill Factor: 1.000000

Cut: 163196.4 cu yd → SAY 165,000 cy
Fill: 14.7 cu yd
Net: 163181.7 cu yd

35' wide
Channel Bottom

NIC SENSITIVITY ANALYSIS

Curve

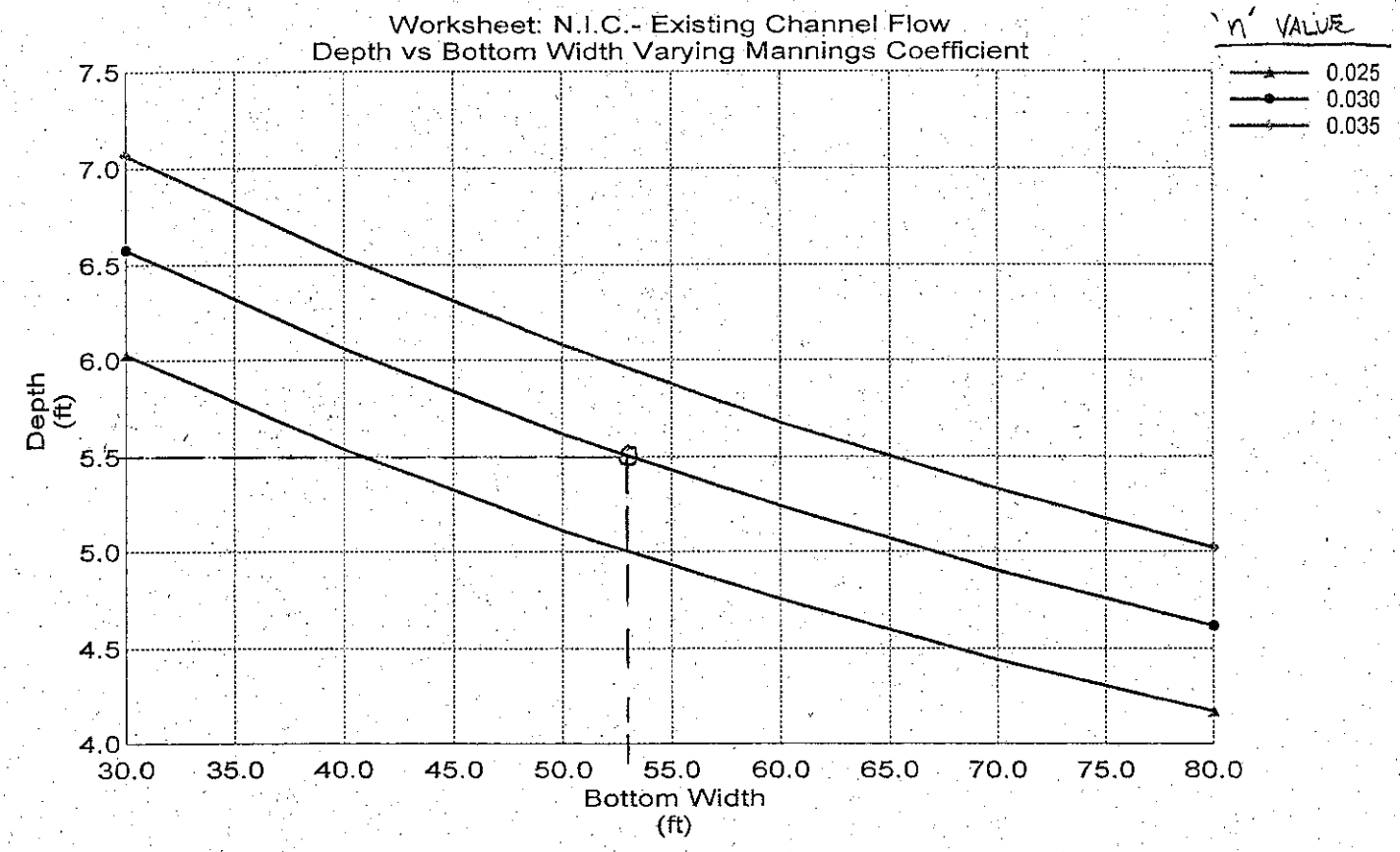
Plotted Curves for Trapezoidal Channel

Project Description	
Worksheet	N.I.C.- Existing Channel
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Channel Slope	000750	ft/ft
Left Side Slop	4.00	ft/ft (H:V)
Right Side Slc	8.00	ft/ft (H:V)
Discharge	1,600.00	cfs

DIVERSION INTO NORTH INLET CHANNEL

Attribute	Minimum	Maximum	Increment
Bottom Width (ft)	30.00	80.00	10.00
Mannings Coefficient	0.025	0.035	0.005



NIC SENSITIVITY ANALYSIS

Curve

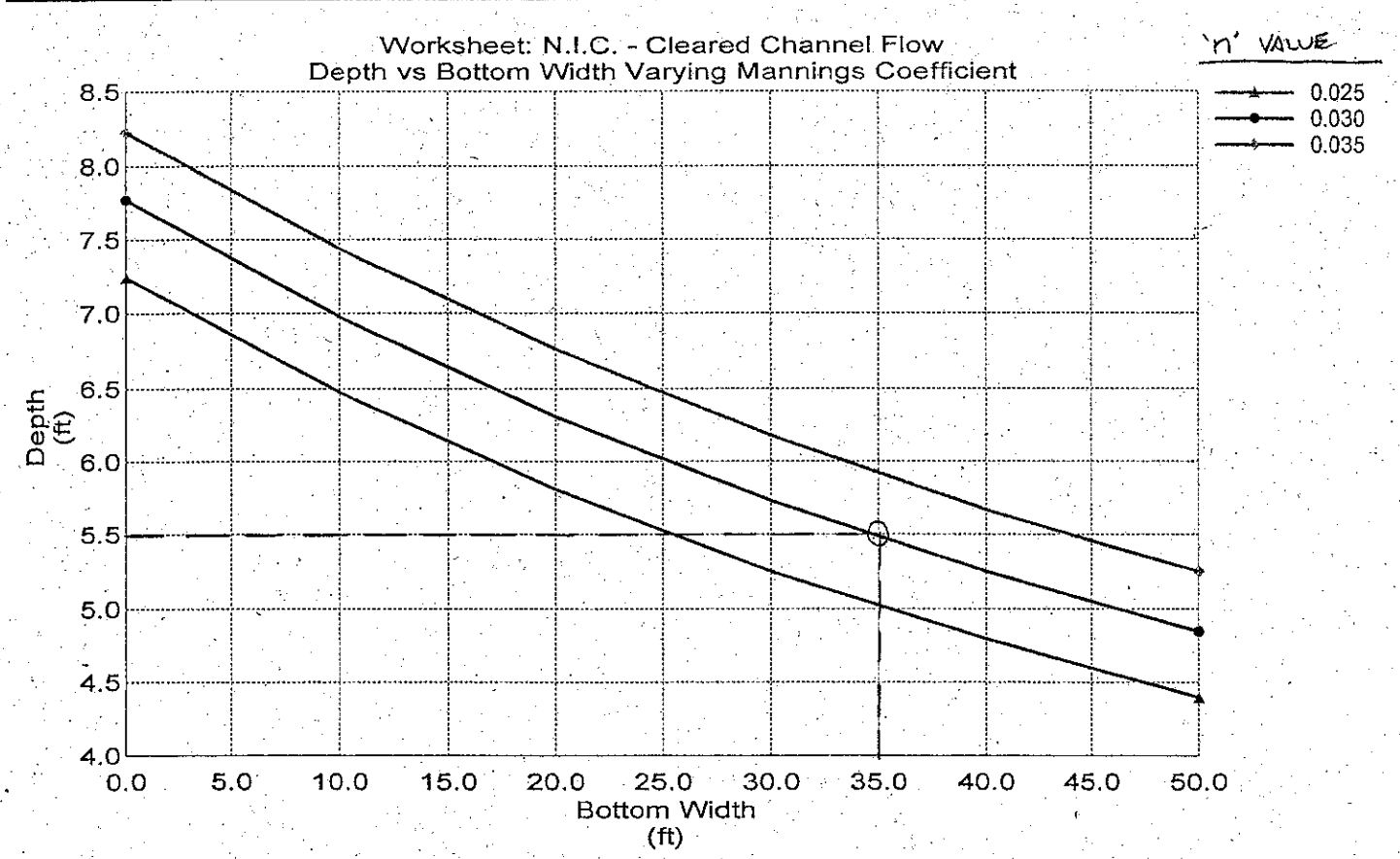
Plotted Curves for Trapezoidal Channel

Project Description	
Worksheet	N.I.C. - Cleared Channe
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Channel Slope	000750	ft/ft
Left Side Slop	4.00	ft/ft (H:V)
Right Side Slc	8.00	ft/ft (H:V)
Discharge	1,200.00	cfs

DIVERSION INTO NORTH INLET CHANNEL

Attribute	Minimum	Maximum	Increment
Bottom Width (ft)	0.00	50.00	10.00
Mannings Coefficient	0.025	0.035	0.005



KIRKHAM MICHAEL
CONSULTING ENGINEERS

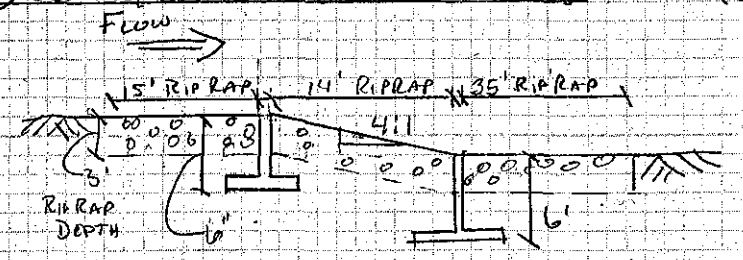
Job Number _____

Sheet 1 of 1

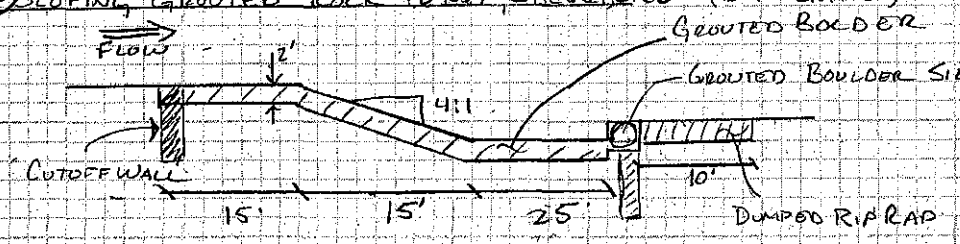
Project NORTH INLET CHANNEL Date 11/1/04

Subject DROP STRUCTE CONCEPTUAL DRAWINGS N.T.S. Designed ACC Checked _____

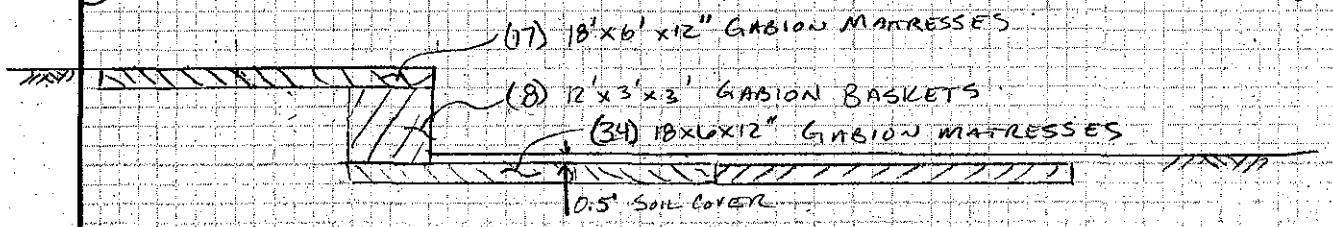
(1) SLOPING BURIED CONCRETE DROP STRUCTURE (LAVEEN CHANNEL)



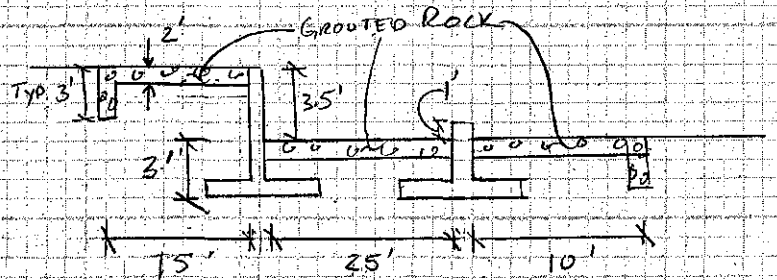
(2) SLOPING GROUTED ROCK DROP STRUCTURE (EMF CHANNEL)



(3) VERTICAL GABION DROP STRUCTURE



(4) VERTICAL EXPOSED CONCRETE DROP STRUCTURE (RITTENHOUSE CHANNEL)



KIRKHAM MICHAEL
CONSULTING ENGINEERS

Job Number _____

Sheet 1 of 2

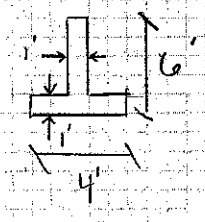
Project NORTH INLET CHANNEL Date 11/2/04

Subject DROP STRUCTURE MATERIALS ESTIMATE Designed ACC Checked _____
1600 CFS FLOW

(1) SLOPING BURIED CONCRETE

REINF. CONCRETE

$2[(1' \times 91' \times 6') + (1' \times 4' \times 91')] = 1820$ CU FT
$= 68$ CU YD



RIP RAP

$[15' \times 2' \times 91'] + [15' \times 101' \times 2'] + [35' \times 101' \times 2'] = 12830$ CU FT
$= 476$ CU YD

(2) SLOPING GROUTED ROCK

REINF. CONCRETE

$2[1' \times 91' \times 6'] = 1092$ CU FT $= 41$ CU YD

GROUTED ROCK

$2[15' \times 101' \times 2'] + [15' \times 91' \times 2'] + [25 \times 101' \times 2] = 10810$ CU FT $= 401$ CU YD

DUMPED RIP RAP $[10' \times 2' \times 101'] = 2020$ CU FT $= 75$ CU YD

(3) VERTICAL GABION

RIP RAP

$51[18' \times 6' \times 1'] + 8[12' \times 3' \times 3'] = 6372$ CU FT $= 236$ CU YD

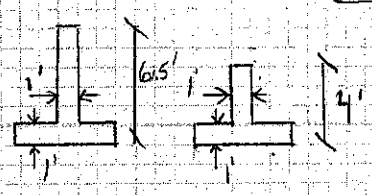
(4) VERTICAL EXPOSED CONCRETE

REINF. CONCRETE

$[(3' \times 101' \times 1') + (1' \times 4' \times 101')] + [(6.5' \times 91' \times 1') + (1' \times 4' \times 91')] = 1572$ CU FT $= 59$ CU YD

GROUTED ROCK

$[15' \times 2' \times 101'] + [25' \times 2' \times 101'] + [10' \times 2' \times 91'] + [3' \times 101' \times 1'] = 10203$ CU FT
$= 378$ CU YD



KIRKHAM MICHAEL
CONSULTING ENGINEERS

Job Number _____

Sheet 2 of 2

Project NORTH INLET CHANNEL Date 11/2/04

Subject DROP STRUCTURE MATERIALS EST. 1200 CFS FLOW Designed ACC Checked _____

① SLOPING BURIED CONCRETE

REINF. CONCRETE

$2[(1' \times 71' \times 6') + (1' \times 4' \times 71')] = 1420$ CUFT = 53 CU YD

DUMPED RIPRAP

$[15' \times 2' \times 71'] + [15' \times 81' \times 2] + [35' \times 81' \times 2'] = 10230$ CUFT = 379 CU YD

② SLOPING GROUTED ROCK

REINF. CONC.

$2[1' \times 71' \times 6'] = 852$ CUFT = 32 CU YD

GROUTED ROCK

$[15' \times 81' \times 2'] + [15' \times 71' \times 2'] + [25' \times 81' \times 2'] = 6342$ CUFT = 235 CU YD

DUMPED RIPRAP

$[10' \times 2' \times 81'] = 1620$ CUFT = 60 CU YD

③ VERTICAL GABION

RIPRAP

$32[18' \times 6' \times 1'] + 7[12' \times 3' \times 3'] = 4212$ CUFT = 156 CU YD

④ VERTICAL EXPOSED CONCRETE

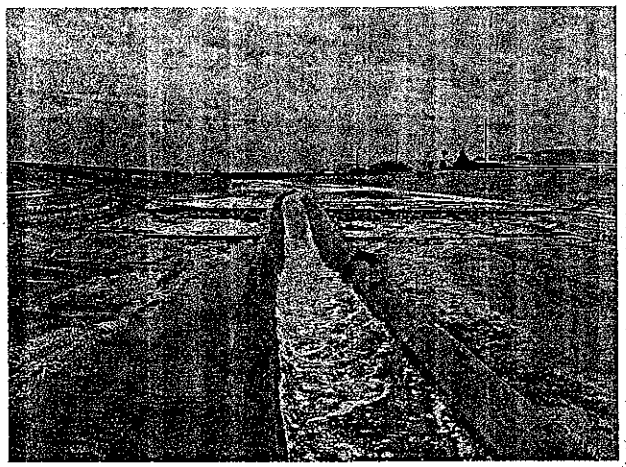
REINF. CONCRETE

$[(3' \times 81' \times 1') + (1' \times 4' \times 81')] + [(5.5' \times 71' \times 1') + (1' \times 4' \times 71')]$
$= 1242$ CUFT = 46 CU YD

GROUTED ROCK

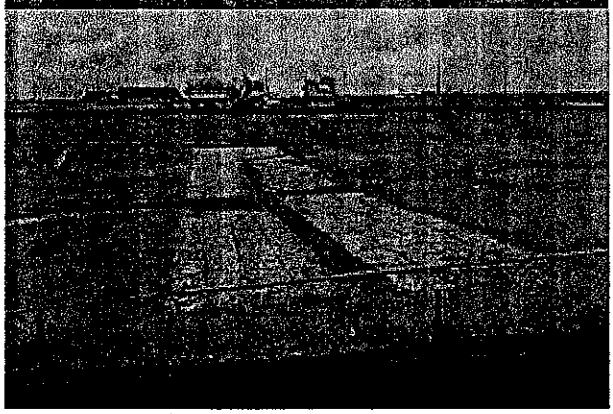
$[15' \times 2' \times 81'] + [25' \times 2' \times 81'] + [10' \times 2' \times 71'] + [3' \times 81' \times 1']$
$= 8143$ CUFT = 302 CU YD

1



2

3



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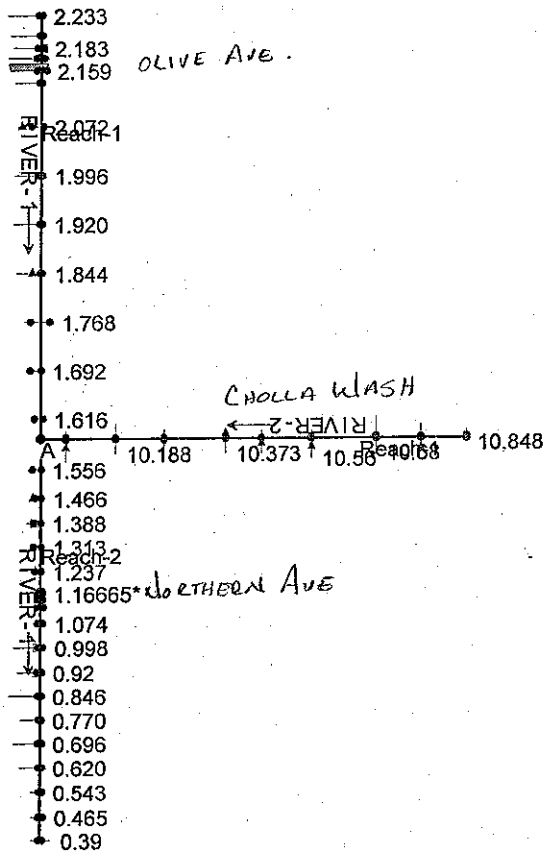
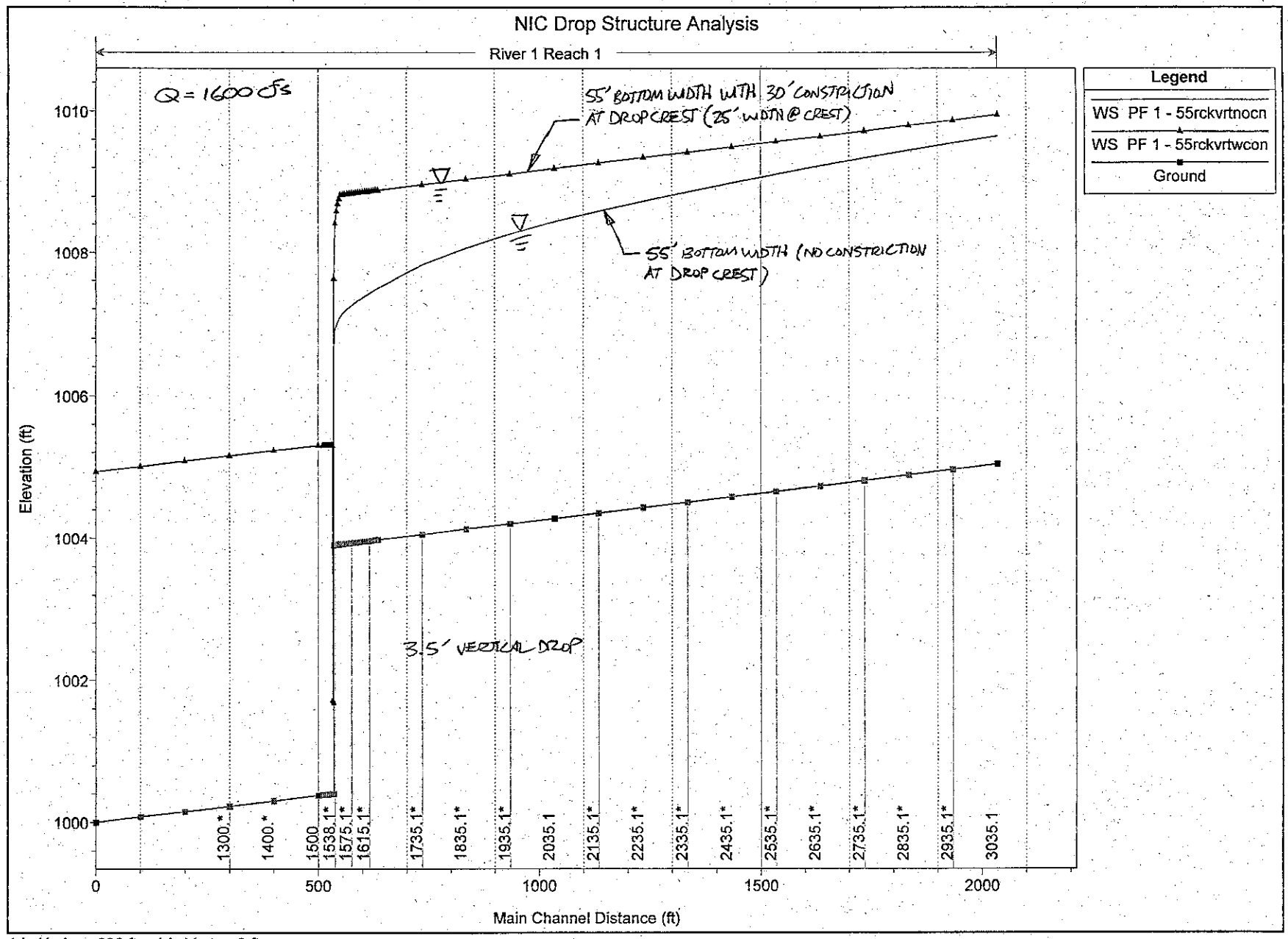

2.233
2.183
2.159
OLIVE AVE.
2.072
Reach-1
RIVER-1
1.996
1.920
1.844
1.768
1.692
1.616
CHOLLA WASH
RIVER-2
A
10.188
10.373
10.56
B
Reach-4
10.848
1.556
1.466
1.388
1.313
Reach-2
1.237
1.16665
NORTHERN AVE
RIVER-1
1.074
0.998
0.92
0.846
0.770
0.696
0.620
0.543
0.465
0.39



1 in Horiz. = 320 ft 1 in Vert. = 2 ft

HEC-RAS River: River 1 Reach: Reach 1 Profile: PF 1

Reach	River Sta	Profile	Plan	Q Total	Length Chnl	Mann Wtd Chnl	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)		(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	3035.1	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1005.03	1009.65	1007.70	1009.92	0.000956	4.19	382.23	110.45	0.40
Reach 1	3035.1	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1005.03	1009.95	1007.70	1010.18	0.000754	3.85	415.88	114.04	0.36
Reach 1	2935.1*	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1004.95	1009.55		1009.82	0.000977	4.22	379.37	110.14	0.40
Reach 1	2935.1*	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1004.95	1009.87		1010.10	0.000754	3.85	415.83	114.04	0.36
Reach 1	2835.1*	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1004.88	1009.44		1009.72	0.001000	4.25	376.22	109.79	0.40
Reach 1	2835.1*	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1004.88	1009.80		1010.03	0.000754	3.85	415.78	114.03	0.36
Reach 1	2735.1*	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1004.80	1009.34		1009.62	0.001027	4.29	372.74	109.41	0.41
Reach 1	2735.1*	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1004.80	1009.72		1009.95	0.000754	3.85	415.72	114.03	0.36
Reach 1	2635.1*	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1004.73	1009.23		1009.52	0.001058	4.34	368.87	108.99	0.42
Reach 1	2635.1*	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1004.73	1009.64		1009.88	0.000755	3.85	415.66	114.02	0.36
Reach 1	2535.1*	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1004.65	1009.11		1009.41	0.001093	4.39	364.55	108.51	0.42
Reach 1	2535.1*	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1004.65	1009.57		1009.80	0.000755	3.85	415.60	114.02	0.36
Reach 1	2435.1*	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1004.58	1008.99		1009.30	0.001136	4.45	359.70	107.97	0.43
Reach 1	2435.1*	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1004.58	1009.49		1009.72	0.000755	3.85	415.53	114.01	0.36
Reach 1	2335.1*	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1004.50	1008.86		1009.18	0.001186	4.52	354.22	107.36	0.44
Reach 1	2335.1*	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1004.50	1009.42		1009.65	0.000756	3.85	415.46	114.00	0.36
Reach 1	2235.1*	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1004.43	1008.73		1009.06	0.001248	4.60	347.95	106.66	0.45
Reach 1	2235.1*	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1004.43	1009.34		1009.57	0.000756	3.85	415.38	113.99	0.36
Reach 1	2135.1*	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1004.35	1008.59		1008.93	0.001325	4.70	340.71	105.84	0.46
Reach 1	2135.1*	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1004.35	1009.27		1009.50	0.000757	3.85	415.29	113.98	0.36
Reach 1	2035.1	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1004.28	1008.43		1008.79	0.001424	4.82	332.22	104.87	0.48
Reach 1	2035.1	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1004.28	1009.19		1009.42	0.000757	3.85	415.20	113.97	0.36
Reach 1	1935.1*	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1004.20	1008.26		1008.64	0.001556	4.97	322.03	103.70	0.50
Reach 1	1935.1*	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1004.20	1009.12		1009.35	0.000758	3.85	415.11	113.96	0.36
Reach 1	1835.1*	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1004.13	1008.06		1008.48	0.001744	5.17	309.37	102.22	0.52
Reach 1	1835.1*	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1004.13	1009.04		1009.27	0.000758	3.86	415.01	113.95	0.36
Reach 1	1735.1*	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1004.05	1007.82		1008.29	0.002046	5.47	292.58	100.23	0.56
Reach 1	1735.1*	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1004.05	1008.96		1009.19	0.000759	3.86	414.89	113.94	0.36
Reach 1	1635.1	PF 1	55rckvrtnocn	1600.00	5.00	0.025	1003.98	1007.49		1008.04	0.002665	6.00	266.85	97.11	0.64
Reach 1	1635.1	PF 1	55rckvrtwcon	1600.00	5.00	0.025	1003.98	1008.89		1009.12	0.000759	3.86	414.77	113.93	0.36
Reach 1	1630.1*	PF 1	55rckvrtnocn	1600.00	5.00	0.025	1003.97	1007.47		1008.03	0.002695	6.02	265.80	96.97	0.64
Reach 1	1630.1*	PF 1	55rckvrtwcon	1600.00	5.00	0.025	1003.97	1008.88		1009.11	0.000759	3.86	414.80	113.93	0.36
Reach 1	1625.1*	PF 1	55rckvrtnocn	1600.00	5.00	0.025	1003.97	1007.45		1008.02	0.002753	6.06	263.87	96.74	0.65
Reach 1	1625.1*	PF 1	55rckvrtwcon	1600.00	5.00	0.025	1003.97	1008.88		1009.11	0.000760	3.86	414.70	113.92	0.36
Reach 1	1620.1*	PF 1	55rckvrtnocn	1600.00	5.00	0.025	1003.96	1007.43		1008.01	0.002769	6.08	263.31	96.67	0.65
Reach 1	1620.1*	PF 1	55rckvrtwcon	1600.00	5.00	0.025	1003.97	1008.88		1009.11	0.000760	3.86	414.72	113.92	0.36

HEC-RAS River: River 1 Reach: Reach 1 Profile: PF 1 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Length Chnl	Mann Wtd Chnl	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)		(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	1615.1*	PF 1	55rckvrtnocn	1600.00	5.00	0.025	1003.96	1007.41		1007.99	0.002831	6.12	261.31	96.42	0.66
Reach 1	1615.1*	PF 1	55rckvrtwcon	1600.00	5.00	0.025	1003.96	1008.87		1009.10	0.000759	3.86	414.75	113.93	0.36
Reach 1	1610.1*	PF 1	55rckvrtnocn	1600.00	5.00	0.025	1003.96	1007.39		1007.98	0.002896	6.17	259.26	96.16	0.66
Reach 1	1610.1*	PF 1	55rckvrtwcon	1600.00	5.00	0.025	1003.96	1008.87		1009.10	0.000759	3.86	414.77	113.93	0.36
Reach 1	1605.1*	PF 1	55rckvrtnocn	1600.00	5.00	0.025	1003.95	1007.37		1007.97	0.002917	6.19	258.60	96.08	0.66
Reach 1	1605.1*	PF 1	55rckvrtwcon	1600.00	5.00	0.025	1003.95	1008.86		1009.10	0.000759	3.86	414.79	113.93	0.36
Reach 1	1600.1*	PF 1	55rckvrtnocn	1600.00	5.00	0.025	1003.95	1007.35		1007.96	0.002988	6.24	256.46	95.81	0.67
Reach 1	1600.1*	PF 1	55rckvrtwcon	1600.00	5.00	0.025	1003.95	1008.86		1009.09	0.000760	3.86	414.69	113.92	0.36
Reach 1	1595.1*	PF 1	55rckvrtnocn	1600.00	5.00	0.025	1003.95	1007.33		1007.94	0.003063	6.29	254.27	95.54	0.68
Reach 1	1595.1*	PF 1	55rckvrtwcon	1600.00	5.00	0.025	1003.95	1008.86		1009.09	0.000760	3.86	414.72	113.92	0.36
Reach 1	1590.1*	PF 1	55rckvrtnocn	1600.00	5.00	0.025	1003.94	1007.31		1007.93	0.003090	6.31	253.48	95.44	0.68
Reach 1	1590.1*	PF 1	55rckvrtwcon	1600.00	5.00	0.025	1003.94	1008.85		1009.08	0.000759	3.86	414.74	113.92	0.36
Reach 1	1585.1*	PF 1	55rckvrtnocn	1600.00	5.00	0.025	1003.94	1007.29		1007.92	0.003172	6.37	251.19	95.15	0.69
Reach 1	1585.1*	PF 1	55rckvrtwcon	1600.00	5.00	0.025	1003.94	1008.85		1009.08	0.000759	3.86	414.77	113.93	0.36
Reach 1	1580.1*	PF 1	55rckvrtnocn	1600.00	5.00	0.025	1003.93	1007.27		1007.90	0.003205	6.39	250.31	95.04	0.69
Reach 1	1580.1*	PF 1	55rckvrtwcon	1600.00	5.00	0.025	1003.94	1008.85		1009.08	0.000760	3.86	414.66	113.92	0.36
Reach 1	1575.1*	PF 1	55rckvrtnocn	1600.00	5.00	0.025	1003.93	1007.24		1007.89	0.003295	6.45	247.90	94.73	0.70
Reach 1	1575.1*	PF 1	55rckvrtwcon	1600.00	5.00	0.025	1003.93	1008.84		1009.07	0.000760	3.86	414.68	113.92	0.36
Reach 1	1570.1*	PF 1	55rckvrtnocn	1600.00	5.00	0.025	1003.93	1007.22		1007.88	0.003392	6.52	245.42	94.42	0.71
Reach 1	1570.1*	PF 1	55rckvrtwcon	1600.00	5.00	0.025	1003.93	1008.84		1009.07	0.000760	3.86	414.71	113.92	0.36
Reach 1	1565.1*	PF 1	55rckvrtnocn	1600.00	5.00	0.025	1003.92	1007.19		1007.86	0.003436	6.55	244.35	94.28	0.72
Reach 1	1565.1*	PF 1	55rckvrtwcon	1600.00	5.00	0.025	1003.92	1008.83		1009.06	0.000759	3.86	414.74	113.92	0.36
Reach 1	1560.1*	PF 1	55rckvrtnocn	1600.00	5.00	0.025	1003.92	1007.16		1007.84	0.003561	6.63	241.33	93.90	0.73
Reach 1	1560.1*	PF 1	55rckvrtwcon	1600.00	5.00	0.025	1003.92	1008.83		1009.06	0.000759	3.86	414.76	113.93	0.36
Reach 1	1555.1*	PF 1	55rckvrtnocn	1600.00	5.00	0.025	1003.92	1007.13		1007.83	0.003694	6.71	238.30	93.51	0.74
Reach 1	1555.1*	PF 1	55rckvrtwcon	1600.00	5.00	0.025	1003.92	1008.83		1009.06	0.000760	3.86	414.64	113.91	0.36
BEGIN APRON Reach 1	1550.1	PF 1	55rckvrtnocn	1600.00	3.00	0.032	1003.91	1007.09		1007.81	0.006266	6.80	235.46	93.14	0.75
Reach 1	1550.1	PF 1	55rckvrtwcon	1600.00	3.00	0.032	1003.91	1008.82		1009.05	0.001246	3.86	414.51	113.90	0.36
Reach 1	1547.1*	PF 1	55rckvrtnocn	1600.00	3.00	0.032	1003.91	1007.06		1007.79	0.006513	6.89	232.34	92.74	0.77
Reach 1	1547.1*	PF 1	55rckvrtwcon	1600.00	3.00	0.032	1003.91	1008.77		1009.04	0.001544	4.22	379.55	107.29	0.39
Reach 1	1544.1*	PF 1	55rckvrtnocn	1600.00	3.00	0.032	1003.91	1007.02		1007.78	0.006825	7.00	228.61	92.26	0.78
Reach 1	1544.1*	PF 1	55rckvrtwcon	1600.00	3.00	0.032	1003.91	1008.69		1009.03	0.001978	4.66	343.26	100.44	0.44
Reach 1	1541.1*	PF 1	55rckvrtnocn	1600.00	3.00	0.032	1003.91	1006.97		1007.76	0.007235	7.14	224.07	91.67	0.80
Reach 1	1541.1*	PF 1	55rckvrtwcon	1600.00	3.00	0.032	1003.91	1008.59		1009.02	0.002660	5.25	304.85	93.20	0.51
Reach 1	1538.1*	PF 1	55rckvrtnocn	1600.00	3.00	0.032	1003.90	1006.93	1006.57	1007.74	0.007454	7.21	221.77	91.37	0.82

HEC-RAS River: River 1 Reach: Reach 1 Profile: PF 1 (Continued)

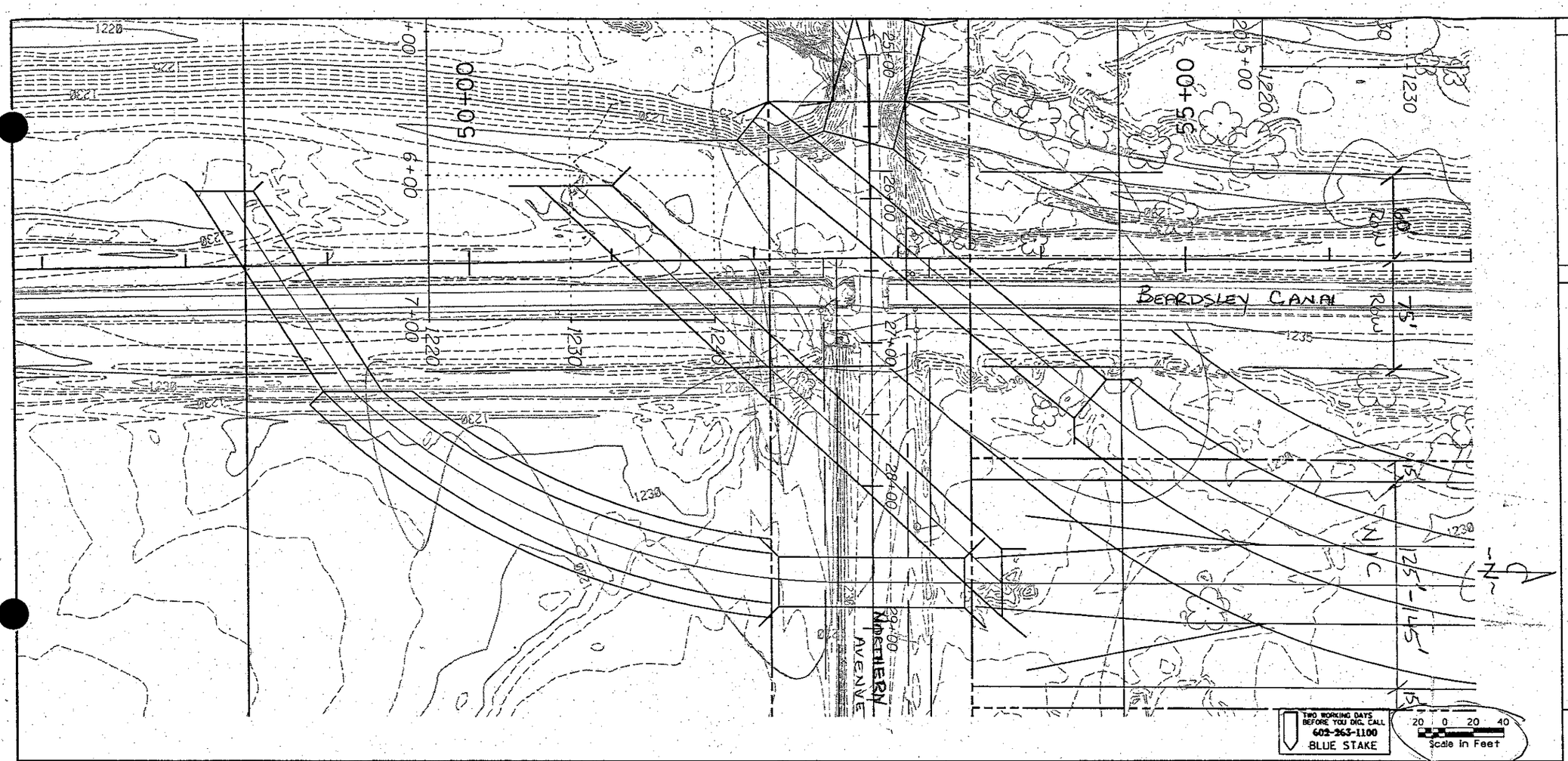
Reach	River Sta	Profile	Plan	Q Total	Length Chnl	Mann Wtd Chnl	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)		(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	1538.1*	PF 1	55rckvrtwcon	1600.00	3.00	0.032	1003.90	1008.41		1008.99	0.003930	6.12	261.51	85.07	0.61
Reach 1	1535.1	PF 1	55rckvrtnocn	1600.00	0.10	0.032	1003.90	1006.57	1006.57	1007.68	0.011735	8.43	189.82	87.07	1.01
Reach 1	1535.1	PF 1	55rckvrtwcon	1600.00	0.10	0.032	1003.90	1007.62	1007.62	1008.90	0.011229	9.08	176.20	69.67	1.01
Reach 1	1535	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.40	1005.30	1003.16	1005.60	0.001468	4.35	367.95	95.11	0.39
Reach 1	1535	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.40	1001.68	1003.16	1008.37	0.161619	20.75	77.10	65.47	3.37
Reach 1	1534.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.40	1005.30		1005.60	0.001463	4.34	368.90	95.48	0.39
Reach 1	1534.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.40	1001.70	1003.16	1008.14	0.152373	20.35	78.61	65.75	3.28
Reach 1	1533.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.40	1005.30		1005.59	0.001459	4.33	369.76	95.85	0.39
Reach 1	1533.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.40	1001.72	1003.15	1007.90	0.143293	19.95	80.22	66.04	3.19
Reach 1	1532.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.40	1005.30		1005.59	0.001454	4.32	370.63	96.23	0.39
Reach 1	1532.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.40	1005.30	1003.15	1005.59	0.001453	4.32	370.76	96.24	0.39
Reach 1	1531.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.40	1005.30		1005.59	0.001450	4.31	371.53	96.61	0.39
Reach 1	1531.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.40	1005.30		1005.59	0.001447	4.30	371.76	96.63	0.39
Reach 1	1530.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.40	1005.30		1005.59	0.001446	4.30	372.45	97.00	0.39
Reach 1	1530.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.40	1005.30		1005.59	0.001442	4.29	372.79	97.04	0.39
Reach 1	1529.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.40	1005.30		1005.59	0.001441	4.29	373.39	97.40	0.39
Reach 1	1529.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.40	1005.30		1005.59	0.001436	4.28	373.84	97.44	0.39
Reach 1	1528.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.40	1005.30		1005.58	0.001437	4.27	374.35	97.81	0.39
Reach 1	1528.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.40	1005.30		1005.58	0.001432	4.27	374.80	97.85	0.38
Reach 1	1527.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.39	1005.30		1005.58	0.001420	4.25	376.42	98.32	0.38
Reach 1	1527.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.40	1005.30		1005.58	0.001426	4.26	375.89	98.28	0.38
Reach 1	1526.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.39	1005.30		1005.58	0.001415	4.24	377.42	98.75	0.38
Reach 1	1526.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.39	1005.30		1005.58	0.001420	4.24	377.01	98.71	0.38
Reach 1	1525.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.39	1005.30		1005.58	0.001410	4.23	378.46	99.18	0.38
Reach 1	1525.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.39	1005.30		1005.58	0.001414	4.23	378.14	99.15	0.38
Reach 1	1524.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.39	1005.30		1005.58	0.001405	4.22	379.51	99.63	0.38
Reach 1	1524.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.39	1005.30		1005.58	0.001409	4.22	379.19	99.60	0.38
Reach 1	1523.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.39	1005.30		1005.57	0.001400	4.20	380.58	100.08	0.38
Reach 1	1523.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.39	1005.30		1005.57	0.001403	4.21	380.37	100.06	0.38
Reach 1	1522.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.39	1005.30		1005.57	0.001395	4.19	381.69	100.54	0.38
Reach 1	1522.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.39	1005.30		1005.57	0.001396	4.19	381.59	100.53	0.38
Reach 1	1521.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.39	1005.30		1005.57	0.001390	4.18	382.81	101.01	0.38
Reach 1	1521.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.39	1005.30		1005.57	0.001390	4.18	382.82	101.01	0.38
Reach 1	1520.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.39	1005.30		1005.57	0.001384	4.17	383.97	101.49	0.38
Reach 1	1520.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.39	1005.30		1005.57	0.001384	4.17	383.97	101.49	0.38

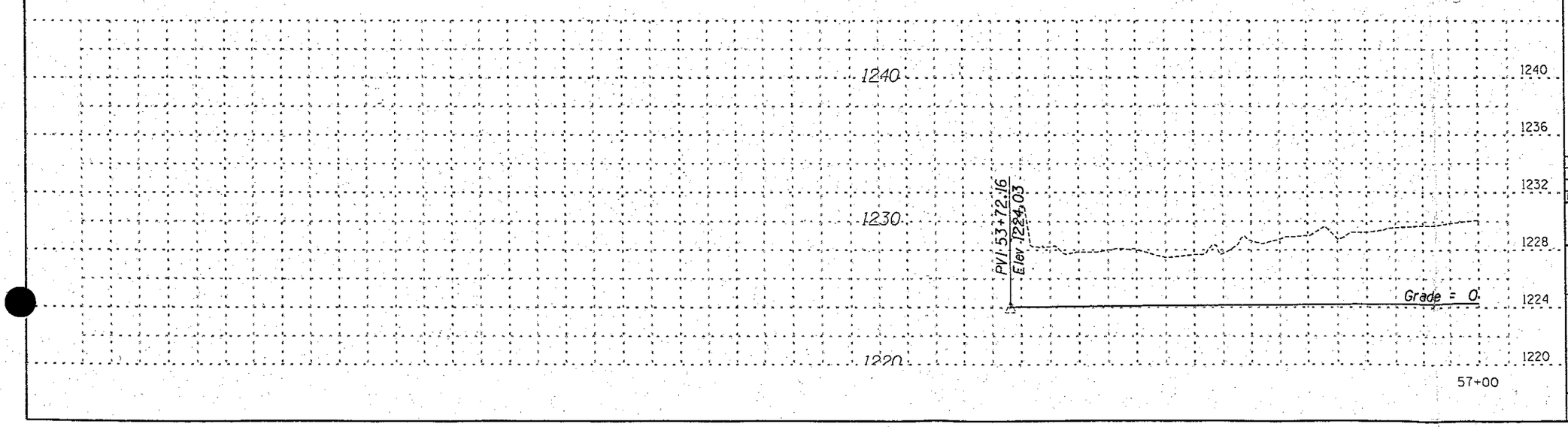
DROP CREST

DROP TOE

HEC-RAS River: River 1 Reach: Reach 1 Profile: PF 1 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Length Chnl	Mann Wtd Chnl	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)		(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	1519.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.39	1005.30		1005.57	0.001379	4.15	385.15	101.98	0.38
Reach 1	1519.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.39	1005.30		1005.57	0.001378	4.15	385.27	101.99	0.38
Reach 1	1518.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.39	1005.30		1005.56	0.001373	4.14	386.36	102.48	0.38
Reach 1	1518.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.39	1005.30		1005.56	0.001371	4.14	386.59	102.51	0.38
Reach 1	1517.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.39	1005.30		1005.56	0.001368	4.13	387.59	103.00	0.38
Reach 1	1517.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.39	1005.30		1005.56	0.001364	4.12	387.94	103.03	0.37
Reach 1	1516.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.39	1005.30		1005.56	0.001362	4.11	388.86	103.52	0.37
Reach 1	1516.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.39	1005.30		1005.56	0.001358	4.11	389.21	103.55	0.37
Reach 1	1515.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.39	1005.30		1005.56	0.001356	4.10	390.16	104.06	0.37
Reach 1	1515.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.39	1005.30		1005.56	0.001351	4.10	390.63	104.10	0.37
Reach 1	1514.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.39	1005.30		1005.56	0.001350	4.09	391.48	104.61	0.37
Reach 1	1514.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.39	1005.30		1005.56	0.001344	4.08	392.07	104.66	0.37
Reach 1	1513.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.38	1005.30		1005.55	0.001332	4.06	394.01	105.28	0.37
Reach 1	1513.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.38	1005.30		1005.55	0.001337	4.07	393.55	105.24	0.37
Reach 1	1512.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.38	1005.30		1005.55	0.001326	4.05	395.41	105.86	0.37
Reach 1	1512.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.38	1005.30		1005.55	0.001330	4.05	394.95	105.81	0.37
Reach 1	1511.*	PF 1	55rckvrtnocn	1600.00	1.00	0.032	1000.38	1005.30		1005.55	0.001319	4.03	396.85	106.45	0.37
Reach 1	1511.*	PF 1	55rckvrtwcon	1600.00	1.00	0.032	1000.38	1005.30		1005.55	0.001323	4.04	396.50	106.41	0.37
END APRON Reach 1	1510	PF 1	55rckvrtnocn	1600.00	10.00	0.032	1000.38	1005.30		1005.55	0.001315	4.02	398.09	107.03	0.37
Reach 1	1510	PF 1	55rckvrtwcon	1600.00	10.00	0.032	1000.38	1005.30		1005.55	0.001315	4.02	398.09	107.03	0.37
Reach 1	1500	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1000.38	1005.30		1005.53	0.000750	3.84	416.51	114.11	0.35
Reach 1	1500	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1000.38	1005.30		1005.53	0.000750	3.84	416.51	114.11	0.35
Reach 1	1400.*	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1000.30	1005.23		1005.46	0.000750	3.84	416.51	114.11	0.35
Reach 1	1400.*	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1000.30	1005.23		1005.46	0.000750	3.84	416.51	114.11	0.35
Reach 1	1300.*	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1000.23	1005.15		1005.38	0.000750	3.84	416.51	114.11	0.35
Reach 1	1300.*	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1000.23	1005.15		1005.38	0.000750	3.84	416.51	114.11	0.35
Reach 1	1200.*	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1000.15	1005.08		1005.31	0.000750	3.84	416.50	114.11	0.35
Reach 1	1200.*	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1000.15	1005.08		1005.31	0.000750	3.84	416.50	114.11	0.35
Reach 1	1100.*	PF 1	55rckvrtnocn	1600.00	100.00	0.025	1000.08	1005.00		1005.23	0.000750	3.84	416.50	114.11	0.35
Reach 1	1100.*	PF 1	55rckvrtwcon	1600.00	100.00	0.025	1000.08	1005.00		1005.23	0.000750	3.84	416.50	114.11	0.35
Reach 1	1000	PF 1	55rckvrtnocn	1600.00		0.025	1000.00	1004.93	1002.67	1005.16	0.000750	3.84	416.50	114.11	0.35
Reach 1	1000	PF 1	55rckvrtwcon	1600.00		0.025	1000.00	1004.93	1002.67	1005.16	0.000750	3.84	416.50	114.11	0.35





☐ REMOVE ☐

○ CONSTRUCT ○

SHEET INDEX MAP

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NORTH INLET FLOODWAY
NORTH INLET CHANNEL
PROJECT CONTROL NO. XXX-XX-XX

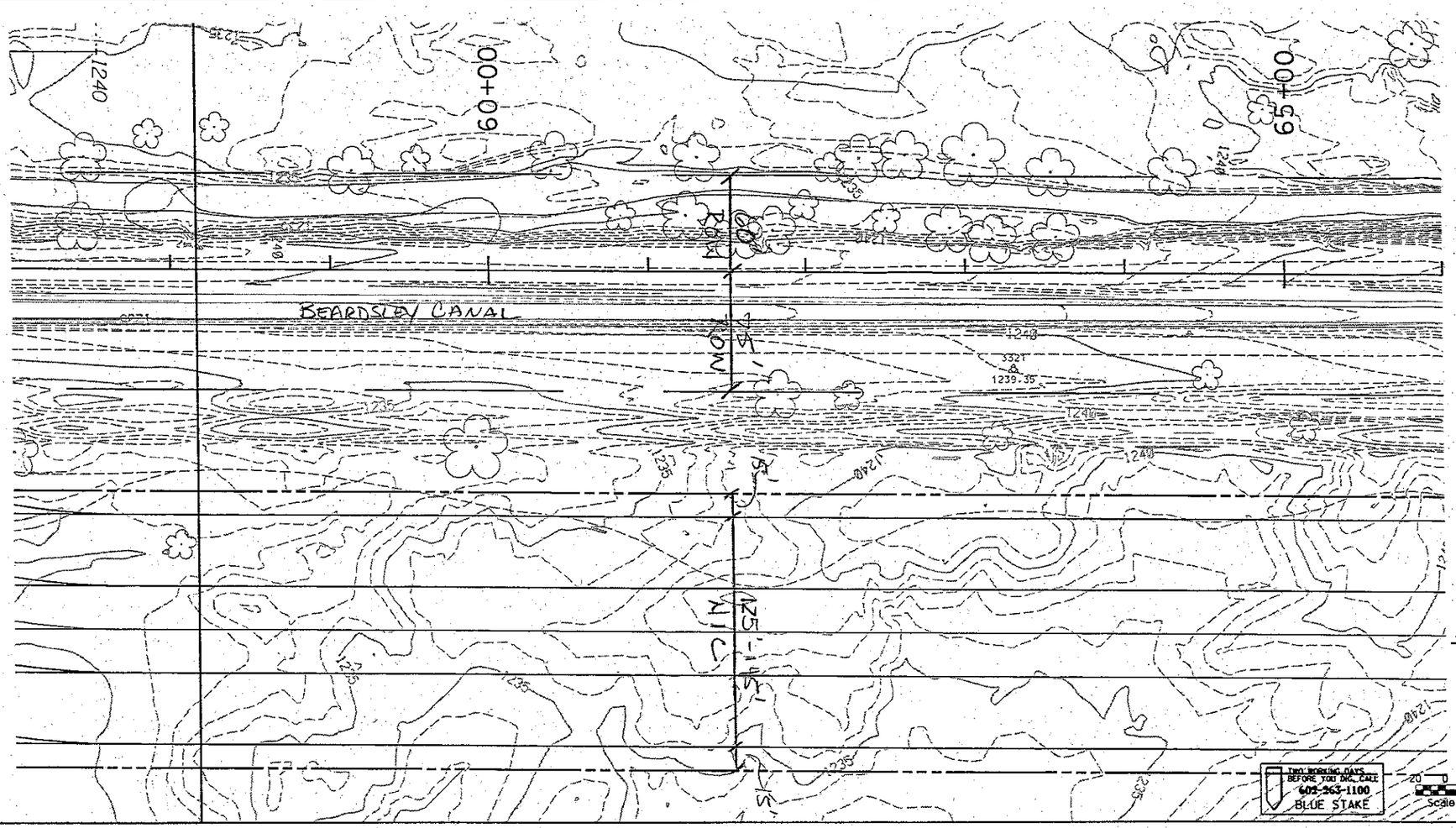
REFER TO PHASE CONSTRUCTION PLANS. SEE NOTE ON COVER

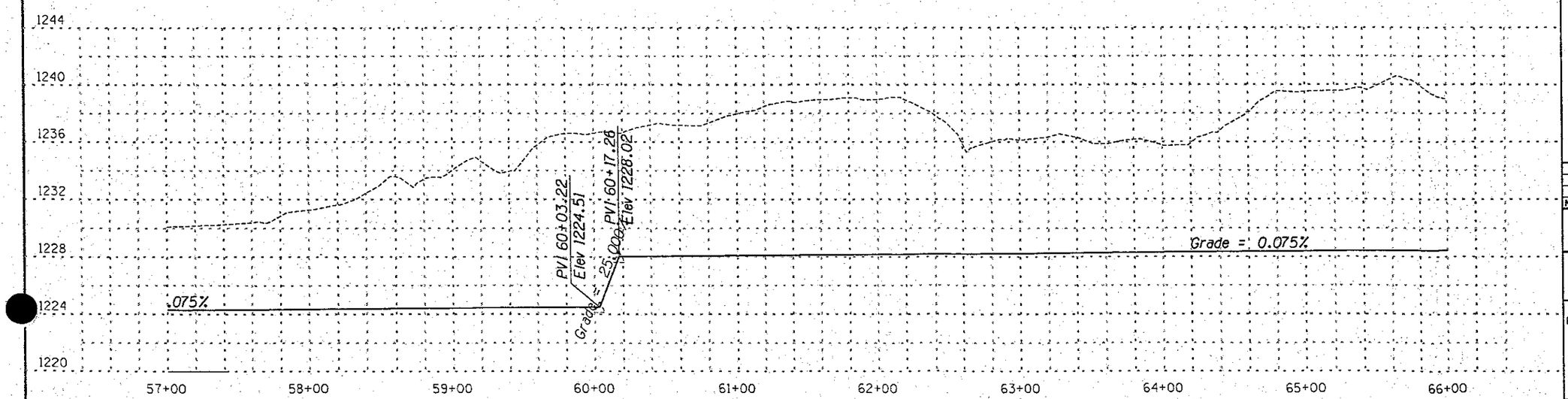
	BY	DATE
DESIGNED	ACC	12/04
DRAWN	KMA	12/04
CHECKED	JKK	12/04

KIRKHAM MICHAEL

DRAWING NO.

SHEET OF XXX





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CONSTRUCT

SHEET INDEX MAP

NO.	REVISION	BY	DATE
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NORTH INLET FLOODWAY
NORTH INLET CHANNEL
PROJECT CONTROL NO. XXX-XX-XX

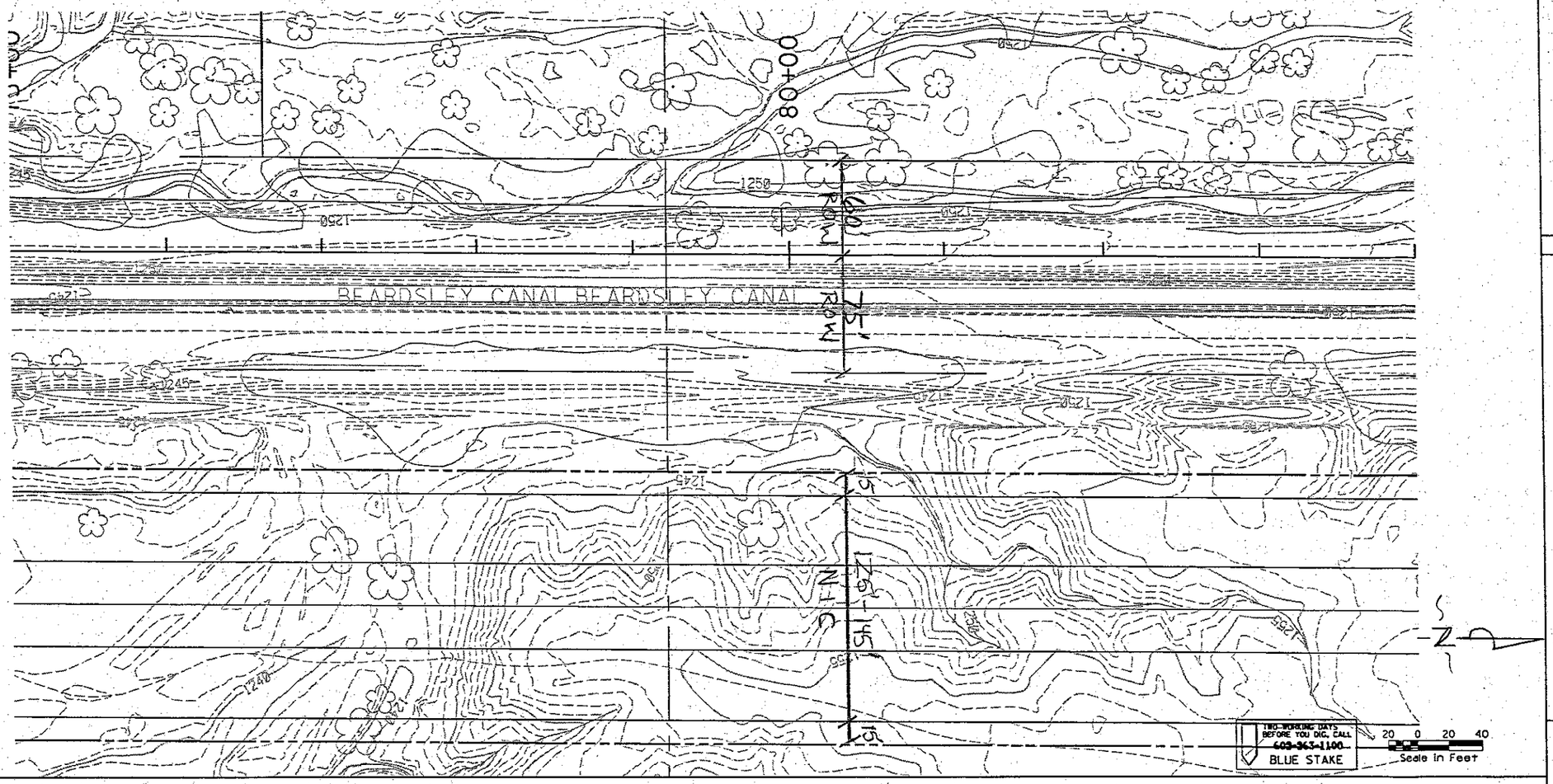
REFER TO PHASE CONSTRUCTION PLANS. SEE NOTE ON COVER

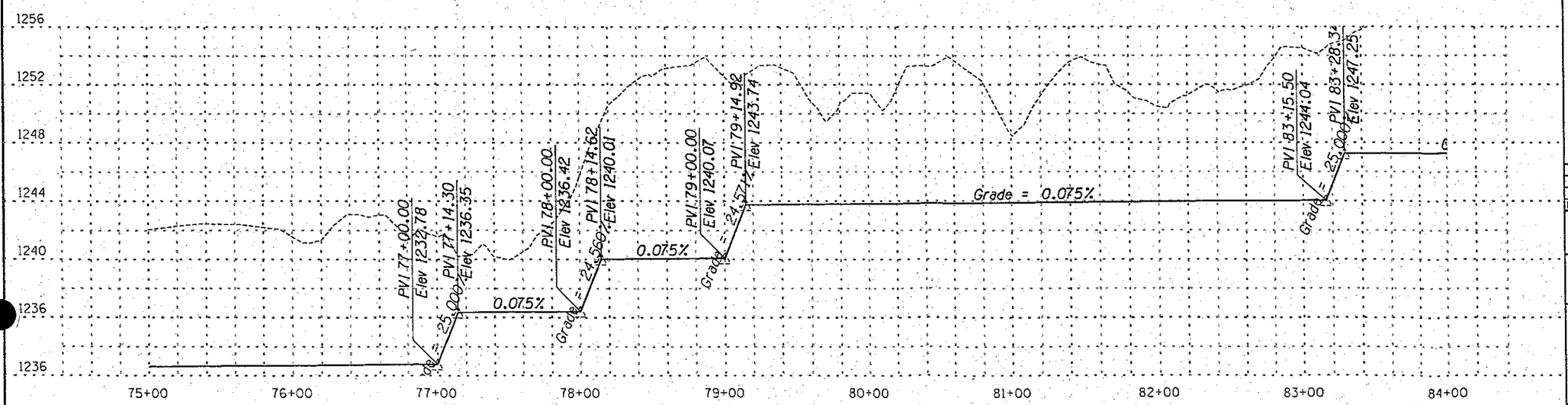
	BY	DATE
DESIGNED	ACC	12/04
DRAWN	KMA	12/04
CHECKED	JKK	12/04

KIRKHAM MICHAEL

DRAWING NO.

SHEET OF XXX





REMOVE

CONSTRUCT

SHEET INDEX MAP

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NORTH INLET FLOODWAY
NORTH INLET CHANNEL
PROJECT CONTROL NO. XXX-XX-XX

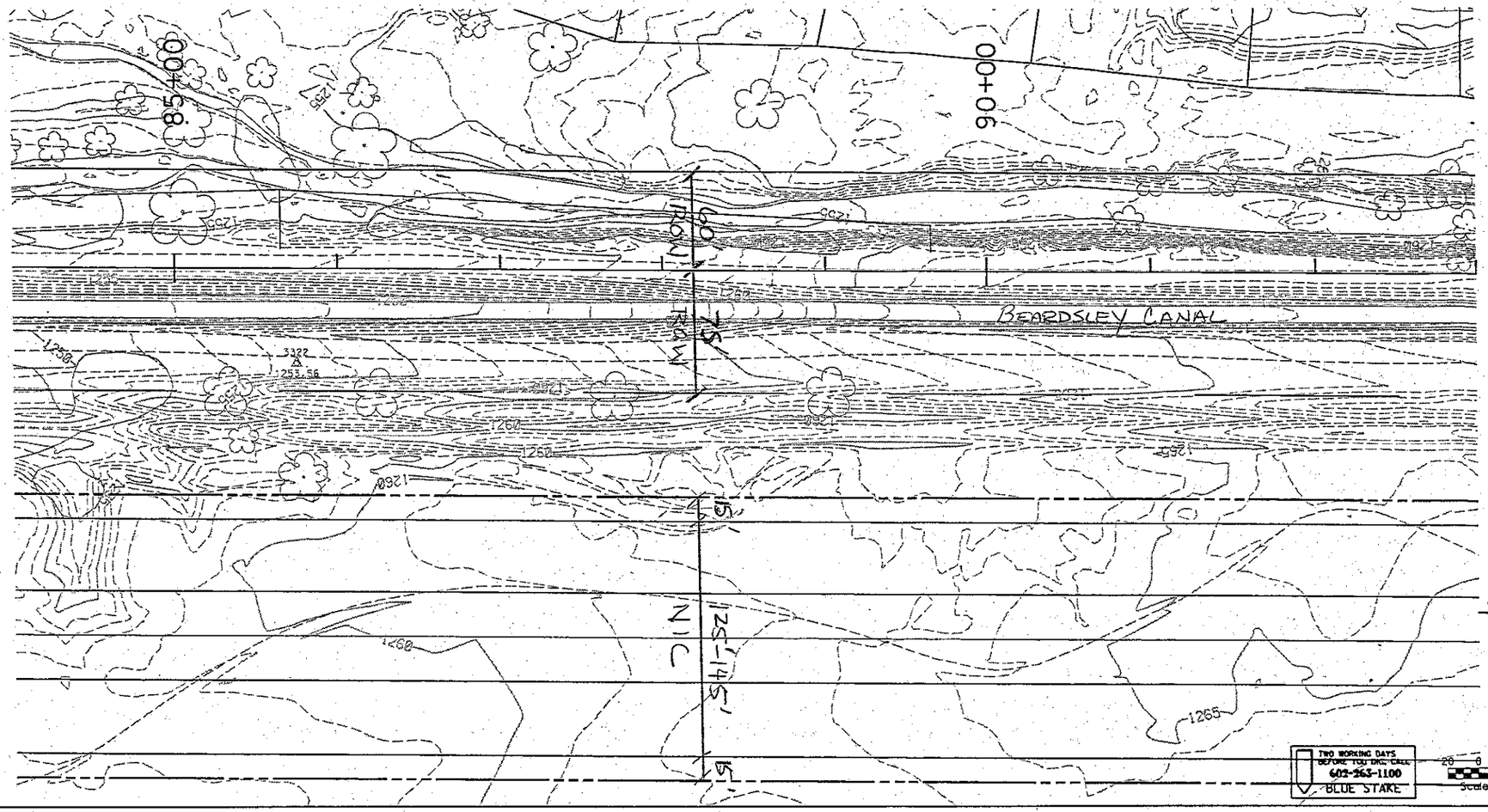
REFER TO PHASE CONSTRUCTION PLANS. SEE NOTE ON COVER

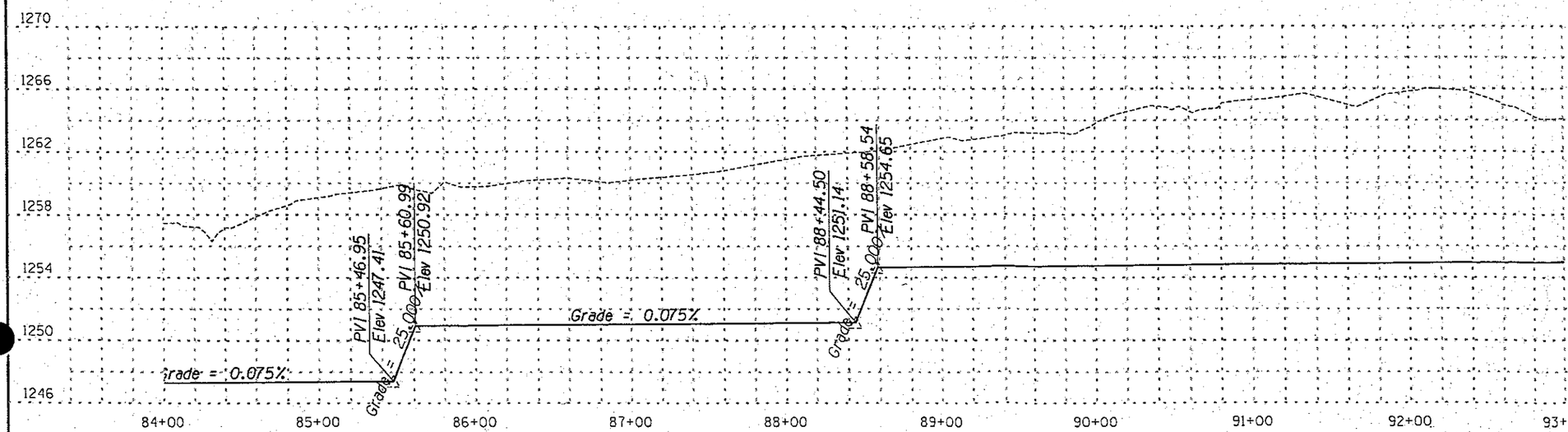
	BY	DATE
DESIGNED	ACC	12/04
DRAWN	KMA	12/04
CHECKED	JKK	12/04

KIRKHAM MICHAEL

DRAWING NO.

SHEET OF XXX





REMOVE

CONSTRUCT

SHEET INDEX MAP

NO.	REVISION	BY	DATE
3			
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

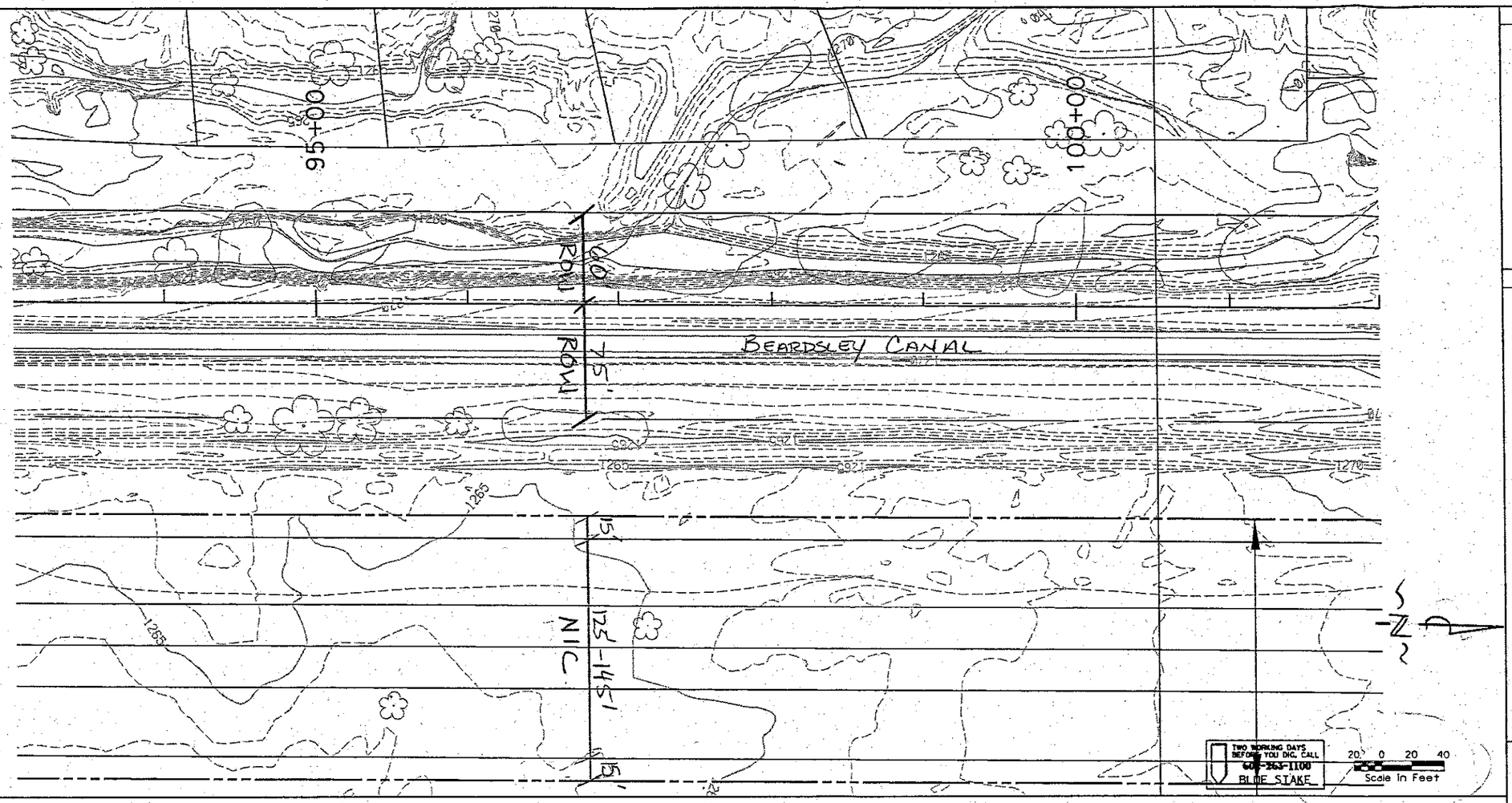
NORTH INLET FLOODWAY
NORTH INLET CHANNEL
PROJECT CONTROL NO. XXX-XX-XX

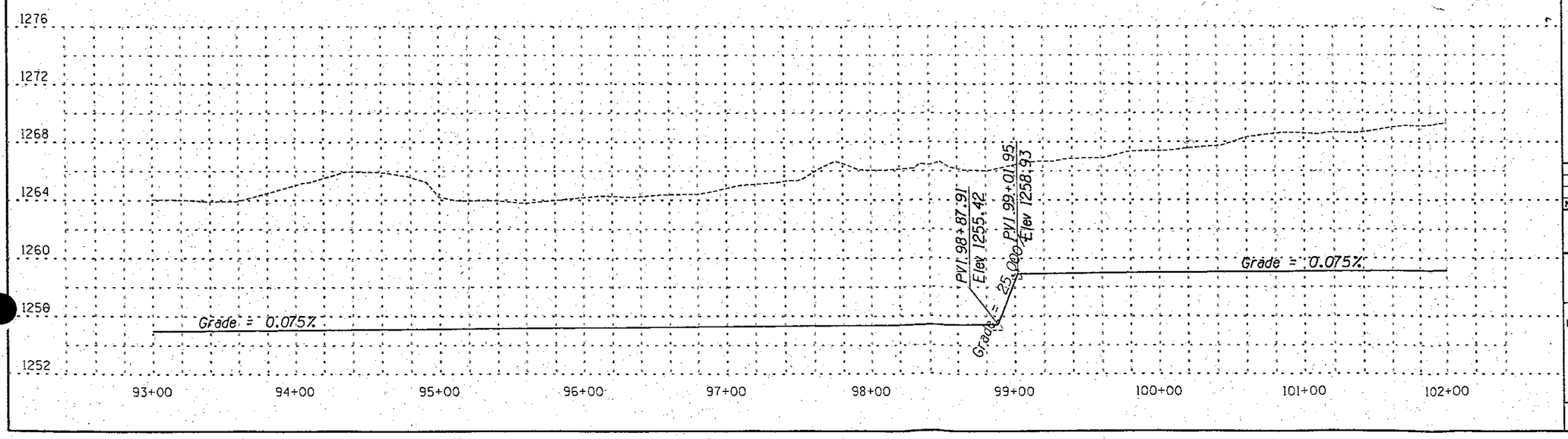
		BY	DATE
REFER TO PHASE CONSTRUCTION PLANS. SEE NOTE ON COVER	DESIGNED	ACC	12/04
	DRAWN	KMA	12/04
	CHECKED	JKK	12/04

KIRKHAM MICHAEL

DRAWING NO.

SHEET OF XXX





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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NORTH INLET FLOODWAY
NORTH INLET CHANNEL
PROJECT CONTROL NO. XXX-XX-XX

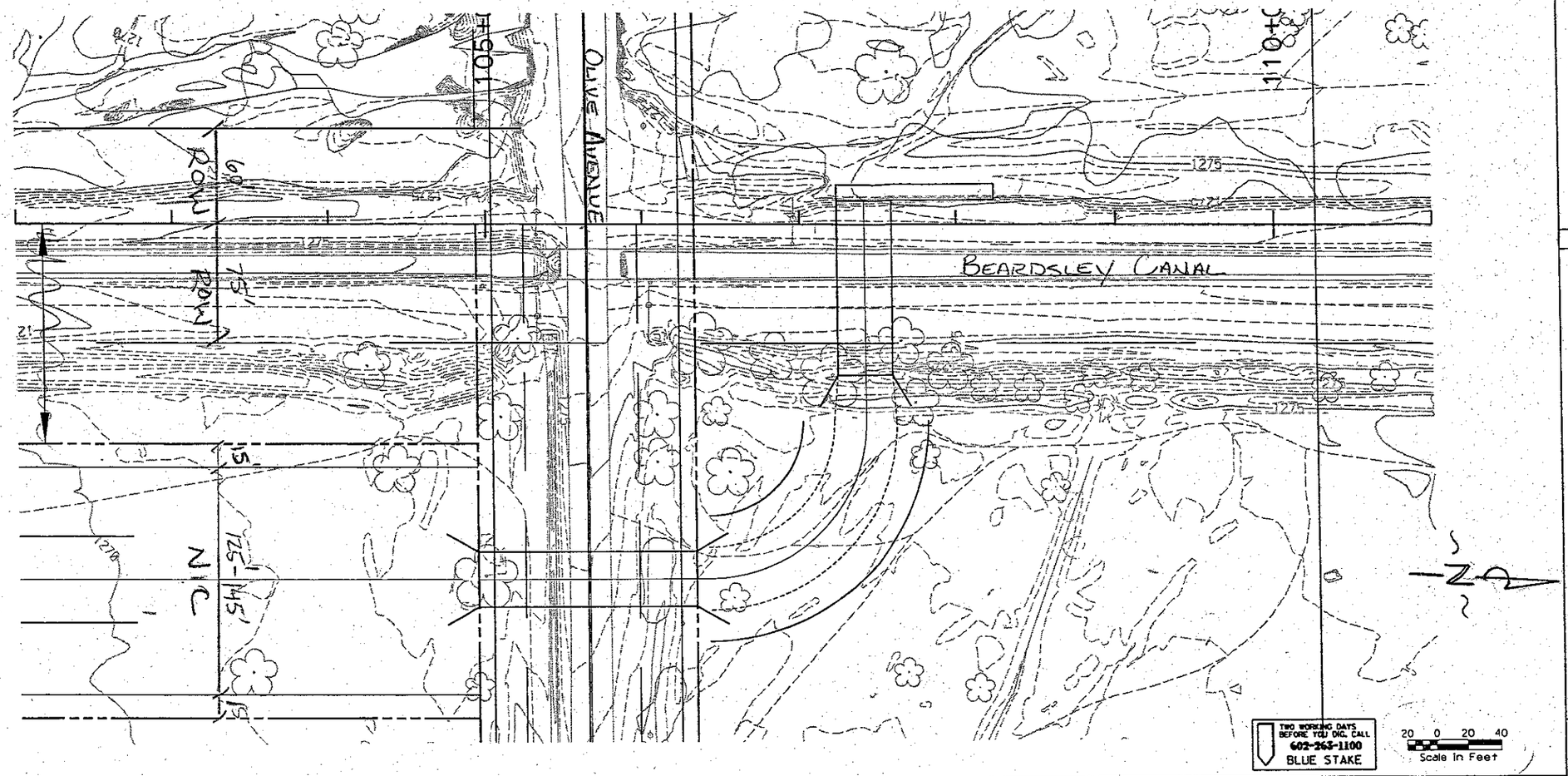
REFER TO PHASE CONSTRUCTION PLANS. SEE NOTE ON COVER

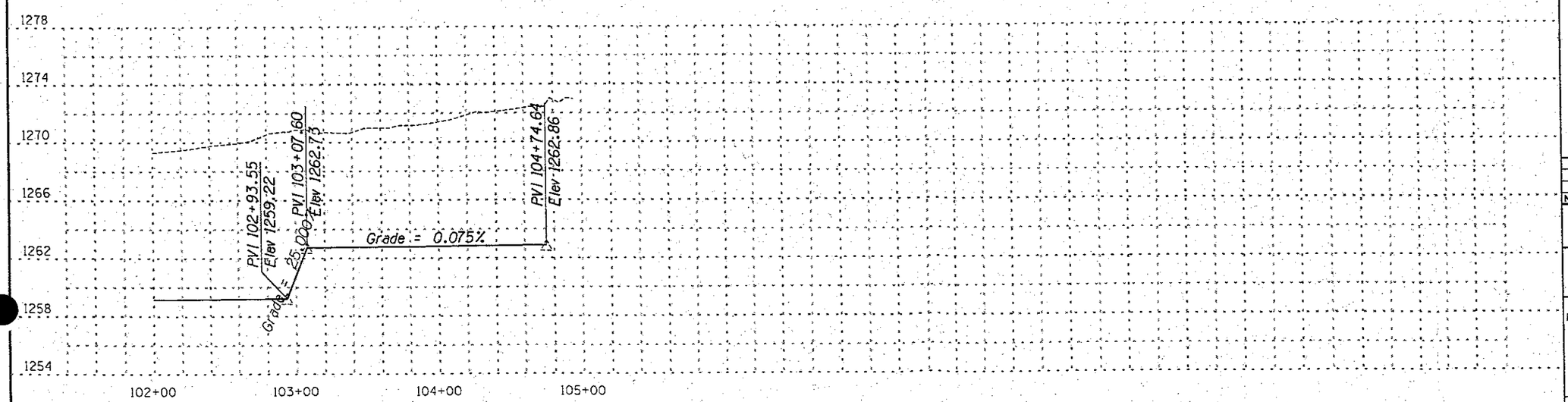
	BY	DATE
DESIGNED	ACC	12/04
DRAWN	KMA	12/04
CHECKED	JKK	12/04

KIRKHAM MICHAEL

DRAWING NO.

SHEET OF XXX





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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NORTH INLET FLOODWAY
NORTH INLET CHANNEL
PROJECT CONTROL NO. XXX-XX-XX

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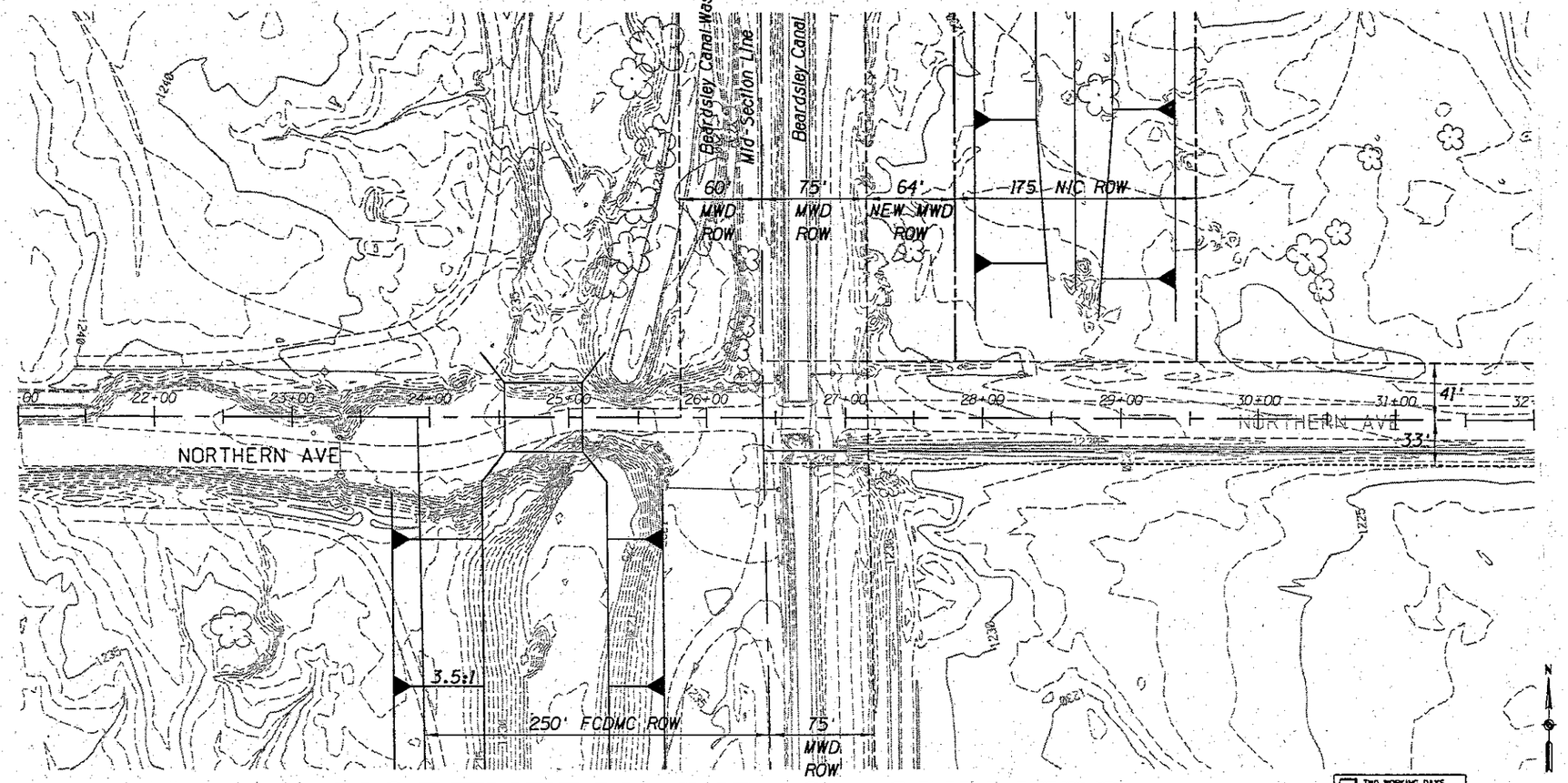
DRAWING NO.

SHEET OF XXX

APPENDIX G – NORTHERN AVENUE WASH CROSSING ANALYSIS

Included in Appendix G

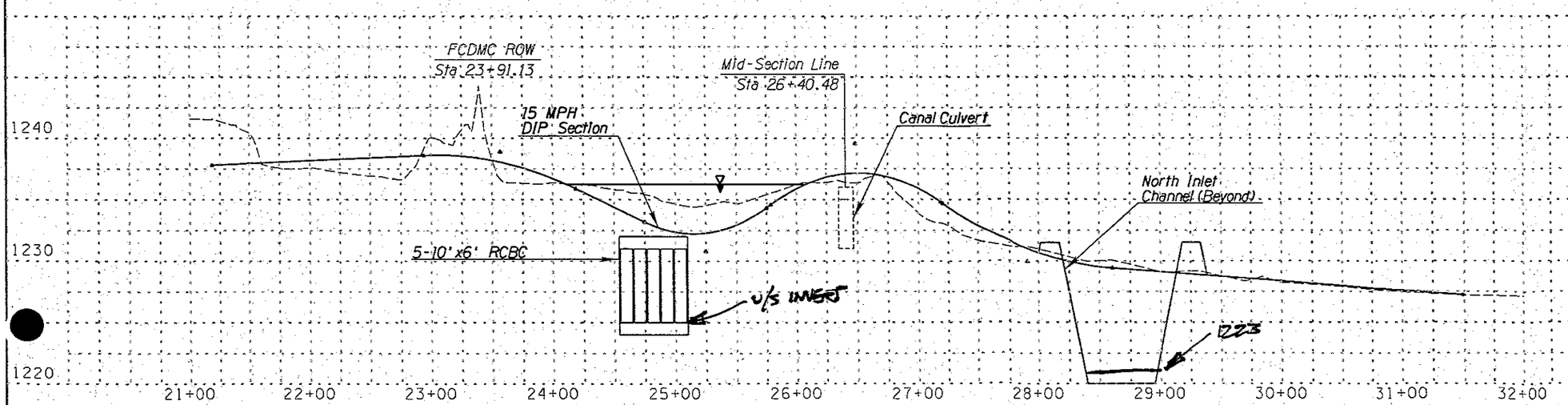
- Dip section with culvert alternative
  - Northern Avenue cross-section
  - Beardsley Canal Wash profile
  - HECRas report including wash cross-sections, profile of water elevations and culvert analysis
- Culvert only alternative
- Roadway build-up
  - Cross-section of canal maintenance road
- HECRas profile of existing and proposed water elevations
- HECRas profile of water elevations after proposed excavation in FRS #3 Channel



NORTHERN DIP & CULVERT

TWO WORKING DAYS BEFORE YOU DIG, CALL 602-263-1100 BLUE STAKE

25 0 25 50
Scale in Feet



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SHEET INDEX MAP

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NORTH INLET FLOODWAY
NORTH INLET CHANNEL
PROJECT CONTROL NO. XXX-XX-XX

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KIRKHAM MICHAEL

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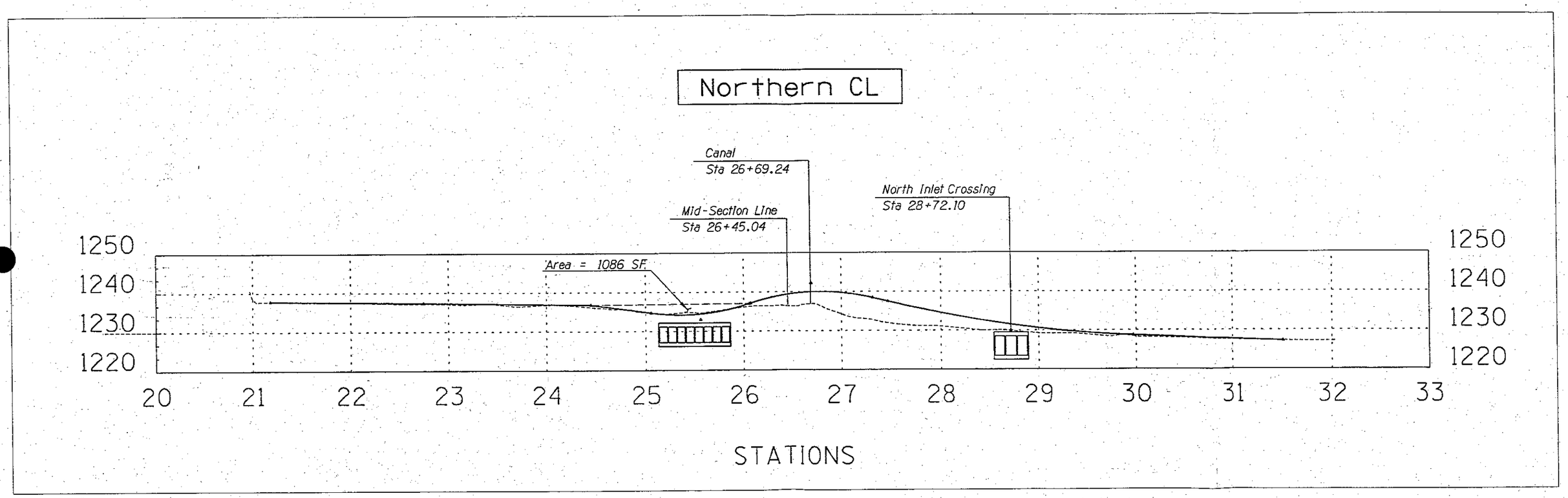
SHEET OF XXX



.../CADD/Profile/northern.dgn 10/19/2004 8:04:50 AM

Culvert Designer/Analyzer Report
Northern Dip

Analysis Component			
Storm Event	Design	Discharge	5,539.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	5,539.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	1,235.44 ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	5-10 x 6 ft Box	2,432.25 cfs	1,236.78 ft	8.11 ft/s
Weir	Roadway	3,105.74 cfs	1,236.77 ft	N/A
Total	————	5,537.99 cfs	1,236.78 ft	N/A

(cf. WITH HEC-RAS = 1236.73)

NOTE: • SAME DIP CROSSING AS HEC-RAS
• THIS CULVERT MASTER SHEET IS A BACKUP CALC TO CHECK THE HEC-RAS ANALYSIS FOR THIS OPTION.

Culvert Designer/Analyzer Report
Northern Dip

Component:Culvert-1

Culvert Summary					
Computed Headwater Elev	1,236.77	ft	Discharge	2,432.25	cfs
Inlet Control HW Elev.	1,235.44	ft	Tailwater Elevation	1,235.44	ft
Outlet Control HW Elev.	1,236.77	ft	Control Type	Outlet Control	
Headwater Depth/Height	1.80				

Grades					
Upstream Invert	1,226.00	ft	Downstream Invert	1,225.00	ft
Length	50.00	ft	Constructed Slope	0.020000	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	10.44	ft
Slope Type	N/A		Normal Depth	2.25	ft
Flow Regime	N/A		Critical Depth	4.19	ft
Velocity Downstream	8.11	ft/s	Critical Slope	0.003439	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	10.00	ft
Section Size	10 x 6 ft		Rise	6.00	ft
Number Sections	5				

Outlet Control Properties					
Outlet Control HW Elev.	1,236.77	ft	Upstream Velocity Head	1.02	ft
Ke	0.20		Entrance Loss	0.20	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,235.44	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	300.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

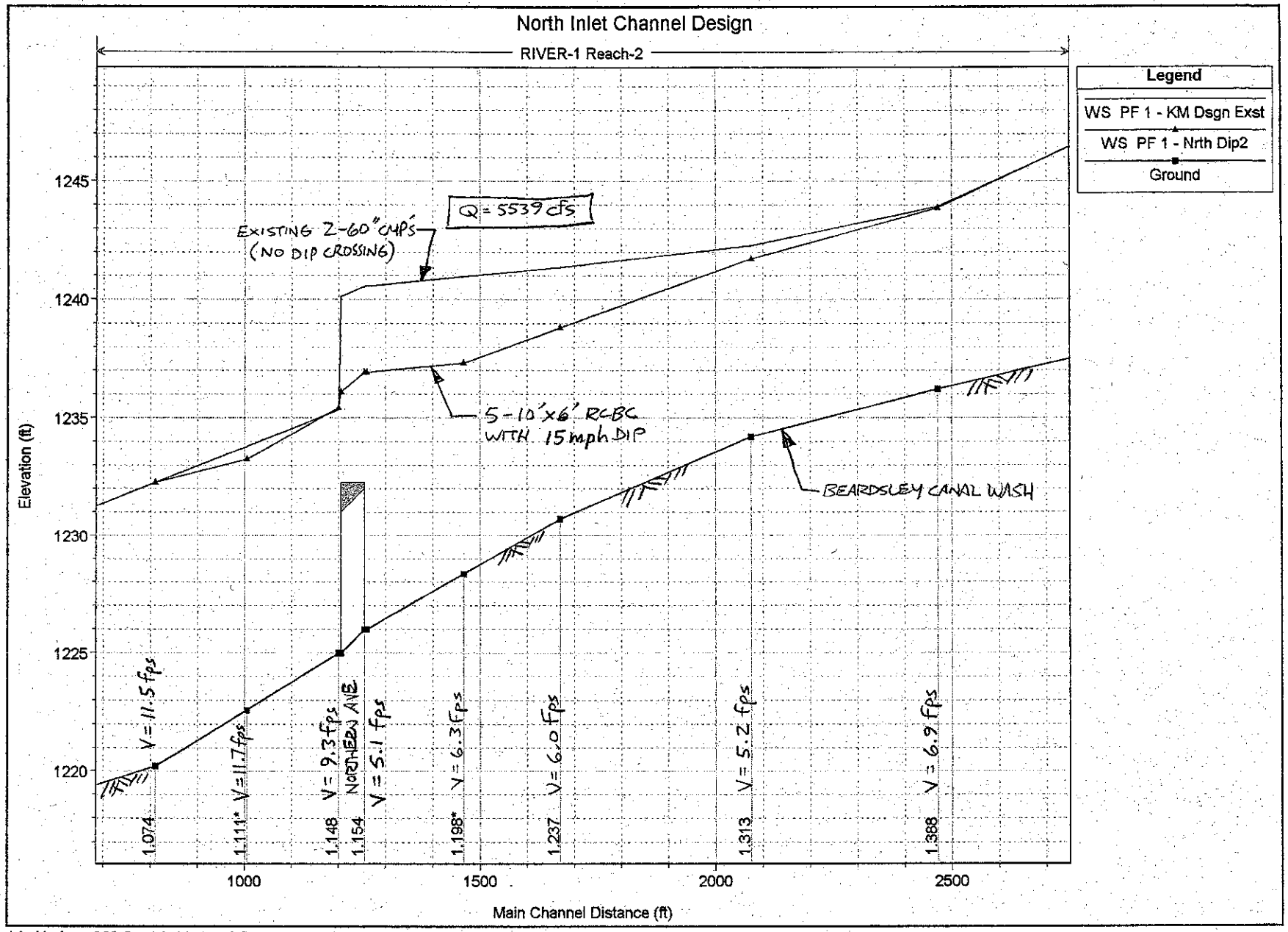
Culvert Designer/Analyzer Report
Northern Dip

Component:Weir

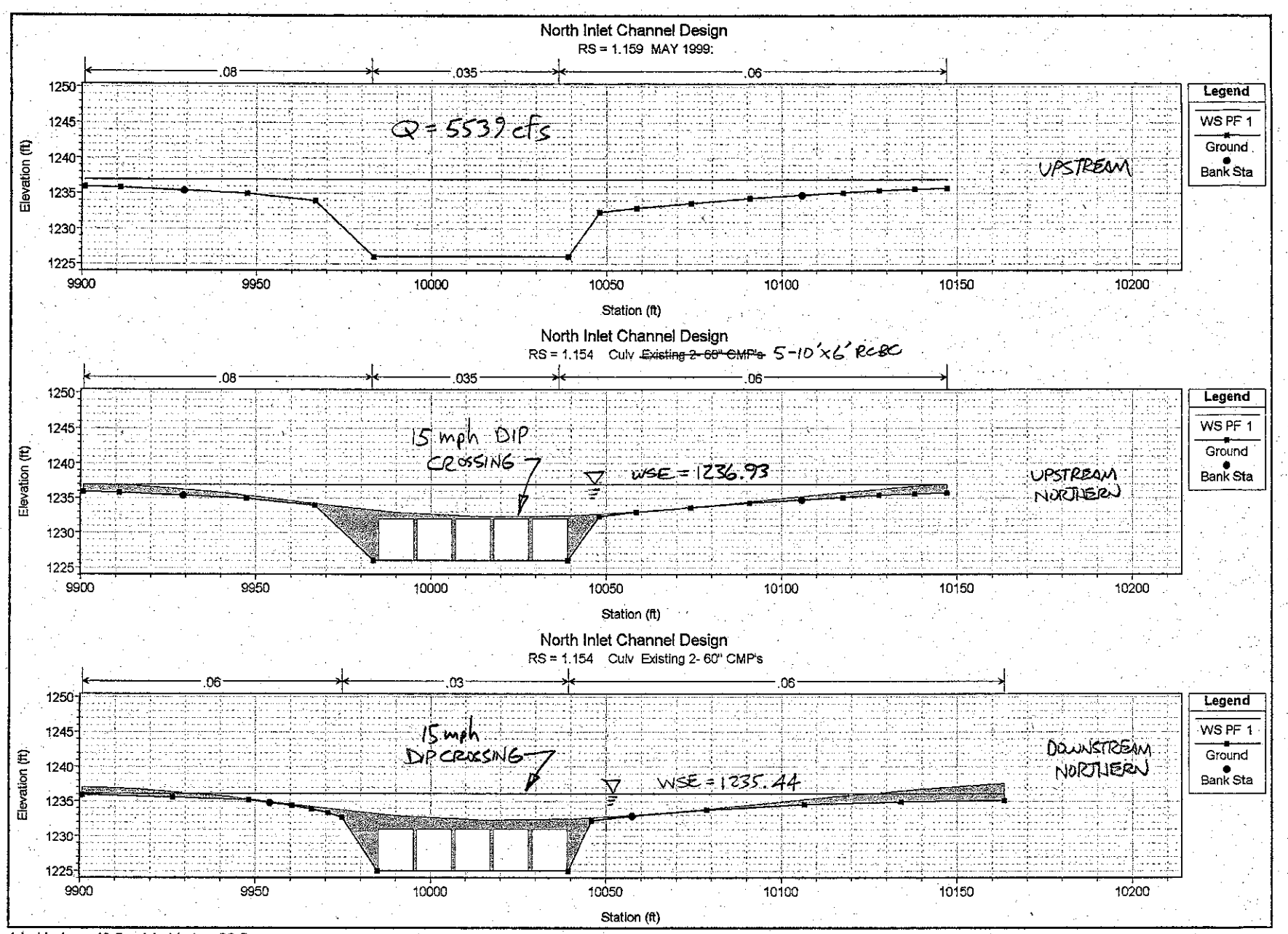
Hydraulic Component(s): Roadway					
Discharge	3,105.74	cfs	Allowable HW Elevation	1,236.77	ft
Roadway Width	50.00	ft	Overtopping Coefficient	2.96	US
Low Point	1,232.26	ft	Headwater Elevation	1,236.77	ft
Discharge Coefficient (Cr)	2.96		Submergence Factor (Kt)	1.00	
Tailwater Elevation	1,235.44	ft			

Sta (ft)	Elev. (ft)
9,865.00	1,236.85
9,890.00	1,237.13
9,915.00	1,236.79
9,940.00	1,235.83
9,965.00	1,234.26
9,990.00	1,232.89
10,015.00	1,232.26
10,040.00	1,232.38
10,065.00	1,233.23
10,090.00	1,234.43
10,115.00	1,235.64
10,140.00	1,236.75
10,165.00	1,237.61
10,190.00	1,238.21

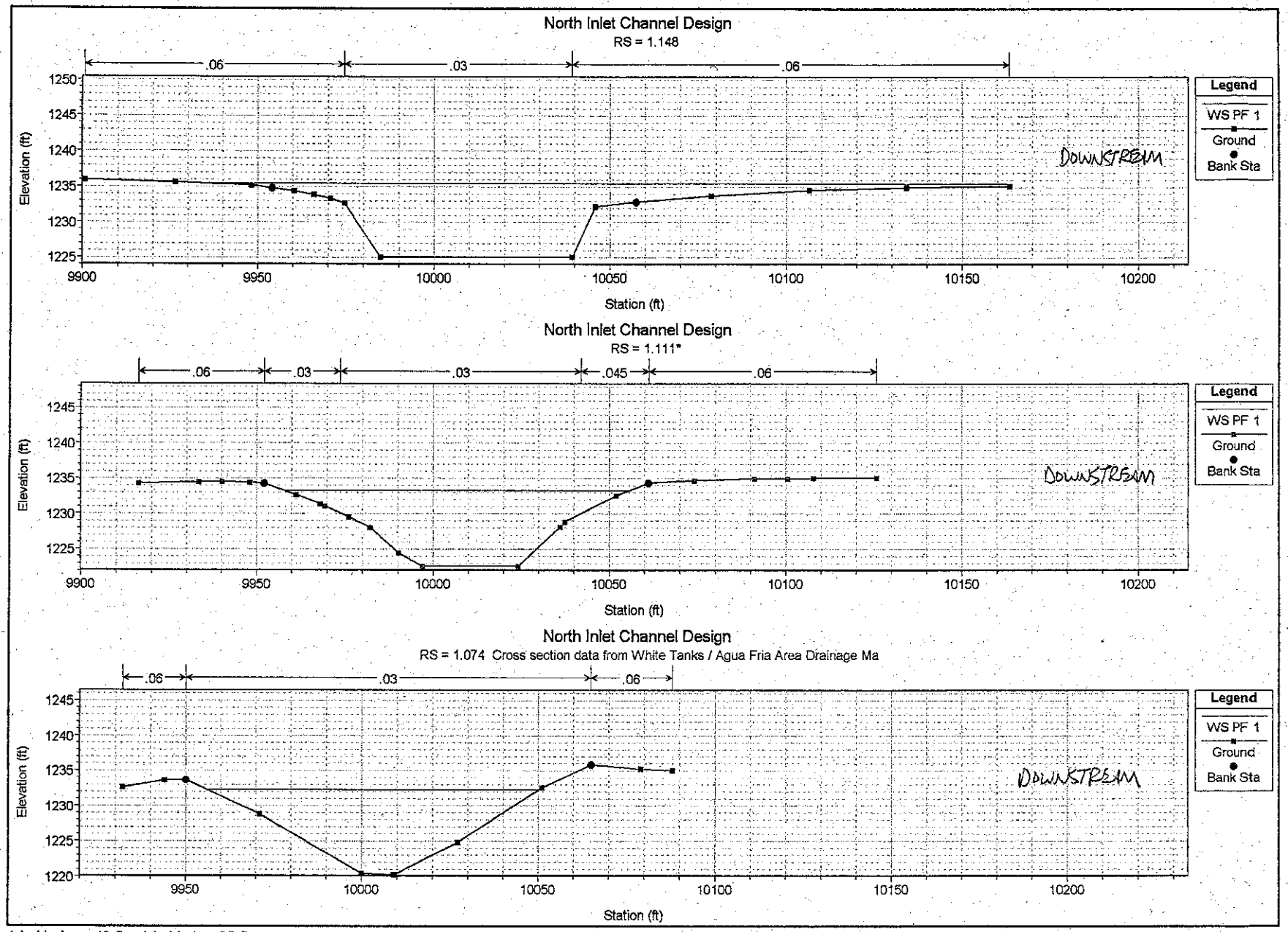
OVERTOPPING COEFFICIENT CALCULATED BY CULVERTMASTER BASED ON ROADWAY GEOMETRY



1 in Horiz. = 300 ft 1 in Vert. = 6 ft



1 in Horiz. = 40 ft 1 in Vert. = 20 ft

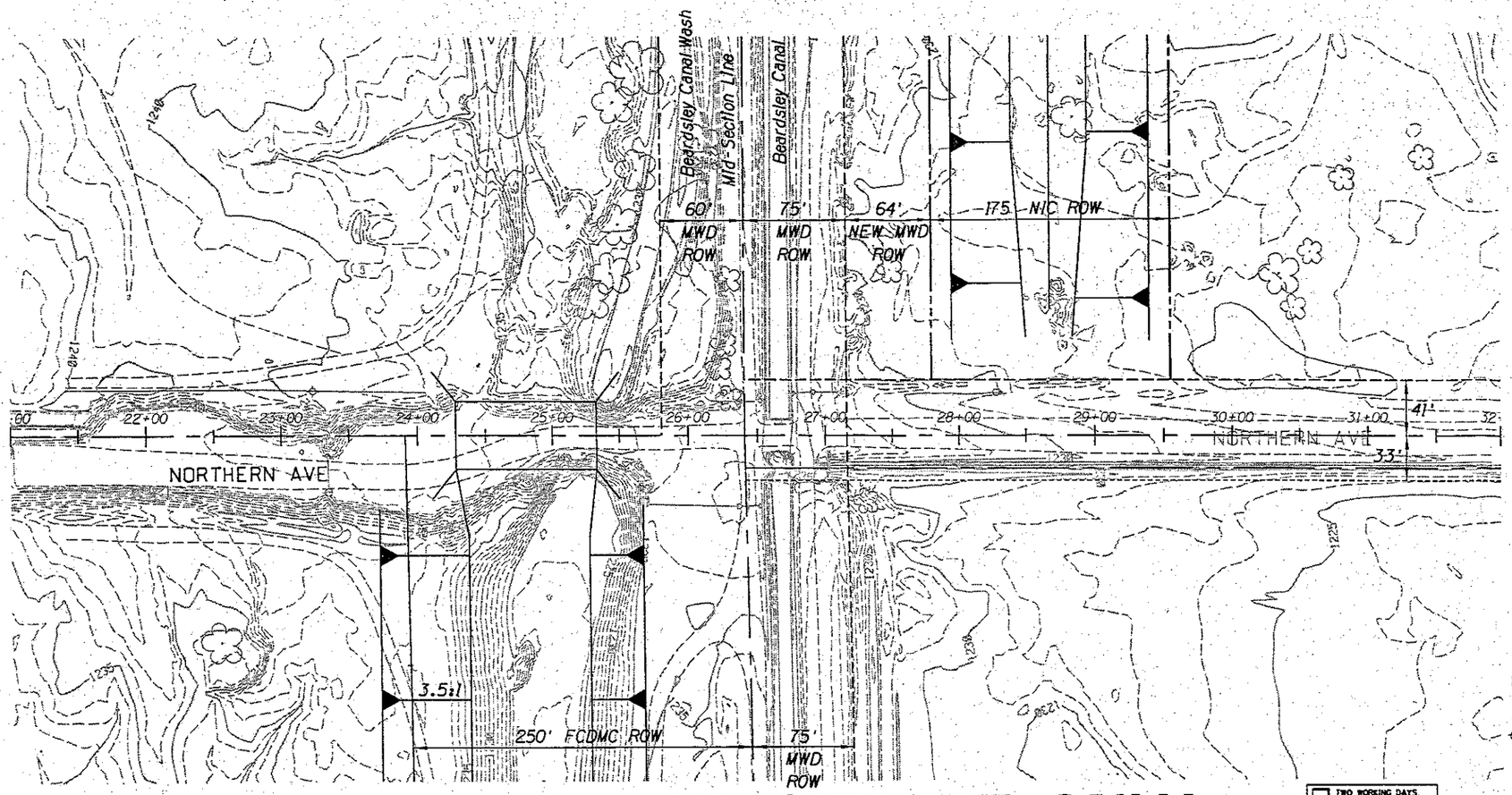


1 in Horiz. = 40 ft 1 in Vert. = 20 ft

5-10'x6' RCBC w/ DIP CROSSING @ NORTHERN AVE 15 mph

HEC-RAS Plan: Nrth Dip2 River: RIVER-1 Reach: Reach-2 Profile: PF 2

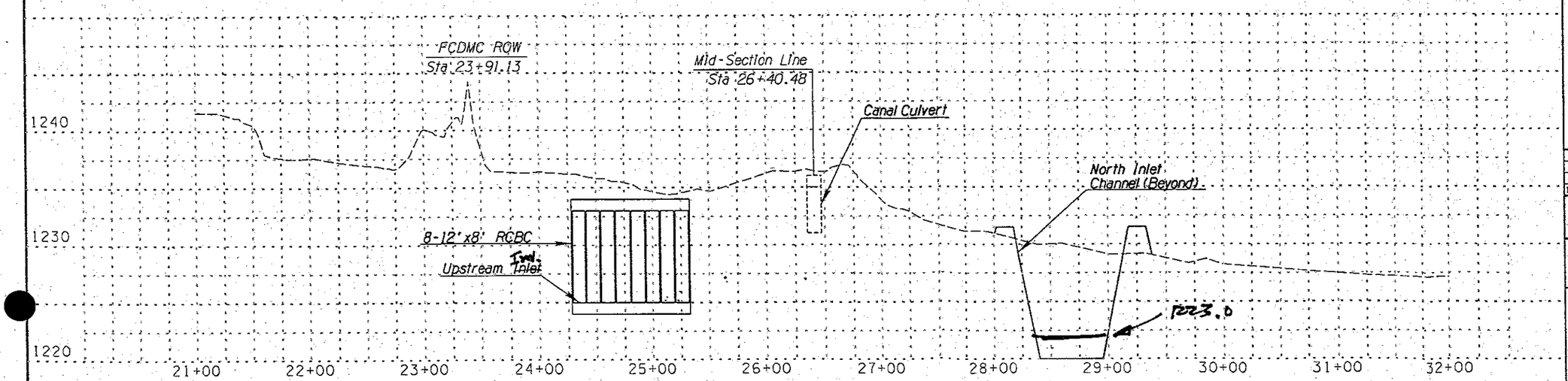
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-2	1.556	PF 2	5539.00	1241.80	1251.27	1247.49	1251.44	0.001768	3.38	1644.11	294.60	0.25
Reach-2	1.466	PF 2	5539.00	1238.10	1247.69	1247.53	1249.23	0.023930	9.97	555.48	158.07	0.94
Reach-2	1.388	PF 2	5539.00	1236.20	1243.86	1242.75	1244.59	0.006061	6.86	807.84	229.10	0.64
Reach-2	1.313	PF 2	5539.00	1234.20	1241.68		1242.10	0.006055	5.23	1079.06	253.97	0.43
Reach-2	1.237	PF 2	5539.00	1230.70	1238.83		1239.39	0.007374	6.01	922.31	214.26	0.51
Reach-2	1.198*	PF 2	5539.00	1228.34	1237.32		1237.92	0.006954	6.29	934.63	273.35	0.53
Reach-2	1.159	PF 2	5539.00	1225.98	1236.93	1232.28	1237.33	0.001333	5.10	1167.19	246.31	0.37
Reach-2	1.154		Culvert									
Reach-2	1.148	PF 2	7139.00	1224.98	1235.44		1236.73	0.005498	9.27	864.64	229.11	0.61
Reach-2	1.111*	PF 2	7139.00	1222.59	1233.27		1235.38	0.005845	11.66	612.13	97.97	0.82
Reach-2	1.074	PF 2	7139.00	1220.20	1232.29		1234.34	0.004582	11.50	620.60	94.30	0.79
Reach-2	0.998	PF 2	7139.00	1217.60	1229.00	1229.00	1231.85	0.008345	13.54	527.43	92.06	1.00
Reach-2	0.92	PF 2	7776.00	1214.50	1225.35	1223.38	1226.00	0.002556	7.10	1263.42	257.36	0.54



NORTHERN WASH CULVERT ONLY

TWO WORKING DAYS BEFORE YOU DIG, CALL 602-263-1100 BLUE STAKE

25 0 25 50
Scale in Feet



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CONSTRUCT

SHEET INDEX MAP

NO.	REVISION	BY	DATE
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NORTH INLET FLOODWAY
NORTH INLET CHANNEL
PROJECT CONTROL NO. XXX-XX-XX

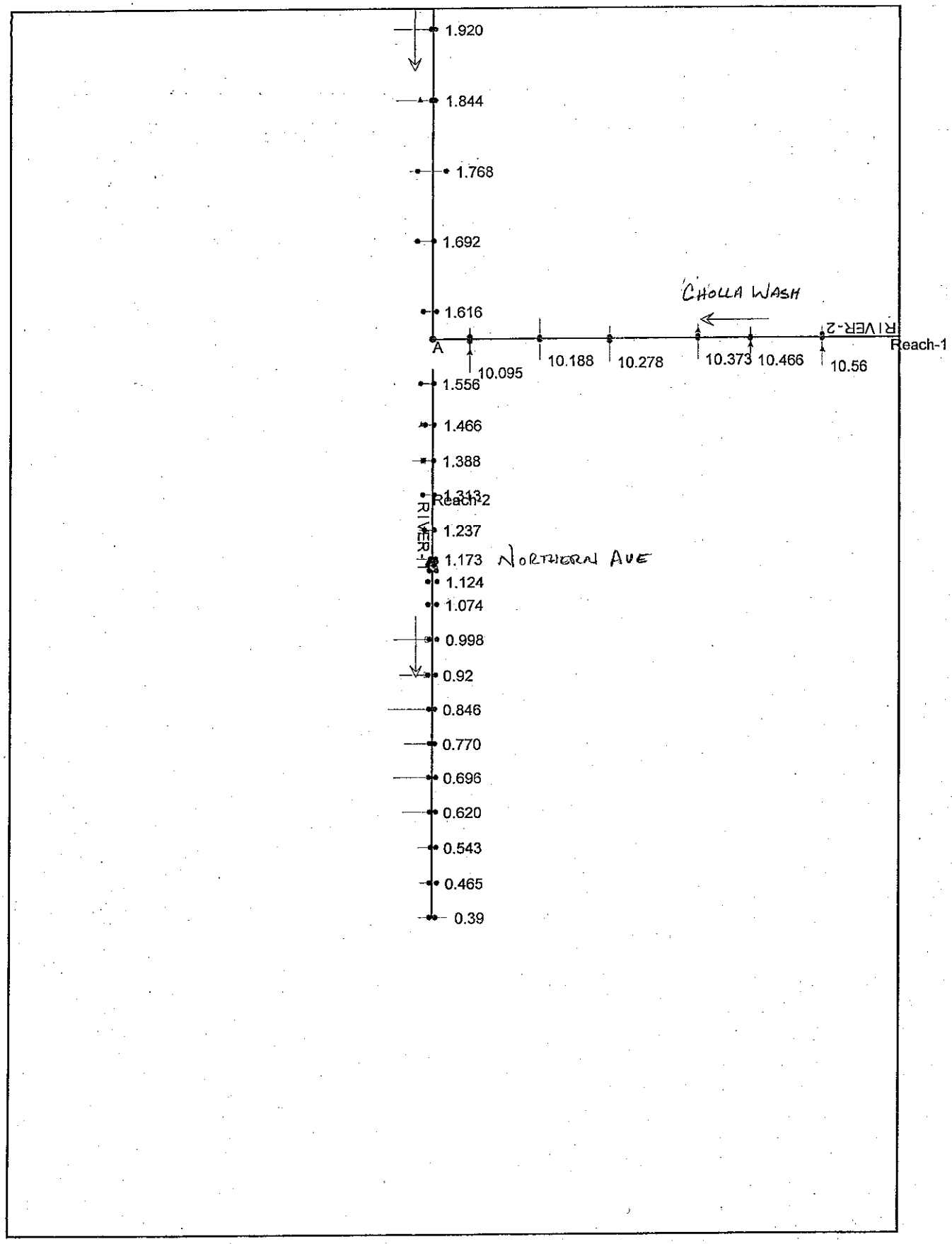
		BY	DATE
REFER TO PHASE CONSTRUCTION PLANS. SEE NOTE ON COVER	DESIGNED	ACC	12/04
	DRAWN	KMA	12/04
	CHECKED	JKK	12/04

KIRKHAM MICHAEL

DRAWING NO.

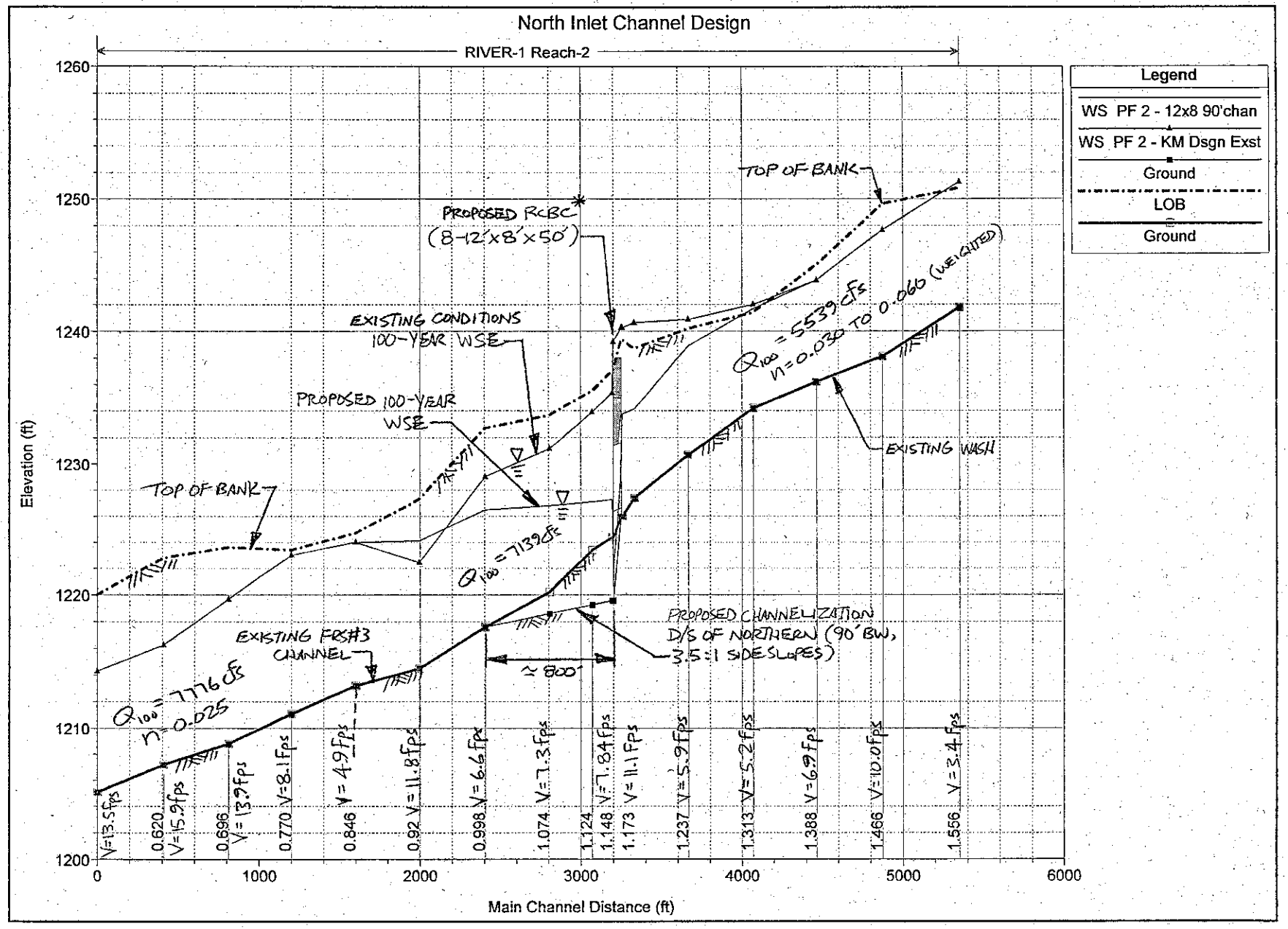
SHEET OF XXX

HEC-RAS RIVER STATIONING



NORTHERN AVENUE
BEARDSLEY WASH CROSSING

8-12'x8' RCBC & 90' BW CHANNELIZATION
CF. WITH EXISTING CONDITIONS



* DROP INLET OR BROKEN BACK TYPE

NORTHERN AVENUE
BEARDSLEY WASH CROSSING

PROPOSED CONDITIONS
LARGE BOX CULVERT AT NORTHERN, 90' BW CHANNELIZATION FOR 800' SOUTH OF NORTHERN

VS.

EXISTING CONDITIONS
2-60" CMP'S, NO CHANNELIZATION

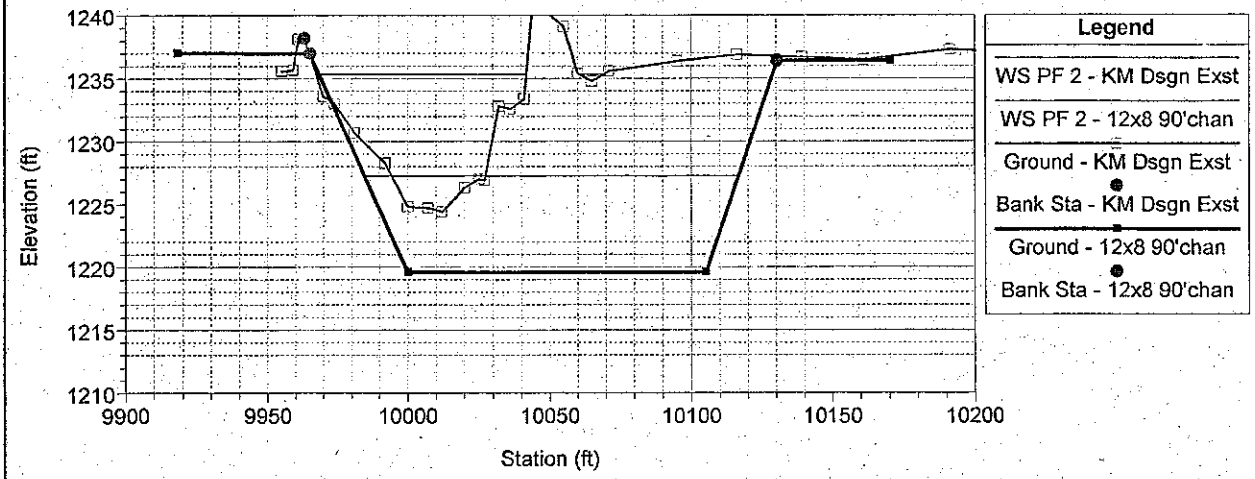
HEC-RAS River: RIVER-1 Reach: Reach-2 Profile: PF 2

Reach	River Sta	Profile	Plan	Q Total	Length Chnl	Mann Wtd Chnl	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)		(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-2	1.556	PF 2	12x8 90'chan	5539.00	475.00	0.058	1241.80	1251.27	9.47	1247.49	1251.44	0.001768	3.38	1644.14	294.60	0.25
Reach-2	1.556	PF 2	KM Dsgn Exst	5539.00	475.00	0.058	1241.80	1251.27	9.47	1247.49	1251.45	0.001766	3.37	1644.79	294.61	0.25
Reach-2	1.466	PF 2	12x8 90'chan	5539.00	410.00	0.052	1238.10	1247.69	9.59	1247.53	1249.23	0.023936	9.97	555.43	158.06	0.94
Reach-2	1.466	PF 2	KM Dsgn Exst	5539.00	410.00	0.052	1238.10	1247.67	9.57	1247.53	1249.23	0.024184	10.01	553.33	157.81	0.94
Reach-2	1.388	PF 2	12x8 90'chan	5539.00	395.00	0.043	1236.20	1243.86	7.66	1242.75	1244.59	0.006060	6.86	807.93	229.10	0.64
Reach-2	1.388	PF 2	KM Dsgn Exst	5539.00	395.00	0.043	1236.20	1243.87	7.67	1242.75	1244.59	0.006004	6.83	810.75	229.32	0.64
Reach-2	1.313	PF 2	12x8 90'chan	5539.00	405.00	0.060	1234.20	1241.67	7.47		1242.09	0.006100	5.24	1076.55	253.97	0.43
Reach-2	1.313	PF 2	KM Dsgn Exst	5539.00	405.00	0.060	1234.20	1242.00	7.80		1242.37	0.004812	4.88	1160.81	253.97	0.39
Reach-2	1.237	PF 2	12x8 90'chan	5539.00	335.00	0.056	1230.70	1238.91	8.20		1239.45	0.006965	5.90	938.79	214.86	0.50
Reach-2	1.237	PF 2	KM Dsgn Exst	5539.00	335.00	0.056	1230.70	1240.87	10.17		1241.12	0.002037	4.03	1407.45	242.00	0.28
Reach-2	1.173	PF 2	12x8 90'chan	5539.00	75.00	0.044	1227.40	1234.13	6.73	1234.13	1235.88	0.016685	11.10	535.99	150.71	0.96
Reach-2	1.173	PF 2	KM Dsgn Exst	5539.00	75.00	0.047	1227.40	1240.64	13.24		1240.78	0.000523	3.31	1909.43	268.67	0.18
Reach-2	1.159	PF 2	12x8 90'chan	5539.00	60.00	0.030	1226.00	1233.76	7.76	1230.03	1234.21	0.000938	5.42	1021.46	147.49	0.36
Reach-2	1.159	PF 2	KM Dsgn Exst	5539.00	60.00	0.038	1226.00	1240.28	14.28	1237.26	1240.69	0.001548	5.25	1157.13	265.00	0.39
Reach-2	1.154			Culvert												
Reach-2	1.148	PF 2	12x8 90'chan	7139.00	125.00	0.025	1219.58	1227.27	7.69		1228.22	0.001377	7.84	911.07	131.93	0.53
Reach-2	1.148	PF 2	KM Dsgn Exst	7139.00	125.00	0.026	1224.40	1235.36	10.96	1235.35	1238.66	0.005715	14.58	492.01	83.29	1.00
Reach-2	1.124	PF 2	12x8 90'chan	7139.00	265.00	0.025	1219.26	1227.10	7.84		1228.04	0.001472	7.75	921.45	144.96	0.54
Reach-2	1.124	PF 2	KM Dsgn Exst	7139.00	265.00	0.025	1223.40	1233.89	10.49	1230.85	1234.93	0.001385	8.17	873.82	120.18	0.53
Reach-2	1.074	PF 2	12x8 90'chan	7139.00	400.00	0.025	1218.60	1226.82	8.22		1227.65	0.001245	7.31	976.37	147.66	0.50
Reach-2	1.074	PF 2	KM Dsgn Exst	7139.00	400.00	0.025	1220.20	1231.16	10.96	1231.09	1234.10	0.005117	13.77	518.42	85.90	0.99
Reach-2	0.998	PF 2	12x8 90'chan	7139.00	410.00	0.025	1217.60	1226.50	8.90	1222.98	1227.18	0.000907	6.64	1078.00	152.89	0.43
Reach-2	0.998	PF 2	KM Dsgn Exst	7139.00	410.00	0.027	1217.60	1229.00	11.40	1229.00	1231.85	0.006052	13.54	527.36	92.05	1.00
Reach-2	0.92	PF 2	12x8 90'chan	7139.00	395.00	0.026	1214.50	1224.11	9.61	1224.11	1226.28	0.005571	11.81	604.28	140.15	1.00
Reach-2	0.92	PF 2	KM Dsgn Exst	7139.00	395.00	0.025	1214.50	1222.46	7.96	1224.11	1227.67	0.017447	18.33	389.43	119.70	1.79
Reach-2	0.846	PF 2	12x8 90'chan	7776.00	400.00	0.025	1213.20	1224.01	10.81	1221.77	1224.23	0.000558	4.94	2967.86	781.45	0.34
Reach-2	0.846	PF 2	KM Dsgn Exst	7776.00	400.00	0.025	1213.20	1224.01	10.81	1221.77	1224.23	0.000558	4.94	2967.86	781.45	0.34
Reach-2	0.770	PF 2	12x8 90'chan	7776.00	390.00	0.025	1211.10	1223.02	11.92		1223.84	0.001422	8.11	1677.95	538.06	0.54
Reach-2	0.770	PF 2	KM Dsgn Exst	7776.00	390.00	0.025	1211.10	1223.02	11.92		1223.84	0.001422	8.11	1677.95	538.06	0.54
Reach-2	0.696	PF 2	12x8 90'chan	7776.00	400.00	0.025	1208.80	1219.68	10.88	1219.68	1222.66	0.005272	13.86	561.08	94.91	1.00
Reach-2	0.696	PF 2	KM Dsgn Exst	7776.00	400.00	0.025	1208.80	1219.68	10.88	1219.68	1222.66	0.005272	13.86	561.08	94.91	1.00
Reach-2	0.620	PF 2	12x8 90'chan	7776.00	410.00	0.025	1207.20	1216.27	9.07	1217.52	1220.02	0.007946	15.88	629.12	314.58	1.22
Reach-2	0.620	PF 2	KM Dsgn Exst	7776.00	410.00	0.025	1207.20	1216.27	9.07	1217.52	1220.02	0.007946	15.88	629.12	314.58	1.22
Reach-2	0.543	PF 2	12x8 90'chan	7776.00		0.025	1205.10	1214.30	9.20	1214.64	1216.89	0.005903	13.53	682.25	192.11	1.05
Reach-2	0.543	PF 2	KM Dsgn Exst	7776.00		0.025	1205.10	1214.30	9.20	1214.64	1216.89	0.005903	13.53	682.25	192.11	1.05

LOOKING DOWNSTREAM (SOUTH)

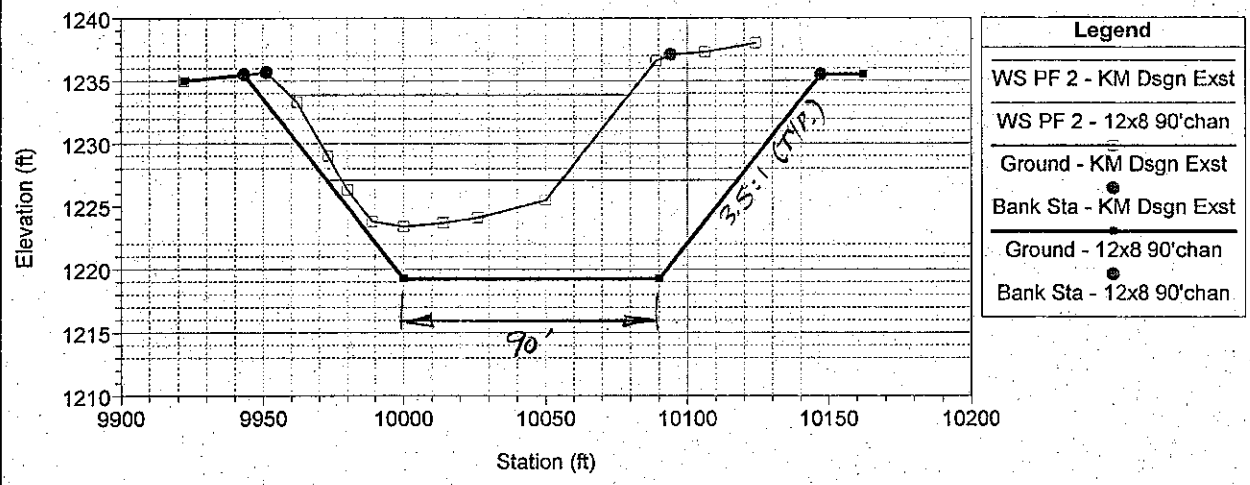
North Inlet Channel Design

RS = 1.148 Downstream side of Northern Culvert



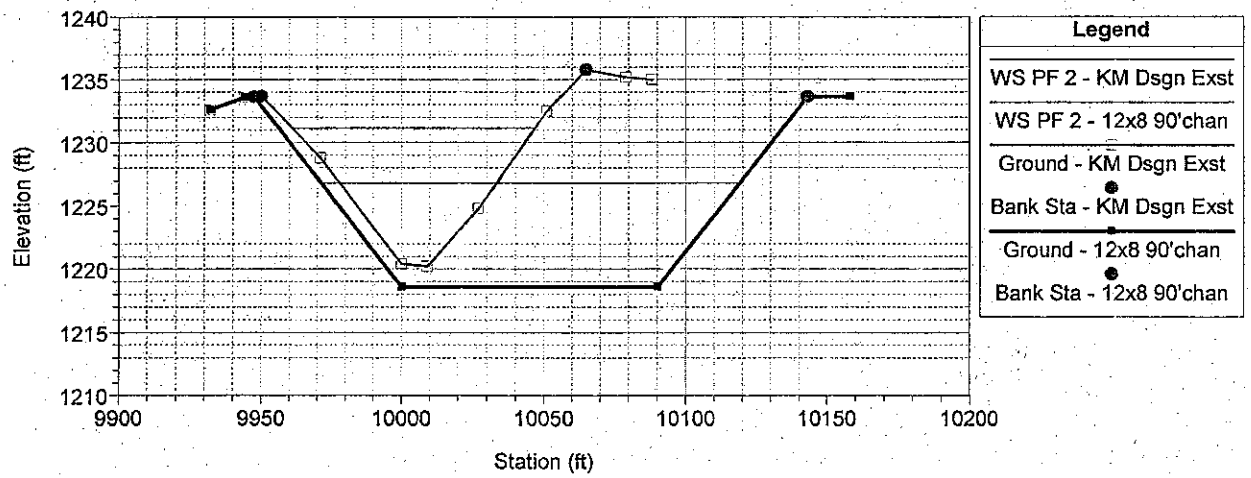
North Inlet Channel Design

RS = 1.124 Added cross section for culvert analysis



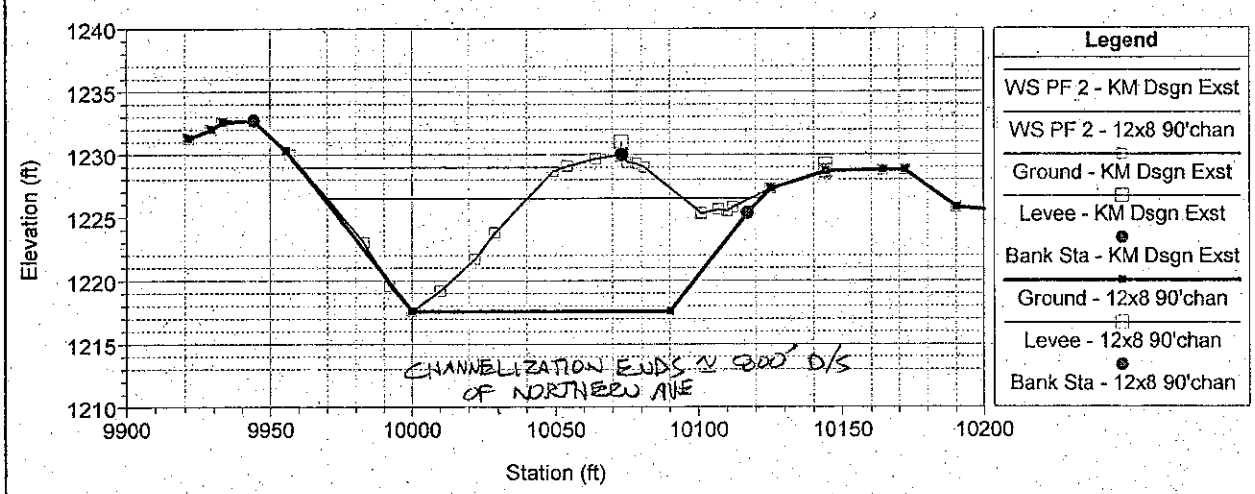
North Inlet Channel Design

RS = 1.074 Cross section data from White Tanks / Agua Fria Area Drainage Ma



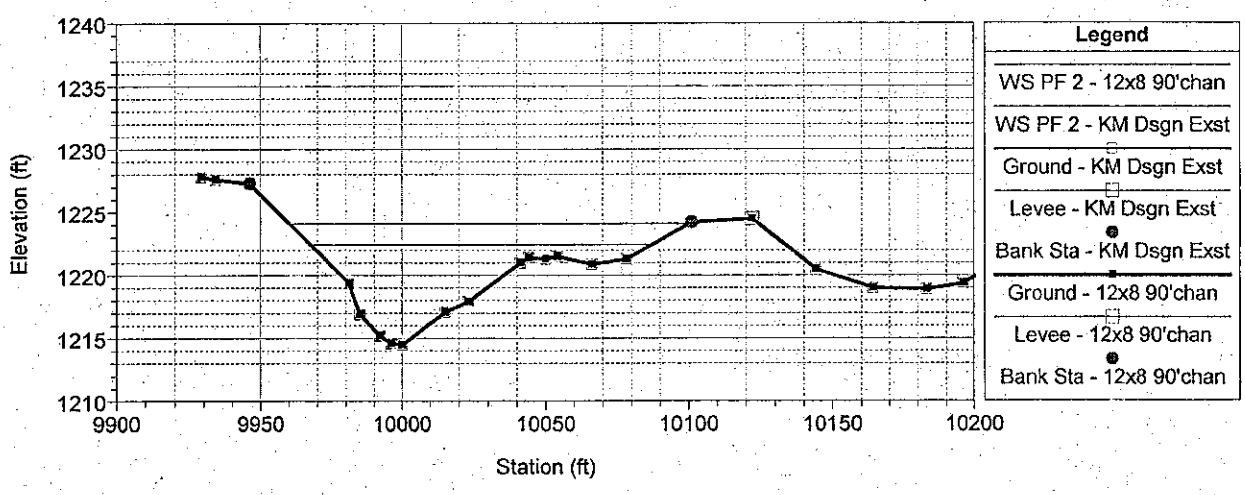
North Inlet Channel Design

RS = 0.998 Cross section data from White Tanks / Agua Fria Area Drainage Ma



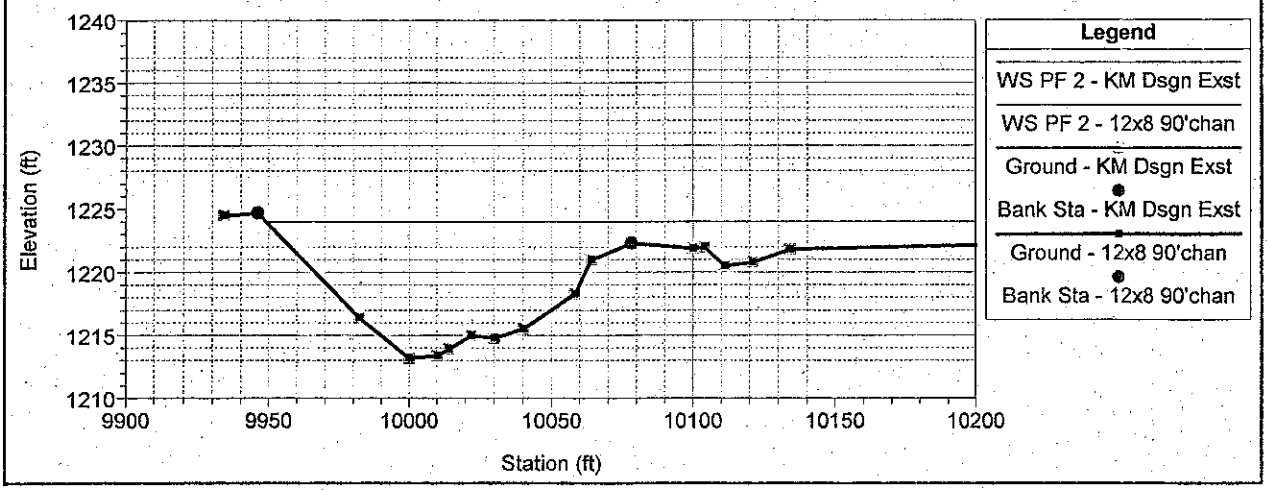
North Inlet Channel Design

RS = 0.92 Cross section data from White Tanks / Agua Fria Area Drainage Ma

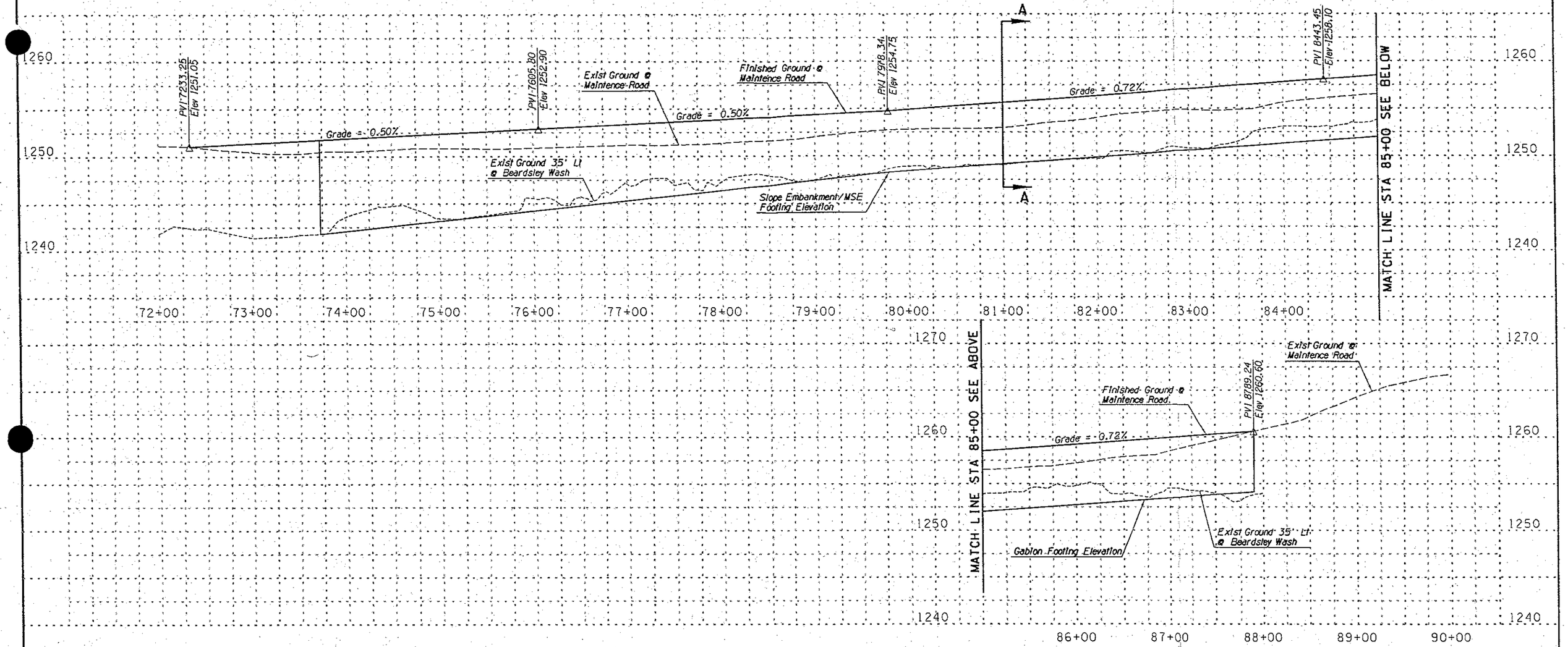


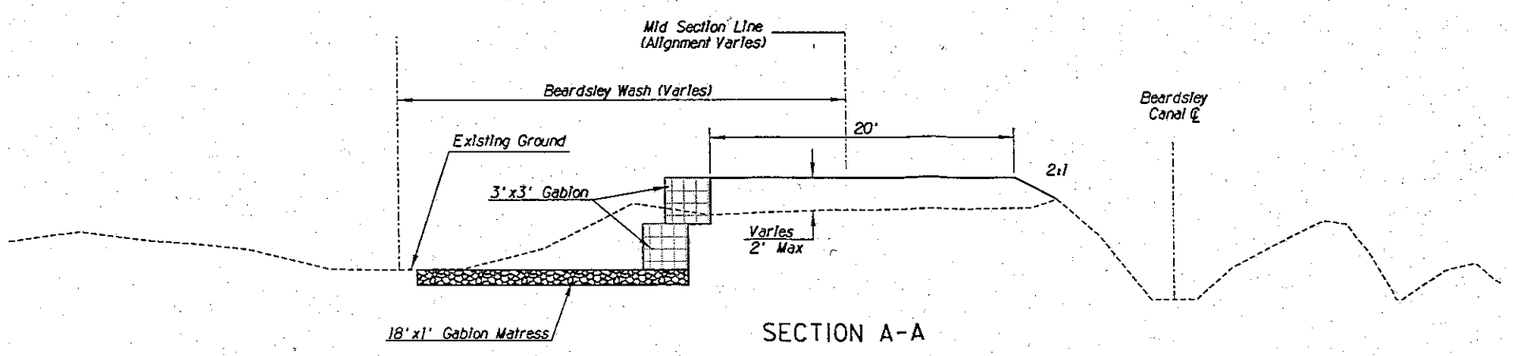
North Inlet Channel Design

RS = 0.846



MAINTENANCE ROAD IMPROVEMENTS @ CHOLLA WASH





SECTION A-A

GABIONS

NTS

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NORTH INLET FLOODWAY
NORTH INLET CHANNEL
PROJECT CONTROL NO. XXX-XX-XX

REFER TO PHASE CONSTRUCTION PLANS. SEE NOTE ON COVER

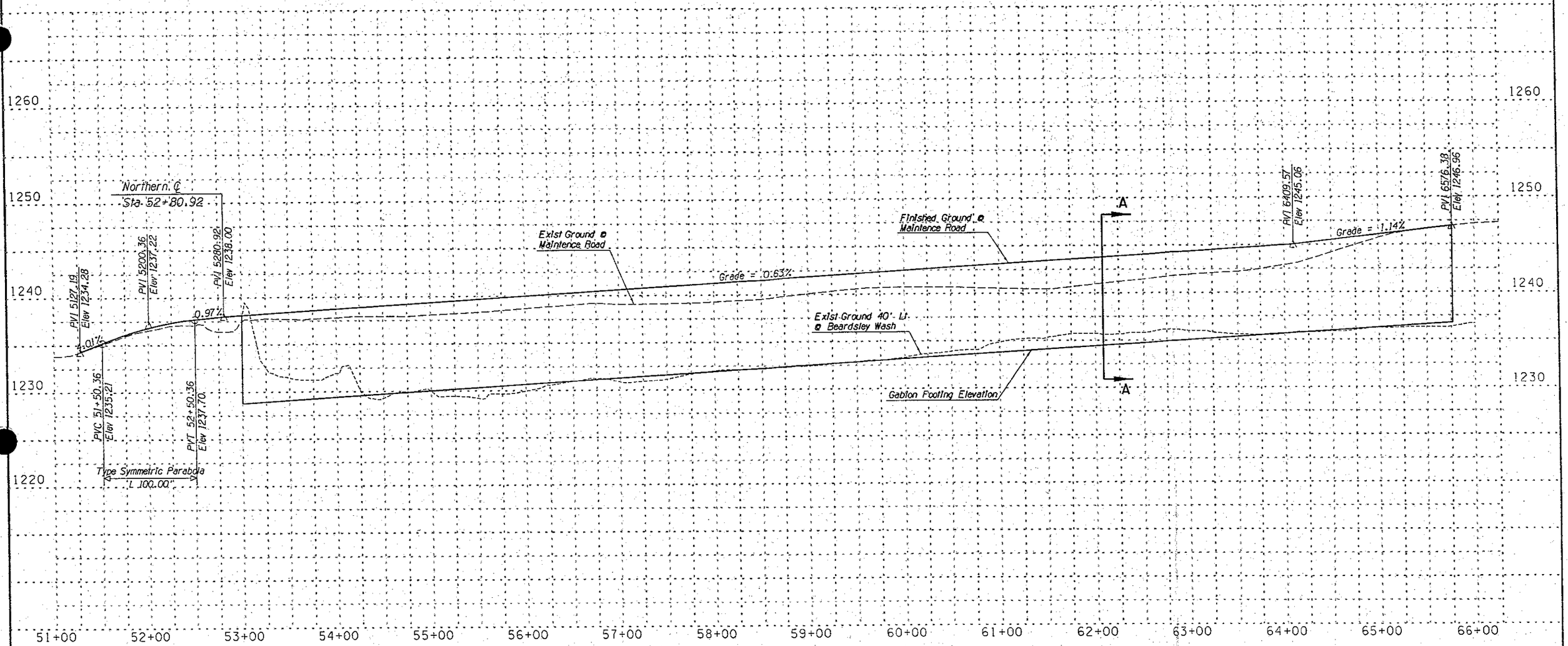
	BY	DATE
DESIGNED	ACC	10/04
DRAWN	KMA	10/04
CHECKED	JKK	10/04

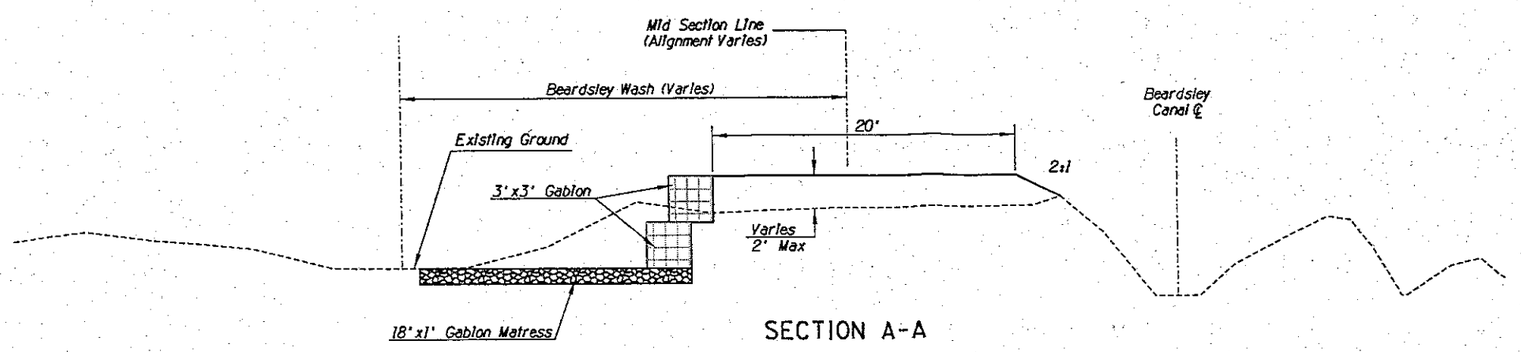
KIRKHAM MICHAEL

DRAWING NO.

SHEET OF

MAINTENANCE ROAD IMPROVEMENTS @ NORTHERN





SECTION A-A

GABIONS

NTS

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NORTH INLET FLOODWAY
NORTH INLET CHANNEL
PROJECT CONTROL NO. XXX-XX-XX

REFER TO PHASE CONSTRUCTION PLANS. SEE NOTE ON COVER

	BY	DATE
DESIGNED	ACC	10/04
DRAWN	KMA	10/04
CHECKED	JKK	10/04

KIRKHAM MICHAEL

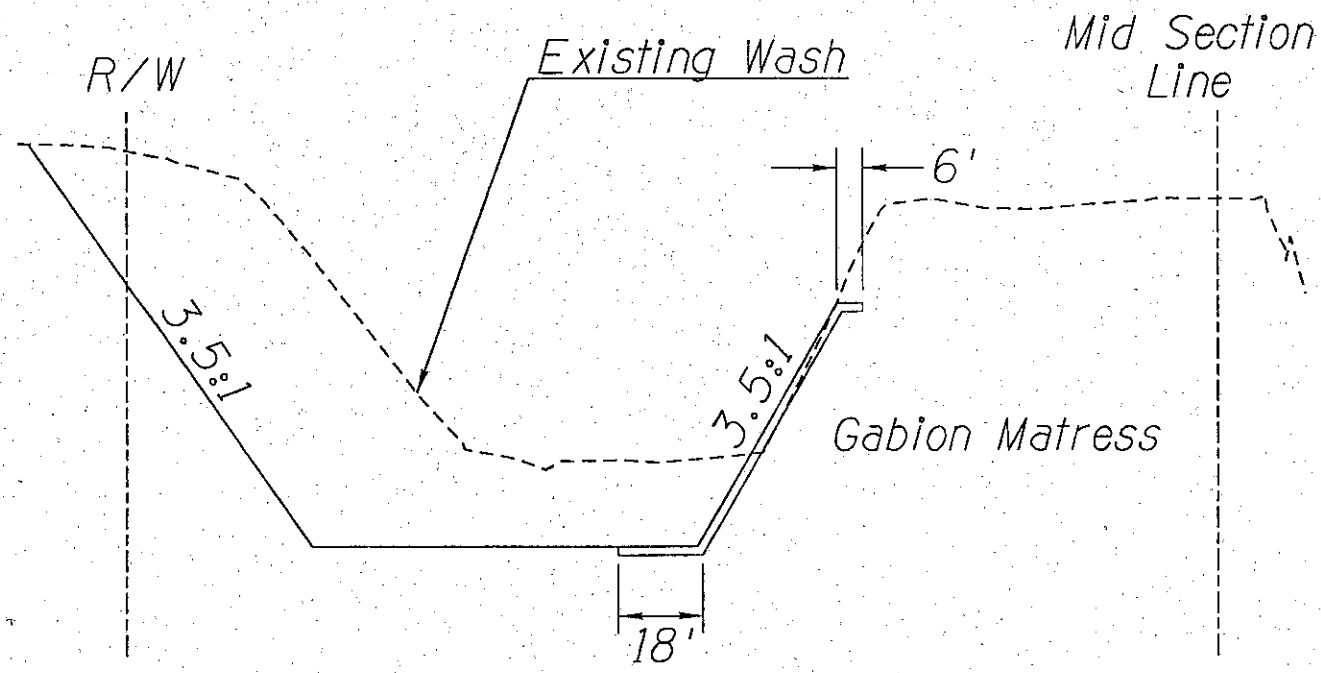
DRAWING NO. ----

SHEET OF

APPENDIX H – FRS #3 CHANNEL

Included in Appendix H

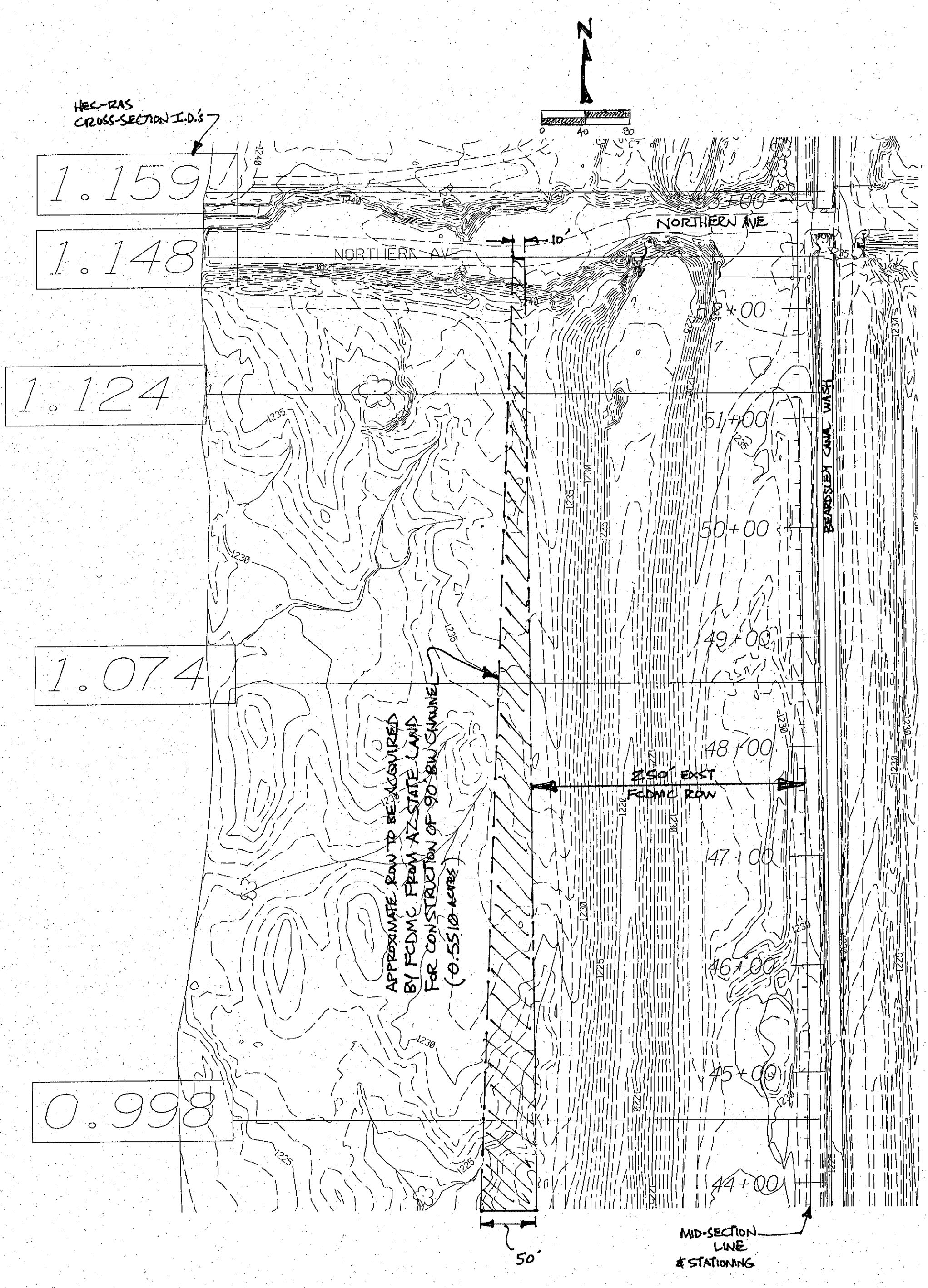
- Map showing approximate R-O-W acquisition
- Cross-section of existing and proposed FRS #3 Channel

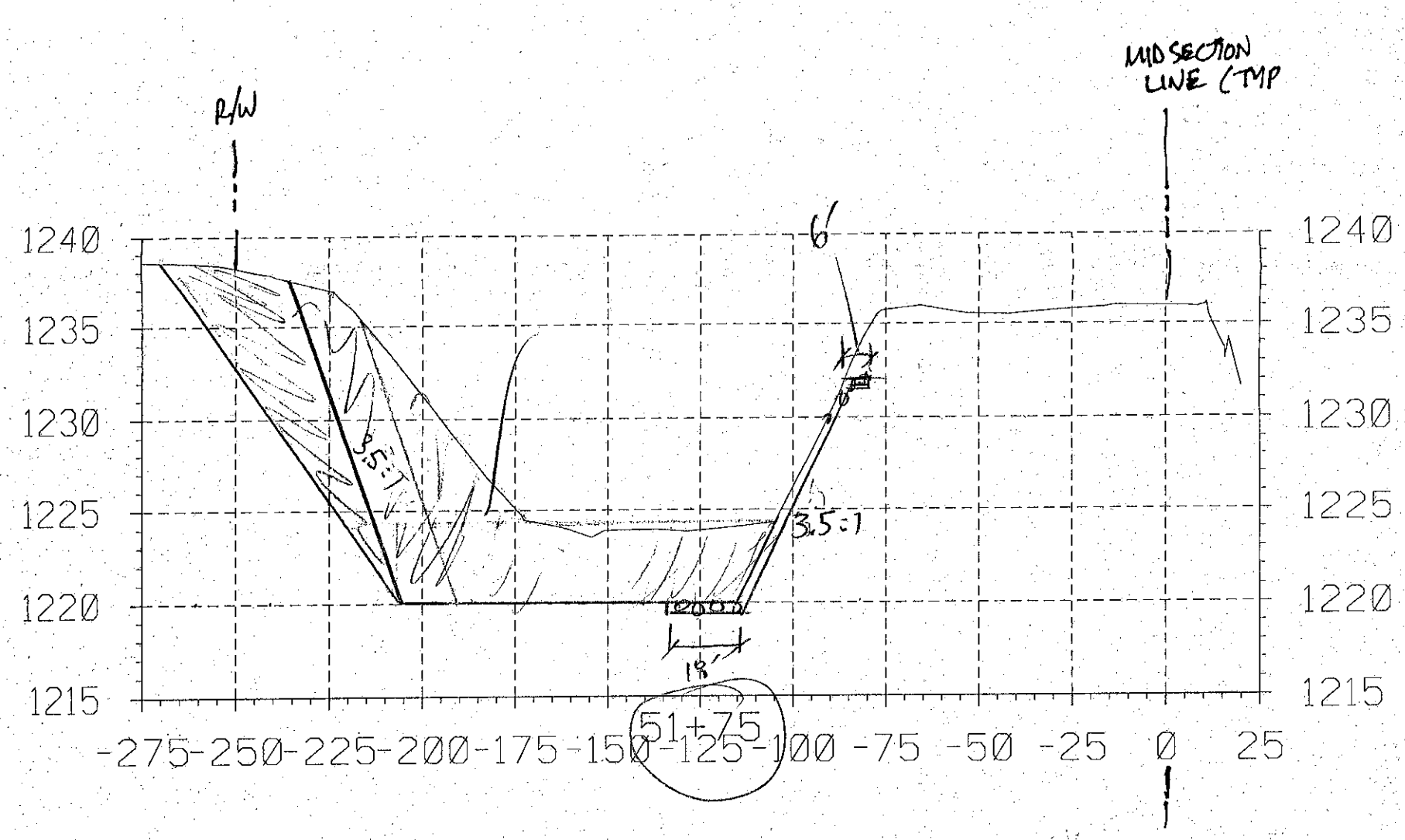


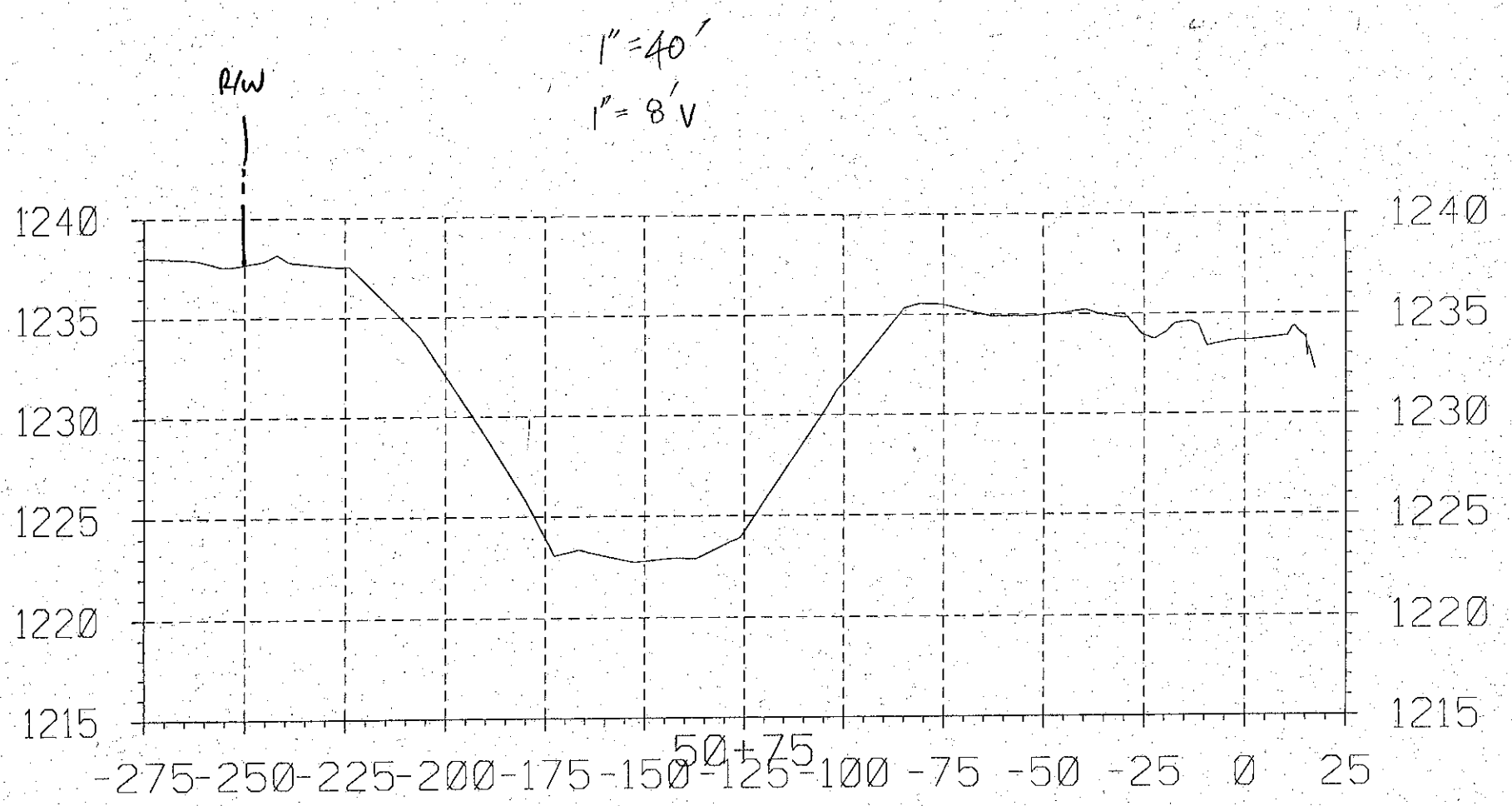
KIRKHAM MICHAEL
CONSULTING ENGINEERS

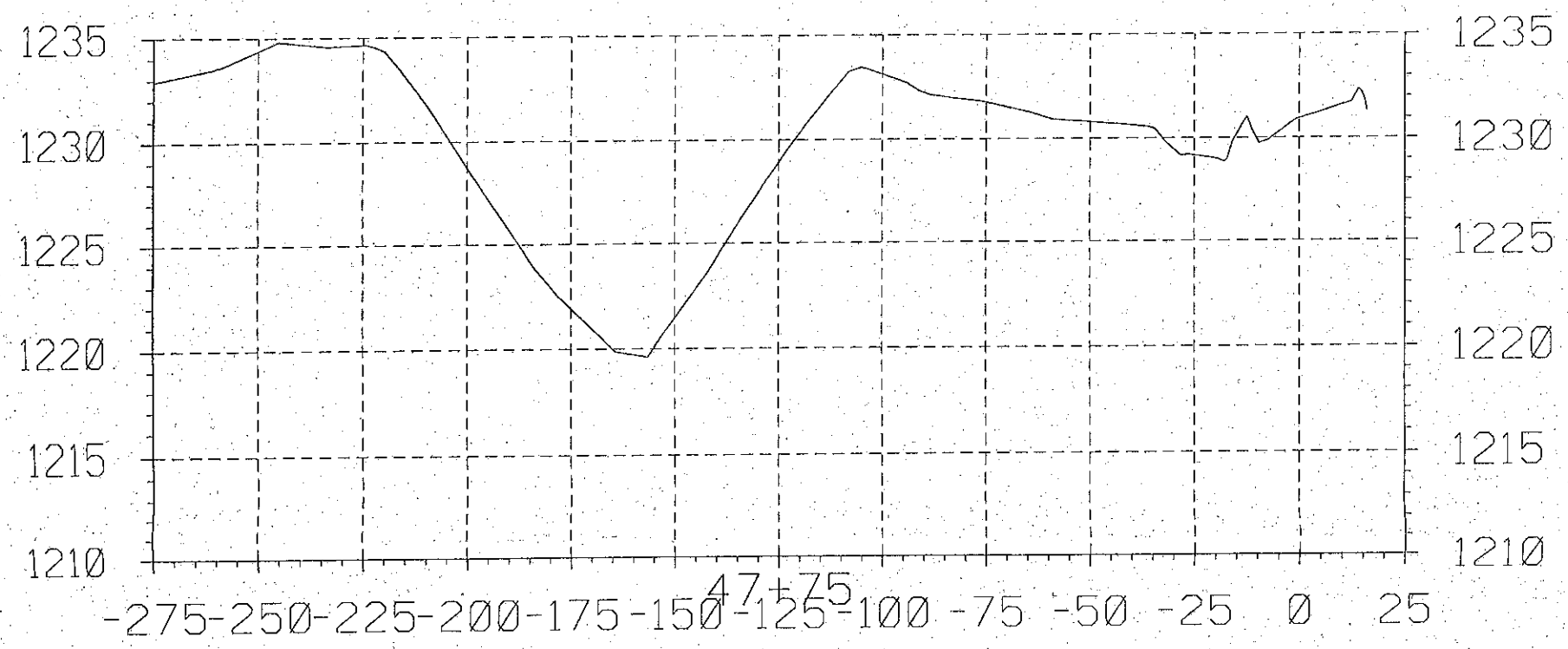
FRS Channel Bank Protection
Typical Section
(Looking Upstream)

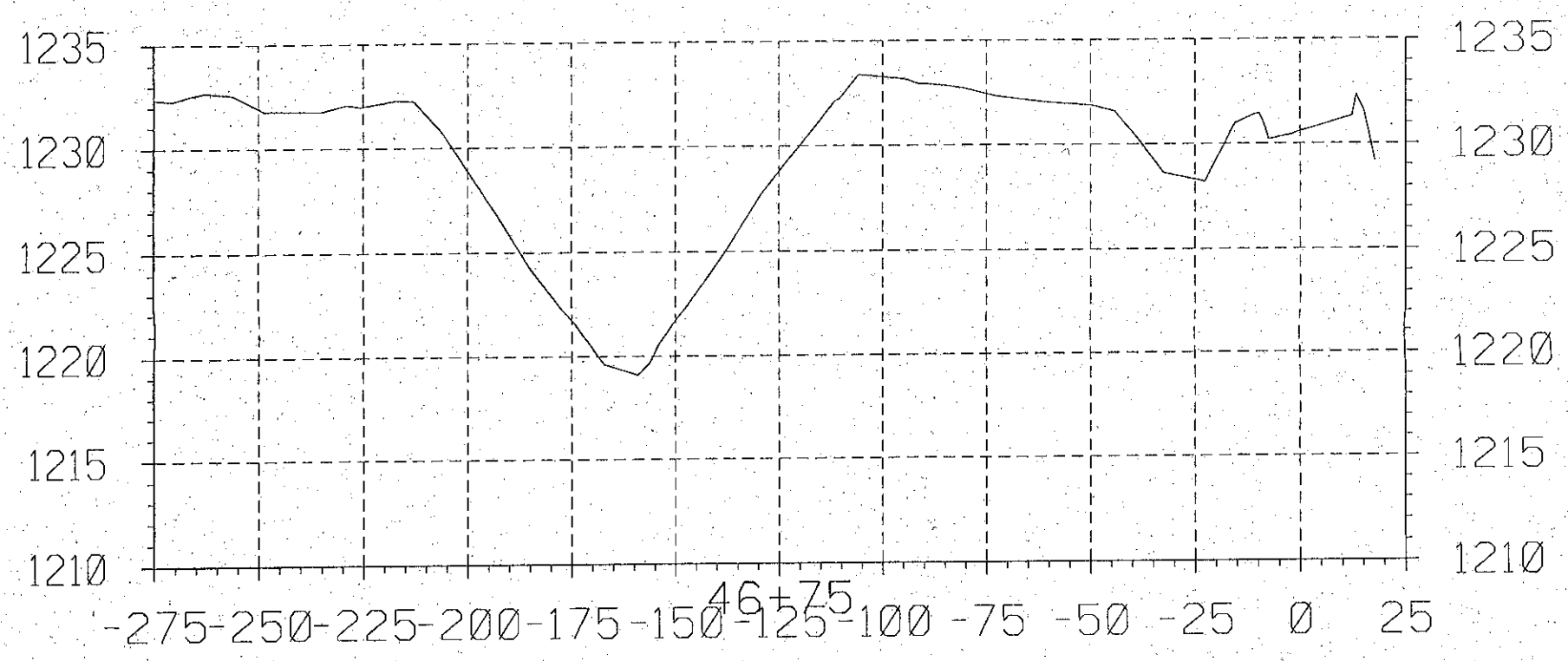
PROJ. NO. North Channel Inlet
DATE 11-04
SHEET _ OF _


HEC-RAS
CROSS-SECTION I.D.'S
1.159
1.148
1.124
1.074
0.998
N
0
40
80
NORTHERN AVE
NORTHERN AVE
10'
55+00
52+00
51+00
50+00
49+00
48+00
47+00
46+00
45+00
44+00
BEARDSLEY CANAL WASH
250' EXST
FCDMC ROW
APPROXIMATE ROW TO BE ACQUIRED
BY FCDMC FROM AZ STATE LAND
FOR CONSTRUCTION OF 90' BW CHANNEL
(0.5510 ACRES)
50'
MID-SECTION
LINE
& STATIONING


R/W
MID SECTION LINE (TYP
6'
3.5:1
3.5:1
18'
51+75
1240
1235
1230
1225
1220
1215
-275 -250 -225 -200 -175 -150 -125 -100 -75 -50 -25 0 25

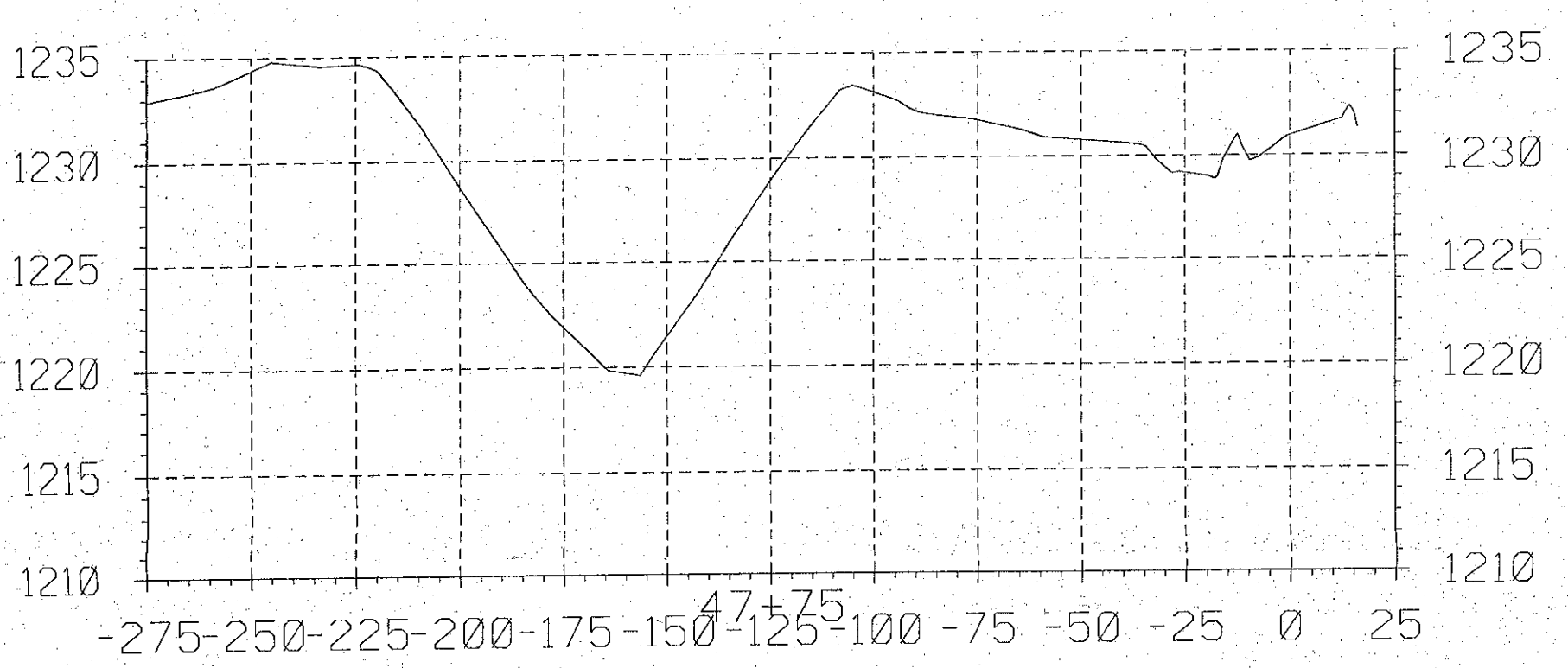

1" = 40'
1" = 8' V
R/W
50+75
1240
1235
1230
1225
1220
1215
-275 -250 -225 -200 -175 -150 -125 -100 -75 -50 -25 0 25

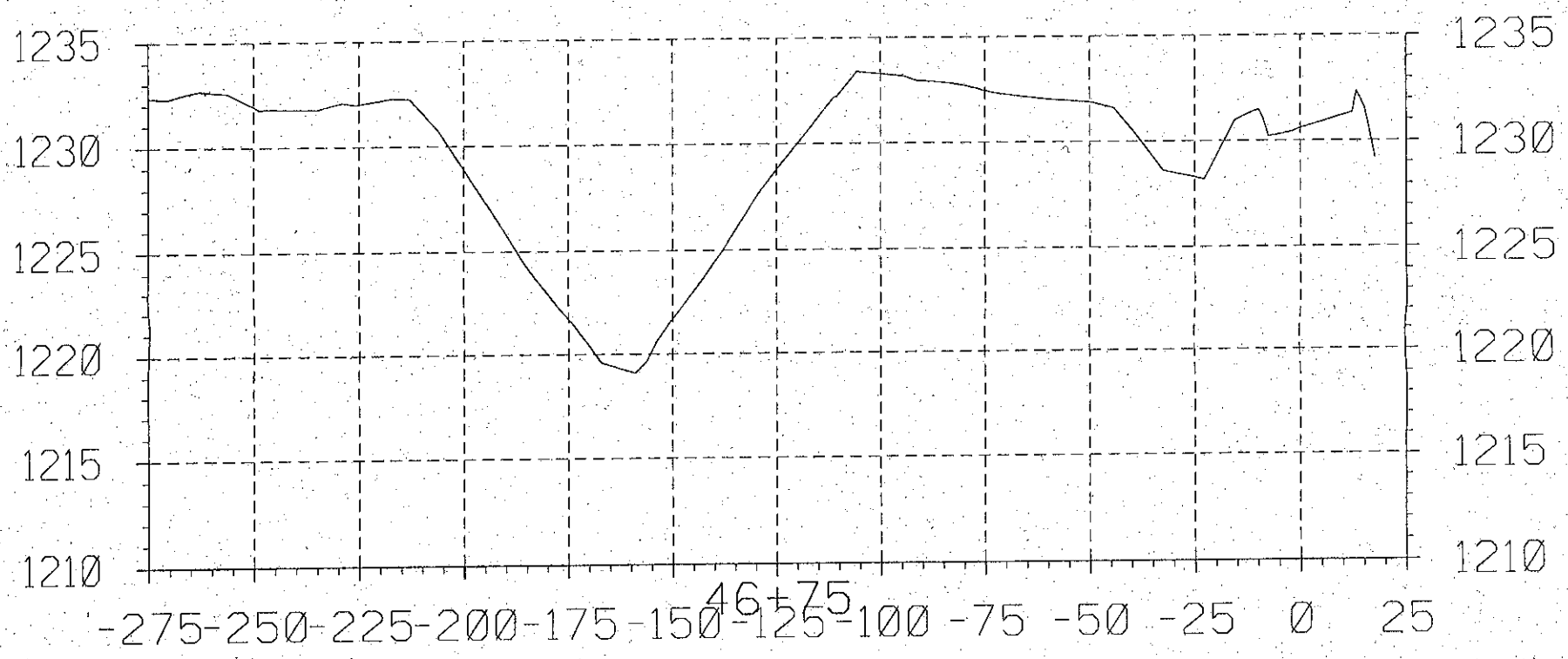

1235
1230
1225
1220
1215
1210
47+75
-275-250-225-200-175-150-125-100 -75 -50 -25 0 25


1235
1230
1225
1220
1215
1210
46+75
-275-250-225-200-175-150-125-100 -75 -50 -25 0 25

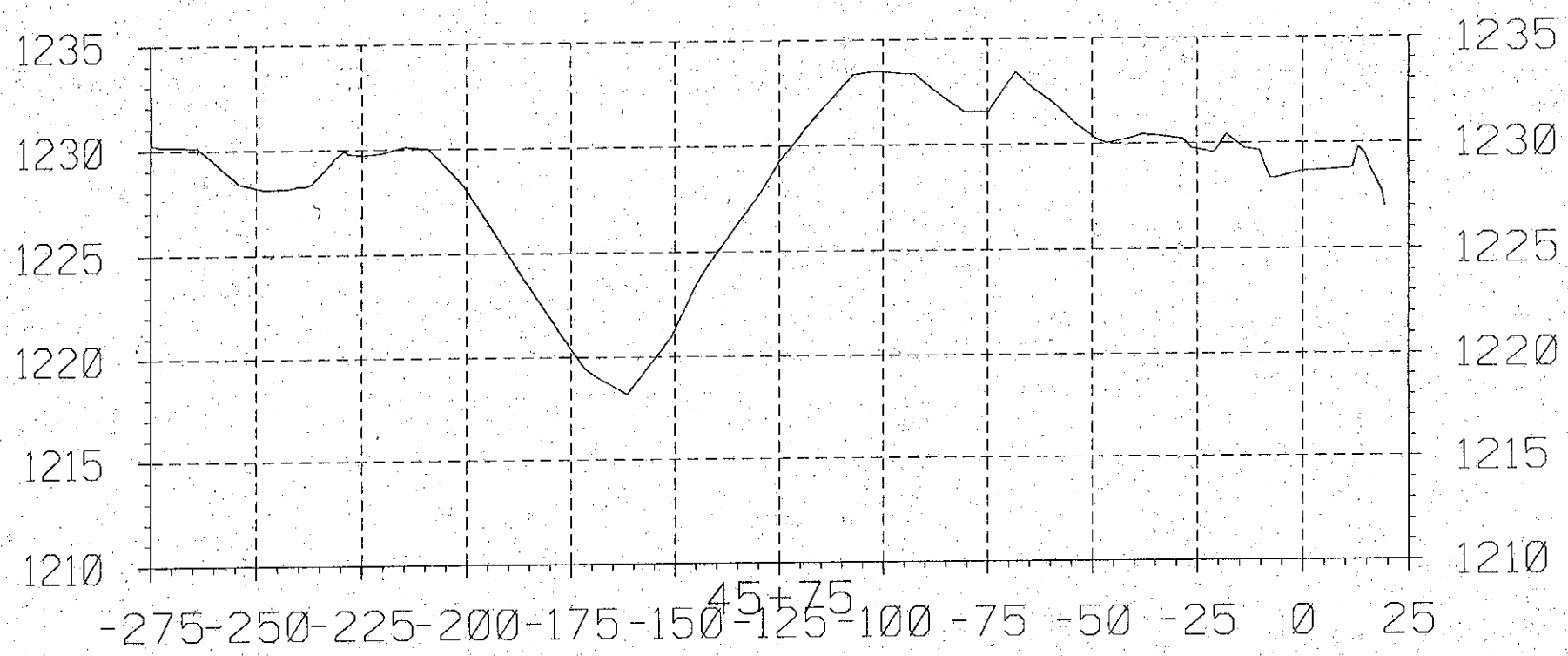
1"=40'

1235
1230
1225
1220
1215
1210
45+75
-275-250-225-200-175-150-125-100 -75 -50 -25 0 25


1235
1230
1225
1220
1215
1210
47+75
-275-250-225-200-175-150-125-100 -75 -50 -25 0 25


1235
1230
1225
1220
1215
1210
46+75
-275-250-225-200-175-150-125-100 -75 -50 -25 0 25

1"=40'


1235
1230
1225
1220
1215
1210
45+75
-275-250-225-200-175-150-125-100 -75 -50 -25 0 25

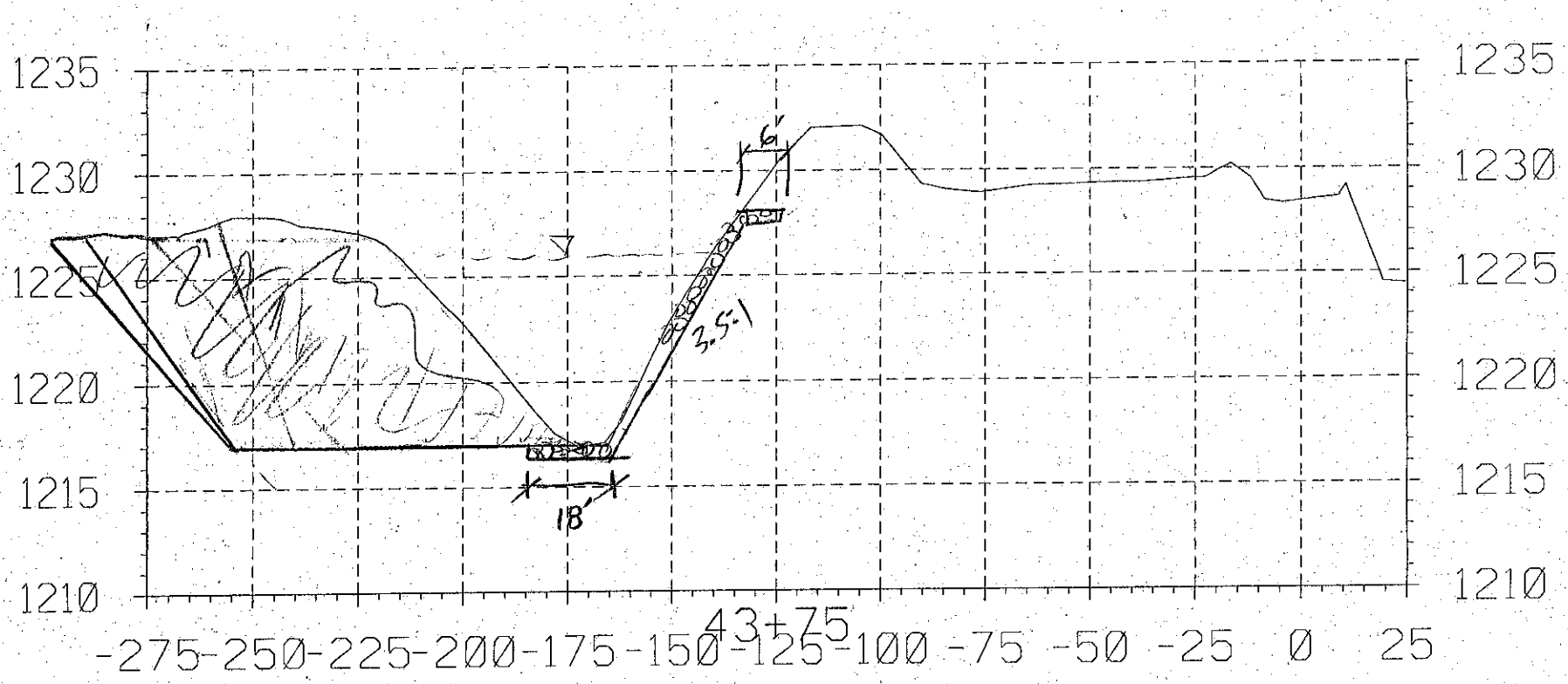
L = 800'

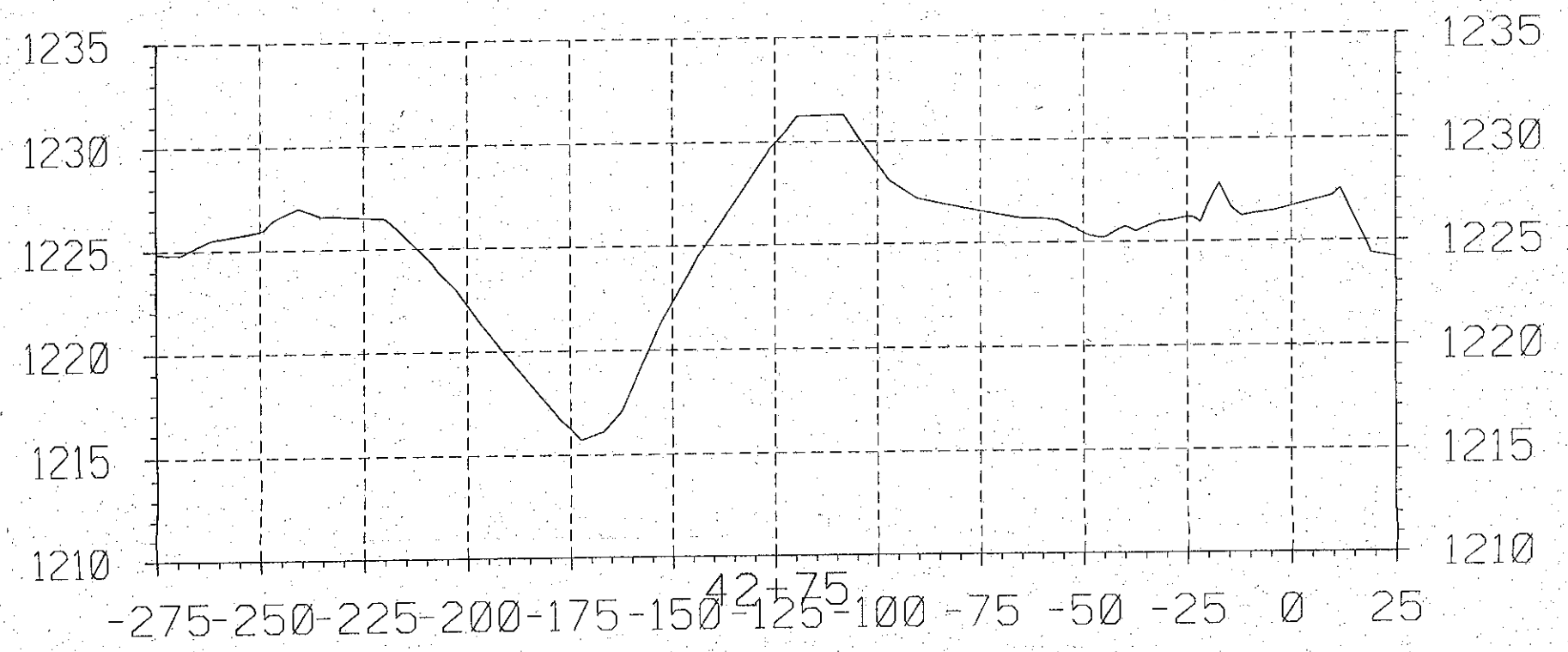
T = 12" & 9"

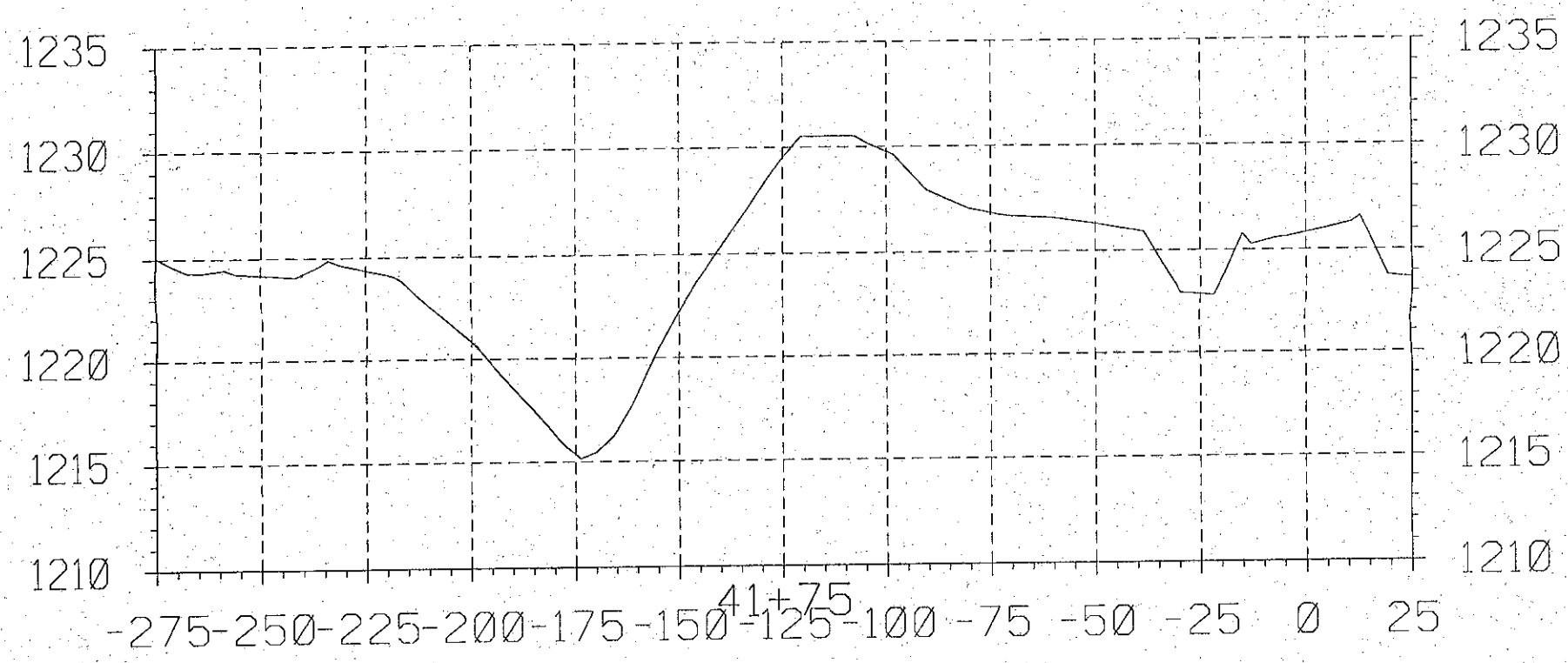
$L = \frac{L_1 + L_2}{2}$

10

1" = 40'

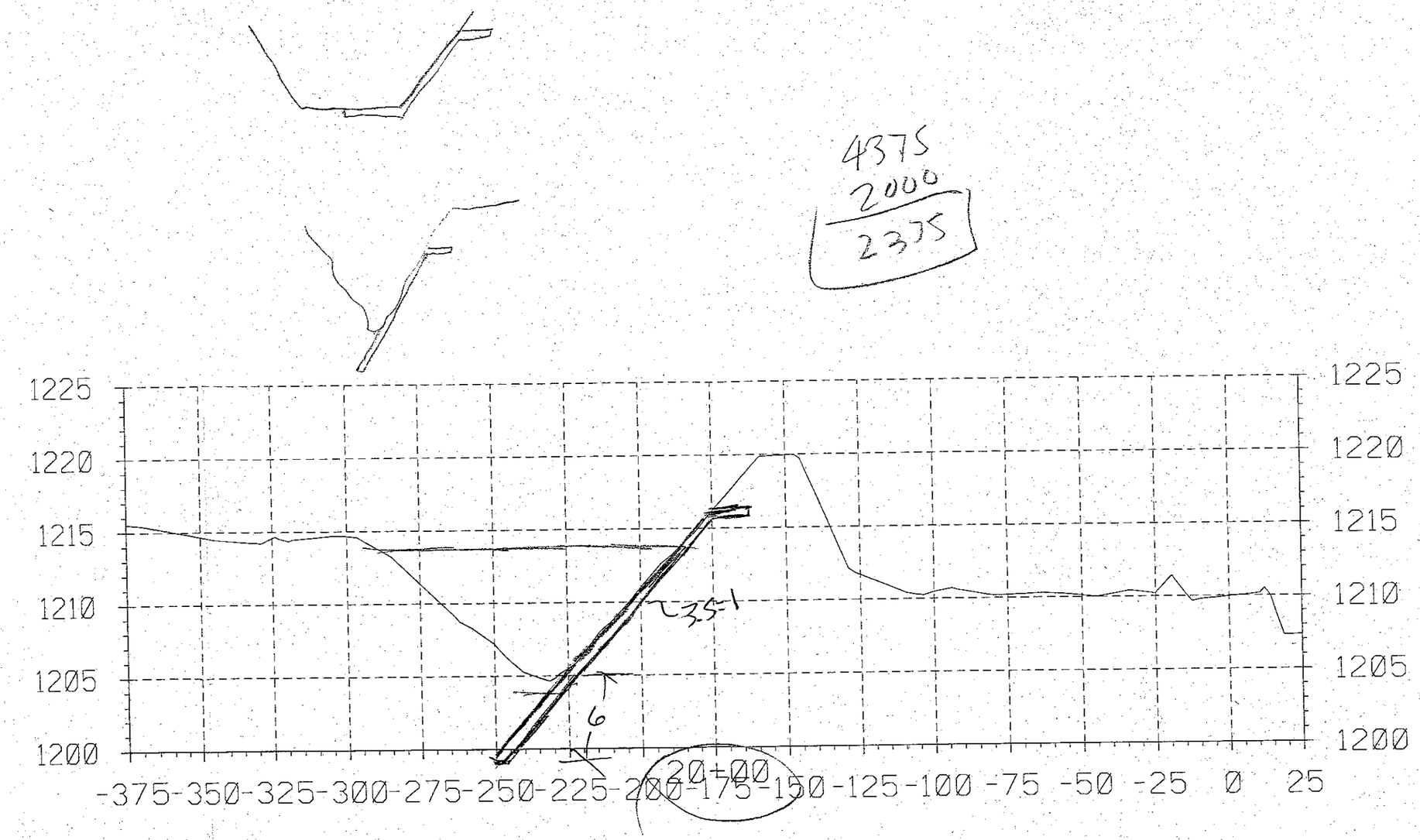



1235
1230
1225
1220
1215
1210
42+75
-275-250-225-200-175-150-125-100 -75 -50 -25 0 25


1235
1230
1225
1220
1215
1210
41+75
-275-250-225-200-175-150-125-100 -75 -50 -25 0 25

1"=40'

1230
1225
1220
1215
1210
1205
40+75
-275-250-225-200-175-150-125-100 -75 -50 -25 0 25


4375
2000
2375
1225
1220
1215
1210
1205
1200
-375 -350 -325 -300 -275 -250 -225 -200 -175 -150 -125 -100 -75 -50 -25 0 25
3.5:1
6
20+00

48"

APPENDIX I – COST ESTIMATES

Included in Appendix I

- Cost summary
- NIC diversion structure alternatives cost
- Box Culvert Cost (varying in number of barrels and length)
- Headwall Cost (varying skew and number of barrels)
- Beardsley Canal Wash improvement cost (per reach)
- Drop structure alternatives cost

Cost Summary

North Inlet Channel Alternatives

NIC Diversion Structure at Olive Avenue	Cost
Crossing at Olive/Canal Intersection (Short Crossing)	$449,067
Crossing East of Olive/Canal Intersection (Long Crossing)	$449,850
Two Culverts Perp. To Olive and Canal (Two Crossings)	$1,188,403
Crossing at Olive/Canal Intersection (Medium Crossing)	$434,308

NIC Diversion Structure at Northern Avenue	Cost
Crossing at Northern/Canal Intersection (Short Crossing)	$493,586
Crossing East of Northern/Canal Intersection (Long Crossing)	$502,668
Two Crossings at Northern and Canal (Double Crossing)	$833,388

Beardsley Wash Alternatives

Olive Avenue to Cholla Wash	Cost
Cleared Beardsley Wash, 1200 cfs Diversion (including NIC construction cost)	$4,012,306
Existing Beardsley Wash, 1600 cfs Diversion (including NIC construction cost)	$3,887,897

Cholla Wash to Northern Avenue	Cost
Culvert Only Crossing at Northern Avenue	$327,811
Maintenace Road Build-Up, includes Cholla Wash confluence protection (Gabion)	$619,667

Northern Avenue to FRS #3	Cost
Lining East Bank (12" Gabion)	$1,641,241
Lining Both Banks (12" Gabion)	$2,942,089

Olive Avenue Crossing/Diversion Structure Alternatives
Cost Estimate

Alternatives	Item Description	Quantity	Unit	Unit Cost	Cost
Crossing at Olive/Canal Intersection (Short Crossing)	Remove/reconstruct canal headwall	2	ea.	$20,000	$40,000
	Remove/reconstruct canal turn out structure	1	ea.	$23,000	$23,000
	Remove/replace guardrail	50	l.f.	$20	$1,000
	Remove/replace cattle guard	1	ea.	$2,500	$2,500
	Remove/replace access road	1	ea.	$3,000	$3,000
	Remove/replace maintenace road gates	2	ea.	$750	$1,500
	Construct wing wall transition	42.22222	ea.	$300	$12,667
	NIC bank protection (riprap)	1000	c.y.	$80	$80,000
	Construct box culvert (3-10'x5'x220')	1	ea.	$247,500	$247,500
	Construct culvert outlet headwall (3-10'x5')	1	ea.	$7,900	$7,900
	Construct weir structure (L=70')	100	c.y.	$300	$30,000
	Total Cost				**$449,067**
Crossing East of Olive/Canal Intersection (Long Crossing)	Remove/replace maintenace road gates	1	ea.	$750	$750
	NIC bank protection (riprap)	500	c.y.	$80	$40,000
	Construct box culvert (3-10'x5'x330')	1	ea.	$371,200	$371,200
	Construct culvert outlet headwall (3-10'x5')	1	ea.	$7,900	$7,900
	Construct weir structure (L=70')	100	c.y.	$300	$30,000
	Total Cost				**$449,850**
Two Culverts Perp. To Olive and Canal (Double Crossing)	NIC bank protection (riprap)	1000	c.y.	$80	$80,000
	Construct box culvert @ Olive Ave. (3-10'x5'x160')	1	ea.	$179,972	$179,972
	Construct box culvert @ Beardsley Canal (3-10'x5'x110')	1	ea.	$123,731	$123,731
	Construct culvert outlet headwall (3-10'x5')	2	ea.	$6,400	$12,800
	Construct culvert inlet headwall (3-10'x5')	1	ea.	$7,100	$7,100
	Construct weir structure (L=70')	100	c.y.	$300	$30,000
	Channel between culverts	2516	c.y.	$300	$754,800
	Total Cost				**$1,188,403**
Crossing at Olive/Canal Intersection (Medium Crossing)	Remove/reconstruct canal headwall	1	ea.	$20,000	$20,000
	Remove/reconstruct canal turn out structure	1	ea.	$23,000	$23,000
	Remove/replace guardrail	50	l.f.	$20	$1,000
	Remove/replace cattle guard	1	ea.	$2,500	$2,500
	Bank protection (riprap)	1000	c.y.	$80	$80,000
	Construct box culvert (3-10'x5'x240')	1	ea.	$269,958	$269,958
	Construct culvert outlet headwall (3-10'x5')	1	ea.	$7,850	$7,850
	Construct weir structure (L=70')	100	c.y.	$300	$30,000
	Total Cost				**$434,308**

Northern Avenue Crossing/Diversion Structure Alternatives
Cost Estimate

Alternatives	Item Description	Quantity	Unit	Cost	Total Cost
Crossing at Northern/Canal Intersection (Short Crossing)	Remove/reconstruct canal headwall	1	ea.	$20,000	$20,000
	Remove/reconstruct canal turn out structure	1	ea.	$23,000	$23,000
	Remove/replace canal maintenace road gates	2	ea.	$750	$1,500
	Bank protection (riprap)	1200	c.y.	$80	$96,000
	Construct box culvert (5-10'x5'x190')	1	ea.	$342,950	$342,950
	Construct culvert outlet headwall (5-10'x5')	1	ea.	$10,136	$10,136
	Total Cost				**$493,586**
Crossing East of Northern/Canal Intersection (Long Crossing)	Remove/reconstruct canal	200	l.f.	$200	$40,000
	Remove/reconstruct canal drop structure	1	ea.	$10,000	$10,000
	Construct box culvert (5-10'x5'x245')	1	ea.	$442,531	$442,531
	Construct culvert outlet headwall (5-10'x5')	1	ea.	$10,136	$10,136
	Total Cost				**$502,668**
Two Culverts Crossing Northern and Canal (Double Crossing)	Remove/replace canal	550	l.f.	$300	$165,000
	Remove/reconstruct canal drop structure	3	ea.	$30,000	$90,000
	Construct fjord dip with cutoff walls	1	ea.	$15,000	$15,000
	Construct box culvert (5-10'x5'x130')	1	ea.	$234,813	$234,813
	Construct box culvert (5-10'x5'x170')	1	ea.	$307,063	$307,063
	Construct culvert outlet headwall (5-10'x5')	1	ea.	$7,953	$7,953
	Construct culvert inlet headwall (5-10'x5')	1	ea.	$13,560	$13,560
	Total Cost				**$833,388**

BOX CULVERT COST BY ALTERNATIVE

North Inlet Channel Crossing Northern Avenue

Crossing Type	Box Culvert		Concrete				Rebar				Total Cost
	Dimension (l x w)	Length (lf)	Unit Quantity (cy/lf)	Total Quantity (cy)	Unit Cost ($/cy)	Cost ($)	Unit Quantity (lb/lf)	Total Quantity (lb)	Unit Cost ($/lb)	Cost ($)	($)
Double Crossing	(3) 10X5	170	3.122	530.740	$250	$132,685	459.1	78047	$0.75	$58,535	$191,220
	(4) 10X5	170	4.076	692.920	$250	$173,230	578.5	98345	$0.75	$73,759	$246,989
	(5) 10X5	170	5.035	855.950	$250	$213,988	730.0	124100	$0.75	$93,075	$307,063
	(3) 10X5	130	3.122	405.860	$250	$101,465	459.1	59683	$0.75	$44,762	$146,227
	(4) 10X5	130	4.076	529.880	$250	$132,470	578.5	75205	$0.75	$56,404	$188,874
	(5) 10X5	130	5.035	654.550	$250	$163,638	730.0	94900	$0.75	$71,175	$234,813
Long Culvert	(3) 10X5	245	3.122	764.890	$250	$191,223	459.1	112480	$0.75	$84,360	$275,582
	(4) 10X5	245	4.076	998.620	$250	$249,655	578.5	141733	$0.75	$106,299	$355,954
	(5) 10X5	245	5.035	1233.575	$250	$308,394	730.0	178850	$0.75	$134,138	$442,531
Short Culvert	(3) 10X5	190	3.122	593.180	$250	$148,295	459.1	87229	$0.75	$65,422	$213,717
	(4) 10X5	190	4.076	774.440	$250	$193,610	578.5	109915	$0.75	$82,436	$276,046
	(5) 10X5	190	5.030	955.700	$250	$238,925	730.0	138700	$0.75	$104,025	$342,950

BOX CULVERT COST BY ALTERNATIVE

North Inlet Channel Crossing Olive Avenue

Crossing Type	Box Culvert		Concrete				Rebar				Total Cost
	Dimension (l x w)	Length (lf)	Unit Quantity (cy/lf)	Total Quantity (cy)	Unit Cost ($/cy)	Cost ($)	Unit Quantity (lb/lf)	Total Quantity (lb)	Unit Cost ($/lb)	Cost ($)	($)
Double Crossing	(3) 10X5	110	3.122	343.420	$250	$85,855	459.1	50501	$0.75	$37,876	$123,731
	(4) 10X5	110	4.076	448.360	$250	$112,090	578.5	63635	$0.75	$47,726	$159,816
	(5) 10X5	110	5.035	553.850	$250	$138,463	730.0	80300	$0.75	$60,225	$198,688
	(3) 10X5	160	3.122	499.520	$250	$124,880	459.1	73456	$0.75	$55,092	$179,972
	(4) 10X5	160	4.076	652.160	$250	$163,040	578.5	92560	$0.75	$69,420	$232,460
	(5) 10X5	160	5.035	805.600	$250	$201,400	730.0	116800	$0.75	$87,600	$289,000
Long Culvert	(3) 10X5	330	3.122	1030.260	$250	$257,565	459.1	151503	$0.75	$113,627	$371,192
	(4) 10X5	330	4.076	1345.080	$250	$336,270	578.5	190905	$0.75	$143,179	$479,449
	(5) 10X5	330	5.035	1661.550	$250	$415,388	730.0	240900	$0.75	$180,675	$596,063
Short Culvert	(3) 10X5	220	3.122	686.840	$250	$171,710	459.1	101002	$0.75	$75,752	$247,462
	(4) 10X5	220	4.076	896.720	$250	$224,180	578.5	127270	$0.75	$95,453	$319,633
	(5) 10X5	220	5.035	1107.700	$250	$276,925	730.0	160600	$0.75	$120,450	$397,375
Medium Culvert	(3) 10X5	240	3.122	749.280	$250	$187,320	459.1	110184	$0.75	$82,638	$269,958
	(4) 10X5	240	4.076	978.240	$250	$244,560	578.5	138840	$0.75	$104,130	$348,690
	(5) 10X5	240	5.035	1208.400	$250	$302,100	730.0	175200	$0.75	$131,400	$433,500

BOX CULVERT COST BY ALTERNATIVE

Beardsley Channel Crossing Northern Avenue

Crossing Type	Box Culvert		Concrete				Rebar				Total Cost
	Dimension (l x w)	Length (lf)	Unit Quantity (cy/lf)	Total Quantity (cy)	Unit Cost ($/cy)	Cost ($)	Unit Quantity (lb/lf)	Total Quantity (lb)	Unit Cost ($/lb)	Cost ($)	($)
Culvert	(7) 12X8	50	10.384	519.200	$250	$129,800	1391.4	69570	$0.75	$52,178	$181,978
	(8) 12X8	50	11.804	590.200	$250	$147,550	1574.6	78730	$0.75	$59,048	$206,598
	(9) 12X8	50	13.224	661.200	$250	$165,300	1757.8	87890	$0.75	$65,918	$231,218

HEADWALL COST

North Inlet Channel Crossings

With 4:1 Slope

Crossing Type	Box Culvert			Concrete			Rebar			Total Cost
	Skew (°)	Number of Barrels	Dimension (l x w)	Quantity (cy)	Unit Cost ($/cy)	Cost ($)	Quantity (lb)	Unit Cost ($/lb)	Cost ($)	($)
Inlet Headwall	0	3	10X5	25.340	$250	$6,335	927	$0.75	$695	$7,030
	0	4	10X5	38.010	$250	$9,503	1057	$0.75	$793	$10,295
	0	5	10X5	50.680	$250	$12,670	1187	$0.75	$890	$13,560
	45	3	10X5	16.300	$250	$4,075	1373	$0.75	$1,030	$5,105
	45	4	10X5	18.290	$250	$4,573	1590	$0.75	$1,193	$5,765
	45	5	10X5	20.280	$250	$5,070	1807	$0.75	$1,355	$6,425
Outlet Headwall	0	3	10X5	20.670	$250	$5,168	1600	$0.75	$1,200	$6,368
	0	4	10X5	23.180	$250	$5,795	1820	$0.75	$1,365	$7,160
	0	5	10X5	25.690	$250	$6,423	2040	$0.75	$1,530	$7,953
	45	3	10X5	25.230	$250	$6,308	2057	$0.75	$1,543	$7,850
	45	4	10X5	28.770	$250	$7,193	2401	$0.75	$1,801	$8,993
	45	5	10X5	32.310	$250	$8,078	2745	$0.75	$2,059	$10,136

HEADWALL COST

Beardsly Canal Wash Crossings

With 4:1 Slope

Crossing Type	Box Culvert			Concrete			Rebar			Total Cost ($)
	Skew (°)	Number of Barrels	Dimension (l x w)	Quantity (cy)	Unit Cost ($/cy)	Cost ($)	Quantity (lb)	Unit Cost ($/lb)	Cost ($)	
Outlet Headwall	0	8	12X8	53.080	$250	$13,270	3886	$0.75	$2,915	$16,185
	0	9	12X8	61.690	$250	$15,423	4485	$0.75	$3,364	$18,786
	0	10	12X8	70.760	$250	$17,690	5205	$0.75	$3,904	$21,594

NIC 1600 cfs Drop Structure Alternatives
Cost Estimate

Alternatives	Item Description	Quantity	Unit	Unit Cost	Cost
1 - Sloping Buried Concrete	Reinforced concrete	68	c.y.	$250	$17,000
	Dumped riprap	401	c.y.	$80	$32,080
	Riprap bank protection upstream of constriction	165	c.y.	$80	$13,200
	Total Cost				**$62,280**
2 - Sloping Grouted Rock	Reinforced concrete	41	c.y.	$250	$10,250
	Grouted rock	326	c.y.	$200	$65,200
	Dumped riprap	75	c.y.	$80	$6,000
	Riprap bank protection upstream of constriction	165	c.y.	$80	$13,200
	Total Cost				**$94,650**
3 -Vertical Gabions	Gabions	235	c.y.	$150	$35,250
	Riprap bank protection upstream of constriction	165	c.y.	$80	$13,200
	Total Cost				**$48,450**
4 - Vertical Exposed Concrete	Reinforced concrete	63	c.y.	$250	$15,750
	Grouted rock (small)	266	c.y.	$100	$26,600
	Total Cost				**$42,350**

NIC 1200 cfs Drop Structure Alternatives
Cost Estimate

Alternatives	Item Description	Quantity	Unit	Unit Cost	Cost
1 - Sloping Buried Concrete	Reinforced concrete	53	c.y.	$250	$13,250
	Dumped riprap	179	c.y.	$80	$14,320
	Riprap bank protection upstream of constriction	145	c.y.	$80	$11,600
	Total Cost				**$39,170**
2 - Sloping Grouted Rock	Reinforced concrete	32	c.y.	$250	$8,000
	Grouted rock	235	c.y.	$200	$47,000
	Dumped riprap	60	c.y.	$80	$4,800
	Riprap bank protection upstream of constriction	145	c.y.	$80	$11,600
	Total Cost				**$71,400**
3 -Vertical Gabions	Gabions	156	c.y.	$150	$23,400
	Riprap bank protection upstream of constriction	145	c.y.	$80	$11,600
	Total Cost				**$35,000**
4 - Vertical Exposed Concrete	Reinforced concrete	46	c.y.	$250	$11,500
	Grouted rock (small)	302	c.y.	$100	$30,200
	Total Cost				**$41,700**

Beardsley Wash, Olive Avenue to Cholla Wash
Cost Estimate

Alternatives	Item Description	Quantity	Unit	Cost	Total Cost
Existing Beardsley Wash, 1600 cfs flow	Construct 15' maintenace road (2)	11000	l.f.	$10	$110,000
	Excavate Channel (BW=55')	146667	c.y.	$8	$1,173,333
	Construct 3.5' drop structures	10	ea.	$42,350	$423,500
	NIC bank protection (riprap)	748	c.y.	$80	$59,852
	Land acquisition	21	ac.	$100,000	$2,121,212
	Total Cost				**$3,887,897**
Cleared Beardsley Wash, 1200 cfs flow	Construct 15' maintenace road (2)	11000	l.f.	$10	$110,000
	Excavate Channel (BW=35')	117333	c.y.	$8	$938,667
	Construct 3.5' drop structures	10	ea.	$35,000	$350,000
	NIC bank protection (riprap)	748	c.y.	$80	$59,852
	Beardlsey Wash bank protection (Gabion)	4500	c.y.	$150	$675,000
	Land acquisition	19	ac.	$100,000	$1,878,788
	Total Cost				**$4,012,306**

Beardsley Wash, Cholla Wash to Northern Avenue
Cost Estimate

Alternatives	Item Description	Quantity	Unit	Cost	Total Cost
Northern Culvert Crossing	Construct box culvert (8-12'x8'x50')	1	ea.	$231,218	$231,218
	Drop inlet structure	250	c.y.	$300	$75,000
	Outlet headwall (8-12'x8')	1	ea.	$21,594	$21,594
	Total Cost				**$327,811**
Maintenance Road Build-Up (with Cholla Wash Protection)	Gabions	3793	c.y.	$150	$569,000
	Enbankment fill	6333	c.y.	$8	$50,667
	Total Cost				**$619,667**

Beardsley Wash, Northern Avenue to FRS #3
Cost Estimate

Alternatives	Item Description	Quantity	Unit	Cost	Total Cost
Lining East Bank, 12" Gabion	Gabions (0'-800' south of Northern)	1987	c.y.	$100	$198,683
	Gabions (800'- 3200' south of Northern)	11436	c.y.	$100	$1,143,647
	R-O-W aquisition	1	ac.	$100,000	$55,000
	Channel Excavation (0'-800' south of Northern)	30489	c.y.	$8	$243,911
	Total Cost				**$1,641,241**
Lining Both Banks, 12" Gabion	Gabions (0'-800' south of Northern)	3974	c.y.	$100	$397,365
	Gabions (800'- 3200' south of Northern)	22873	c.y.	$100	$2,287,294
	R-O-W aquisition	1	ac.	$100,000	$55,000
	Channel Excavation (0'-800' south of Northern)	25304	c.y.	$8	$202,430
	Total Cost				**$2,942,089**
Lining East Bank, 9" Gabion	Gabions (0'-800' south of Northern)	1490	c.y.	$100	$149,012
	Gabions (800'- 3200' south of Northern)	8577	c.y.	$100	$857,735
	R-O-W aquisition	1	ac.	$100,000	$55,000
	Channel Excavation (0'-800' south of Northern)	25304	c.y.	$8	$202,430
	Total Cost				**$1,264,177**
Lining Both Banks, 9" Gabion	Gabions (0'-800' south of Northern)	2980	c.y.	$100	$298,024
	Gabions (800'- 3200' south of Northern)	17155	c.y.	$100	$1,715,471
	R-O-W aquisition	1	ac.	$100,000	$55,000
	Channel Excavation (0'-800' south of Northern)	25304	c.y.	$8	$202,430
	Total Cost				**$2,270,924**

INCLUDE WITH CROSSING ALT # ESTIMATE FOR BACKUP

Davey-Cairo Engineering, Inc.

- Consulting Civil and Agricultural Engineers
- Water Resources Specialists

2121 West University Drive, Tech Plaza Suite 123
Tempe, Arizona 85281
480.921.4080 480.921.4087 Fax
www.daveycairo.com

Fax

To:	Ms. Amzie Cox	**From:**	Heather Carnahan
Company:	Kirkham Michael	**Address:**	
Fax:	602.997.5980	**Pages:**	2
Phone:	602.328.5723	**Date:**	Tuesday, October 26, 2004
Re:	Irrigation Facilities Costs	**CC:**	MWD

☒**For Your Information** ☐**Please Reply** ☐**Urgent**

Comments: Ms. Cox --
Per our phone conversation, here are the approximate costs for the irrigation facilities that you specified. It should also be noted that Davey-Cairo Engineering, Inc. (DCE) is the engineer of record for the Maricopa Water District (MWD); therefore, any design of irrigation facilities for MWD is typically performed by DCE. Projects are coordinated and set up through MWD and then engineered by DCE.

These cost estimate numbers are for reference only and are strictly plan level costs. These estimates do not take into account costs associated with by-pass pumping or cofferdam installation since the Beardsley Canal is in continual operation and the dry-up times are not long enough to perform the listed construction.

Concrete Canal Lining

- Beardsley Canal is currently shot-creted
- Height of lining = 6 ft
- Length of repair is less than 500 ft
- Cost = $10.00/sq. ft

Turnout Structures

- 24" or 36" gates on turnout
- Cost = $23,000/turnout (This cost is for the structure and minor appurtenances only and does not account for flow measurement devices, if necessary.)

Drop Structure

- Cost = $30,000/structure (This cost is for the structure and minor appurtenances only and does not account for flow measurement devices.)

Canal Crossing Headwalls

- Cost = $20,000/headwall (Additional cost will be incurred for the fabrication and installation of trash racks, if necessary.)

I hope that this estimate is useful for your planning. If you have any other questions or if you would like to discuss the project implementation process for MWD, please feel free to contact us.

Sent By:

Heather Carnahan

APPENDIX J – VALUE ENGINEERING SESSION

Included in Appendix J

- Value Engineering Session Report

Flood Control District
Of
Maricopa County

VALUE ENGINEERING

WHITE TANKS FRS #3
NORTH INLET CHANNEL

Pre-Design Phase Value Engineering Study

November 9 & 10, 2004

Prepared by:

SiteTek
Financial Arts

DRAFT
November 15, 2004

SUBJECT: **WHITE TANKS FRS #3 NORTH INLET CHANNEL VALUE ENGINEERING STUDY**

DATES: November 9 & 10, 2004

TEAM LEADER: John Pucetas – SiteTek Financial Arts, Inc.

TEAM MEMBERS:
Joe Rumann – FCDMC
Don Rerick – FCDMC
Michael Lopez – FCDMC
David Maguire – Land Solutions Inc.
Glen Vorthrems – Maricopa Water District
Bobbie Ohler – FCDMC
Jason Kelley – Kirkham Michael
Amzie Cox – Kirkham Michael
Barry Ling – Kirkham Michael
Gary Maiers – FCDMC
Bob Stevens - FCDMC
Mike Duncan – FCDMC (part time)
Tom Renckly – FCDMC (part time)
Greg Myers – FCDMC (part time)

DESIGN PRESENTATION BY:
Jason Kelley – Kirkham Michael
Barry Ling – Kirkham Michael

DOCUMENTS USED:
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North Inlet Channel Pre-Design Study Report, dated July 2002, by Wood Patel & Associates, Inc.

WORKSHOP OBJECTIVES

- Determine flow split at Olive Avenue
- Select diversion crossing alternative at Olive Avenue
- Evaluate Cholla Wash alternatives
- Determine configuration of wash crossing at Northern Avenue

- Determine configuration of diversion structure crossing at Northern Avenue
- Evaluate existing channel cross section alternatives
- Evaluate new channel cross section east of the Beardsley Canal
- Evaluate FRS #3 channel
- Do not increase size of existing flood plain
- Identify Sonoran Ridge Estates (SRE) responsibilities / obligations in existing Beardsley Wash
- Keep new channel on east side of Beardsley Canal as narrow as possible

DESIGN PRESENTATION

1. The purpose of the project is to prevent three existing breakouts: Beardsley Wash at Olive Avenue, Beardsley – Cholla Wash confluence and Beardsley Wash at Northern Avenue by constructing a diversion channel to reduce flows in Beardsley Wash.
2. Inflow of 2700 cfs at Olive and divert 1500-1600 cfs to the new channel with an additional 5000 cfs flow coming in at Cholla Wash. Design flows have increased by approximately 600 cfs from previous reports.
3. The will be the first time FCDMC is designing a diversion channel on the downstream side of a canal.
4. This project is armoring the east bank of the Beardsley Wash to protect the canal maintenance road. There is concern regarding a potential increase in erosion and scour along the west side due to this improvement.
5. The preferred alternative has been through a public approval process and was chosen for its low maintenance and least impact to adjacent neighborhoods.

PROJECT COST MODEL

(based on lowest cost alternatives for each element from pre-design study)

ELEMENT	FUNCTION	COST	PERCENT OF TOTAL
North Inlet Channel (incl. ROW)	**Convey Flow**	**$ 3,800,000**	**52%**
FRS #3 Channel Lining	**Protect Structure**	**$ 1,600,000**	**22%**
Maintenance Road (incl. Cholla Wash confluence protection)	**Protect Structure**	**$ 620,000**	**8%**
Northern Ave. Diversion Structure	Divert Flow	$ 490,000	7%
Olive Ave. Diversion Structure	Divert Flow	$ 430,000	6%
Beardsley Culvert Crossing at Northern Ave.	Convey Flow	$ 330,000	4%
TOTAL PROJECT COST		$ 7,300,000	

The three project elements indicated in bold represent approximately 82% of the total project cost and would become the primary focus for value improvement.

FCDMC CONSTRUCTION BUDGET

Total Project Cost: $ 7,300,000
Less ROW Costs: $ 2,100,000
Total Construction Cost: $ 5,200,000 vs. FCDMC Construction Budget: $ 4,250,000

Approximately $ 1,000,000 over budget at Pre-Design Phase.

DROP STRUCTURE ALTERNATIVES

Alternatives	Cost per Structure @ 1600 cfs flow
Sloping grouted rock	$ 95,000
Sloping buried concrete	$ 62,000
Vertical gabions	$ 48,000
Vertical exposed concrete	$ 42,000

Sloping buried concrete was selected by the group as the preferred drop structure alternative based on a combination of cost, performance, maintenance and aesthetics.

VALUE ENGINEERING ALTERNATIVES

(the VE alternatives indicated in bold were selected by the VE Team as having the best potential for value improvement and further cost analysis)

	ALTERNATIVES	ESTIMATED COST SAVINGS
1.	**Detention Basin Design**	**$ 250,000 Add**
2.	**Piping of Beardsley Canal (full or partial)**	**$ 1,490,000 Add**
2a.	**Relocate Beardsley Canal**	**$ 1,050,000 Add**
3.	Divert Cholla Wash along Jackrabbit alignment	
4.	Beardsley Wash improvements south of Cholla Wash confluence only	
5.	Double detention basin design – Waterfall & Cholla Washes	
6.	**MCDOT cost participation in Olive Ave. diversion structure**	**($ 200,000)**
7.	Potential funding from FRS #3 Remediation Project	
8.	**Coordinate Channel excavation with FRS #3 Remediation Project**	**($ 600,000)**
9.	Consider reduction in bank protection length at FRS #3 channel	
10.	Consider lower cost alternatives to gabions for channel lining south of Northern	Design Suggestion
11.	Concrete lined channel (supercritical flow) in lieu of current design	
12.	Soil cement in lieu of gabions for Maintenance Road protection	
13.	Incise Beardsley Wash channel and line both sides	
14.	Channelizing vs. raising road at Cholla Wash confluence	
15.	**Improve Beardsley Wash in lieu of New Channel**	**$ 2,450,000 Add**
16.	MWD designate spoil site for excavation	Design Suggestion
17.	**Divert portion of Cholla Wash flow to New Channel**	**$ 1,380,000 Add**

POST VE COST MODEL

(the following revised cost model indicates the anticipated cost impact on the project estimate from VE alternatives identified in this workshop)

ELEMENT	PRE-DESIGN COST	POST-VE ESTIMATE
North Inlet Channel (incl. ROW)	$ 3,800,000	**$ 3,200,000**
FRS #3 Channel Lining	$ 1,600,000	**$ 1,500,000**
Maintenance Road (incl. Cholla Wash confluence protection)	$ 620,000	**$ 300,000**
Northern Ave. Diversion Structure	$ 490,000	$ 490,000
Olive Ave. Diversion Structure	$ 430,000	$ 430,000
Beardsley Culvert Crossing at Northern Ave.	$ 330,000	$ 330,000
TOTAL PROJECT COST	$ 7,300,000	$ 6,250,000

OUTSTANDING PROJECT ISSUES

1. Coordinate with Maricopa County P&D regarding potential erosion hazards along Beardsley Wash and floodway easement width requirements for south portion of site (Cholla Wash to Northern Ave.)

2. Coordinate with FRS #3 engineering team regarding design and detail of overlap between NIC project and north dam extension.

3. Coordinate with Ken Eugene regarding potential for earth fissures and / or subsidence within the channel section and associated monitoring or remediation. Address the question: If there is an earth fissure, will it fail the channel?

Cost Worksheet

Project: White Tanks FRS#3 North Inlet Channel — VE No.

Item: **Divert portion of Cholla Wash flow to new channel** — **17**

Original Design

	Quantity	Unit	Unit Cost	Total
New Channel & Crossings	1	LS	7,300,000	7,300,000
			Total Cost ($)	**7,300,000**

Proposed Design

	Quantity	Unit	Unit Cost	Total
Over shoot at Cholla Wash	1	LS	530,000	530,000
Upsize Channel (Cholla to Northern)	2,000	LF	500	1,000,000
North Inlet Channel	1	LS	3,800,000	3,800,000
Northern Diversion Structure	1	LS	1,000,000	1,000,000
FRS #3 Channel Lining	1	LS	1,600,000	1,600,000
Olive Diversion Structure	1	LS	430,000	430,000
Bank Protection @ Cholla Wash	1	LS	200,000	200,000
Pipe Beardsley Canal	300	LF	400	120,000
			Total Cost ($)	**8,680,000**

Potential Savings

Potential Add ($) **1,380,000**

ATTENDANCE LIST

Value Engineering Workshop

SiteTek Financial Arts

Project: **White Tanks FRS No.3 North Inlet Channel**
Location: **Phoenix, Arizona**
Date: **November 9 & 10, 2004**

PARTICIPANTS:

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Jason Kelley	Kirkham Michael	
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	Phoenix, AZ	jkelley@kirkham.com

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Value Engineering Workshop

SiteTek
Financial Arts

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Location: **Phoenix, Arizona**
Date: **November 9 & 10, 2004**

PARTICIPANTS:

Name:	Organization/Address:	Phone/ Fax/ e-mail:
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	Phoenix, AZ 85009	
Tom Renckly	Flood Control District of Maricopa County	
	2801 West Durango	
	Phoenix, AZ 85009	trr@mail.maricopa.gov

Flood Control District
Of
Maricopa County

VALUE ENGINEERING

WHITE TANKS FRS #3
NORTH INLET CHANNEL

Pre-Design Phase Value Engineering Study

November 9 & 10, 2004

Prepared by:

SiteTek
Financial Arts

DRAFT
November 15, 2004

SUBJECT: WHITE TANKS FRS #3 NORTH INLET CHANNEL VALUE ENGINEERING STUDY

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Maintenance Road (incl. Cholla Wash confluence protection)	**Protect Structure**	**$ 620,000**	**8%**
Northern Ave. Diversion Structure	Divert Flow	$ 490,000	7%
Olive Ave. Diversion Structure	Divert Flow	$ 430,000	6%
Beardsley Culvert Crossing at Northern Ave.	Convey Flow	$ 330,000	4%
TOTAL PROJECT COST		$ 7,300,000	

The three project elements indicated in bold represent approximately 82% of the total project cost and would become the primary focus for value improvement.

FCDMC CONSTRUCTION BUDGET

Total Project Cost: $ 7,300,000
Less ROW Costs: $ 2,100,000
Total Construction Cost: $ 5,200,000 vs. FCDMC Construction Budget: $ 4,250,000

Approximately $ 1,000,000 over budget at Pre-Design Phase.

DROP STRUCTURE ALTERNATIVES

Alternatives	Cost per Structure @ 1600 cfs flow
Sloping grouted rock	$ 95,000
Sloping buried concrete	$ 62,000
Vertical gabions	$ 48,000
Vertical exposed concrete	$ 42,000

Sloping buried concrete was selected by the group as the preferred drop structure alternative based on a combination of cost, performance, maintenance and aesthetics.

VALUE ENGINEERING ALTERNATIVES

(the VE alternatives indicated in bold were selected by the VE Team as having the best potential for value improvement and further cost analysis)

	ALTERNATIVES	ESTIMATED COST SAVINGS
1.	**Detention Basin Design**	**$ 250,000 Add**
2.	**Piping of Beardsley Canal (full or partial)**	**$ 1,490,000 Add**
2a.	**Relocate Beardsley Canal**	**$ 1,050,000 Add**
3.	Divert Cholla Wash along Jackrabbit alignment	
4.	Beardsley Wash improvements south of Cholla Wash confluence only	
5.	Double detention basin design – Waterfall & Cholla Washes	
6.	**MCDOT cost participation in Olive Ave. diversion structure**	**($ 200,000)**
7.	Potential funding from FRS #3 Remediation Project	
8.	**Coordinate Channel excavation with FRS #3 Remediation Project**	**($ 600,000)**
9.	Consider reduction in bank protection length at FRS #3 channel	
10.	Consider lower cost alternatives to gabions for channel lining south of Northern	Design Suggestion
11.	Concrete lined channel (supercritical flow) in lieu of current design	
12.	Soil cement in lieu of gabions for Maintenance Road protection	
13.	Incise Beardsley Wash channel and line both sides	
14.	Channelizing vs. raising road at Cholla Wash confluence	
15.	**Improve Beardsley Wash in lieu of New Channel**	**$ 2,450,000 Add**
16.	MWD designate spoil site for excavation	Design Suggestion
17.	**Divert portion of Cholla Wash flow to New Channel**	**$ 1,380,000 Add**

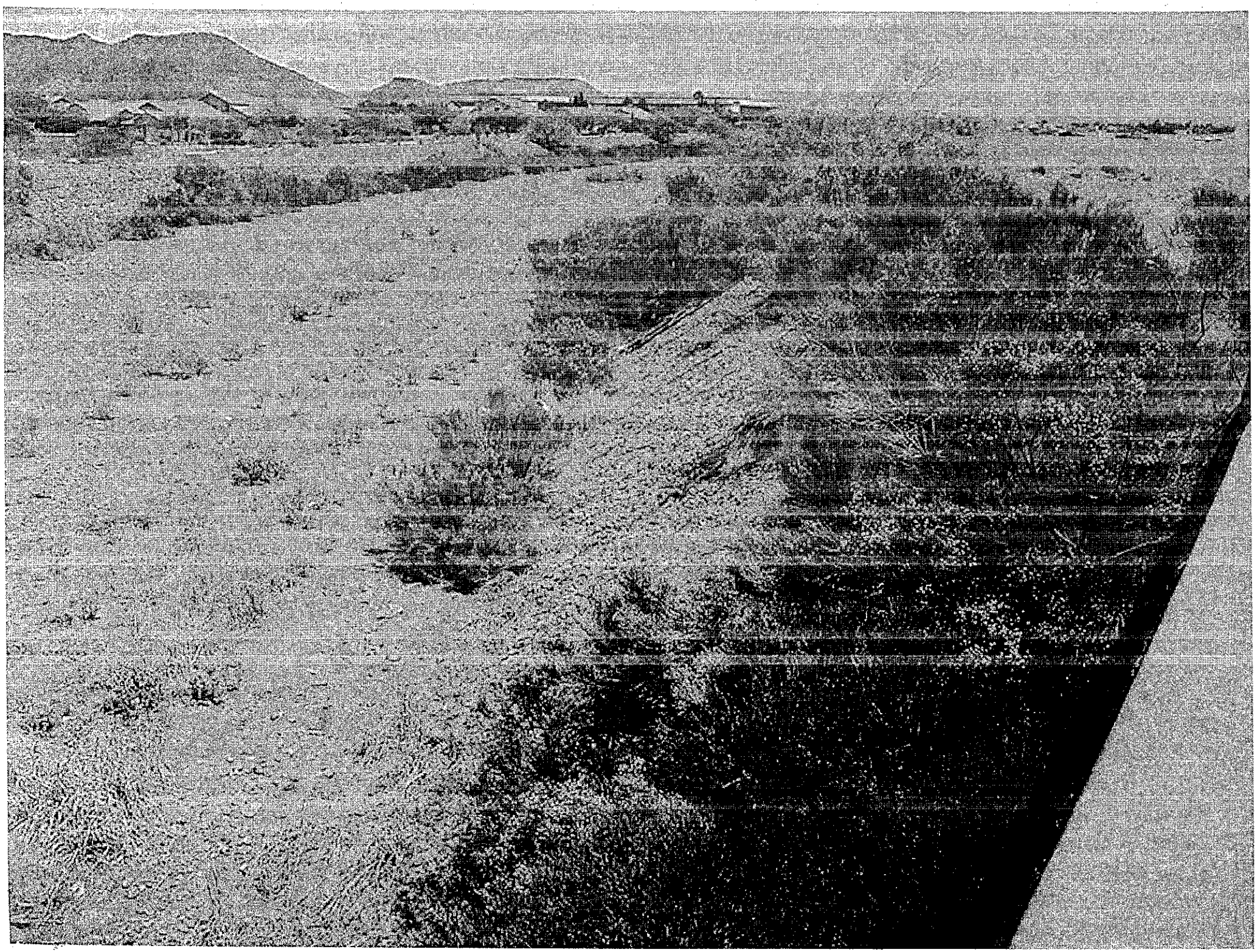
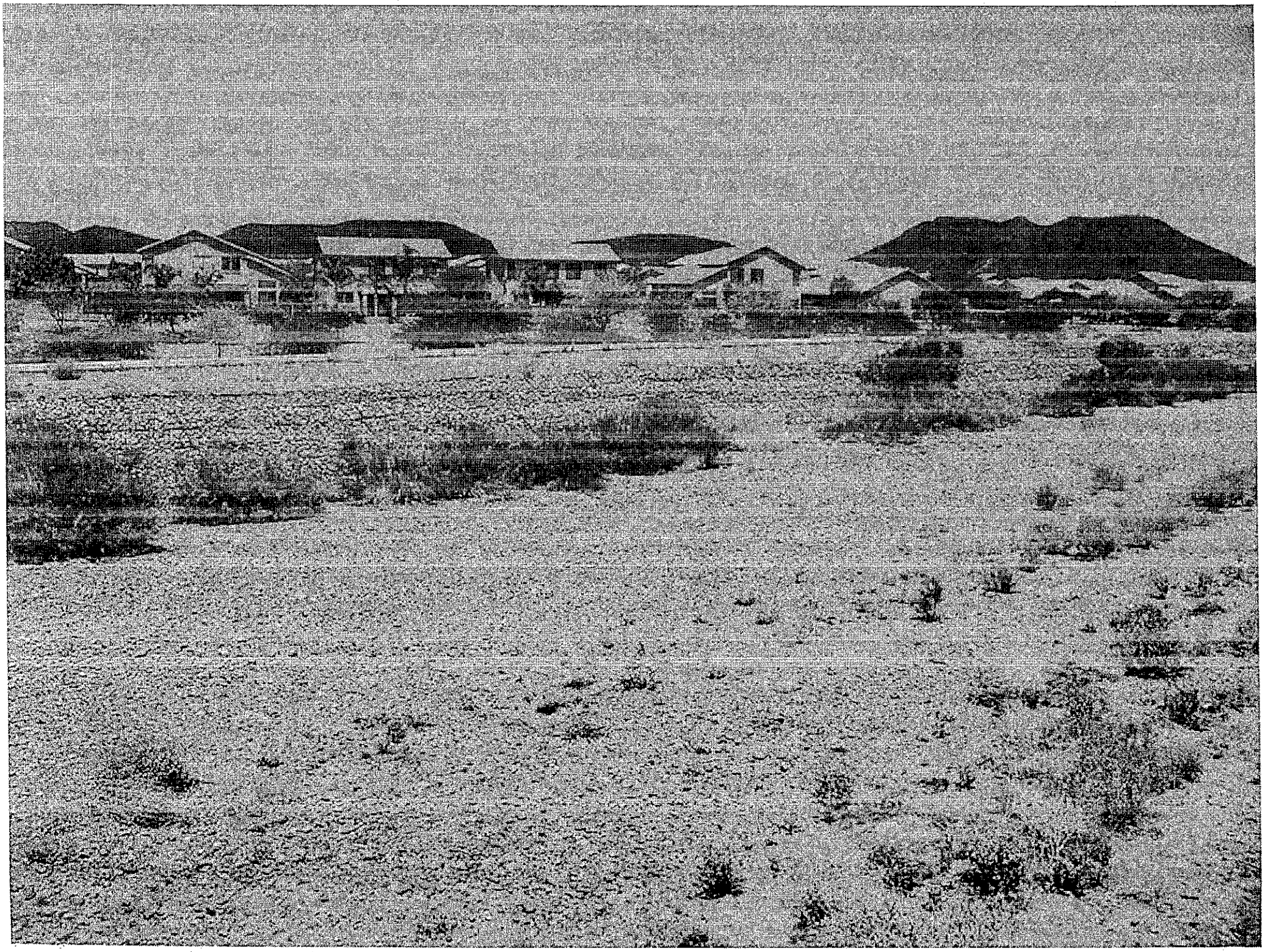
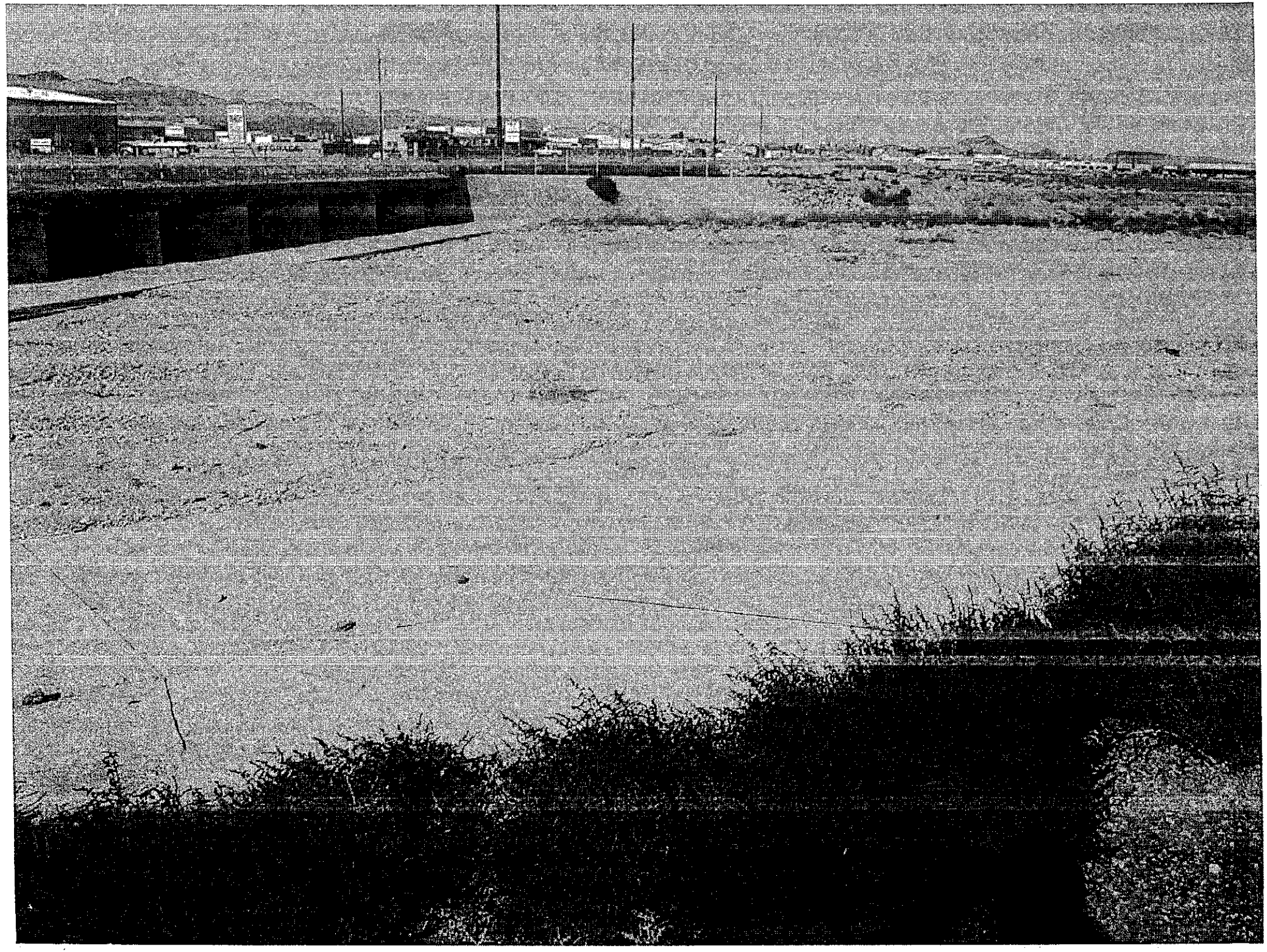
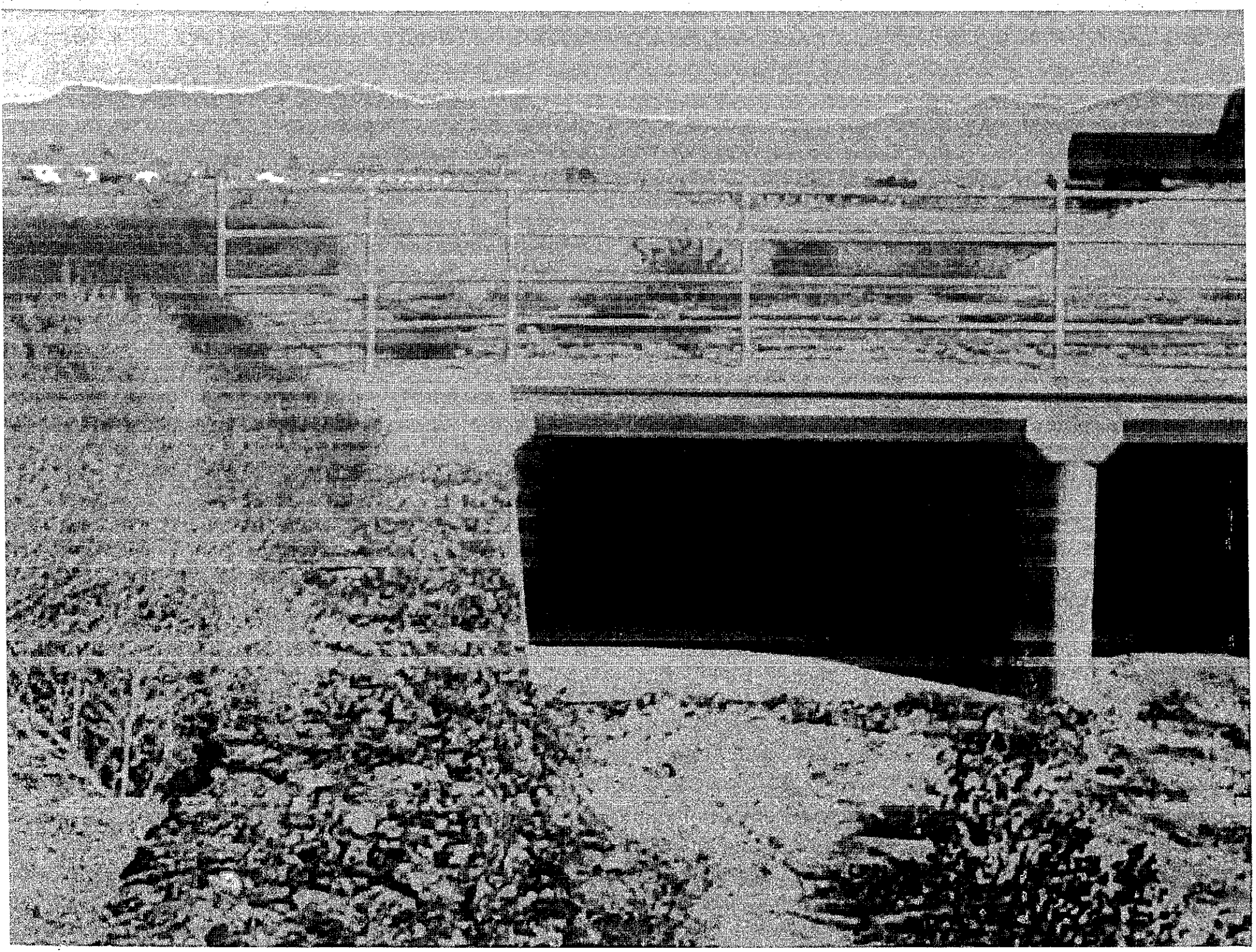
POST VE COST MODEL

(the following revised cost model indicates the anticipated cost impact on the project estimate from VE alternatives identified in this workshop)

ELEMENT	PRE-DESIGN COST	POST-VE ESTIMATE
North Inlet Channel (incl. ROW)	$ 3,800,000	**$ 3,200,000**
FRS #3 Channel Lining	$ 1,600,000	**$ 1,500,000**
Maintenance Road (incl. Cholla Wash confluence protection)	$ 620,000	**$ 300,000**
Northern Ave. Diversion Structure	$ 490,000	$ 490,000
Olive Ave. Diversion Structure	$ 430,000	$ 430,000
Beardsley Culvert Crossing at Northern Ave.	$ 330,000	$ 330,000
TOTAL PROJECT COST	$ 7,300,000	$ 6,250,000

OUTSTANDING PROJECT ISSUES

1. Coordinate with Maricopa County P&D regarding potential erosion hazards along Beardsley Wash and floodway easement width requirements for south portion of site (Cholla Wash to Northern Ave.)

2. Coordinate with FRS #3 engineering team regarding design and detail of overlap between NIC project and north dam extension.

3. Coordinate with Ken Eugene regarding potential for earth fissures and / or subsidence within the channel section and associated monitoring or remediation. Address the question: If there is an earth fissure, will it fail the channel?