DRAFT

PIMA FREEWAY
Junction I-17 to 56th Street

Bridge Hydraulics Report

for Cave Creek Wash Crossing

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ARIZONA DEPARTMENT OF TRANSPORTATION

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Prepared by

PB PARSONS BRINCKERHOFF

CONTRACT NO. 95-18

JULY, 1996

PIMA FREEWAY – JCT I-17 TO 56 STREET
Contract No. 95-18

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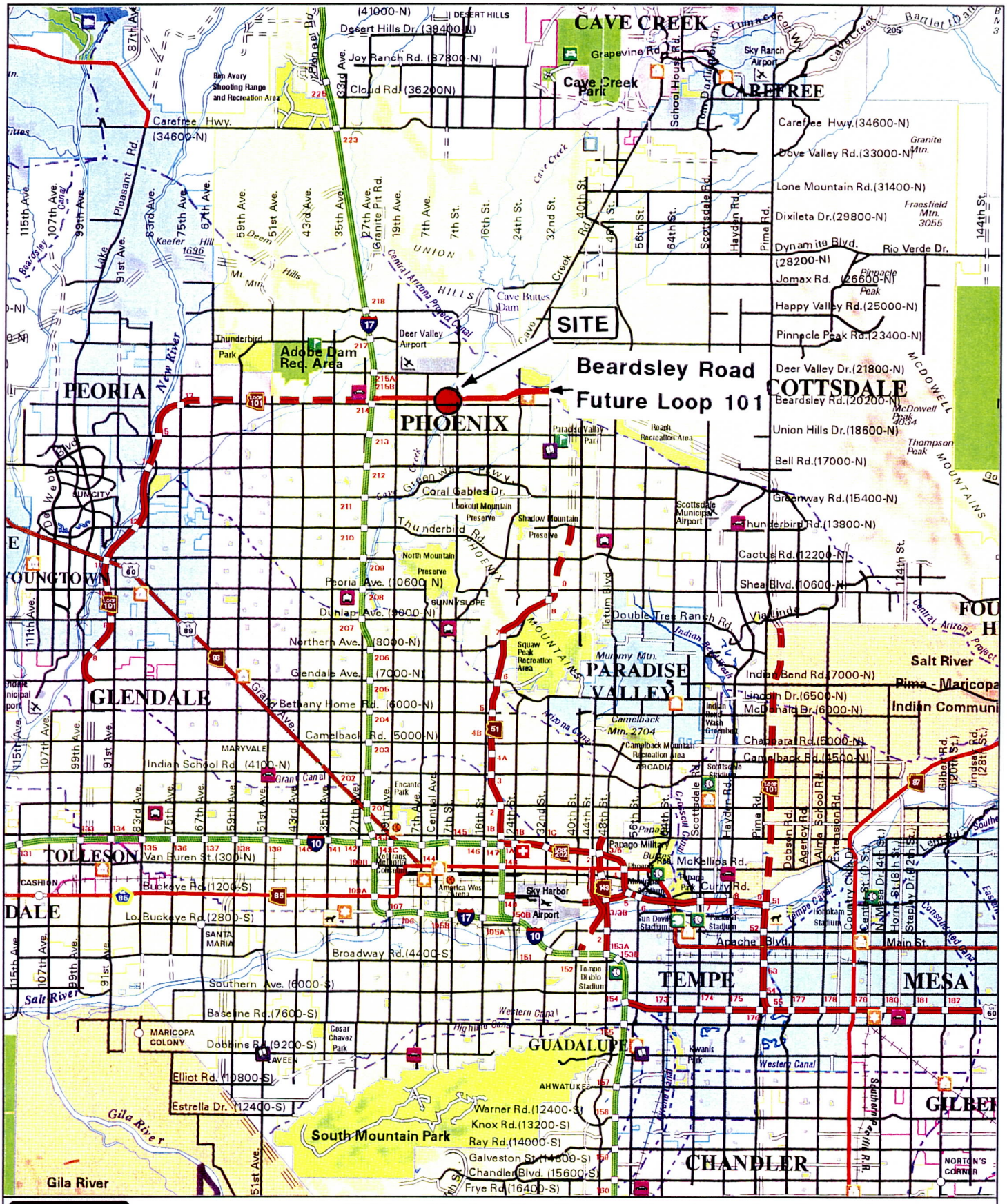
Draft Bridge Hydraulics Report for Cave Creek Wash Crossing

I. INTRODUCTION

The proposed Cave Creek Wash bridge crossing for the Outer Loop Freeway (Loop 101) is located approximately 4.1 kilometers (2.5 miles) east of Interstate 17 along the Beardsley Road alignment. This area comprises part of the S.E. 1/4 of Section 20, Range 3 east, Township 4 north in the City of Phoenix, part of Maricopa County, Arizona, (see Figure 1). Cave Buttes dam and recreational area lies 7.1 kilometers (4.4 miles) upstream (north) of this crossing. Immediately upstream and contiguous downstream is the Sanifill Inc., landfill operation. The constituents of their operation are construction debris comprised of solid waste materials such as concrete, asphalt, lumber and other commonly used building materials. No toxic chemicals or otherwise hazardous waste are permitted to be disposed at this landfill. At present there exists no downstream channelization, other than Sanifill's operation, for approximately 1.75 km (1.1 mile), to the juncture of Union Hills Drive. At this point the wash encounters another bridge waterway crossing and a man made improved channel ensues all the way to the Arizona Canal Diversion Channel (ACDC). PB understands that the City of Phoenix has future plans to construct a similar improved channel and linear recreational facility (greenbelt) between Union Hills Drive and Beardsley Road (future Loop 101 crossing). No construction plans have yet been prepared for coordination purposes at this time.

Due to the extent of the 100 year runoff at this crossing (155.7 cubic meters per second or 5,500 cfs) it was determined that waterway bridges would be the best way to convey the floodwaters though the freeway cross section.

The various bridge types have been evaluated as part of the "Bridge Structure Selection Report for the Cave Creek Wash Bridges" prepared and submitted in December, 1995 (see references). More discussion will follow on this topic later in this report. The original concept plans for the outer loop freeway identified a culvert crossing for this location employing 24 (twenty-four) 10 ft. X 4 ft. High reinforced concrete box culverts, 400 ft. In length. Due to the



Bridge Hydraulics Report for Cave Creek Wash Crossing

Site Location Map

Figure 1

nature of the flow upstream and the large volume, this concept was eliminated early in the design phase as not being appropriate for a freeway crossing in a highly urbanized environment. Safety concerns dictate that channelization and the installation of bridge crossings are warranted at this location.

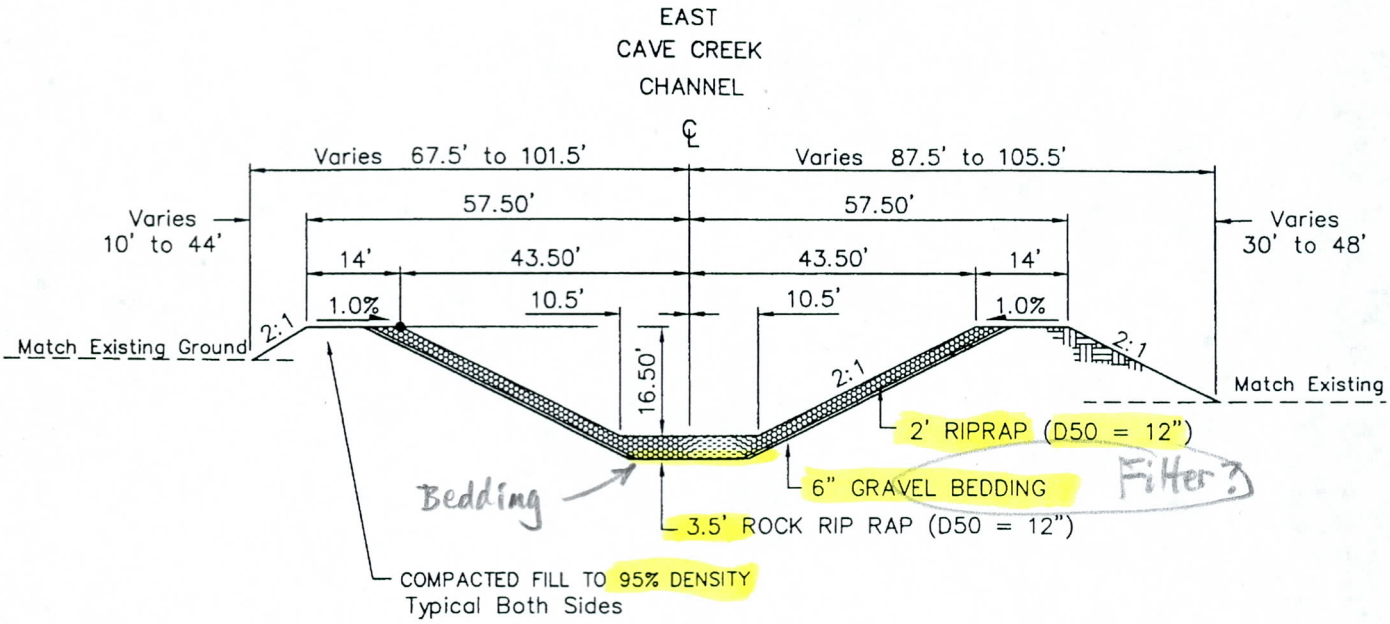
PB has coordinated with Sanifill, Inc. of Arizona to transition their future upstream channel to match the required cross-section at the Pima Freeway bridges. Their improvements are expected to be in place before ADOT's construction. Final sealed construction plans from Sanifill were forwarded to PB in April, 1996. This information was used to make the upstream tie – in connection.

The interim phase of this contract calls for the installation of the Eastbound and Westbound Frontage Road bridges connected in between by a temporary channel consisting of a natural graded bottom and riprap sideslopes. These two bridges will provide for 2 lanes of traffic in each direction until funding is available to construct the ultimate improvements consisting of three lanes in each direction with future high occupancy vehicle (HOV) lanes (one in each direction) to complete the final configuration.

In addition to accommodating the bridge crossings the re-channelization design must provide for an outlet to the 7th Street detention basin located at the Northeast corner of Beardsley Road and 7th Street. This will be accomplished by tying in an outlet channel to the Cave Creek Wash Channel approximately 50 meters downstream of the Eastbound Frontage Road. These improvements are shown in the plans at the end of this report.

II. COORDINATION WITH UPSTREAM IMPROVEMENTS

In April, 1996 Sanifill Inc., of Arizona completed final construction plans for improvements to Cave Creek Wash. The limits for their channel will end at the north right-of-way of ADOT's Loop 101 and extend north for about 305 meters or 1,000 ft. PB has had several meetings with Sanifill's manager of operations and their consulting engineer, Morrison-Maierle/ CSSA, Inc. to coordinate the geometics and hydraulic parameters to tie-in the channel design. The normal trapezoidal channel for Sanifill consists of a 21 foot flat bottom with 2:1 sideslopes extending 3.5 feet above the 100 year water surface elevation (freeboard), see Figure 2. The



TYPICAL SECTION STA. 13+26.65 TO 20+50

Bridge Hydraulics Report for Cave Creek Wash Crossing

Typical Sanifill Channel

Figure 2

Suggest 3' per FEMA

trapezoidal channel for ADOT's improvements that PB will employ uses a 31 meter flat bottom (101.7 ft.) with 2:1 sideslopes extending 0.610 meters or 2 ft. Above the 100 year water surface elevation. The difference in bottom widths is about 24.6 meters (80.71 ft.) and is transitioned out for 256.65 ft. (78.23 meters) upstream of the North right-of-way in Sanifill's channel. This was done to create a gradual transition (6.36:1 taper transition/side) between projects thereby reducing expansion losses and keep steady state flow regimes before entering the bridge/pier sections beginning of the Westbound Frontage Road. The Sanifill Channel Section uses a 2 ft. Deep riprap mattress on the sideslopes with a D50 particle size of 12 inches over a 6 inch gravel bedding. The Manning's "n" value used in their HEC-2 model is 0.045. The approach grade is relatively flat at 0.492% with a 100 year flow velocity of 2.0 m/s (6.6 fps) just before the bridge, (500 yr. Superflood velocity is 2.8 m/s (9.2 fps). The resulting design will employ a smooth transition with relatively steady state water surface profile through the freeway bridges facilitating easy passing of flowing debris. PB has made several HEC-2 model runs of which include the existing condition before the Sanifill Improvements and with the Sanifill and ADOT Improvements in place. Further discussion is differed to Section VI, Hydraulics.

III. DESIGN CONCEPT

Downstream Re-channelization

Due to the fact that this channel reach is fairly steep in grade for a major wash (about 1.0%) and there were no adverse downstream impacts PB's original concept maintained the existing curving alignment of the wash to preserve natural; as well as streamflow characteristics. This concept required bridges to be skewed (approximately 30°) and to employ horizontal curved transitions from the Sanifill channel section and also at the downstream end of the Eastbound Frontage Road bridge. Upon review by ADOT bridge hydraulics it was preferred to have the wash re-aligned so that the channel would run on a straight line from the Sanifill improvements upstream to a point of intersection downstream that returned back to the natural wash thalweg. This would also allow the bridges to be shortened somewhat, by about 6 meters by substantially reducing the skew angles to under 5°. Upon review it was determined this could be accomplished by flattening out the wash between the bridges and adding a grade control "drop structure" downstream so that velocities would not increase and Froude Numbers

would be maintained below 0.86. This is necessary due to the fact that the realigned grade without a drop structure would have been 18.5% steeper than the existing condition (0.925% vs. 1.097%). The resulting Froude Numbers, velocities and total scour encountered would be excessive, especially with bridge pier and channel bank protection. This would result in increased costs considerably above and beyond what the cost of the drop structure will be, not to mention increased operation and maintenance cost for the lifetime of the installation. The resulting design uses a 0.600% outgoing grade downstream of the Sanifill Channel (grade @ 0.492%), through the ADOT right-of-way to a point about 16 meters downstream of the 7th Street detention outfall channel (Q100 = 24.64 cms = 870 cts) whereby it intersects a 10.00% grade into a drop structure with hardbank channel improvements terminating shortly thereafter. From this point it is necessary to re-grade a distance of about 57 meters back to the point of rechannelization meeting the existing wash configuration. All this is depicted in plans shown at the end of the report. It is important to note that the grade control drop structure was placed just downstream of the 7th Street outfall channel outlet so that it's hydraulic influence will be outside the bridge limits. This insures lower velocities and Froude Numbers through the bridge sections as well as not encountering rapidly varying flow conditions there.

It is foreseen that this "straightened out" channel will work better with future City of Phoenix/Flood Control District of Maricopa County downstream channel improvements, that someday will extend to existing facilities at Union Hill's Drive about 1 mile away.

Construction Sequencing

At present, there exists two way traffic (2 lanes) along Beardsley Road, which aligns with the Westbound Frontage Road. In order to keep this traffic operative the Eastbound Frontage Road and bridge will be constructed first. After it's completion 2-way traffic will be shifted onto the Eastbound Frontage Road so that existing Beardsley Road can be torn up and cleared to allow construction of the Westbound Frontage Road. While this is taking place the new Cave Creek Wash channel will be built between the Eastbound and Westbound Frontage Road bridges. In addition, the 7th Street outfall channel will be constructed across the existing limits of Cave Creek Wash. In order prevent flood damage during construction the

PICTURES

embankment for the channel must be placed ahead of the Westbound Frontage Road bridge to prevent flow breakout behind the east abutment and approach. As much of the riprap construction as can be constructed at the time should be installed to protect the slopes (channel banks) until completion of the WBFR bridge. This will also act to protect construction of the 7th Street outlet channel. This construction should proceed without delay to minimize any chance for a major storm event happening during the construction phase. If for some reason the upstream Sanifill Channel has not been constructed at the time of ADOT's completion a temporary channel extension would have to be built tying in this channel with the existing wash. These "flair outs" would then have to be taken out as part of Sanifills construction, before they would make the permanent tie-in to ADOT's facilities.

Need details

Also e D/s terminui

IV. INTERIM FREEWAY CONDITION

This contract includes only the 1st stage of construction whereby the Eastbound and Westbound Frontage Roads and bridges are built. This will accommodate 2-way traffic in each direction (4-lanes total) until the 2nd stage of construction installs the mainline Pima Freeway (Loop 101) providing 3-lanes of traffic in each direction with a depressed median that will eventually be paved for HOV lanes.

The nature of the construction staging for the project requires that a hydraulic analysis be performed to model this condition vs. The ultimate condition to see which will control for various aspects of the design even though it is only expected that the Interim phase will exist for about 5 years, the design needs to consider the "worst case" scenario. From running numerous HEC-2 models it was found that the Interim freeway condition was the control for scour computations in both the 100 year and the 500 year superflood event. This is due to the fact that without the numerous piers (including debris blockage) for the ramp and future mainline bridges the Froude Numbers and velocities are highest for this case, and that has the greatest influence for effecting the depth of scour. Since this scenario experiences the highest velocities however, it results in a lower depth of flow and water surface profile. Because of this the ultimate condition will be used to establish freeboard to the top of the channel and low chord of bridges discussed in Section V, next.

V. ULTIMATE FREEWAY CONDITION

For this stage a total of 5 bridges will be in place:

1. Eastbound Frontage Road Bridge (built in Interim phase).
2. Ramp "B" bridge.
3. Pima Freeway (Loop 101) Mainline Bridge (1 structure).
4. Ramp "A" bridge.
5. Westbound Frontage Road Bridge (built in Interim phase).

All bridges will be constructed as double spans, with a single center pier arranged in 2-column bents for all bridges except the Pima Freeway mainline bridge, which will have a 4 column bent. The columns will be supported on 1.219m (4 ft. diameter equiv.) drilled shafts. The pier diameter will also be 1.219m. All pier bents will be aligned with the flow, as well as the abutments. In order to achieve this the skew angle of all bridges will vary slightly depending upon the ramp and road centerline geometry. A constant channel bottom width of 31.00m will be maintained throughout the reach. The depth of flow varies, per the computed water surface profile and the top of channel grade was set to achieve as close to 0.61m (2.0 ft.) freeboard as possible (see calc's in technical appendix). This being the case, the amount of "shelf" distance will vary slightly from the bridge abutment to the edge of the top of the channel. A minimum freeboard distance of 0.914m (3.0 ft.) was maintained to the low chord elevation of all bridge structures. Bridge clearance calculations are included in the technical appendix. The design storm event for this installation is 100 year, due to urbanized conditions in a "FEMA" controlled floodway. Scour computations for the 500 year superflood event will control the design for depth of drilled shafts and channel bank protection, as well as the grade control structure.

3' (min)

For purposes of 404 permitting it has been estimated that the total area of disturbance will be 2.7 acres. Since the area is under 10 acres, but over 1/3 acre, application will be made for a nationwide permit, section 26, to the U.S. Army Corps of Engineers. Under this section, no extensive mitigation measures are necessary after acceptability to U.S. Fish and Wildlife and Arizona Game and Fish Services.

VI. HYDRAULICS COMPUTATIONS/HEC-2 INPUT

Bridge hydraulics computations have been done in accordance with section 610 of the ADOT "draft" Metric Roadway Design Guidelines of May 27, 1994, as the final edition is not yet available. No adverse backwater conditions are created by the design, and the water surface profile returns to the existing state just beyond the drop structure at station 10+180, (see HEC-2 runs in technical appendix). An existing residential subdivision exists approximately 80m east of the centerline of Cave Creek Wash at Station 10+070. Comparing the computed water surface for the 100 year storm with the lowest adjacent pad elevation at the north most residence on the west side of 4th street reveals that it is 1.38m (or 4.5 ft.) above the flood stage. This condition is the same for both the re-channelized design as well as the wash in it's existing state.

The following list describes the HEC-2 computer model runs to analyze and design the bridge hydraulics and re-channelization of Cave Creek Wash.

1. **File: CC1.IN** – this run computes the 100 year water surface profile for the existing Cave Creek Wash before rechannelization and excluding future Sanifill Inc., upstream improvements. The model simulates the behavior of the wash in it's present state.
2. **File: CC1A.IN** – this run computes the 100 year water surface profile for existing Cave Creek Wash with future Sanifill Improvements in place, (e.g., to 1,000 ft. north of ADOT right-of-way); and no ADOT rechannelization in place yet. This simulates the condition of how the stream will react to upstream Sanifill Improvements before ADOT construction begins for the Outer Loop.
3. **File: CC1B.IN** – this run is superseded and is not included in the appendix. Upon an initial, informal review with ADOT, it was desired to move the drop structure upstream to the north to cut down the amount of hardbank channelization necessary before daylighting back to the existing channel thalweg. Therefore the drop structure was moved about 65m (215 ft.) upstream, and channel improvements terminated shortly thereafter. From this point of termination, channel grading will be done to reach the point of beginning of re-channelization at Cave Creek Wash-station 10+115.378. This can be seen on the plans provided at the end of the report.

4. **File: CC1C.IN** – this run computes the 100 year and 500 year superflood water surface profiles for Cave Creek Wash with re-channelization and the Eastbound and Westbound Frontage Road bridges inplace. This model also employs the upstream Sanifill improvements. As mentioned earlier, the 500 year event is run with this model in the interim condition, because it yields the highest velocities, and Froude Numbers, before future ramp and mainline bridges are installed providing greater resistance to streamflows. This being the case, it will have the greatest impact on scour depths and will be the controlling water surface profile in that regard. This model simulates the expected streamflow conditions for this project before ultimate conditions are installed.
5. **File: CC1D.IN** – this run computes the 100 year water surface profile for ultimate, full buildout conditions of the freeway. It includes all 5 bridges in place, 3 more than the previous model, CC1C.IN (Ramp A&B and mainline bridge). This simulates the water surface profile expected after completion of all freeway facilities and is the controlling highwater surface for channel design and minimum freeboard design to the low chord of all bridge structures (e.g., 0.914m or 3.0 ft. Minimum). This run utilizes proposed re-channelization as well as upstream Sanifill improvements.

The input and output files (hardcopy) for these runs can be found in the technical appendix of the report. For clarity and convenience cross sections are included with all runs plotted to a scale that fits on 8-1/2" x 11" standard size sheets. To accomplish this the "Plot-2" routine was used in the HEC-2 program.

The Mannings "n" value used for the Sanifill Improvements was 0.045. This included a wetted perimeter comprised of riprap on the bottom and sidescopes using a size of 12"-D50 (average particle size), 2 ft. deep on the slopes and 3.5 ft. deep in the channel bottom. This can be seen in Figure 2.

PB proposes to use a temporary Riprap channel within the limits between the Eastbound and Westbound Frontage Road bridges. This was chosen as the most economical method of construction given the fact that this reach of the channel is temporary and will have to be removed and replaced at the time of future freeway construction for ultimate conditions at the time the ramp and mainline bridges will be installed. PB asked AGRA Earth and Environmental to give it's recommendation on riprap lining on a 2:1 sideslope. They

computed a D50 Size of 10 inches minimum (conventional 12" size will be used). This was feasible in large part due to the fact that the Froude Number is in the 0.55 to 0.60 range. This was made possible because the channel through the bridge section was flattened to 0.60% and a 1.7 meter (5.6 ft.) grade control drop structure was placed approximately 66 meters downstream of the Eastbound Frontage Road bridge. This location was chosen because it is just downstream of the 7th Street outfall system and also because it was not too close to the bridge structures and out of the hydraulic influence of rapidly varying flow conditions. More is discussed on this topic in next two sections.

The following expansion and contraction coefficients were used in the HEC-2 model:

	Contraction	*Expansion*
Normal channel outside of bridge limits	0.1	0.3
*Within Bridge Sections	0.5	0.7

* This coefficient is slightly higher than normally used. The reason for this was suggested by Bob Ward, P.E. due to the fact that substantial debris blockage will most likely be encountered in this area. It's better to be a little on the conservative side for design. Bob is acting in a Subconsultant capacity to PB on the project and is well recognized as one of the foremost authorities in hydrology and hydraulic design in the Phoenix Metro area. The September 1990 version No. 4.5.1 of the HEC-2 model was use to perform "Standard Step" backwater analysis for this project (see references). For the most part the design employs gradually varying flow conditions in steady state regimes. Other than flow through the grade control drop structure, subcritical flow is maintained within ADOT's limits of construction. Without the drop structure this would not be the case as flow conditions would be in the supercritical range.

VII. SCOUR COMPUTATIONS

Scour Computations have been performed in accordance with ADOT Criteria and Hydraulic Engineering Circular No. 18 (HEC-18, see references). The following table summarizes the

total scour computed for the 100 year and 500 year superflood event. This will be followed by a brief discussion of the individual scour components.

Scour Results Summary

100 Year Flood Q = 5500cfs = 155.7cms	***Abutments E&W***	***Pier***
Degradation	2.5'	2.5'
Contraction Scour	0.5'	0.5'
Bend Scour	0	0
Local Scour	6.5'	13.5'
TOTAL	9.5'	16.5'
500 Year Superflood Q500 = 11,000 cfs = 311.5 cms	***Abutments E&W***	***Pier***
Degradation	2.5'	2.5'
Contraction Scour	0.5'	0.5'
Bend Scour	0	0
Local Scour	9.5'	15.5'
TOTAL	*12.5'	18.5'

* Note: ADOT requires design scour to be for the 500 year Superflood Event. Also, policy for bridge structure is to design abutments for the same depth as piers when abutment scour computes less than pier scour.

In order to gain an appreciation for existing conditions PB personnel have visited the site on several occasions, (see pictures, page 13). In addition, Bob Ward, P.E., PB's hydrology and hydraulic subconsultant has visited the site. This is an important task to complete before attempting hydraulic modeling and scour computations because experience and judgment play an important role in the calculation process. The individual components to scour are as follows: Total Scour is comprised of 4 components: Long-term trends, Contraction scour, Bend scour (where applicable), and Local pier and Abutment scour.

Cave Creek Wash Looking Upstream from Loop 101

Cave Creek Wash Looking Downstream from Loop 101

- **Long-term Trends**

  Long-term trends in channel aggradation, degradation, and lateral migration are predicted qualitatively based on available sources of information including mapping, field observations, history of flooding and erosion, previous inspection reports, geomorphology, soil characteristics, land uses, flow patterns, control works, and any other factors which may have an influence on the river. Since upstream conditions are more clear–water in nature, due to Sanifill's installation of rock gabion mattresses, the opportunity for a deficit in sediment supply exists. This alone would be cause for some concern, but in addition, the HEC-2 model reveals that excessive velocities occur just 100m upstream of the Westbound Frontage Road bridge (V=4m/s), with Froude Number approaching 1.0 or more. Re-grading the downstream channel through the ADOT right-of-way will help substantially, by reducing the grade from almost 1.00% to 0.60%. Even so, it is not unreasonable to predict that over time significant sediment will be transported downstream, degrading the new channel. Given these circumstances we predict that 0.75m (or 2.5 ft.) should be used in estimating long term degradation.

  ok based on Q500 scour protection

- **Contraction Scour**

  Contraction scour is caused by the channel width decreasing at the bridge crossing. contraction scour occurs when the area of flow is decreased, resulting increases in both velocity and bed shear stress in the contracted area. There are two basic forms of contraction scour, live-bed and clear-water, both of which are based on the principle of conservation of sediment transport. Live-bed is the condition where bed material upstream of the crossing is being transported. For live-bed scour, material is removed until equilibrium is reached between sediment transported into and out of the contracted section. Clear-water is the condition where there is no transportation of upstream bed material.

  Live bed conditions exist at the site because the critical velocity for beginning sediment motion is less than average channel velocity. Critical velocities for the flood conditions are below the average flow velocities calculated in the hydraulic analysis.

  FHWA recommends the modified version of Laursen's 1960 equation for estimating live-bed contraction scour. Input parameters for the equation include average depth,

discharge, bottom width, and D_{50} of the bed material. It should be noted that Laursen's equation will overestimate scour if the contraction is the result of bridge piers and abutments. Using the median grain size, k_1 conservatively assumes transported sediment is mostly suspended bed material discharge. The equation is:

$$\left(\frac{Y_2}{Y_1}\right) = \left(\frac{Q_2}{Q_1}\right)^{\frac{6}{7}} \left(\frac{W_1}{W_2}\right)^{k1} \left(\frac{n_2}{n_1}\right)^{k2}$$

where:

Y_1 = average depth in the upstream main channel.

Y_2 = average depth in the contracted section

W_1 = bottom width of the upstream main channel

W_2 = bottom width of the contracted section

Q_1 = flow in the upstream channel transporting sediment

Q_2 = flow in the contracted channel

K_1 and K_2 = relates to the mode of bed material transport (contact bed material vs. Suspended bed load). (Page 10-HEC-L8)

$Y_S=Y_2-Y_1$=average scour depth.

n_1 = Manning's "n" for upstream main channel

n_2 = Manning's "n" for contracted section.

For the Cave Creek Wash crossing live-bed conditions will prevail. Since the flow area of the stream is only decreased by the pier width plus debris blockage (4'+4'=8' for 2 span bridge) we would expect to see minimal contractual scour here.

- **<u>Bend Scour</u>**

Since the stream is being re-aligned horizontal deflections are very minor and no channel bends will occur. Therefore there will be no bend scour for these bridges.

- **Local Scour**

Local scour is the result of water flowing around a pier, abutment, or other obstruction. These obstructions induce the formation of vortex systems caused by the acceleration of the flow around the obstruction. A horseshoe vortex is formed by water hitting the upstream surface of the obstruction and then traveling down the pier. In addition, piers have horizontal vortices, referred to as wake vortices, acting transverse to the pier downstream of the obstruction. Both vortices remove material from the base of the obstruction. However, the intensity of the vortices diminishes downstream from the obstruction.

The Colorado State University (CSU) equation is recommended for both live-bed and clear-water pier scour. The basic input parameters are flow depth, pier shape. Froude number, pier width, and angle of attack. The angle of attach on the bridges is 0 degrees, i.e., the flow is normal to the bridge. A pier width of 4 feet was used of which an additional 4 feet was added for debris blockage.

The CSU equation estimates equilibrium scour depths. Depending on the bed configuration, adding a recommended correction factor to the equilibrium scour yields the estimated maximum scour. The CSU equation is:

$$\frac{Y_s}{Y_1} = 2.0 K_1 K_2 K_3 \left(\frac{a}{Y_1}\right)^{0.65} Fr_1^{\,0.43}$$

where:

Y_S = scour depth

Y_1 = flow depth just upstream of the pier

K_1 = correction for pier nose shape

K_2 = correction for angle of attack

K_3 = correction for bed configuration

a = pier width (plus debris blockage)

Fr_1 = Froude number; $Fr_1 = V_1/(gY_1)^{1/2}$

V_1 = Mean Velocity of flow directly upstream of the pier.

Froehlich's live-bed equation, shown below, is used for estimating live-bed and clear-water scour at abutments. The equation is based entirely on laboratory data and provides very conservative estimates of scour. The basic input parameters are Froude number, shape, and projection of abutment, skew, and depth of flow. The use of engineering judgment is recommended in using these estimates of abutment scour depth, because cost will be the deciding factor between greater foundation depth or protection of the abutment area.

$$\frac{Y_s}{Y_a} = 2.27 K_1 K_2 \left(\frac{a'}{Y_a}\right)^{0.43} Fr^{0.61} + 1$$

Where:

K_1 = coefficient for abutment shape.

K_2 = coefficient for angle of embankment to flow.

$a' = A_e/Y_a$ = length of abutment projected normal to flow.

A_e = flow area of the approach cross section obstructed by the embankment.

$Fre = V_e/(gY_a)$ = Froude number of approach flow upstream of the abutment.

$V_e = Q_e/A_e$.

Q_e = flow obstructed by the abutment and approach embankment.

Y_a = average depth of flow on the floodplain.

Y_s = scour depth.

- **Total Scour**

Total scour at any location is estimated as the sum of any long term trends, contraction scour, and local scour. The top width of a scour hole is estimated to be 2.8 times the predicted scour depth. Debris blockage will add to the effective width of the piers and thus increase the scour depth. This increase in the scour depth has a direct result on the width of the scour hole as noted above.

Studies have shown that if the estimated limits of the scour holes overlap, the resulting scour may be deeper than originally estimated. It may be appropriate to use some factor of safety in determining total scour if this condition applies in dense pier configurations. Scour computations can be found in the technical appendix of this report.

VII. BANK PROTECTION

Because of the channelization involved to tie-in bridge structures, with downstream re-channelization and a grade control drop structure, bank protection will be necessary for both the interim and ultimate conditions. PB retained the services of it's subconsultant, Agra Earth and Environmental, Inc., geotechnical engineers to make recommendations for the bank lining improvements (see references).

For the reach of channel between the Eastbound and Westbound Frontage Road bridges a temporary bank lining is necessary, due to the fact that the remaining bridges (ramp "A", "B", and Pima Mainline – Loop 101) will be installed sometime in the future. This will require removal of the bank protection to install those bridges. At that time permanent bank protection will be installed. The most cost effective interim bank protection is a riprap layer installed on 2:1 sideslopes (ungrouted). This is possible due to the relatively low Froude number within this reach (≅0.60), which is facilitated by reducing the grade to 0.60% and installing a drop structure downstream. Agra Earth has recommended that 12" D50 riprap be used for a depth of 2.5 ft. (~0.75m) on the sideslopes extending 8 ft. (2.44m) minimum horizontally across the channel bottom. The top of the riprap layer should extend down to the predicted scour depth (13 ft. or ~4m). This is depicted in the typical sections in the plans portion of this report. Agra Earth also recommended a high survivability filter fabric under the riprap layer. Upon further discussions with PB less costly alternatives will be explored such as gravel bedding or low survivability fabrics, since it is expected to be in place for only 5 years. A decision will be deferred to final design.

For that portion of the channel that is permanent, e.g., downstream of the Eastbound Frontage Road bridge, Agra Earth has recommended Cement Stabilized Alluvium (CSA) hardback improvements for both the channel bank and the drop structure. This is the most economical choice and will integrate well to provide a natural (riparian) look to the improvements with an earth graded bottom.

The geotechnical report by Agra Earth indicates that the surface materials present within the active wash consist of gravely sand, sand, gravel and cobbles. The deeper borings indicate that coarse grained materials extend to depths of about 10 meters below existing grade.

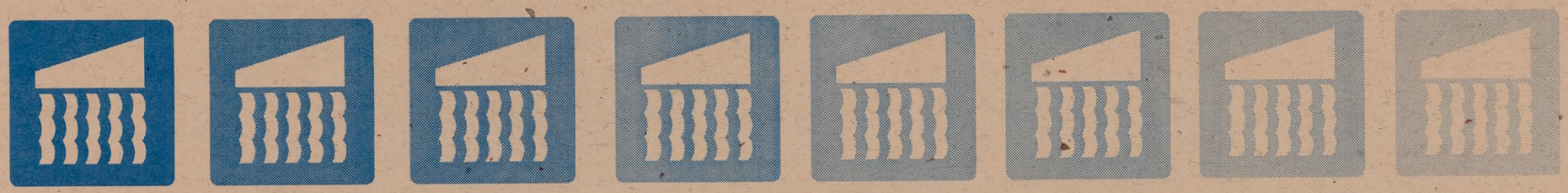
Soils are generally nonplastic to low in plasticity and tan to light brown in color. These materials would be suitable for constructing a CSA hardbank. Agra recommends widths of 2.4m (~7.9 ft.) be used in bringing up lifts when constructing the embankment. Also, the soil cement should extend a minimum of 1 meter below the maximum predicted level of scour. In this case that would be, 12.5' + 4.3 ≃17 ft. Rounded, or about 5 meters. Constructing the channel banks on a 2:1 sideslope ~26.5°) should present no problem as Agra recommends a maximum sideslope of 1.25:1 not be exceeded. This allows us to use a 1.5:1 sideslope below the channel grade to minimize excavation in the wash, (see typical sections in plans). The geotechnical report, included with this submittal gives a design mix in Appendix C and some guidelines to be included in the special provisions.

The plans included herein show typical sections and the stationing limits of CSA construction. In addition, as mentioned earlier, the grade control drop structure will also be constructed of CSA, and can be easily integrated into the permanent construction of the channel banks.

CSA should be trimmed above the channel invert. ✓

IX. REFERENCES

1. "Bridge Structure Selection Report for Cave Creek Wash Bridges at the Pima Freeway (Loop 101) Crossing". By Cannon and Associates, Inc. for ADOT, revised December 11, 1995.
2. Final (sealed) construction plans for Sanifill Inc. of Arizona, "East Cave Creek Wash Channelization for Lone Cactus Landfill (Phase II)". By Morrison Maierle/CSSA Inc., March 29, 1996.
3. ADOT "Draft metric Roadway Design Guidelines, Chapter 600, Highway Drainage Design", May 27, 1994.
4. "Open Channel Hydraulics", Ven Te Chow, Ph.D., McGraw-Hill Publishers, 1959.
5. "Handbook of Hydraulics", 5th Edition, King and Brater, McGraw-Hill Publishers, 1963.
6. "Embankment Stabilization Design Report for Interim Design of the Pima Freeway @ Cave Creek Wash," by AGRA Earth and Environmental, Inc., June 26, 1996.
7. "HEC-2 Water Surface Profiles User's Manual," by the U.S. Army Corps of Engineers, Hydrologic Engineering Center, September, 1990, revised September, 1991.
8. "Hydraulic Engineering Circular No. 18, Evaluating Scour at Bridges, second edition," U.S. Department of Transportation, Federal Highway Administration, revised April, 1993.



PART A CORRESPONDENCES

PARSONS BRINCKERHOFF

TELEPHONE CONVERSATION MEMORANDUM

Project: Pima Freeway - 56th St. **Job No.:** 11032S **Date:** June 26,96

From: Bob Battistello **Talked to:** Amir Motamedi - FCDMC
Ph: 506-1501

Re: Inquire as to what the 500 year "Superflood" flowrate is to do bridge scour computations.

Amir supplied me with the following:

The 500 year flowrate below Deer Valley Road is 11,000 cfs or = 311.48 cms. in Cave Creek. He obtained this information from the FEMA Flood Insurance Study, revised in September, 1995.

The reason this flow is so much greater than the 100 year event is due to the fact that Cave Buttes Dam is designed for a ~~Probable Maximum Flood~~ Standard Project Flood event "~~PMF~~ SPF" in the range of 200 to 300 year event. Overtopping occurs through the emergency spillway beyond the ~~PMF~~ SPF event.

This flowrate (311.48 cms) will be used in our HEC-2 model to compute pier and abutment scour for toe-down depths.

cc: file

RECEIVED
APR - 1 1996
PARSONS BRINCKERHOFF
TEMPE

Morrison-Maierle/CSSA, Inc.
4621 North 16th Street Suite, D-401, Phoenix, Arizona 85016 *Phone: 602-277-2828 Fax: 602-279-2554*

Project No. 11032
Original To Central File
PM RCM
Route To:
DJH
BJB
R Miro

Remarks Plans to Miro

April 01, 1996

Mr. Bob Battistello, P.E.
Project Manager
Parsons Brinkerhoff Quade and Douglas
1501 West Fountainhead Parkway, Suite 400
Tempe, Arizona 85282

ATTN: Sulista

RE: Pima Freeway, JCT I-17 to 56th Street
TRACS NO. H 3565 01D
Cave Creek Wash

Transmitted herewith for your use are two sets of the Final Construction Plans for East Cave Creek Wash Channelization at Lone Cactus Landfill (Phase II), MMI, 3-29-96.

Please submit any comments you may have no later than April 12, 1996.

MORRISON-MAIERLE/CSSA, INC.

Bruce Friedhoff

Bruce J. Friedhoff, P.E.
Phoenix Office Manager

Enclosures
Copy: Greg Czerniski

Sanifill

Quality Service with Integrity

June 21, 1995

Bob Battistello
Parsons Brinkerhoff Quade & Douglas, Inc.
1501 West Fountainhead Parkway
Suite 400
Tempe, Arizona 85282

RE: Cave Creek Wash (CCW) and Pima Freeway - OuterLoop 101 Intersection.

Dear Bob:

I have enclosed a blueline copy, along with descriptive documentation for the CCW channelization. As you can see, the original design called for the CCW to widen near the southern end (CCW and Beardsley intersection) to accommodate for 24 10-foot box culverts.

I've also enclosed the most recent aerial topographical blueline to show existing contours.

Sanifill wishes to have DOT re-designed the CCW and 101 intersection to accommodate the existing uniform channel and not require CCW to widen near this intersection. Sanifill believes that one of the only ways to accomplish this is to use bridges, instead of box culverts.

If you have any questions please don't hesitate to contact me at 242-5143.

Sincerely,
Sanifill of Arizona, Inc.

Greg Czerniski
District Engineering Coordinator

ARIZONA DEPARTMENT OF TRANSPORTATION
OFFICE MEMO
January 10, 1991

To: Drainage Design Services

From: George Lopez-Cepero, Supervisor
Bridge Drainage Services

Subject: Bridge Pier Debris and Stream Force Criteria

As stated in Vol. I POLICY, Section B.3 BRIDGE SCOUR debris shall be considered when calculating pier scour. The debris blockage shall be considered for a depth of 12 feet and a width of 4 feet. The effective pier diameter "a" in Colorado State's pier scour equation (Richardson et al, 1987) shall be determined as follows:

For framed bents: a.) If the clear spacing between columns/shafts is less than 16 feet, the sum of the column/shaft diameters plus 4 feet shall be used as the pier diameter. b.) If the clear spacing is 16 feet or more, use the individual column/shaft diameter plus 4 feet as the pier diameter.

For bridges with stem wall piers use the pier width plus 4 feet.

The skew angle shall be applied to this effective width.

The debris blockage shall extend to a depth of 12 feet from the computed water surface. When the depth of flow is less than 12 feet, the depth of debris blockage shall be set equal to the depth of flow. If the depth of flow is greater than 12 feet, use the debris blocked width to 12 feet, then use the pier width below 12 feet. In determining the design scour depth where the depth of flow is greater than 12 feet, two computations may be necessary; one based on a debris blocked width and one based on the pier width. The calculated scour depth based on the blocked width shall be applied from the bottom of the debris blockage. The calculated pier scour depth based on the unblocked width shall be applied from the stream bed after application of degradation and contraction scour. The greater of the two depths shall be used as the pier scour.

The stream force shall be applied by considering the debried width for the length of column with debris (h<=12). The column width shall be used from the bottom of debris to the channel bottom. The force shall linearly decrease to zero from the channel bottom to the bottom of the scour hole. For columns at a spacing of 16 feet or greater, the stream force shall be applied to each column. For columns at less than 16 feet, the stream force may be equally distributed to all the columns in the frame.

George Lopez-Cepero
George Lopez-Cepero

PART B HEC-2 WATER SURFACE PROFILES

```
*********************************************
*  HEC-2 WATER SURFACE PROFILES             *
*                                           *
*  Version   4.5.1;  September 1990         *
*                                           *
*  RUN DATE    03JUN96    TIME    13:27:57  *
*********************************************
```

```
*****************************************
*  U.S. ARMY CORPS OF ENGINEERS         *
*  HYDROLOGIC ENGINEERING CENTER        *
*  609 SECOND STREET, SUITE D           *
*  DAVIS, CALIFORNIA 95616-4687         *
*          (916) 756-1104               *
*****************************************
```

```
X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X    X            X     X
X     X  X        X                 X     X
XXXXXXX  XXXX     X         XXXXX    XXXXX
X     X  X        X                 X
X     X  X        X    X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
```

END OF BANNER

FILE: CC1.IN, DAT FILE
CC1.OUT, OUTPUT FILE

→ EXISTING CAVE CREEK WASH without REMAINING (LAST) 1000 ft. OF CHANNEL IMPROVEMENTS BY SANIFILL INC. (Const. LANDFILL Oper.) e.g. FROM BEARDSLEY RD. TO 1000 ft NORTH THEREOF.

→ Q 100 YR. = 5500 cfs = 155.7 CMS
PER BOB WARD RESEARCH (FROM DCCO cont'd.)

NEXT IN SEQUENCE — SEE FILE: CC1A.IN, FOR EXISTING CONDITIONS INCLUDING the NEW Improved SANIFILL CHANNEL 1000 ft. NORTH OF BEARDSLEY RD.

```
menu2

G:\DRNG\HECEXE2>hec2menu.exe
Stop - Program terminated.

G:\DRNG\HECEXE2>echo off

CAVE CREEK, EXISTING

  Starting profile number  1

        CWSEL for cross section  10016.000 is   433.43
        CWSEL for cross section  10050.000 is   433.74
        CWSEL for cross section  10090.000 is   433.97
        CWSEL for cross section  10138.000 is   434.23
        CWSEL for cross section  10181.000 is   434.48
        CWSEL for cross section  10220.000 is   434.90
        CWSEL for cross section  10258.000 is   435.26
        CWSEL for cross section  10298.000 is   435.75
        CWSEL for cross section  10318.000 is   435.95
        CWSEL for cross section  10346.000 is   436.35
        CWSEL for cross section  10386.000 is   437.24
        CWSEL for cross section  10434.000 is   437.47
        CWSEL for cross section  10480.000 is   437.87
        CWSEL for cross section  10536.000 is   437.69
        CWSEL for cross section  10608.000 is   438.98
        CWSEL for cross section  10684.000 is   440.41
        CWSEL for cross section  10745.000 is   440.64
        CWSEL for cross section  10819.000 is   440.81
        CWSEL for cross section  10872.000 is   441.14
        CWSEL for cross section  10924.000 is   441.38

Normal program termination

Press any key to continue . . .

Stop - Program terminated.
```

THIS RUN EXECUTED 03JUN96 13:27:57

```
*************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.5.1;  September 1990
*************************************


T1      PIMA FREEWAY BRIDGE CROSSING AT CAVE CREEK (BEARDSLEY ROAD ALIGNMENT)
T2      HYDRAULIC ANALYSIS FOR EXISTING CAVE CREEK 100-YEAR FLOODPLAIN
T3      CAVE CREEK, EXISTING
T4      MODEL CC1.IN, SUBCRITICAL FLOW
T5      ALL INPUT DATA IS IN METRIC UNITS
T6 *    DISCHARGES IN cfs: 5,500,  ---> no, in cms
T7      ALL CROSS-SECTION DATA COMPILED BY INTER-GRAPH DTM USING "INROADS"

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

              2                             .0090       1                             434

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

    1                   -1                                      -1


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

    38        43        1         8         4         55        13        26        14        56
    15        27        28        0         38        43        16        17        18        21
    22        53        54        5         68        39        66

J5  LPRNT     NUMSEC                        ********REQUESTED SECTION NUMBERS********

    -10       -10


NC     .070      .070      .055      .1        .3
QT        1     155.7 = 5500 cfs

X1    10016        26     24.05     92.25      0.00      0.00      0.00
GR    435.1      0.00    434.17      3.97    434.00     12.60    434.43     21.14    434.77     24.05
GR    433.1     28.29    432.52     37.64    432.58     42.85    432.64     45.19    432.25     49.18
GR    431.6     52.47    431.91     64.73    431.15     71.89    431.22     78.26    433.74     83.03
GR    434.3     84.41    434.67     92.25    437.40    105.73    437.36    108.04    435.13    112.82
GR    435.4    118.85    435.95    130.73    435.84    156.21    436.31    160.77    436.01    164.00
GR    435.9    176.58
```

X1	10050	23	35.40	108.84	40.50	103.00	34.34			
GR	435.8	0.00	435.51	10.13	435.28	31.52	434.90	35.40	433.01	46.79
GR	432.8	59.86	432.55	62.60	431.85	64.32	432.08	73.93	431.89	84.94
GR	431.3	91.76	431.35	97.50	434.94	102.80	435.07	108.84	437.52	122.01
GR	437.4	124.54	435.95	128.39	436.05	132.85	436.68	139.98	437.04	147.16
GR	437.4	150.41	436.52	161.21	436.67	171.80				
X1	10090	25	22.89	90.00	40.00	39.60	39.64			
X3				22						
GR	434.5	0.00	434.88	4.06	433.52	13.51	435.01	20.53	435.11	22.89
GR	432.8	30.64	432.73	41.24	432.04	43.25	432.30	55.29	432.86	63.13
GR	432.3	68.19	432.14	75.05	431.52	77.65	431.52	82.13	434.93	88.12
GR	435.4	90.00	435.53	94.70	437.66	106.05	437.61	108.96	436.15	111.67
GR	436.5	121.17	437.35	125.11	437.92	132.78	437.48	137.78	437.66	158.31
X1	10138	26	13.15	78.46	37.80	50.00	48.59			
GR	434.8	0.00	434.11	8.52	433.59	13.15	433.15	21.77	432.68	29.95
GR	432.0	32.23	433.01	43.89	432.77	58.72	432.80	63.36	432.01	67.94
GR	432.2	72.91	435.25	78.46	435.33	78.61	435.33	78.64	435.47	83.19
GR	435.2	85.63	435.54	94.45	438.23	107.92	438.26	110.86	436.94	113.74
GR	437.0	117.62	438.01	119.98	438.03	126.60	437.81	131.50	438.06	147.90
GR	438.0	149.98								
X1	10181	23	0	65.87	33.50	42.50	42.84			
GR	435.7	0.00	434.84	10.45	434.35	21.04	433.28	24.41	433.15	32.70
GR	433.1	51.68	432.66	58.77	432.46	63.14	432.97	65.87	432.88	69.68
GR	434.4	78.04	435.52	82.70	435.50	90.68	435.25	93.97	435.43	105.66
GR	435.7	108.97	438.23	122.27	438.16	125.28	437.21	127.50	438.20	131.59
GR	438.5	147.81	438.68	161.84	438.75	167.81				
X1	10220	27	4.52	57.88	47.20	35.00	38.72			
GR	435.7	0.00	435.64	4.52	434.55	10.17	434.22	17.02	434.39	19.29
GR	434.2	27.84	433.76	30.69	433.44	40.92	432.82	52.48	433.65	57.88
GR	433.4	68.63	433.40	74.95	434.23	78.88	434.27	81.88	435.00	85.50
GR	436.1	92.49	436.25	98.60	435.29	104.15	435.54	116.75	435.71	119.93
GR	438.3	132.66	438.54	135.59	437.60	138.26	438.48	142.60	438.39	152.68
GR	438.5	167.67	438.87	177.08						
X1	10258	28	30.08	58.27	40.00	35.50	38.55			
X3				3.5						
GR	436.2	0.00	436.68	3.39	435.92	6.68	435.42	27.54	435.42	29.71
GR	435.4	30.08	434.37	38.43	433.61	42.87	433.55	55.98	434.06	58.27
GR	434.2	71.89	433.86	83.18	433.92	86.26	434.85	88.56	434.95	89.99
GR	435.1	94.39	435.57	101.08	436.27	105.31	436.24	116.72	435.48	125.81
GR	435.9	139.00	438.34	151.93	438.50	156.27	438.40	159.18	438.83	162.55
GR	439.0	176.33	438.79	185.59	438.93	193.10				

X1	10298	29	54.49	79.63	44.40	31.60	39.85			
X3				51.9		126.3				
GR	436.4	0.00	436.90	8.21	436.69	13.19	436.84	21.38	436.23	27.88
GR	435.5	35.01	435.90	37.47	435.41	41.13	435.45	47.74	436.55	51.34
GR	436.3	54.49	434.54	58.85	434.08	66.40	434.07	77.03	434.61	79.63
GR	434.4	91.49	434.18	95.92	434.55	102.16	435.69	106.93	435.49	113.14
GR	435.6	116.85	436.58	121.75	436.59	129.46	436.09	145.86	435.75	151.61
GR	435.9	160.13	438.46	173.52	438.93	184.15	439.31	193.71		
X1	10318	23	9.88	34.71	26	13.00	19.52			
X3				6		74.9				
GR	438.6	0.00	437.80	3.93	437.73	8.08	437.15	9.88	434.75	14.54
GR	434.5	19.69	434.18	21.68	434.47	31.67	434.60	34.71	434.36	38.21
GR	434.6	43.87	434.35	47.74	435.62	53.62	435.19	58.21	436.61	67.38
GR	436.7	77.48	436.47	88.63	435.87	106.14	435.97	109.88	438.60	123.09
GR	439.0	131.28	439.80	136.21	440.37	142.59				
X1	10346	29	36.34	58.89	29.50	28.00	28.49			
X3				29.4		88.5				
GR	437.6	0.00	437.35	9.29	435.58	15.99	435.67	20.91	435.63	21.62
GR	435.2	29.00	435.31	36.34	434.99	46.86	433.99	49.74	434.16	52.97
GR	435.4	58.89	435.52	62.75	436.16	65.35	435.85	66.38	435.44	68.24
GR	435.9	70.80	436.61	75.86	436.56	81.61	436.83	90.48	436.54	112.65
GR	436.6	114.80	435.98	119.63	436.01	127.57	439.04	141.74	439.07	149.70
GR	438.8	153.55	439.15	156.73	439.19	160.41	439.75	166.51		
NC				.3	.5					
X1	10386	23	49.72	78.85	39.80	38.50	39.65			
X3				54		102.5				
GR	437.7	0.00	435.97	6.23	435.84	11.20	435.34	15.47	435.35	31.41
GR	435.3	42.41	435.45	49.72	435.30	61.99	435.25	69.83	434.66	72.15
GR	434.6	74.88	435.16	78.85	435.85	90.65	436.72	103.87	436.81	108.40
GR	436.3	120.14	436.42	131.74	436.07	138.32	436.47	145.46	438.47	159.93
GR	439.2	163.61	439.37	174.39	438.75	184.83				
NC	.045	.045	.045							
X1	10434	14	28.53	77.29	37.00	55.00	48.34			
X3				32.5		67				
GR	437.4	0.00	437.88	14.85	438.15	28.53	437.57	32.45	435.70	36.80
GR	435.5	40.61	435.33	48.96	435.76	58.39	436.11	62.98	437.17	68.33
GR	437.7	77.29	437.49	87.14	437.56	92.65	437.25	112.12		

NC				.1	.3					
X1	10480	16	32.45	77.26	0.00	0.00	45.59			
X3				32.45		77.26				
GR	434.7	0.00	434.77	9.70	434.83	22.76	437.48	27.36	437.55	32.45
GR	434.9	37.82	434.91	44.64	435.17	48.10	434.93	61.87	439.02	68.95
GR	439.1	77.26	436.62	86.32	436.80	95.87	436.89	101.55	437.26	107.34
GR	437.4	115.39								
X1	10536	15	35.63	62.20	0.00	0.00	56.16			
X3				35.63		62.2				
GR	434.8	0.00	434.70	21.62	438.08	29.85	438.22	35.63	435.43	40.26
GR	435.2	52.84	438.91	59.36	440.12	62.20	440.14	66.45	438.34	68.50
GR	437.9	70.03	437.85	80.18	437.66	90.16	437.49	110.12	437.43	132.86
X1	10608	11	11.98	31.55	0.00	0.00	71.46			
X3				11.98		31.55				
GR	437.4	0.00	438.44	2.42	438.61	11.98	435.86	17.36	435.84	22.55
GR	441.5	31.55	441.27	40.37	440.90	43.87	438.68	49.31	438.09	51.50
GR	438.2	59.64								
X1	10684	14	13.30	47.30	0.00	0.00	76.63			
X3				13.30		47.30				
GR	437.4	0.00	439.02	3.14	438.66	4.84	438.89	11.62	440.03	13.30
GR	437.5	18.22	437.19	20.66	437.00	31.65	439.25	37.18	441.74	41.80
GR	441.8	47.30	438.38	57.41	438.18	70.43	438.18	76.83		
X1	10745	11	13.28	42.81	0.00	0.00	60.57			
X3				13.28		42.81				
GR	437.9	0.00	438.44	1.51	441.73	8.57	441.82	13.28	439.44	18.14
GR	436.0	26.20	436.07	30.78	436.62	32.55	441.63	42.81	441.55	48.73
GR	437.3	57.57								
X1	10819	11	0.00	32.38	0.00	0.00	74.28			
X3						32.38				
GR	442.5	0.00	442.07	3.44	437.35	13.39	437.26	21.46	442.46	32.38
GR	442.4	37.03	440.25	41.44	439.82	46.86	437.83	50.50	437.92	58.72
GR	437.8	60.47								
X1	10872	10	2.43	32.49	0.00	0.00	53.12			
X3				2.43		32.49				
GR	442.6	0.00	442.67	2.43	437.58	13.31	437.44	21.27	442.72	32.49
GR	442.7	37.54	440.08	45.64	437.33	52.09	435.56	55.81	435.22	64.46

X1	10924	13	2.89	31.84	0.00	0.00	51.74			
X3				2.89		31.84				
GR	442.9	0.00	442.94	2.89	439.24	10.76	437.89	14.73	437.66	21.00
GR	443.0	31.84	442.72	40.41	441.58	46.02	439.62	48.10	437.84	52.29
GR	436.4	57.15	435.78	63.16	435.42	69.91				

THIS RUN EXECUTED 03JUN96 13:27:57

****
HEC-2 WATER SURFACE PROFILES

Version 4.5.1; September 1990
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

CAVE CREEK, EXISTING

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	DEPTH	TOPWID	VLOB	QLOB	VCH	QCH	VROB	QROB	STENCL	STENCR
	10016.000	155.70	433.43	2.28	54.99	.00	.00	2.10	155.70	.00	.00	.00	.00
	10050.000	155.70	433.74	2.44	58.66	.00	.00	1.78	155.70	.00	.00	.00	.00
	10090.000	155.70	433.97	2.45	59.73	.00	.00	1.70	155.70	.00	.00	22.00	158.31
	10138.000	155.70	434.23	2.23	69.39	.52	.92	1.70	154.78	.00	.00	.00	.00
	10181.000	155.70	434.48	2.02	60.15	.00	.00	2.15	135.85	1.53	19.85	.00	.00
	10220.000	155.70	434.90	2.08	76.64	.00	.00	1.88	104.94	1.62	50.76	.00	.00
	10258.000	155.70	435.26	1.71	65.39	.00	.00	2.54	86.80	1.86	68.90	3.50	193.10
	10298.000	155.70	435.75	1.68	61.74	.00	.00	2.67	91.18	1.86	64.52	51.90	126.30
	10318.000	155.70	435.95	1.77	50.94	.00	.00	2.95	94.56	2.08	61.13	6.00	74.90
	10346.000	155.70	436.35	2.36	44.64	2.06	15.67	3.61	125.28	1.65	14.74	29.40	88.50
*	10386.000	155.70	437.24	2.64	48.50	.00	.00	2.14	111.71	1.36	43.98	54.00	102.50
	10434.000	155.70	437.47	2.14	34.33	.00	.00	2.72	155.70	.00	.00	32.50	67.00
*	10480.000	155.70	437.87	3.17	34.52	.00	.00	1.83	155.70	.00	.00	32.45	77.26
*	10536.000	155.70	437.69	2.99	20.72	.00	.00	3.93	155.70	.00	.00	35.63	62.20
*	10608.000	155.70	438.98	3.14	15.57	.00	.00	4.65	155.70	.00	.00	11.98	31.55
*	10684.000	155.70	440.41	3.41	26.02	.00	.00	2.37	155.70	.00	.00	13.30	47.30
	10745.000	155.70	440.64	4.64	25.05	.00	.00	2.23	155.70	.00	.00	13.28	42.81

	SECNO	Q	CWSEL	DEPTH	TOPWID	VLOB	QLOB	VCH	QCH	VROB	QROB	STENCL	STENCR
*	10819.000	155.70	440.81	3.55	22.81	.00	.00	2.88	155.70	.00	.00	.00	32.38
	10872.000	155.70	441.14	5.92	23.44	.00	.00	2.73	155.70	.00	.00	2.43	32.49
	10924.000	155.70	441.38	5.96	22.37	.00	.00	2.95	155.70	.00	.00	2.89	31.84

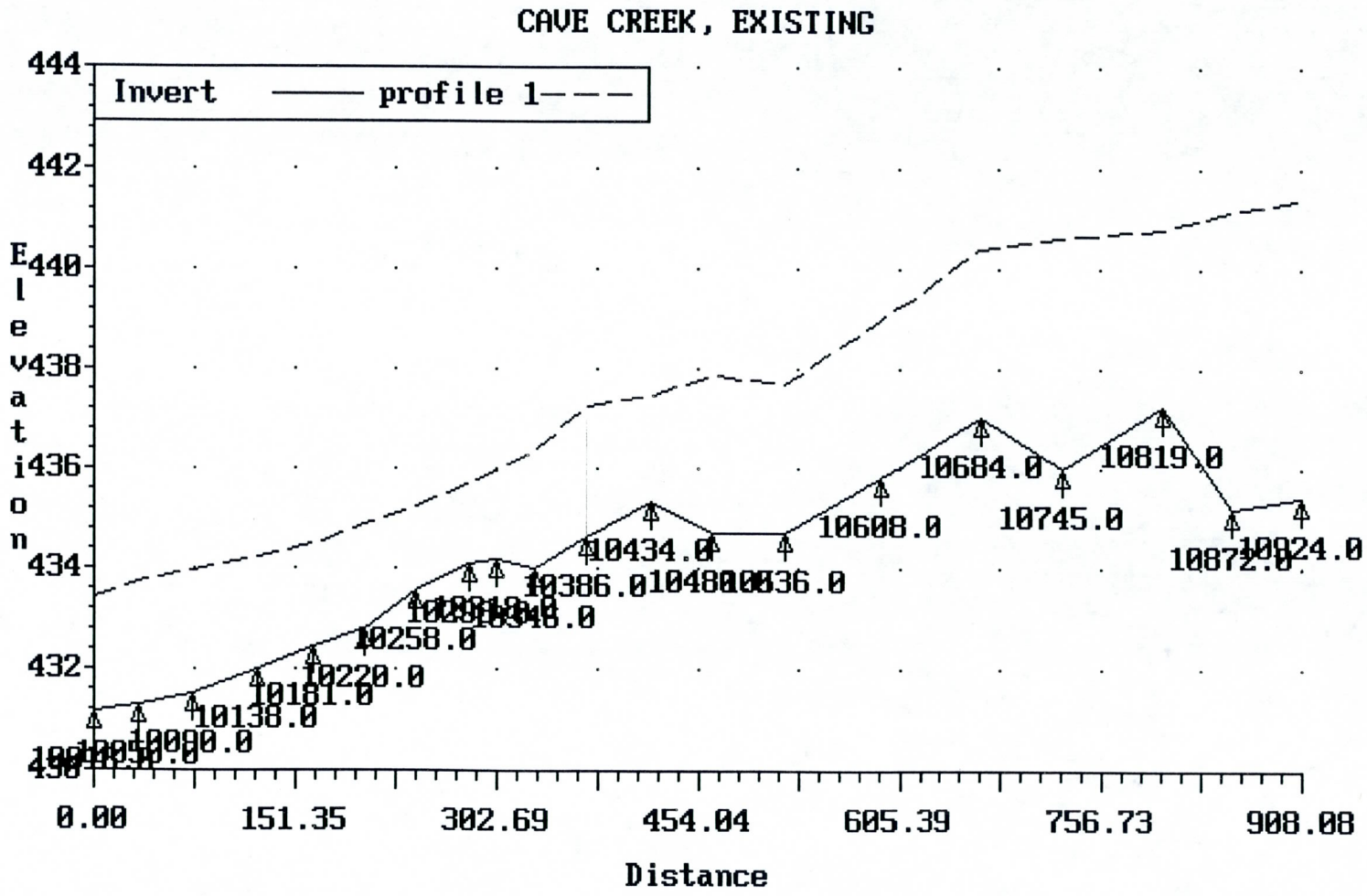
CAVE CREEK, EXISTING

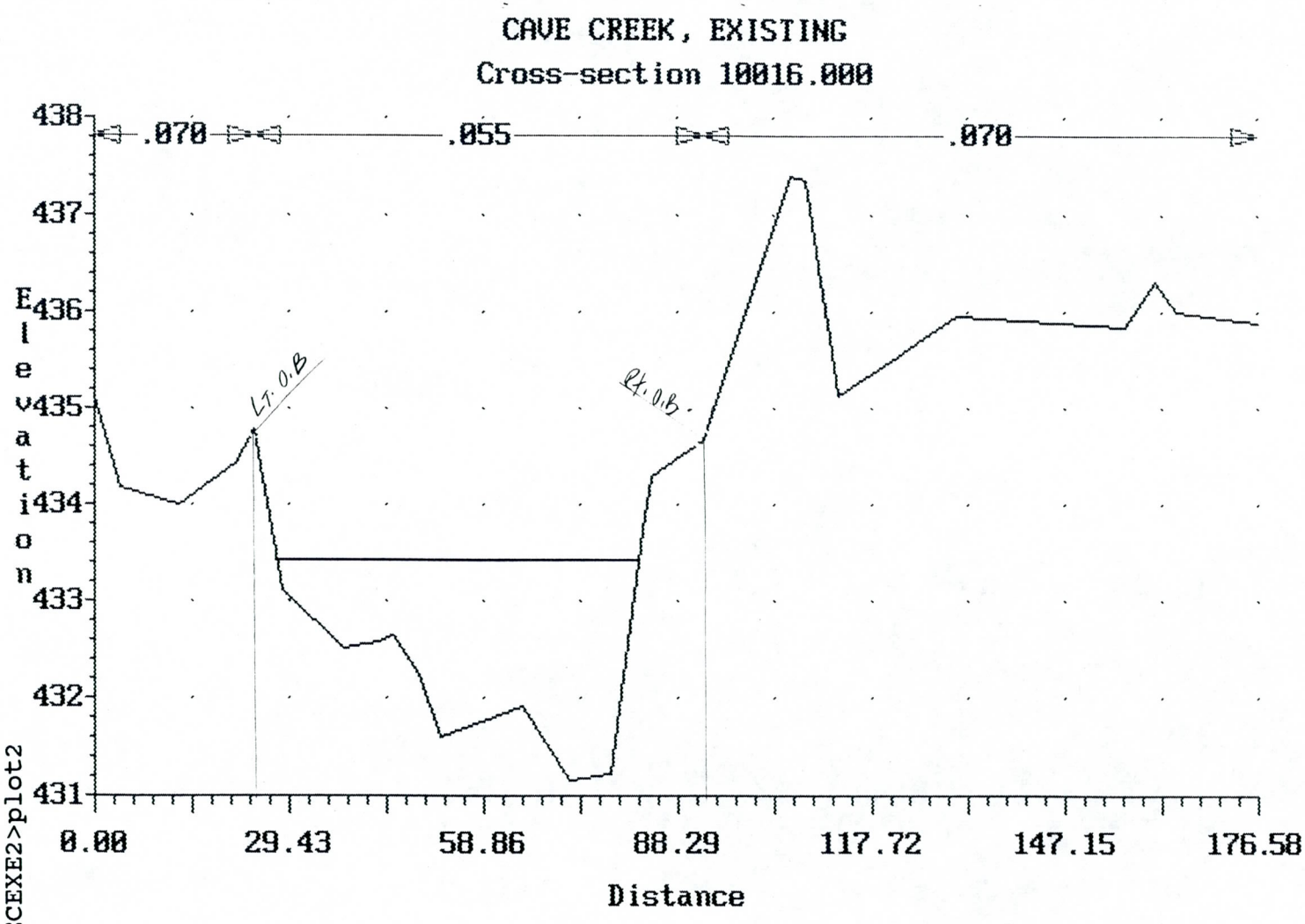
SUMMARY PRINTOUT

	SECNO	Q	K*XNL	K*XNCH	K*XNR	STCHL	STCHR	SSTA	ENDST	10*KS	FRCH	XLCH	CUMDS
	10016.000	155.70	.00	55.00	.00	24.05	92.25	27.46	82.44	90.49	.58	.00	.00
	10050.000	155.70	.00	55.00	.00	35.40	108.84	42.38	101.03	57.86	.47	34.34	34.34
	10090.000	155.70	.00	55.00	.00	22.89	90.00	26.71	86.44	50.20	.44	39.64	73.98
	10138.000	155.70	70.00	55.00	.00	13.15	78.46	7.19	76.58	54.81	.45	48.59	122.57
	10181.000	155.70	.00	55.00	70.00	.00	65.87	18.22	78.37	96.55	.60	42.84	165.41
	10220.000	155.70	.00	55.00	70.00	4.52	57.88	8.36	85.00	92.26	.57	38.72	204.13
	10258.000	155.70	.00	55.00	70.00	30.08	58.27	31.24	96.63	144.55	.72	38.55	242.68
	10298.000	155.70	.00	55.00	70.00	54.49	79.63	55.86	117.59	135.68	.71	39.85	282.53
	10318.000	155.70	.00	55.00	70.00	9.88	34.71	12.20	63.15	167.52	.79	19.52	302.05
	10346.000	155.70	70.00	55.00	70.00	36.34	58.89	29.40	74.04	225.35	.93	28.49	330.54
*	10386.000	155.70	.00	55.00	70.00	49.72	78.85	54.00	102.50	56.77	.47	39.65	370.19
	10434.000	155.70	.00	45.00	.00	28.53	77.29	32.67	67.00	79.10	.67	48.34	418.53
*	10480.000	155.70	.00	45.00	.00	32.45	77.26	32.45	66.97	21.57	.37	45.59	464.12
*	10536.000	155.70	.00	45.00	.00	35.63	62.20	36.50	57.22	142.55	.91	56.16	520.28
*	10608.000	155.70	.00	45.00	.00	11.98	31.55	11.98	27.55	183.86	1.01	71.46	591.74
*	10684.000	155.70	.00	45.00	.00	13.30	47.30	13.30	39.32	35.93	.48	76.63	668.37
	10745.000	155.70	.00	45.00	.00	13.28	42.81	15.71	40.76	28.22	.42	60.57	728.94
*	10819.000	155.70	.00	45.00	.00	.00	32.38	6.10	28.91	57.97	.60	74.28	803.22
	10872.000	155.70	.00	45.00	.00	2.43	32.49	5.70	29.13	50.46	.56	53.12	856.34
	10924.000	155.70	.00	45.00	.00	2.89	31.84	6.20	28.56	61.24	.61	51.74	908.08

SUMMARY OF ERRORS AND SPECIAL NOTES

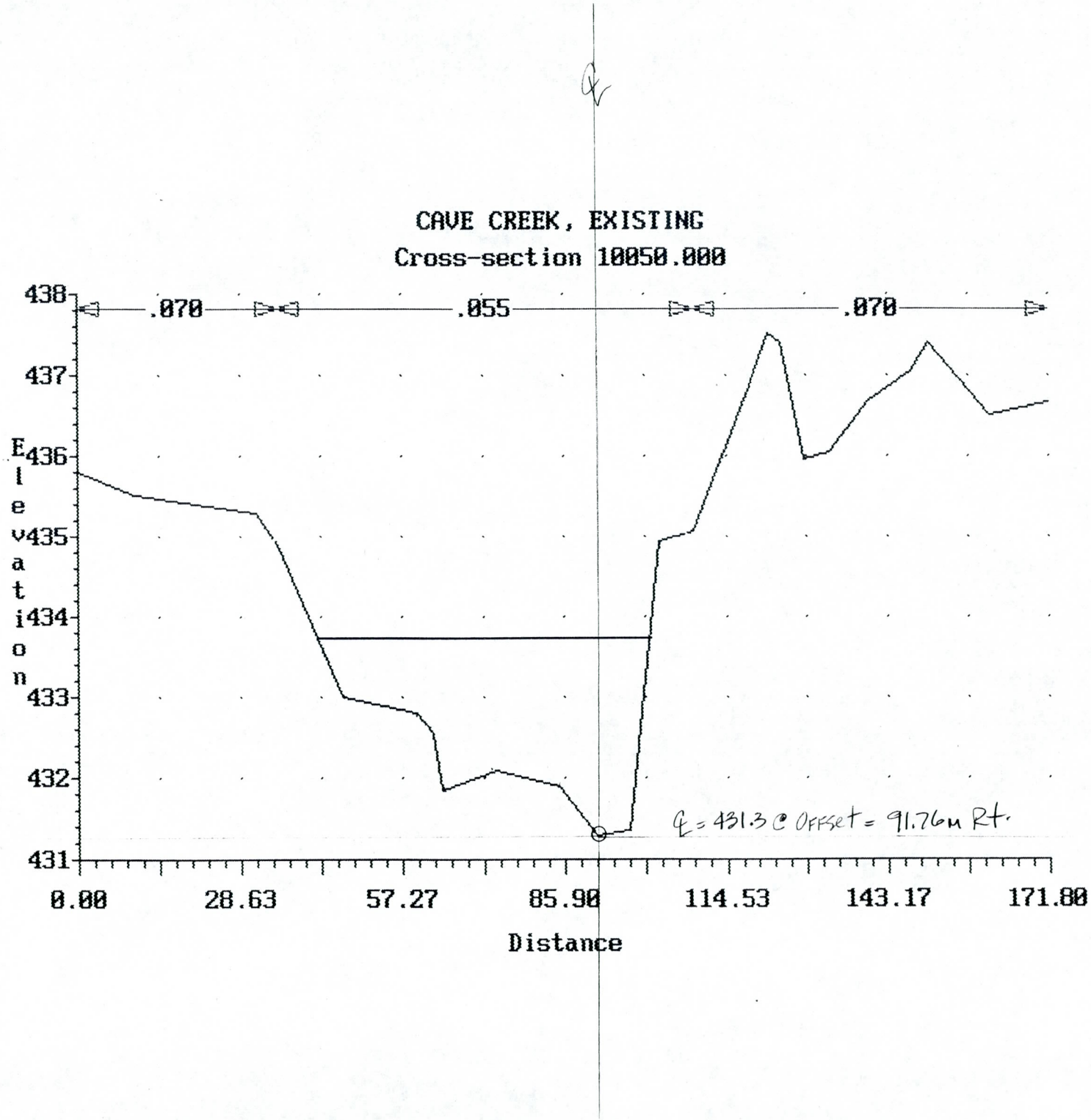
```
WARNING SECNO=  10386.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=  10480.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=  10536.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=  10608.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  10608.000  PROFILE=  1  MINIMUM SPECIFIC ENERGY

WARNING SECNO=  10684.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=  10819.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
```

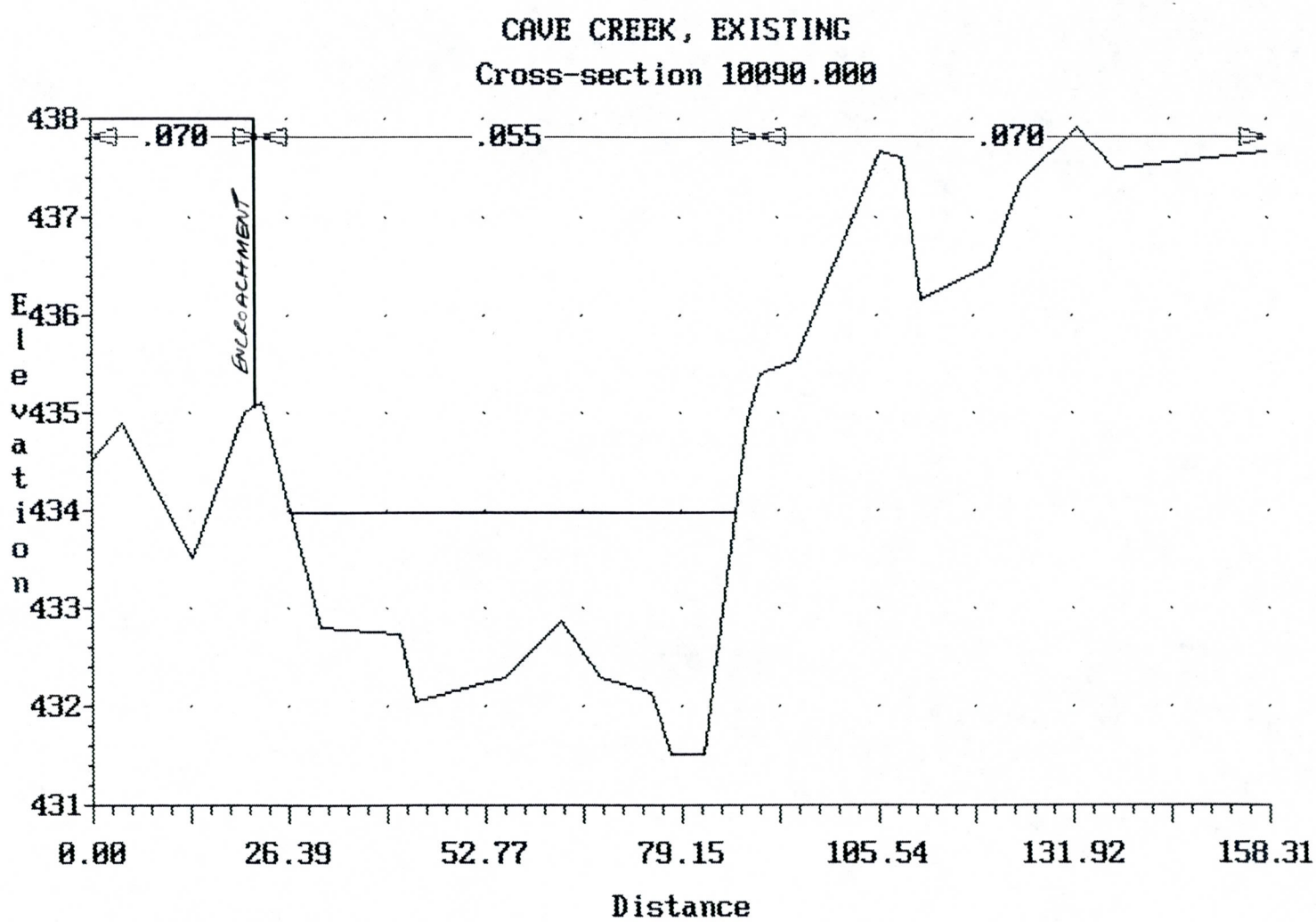

CAVE CREEK, EXISTING
Invert
profile 1
Elevation
444
442
440
438
436
434
432
430
0.00
151.35
302.69
454.04
605.39
756.73
908.08
Distance
10138.0
10181.0
10220.0
10258.0
10434.0
10608.0
10684.0
10745.0
10819.0
10872.0
10924.0

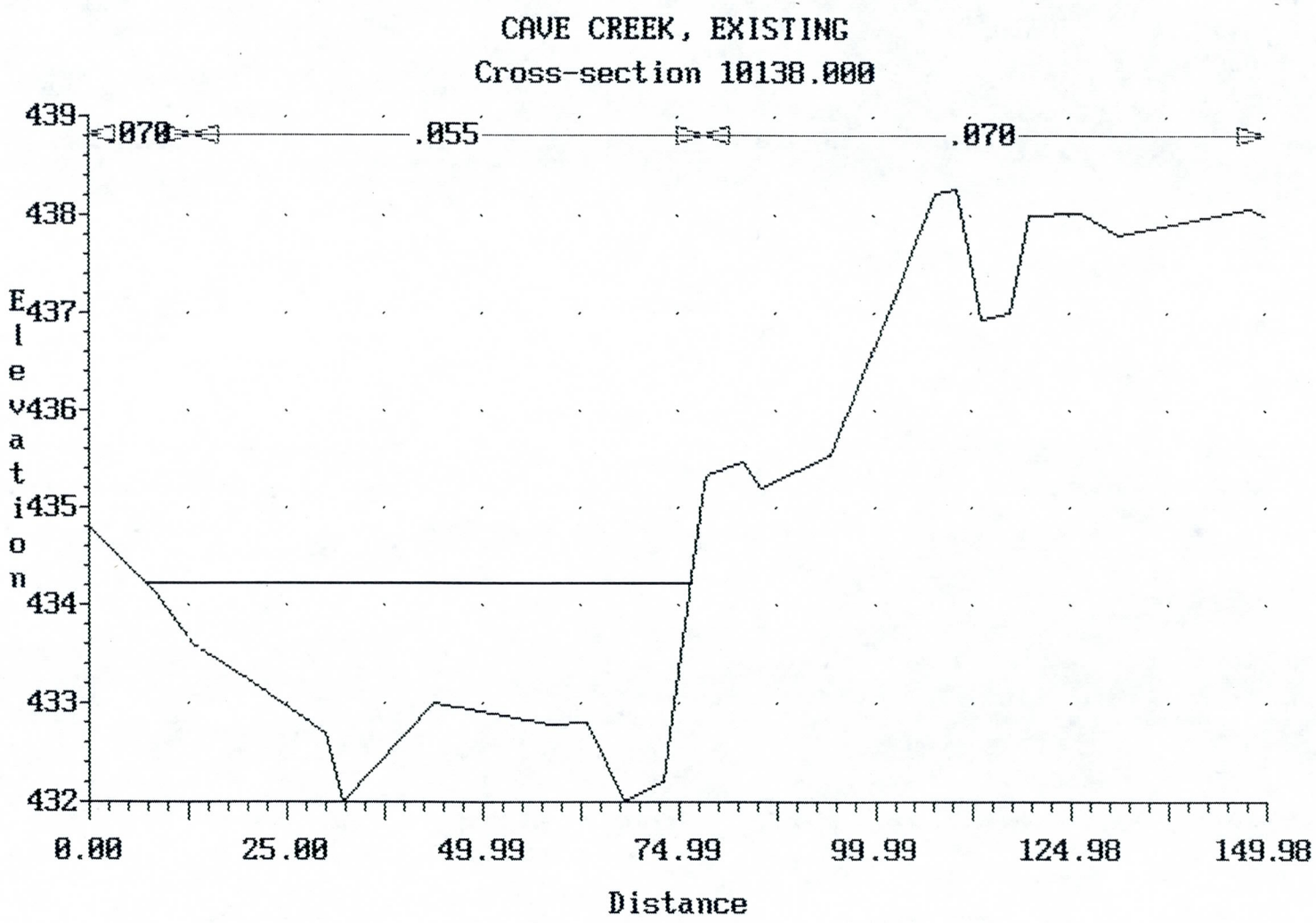


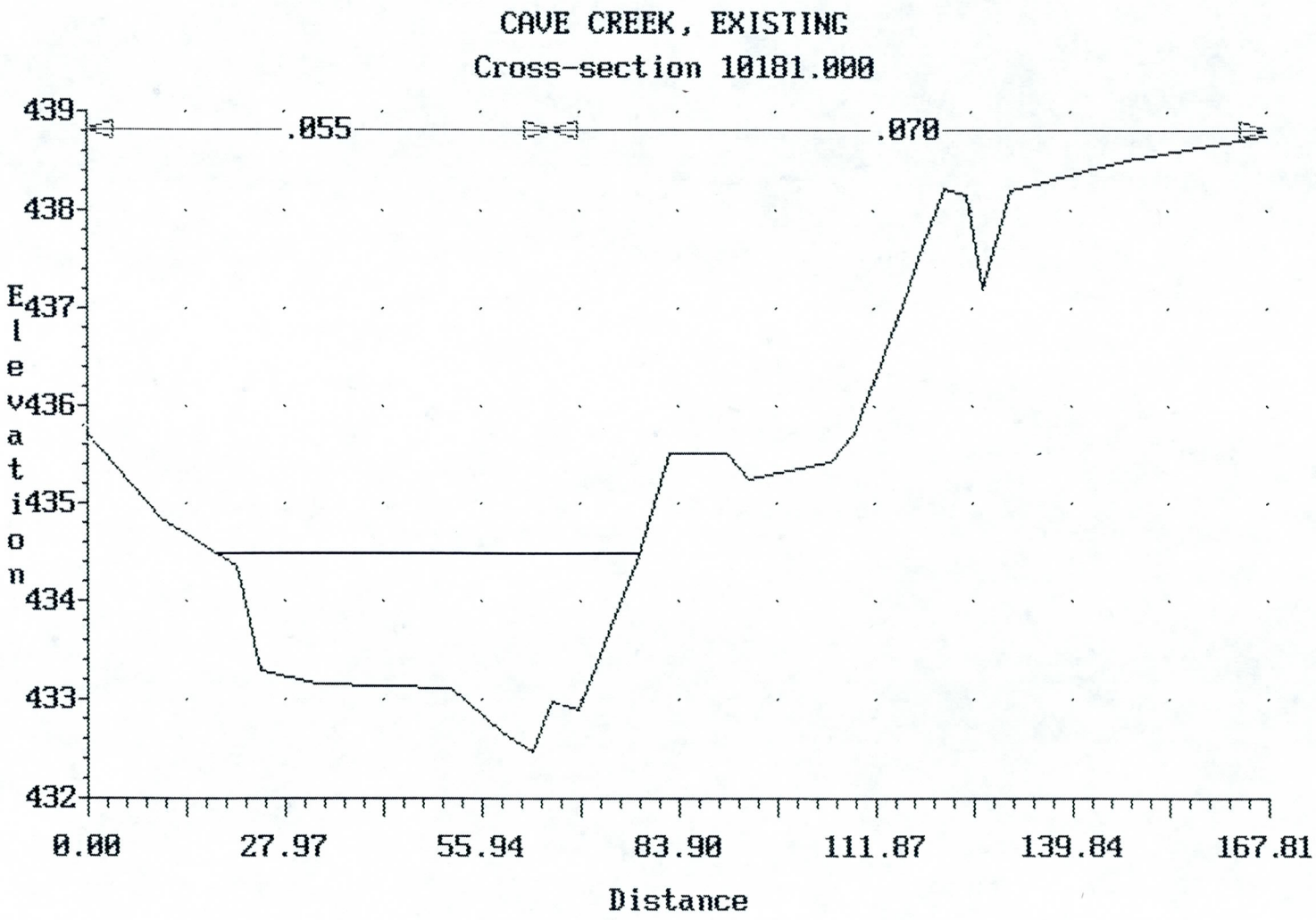

```
Stop - Program terminated.
G:\DRNG\HECEXE2>pconsile
Bad command or file name
G:\DRNG\HECEXE2>pconsole
G:\DRNG\HECEXE2>graphics deskjet
G:\DRNG\HECEXE2>plot2
```

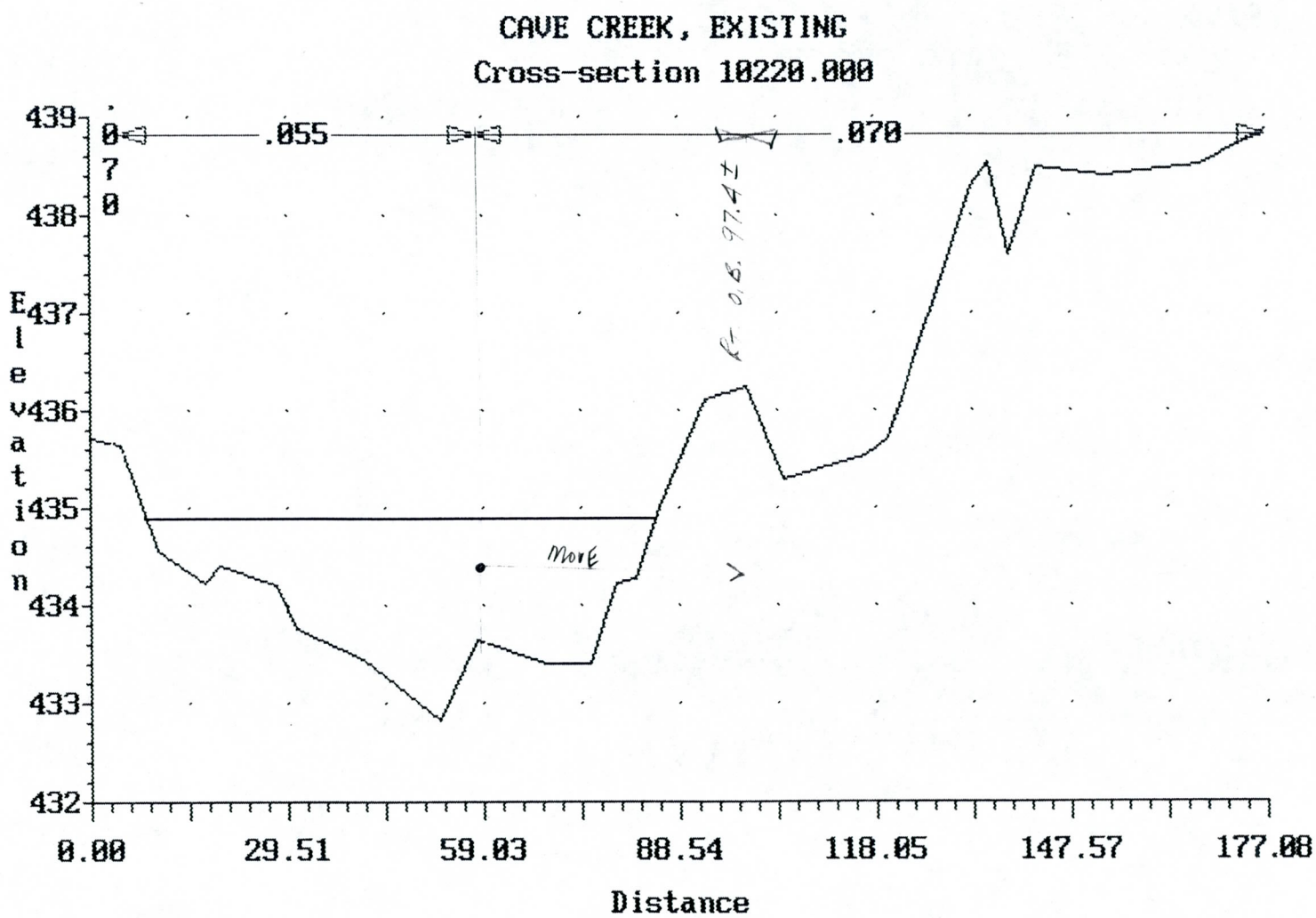
All X-Sect's HEC-2 format Looking Downstream (South)

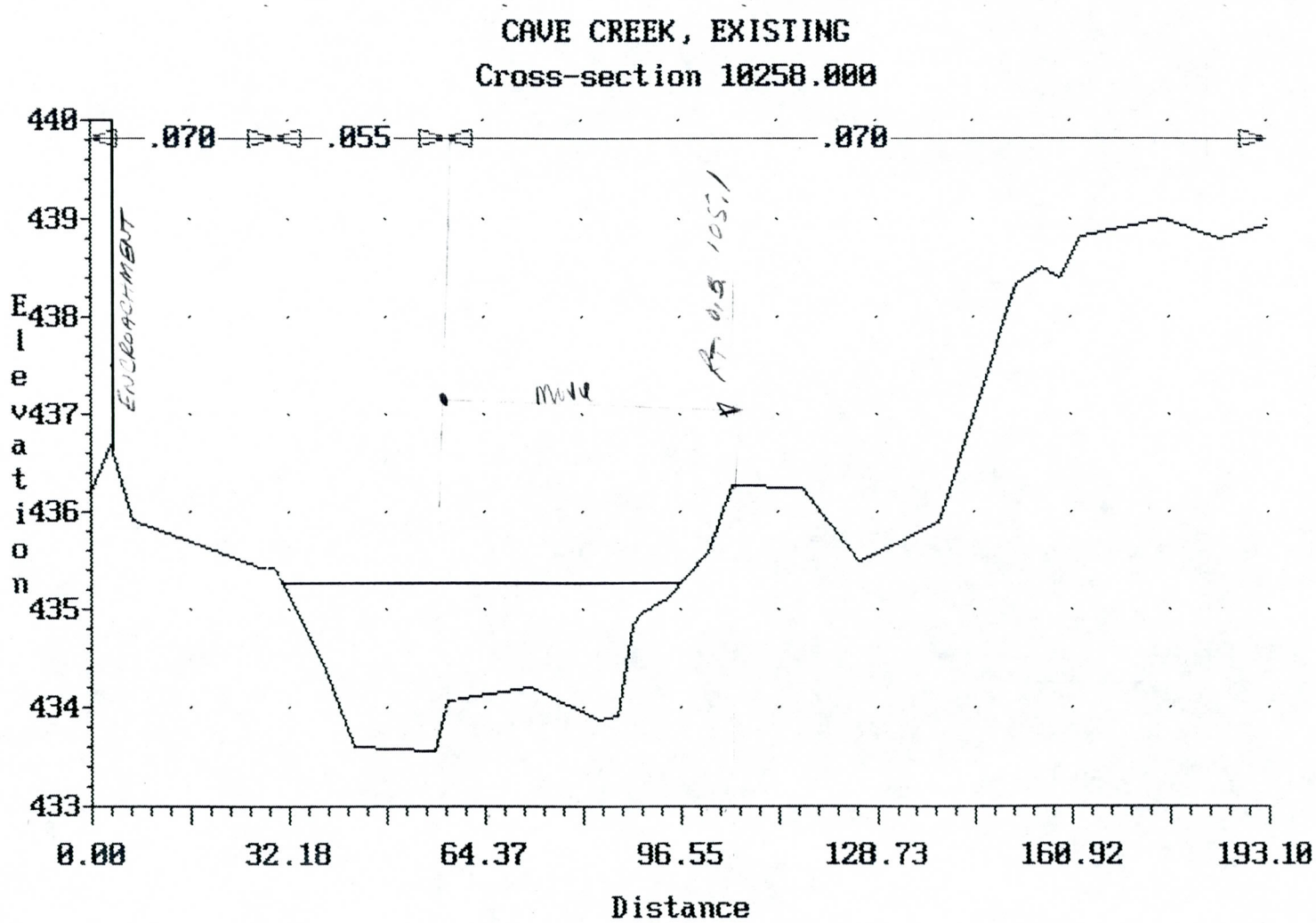

CAVE CREEK, EXISTING
Cross-section 10050.000
.070
.055
.070
438
437
436
435
434
433
432
431
Elevation
0.00
28.63
57.27
85.90
114.53
143.17
171.80
Distance
℄ = 431.3 @ Offset = 91.76m Rt.

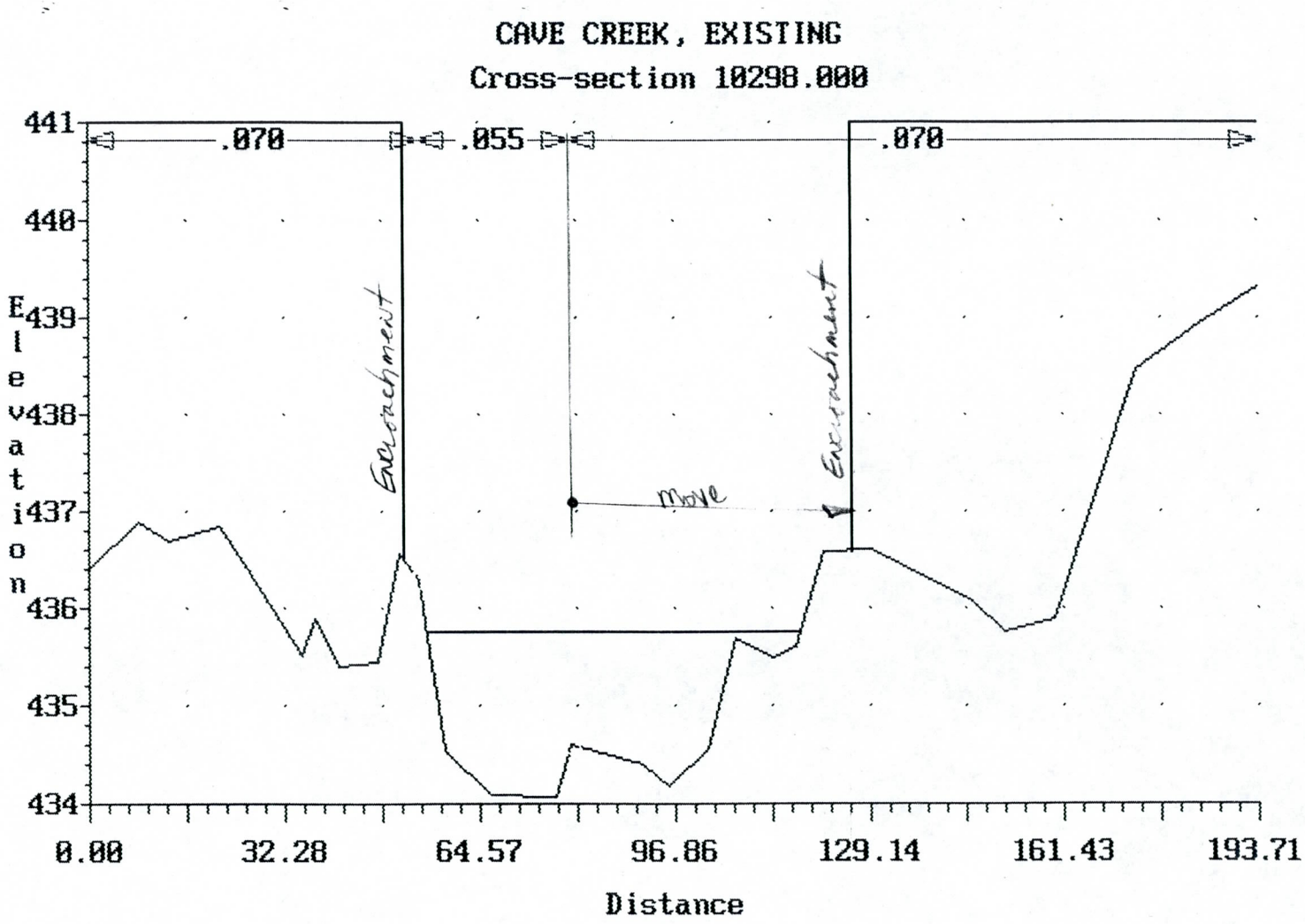

CAVE CREEK, EXISTING
Cross-section 10090.000
.070
.055
.070
ENCROACHMENT
438
437
436
435
434
433
432
431
Elevation
0.00
26.39
52.77
79.15
105.54
131.92
158.31
Distance

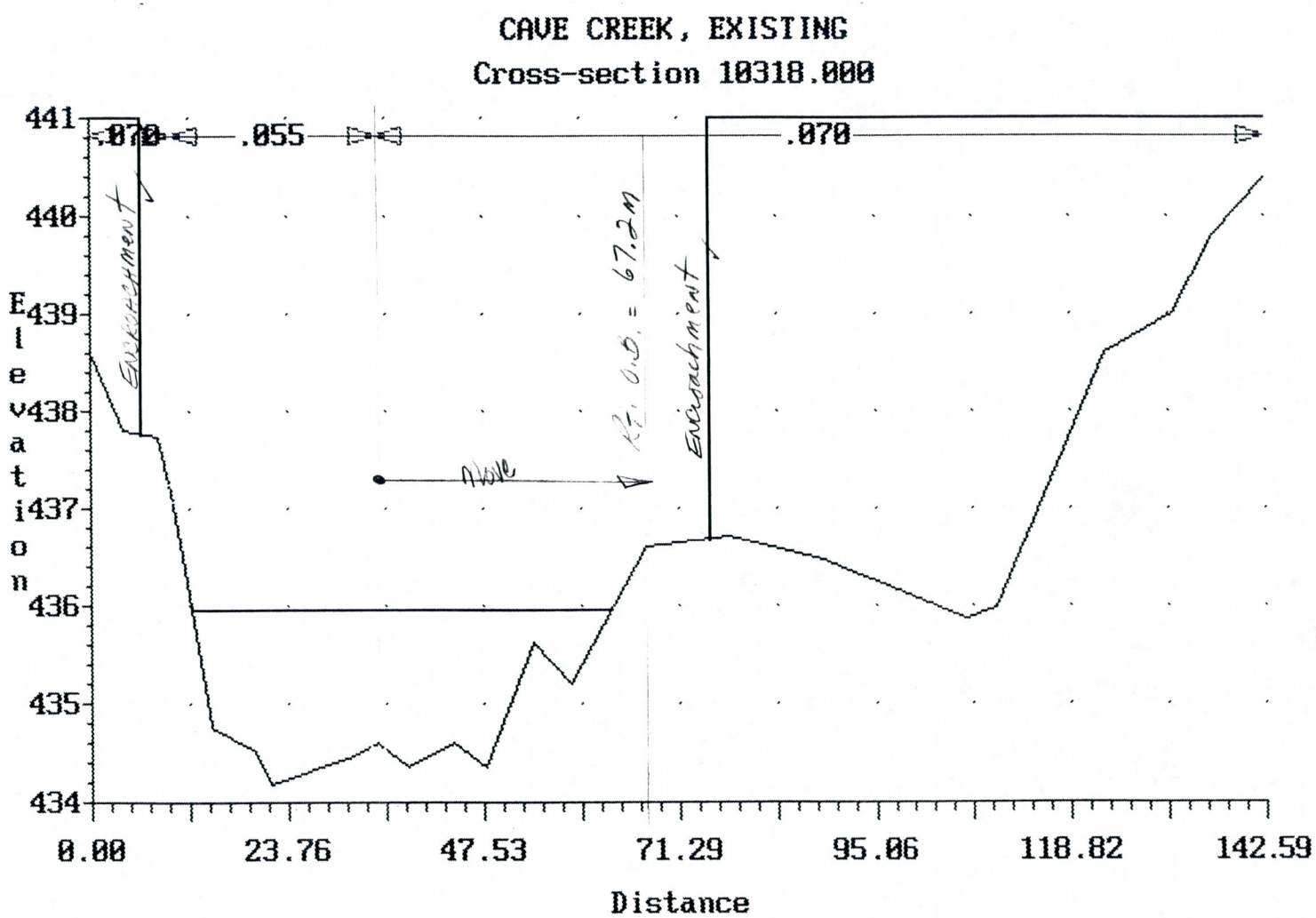

CAVE CREEK, EXISTING
Cross-section 10138.000
.070
.055
.070
439
438
437
436
435
434
433
432
Elevation
0.00
25.00
49.99
74.99
99.99
124.98
149.98
Distance

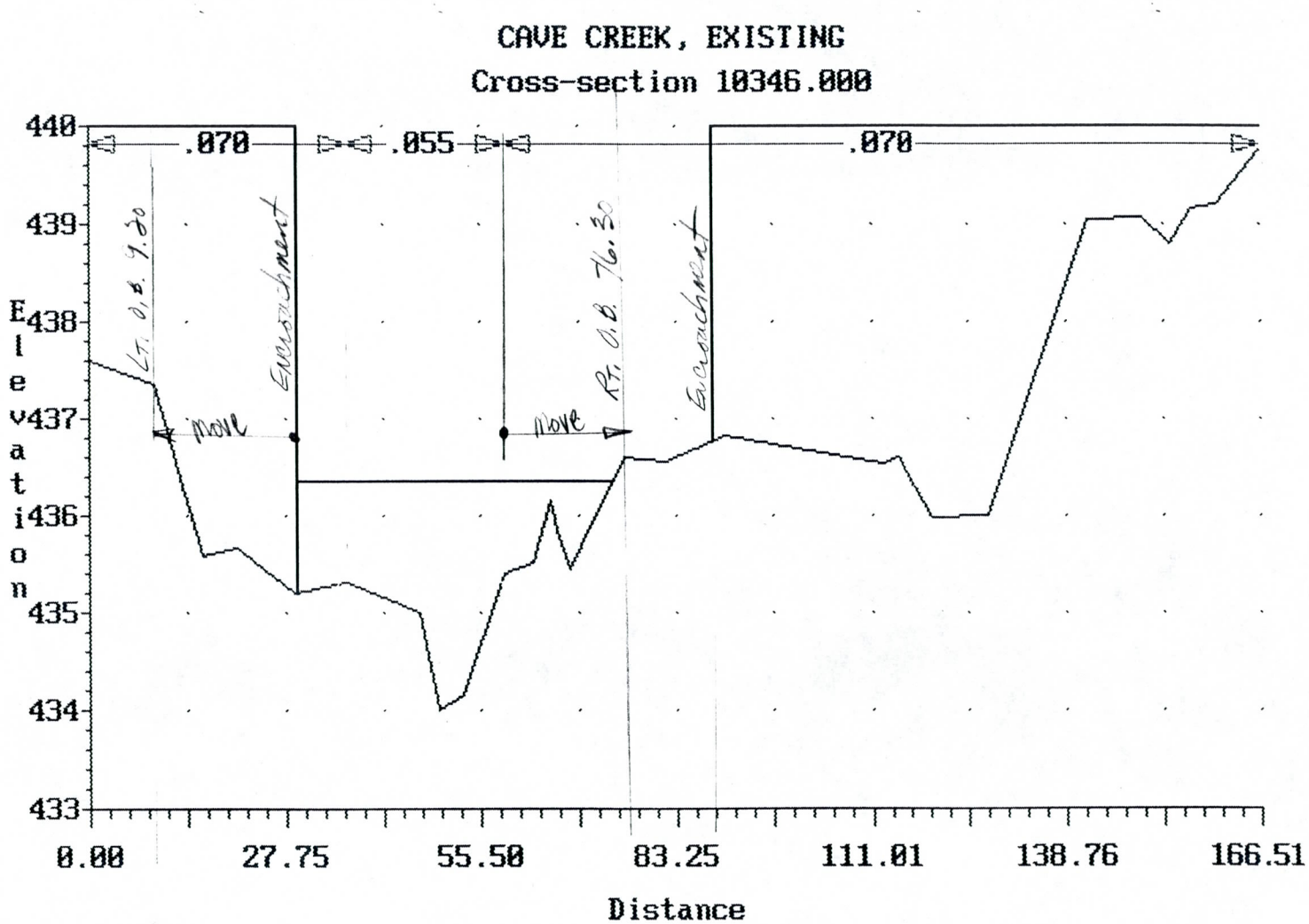

CAVE CREEK, EXISTING
Cross-section 10181.000
.055
.070
439
438
437
436
435
434
433
432
Elevation
0.00
27.97
55.94
83.90
111.87
139.84
167.81
Distance

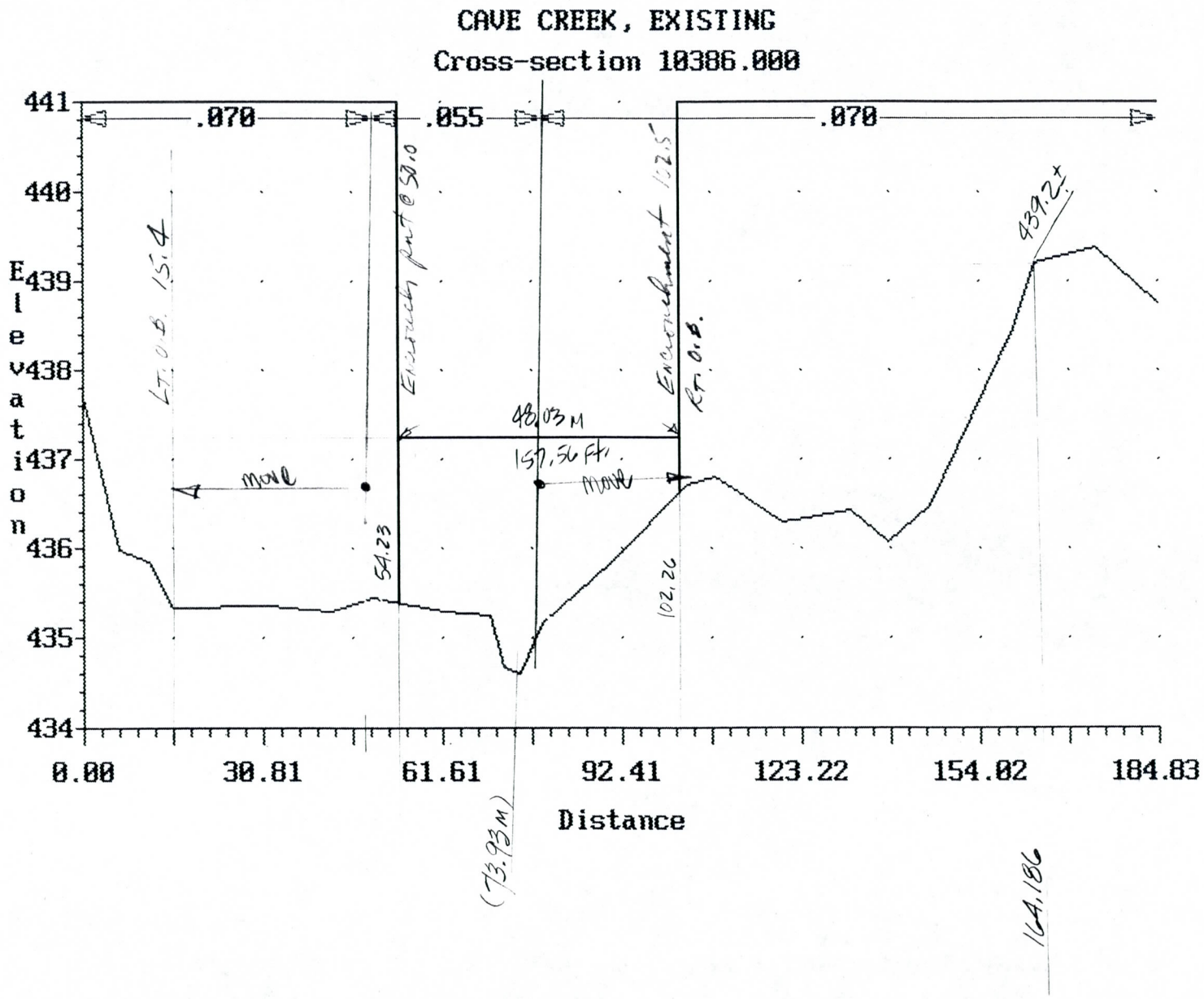

CAVE CREEK, EXISTING
Cross-section 10220.000
.055
.070
0.70
Elevation
439
438
437
436
435
434
433
432
0.00
29.51
59.03
88.54
118.05
147.57
177.00
Distance
Mark

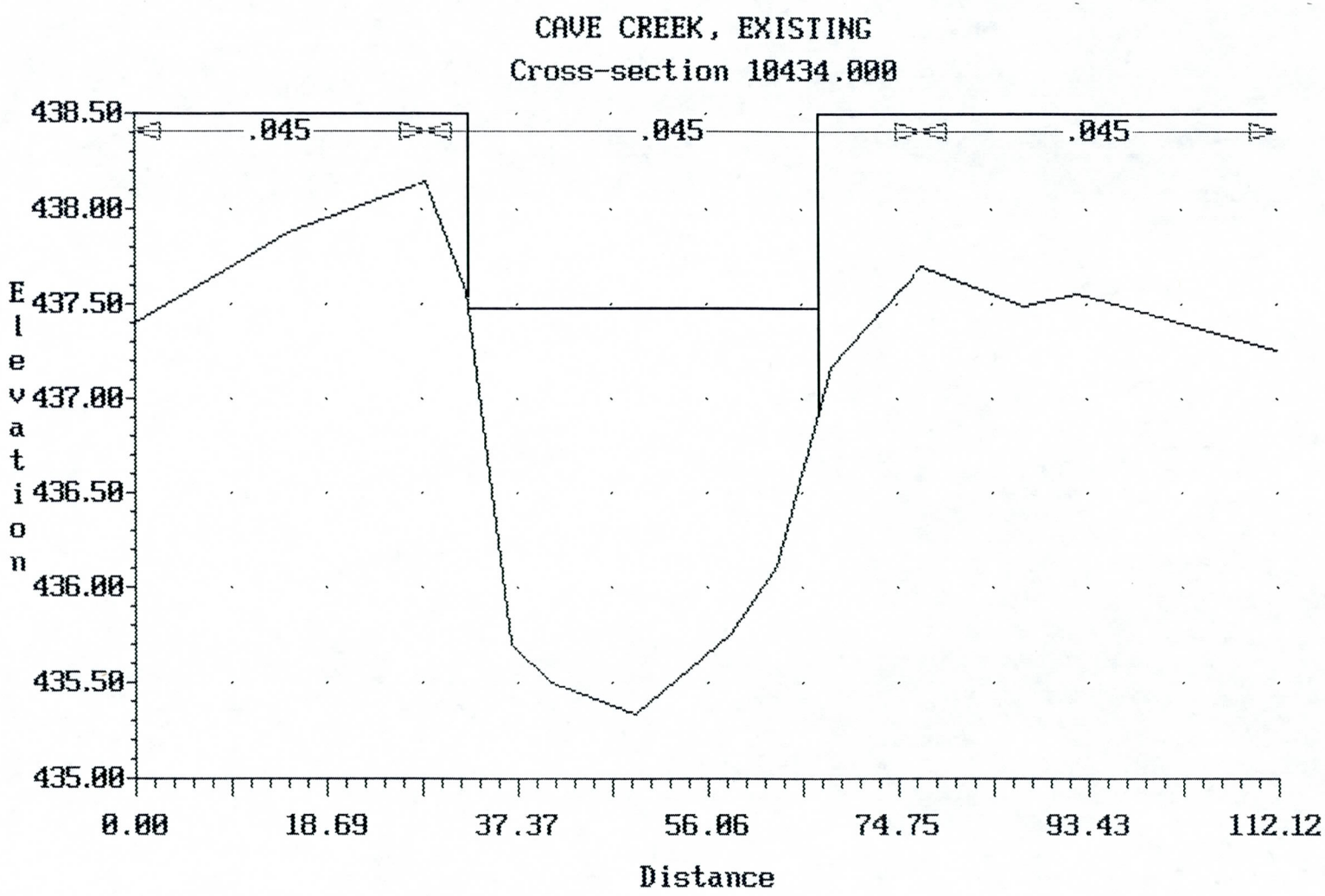

CAVE CREEK, EXISTING
Cross-section 10258.000
.070
.055
.070
ENCROACHMENT
MOVE
Elevation
440
439
438
437
436
435
434
433
0.00
32.18
64.37
96.55
128.73
160.92
193.10
Distance

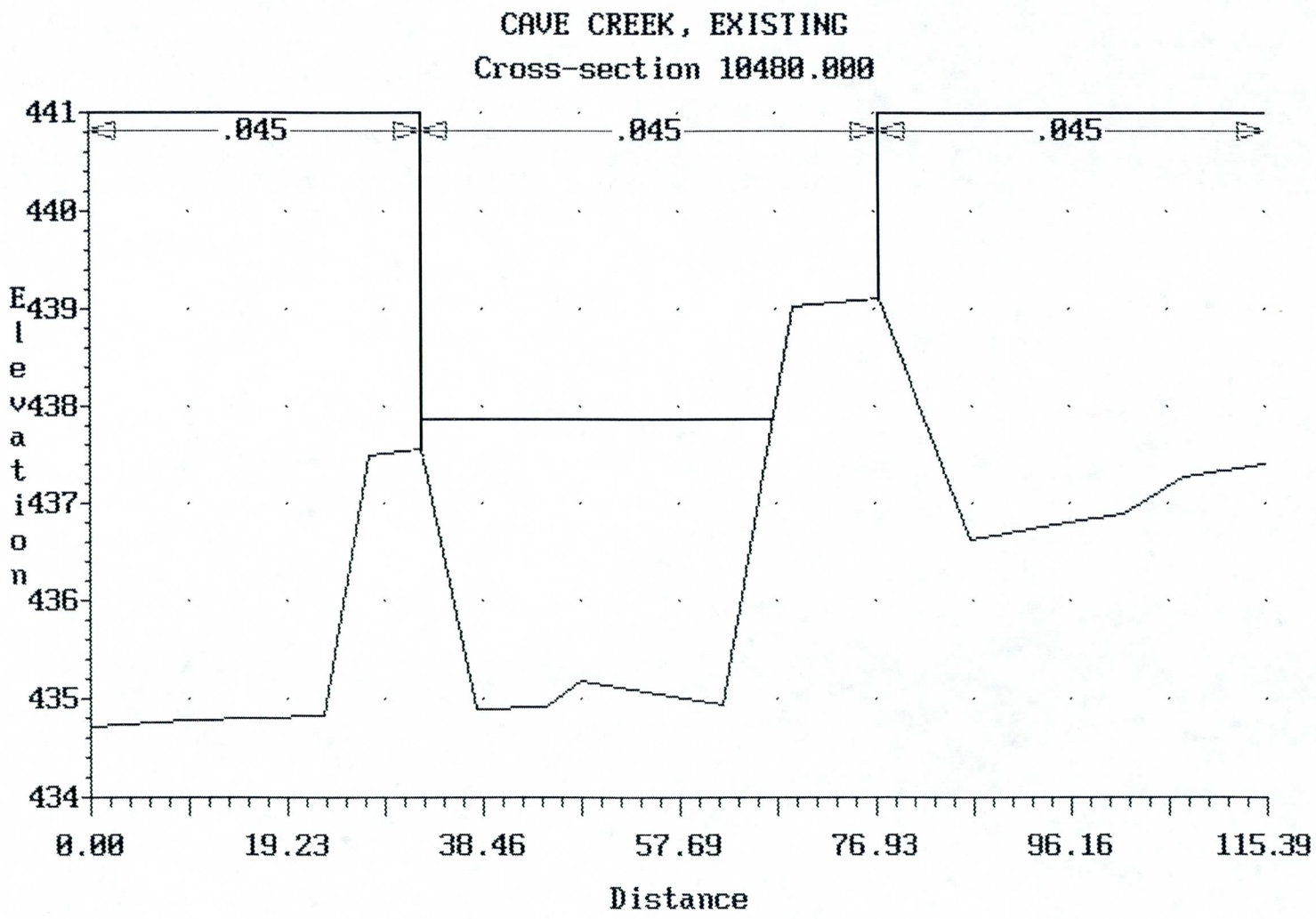

CAVE CREEK, EXISTING
Cross-section 10298.000
.070
.055
.070
Encroachment
Encroachment
Move
Elevation
441
440
439
438
437
436
435
434
0.00
32.28
64.57
96.86
129.14
161.43
193.71
Distance

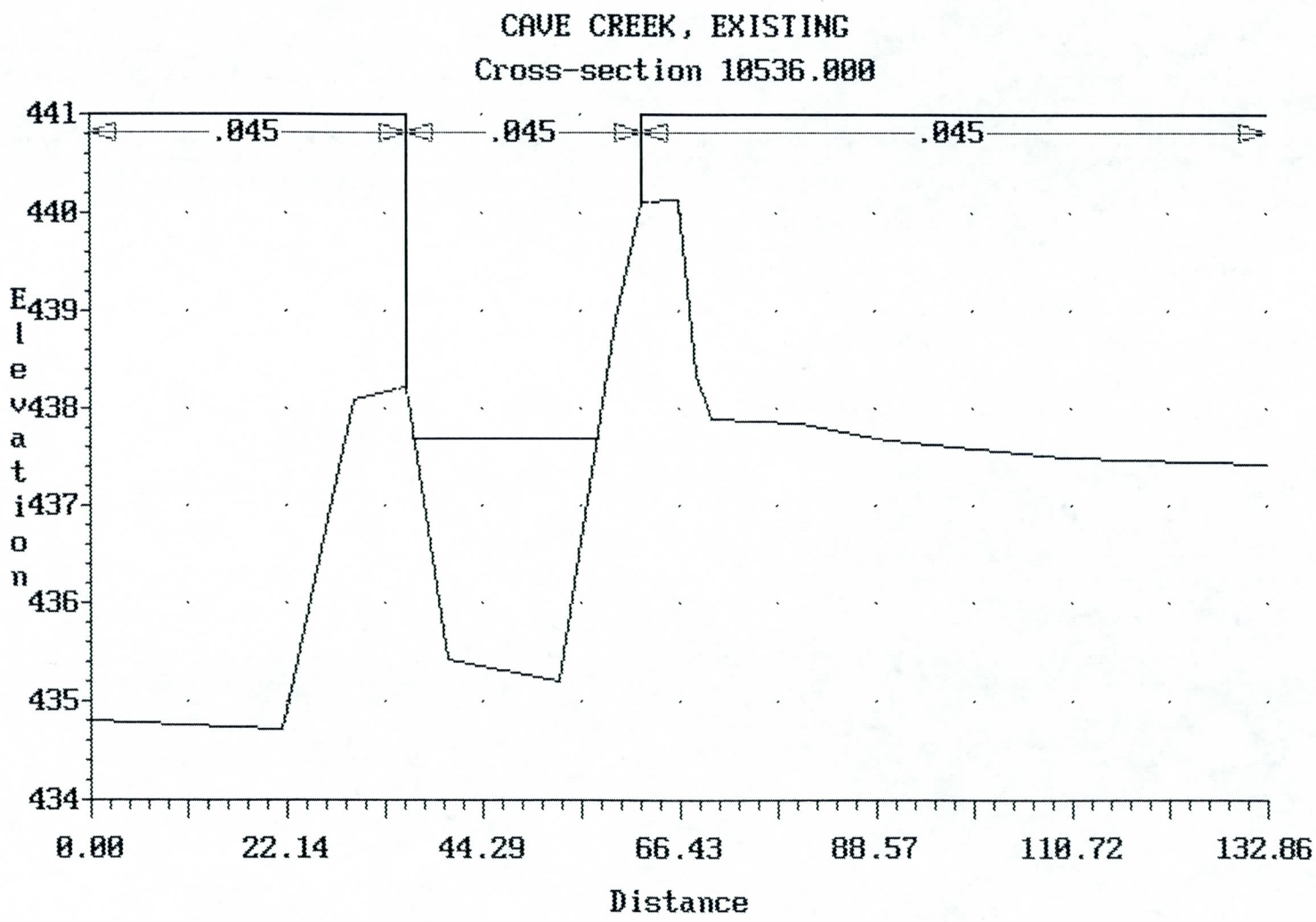

CAVE CREEK, EXISTING
Cross-section 10318.000
.070
.055
.070
Encroachment
Encroachment
Hole
Elevation
441
440
439
438
437
436
435
434
0.00
23.76
47.53
71.29
95.06
118.82
142.59
Distance

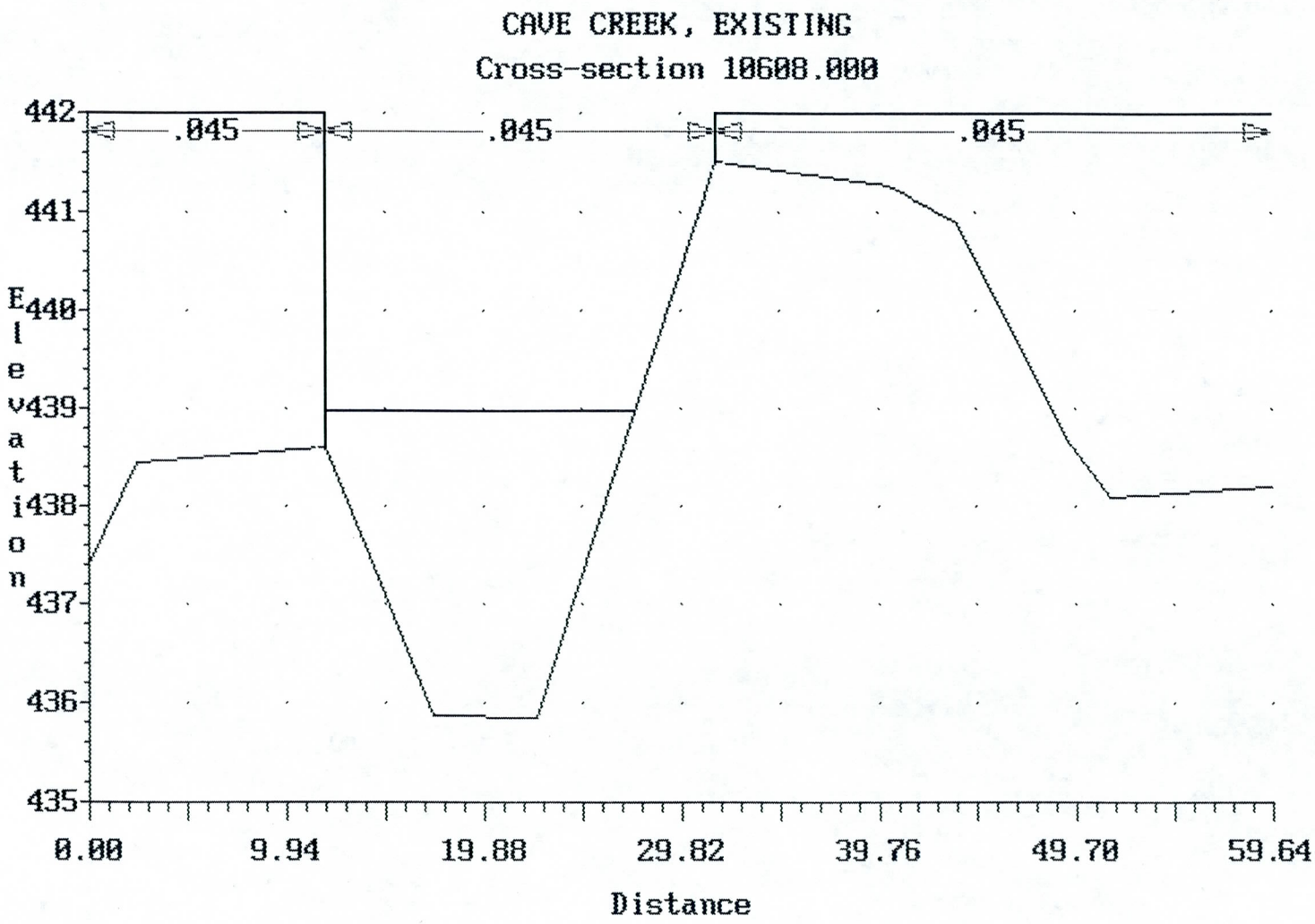

CAVE CREEK, EXISTING
Cross-section 10346.000
.070
.055
.070
Lt. O.B. 7.20
Encroachment
Rt. O.B. 76.30
Encroachment
Move
Move
440
439
438
437
436
435
434
433
Elevation
0.00
27.75
55.50
83.25
111.01
138.76
166.51
Distance

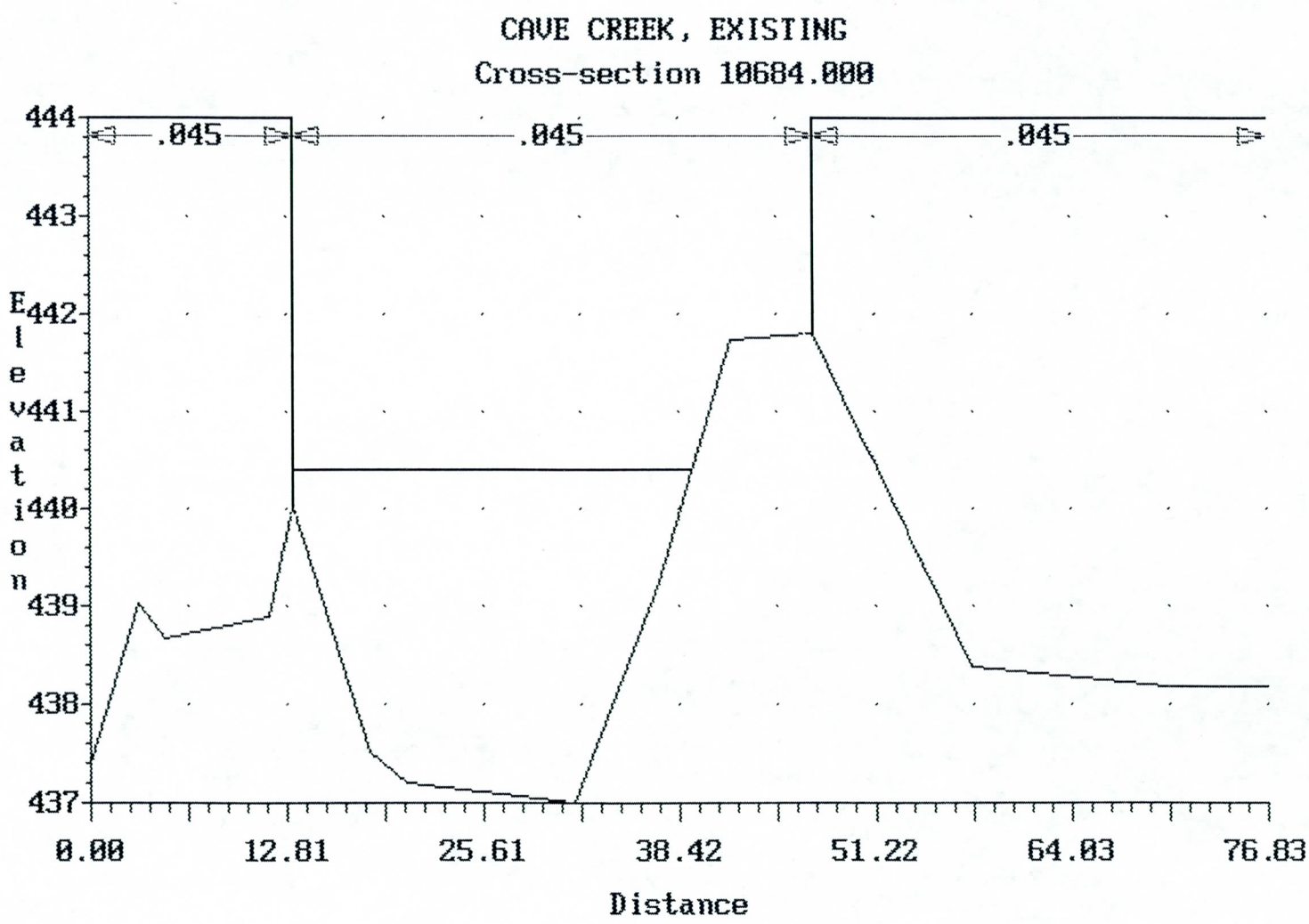

CAVE CREEK, EXISTING
Cross-section 10386.000
.070
.055
.070
441
440
439
438
437
436
435
434
Elevation
0.00
30.81
61.61
92.41
123.22
154.02
184.83
Distance
Lt. O.B. 15.4
Encroachment Lt @ 50.0
Encroachment 102.5
Rt. O.B.
48.03 M
157.56 Ft.
move
move
54.23
102.26
(73.93M)
164.186
439.2+

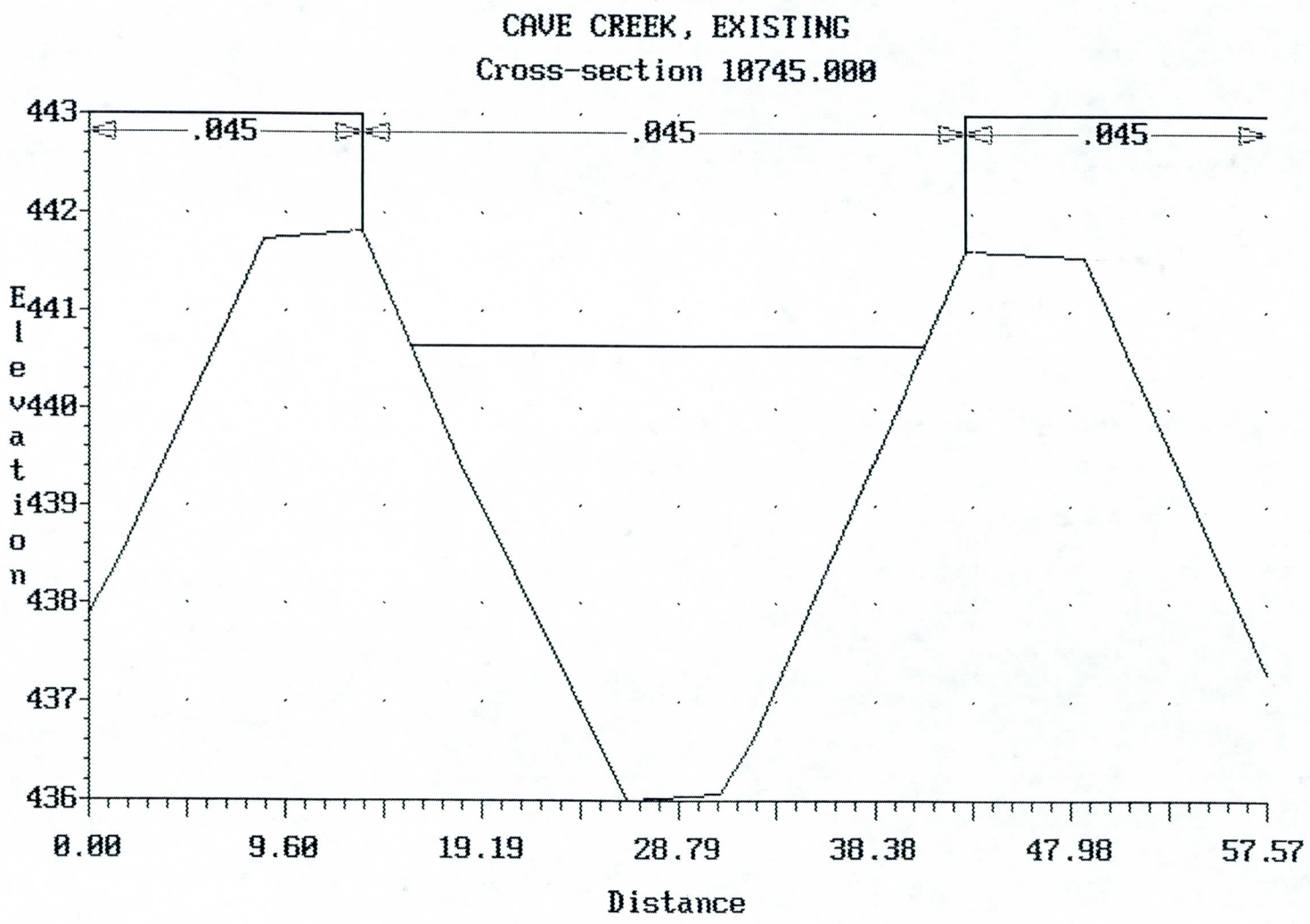

CAVE CREEK, EXISTING
Cross-section 10434.000
.045
.045
.045
438.50
438.00
437.50
437.00
436.50
436.00
435.50
435.00
Elevation
0.00
18.69
37.37
56.06
74.75
93.43
112.12
Distance

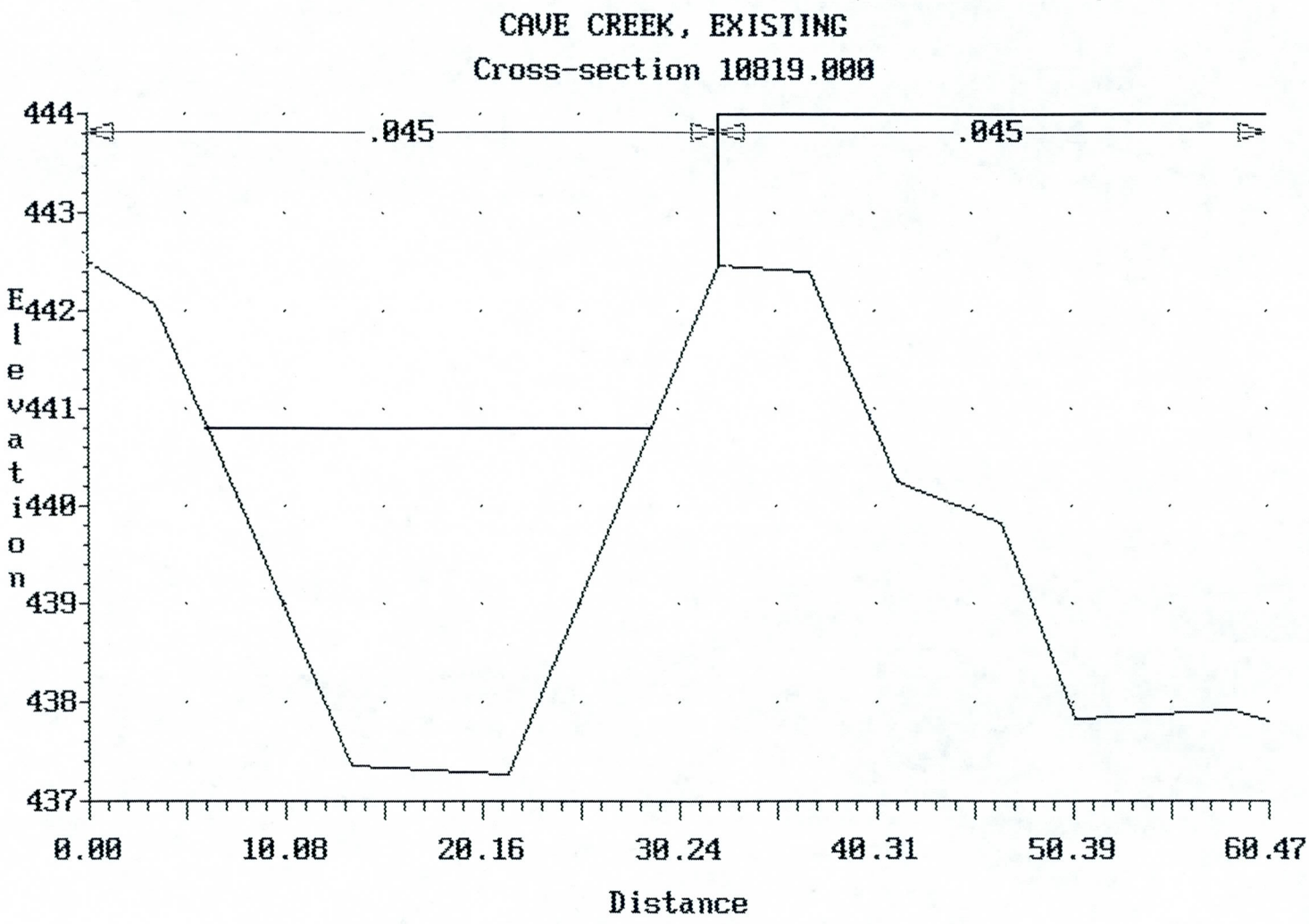

CAVE CREEK, EXISTING
Cross-section 10480.000
.045
.045
.045
441
440
439
438
437
436
435
434
Elevation
0.00
19.23
38.46
57.69
76.93
96.16
115.39
Distance

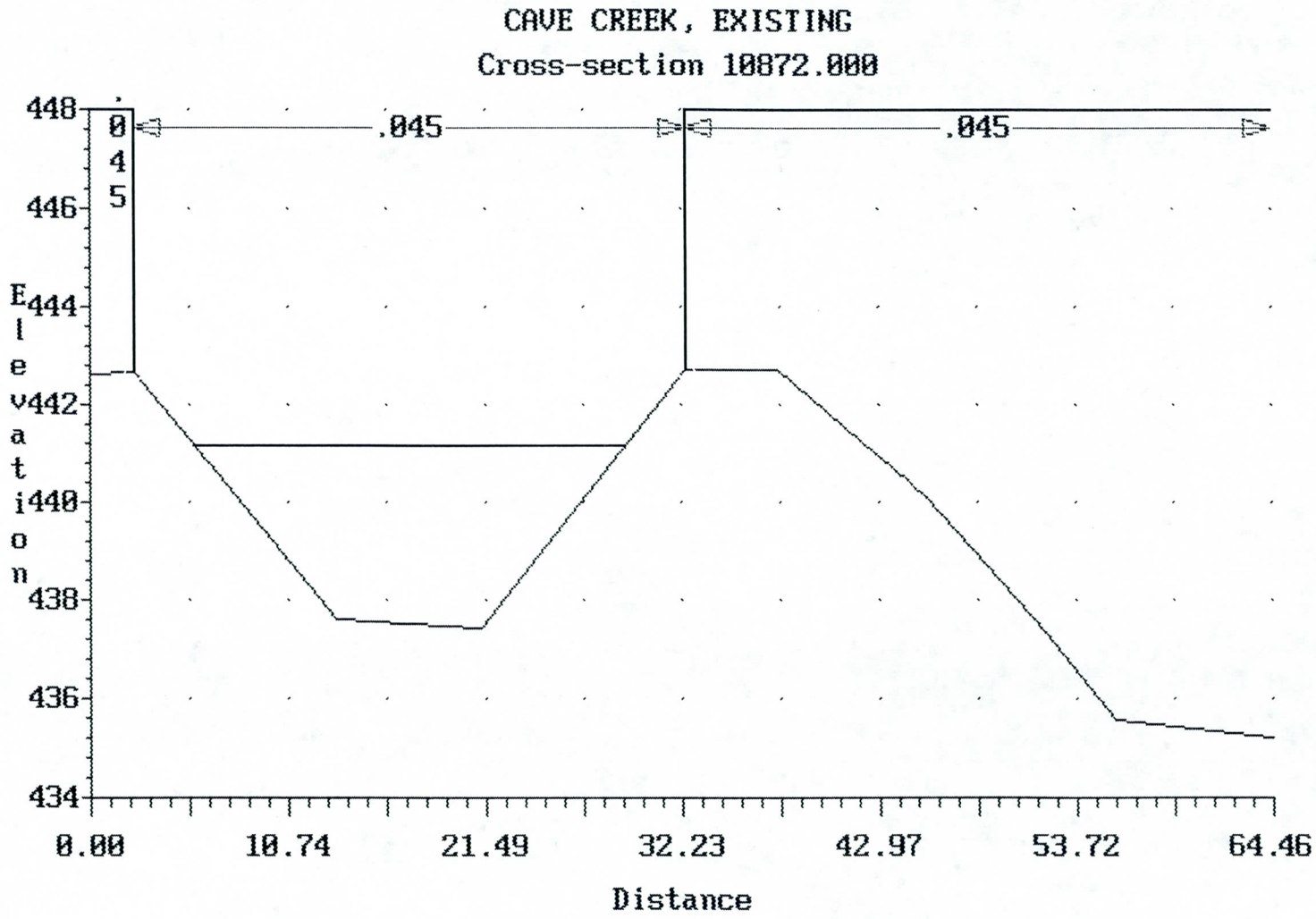

CAVE CREEK, EXISTING
Cross-section 10536.000
.045
.045
.045
441
440
439
438
437
436
435
434
Elevation
0.00
22.14
44.29
66.43
88.57
110.72
132.86
Distance

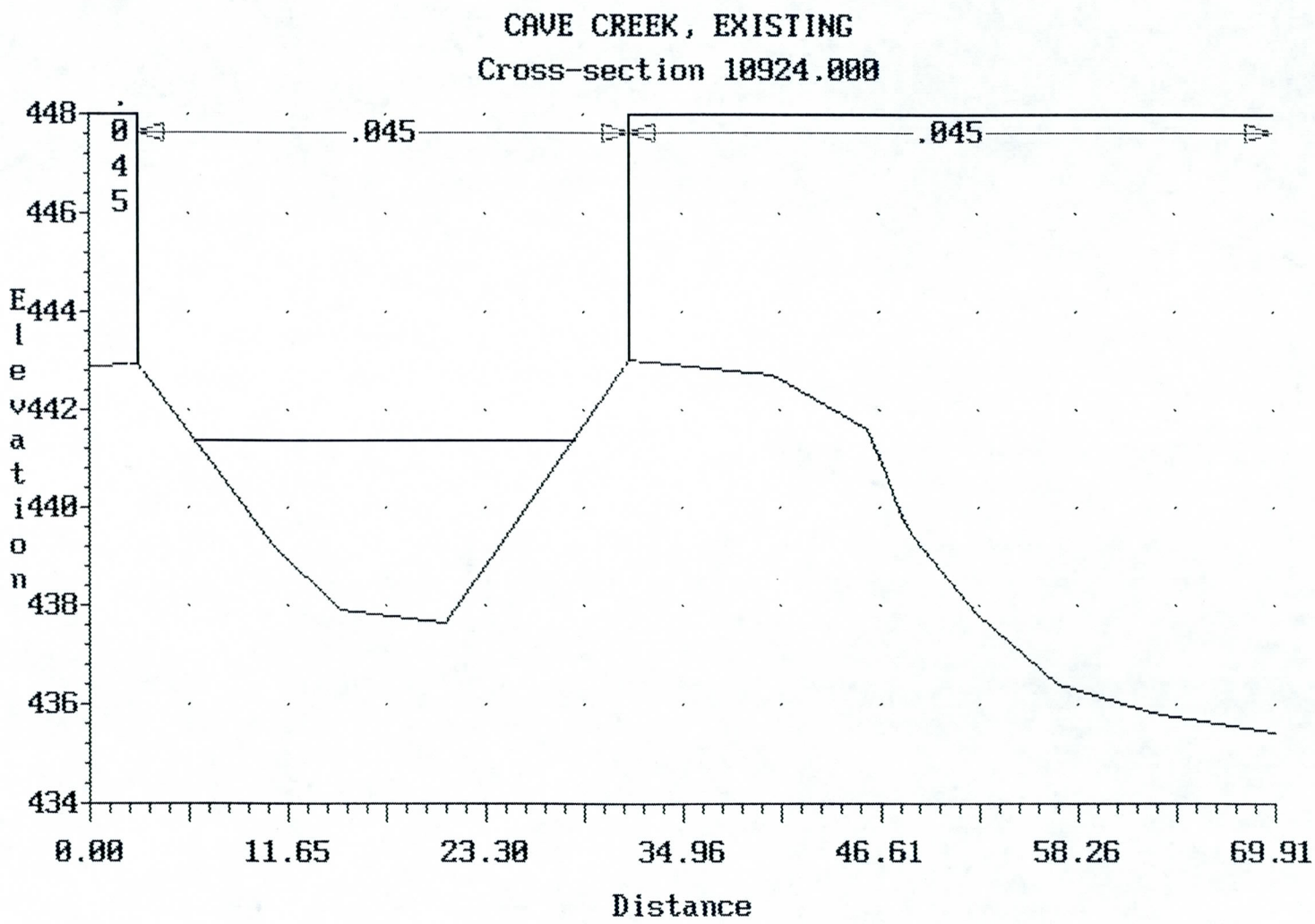

CAVE CREEK, EXISTING
Cross-section 10608.000
.045
.045
.045
442
441
440
439
438
437
436
435
Elevation
0.00
9.94
19.88
29.82
39.76
49.70
59.64
Distance

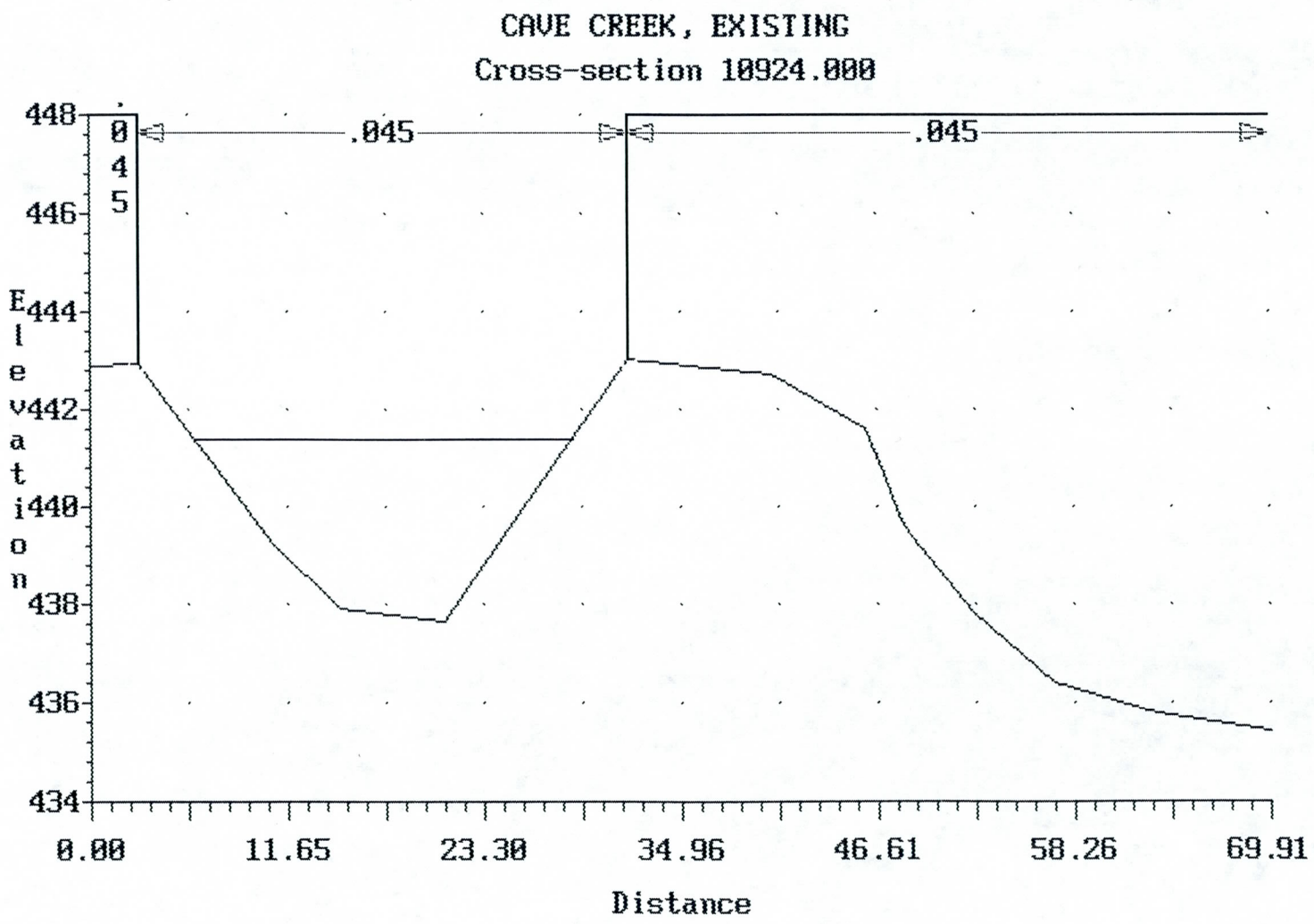

CAVE CREEK, EXISTING
Cross-section 10684.000
.045
.045
.045
444
443
442
441
440
439
438
437
Elevation
0.00
12.81
25.61
38.42
51.22
64.03
76.83
Distance


CAVE CREEK, EXISTING
Cross-section 10745.000
.045
.045
.045
443
442
441
440
439
438
437
436
Elevation
0.00
9.60
19.19
28.79
38.38
47.98
57.57
Distance


CAVE CREEK, EXISTING
Cross-section 10819.000
.045
.045
444
443
442
441
440
439
438
437
Elevation
0.00
10.08
20.16
30.24
40.31
50.39
60.47
Distance


CAVE CREEK, EXISTING
Cross-section 10872.000
.045
.045
.045
Elevation
448
446
444
442
440
438
436
434
0.00
10.74
21.49
32.23
42.97
53.72
64.46
Distance


CAVE CREEK, EXISTING
Cross-section 10924.000
.045
.045
.045
448
446
444
442
440
438
436
434
Elevation
0.00
11.65
23.30
34.96
46.61
58.26
69.91
Distance


CAVE CREEK, EXISTING
Cross-section 10924.000
.045
.045
0
4
5
448
446
444
442
440
438
436
434
Elevation
0.00
11.65
23.30
34.96
46.61
58.26
69.91
Distance

```
*********************************************
*  HEC-2 WATER SURFACE PROFILES             *
*                                           *
*  Version   4.5.1;  September 1990         *
*                                           *
*  RUN DATE    13JUN96    TIME   08:59:35   *
*********************************************
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*****************************************
*  U.S. ARMY CORPS OF ENGINEERS         *
*  HYDROLOGIC ENGINEERING CENTER        *
*  609 SECOND STREET, SUITE D           *
*  DAVIS, CALIFORNIA 95616-4687         *
*          (916) 756-1104               *
*****************************************
```

```
X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X    X            X     X
X     X  X        X                      X
XXXXXXX  XXXX     X         XXXXX    XXXXX
X     X  X        X                 X
X     X  X        X    X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
```

END OF BANNER

FILE: CC1A.IN AND .OUT

EXISTING CAVE CREEK WASH W/ SANIFILL'S UPSTREAM IMPROVEMENTS - NORTH OF BEARDSLEY RD.

ENCROACHMENTS @ STA. 10+386 REMOVED
(FOR THIS EXIST. COND'S RUN.)

NEXT IN SEQUENCE - SEE FILE: CC1B.IN, FOR PROPOSED RE-CHANNELIZATION W/ NEW UPSTREAM SANIFILL IMPROVEMENTS 1000'+ NORTH OF BEARDSLEY RD. INCLUDING E.B & W.B. FRONT. RD. BRIDGES.

Parsons Brinckerhoff **Computation Sheet**

Page 1 of 2 | 110323

Made by Bob B.

Date June 10, 96

Checked by

Date

Subject: Pima Fwy — Jct I-17 to 56th St.
X-Section @ Cave Creek Wash
Sanifill Re-Channelization Portion

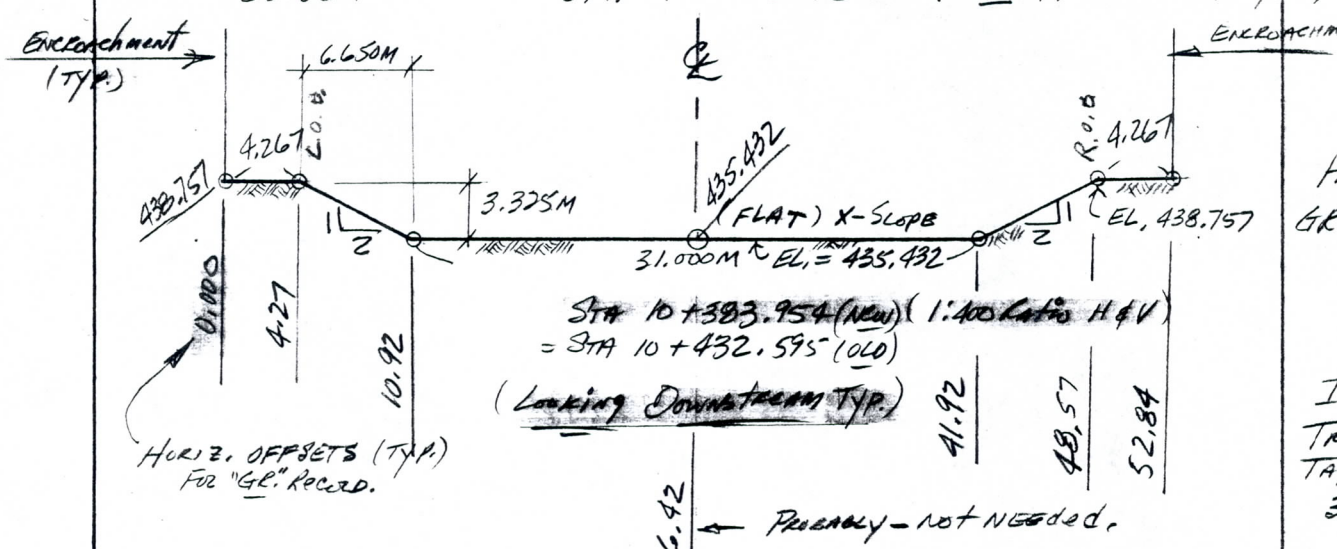
I New X-Sections to Input Sanifill Inc. — Re-Channelization, Sta. 10+383.954 to 10+731.369 = Sta. 10+69.77 to 20+50.00 (Sanifill Sta./Engl.)

Reference: See Sanifill Plans

(a.) Proceeding Upstream From Exist Wash Sta. 10+386.000 (Old — Nat. Align. Before Re-Channelization)

(dist. = 46.6 m ±)

(b.) (End Sanifill Const.) Sta. 10+383.954 (Re-Align. Stationing) — Now Being Used
Close to Sta. 10+432.595 (Old Natural. Align.)



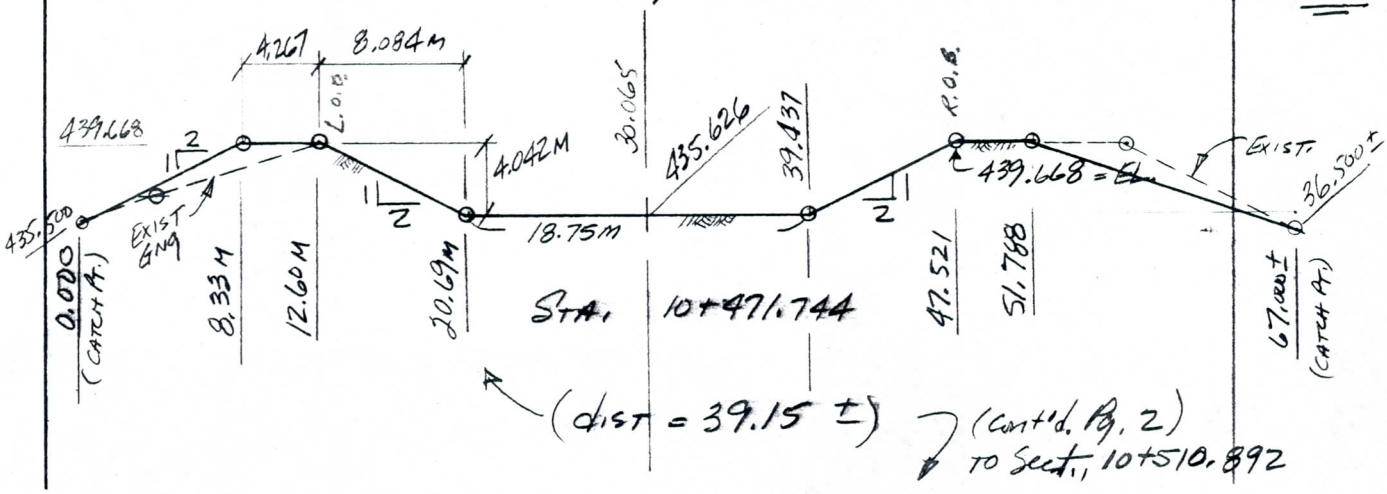
HEC-2 GR-Record

In Horiz. Trans. Taper = 3.2:1

(dist. = 39.15 ±)

(c.) Sta. 10+471.744 — 1/2 Way Through Horiz. Transition

Sta. 11+98.21 Sanifill



(dist = 39.15 ±)

(Cont'd. Pg. 2) To Sect. 10+510.892

Parsons Brinckerhoff **Computation Sheet**

Page 2 of 2 | 110323

Made by BobB.

Date JUNE 11, 96

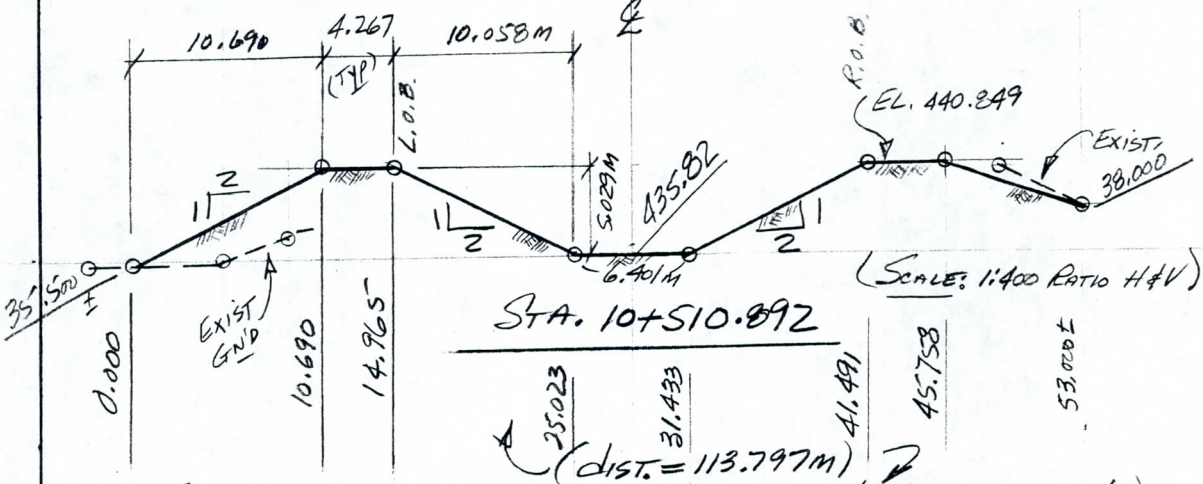
Checked by

Date

Subject PIMA FWY. – JCT I-17 TO 56TH ST.
X-SECTIONS @ CAVE CREEK WASH
SANIFILL RE-CHANNELIZATION PORTION

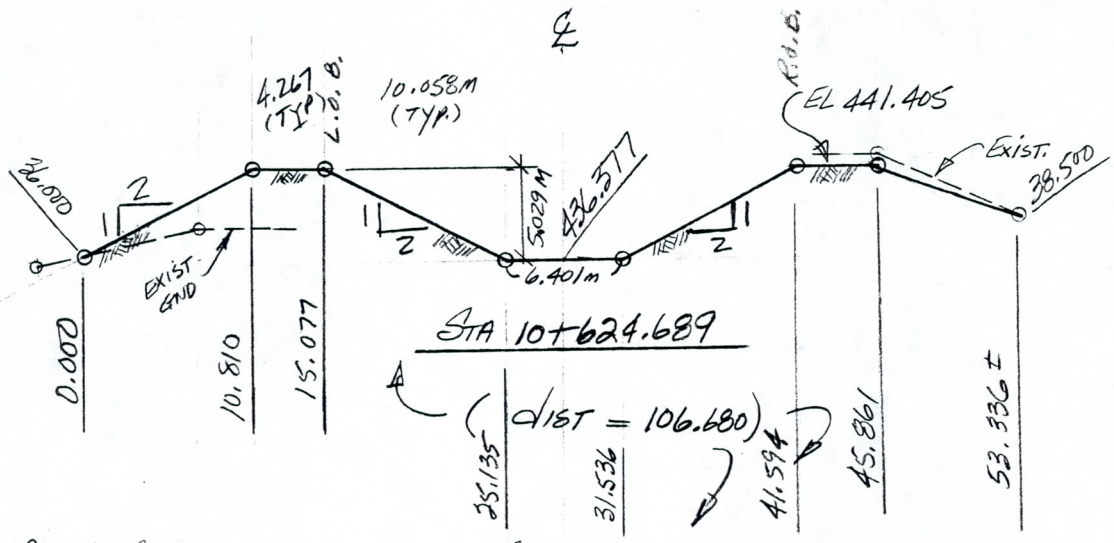
(d.) @ STA. 10+510.892 = SANIFILL 13+26.65 (END HORIZ. TRANS.)

REFERENCE

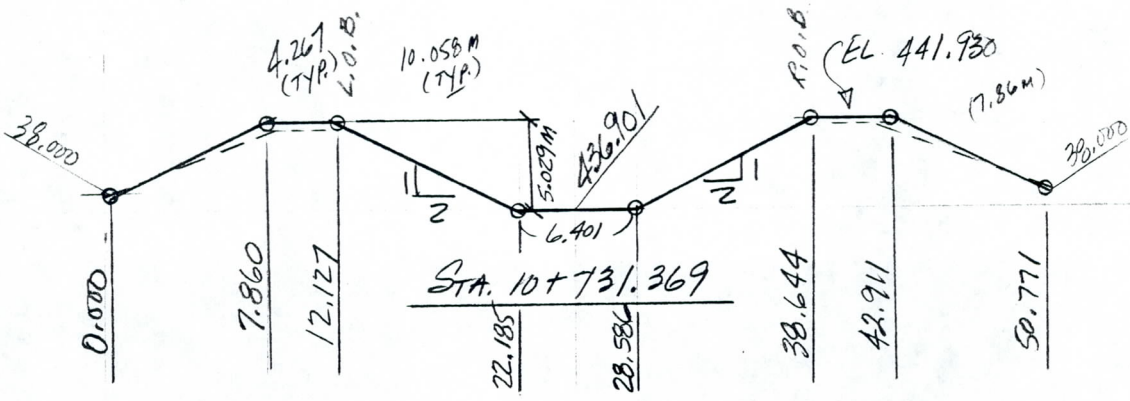


$S_L = 0.492\%$

(e.) @ STA. 10+624.689 = SANIFILL 17+00 (NORMAL X-SECT.)



(f.) @ STA. 10+731.369 = SANIFILL 20+50



END OF RE-CHANNELIZATION BY SANIFILL.

```
MENU2

G:\DRNG\HECEXE2>hec2menu.exe
Stop - Program terminated.

G:\DRNG\HECEXE2>echo off

CAVE CREEK, EXISTING - W

  Starting profile number  1

       CWSEL for cross section  10016.000 is   433.43
       CWSEL for cross section  10050.000 is   433.74
       CWSEL for cross section  10090.000 is   433.97
       CWSEL for cross section  10138.000 is   434.23
       CWSEL for cross section  10181.000 is   434.48
       CWSEL for cross section  10220.000 is   434.89
       CWSEL for cross section  10258.000 is   435.24
       CWSEL for cross section  10298.000 is   435.77
       CWSEL for cross section  10318.000 is   435.98
       CWSEL for cross section  10346.000 is   436.44
       CWSEL for cross section  10386.000 is   436.87
       CWSEL for cross section  10384.000 is   436.86
       CWSEL for cross section  10472.000 is   437.39
       CWSEL for cross section  10511.000 is   438.70
       CWSEL for cross section  10625.000 is   440.34
       CWSEL for cross section  10731.000 is   440.87

Normal program termination

Press any key to continue . . .

Stop - Program terminated.
```

THIS RUN EXECUTED 13JUN96 08:59:35

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*************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.5.1;  September 1990
*************************************


T1      PIMA FREEWAY BRIDGE CROSSING AT CAVE CREEK (BEARDSLEY ROAD ALIGNMENT)
T2      HYDRAULIC ANALYSIS FOR EXISTING CAVE CREEK 100-YEAR FLOODPLAIN
T3      CAVE CREEK, EXISTING - WITH UPSTREAM SANIFILL INC. IMPROVEMENTS
T4      MODEL CC1A.IN,SUBCRITICAL FLOW  - WITH SANIFILL IMPROVEMENTS OF 6/96
T5      ALL INPUT DATA IS IN METRIC UNITS
T6      DISCHARGES IN cfs: 5,500, = 155.7 CMS
T7      ALL CROSS-SECTION DATA COMPILED BY INTER-GRAPH DTM USING "INROADS"
        SANIFILL SECTIONS UPSTREAM BEGINNING WITH STA 10+383.954 WERE IMPUT
        MANUALLY BY BOB BATTISTELLO ON JUNE 11,1996 - CONSEQUENTLY, ALL OTHER
        UPSTREAM SECTIONS HAVE BEEN REMOVED FROM THIS MODEL.
        BASE MODEL WAS DONE BY BOB WARD AS FILE: CC1.IN  -  SEPT,95.

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

                2                           .0090        1                           434

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

     1                 -1                                        -1


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

     38        43         1         8         4        55        13        26        14        56
     15        27        28         0        38        43        16        17        18        21
     22        53        54         5        68        39        66

J5  LPRNT    NUMSEC                    ********REQUESTED SECTION NUMBERS********

    -10       -10


NC     .070      .070      .055        .1        .3
QT        1     155.7

X1    10016        26     24.05     92.25      0.00      0.00      0.00
GR    435.1      0.00    434.17      3.97    434.00     12.60    434.43     21.14    434.77     24.05
GR    433.1     28.29    432.52     37.64    432.58     42.85    432.64     45.19    432.25     49.18
GR    431.6     52.47    431.91     64.73    431.15     71.89    431.22     78.26    433.74     83.03
GR    434.3     84.41    434.67     92.25    437.40    105.73    437.36    108.04    435.13    112.82
GR    435.4    118.85    435.95    130.73    435.84    156.21    436.31    160.77    436.01    164.00
GR    435.9    176.58
```

X1	10050	23	35.40	108.84	34.50	34.00	34.34			
GR	435.8	0.00	435.51	10.13	435.28	31.52	434.90	35.40	433.01	46.79
GR	432.8	59.86	432.55	62.60	431.85	64.32	432.08	73.93	431.89	84.94
GR	431.3	91.76	431.35	97.50	434.94	102.80	435.07	108.84	437.52	122.01
GR	437.4	124.54	435.95	128.39	436.05	132.85	436.68	139.98	437.04	147.16
GR	437.4	150.41	436.52	161.21	436.67	171.80				
X1	10090	25	22.89	90.00	40.00	39.60	39.64			
X3				22						
GR	434.5	0.00	434.88	4.06	433.52	13.51	435.01	20.53	435.11	22.89
GR	432.8	30.64	432.73	41.24	432.04	43.25	432.30	55.29	432.86	63.13
GR	432.3	68.19	432.14	75.05	431.52	77.65	431.52	82.13	434.93	88.12
GR	435.4	90.00	435.53	94.70	437.66	106.05	437.61	108.96	436.15	111.67
GR	436.5	121.17	437.35	125.11	437.92	132.78	437.48	137.78	437.66	158.31
X1	10138	26	13.15	78.46	37.80	50.00	48.59			
GR	434.8	0.00	434.11	8.52	433.59	13.15	433.15	21.77	432.68	29.95
GR	432.0	32.23	433.01	43.89	432.77	58.72	432.80	63.36	432.01	67.94
GR	432.2	72.91	435.25	78.46	435.33	78.61	435.33	78.64	435.47	83.19
GR	435.2	85.63	435.54	94.45	438.23	107.92	438.26	110.86	436.94	113.74
GR	437.0	117.62	438.01	119.98	438.03	126.60	437.81	131.50	438.06	147.90
GR	438.0	149.98								
X1	10181	23	0	65.87	33.50	42.50	42.84			
GR	435.7	0.00	434.84	10.45	434.35	21.04	433.28	24.41	433.15	32.70
GR	433.1	51.68	432.66	58.77	432.46	63.14	432.97	65.87	432.88	69.68
GR	434.4	78.04	435.52	82.70	435.50	90.68	435.25	93.97	435.43	105.66
GR	435.7	108.97	438.23	122.27	438.16	125.28	437.21	127.50	438.20	131.59
GR	438.5	147.81	438.68	161.84	438.75	167.81				
X1	10220	27	4.52	97.40	47.20	35.00	38.72			
GR	435.7	0.00	435.64	4.52	434.55	10.17	434.22	17.02	434.39	19.29
GR	434.2	27.84	433.76	30.69	433.44	40.92	432.82	52.48	433.65	57.88
GR	433.4	68.63	433.40	74.95	434.23	78.88	434.27	81.88	435.00	85.50
GR	436.1	92.49	436.25	98.60	435.29	104.15	435.54	116.75	435.71	119.93
GR	438.3	132.66	438.54	135.59	437.60	138.26	438.48	142.60	438.39	152.68
GR	438.5	167.67	438.87	177.08						
X1	10258	28	30.08	105.10	40.00	35.50	38.55			
X3				3.5						
GR	436.2	0.00	436.68	3.39	435.92	6.68	435.42	27.54	435.42	29.71
GR	435.4	30.08	434.37	38.43	433.61	42.87	433.55	55.98	434.06	58.27
GR	434.2	71.89	433.86	83.18	433.92	86.26	434.85	88.56	434.95	89.99
GR	435.1	94.39	435.57	101.08	436.27	105.31	436.24	116.72	435.48	125.81
GR	435.9	139.00	438.34	151.93	438.50	156.27	438.40	159.18	438.83	162.55
GR	439.0	176.33	438.79	185.59	438.93	193.10				

Insert new re-aligned channel where crossed out.

```
X1    10298      29      54.49    126.30     44.40     31.60     39.85
X3                              51.9                 126.3
GR    436.4    0.00     436.90     8.21    436.69     13.19    436.84     21.38    436.23     27.88
GR    435.5   35.01     435.90    37.47    435.41     41.13    435.45     47.74    436.55     51.34
GR    436.3   54.49     434.54    58.85    434.08     66.40    434.07     77.03    434.61     79.63
GR    434.4   91.49     434.18    95.92    434.55    102.16    435.69    106.93    435.49    113.14
GR    435.6  116.85     436.58   121.75    436.59    129.46    436.09    145.86    435.75    151.61
GR    435.9  160.13     438.46   173.52    438.93    184.15    439.31    193.71

X1    10318      23       9.88     67.20        26     13.00     19.52
X3                                   6                  74.9
GR    438.6    0.00     437.80     3.93    437.73      8.08    437.15      9.88    434.75     14.54
GR    434.5   19.69     434.18    21.68    434.47     31.67    434.60     34.71    434.36     38.21
GR    434.6   43.87     434.35    47.74    435.62     53.62    435.19     58.21    436.61     67.38
GR    436.7   77.48     436.47    88.63    435.87    106.14    435.97    109.88    438.60    123.09
GR    439.0  131.28     439.80   136.21    440.37    142.59

X1    10346      29       9.20     76.30     29.50     28.00     28.49
X3                                 9.2                  88.5
GR    437.6    0.00     437.35     9.29    435.58     15.99    435.67     20.91    435.63     21.62
GR    435.2   29.00     435.31    36.34    434.99     46.86    433.99     49.74    434.16     52.97
GR    435.4   58.89     435.52    62.75    436.16     65.35    435.85     66.38    435.44     68.24
GR    435.9   70.80     436.61    75.86    436.56     81.61    436.83     90.48    436.54    112.65
GR    436.6  114.80     435.98   119.63    436.01    127.57    439.04    141.74    439.07    149.70
GR    438.8  153.55     439.15   156.73    439.19    160.41    439.75    166.51

          CHANGE CONTRACTION AND EXPANSION COEFFICIENT AT BRIDGE X-ING

NC                                  .3       .5
X1    10386      23      15.40    102.50     39.80     38.50     39.65
X3
GR    437.7    0.00     435.97     6.23    435.84     11.20    435.34     15.47    435.35     31.41
GR    435.3   42.41     435.45    49.72    435.30     61.99    435.25     69.83    434.66     72.15
GR    434.6   74.88     435.16    78.85    435.85     90.65    436.72    103.87    436.81    108.40
GR    436.3  120.14     436.42   131.74    436.07    138.32    436.47    145.46    438.47    159.93
GR    439.2  163.61     439.37   174.39    438.75    184.83

NC     .045    .045       .045

   EQUATION STATION WILL BE REQUIRED AT STREAM ANGLE POINT JUST NORTH OF
   BEARDSLEY ROAD DUE TO DOWNSTREAM RE-CHANNELIZATION REQUESTED BY ADOT.
   STA 10+385.479 (BACK) = STA 10+434.120 (AHEAD)
   THE FOLLOWING SECTION HAS AN EQUIVALENT "OLD" STATION OF 10+432.595
X1    10384       6       4.27     48.57     35.00     55.00     46.60
X3                                 0.00                 52.84
GR    438.8    0.00      438.8     4.27     435.4     10.92     435.4     41.92     438.7     48.57
GR    438.7   52.84
```

```
NC                                        .1        .3
   RETURN TO NORMAL CONTRACTON AND EXPANSION COEFFICIENTS UPSTREAM OF BRIDGE

   1/2 WAY THROUGH HORIZONTAL TRANSITION
X1    10472        8      12.60     47.52     39.15     39.15     39.15
X3                                  8.33               51.78
GR    435.5     0.00      439.7      8.33     439.7     12.60     435.6     20.69     435.6     39.44
GR    439.7    47.52      439.7     51.78     436.5     67.00

   NORMAL UPSTREAM SECTION - SANIFILL CONST.

X1    10511        8      14.97     41.49     39.15     39.15     39.15
X3                                 10.69               45.76
GR    435.5     0.00      440.9     10.69     440.9     14.97     435.8     25.02     435.8     31.43
GR    440.9    41.49      440.9     45.76     438.0     53.00


X1    10625        8      15.08     41.59    113.80    113.80    113.80
X3                                 10.81               45.86
GR    436.0     0.00      441.4     10.81     441.4     15.08     436.4     25.14     436.4     31.57
GR    441.4    41.59      441.4     45.86     438.5     53.34


X1    10731        8      12.13     38.64    106.68    106.68    106.68
X3                                  7.86               42.91
GR    438.0     0.00      441.9      7.86     441.9     12.13     436.9     22.19     436.9     28.59
GR    441.9    38.64      441.9     42.91     438.0     50.77
```

THIS RUN EXECUTED 13JUN96 08:59:35

****
HEC-2 WATER SURFACE PROFILES

Version 4.5.1; September 1990
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

CAVE CREEK, EXISTING - W

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	DEPTH	TOPWID	VLOB	QLOB	VCH	QCH	VROB	QROB	STENCL	STENCR
	10016.000	155.70	433.43	2.28	54.99	.00	.00	2.10	155.70	.00	.00	.00	.00
	10050.000	155.70	433.74	2.44	58.63	.00	.00	1.79	155.70	.00	.00	.00	.00
	10090.000	155.70	433.97	2.45	59.74	.00	.00	1.69	155.70	.00	.00	22.00	158.31
	10138.000	155.70	434.23	2.23	69.43	.52	.93	1.70	154.77	.00	.00	.00	.00
	10181.000	155.70	434.48	2.02	60.14	.00	.00	2.15	135.85	1.53	19.85	.00	.00
	10220.000	155.70	434.89	2.07	76.52	.00	.00	1.81	155.70	.00	.00	.00	.00
	10258.000	155.70	435.24	1.69	64.82	.00	.00	2.24	155.70	.00	.00	3.50	193.10
	10298.000	155.70	435.77	1.70	61.90	.00	.00	2.22	155.70	.00	.00	51.90	126.30
	10318.000	155.70	435.98	1.80	51.13	.00	.00	2.54	153.91	.89	1.78	6.00	74.90
	10346.000	155.70	436.44	2.45	61.91	.00	.00	2.25	155.70	.00	.00	9.20	88.50
*	10386.000	155.70	436.87	2.27	145.37	.59	3.70	1.14	140.42	.43	11.58	.00	.00
*	10384.000	155.70	436.86	1.46	36.80	.00	.00	3.14	155.70	.00	.00	.00	52.84
*	10472.000	155.70	437.39	1.89	25.79	.00	.00	3.92	155.70	.00	.00	8.33	51.78
*	10511.000	155.70	438.70	3.20	17.84	.00	.00	4.43	155.70	.00	.00	10.69	45.76
*	10625.000	155.70	440.34	4.34	22.23	.00	.00	2.76	155.70	.00	.00	10.81	45.86
	10731.000	155.70	440.87	3.97	22.37	.00	.00	2.73	155.70	.00	.00	7.86	42.91

CAVE CREEK, EXISTING - W

SUMMARY PRINTOUT

Energy Slope x 10^4 | Reach Length | Σ Channel Length

	SECNO	Q	K*XNL	K*XNCH	K*XNR	STCHL	STCHR	SSTA	ENDST	10*KS	FRCH	XLCH	CUMDS
	10016.000	155.70	.00	55.00	.00	24.05	92.25	27.46	82.44	90.49	.58	.00	.00
	10050.000	155.70	.00	55.00	.00	35.40	108.84	42.40	101.03	58.26	.47	34.34	34.34
	10090.000	155.70	.00	55.00	.00	22.89	90.00	26.70	86.44	50.03	.44	39.64	73.98
	10138.000	155.70	70.00	55.00	.00	13.15	78.46	7.16	76.59	54.53	.45	48.59	122.57
	10181.000	155.70	.00	55.00	70.00	.00	65.87	18.23	78.37	96.64	.60	42.84	165.41
	10220.000	155.70	.00	55.00	.00	4.52	92.49	8.42	84.94	84.50	.54	38.72	204.13
	10258.000	155.70	.00	55.00	.00	30.08	101.08	31.45	96.26	138.76	.69	38.55	242.68
	10298.000	155.70	.00	55.00	.00	54.49	121.75	55.80	117.70	127.60	.67	39.85	282.53
	10318.000	155.70	.00	55.00	70.00	9.88	58.21	12.16	63.29	137.86	.71	19.52	302.05
	10346.000	155.70	.00	55.00	.00	.00	75.86	12.74	74.65	134.37	.68	28.49	330.54
*	10386.000	155.70	70.00	55.00	70.00	11.20	90.65	2.99	148.36	21.97	.29	39.65	370.19
*	10384.000	155.70	.00	45.00	.00	4.27	48.57	8.06	44.87	137.91	.86	46.60	416.79
*	10472.000	155.70	.00	45.00	.00	12.60	47.52	17.17	42.96	182.18	1.01	39.15	455.94
*	10511.000	155.70	.00	45.00	.00	14.97	41.49	19.31	37.15	177.52	1.01	39.15	495.09
*	10625.000	155.70	.00	45.00	.00	15.08	41.59	17.23	39.45	49.71	.55	113.80	608.89
	10731.000	155.70	.00	45.00	.00	12.13	38.64	14.20	36.57	47.99	.54	106.68	715.57

SUMMARY OF ERRORS AND SPECIAL NOTES

```
WARNING SECNO=  10386.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

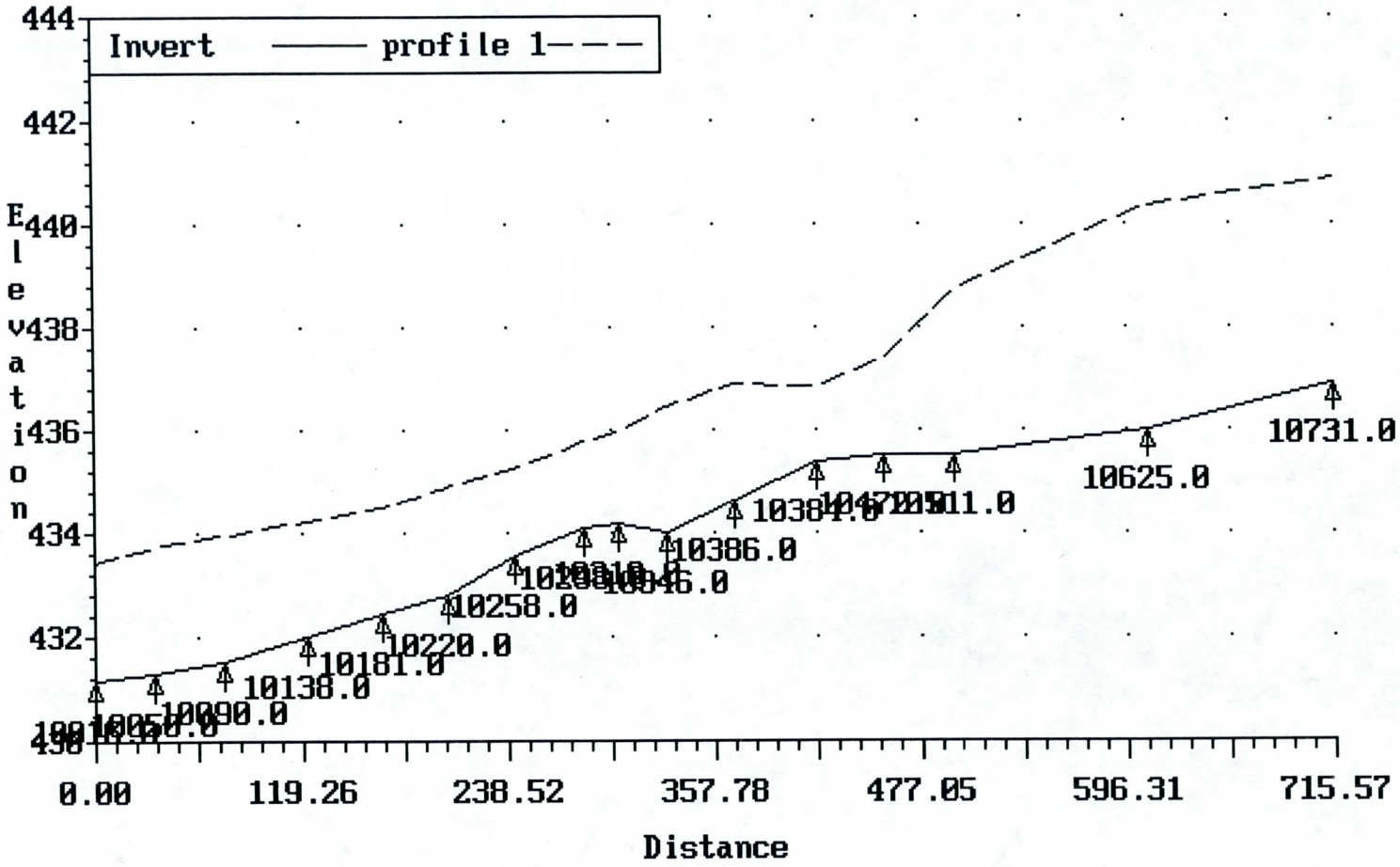
WARNING SECNO=  10384.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=  10472.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  10472.000  PROFILE=  1  MINIMUM SPECIFIC ENERGY

CAUTION SECNO=  10511.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  10511.000  PROFILE=  1  MINIMUM SPECIFIC ENERGY

WARNING SECNO=  10625.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
```

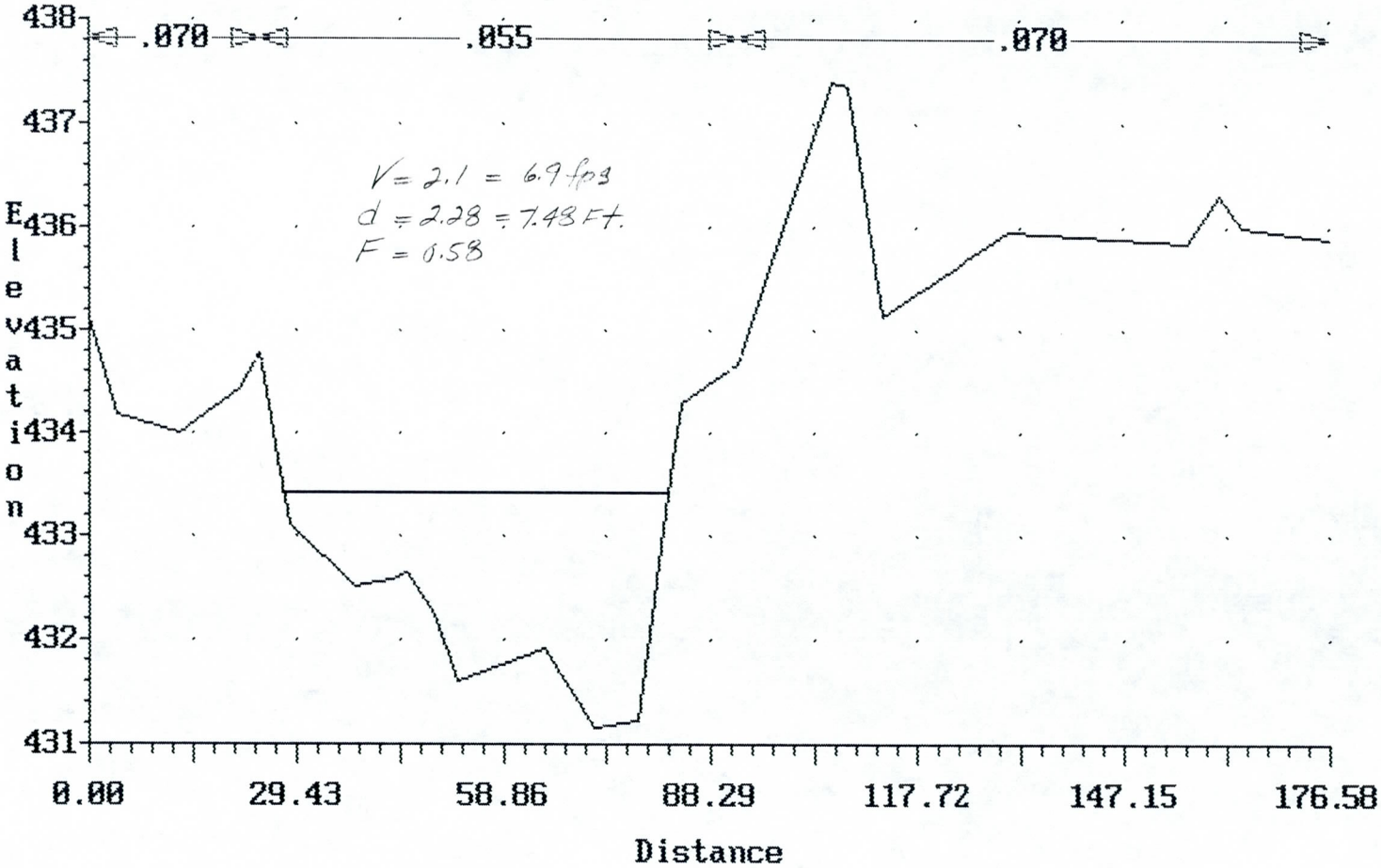
CAVE CREEK, EXISTING
WITH SANIFILL SECTIONS U



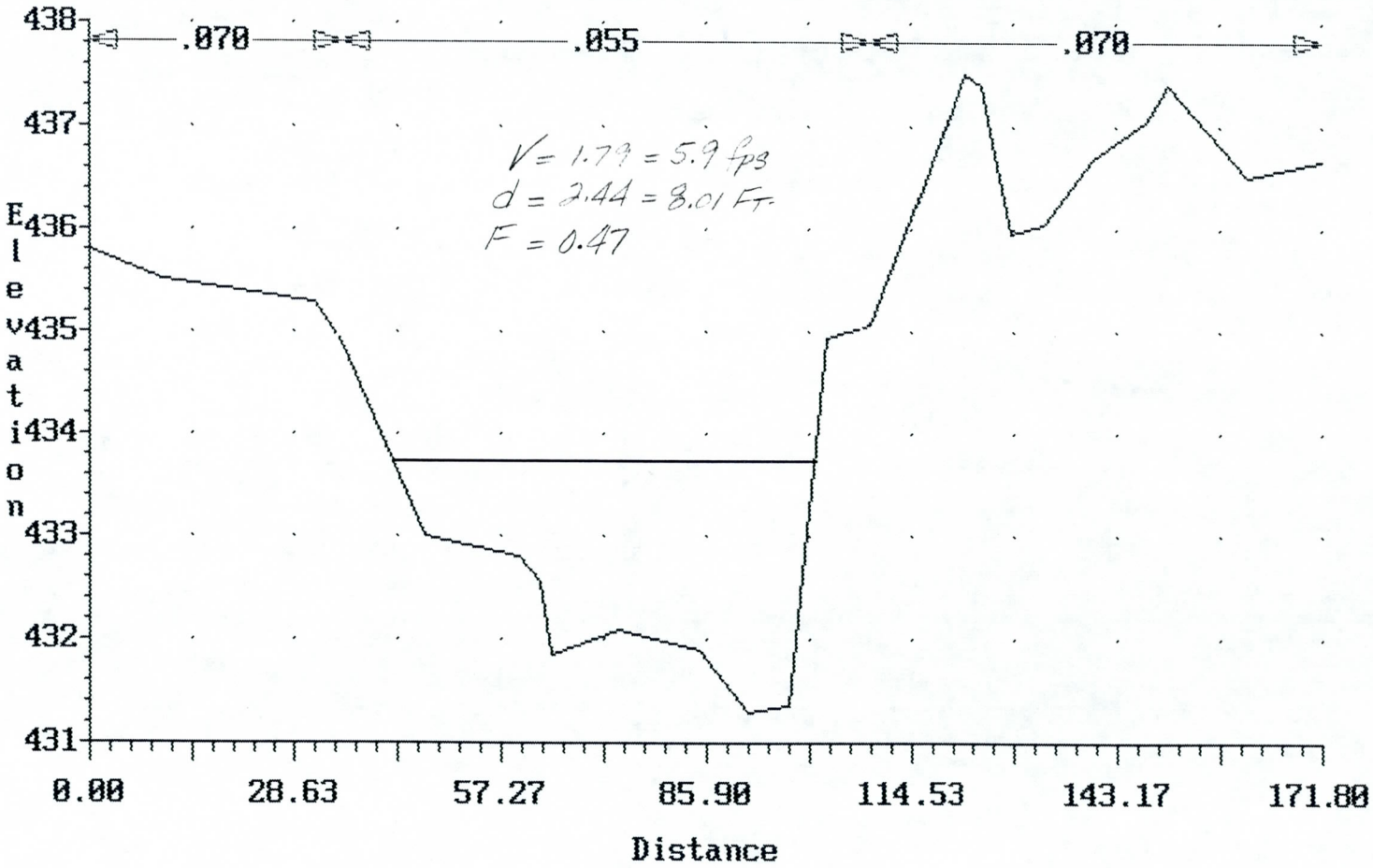
Stop - Program terminated.

Stop - Program terminated.
G:\DRNG\HECEXE2>

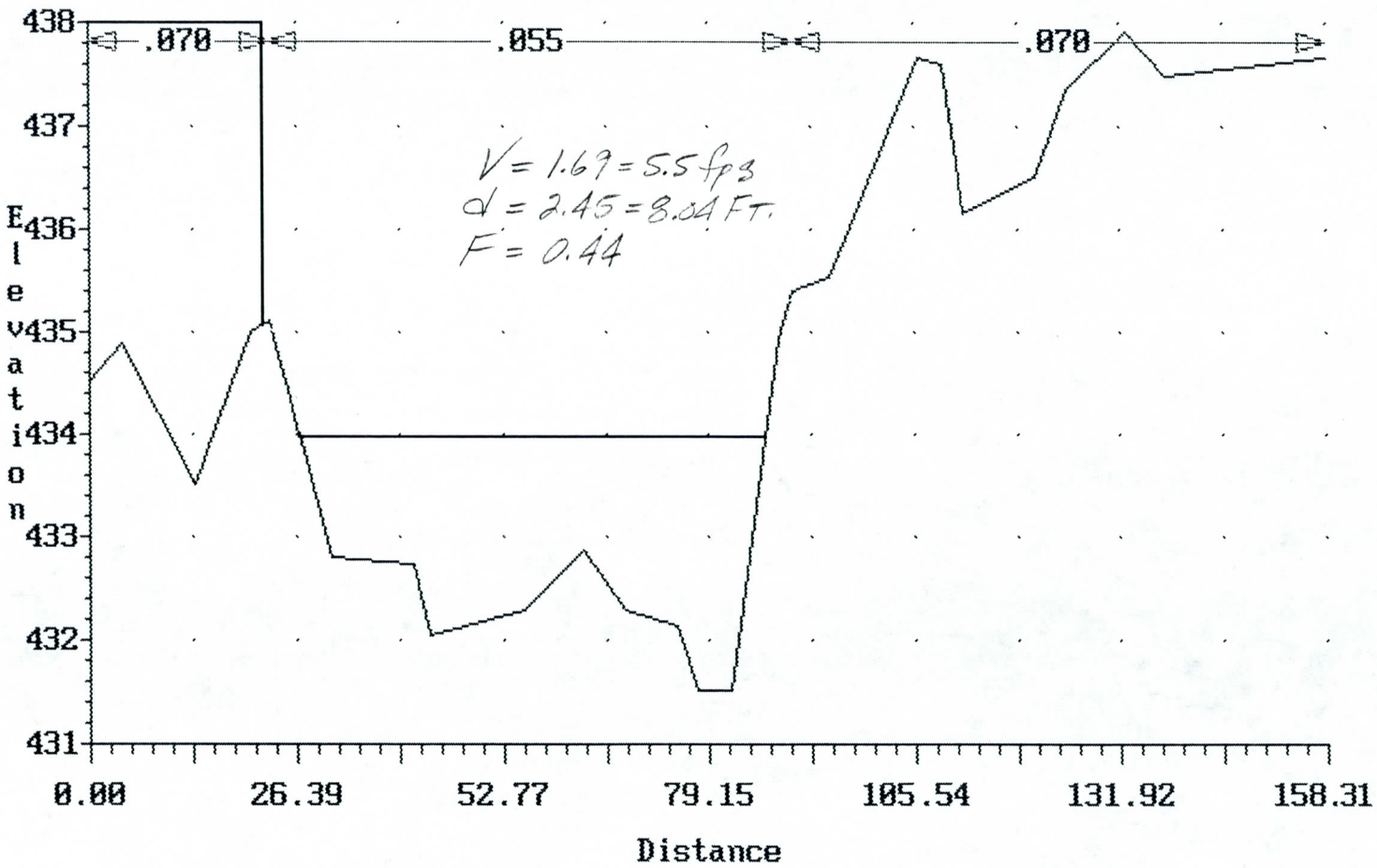
CAVE CREEK, EXISTING
WITH SANIFILL SECTIONS
Cross-section 10016.000



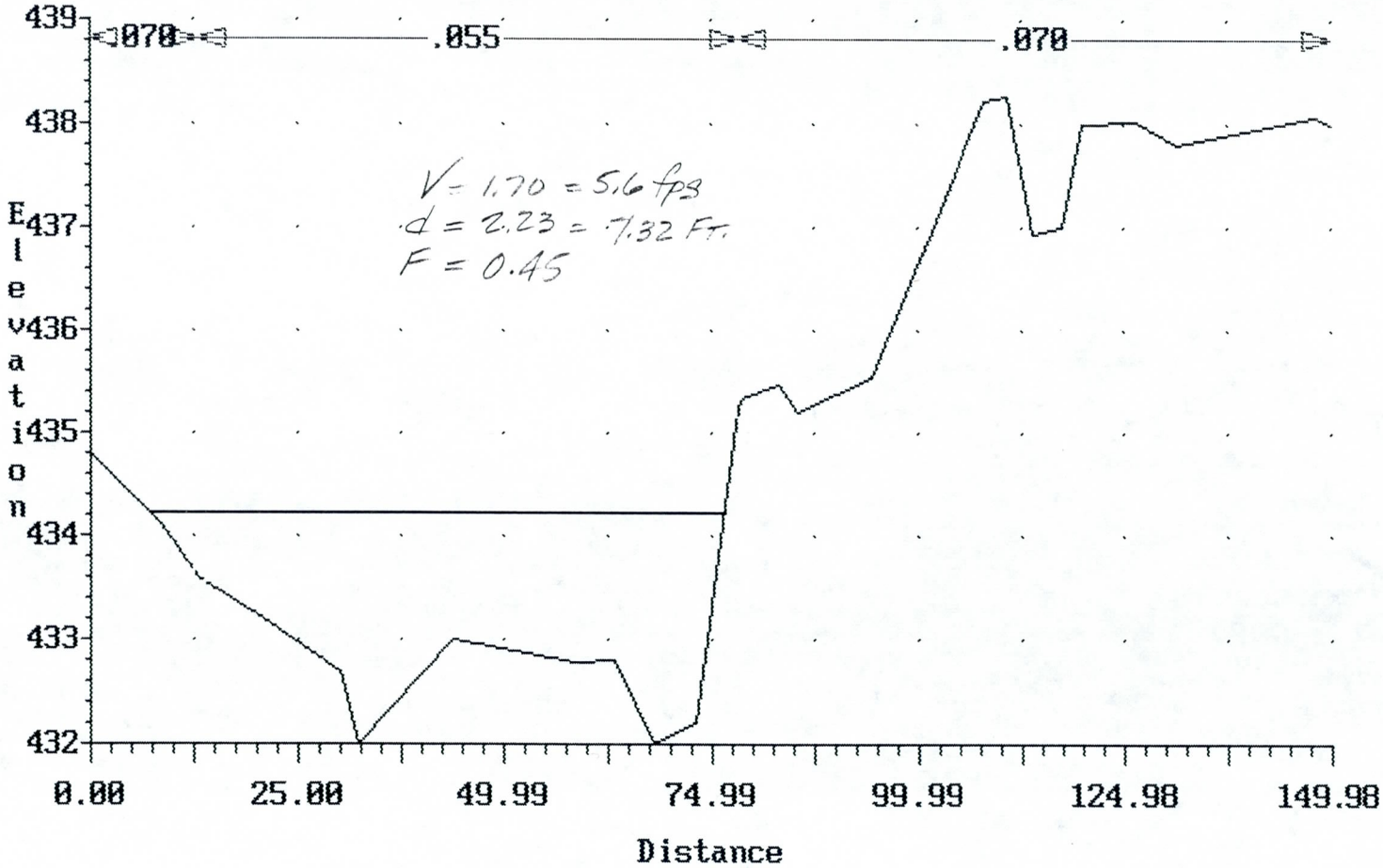
CAVE CREEK, EXISTING
WITH SANIFILL SECTIONS
Cross-section 10050.000

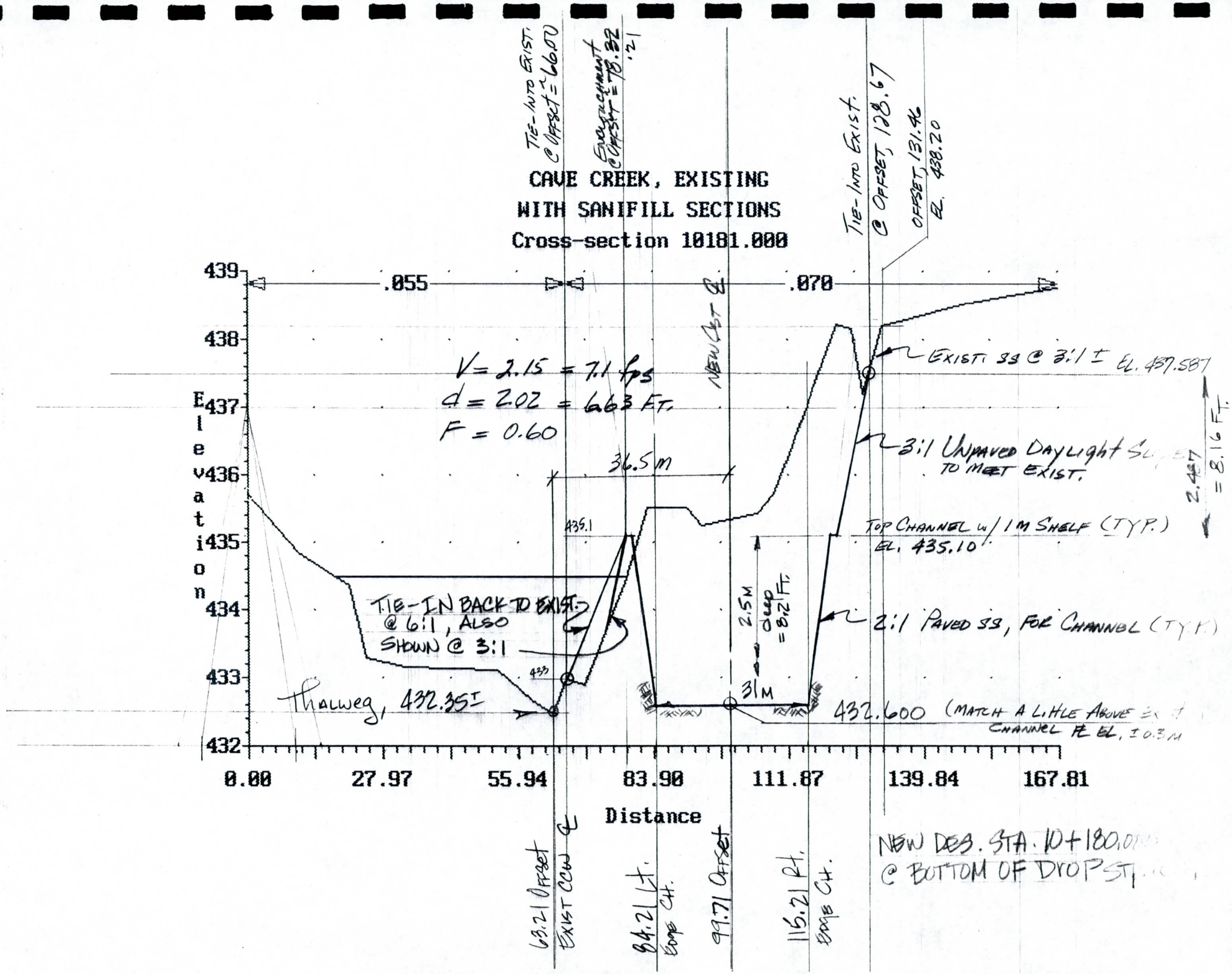


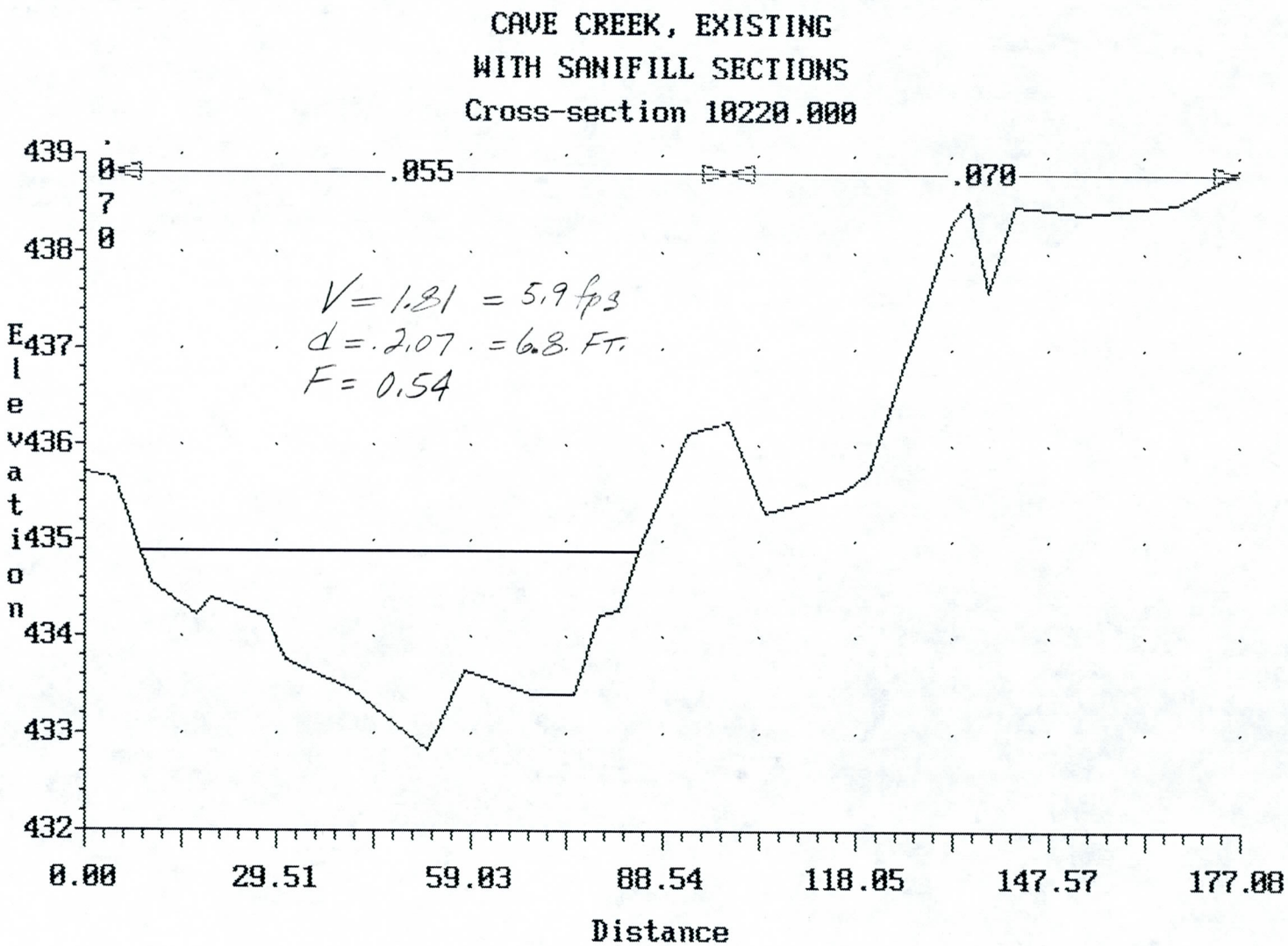
CAVE CREEK, EXISTING
WITH SANIFILL SECTIONS
Cross-section 10090.000



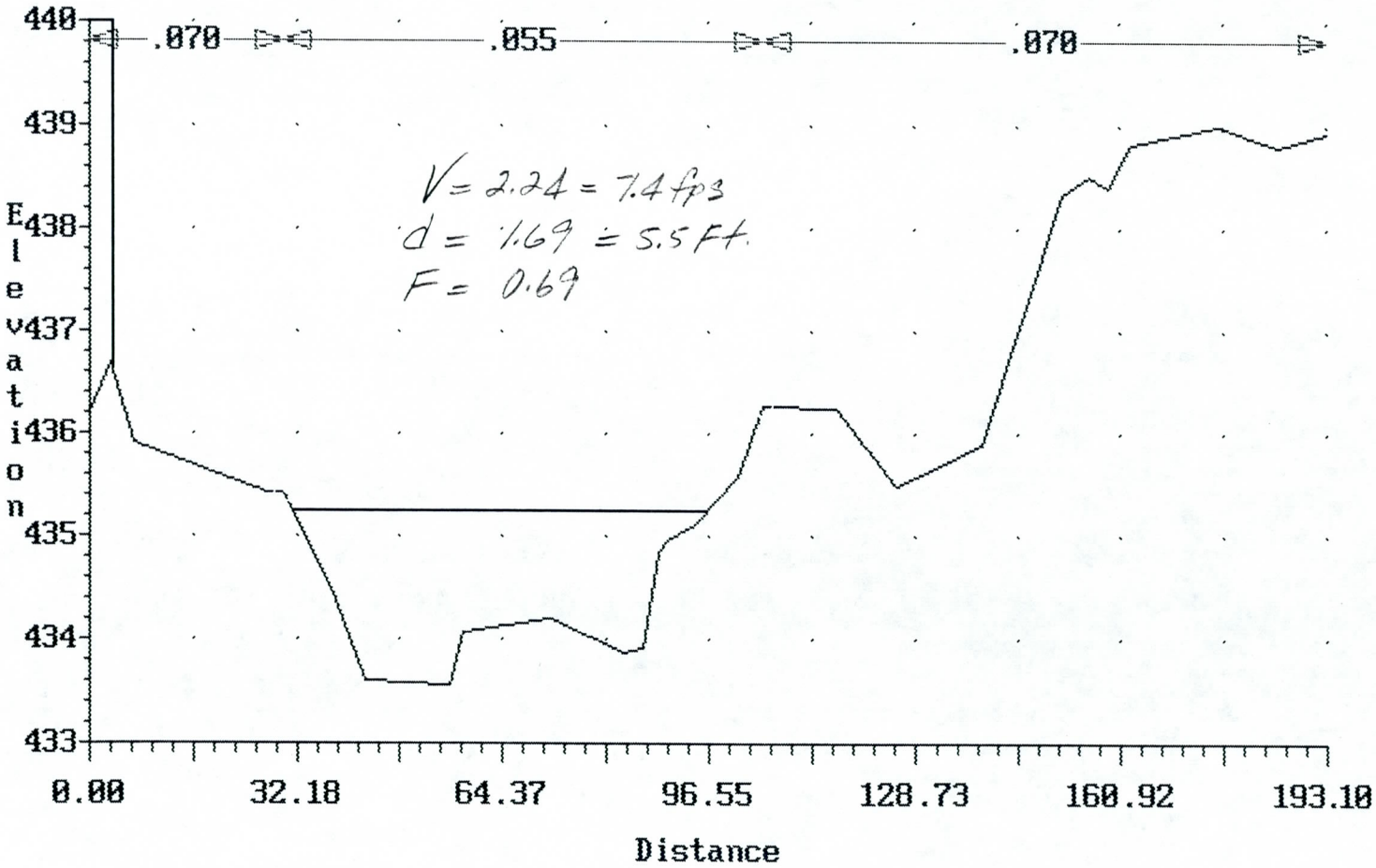
CAVE CREEK, EXISTING
WITH SANIFILL SECTIONS
Cross-section 10138.000



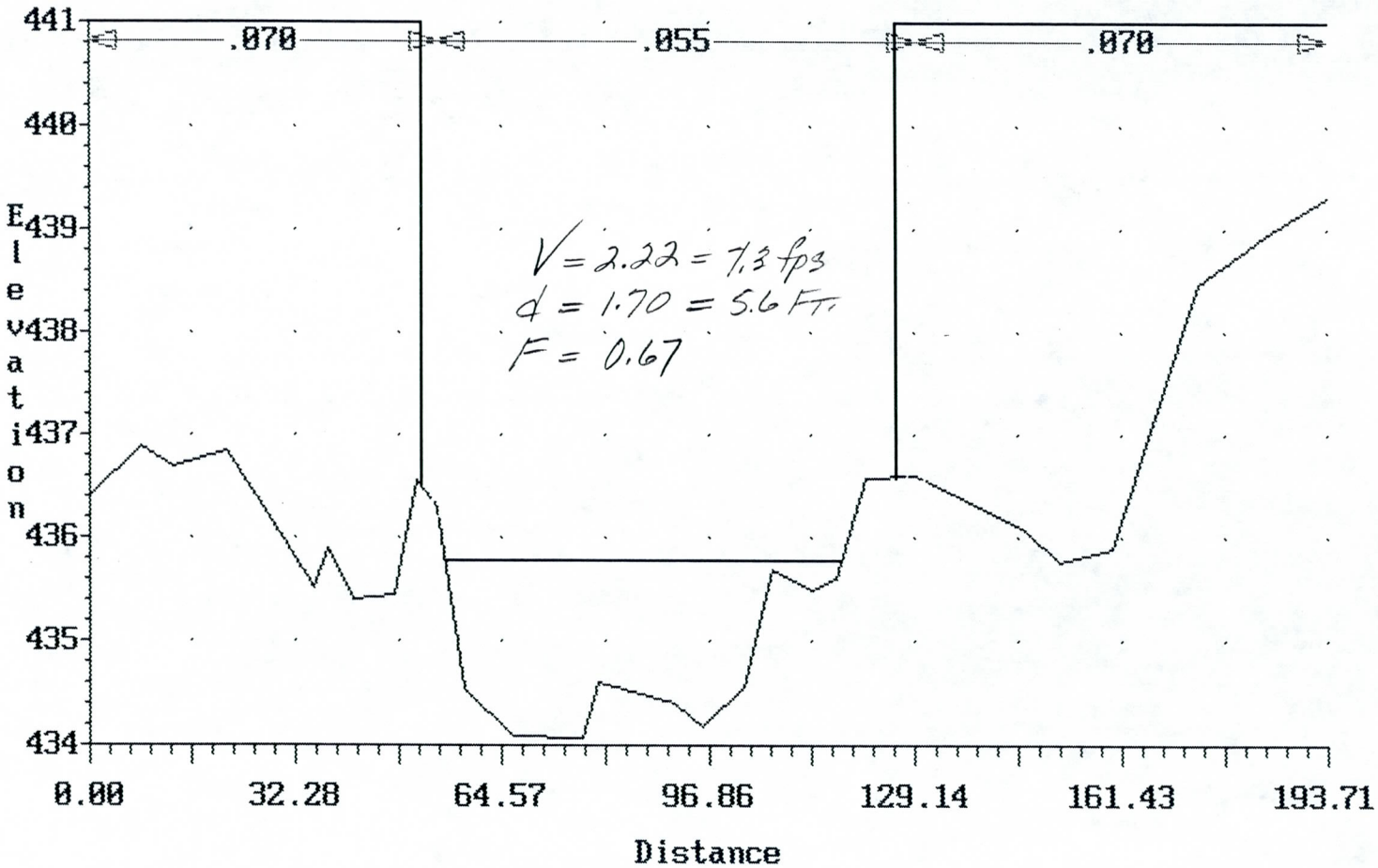

CAVE CREEK, EXISTING
WITH SANIFILL SECTIONS
Cross-section 10181.000
TIE-INTO EXIST. @ OFFSET ≈ 66.00
ENCROACHMENT @ OFFSET = 78.32
TIE-INTO EXIST. @ OFFSET, 128.67
OFFSET, 131.46 EL. 438.20
.055
.070
NEW CST ℄
V = 2.15 = 7.1 fps
d = 2.02 = 6.63 FT.
F = 0.60
36.5 m
435.1
EXIST. SS @ 3:1 ± EL. 437.587
3:1 UNPAVED DAYLIGHT SLOPE TO MEET EXIST.
2.497 = 8.16 FT.
TOP CHANNEL w/ 1 M SHELF (TYP.) EL. 435.10
2.5 M = 8.2 FT.
2:1 PAVED SS, FOR CHANNEL (TYP.)
TIE-IN BACK TO EXIST. @ 6:1, ALSO SHOWN @ 3:1
433
Thalweg, 432.35±
3 M
432.600 (MATCH A LITTLE ABOVE EXIST. CHANNEL FL EL. ± 0.3 M)
Elevation
439
438
437
436
435
434
433
432
0.00
27.97
55.94
83.90
111.87
139.84
167.81
Distance
63.21 Offset EXIST CON ℄
84.21 Lt. Edge Ct.
99.71 Offset
116.21 Rt. Edge Ct.
NEW DES. STA. 10+180.00 @ BOTTOM OF DROP ST.


CAVE CREEK, EXISTING
WITH SANIFILL SECTIONS
Cross-section 10220.000
.070
.055
.070
V= 1.81 = 5.9 fps
d = 2.07 = 6.8 FT.
F = 0.54
Elevation
439
438
437
436
435
434
433
432
0.00
29.51
59.03
88.54
118.05
147.57
177.08
Distance

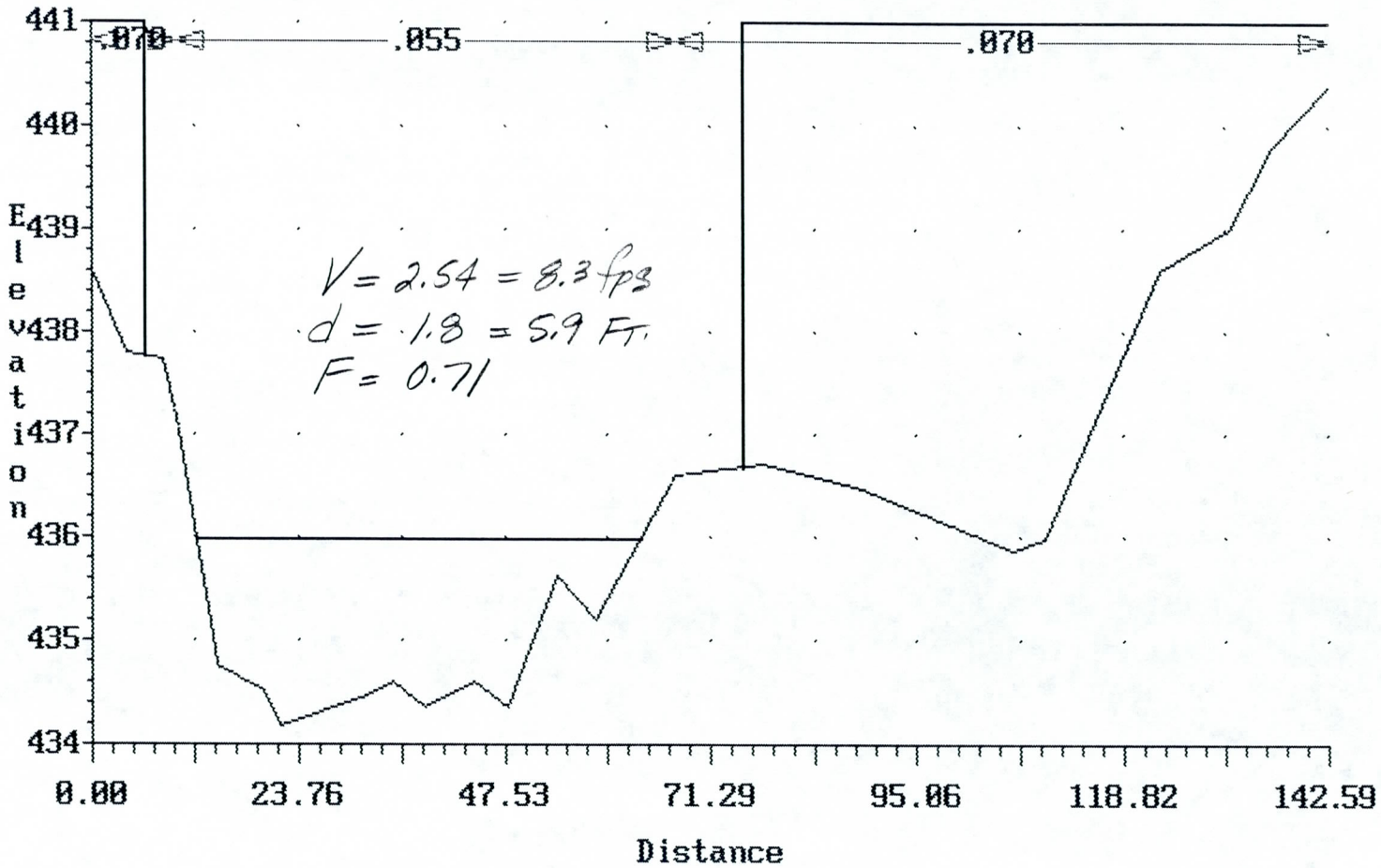
CAVE CREEK, EXISTING
WITH SANIFILL SECTIONS
Cross-section 10258.000



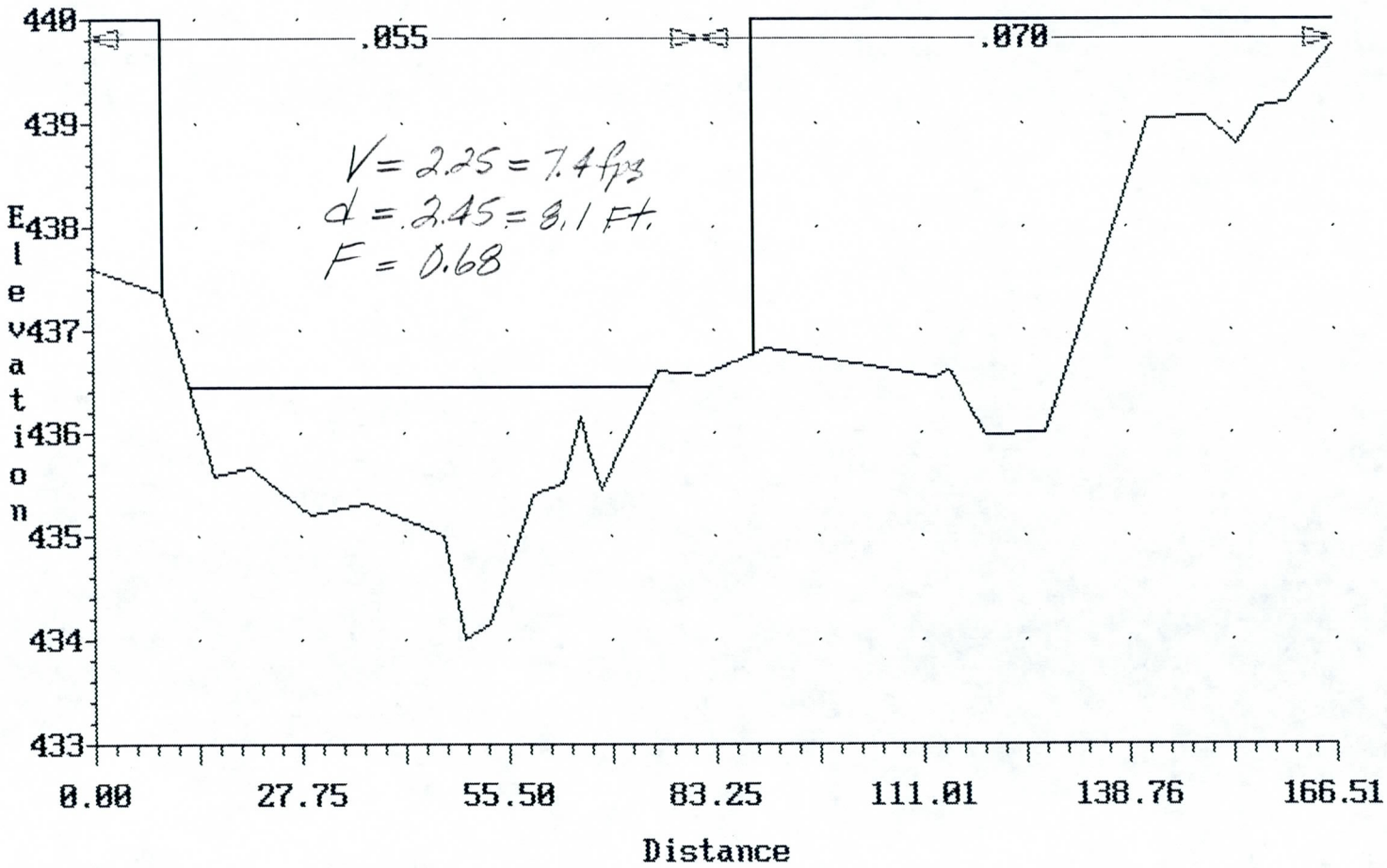
CAVE CREEK, EXISTING
WITH SANIFILL SECTIONS
Cross-section 10298.000

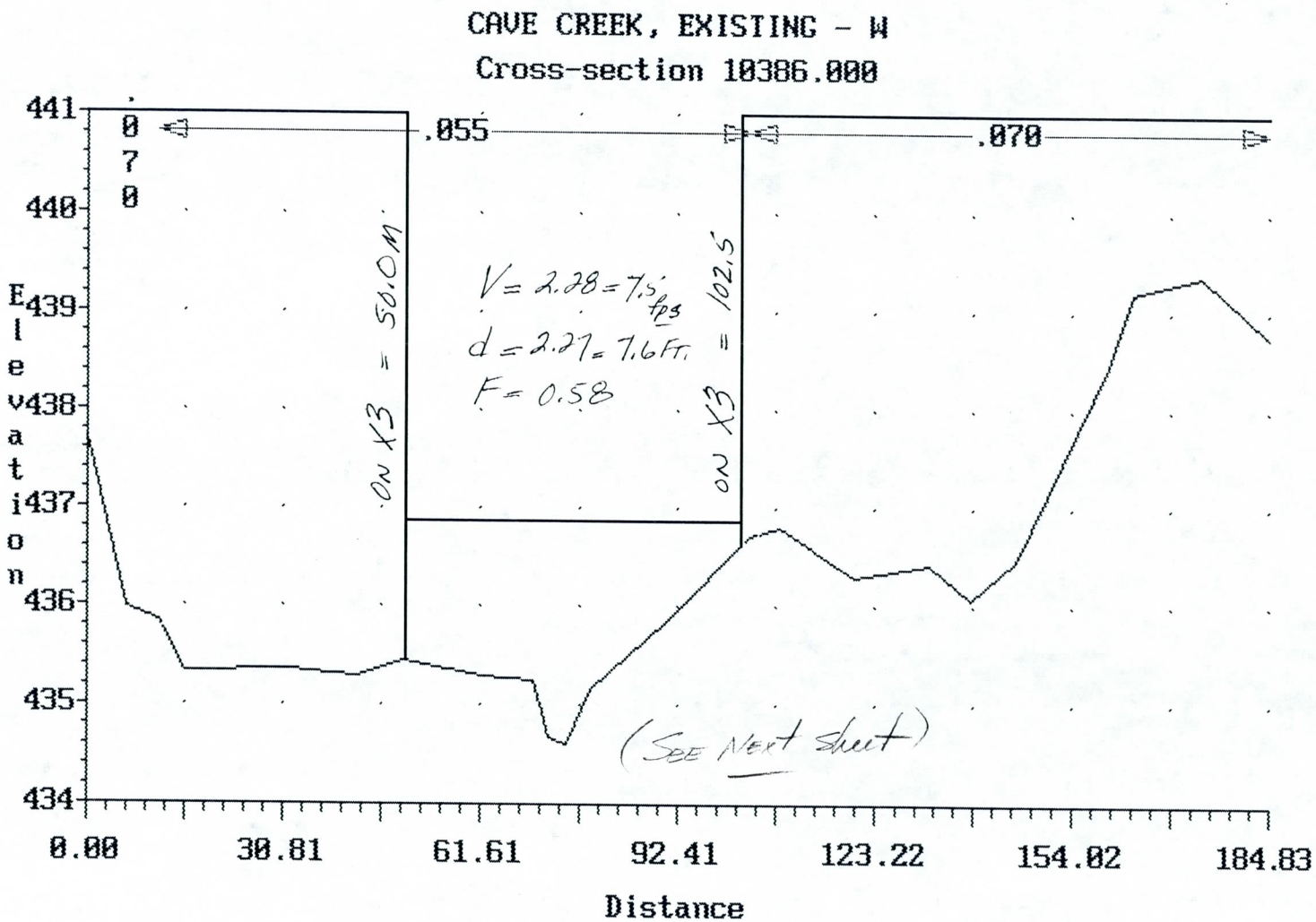


CAVE CREEK, EXISTING
WITH SANIFILL SECTIONS
Cross-section 10318.000



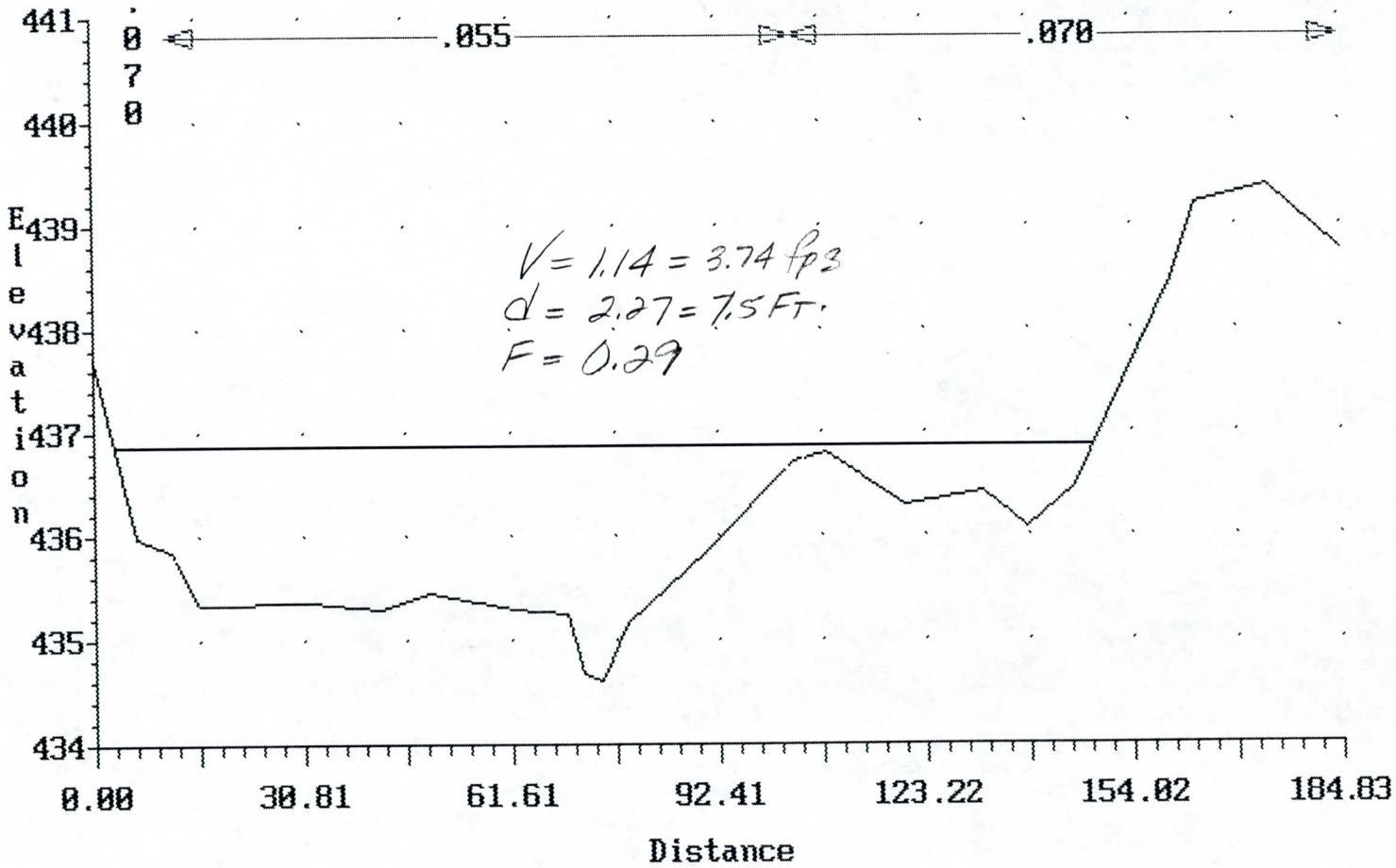
CAVE CREEK, EXISTING
WITH SANIFILL SECTIONS
Cross-section 10346.000



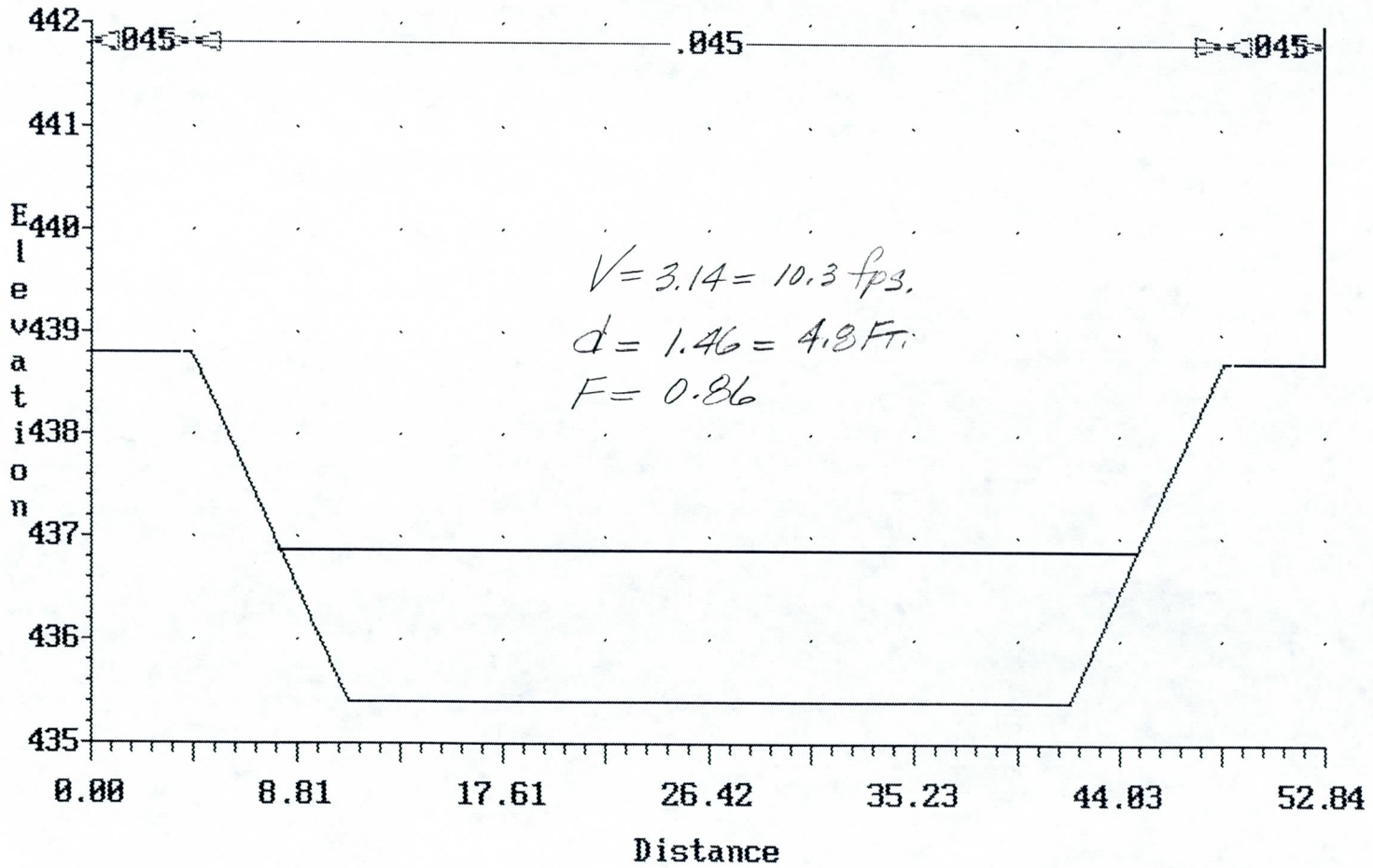


THESE ENCROACHMENTS WERE REMOVED FOR THIS RUN — DEEMED TO BE NOT NECESSARY (≅ 48m DOWNSTREAM FROM NORTH TIE-IN TO RE-CHANNELIZATION)

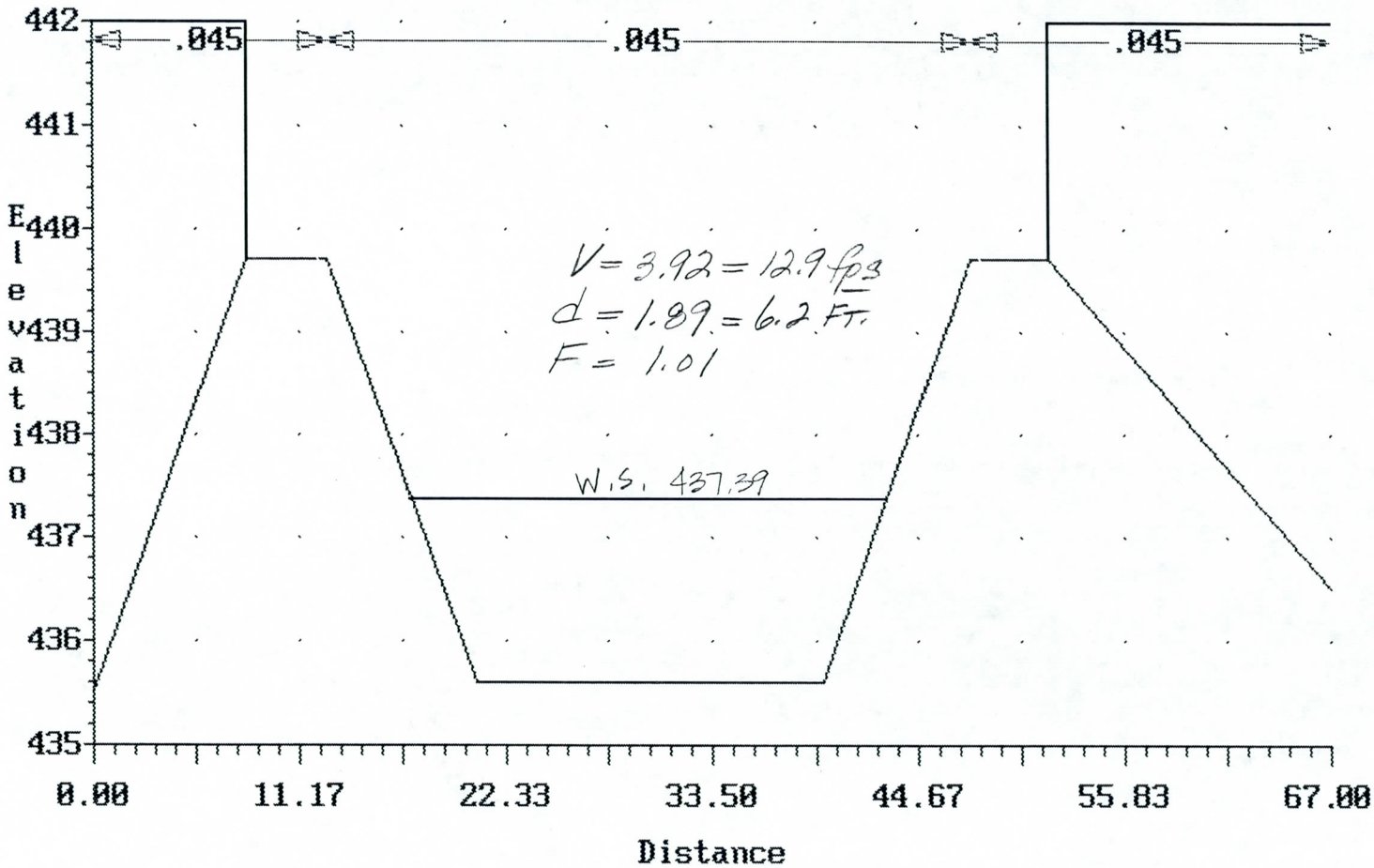
CAVE CREEK, EXISTING
WITH SANIFILL SECTIONS
Cross-section 10386.000



CAVE CREEK, EXISTING
WITH SANIFILL SECTIONS
Cross-section 10384.000

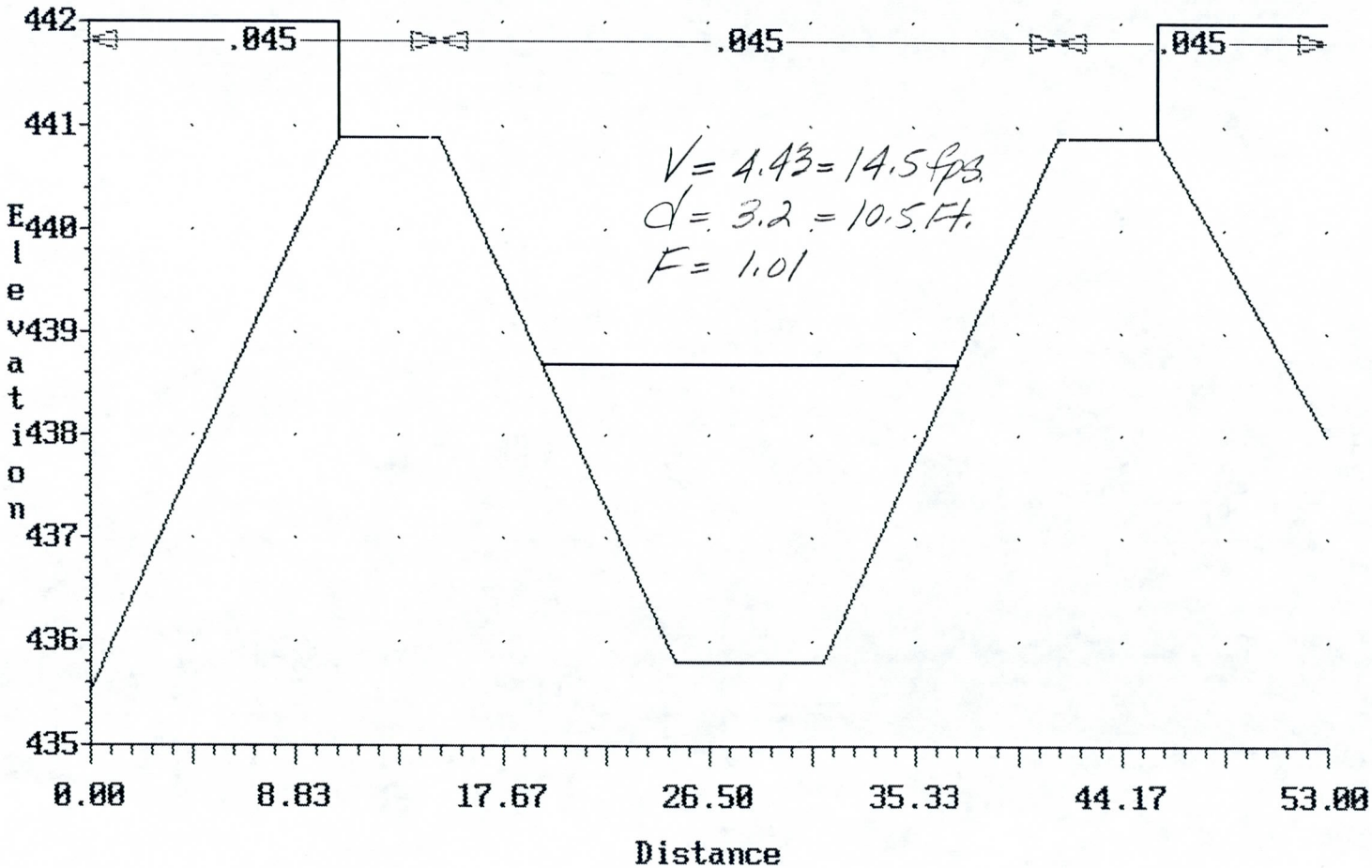


CAVE CREEK, EXISTING
WITH SANIFILL SECTIONS
Cross-section 10472.000



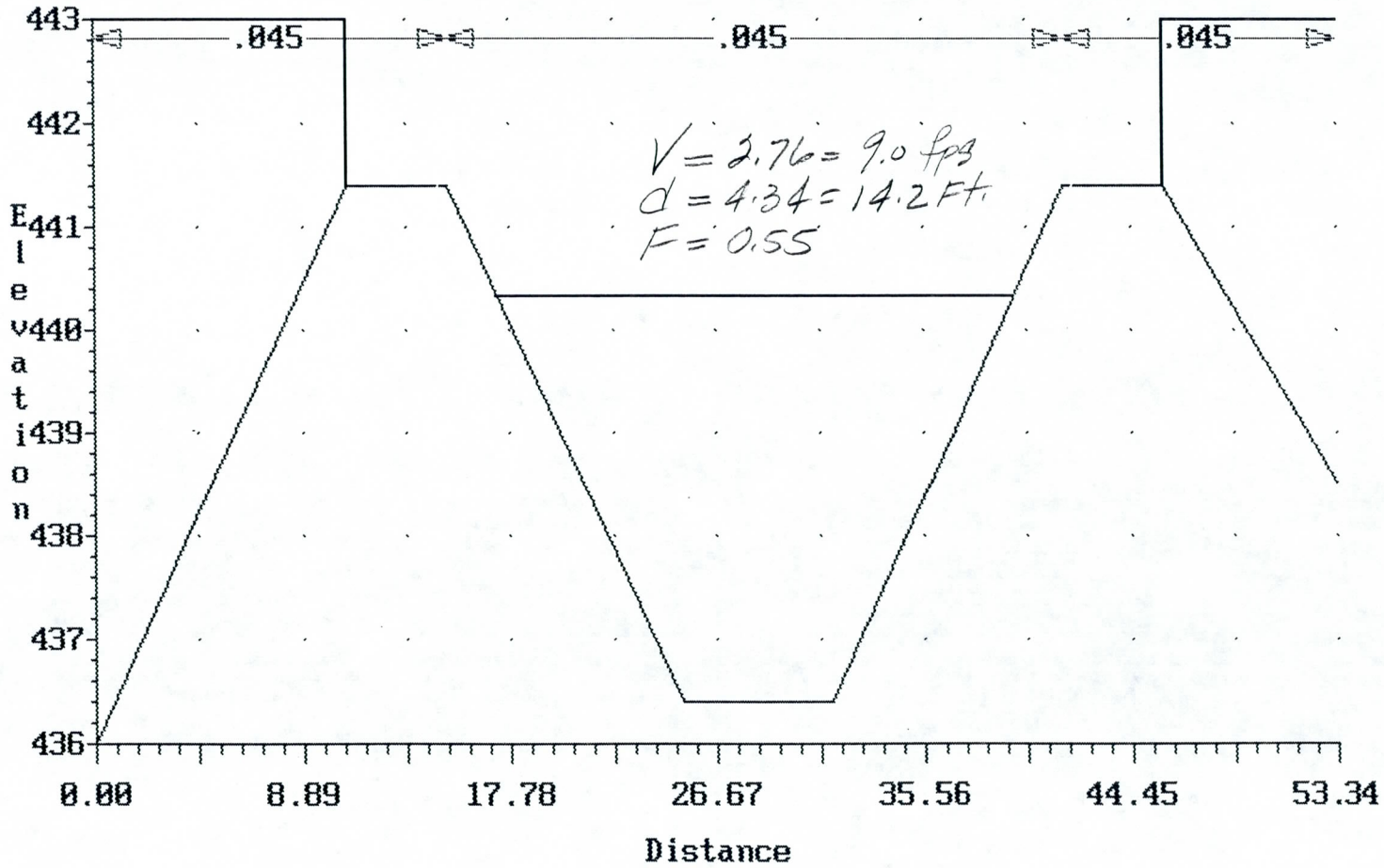
(HEC-2 DEFAULTED TO CRITICAL DEPTH)
MAY BE A HYDRAULIC JUMP
OCCURING UPSTM.

CAVE CREEK, EXISTING
WITH SANIFILL SECTIONS
Cross-section 10511.000

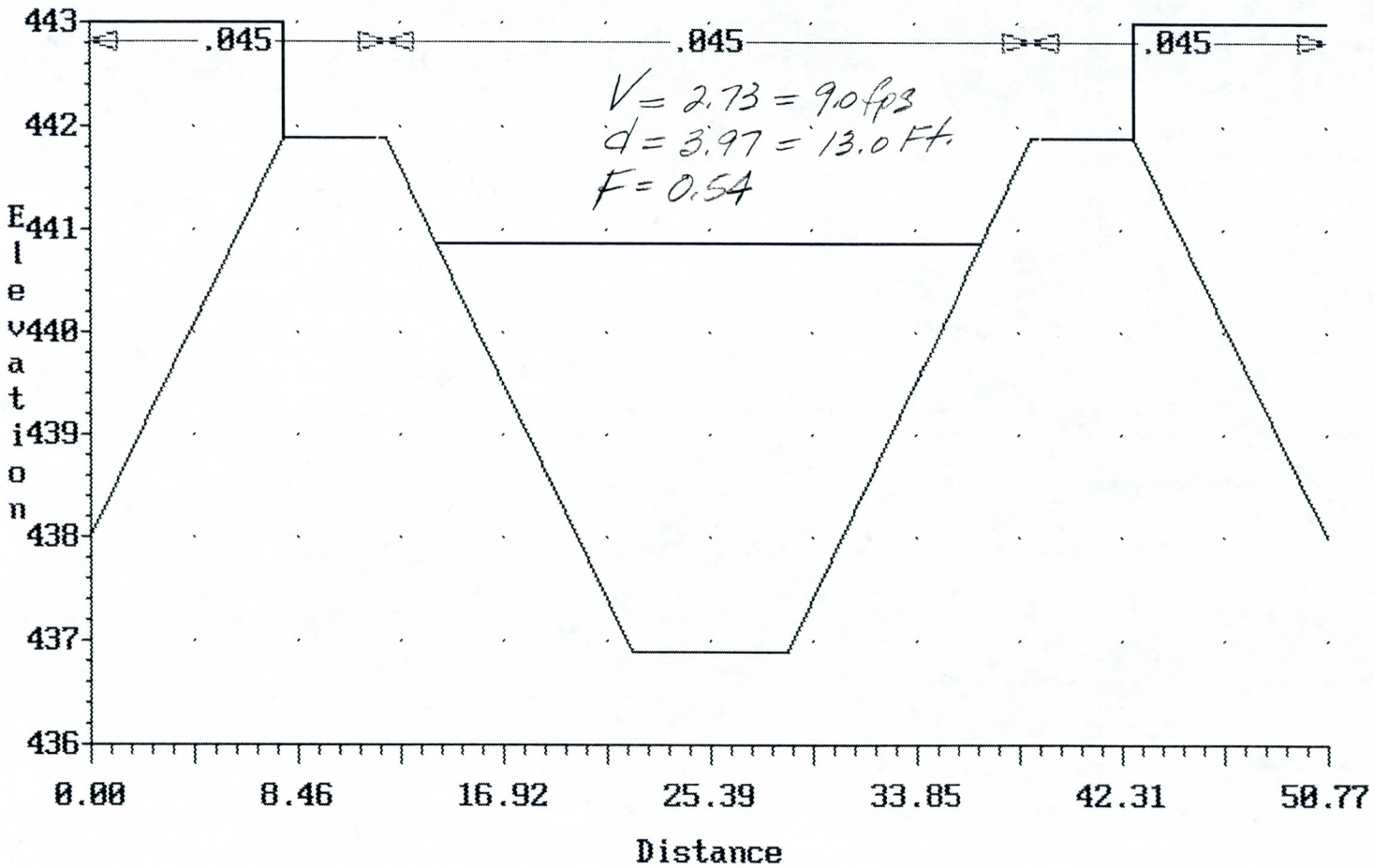


(HEC-2 DEFAULTED TO CRITICAL DEPTH)

CAVE CREEK, EXISTING
WITH SANIFILL SECTIONS
Cross-section 10625.000



CAVE CREEK, EXISTING
WITH SANIFILL SECTIONS
Cross-section 10731.000



```
*********************************************
*  HEC-2 WATER SURFACE PROFILES             *
*                                           *
*  Version   4.5.1;  September 1990         *
*                                           *
*  RUN DATE    26JUN96    TIME    14:19:38  *
*********************************************
```

```
****************************************
*  U.S. ARMY CORPS OF ENGINEERS        *
*  HYDROLOGIC ENGINEERING CENTER       *
*  609 SECOND STREET, SUITE D          *
*  DAVIS, CALIFORNIA 95616-4687        *
*          (916) 756-1104              *
****************************************
```

```
X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X    X             X    X
X     X  X        X                       X
XXXXXXX  XXXX     X         XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X    X             X
X     X  XXXXXXX   XXXXX              XXXXXXX
```

END OF BANNER

Multiple Profile Run Q100 & Q500

FILE: CC1C.IN

RE-CHANNELIZATION w/ INTERIM E.B. & W.B. FRNT. RD. BRIDGES AS WELL AS upstream SANIFILL IMPROVEMENTS (1000' NORTH OF BEARDSLEY RD.)

RUN for: Q_{100} = 5500 cfs.
Q_{500} = 11,000 cfs. Superflood for Scour.

Parsons Brinckerhoff Computation Sheet

Page 1 of _____ | 110325

Made by BOB B.

Date JUNE 20, 96

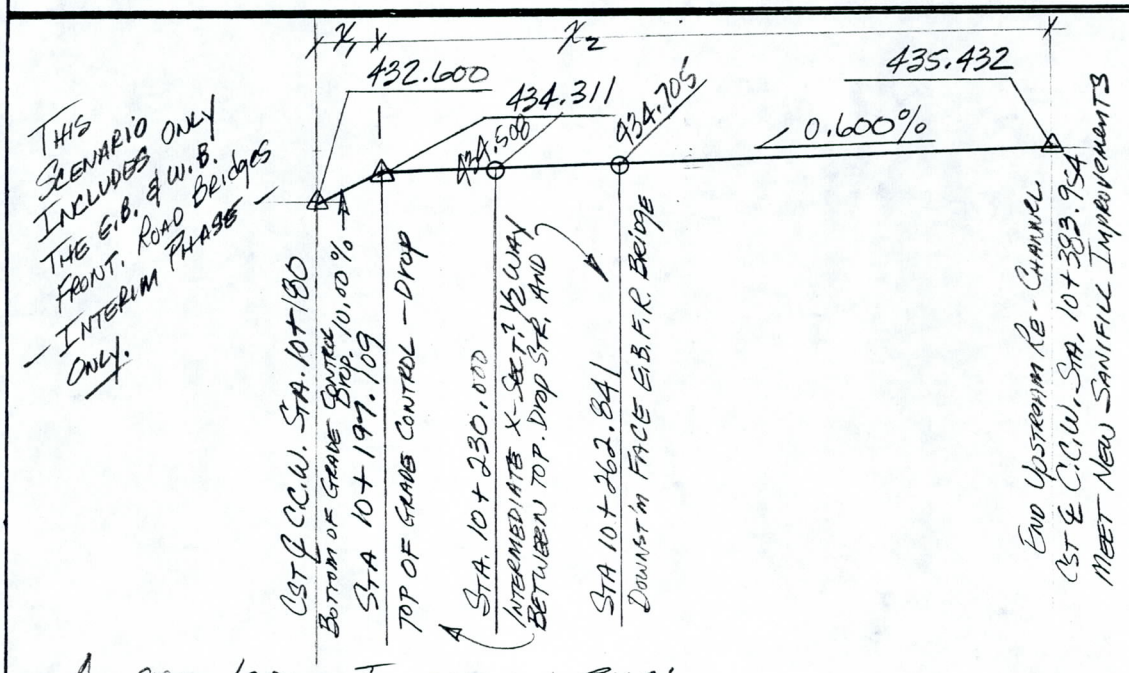
Checked by _____

Date _____

Subject CAVE CREEK WASH RE-CHANNELIZATION DESIGN – PIMA FWY. JCT I-17 TO 56TH ST.

REFERENCE

SCALE: 1:3000 RATIO HOR. 1:200 RATIO VERT.



DO GRADE / GRADE INTERSECTION CALC:

- EQU. 1 – $X_1 + X_2 = 203.954\,M$
- EQU 2 – $432.600 + X_1(0.10) = 435.432 - X_2(0.006)$

SINCE $X_1 = 203.954 - X_2$, SUBSTITUTE INTO EQU. 2 ABOVE

So, $432.600 + [(203.954 - X_2)(0.10)] = 435.432 - 0.006X_2$

$432.600 + (20.3954 - 0.10X_2) = 435.432 - 0.006X_2$

$X_2 = 186.845$

$X_1 = 17.109.$

Intersection STA. = 10+197.109
Intersection EL = 434.311

Drop Δ ELEV. = 1.711 m = 5.61 FT. } @ 10.00% GRADE

Drop. Length = 17.109 m = 56.13 FT. }

```
G:\DRNG\HECEXE2>hec2menu.exe
Stop - Program terminated.

G:\DRNG\HECEXE2>echo off

ULTIMATE FREEWAY PLAN, W

  Starting profile number  1

       CWSEL for cross section  10016.000 is   433.43
       CWSEL for cross section  10050.000 is   433.74
       CWSEL for cross section  10090.000 is   433.97
       CWSEL for cross section  10138.000 is   434.23
       CWSEL for cross section  10180.000 is   434.40
       CWSEL for cross section  10197.000 is   435.64
       CWSEL for cross section  10230.000 is   436.37
       CWSEL for cross section  10263.000 is   436.73
       CWSEL for cross section  10269.000 is   436.75
       CWSEL for cross section  10315.000 is   437.03
       CWSEL for cross section  10368.000 is   437.23
       CWSEL for cross section  10374.000 is   437.26
       CWSEL for cross section  10384.000 is   437.42
       CWSEL for cross section  10472.000 is   437.41
       CWSEL for cross section  10511.000 is   438.70
       CWSEL for cross section  10625.000 is   440.34
       CWSEL for cross section  10731.000 is   440.87

ULTIMATE FREEWAY PLAN, W

  Starting profile number  2

       CWSEL for cross section  10016.000 is   434.16
       CWSEL for cross section  10050.000 is   434.52
       CWSEL for cross section  10090.000 is   434.77
       CWSEL for cross section  10138.000 is   435.04
       CWSEL for cross section  10180.000 is   435.16
       CWSEL for cross section  10197.000 is   436.38
       CWSEL for cross section  10230.000 is   437.29
       CWSEL for cross section  10263.000 is   437.67
       CWSEL for cross section  10269.000 is   437.69
       CWSEL for cross section  10315.000 is   438.02
       CWSEL for cross section  10368.000 is   438.22
       CWSEL for cross section  10374.000 is   438.24
       CWSEL for cross section  10384.000 is   438.43
       CWSEL for cross section  10472.000 is   438.35
       CWSEL for cross section  10511.000 is   439.94
       CWSEL for cross section  10625.000 is   441.74
       CWSEL for cross section  10731.000 is   442.28

Normal program termination

Press any key to continue . . .

Stop - Program terminated.
G:\DRNG\HECEXE2>
```

FILE: CC1C.IN & OUT
EB & WB FRONT. RD. BRIDGES w/ Q500YR.

= Q100 5500 cfs

= Q500 11,000 cfs

THIS RUN EXECUTED 26JUN96 14:19:38

```
****************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.5.1;  September 1990
****************************************
```

```
T1      PIMA FREEWAY BRIDGE CROSSING AT CAVE CREEK (BEARDSLEY ROAD ALIGNMENT)
T2      HYDRAULIC ANALYSIS FOR FUTURE RE-CHANNELIZATION WITH W.B.,E.B. BRIDGES
        USING A REVISED RE-CHANNELIZATION ALIGNMENT W/ DROP AT STA 10+180 TO
        10+213.188 PER R. JORDAN REVIEW AT ADOT ON JUNE 18, 1996 - INCLUDING THE
T3      ULTIMATE FREEWAY PLAN, WITH UPSTREAM SANIFILL INC. IMPROVEMENTS
T4      MODEL CC1C.IN,SUBCRITICAL FLOW  - WITH SANIFILL IMPROVEMENTS OF 6/96
T5      ALL INPUT DATA IS IN METRIC UNITS
T6      DISCHARGES IN cfs: 5,500, = 155.7 CMS
T7      ALL CROSS-SECTION DATA COMPILED BY INTER-GRAPH DTM USING "INROADS"
        SANIFILL SECTIONS UPSTREAM BEGINNING WITH STA 10+383.954 WERE IMPUT
        MANUALLY BY BOB BATTISTELLO ON JUNE 11,1996 - CONSEQUENTLY, ALL OTHER
        UPSTREAM SECTIONS HAVE BEEN REMOVED FROM THIS MODEL.
        BASE MODEL WAS DONE BY BOB WARD AS FILE: CC1.IN  -  SEPT,95.
        LAST REVISED FILE TO CREATE THIS FILE WAS CC1B.IN - B. BATTISTELLO 6/96
        WICH USES "OLD" RE-CHANNELIZATION TIE-IN POINT @ STA 10+115.378, -
        ACTUAL CHANNEL LINING IMPROVEMENTS BEGIN AT CCW STA. 10+180.000

        SUPERFLOOD - 500 YEAR EVENT ALSO RUN FOR BRIDGE SCOUR COMPUTATIONS
                     (Q500 = 11,000. CFS OR 311.48 CMS)
```

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
		2			.0090	1			434	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	1		-1				-1			

J3 VARIABLE CODES FOR SUMMARY PRINTOUT

38	43	1	8	4	55	13	26	14	56
15	27	28	0	38	43	16	17	18	21
22	53	54	5	68	39	66			

J5	LPRNT	NUMSEC	********REQUESTED SECTION NUMBERS********
	-10	-10	

```
NC     .070     .070     .055       .1       .3
QT        3    155.7    311.5

X1    10016       26    24.05    92.25     0.00     0.00     0.00
GR    435.1     0.00   434.17     3.97   434.00    12.60   434.43    21.14   434.77    24.05
GR    433.1    28.29   432.52    37.64   432.58    42.85   432.64    45.19   432.25    49.18
GR    431.6    52.47   431.91    64.73   431.15    71.89   431.22    78.26   433.74    83.03
GR    434.3    84.41   434.67    92.25   437.40   105.73   437.36   108.04   435.13   112.82
GR    435.4   118.85   435.95   130.73   435.84   156.21   436.31   160.77   436.01   164.00
GR    435.9   176.58

X1    10050       23    35.40   108.84    34.50    34.00    34.34
GR    435.8     0.00   435.51    10.13   435.28    31.52   434.90    35.40   433.01    46.79
GR    432.8    59.86   432.55    62.60   431.85    64.32   432.08    73.93   431.89    84.94
GR    431.3    91.76   431.35    97.50   434.94   102.80   435.07   108.84   437.52   122.01
GR    437.4   124.54   435.95   128.39   436.05   132.85   436.68   139.98   437.04   147.16
GR    437.4   150.41   436.52   161.21   436.67   171.80

X1    10090       25    22.89    90.00    40.00    39.60    39.64
X3                              22
GR    434.5     0.00   434.88     4.06   433.52    13.51   435.01    20.53   435.11    22.89
GR    432.8    30.64   432.73    41.24   432.04    43.25   432.30    55.29   432.86    63.13
GR    432.3    68.19   432.14    75.05   431.52    77.65   431.52    82.13   434.93    88.12
GR    435.4    90.00   435.53    94.70   437.66   106.05   437.61   108.96   436.15   111.67
GR    436.5   121.17   437.35   125.11   437.92   132.78   437.48   137.78   437.66   158.31

X1    10138       26    13.15    78.46    37.80    50.00    48.59
GR    434.8     0.00   434.11     8.52   433.59    13.15   433.15    21.77   432.68    29.95
GR    432.0    32.23   433.01    43.89   432.77    58.72   432.80    63.36   432.01    67.94
GR    432.2    72.91   435.25    78.46   435.33    78.61   435.33    78.64   435.47    83.19
GR    435.2    85.63   435.54    94.45   438.23   107.92   438.26   110.86   436.94   113.74
GR    437.0   117.62   438.01   119.98   438.03   126.60   437.81   131.50   438.06   147.90
GR    438.0   149.98

                    BEGIN RE-CHANNELIZATION
      DOWNSTREAM END OF GRADE CONTROL - DROP STRUCTURE - MEET EXISTING HERE

NC                     0.039       .5       .7
X1    10180       20    79.21   120.21    42.00    42.00    42.00
X3                              79.21
GR    435.7     0.00   434.84    10.45   434.35    21.04   433.28    24.41   433.15    32.70
GR    433.1    51.68   432.66    58.77   432.46    63.14   432.97    65.87   435.10    78.21
GR    435.1    79.21   432.60    84.21   432.60   115.21   435.10   120.21   435.10   121.21
GR    437.6   128.67   438.20   131.59   438.50   147.81   438.68   161.84   438.75   167.81

      UPSTREAM END OF GRADE CONTROL - DROP STRUCTURE
```

```
X1    10197      4       0     40.60     17.11     17.11     17.11
X3                           0.00                40.60
GR    436.7    0.00    434.31   4.80    434.31    35.80    436.71    40.60

X1    10230      4       0     40.60     32.89     32.89     32.89
X3                           0.00                40.60
GR    436.9    0.00    434.51   4.80    434.51    35.80    436.91    40.60

      DOWNSTREAM FACE OF EASTBOUND FRONTAGE ROAD BRIDGE

X1    10263      8       0     40.60        73        73        73
X3                           0.00                40.60
GR    437.1    0.00     434.7   4.80     434.7    19.08     437.1    19.08     437.1    21.52
GR    434.7   21.52     434.7  35.80     437.1    40.60

      UPSTREAM FACE OF EASTBOUND FRONTAGE ROAD BRIDGE

X1    10269      8       0     40.60       6.5       6.5       6.5
X3                           0.00                40.60
GR    437.2    0.00     434.8   4.80     434.8    19.08     437.2    19.08     437.2    21.52
GR    434.8   21.52     434.8  35.80     437.2    40.60

X1    10315      4       0     40.60        46        46        46
X3                           0.00                40.60
GR    437.4    0.00     435.0   4.80     435.0    35.80     437.4    40.60

      DOWNSTREAM FACE OF WESTBOUND FRONTAGE ROAD BRIDGE

X1    10368      8       0     40.60      52.5      52.5      52.5
X3                           0.00                40.60
GR    437.7    0.00     435.3   4.80     435.3    19.08     437.7    19.08     437.7    21.52
GR    435.3   21.52     435.3  35.80     437.7    40.60

      UPSTREAM FACE OF WESTBOUND FRONTAGE ROAD BRIDGE

X1    10374      8       0     40.60       6.5       6.5       6.5
X3                           0.00                40.60
GR    437.8    0.00     435.4   4.80     435.4    19.08     437.8    19.08     437.8    21.52
GR    435.4   21.52     435.4  35.80     437.8    40.60

      CHANGE CONTRACTION AND EXPANSION COEFFICIENT AT BRIDGE X-ING
```

```
NC     .045      .045      .045       .3        .5

   EQUATION STATION WILL BE REQUIRED AT STREAM ANGLE POINT JUST NORTH OF
   BEARDSLEY ROAD DUE TO DOWNSTREAM RE-CHANNELIZATION REQUESTED BY ADOT.
   STA 10+385.479 (BACK) = STA 10+434.120 (AHEAD)
   THE FOLLOWING SECTION HAS AN EQUIVALENT "OLD" STATION OF 10+432.595
X1    10384         6      4.27     48.57      9.9       9.9       9.9
X3                                   0.00                52.84
GR    438.8      0.00     438.8      4.27    435.46     10.92    435.46     41.92     438.7     48.57
GR    438.7     52.84

NC                                     .1        .3
   RETURN TO NORMAL CONTRACTON AND EXPANSION COEFFICIENTS UPSTREAM OF BRIDGE

   1/2 WAY THROUGH HORIZONTAL TRANSITION
X1    10472         8     12.60     47.52     39.15     39.15     39.15
X3                                   8.33                51.78
GR    435.5      0.00     439.7      8.33     439.7     12.60     435.6     20.69     435.6     39.44
GR    439.7     47.52     439.7     51.78     436.5     67.00

   NORMAL UPSTREAM SECTION - SANIFILL CONST.

X1    10511         8     14.97     41.49     39.15     39.15     39.15
X3                                  10.69                45.76
GR    435.5      0.00     440.9     10.69     440.9     14.97     435.8     25.02     435.8     31.43
GR    440.9     41.49     440.9     45.76     438.0     53.00

X1    10625         8     15.08     41.59    113.80    113.80    113.80
X3                                  10.81                45.86
GR    436.0      0.00     441.4     10.81     441.4     15.08     436.4     25.14     436.4     31.57
GR    441.4     41.59     441.4     45.86     438.5     53.34

X1    10731         8     12.13     38.64    106.68    106.68    106.68
X3                                   7.86                42.91
GR    438.0      0.00     441.9      7.86     441.9     12.13     436.9     22.19     436.9     28.59
GR    441.9     38.64     441.9     42.91     438.0     50.77
```

```
T1      SUPERFLOOD - 500 YR EVENT - Q500 = 311.5CMS
T2      THESE VELOCITIES WILL WE USED FOR BRIDGE SCOUR

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

              3                             .0090       1                             434

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

    2                   -1                                      -1
```

THIS RUN EXECUTED 26JUN96 14:19:39

****
HEC-2 WATER SURFACE PROFILES

Version 4.5.1; September 1990
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

ULTIMATE FREEWAY PLAN, W

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	DEPTH	TOPWID	VLOB	QLOB	VCH	QCH	VROB	QROB	STENCL	STENCR
	10016.000	155.70	433.43	2.28	54.99	.00	.00	2.10	155.70	.00	.00	.00	.00
	10016.000	311.50	434.16	3.01	69.84	.25	.23	2.69	311.27	.00	.00	.00	.00
	10050.000	155.70	433.74	2.44	58.63	.00	.00	1.79	155.70	.00	.00	.00	.00
	10050.000	311.50	434.52	3.22	64.50	.00	.00	2.30	311.50	.00	.00	.00	.00
	10090.000	155.70	433.97	2.45	59.74	.00	.00	1.69	155.70	.00	.00	22.00	158.31
	10090.000	311.50	434.77	3.25	63.81	.00	.00	2.21	311.50	.00	.00	22.00	158.31
	10138.000	155.70	434.23	2.23	69.43	.52	.93	1.70	154.77	.00	.00	.00	.00
	10138.000	311.50	435.04	3.04	78.07	.90	9.35	2.10	302.15	.00	.00	.00	.00
	10180.000	155.70	434.40	1.94	38.19	.00	.00	2.50	155.70	.00	.00	79.21	167.81
	10180.000	311.50	435.16	2.70	42.18	.00	.00	3.37	311.50	.01	.00	79.21	167.81
*	10197.000	155.70	435.64	1.33	36.31	.00	.00	3.49	155.70	.00	.00	.00	40.60
*	10197.000	311.50	436.38	2.07	39.29	.00	.00	4.29	311.50	.00	.00	.00	40.60
*	10230.000	155.70	436.37	1.86	38.43	.00	.00	2.42	155.70	.00	.00	.00	40.60
*	10230.000	311.50	437.29	2.78	40.60	.00	.00	3.08	311.50	.00	.00	.00	40.60
	10263.000	155.70	436.73	2.02	36.70	.00	.00	2.35	155.70	.00	.00	.00	40.60
	10263.000	311.50	437.67	2.97	40.60	.00	.00	3.01	311.50	.00	.00	.00	40.60
	10269.000	155.70	436.75	1.95	36.38	.00	.00	2.45	155.70	.00	.00	.00	40.60
	10269.000	311.50	437.69	2.89	40.60	.00	.00	3.11	311.50	.00	.00	.00	40.60
	10315.000	155.70	437.03	2.03	39.14	.00	.00	2.18	155.70	.00	.00	.00	40.60
	10315.000	311.50	438.02	3.02	40.60	.00	.00	2.80	311.50	.00	.00	.00	40.60
	10368.000	155.70	437.23	1.93	36.29	.00	.00	2.49	155.70	.00	.00	.00	40.60
	10368.000	311.50	438.22	2.92	40.60	.00	.00	3.08	311.50	.00	.00	.00	40.60

	SECNO	Q	CWSEL	DEPTH	TOPWID	VLOB	QLOB	VCH	QCH	VROB	QROB	STENCL	STENCR
	10374.000	155.70	437.26	1.86	36.00	.00	.00	2.59	155.70	.00	.00	.00	40.60
	10374.000	311.50	438.24	2.84	40.60	.00	.00	3.18	311.50	.00	.00	.00	40.60
	10384.000	155.70	437.42	1.96	38.93	.00	.00	2.27	155.70	.00	.00	.00	52.84
	10384.000	311.50	438.43	2.97	43.04	.00	.00	2.83	311.50	.00	.00	.00	52.84
*	10472.000	155.70	437.41	1.91	25.88	.00	.00	3.86	155.70	.00	.00	8.33	51.78
*	10472.000	311.50	438.35	2.85	29.58	.00	.00	4.69	311.50	.00	.00	8.33	51.78
*	10511.000	155.70	438.70	3.20	17.84	.00	.00	4.43	155.70	.00	.00	10.69	45.76
*	10511.000	311.50	439.94	4.44	22.74	.00	.00	5.16	311.50	.00	.00	10.69	45.76
*	10625.000	155.70	440.34	4.34	22.23	.00	.00	2.76	155.70	.00	.00	10.81	45.86
*	10625.000	311.50	441.74	5.74	35.05	.73	1.05	3.39	309.40	.73	1.05	10.81	45.86
	10731.000	155.70	440.87	3.97	22.37	.00	.00	2.73	155.70	.00	.00	7.86	42.91
	10731.000	311.50	442.28	5.38	35.05	.76	1.23	3.35	309.03	.76	1.23	7.86	42.91

ULTIMATE FREEWAY PLAN, W

SUMMARY PRINTOUT

	SECNO	Q	K*XNL	K*XNCH	K*XNR	STCHL	STCHR	SSTA	ENDST	10*KS	FRCH	XLCH	CUMDS
	10016.000	155.70	.00	55.00	.00	24.05	92.25	27.46	82.44	90.49	.58	.00	.00
	10016.000	311.50	70.00	55.00	.00	24.05	92.25	4.43	84.07	89.96	.62	.00	.00
	10050.000	155.70	.00	55.00	.00	35.40	108.84	42.40	101.03	58.26	.47	34.34	34.34
	10050.000	311.50	.00	55.00	.00	35.40	108.84	37.68	102.18	61.33	.51	34.34	34.34
	10090.000	155.70	.00	55.00	.00	22.89	90.00	26.70	86.44	50.03	.44	39.64	73.98
	10090.000	311.50	.00	55.00	.00	22.89	90.00	24.03	87.84	52.67	.47	39.64	73.98
	10138.000	155.70	70.00	55.00	.00	13.15	78.46	7.16	76.59	54.53	.45	48.59	122.57
	10138.000	311.50	70.00	55.00	.00	13.15	78.46	.00	78.07	47.43	.45	48.59	122.57
	10180.000	155.70	.00	39.00	.00	79.21	120.21	80.61	118.81	51.24	.63	42.00	164.57
	10180.000	311.50	.00	39.00	70.00	79.21	120.21	79.21	121.39	60.72	.72	42.00	164.57
*	10197.000	155.70	.00	39.00	.00	.00	40.60	2.14	38.45	143.88	1.00	17.11	181.68
*	10197.000	311.50	.00	39.00	.00	.00	40.60	.65	39.93	127.27	1.01	17.11	181.68
*	10230.000	155.70	.00	39.00	.00	.00	40.60	1.08	39.51	46.06	.60	32.89	214.57
*	10230.000	311.50	.00	39.00	.00	.00	40.60	.00	40.60	45.25	.62	32.89	214.57
	10263.000	155.70	.00	39.00	.00	.00	40.60	.73	39.87	45.08	.57	73.00	287.57
	10263.000	311.50	.00	39.00	.00	.00	40.60	.00	40.60	49.29	.60	73.00	287.57
	10269.000	155.70	.00	39.00	.00	.00	40.60	.89	39.71	51.47	.61	6.50	294.07
	10269.000	311.50	.00	39.00	.00	.00	40.60	.00	40.60	54.36	.63	6.50	294.07
	10315.000	155.70	.00	39.00	.00	.00	40.60	.73	39.87	33.62	.52	46.00	340.07
	10315.000	311.50	.00	39.00	.00	.00	40.60	.00	40.60	33.52	.54	46.00	340.07
	10368.000	155.70	.00	39.00	.00	.00	40.60	.94	39.66	53.55	.62	52.50	392.57
	10368.000	311.50	.00	39.00	.00	.00	40.60	.00	40.60	52.97	.62	52.50	392.57
	10374.000	155.70	.00	39.00	.00	.00	40.60	1.08	39.52	60.72	.66	6.50	399.07
	10374.000	311.50	.00	39.00	.00	.00	40.60	.00	40.60	58.18	.65	6.50	399.07
	10384.000	155.70	.00	45.00	.00	4.27	48.57	7.01	45.95	50.59	.55	9.90	408.97
	10384.000	311.50	.00	45.00	.00	4.27	48.57	4.99	48.03	48.13	.56	9.90	408.97
*	10472.000	155.70	.00	45.00	.00	12.60	47.52	17.12	43.00	174.38	.99	39.15	448.12
*	10472.000	311.50	.00	45.00	.00	12.60	47.52	15.27	44.85	160.98	1.00	39.15	448.12
*	10511.000	155.70	.00	45.00	.00	14.97	41.49	19.31	37.15	177.95	1.01	39.15	487.27
*	10511.000	311.50	.00	45.00	.00	14.97	41.49	16.86	39.60	163.97	1.01	39.15	487.27
*	10625.000	155.70	.00	45.00	.00	15.08	41.59	17.22	39.45	49.67	.55	113.80	601.07
*	10625.000	311.50	45.00	45.00	45.00	15.08	41.59	10.81	45.86	50.01	.58	113.80	601.07

SECNO	Q	K*XNL	K*XNCH	K*XNR	STCHL	STCHR	SSTA	ENDST	10*KS	FRCH	XLCH	CUMDS
10731.000	155.70	.00	45.00	.00	12.13	38.64	14.20	36.57	47.97	.54	106.68	707.75
10731.000	311.50	45.00	45.00	45.00	12.13	38.64	7.86	42.91	48.15	.57	106.68	707.75

SUMMARY OF ERRORS AND SPECIAL NOTES

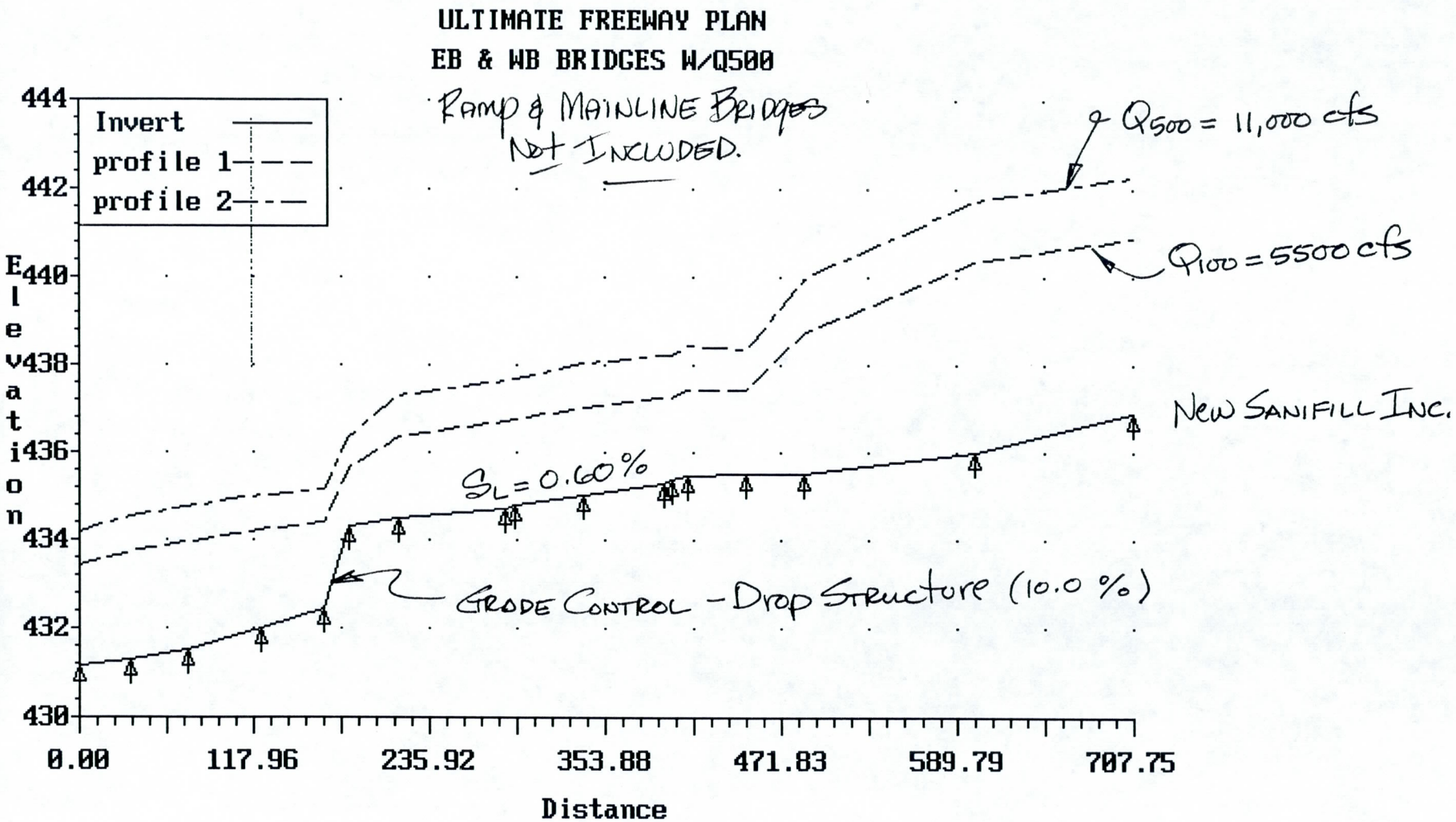
```
CAUTION SECNO=  10197.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  10197.000  PROFILE=  1  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  10197.000  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  10197.000  PROFILE=  2  MINIMUM SPECIFIC ENERGY

WARNING SECNO=  10230.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=  10230.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

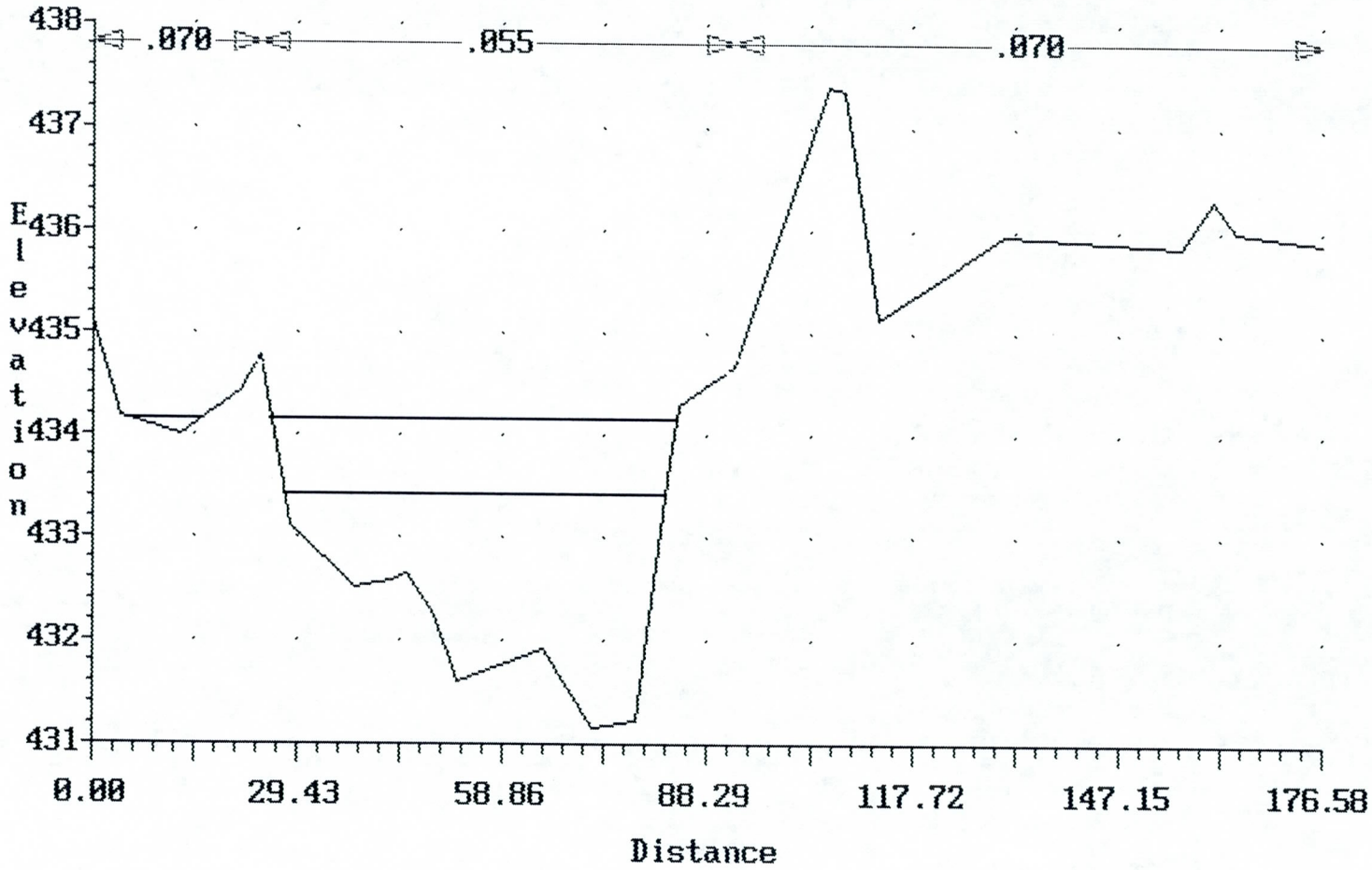
WARNING SECNO=  10472.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
CAUTION SECNO=  10472.000  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  10472.000  PROFILE=  2  MINIMUM SPECIFIC ENERGY

CAUTION SECNO=  10511.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  10511.000  PROFILE=  1  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  10511.000  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  10511.000  PROFILE=  2  MINIMUM SPECIFIC ENERGY

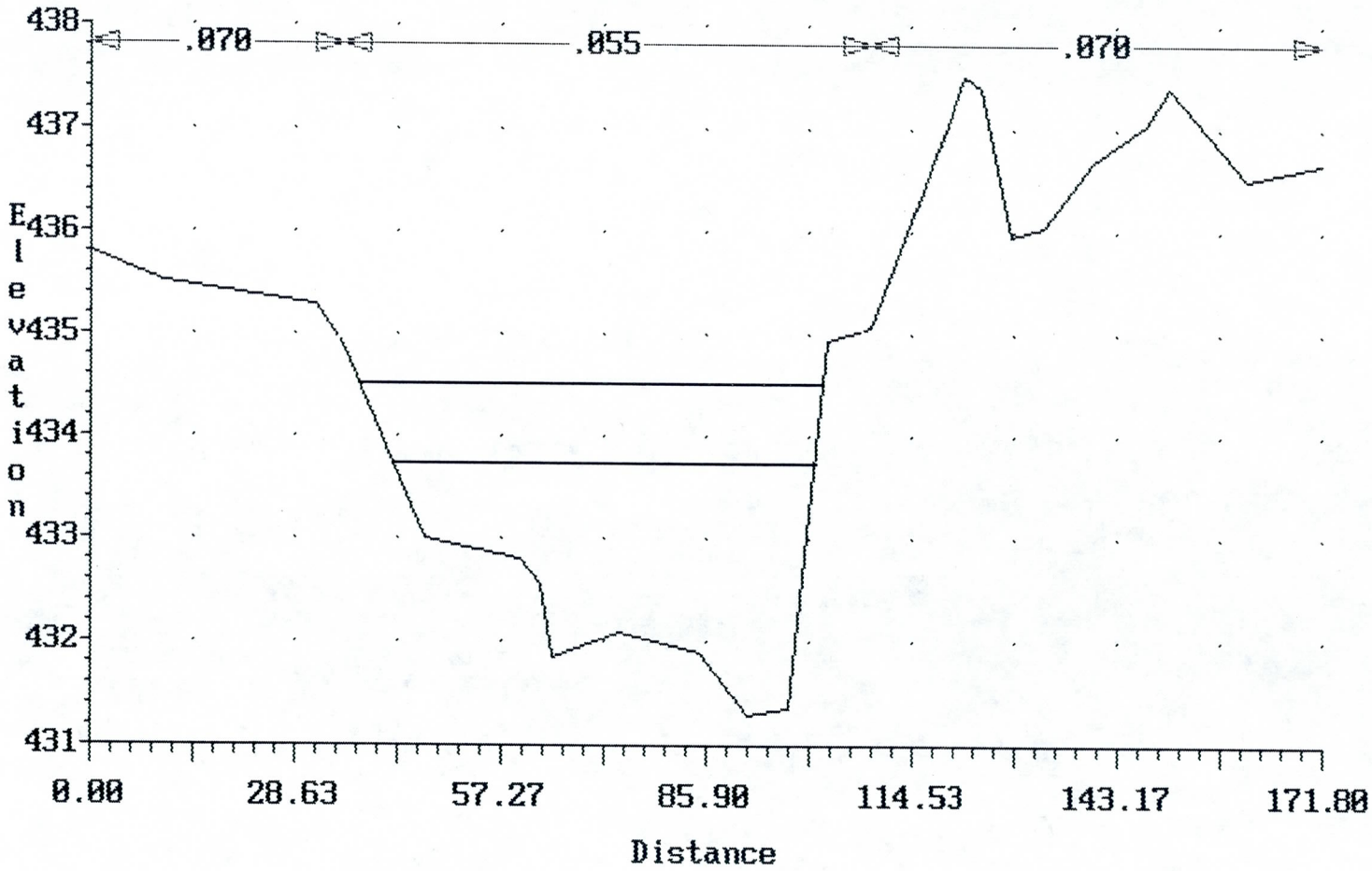
WARNING SECNO=  10625.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=  10625.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
```

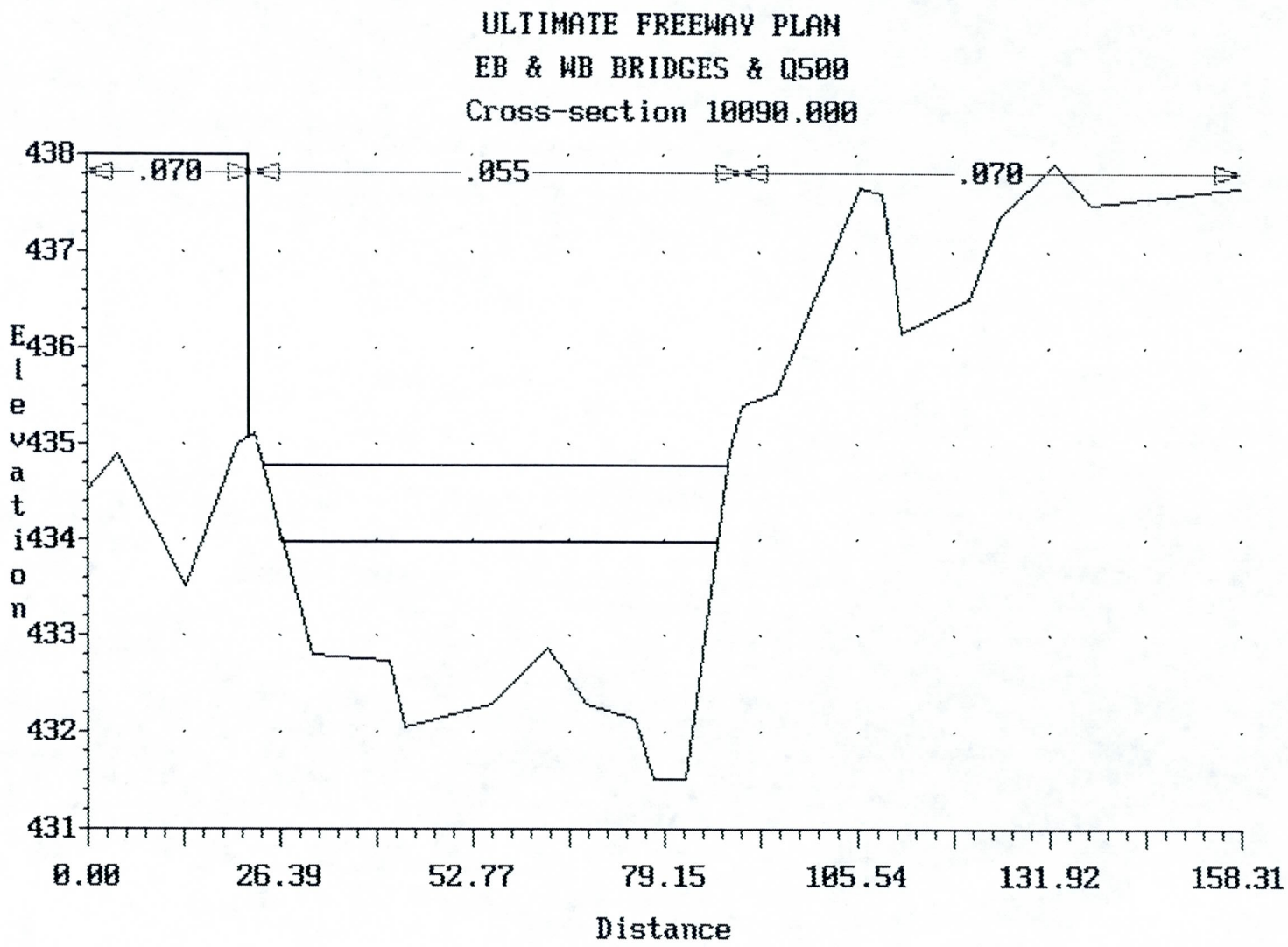

ULTIMATE FREEWAY PLAN
EB & WB BRIDGES W/Q500
Ramp & Mainline Bridges Not Included.
Invert
profile 1
profile 2
Elevation
444
442
440
438
436
434
432
430
0.00
117.96
235.92
353.88
471.83
589.79
707.75
Distance
Q500 = 11,000 cfs
Q100 = 5500 cfs
New Sanifill Inc.
SL = 0.60%
Grade Control - Drop Structure (10.0 %)

ULTIMATE FREEWAY PLAN
EB & WB BRIDGES & Q500
Cross-section 10016.000

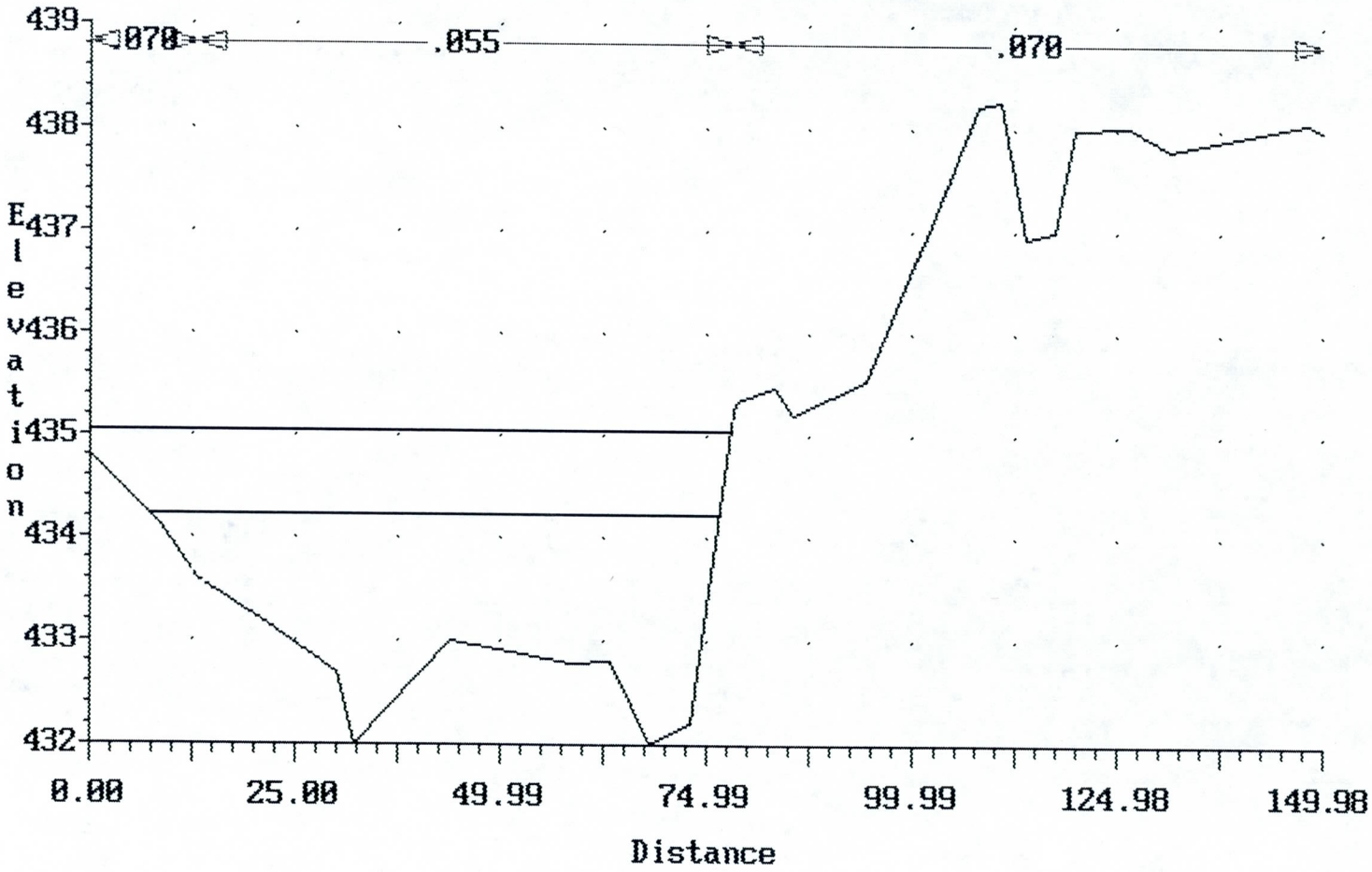


ULTIMATE FREEWAY PLAN
EB & WB BRIDGES & Q500
Cross-section 10050.000

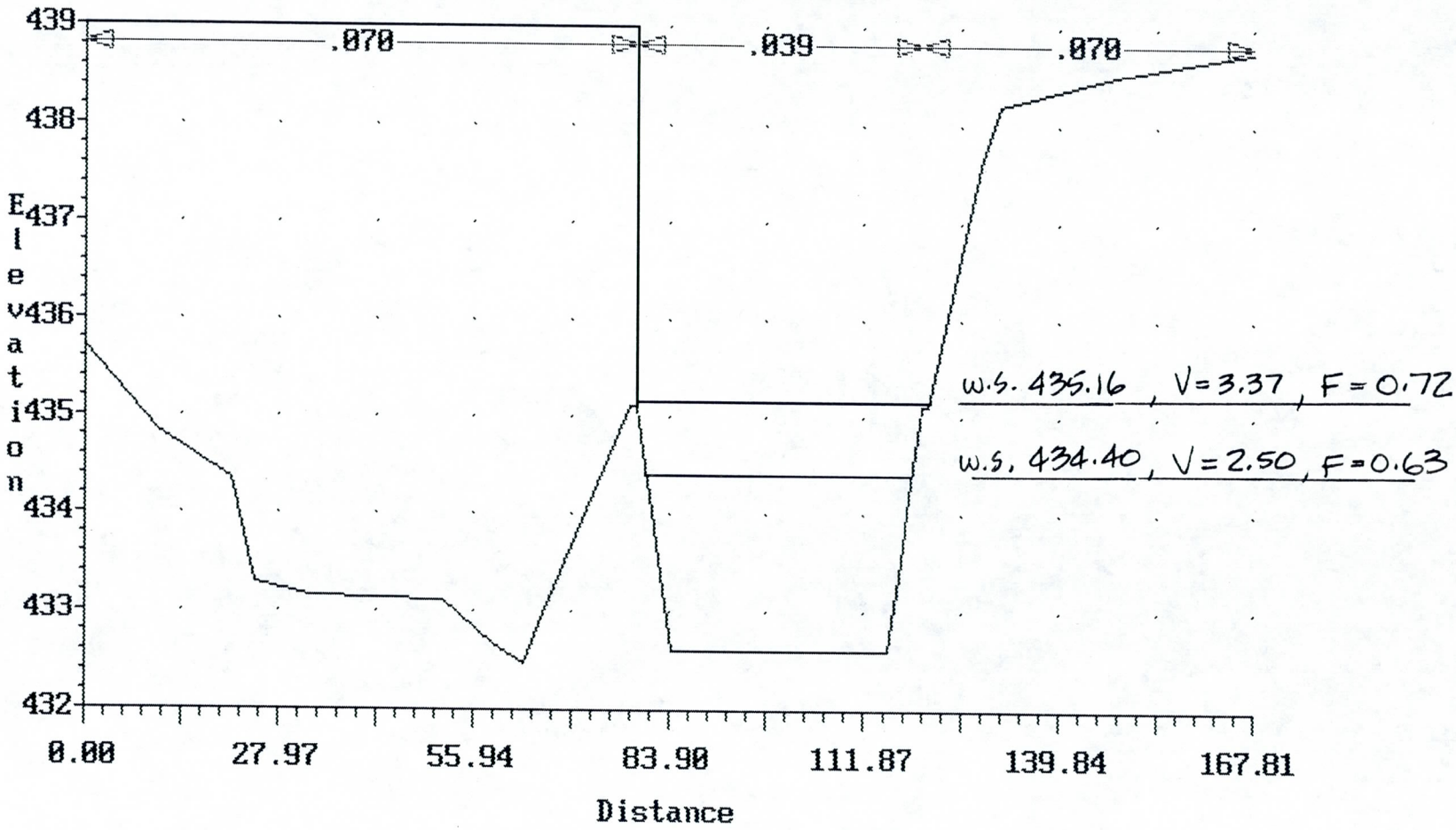



ULTIMATE FREEWAY PLAN
EB & WB BRIDGES & Q500
Cross-section 10090.000
.070
.055
.070
438
437
436
435
434
433
432
431
Elevation
0.00
26.39
52.77
79.15
105.54
131.92
158.31
Distance

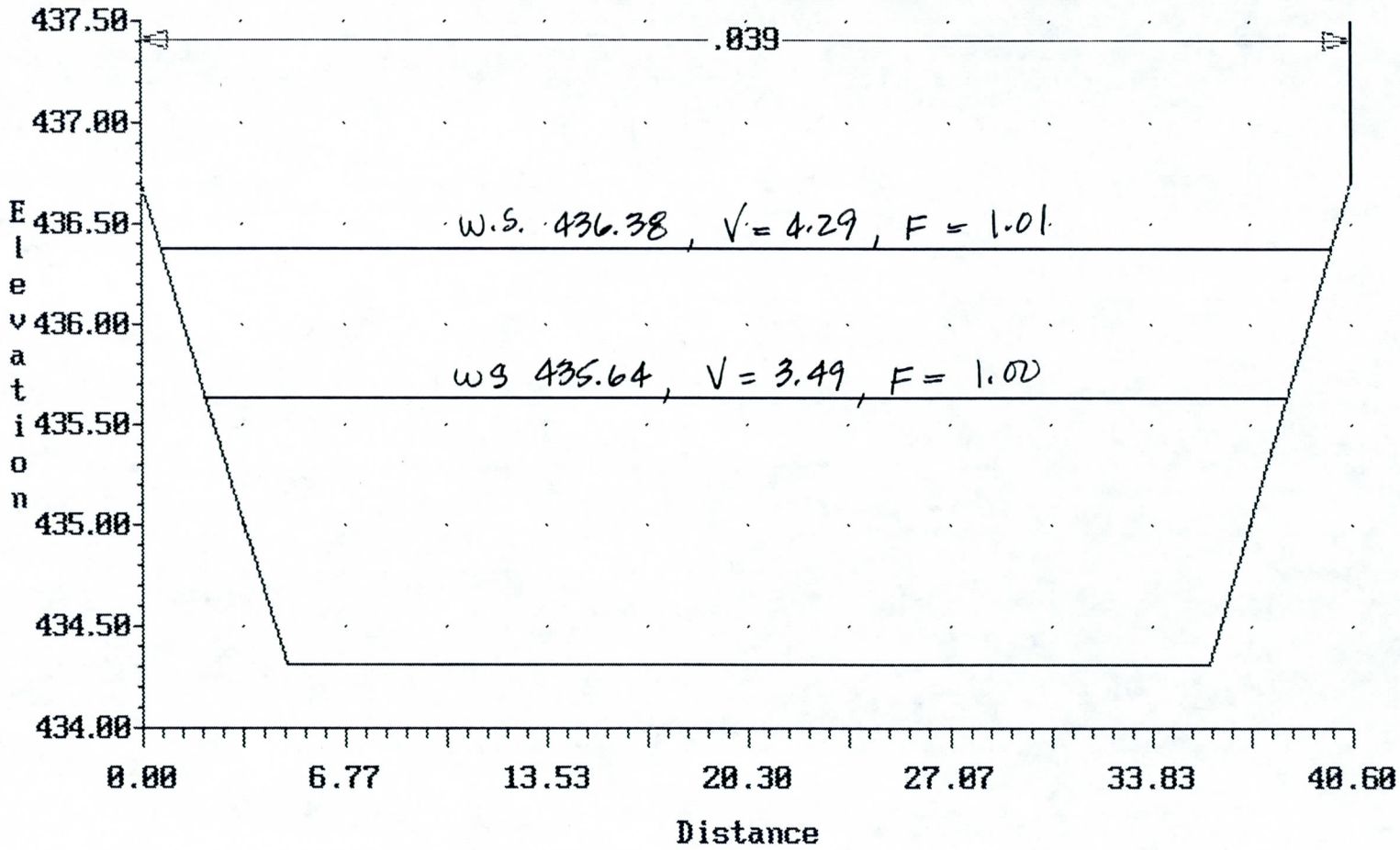
ULTIMATE FREEWAY PLAN
EB & WB BRIDGES & Q500
Cross-section 10138.000



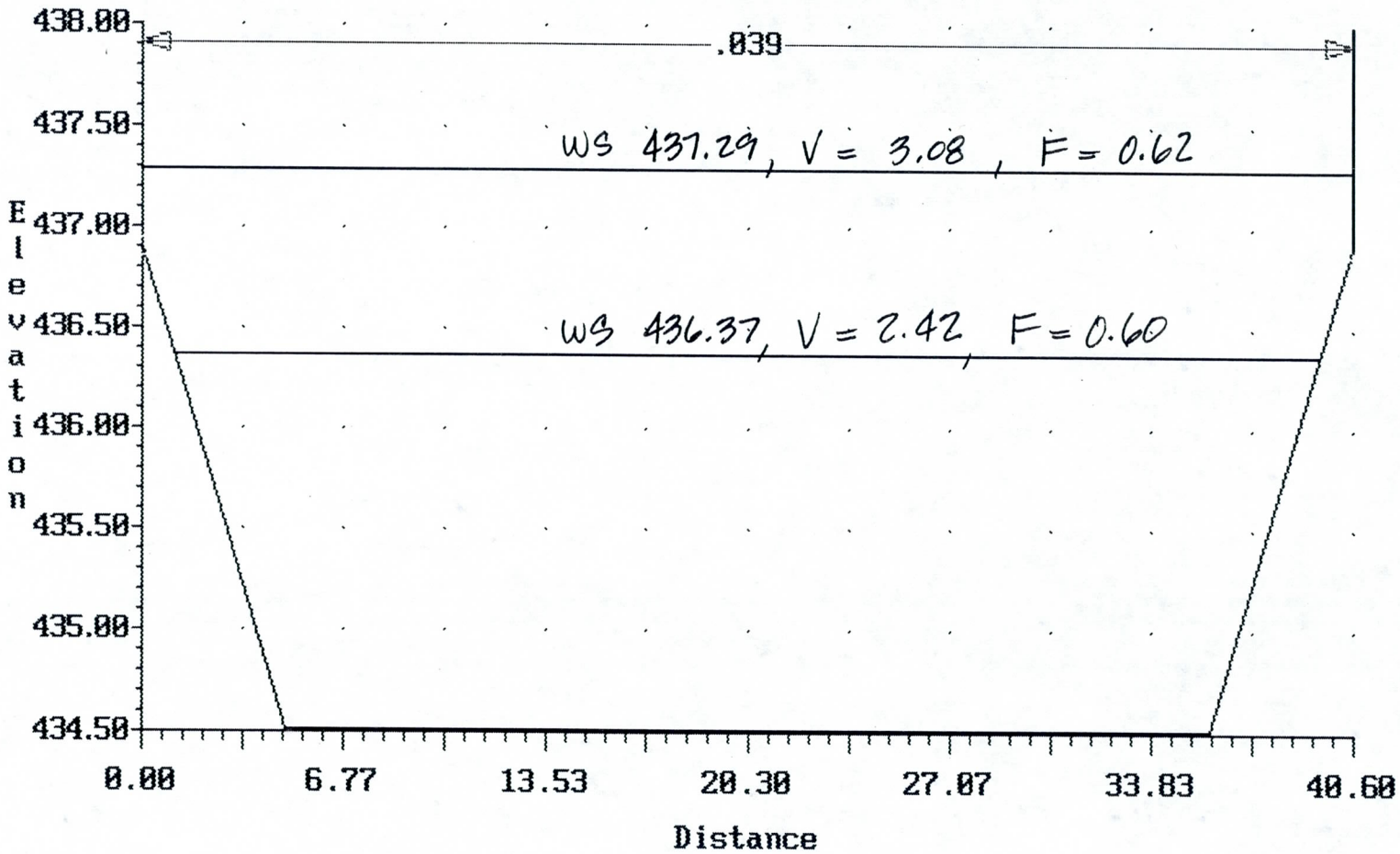
ULTIMATE FREEWAY PLAN
EB & WB BRIDGES & Q500
Cross-section 10180.000



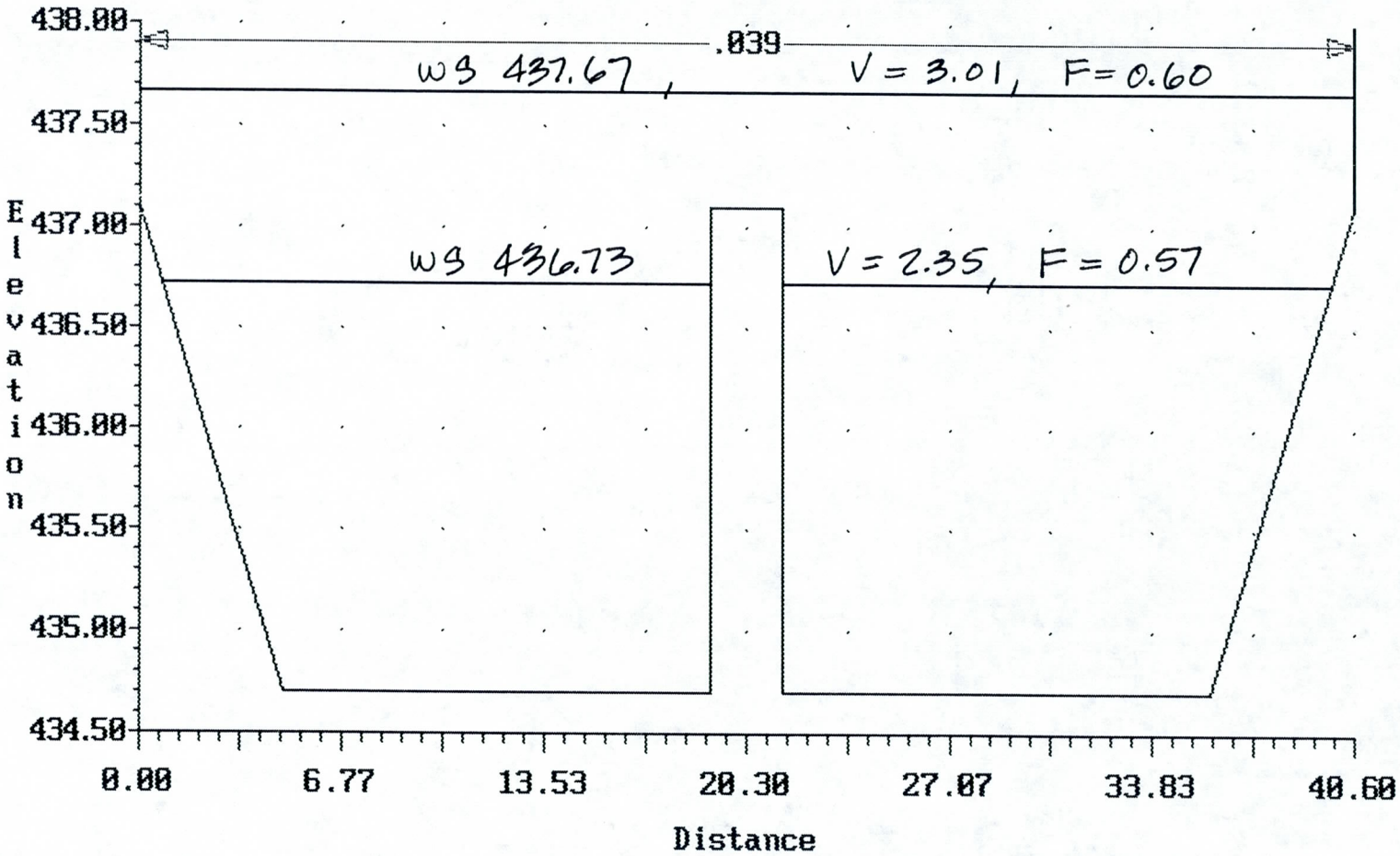
ULTIMATE FREEWAY PLAN
EB & WB BRIDGES & Q500
Cross-section 10197.000



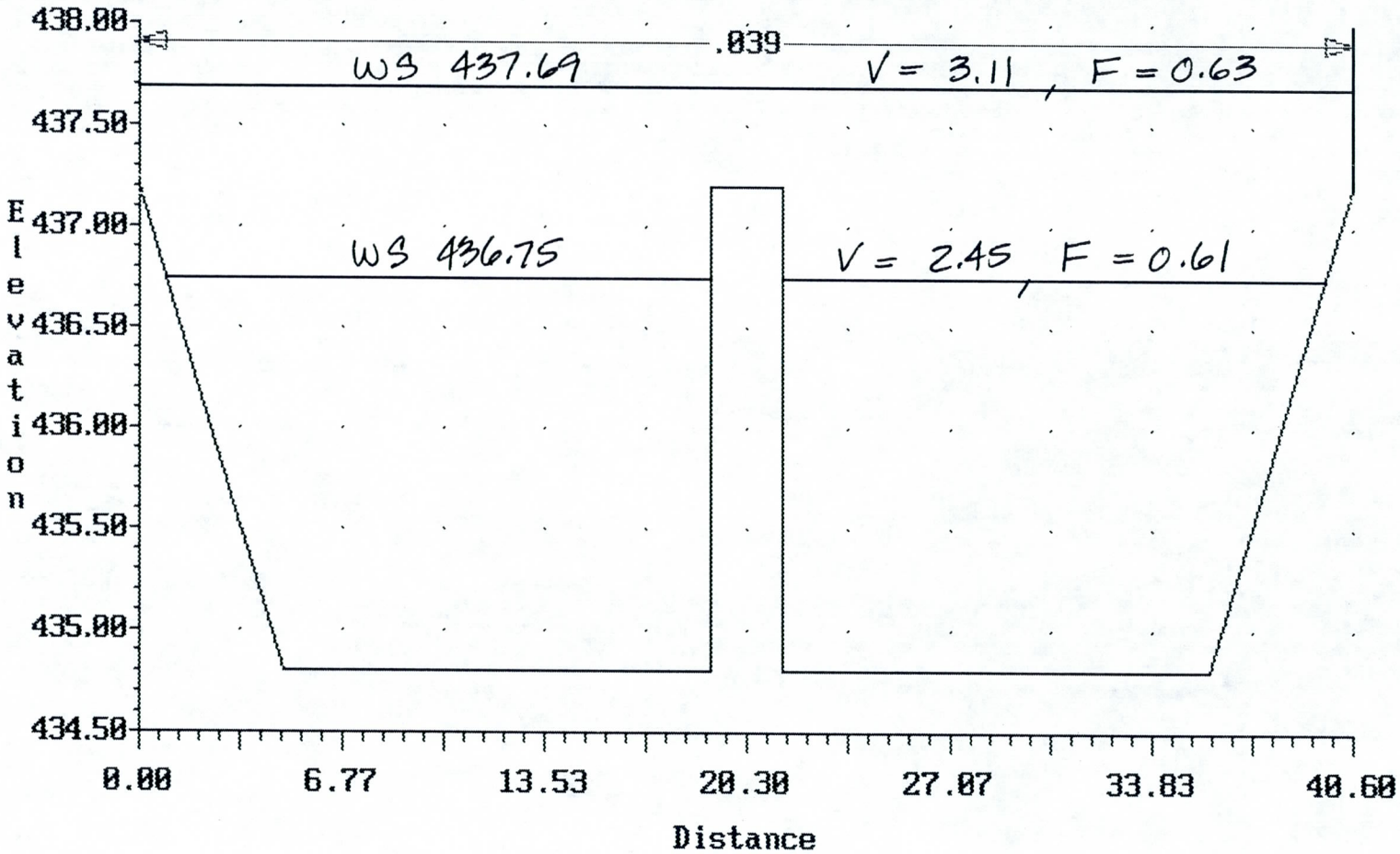
ULTIMATE FREEWAY PLAN
EB & WB BRIDGES & Q500
Cross-section 10230.000



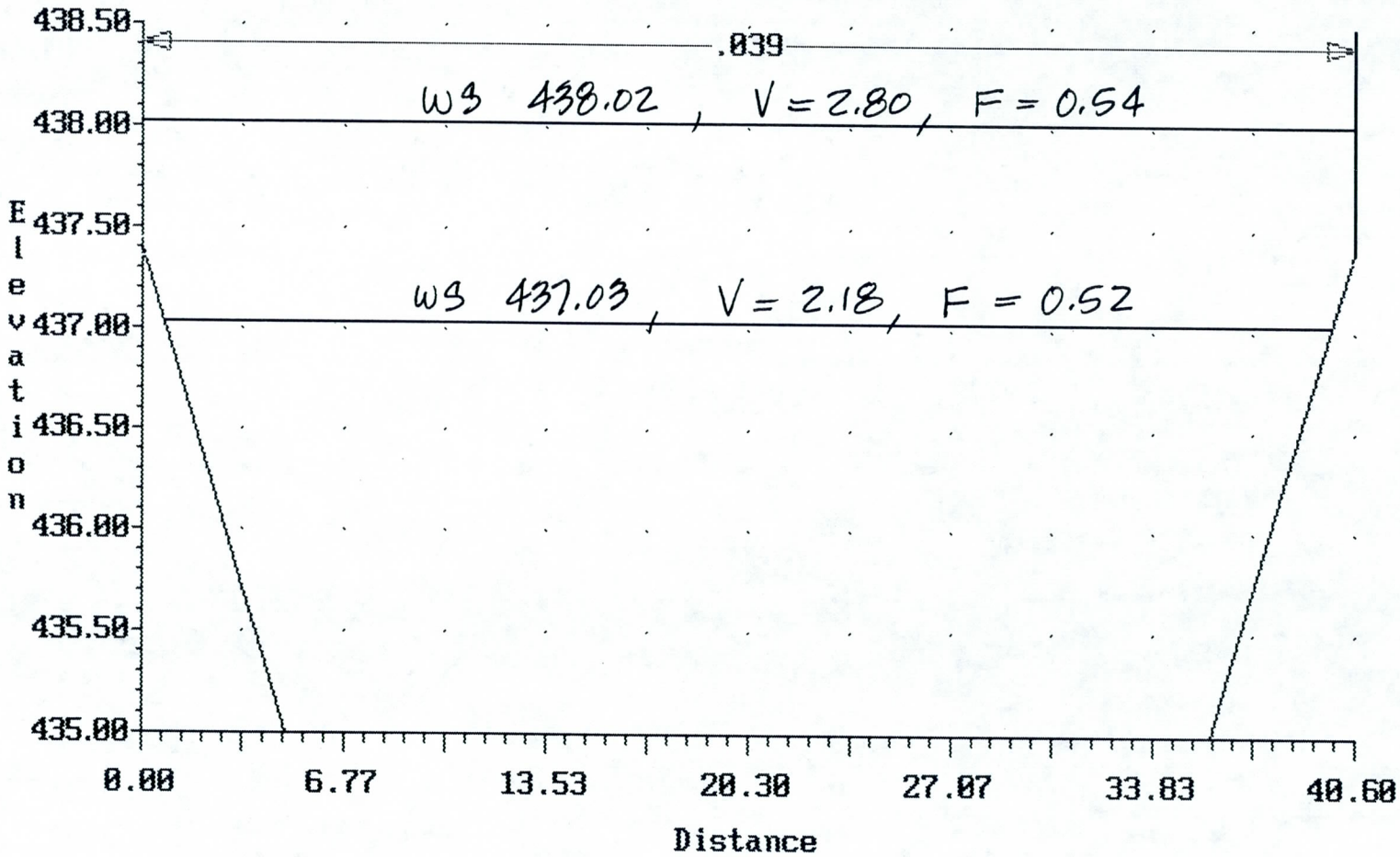
ULTIMATE FREEWAY PLAN
EB & WB BRIDGES & Q500
Cross-section 10263.000



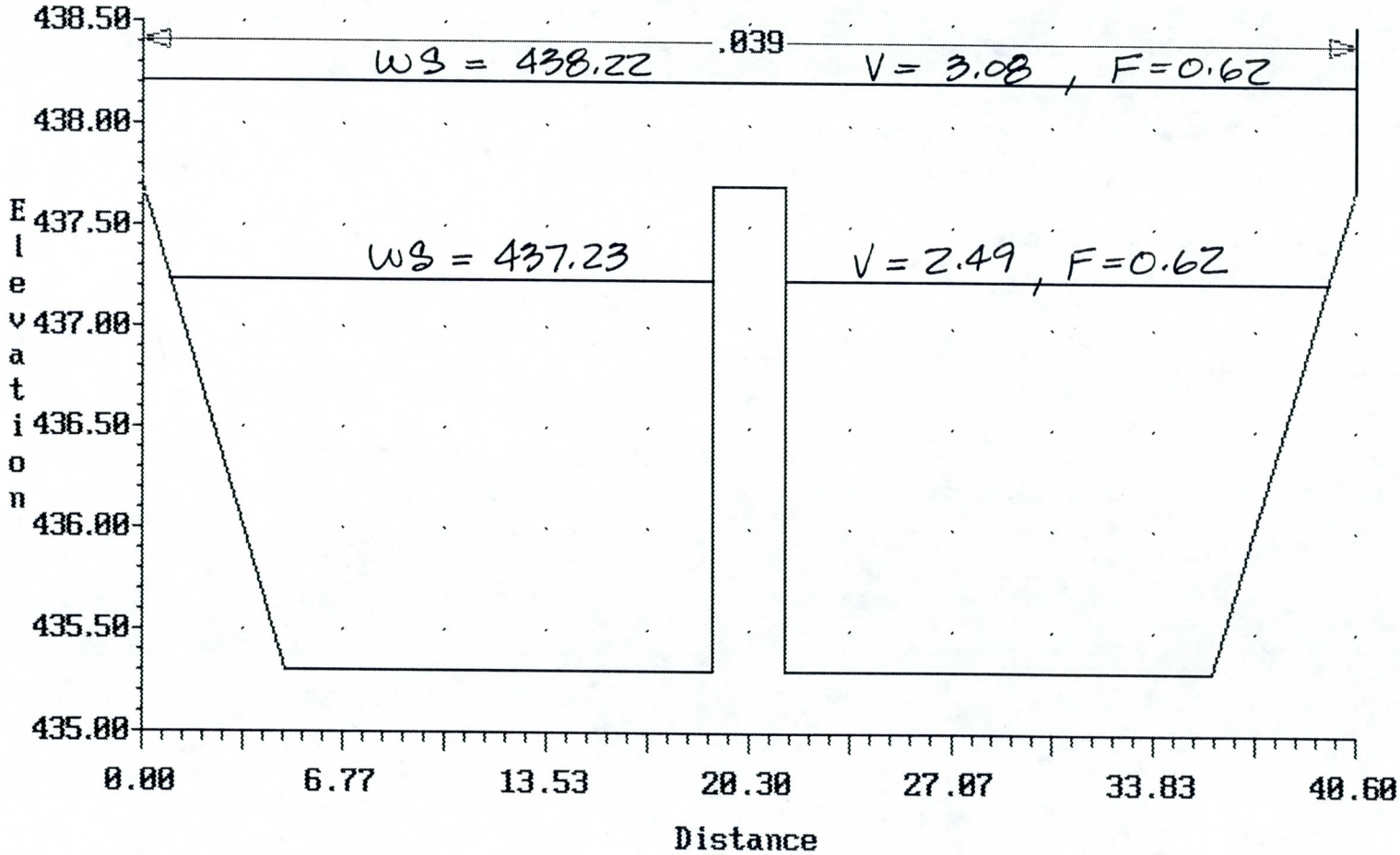
ULTIMATE FREEWAY PLAN
EB & WB BRIDGES & Q500
Cross-section 10269.000



ULTIMATE FREEWAY PLAN
EB & WB BRIDGES & Q500
Cross-section 10315.000

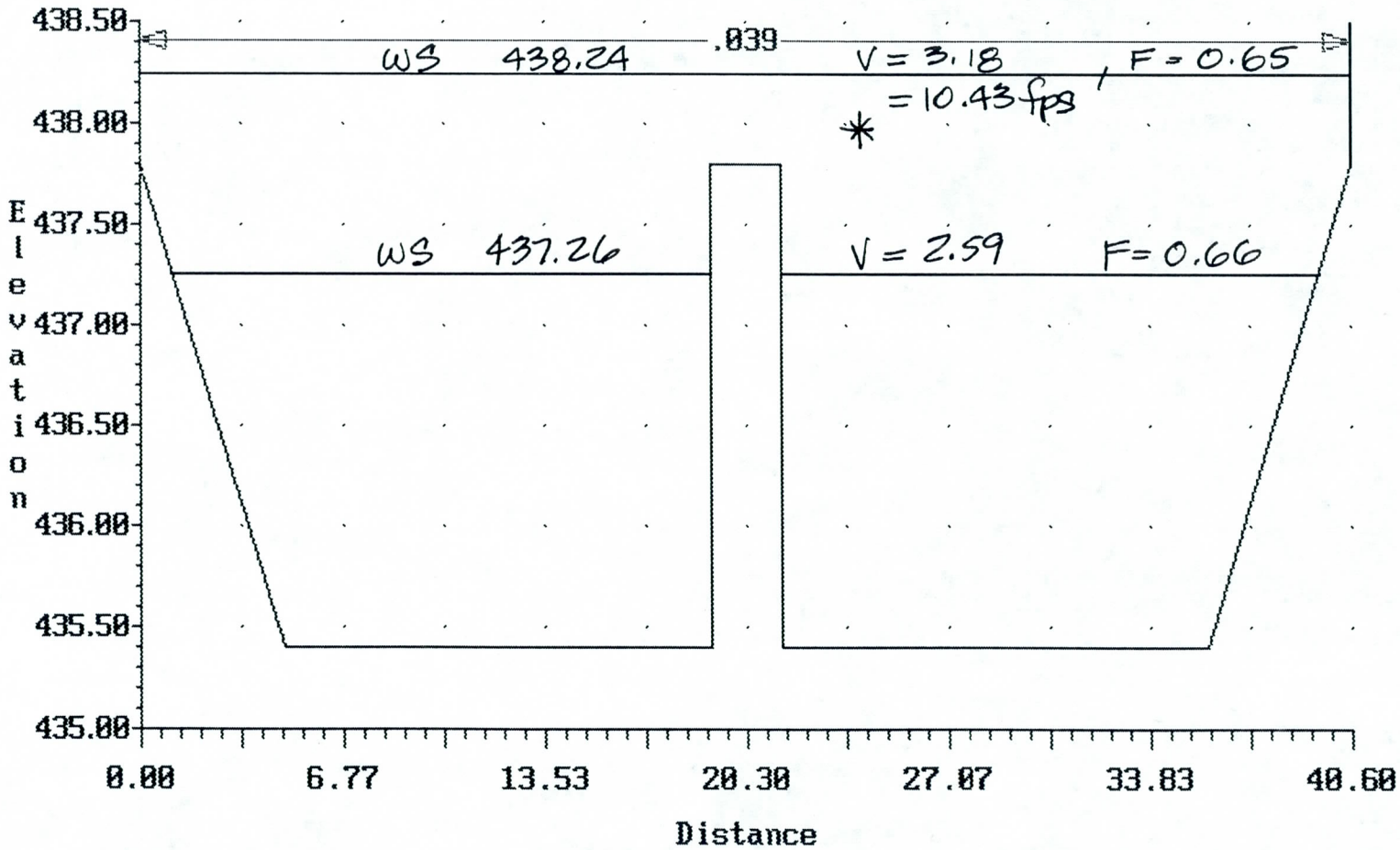


ULTIMATE FREEWAY PLAN
EB & WB BRIDGES & Q500
Cross-section 10368.000

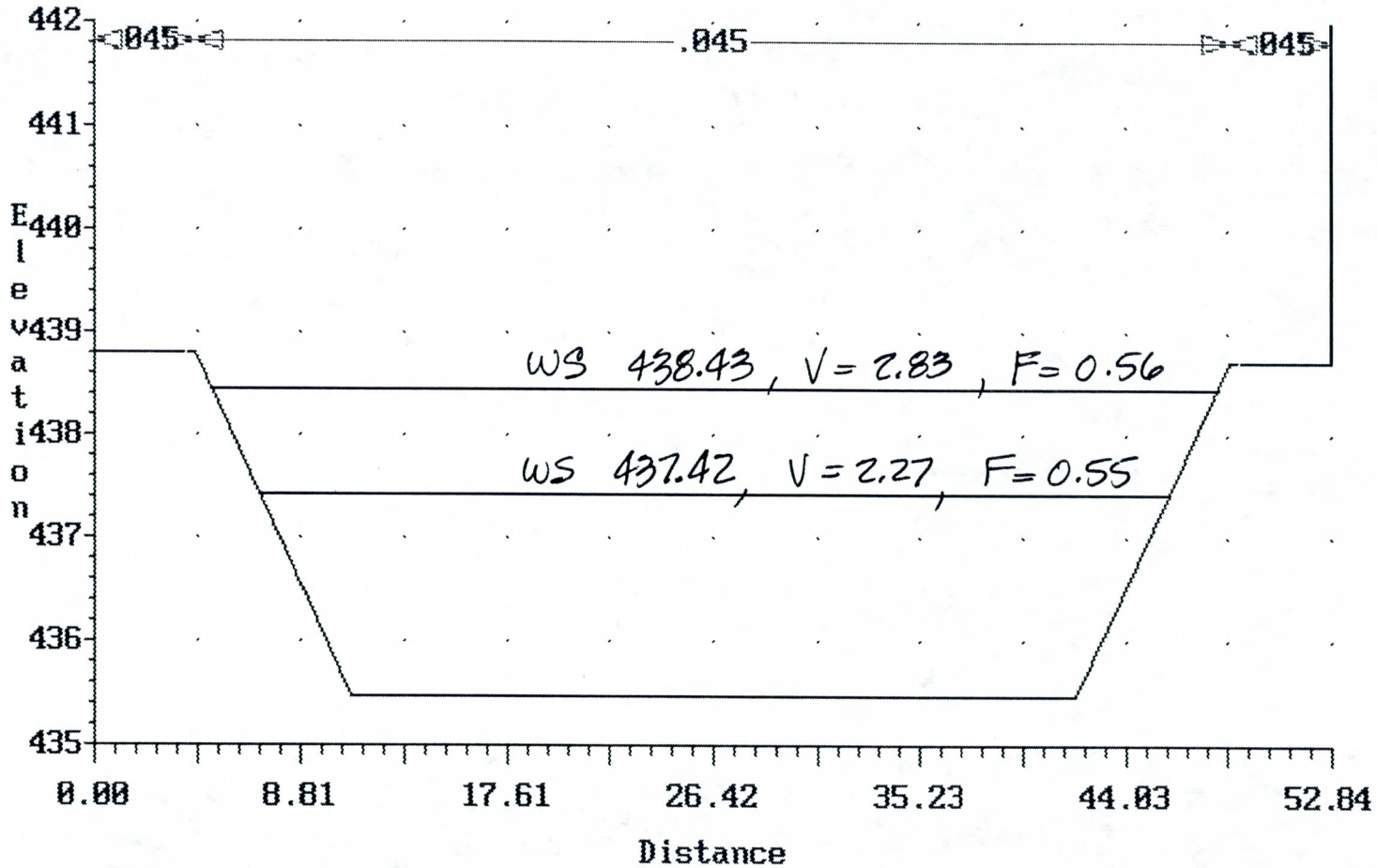


* Max. Velocity For Q500 Superflood Is here through Bridge Sections (Use For Scour Comp's.)

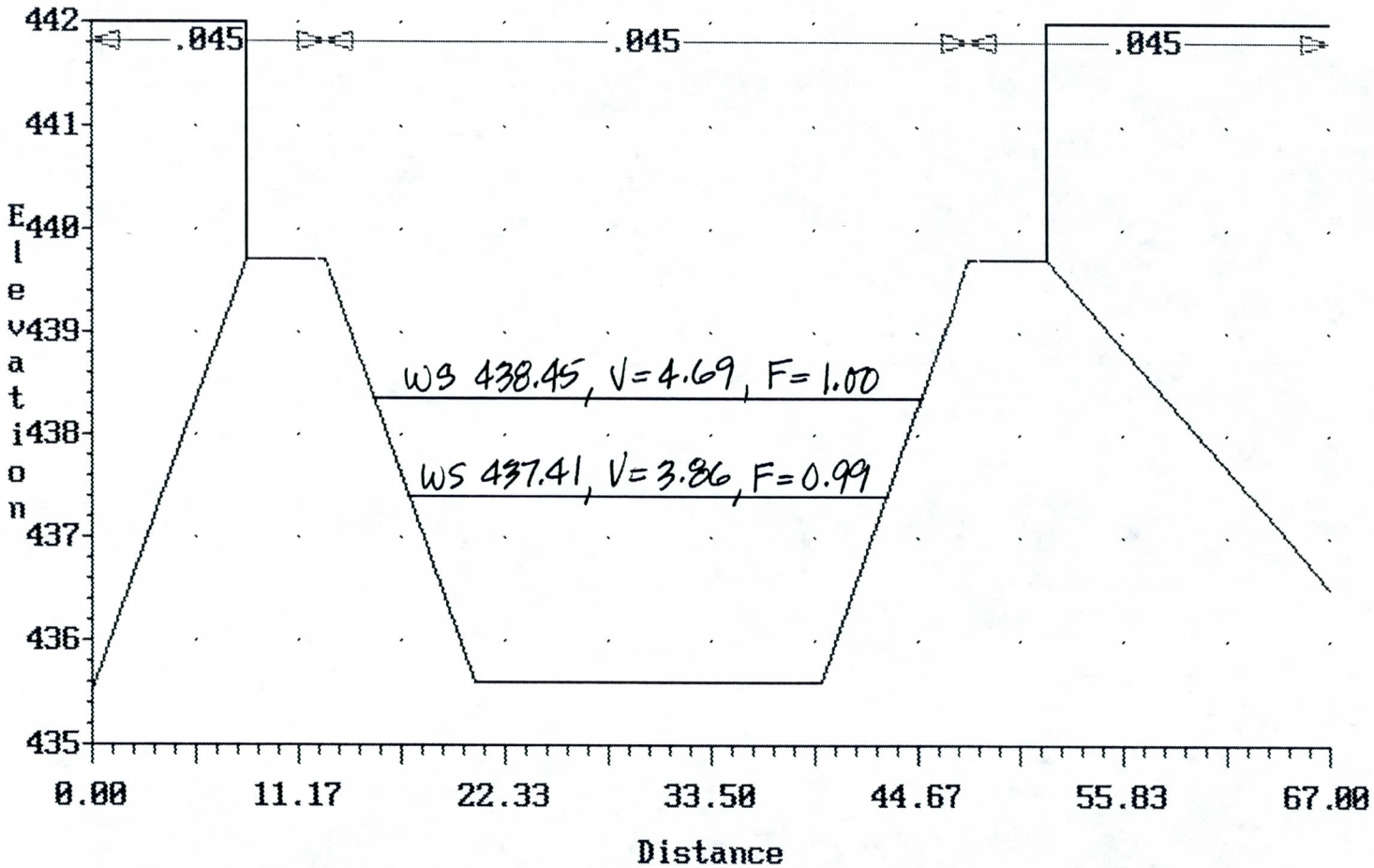
ULTIMATE FREEWAY PLAN
EB & WB BRIDGES & Q500
Cross-section 10374.000



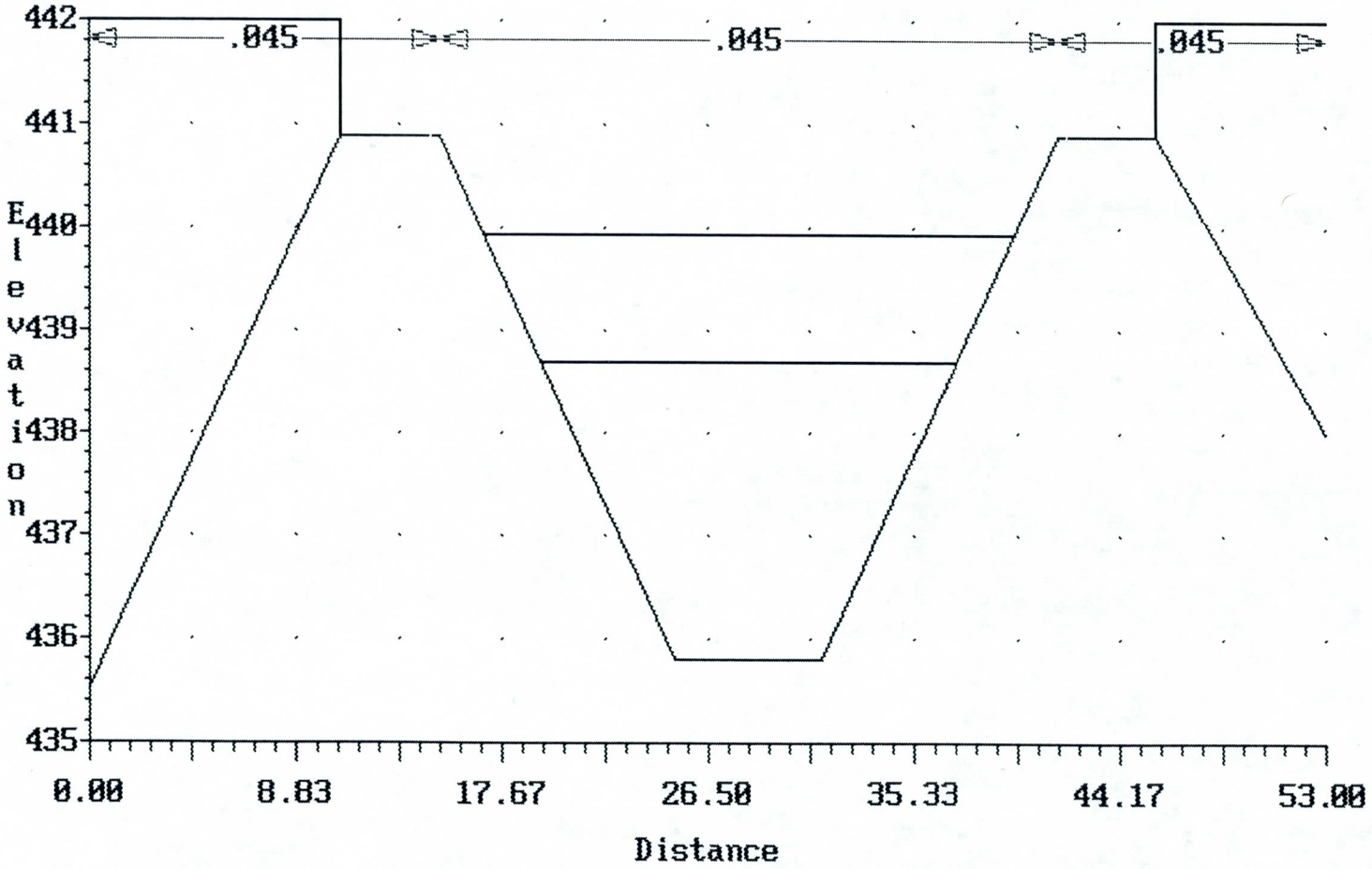
ULTIMATE FREEWAY PLAN
EB & WB BRIDGES & Q500
Cross-section 10384.000



ULTIMATE FREEWAY PLAN
EB & WB BRIDGES & Q500
Cross-section 10472.000



ULTIMATE FREEWAY PLAN
EB & WB BRIDGES & Q500
Cross-section 10511.000



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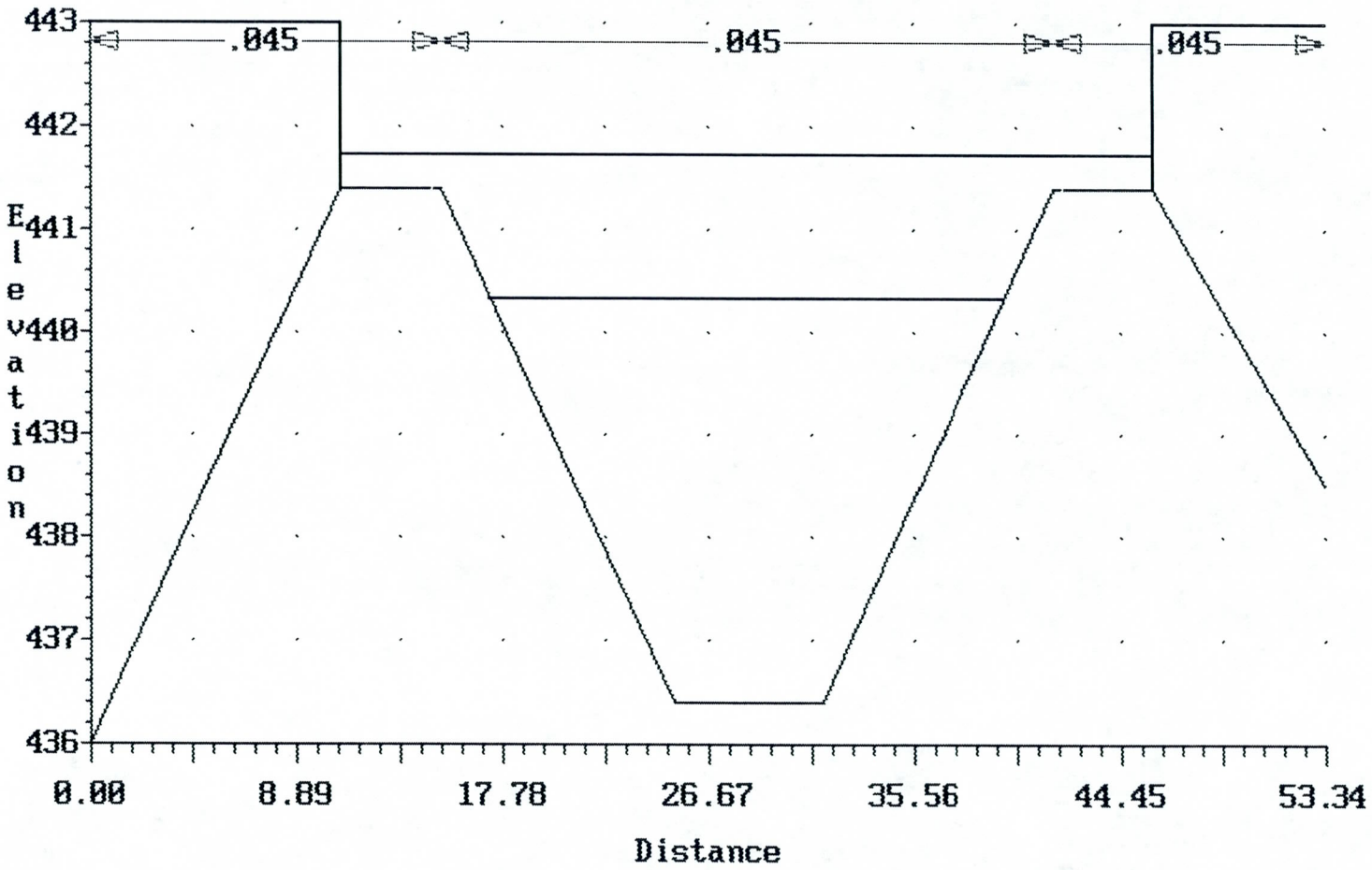
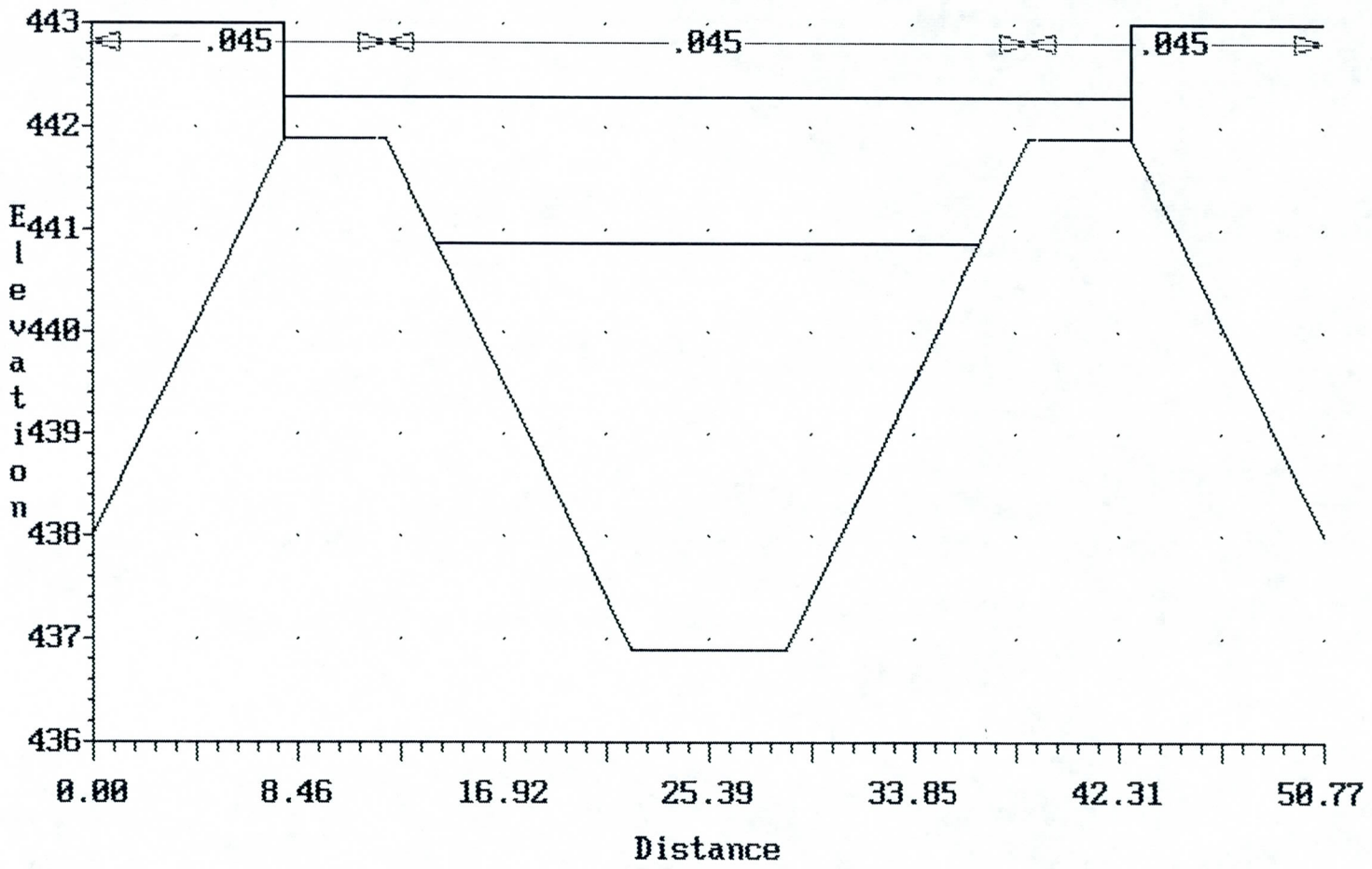
EB & WB BRIDGES & Q500
Cross-section 10625.000



ULTIMATE FREEWAY PLAN
EB & WB BRIDGES & Q500
Cross-section 10731.000



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*********************************************
*  HEC-2 WATER SURFACE PROFILES             *
*                                           *
*  Version   4.5.1;  September 1990         *
*                                           *
*  RUN DATE    24JUN96    TIME   15:45:15   *
*********************************************
```

```
****************************************
*  U.S. ARMY CORPS OF ENGINEERS        *
*  HYDROLOGIC ENGINEERING CENTER       *
*  609 SECOND STREET, SUITE D          *
*  DAVIS, CALIFORNIA 95616-4687        *
*          (916) 756-1104              *
****************************************
```

```
X     X  XXXXXXX   XXXXX              XXXXX
X     X  X       X    X            X    X
X     X  X       X                      X
XXXXXXX  XXXX     X         XXXXX   XXXXX
X     X  X       X                 X
X     X  X       X    X            X
X     X  XXXXXXX   XXXXX            XXXXXXX
```

END OF BANNER

FILE: CC1D.IN AND OUT

FINAL RUN w/ SANIFILL IMPROVEMENTS UPSTREAM AND ALL FUTURE LOOP101 RAMP AND MAINLINE BRIDGES INSTALLED w/ INTERIM E.B. & W.B. FRONTAGE RD. BRIDGES.

ALSO, GRADE CONTROL – DROP STRUCTURE @ CCW STA. 10+180.000 (MEET EXIST. HEL)

→ REPRESENTS ULTIMATE BUILDOUT CONDITION AND CONTROLING 100YR. HIGH WATER SURFACE ELEV.

→ FOR MAX. VELOCITIES FOR SCOUR – USE FILE: CC1C.IN – INTERIM COND. w/ ONLY E.B. AND W.B. FRONTAGE RD. BRIDGES INSTALLED. RUN FOR SUPERFLOOD COND. e.g. Q500YR.

Parsons Brinckerhoff Computation Sheet

Page 2 of _____ | 110323

Made by Bob B.

Date June 24, 96

Checked by _____

Date _____

Subject Cave Creek Wash Re-Channelization Design – Pima Fwy, Jct I-17 to 56th St.

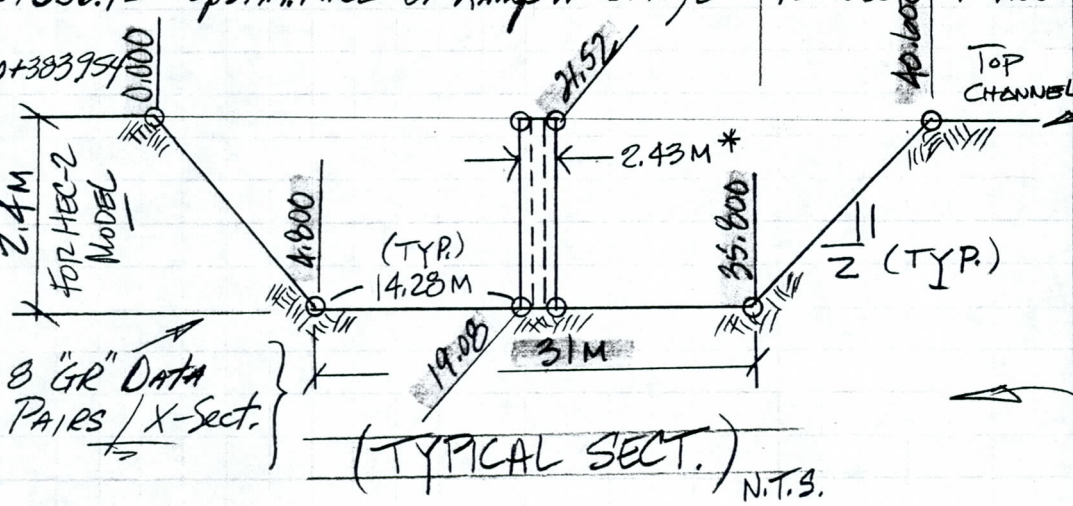
X-Sections Added to File CC1D.IN (HEC-2)

Add the Remainder of Ramp and Mainline Bridges Between E.B. and W.B. Frontage Rd. Bridges (That were previously added to File CC1C.IN – HEC-2)

Reference: Last HEC-2 Run for Ultimate Full-Build-Out Cond's.

Dist.	Station	Location	Thalweg.	Top Channel
13.859	10+269.341			
	10+283.2 ±	Downstm. Face of Ramp "B" Bridge	434.827	437.227
6.60				
	10+289.8 ±	Upstm. Face of Ramp "B" Bridge	434.867	437.267
11.90				
	10+301.7 ±	Downstm. Face of Loop 101 M.L. Bridge	434.938	437.338
8.40				
	10+310.1 ±	Intermediate Pier for " "	434.989	437.389
21.10	10+315.000	Remove X-Sect. in File CC1C.IN – Normal Channel Sect.		
	10+331.2 ±	Intermediate Pier for M.L. Bridge	435.115	437.515
8.40				
	10+339.6 ±	Upstm. Face of Loop 101 M.L. Bridge	435.166	437.566
9.90				
	10+349.5 ±	Downstm. Face of Ramp "A" Bridge	435.225	437.625
6.60				
	10+356.1 ±	Upstm. Face of Ramp "A" Bridge	435.265	437.665
27.854	10+383.954			

Grade = 0.600 % Re-Channelized



(Typical Sect.) N.T.S.

* Use 8' wide equiv. = 2x4' for Debris Blockage.

Use for Coding "GR" Records (HEC-2)

```
CLS

G:\DRNG\HECEXE2>MENU2

G:\DRNG\HECEXE2>hec2menu.exe
Stop - Program terminated.

G:\DRNG\HECEXE2>echo off

ULTIMATE FREEWAY PLAN, W

  Starting profile number  1

        CWSEL for cross section  10016.000 is   433.43
        CWSEL for cross section  10050.000 is   433.74
        CWSEL for cross section  10090.000 is   433.97
        CWSEL for cross section  10138.000 is   434.23
        CWSEL for cross section  10180.000 is   434.40
        CWSEL for cross section  10197.000 is   435.64
        CWSEL for cross section  10230.000 is   436.37
        CWSEL for cross section  10263.000 is   436.72
        CWSEL for cross section  10269.000 is   436.75
        CWSEL for cross section  10283.000 is   436.85
        CWSEL for cross section  10290.000 is   436.88
        CWSEL for cross section  10302.000 is   436.94
        CWSEL for cross section  10310.000 is   436.98
        CWSEL for cross section  10331.000 is   437.08
        CWSEL for cross section  10340.000 is   437.12
        CWSEL for cross section  10350.000 is   437.17
        CWSEL for cross section  10356.000 is   437.21
        CWSEL for cross section  10368.000 is   437.56
        CWSEL for cross section  10374.000 is   437.58
        CWSEL for cross section  10384.000 is   437.66
        CWSEL for cross section  10472.000 is   437.62
        CWSEL for cross section  10511.000 is   438.69
        CWSEL for cross section  10625.000 is   440.34
        CWSEL for cross section  10731.000 is   440.87

Normal program termination

Press any key to continue . . .

Stop - Program terminated.
G:\DRNG\HECEXE2>
```

THIS RUN EXECUTED 24JUN96 15:45:15

```
****************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.5.1;  September 1990
****************************************


T1      PIMA FREEWAY BRIDGE CROSSING AT CAVE CREEK (BEARDSLEY ROAD ALIGNMENT)
T2      HYDRAULIC ANALYSIS FOR FUTURE RE-CHANNELIZATION WITH W.B.,E.B. BRIDGES
        AS WELL AS FUTURE RAMP A & B AND LOOP 101 MAINLINE BRIDGES (ULT. COND,)
        USING A REVISED RE-CHANNELIZATION ALIGNMENT W/ DROP AT STA 10+180 TO
        10+213.188 PER R. JORDAN REVIEW AT ADOT ON JUNE 18, 1996 - INCLUDING THE
T3      ULTIMATE FREEWAY PLAN, WITH UPSTREAM SANIFILL INC. IMPROVEMENTS
T4      MODEL CC1D.IN,SUBCRITICAL FLOW  - WITH SANIFILL IMPROVEMENTS OF 6/96
T5      ALL INPUT DATA IS IN METRIC UNITS
T6      DISCHARGES IN cfs: 5,500, = 155.7 CMS
T7      ALL CROSS-SECTION DATA COMPILED BY INTER-GRAPH DTM USING "INROADS"
        SANIFILL SECTIONS UPSTREAM BEGINNING WITH STA 10+383.954 WERE IMPUT
        MANUALLY BY BOB BATTISTELLO ON JUNE 11,1996 - CONSEQUENTLY, ALL OTHER
        UPSTREAM SECTIONS HAVE BEEN REMOVED FROM THIS MODEL.
        BASE MODEL WAS DONE BY BOB WARD AS FILE: CC1.IN  -  SEPT,95.
        LAST REVISED FILE TO CREATE THIS FILE WAS CC1C.IN - B. BATTISTELLO 6/96
        WICH USES "OLD" RE-CHANNELIZATION TIE-IN POINT @ STA 10+115.378, -
        ACTUAL CHANNEL LINING IMPROVEMENTS BEGIN AT CCW STA. 10+180.000

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

                2                           .0090       1                           434

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

     1                  -1                                      -1


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

     38        43        1         8         4         55        13        26        14        56
     15        27        28        0         38        43        16        17        18        21
     22        53        54        5         68        39        66

J5  LPRNT     NUMSEC                    ********REQUESTED SECTION NUMBERS********

    -10       -10
```

```
NC     .070     .070     .055      .1       .3
QT        1    155.7

X1    10016       26    24.05    92.25     0.00     0.00     0.00
GR    435.1     0.00   434.17     3.97   434.00    12.60   434.43    21.14   434.77    24.05
GR    433.1    28.29   432.52    37.64   432.58    42.85   432.64    45.19   432.25    49.18
GR    431.6    52.47   431.91    64.73   431.15    71.89   431.22    78.26   433.74    83.03
GR    434.3    84.41   434.67    92.25   437.40   105.73   437.36   108.04   435.13   112.82
GR    435.4   118.85   435.95   130.73   435.84   156.21   436.31   160.77   436.01   164.00
GR    435.9   176.58

X1    10050       23    35.40   108.84    34.50    34.00    34.34
GR    435.8     0.00   435.51    10.13   435.28    31.52   434.90    35.40   433.01    46.79
GR    432.8    59.86   432.55    62.60   431.85    64.32   432.08    73.93   431.89    84.94
GR    431.3    91.76   431.35    97.50   434.94   102.80   435.07   108.84   437.52   122.01
GR    437.4   124.54   435.95   128.39   436.05   132.85   436.68   139.98   437.04   147.16
GR    437.4   150.41   436.52   161.21   436.67   171.80

X1    10090       25    22.89    90.00    40.00    39.60    39.64
X3                                 22
GR    434.5     0.00   434.88     4.06   433.52    13.51   435.01    20.53   435.11    22.89
GR    432.8    30.64   432.73    41.24   432.04    43.25   432.30    55.29   432.86    63.13
GR    432.3    68.19   432.14    75.05   431.52    77.65   431.52    82.13   434.93    88.12
GR    435.4    90.00   435.53    94.70   437.66   106.05   437.61   108.96   436.15   111.67
GR    436.5   121.17   437.35   125.11   437.92   132.78   437.48   137.78   437.66   158.31

X1    10138       26    13.15    78.46    37.80    50.00    48.59
GR    434.8     0.00   434.11     8.52   433.59    13.15   433.15    21.77   432.68    29.95
GR    432.0    32.23   433.01    43.89   432.77    58.72   432.80    63.36   432.01    67.94
GR    432.2    72.91   435.25    78.46   435.33    78.61   435.33    78.64   435.47    83.19
GR    435.2    85.63   435.54    94.45   438.23   107.92   438.26   110.86   436.94   113.74
GR    437.0   117.62   438.01   119.98   438.03   126.60   437.81   131.50   438.06   147.90
GR    438.0   149.98

                    BEGIN RE-CHANNELIZATION
      DOWNSTREAM END OF GRADE CONTROL - DROP STRUCTURE - MEET EXISTING HERE

NC                     0.039      .5       .7
X1    10180       20    79.21   120.21    42.00    42.00    42.00
X3                              79.21
GR    435.7     0.00   434.84    10.45   434.35    21.04   433.28    24.41   433.15    32.70
GR    433.1    51.68   432.66    58.77   432.46    63.14   432.97    65.87   435.10    78.21
GR    435.1    79.21   432.60    84.21   432.60   115.21   435.10   120.21   435.10   121.21
GR    437.6   128.67   438.20   131.59   438.50   147.81   438.68   161.84   438.75   167.81

      UPSTREAM END OF GRADE CONTROL - DROP STRUCTURE
```

X1	10197	4	0	40.60	17.11	17.11	17.11			
GR	436.7	0.00	434.31	4.80	434.31	35.80	436.71	40.60		
X1	10230	4	0	40.60	32.89	32.89	32.89			
GR	436.9	0.00	434.51	4.80	434.51	35.80	436.91	40.60		

DOWNSTREAM FACE OF EASTBOUND FRONTAGE ROAD BRIDGE

X1	10263	8	0	40.60	73	73	73			
GR	437.1	0.00	434.7	4.80	434.7	19.08	437.1	19.08	437.1	21.52
GR	434.7	21.52	434.7	35.80	437.1	40.60				

UPSTREAM FACE OF EASTBOUND FRONTAGE ROAD BRIDGE

X1	10269	8	0	40.60	6.5	6.5	6.5			
GR	437.2	0.00	434.8	4.80	434.8	19.08	437.2	19.08	437.2	21.52
GR	434.8	21.52	434.8	35.80	437.2	40.60				

DOWNSTREAM FACE OF RAMP "B" - FUTURE BRIDGE

X1	10283	8	0	40.60	13.9	13.9	13.9			
GR	437.2	0.00	434.83	4.80	434.83	19.08	437.23	19.80	437.23	21.52
GR	434.8	21.52	434.83	35.80	437.23	40.60				

UPSTREAM FACE OF RAMP "B" - FUTURE BRIDGE

X1	10290	8	0	40.60	6.6	6.6	6.6			
GR	437.3	0.00	434.87	4.80	434.87	19.08	437.27	19.08	437.27	21.52
GR	434.9	21.52	434.87	35.80	437.27	40.60				

DOWNSTREAM FACE OF FUTURE LOOP 101 MAINLINE BRIDGE

X1	10302	8	0	40.60	11.9	11.9	11.9			
GR	437.3	0.00	434.94	4.80	434.94	19.08	437.34	19.08	437.34	21.52
GR	434.9	21.52	434.94	35.80	437.34	40.60				

INTERMEDIATE PIER FOR FUTURE LOOP 101 MAINLINE BRIDGE

X1	10310	8	0	40.60	8.4	8.4	8.4			
GR	437.4	0.00	434.99	4.80	434.99	19.08	437.39	19.08	437.39	21.52
GR	435.0	21.52	434.99	35.80	437.39	40.60				

INTERMEDIATE PIER FOR FUTURE LOOP 101 MAINLINE BRIDGE

```
X1    10331      8        0      40.60      21.1      21.1      21.1
GR    437.5    0.00   435.12      4.80    435.12     19.08    437.52     19.08    437.52     21.52
GR    435.1   21.52   435.12     35.80    437.52     40.60

      UPSTREAM FACE OF FUTURE LOOP 101 MAINLINE BRIDGE

X1    10340      8        0      40.60       8.4       8.4       8.4
GR    437.6    0.00   435.17      4.80    435.17     19.08    437.57     19.08    437.57     21.52
GR    435.2   21.52   435.17     35.80    437.57     40.60

      DOWNSTREAM FACE OF FUTURE RAMP "A" BRIDGE

X1    10350      8        0      40.60       9.9       9.9       9.9
GR    437.6    0.00   435.23      4.80    435.23     19.08    437.63     19.08    437.63     21.52
GR    435.2   21.52   435.23     35.80    437.63     40.60

      UPSTREAM FACE OF FUTURE RAMP "A" BRIDGE

X1    10356      8        0      40.60       6.6       6.6       6.6
GR    437.7    0.00   435.27      4.80    435.27     19.08    437.67     19.08    437.67     21.52
GR    435.3   21.52   435.27     35.80    437.67     40.60

      DOWNSTREAM FACE OF WESTBOUND FRONTAGE ROAD BRIDGE

X1    10368      8        0      40.60      52.5      52.5      52.5
GR    437.7    0.00    435.3      4.80     435.3     19.08     437.7     19.08     437.7     21.52
GR    435.3   21.52    435.3     35.80     437.7     40.60

      UPSTREAM FACE OF WESTBOUND FRONTAGE ROAD BRIDGE

X1    10374      8        0      40.60       6.5       6.5       6.5
GR    437.8    0.00    435.4      4.80     435.4     19.08     437.8     19.08     437.8     21.52
GR    435.4   21.52    435.4     35.80     437.8     40.60

      CHANGE CONTRACTION AND EXPANSION COEFFICIENT AT BRIDGE X-ING

IC     .045    .045     .045        .3        .5

  EQUATION STATION WILL BE REQUIRED AT STREAM ANGLE POINT JUST NORTH OF
  BEARDSLEY ROAD DUE TO DOWNSTREAM RE-CHANNELIZATION REQUESTED BY ADOT.
  STA 10+385.479 (BACK) = STA 10+434.120 (AHEAD)
  THE FOLLOWING SECTION HAS AN EQUIVALENT "OLD" STATION OF 10+432.595
1     10384      6     4.27     48.57       9.9       9.9       9.9
3                              0.00                 52.84
R     438.8    0.00    438.8      4.27    435.46     10.92    435.46     41.92     438.7     48.57
R     438.7   52.84
```

```
NC                                        .1        .3
   RETURN TO NORMAL CONTRACTON AND EXPANSION COEFFICIENTS UPSTREAM OF BRIDGE

   1/2 WAY THROUGH HORIZONTAL TRANSITION
X1    10472        8     12.60     47.52     39.15     39.15     39.15
X3                                 8.33                51.78
GR    435.5     0.00     439.7      8.33     439.7     12.60     435.6     20.69     435.6     39.44
GR    439.7    47.52     439.7     51.78     436.5     67.00

   NORMAL UPSTREAM SECTION - SANIFILL CONST.

X1    10511        8     14.97     41.49     39.15     39.15     39.15
X3                                10.69                45.76
GR    435.5     0.00     440.9     10.69     440.9     14.97     435.8     25.02     435.8     31.43
GR    440.9    41.49     440.9     45.76     438.0     53.00


X1    10625        8     15.08     41.59    113.80    113.80    113.80
X3                                10.81                45.86
GR    436.0     0.00     441.4     10.81     441.4     15.08     436.4     25.14     436.4     31.57
GR    441.4    41.59     441.4     45.86     438.5     53.34


X1    10731        8     12.13     38.64    106.68    106.68    106.68
X3                                 7.86                42.91
GR    438.0     0.00     441.9      7.86     441.9     12.13     436.9     22.19     436.9     28.59
GR    441.9    38.64     441.9     42.91     438.0     50.77
```

THIS RUN EXECUTED 24JUN96 15:45:15

****
HEC-2 WATER SURFACE PROFILES

Version 4.5.1; September 1990
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

ULTIMATE FREEWAY PLAN, W

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	DEPTH	TOPWID	VLOB	QLOB	VCH	QCH	VROB	QROB	STENCL	STENCR
	10016.000	155.70	433.43	2.28	54.99	.00	.00	2.10	155.70	.00	.00	.00	.00
	10050.000	155.70	433.74	2.44	58.63	.00	.00	1.79	155.70	.00	.00	.00	.00
	10090.000	155.70	433.97	2.45	59.74	.00	.00	1.69	155.70	.00	.00	22.00	158.31
	10138.000	155.70	434.23	2.23	69.43	.52	.93	1.70	154.77	.00	.00	.00	.00
	10180.000	155.70	434.40	1.94	38.19	.00	.00	2.50	155.70	.00	.00	79.21	167.81
*	10197.000	155.70	435.64	1.33	36.32	.00	.00	3.49	155.70	.00	.00	.00	.00
*	10230.000	155.70	436.37	1.86	38.43	.00	.00	2.42	155.70	.00	.00	.00	.00
	10263.000	155.70	436.72	2.02	36.70	.00	.00	2.35	155.70	.00	.00	.00	.00
	10269.000	155.70	436.75	1.95	36.38	.00	.00	2.45	155.70	.00	.00	.00	.00
	10283.000	155.70	436.86	2.06	37.36	.00	.00	2.31	155.70	.00	.00	.00	.00
	10290.000	155.70	436.89	2.02	36.61	.00	.00	2.37	155.70	.00	.00	.00	.00
	10302.000	155.70	436.95	2.05	36.64	.00	.00	2.37	155.70	.00	.00	.00	.00
	10310.000	155.70	436.98	1.99	36.52	.00	.00	2.40	155.70	.00	.00	.00	.00
	10331.000	155.70	437.08	1.98	36.45	.00	.00	2.43	155.70	.00	.00	.00	.00
	10340.000	155.70	437.13	1.96	36.34	.00	.00	2.46	155.70	.00	.00	.00	.00
	10350.000	155.70	437.18	1.98	36.39	.00	.00	2.45	155.70	.00	.00	.00	.00
	10356.000	155.70	437.21	1.94	36.29	.00	.00	2.48	155.70	.00	.00	.00	.00

	SECNO	Q	CWSEL	DEPTH	TOPWID	VLOB	QLOB	VCH	QCH	VROB	QROB	STENCL	STENCR
	10368.000	155.70	437.56	2.26	37.61	.00	.00	2.08	155.70	.00	.00	.00	.00
	10374.000	155.70	437.58	2.18	37.30	.00	.00	2.16	155.70	.00	.00	.00	.00
	10384.000	155.70	437.66	2.20	39.90	.00	.00	2.00	155.70	.00	.00	.00	52.84
*	10472.000	155.70	437.62	2.12	26.74	.00	.00	3.38	155.70	.00	.00	8.33	51.78
*	10511.000	155.70	438.69	3.19	17.82	.00	.00	4.44	155.70	.00	.00	10.69	45.76
*	10625.000	155.70	440.34	4.34	22.24	.00	.00	2.76	155.70	.00	.00	10.81	45.86
	10731.000	155.70	440.87	3.97	22.37	.00	.00	2.73	155.70	.00	.00	7.86	42.91

ULTIMATE FREEWAY PLAN, W

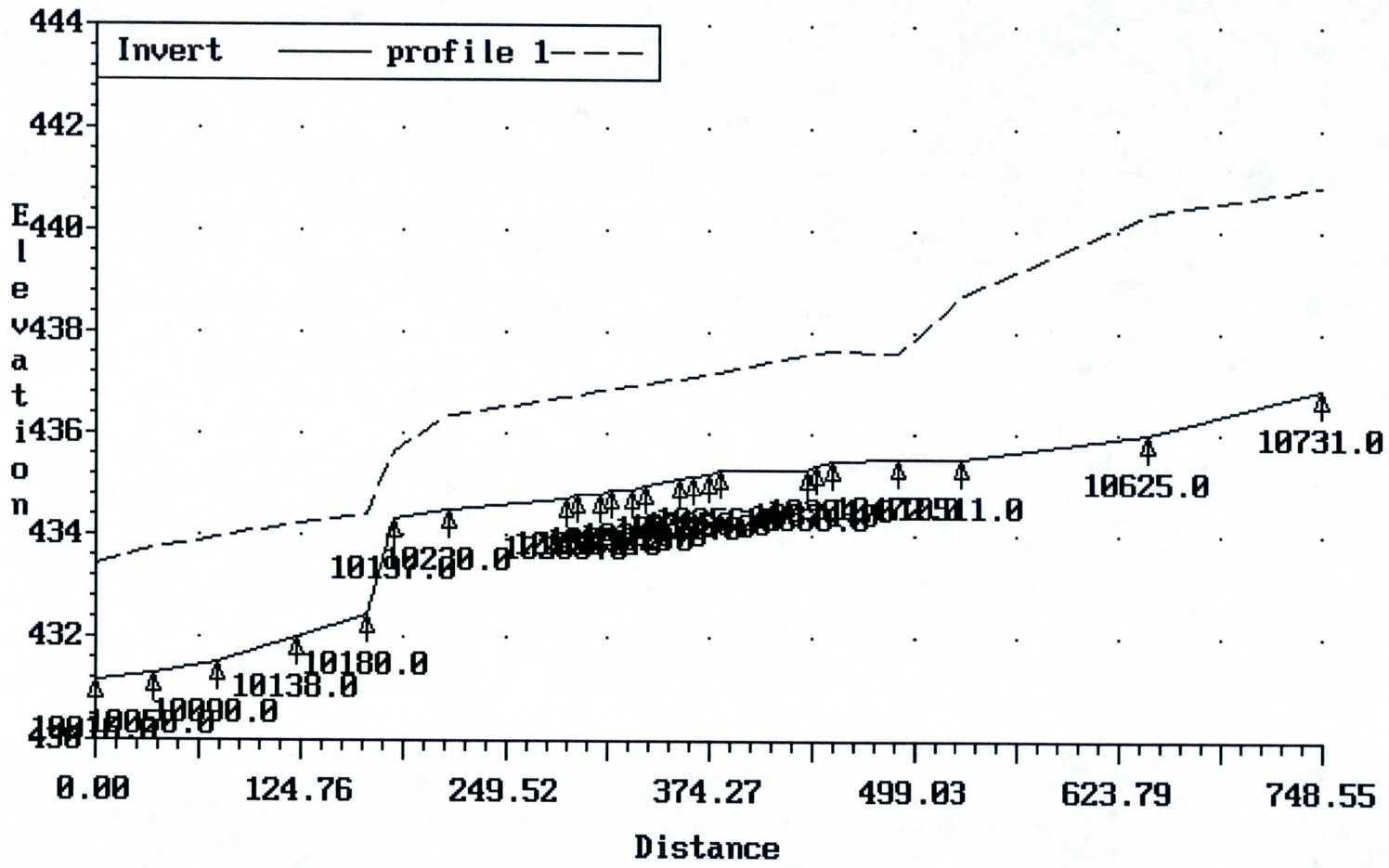
SUMMARY PRINTOUT

	SECNO	Q	K*XNL	K*XNCH	K*XNR	STCHL	STCHR	SSTA	ENDST	10*KS	FRCH	XLCH	CUMDS
	10016.000	155.70	.00	55.00	.00	24.05	92.25	27.46	82.44	90.49	.58	.00	.00
	10050.000	155.70	.00	55.00	.00	35.40	108.84	42.40	101.03	58.26	.47	34.34	34.34
	10090.000	155.70	.00	55.00	.00	22.89	90.00	26.70	86.44	50.03	.44	39.64	73.98
	10138.000	155.70	70.00	55.00	.00	13.15	78.46	7.16	76.59	54.53	.45	48.59	122.57
	10180.000	155.70	.00	39.00	.00	79.21	120.21	80.61	118.81	51.24	.63	42.00	164.57
*	10197.000	155.70	.00	39.00	.00	.00	40.60	2.14	38.45	143.76	1.00	17.11	181.68
*	10230.000	155.70	.00	39.00	.00	.00	40.60	1.08	39.51	46.08	.60	32.89	214.57
	10263.000	155.70	.00	39.00	.00	.00	40.60	.73	39.87	45.09	.57	73.00	287.57
	10269.000	155.70	.00	39.00	.00	.00	40.60	.89	39.71	51.48	.61	6.50	294.07
	10283.000	155.70	.00	39.00	.00	.00	40.60	.68	39.87	43.27	.56	13.90	307.97
	10290.000	155.70	.00	39.00	.00	.00	40.60	.80	39.85	46.19	.58	6.60	314.57
	10302.000	155.70	.00	39.00	.00	.00	40.60	.72	39.81	46.70	.58	11.90	326.47
	10310.000	155.70	.00	39.00	.00	.00	40.60	.83	39.79	48.33	.59	8.40	334.87
	10331.000	155.70	.00	39.00	.00	.00	40.60	.84	39.73	50.34	.61	21.10	355.97
	10340.000	155.70	.00	39.00	.00	.00	40.60	.94	39.71	51.93	.61	8.40	364.37
	10350.000	155.70	.00	39.00	.00	.00	40.60	.86	39.69	51.62	.61	9.90	374.27
	10356.000	155.70	.00	39.00	.00	.00	40.60	.96	39.69	53.06	.62	6.60	380.87
	10368.000	155.70	.00	39.00	.00	.00	40.60	.27	40.33	31.58	.49	52.50	433.37
	10374.000	155.70	.00	39.00	.00	.00	40.60	.43	40.17	35.54	.51	6.50	439.87
	10384.000	155.70	.00	45.00	.00	4.27	48.57	6.54	46.44	34.17	.46	9.90	449.77
	10472.000	155.70	.00	45.00	.00	12.60	47.52	16.69	43.43	117.42	.82	39.15	488.92
	10511.000	155.70	.00	45.00	.00	14.97	41.49	19.32	37.14	178.96	1.01	39.15	528.07
	10625.000	155.70	.00	45.00	.00	15.08	41.59	17.22	39.46	49.58	.55	113.80	641.87
	10731.000	155.70	.00	45.00	.00	12.13	38.64	14.20	36.57	47.93	.54	106.68	748.55

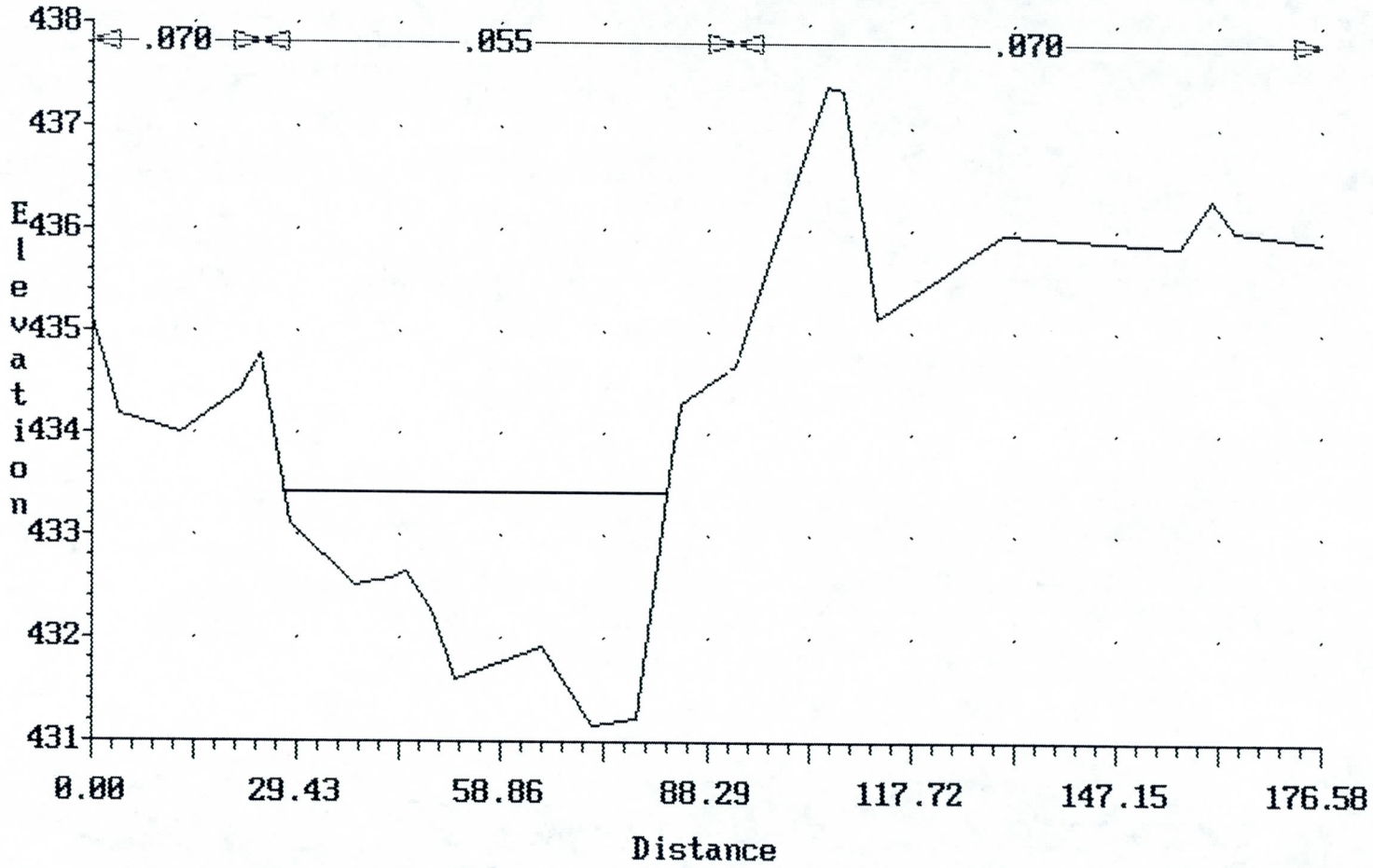
SUMMARY OF ERRORS AND SPECIAL NOTES

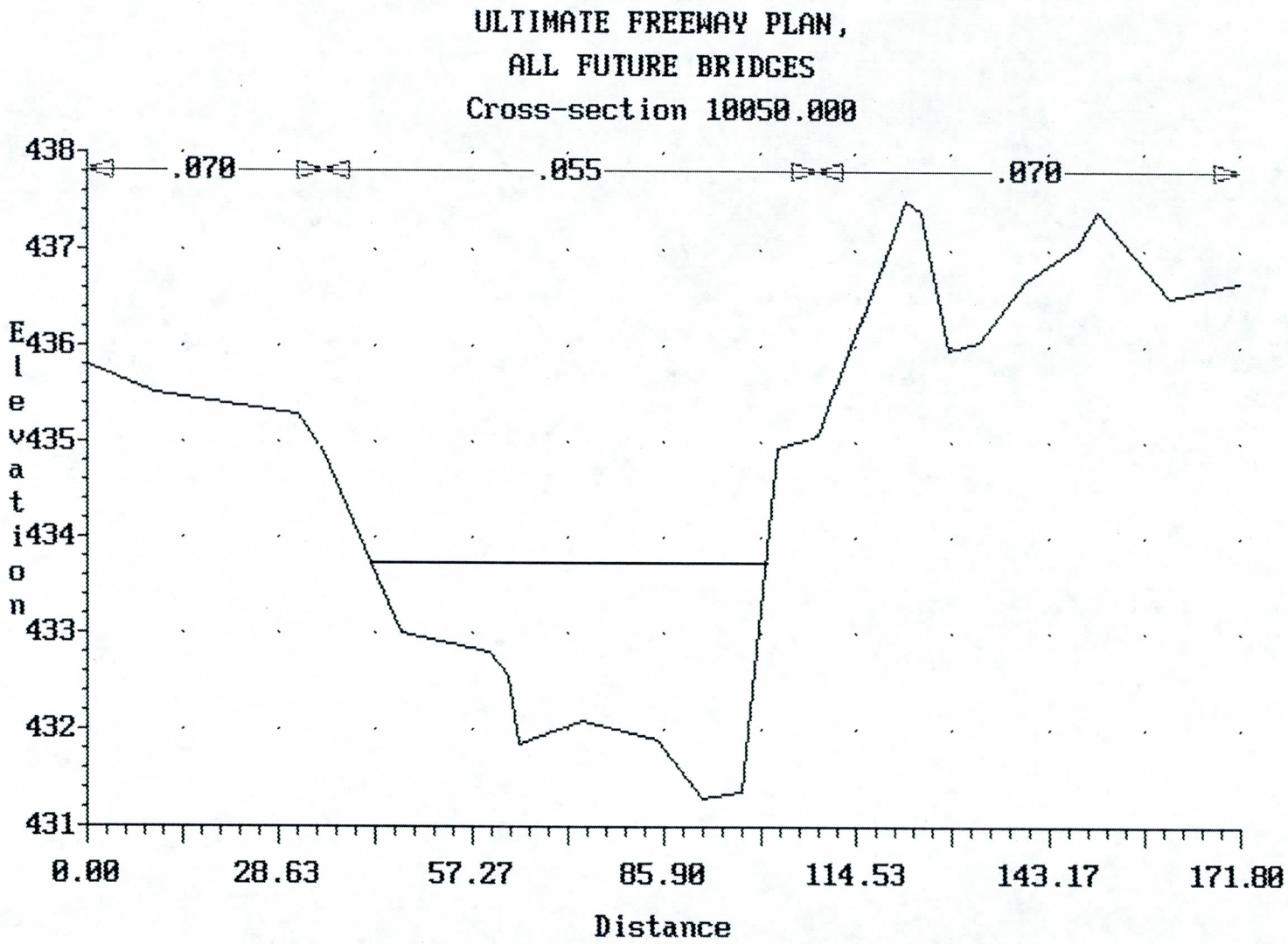
```
CAUTION SECNO=  10197.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  10197.000  PROFILE=  1  MINIMUM SPECIFIC ENERGY

WARNING SECNO=  10230.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=  10472.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=  10511.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  10511.000  PROFILE=  1  MINIMUM SPECIFIC ENERGY

WARNING SECNO=  10625.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
```

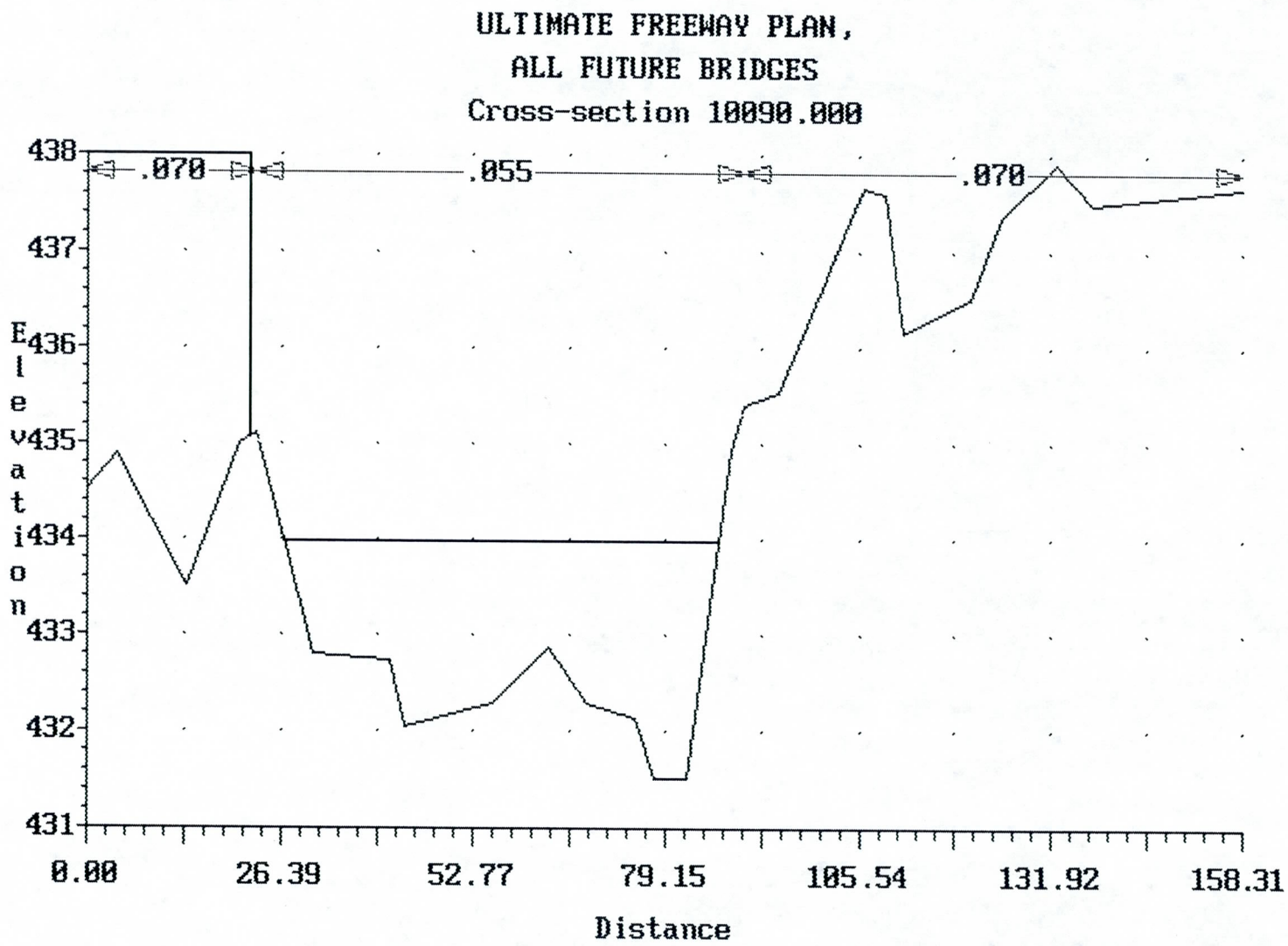
ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES

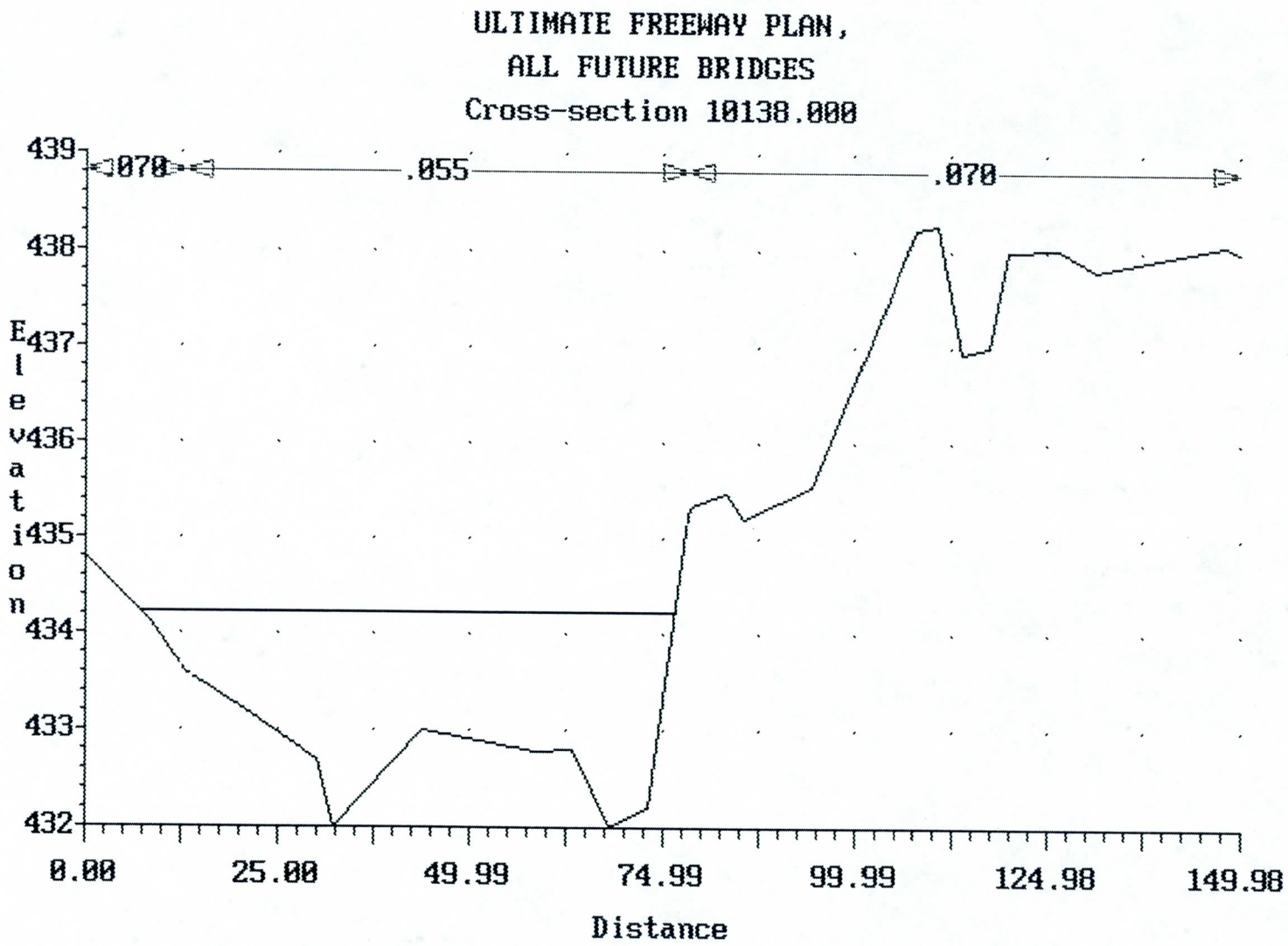


ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10016.000

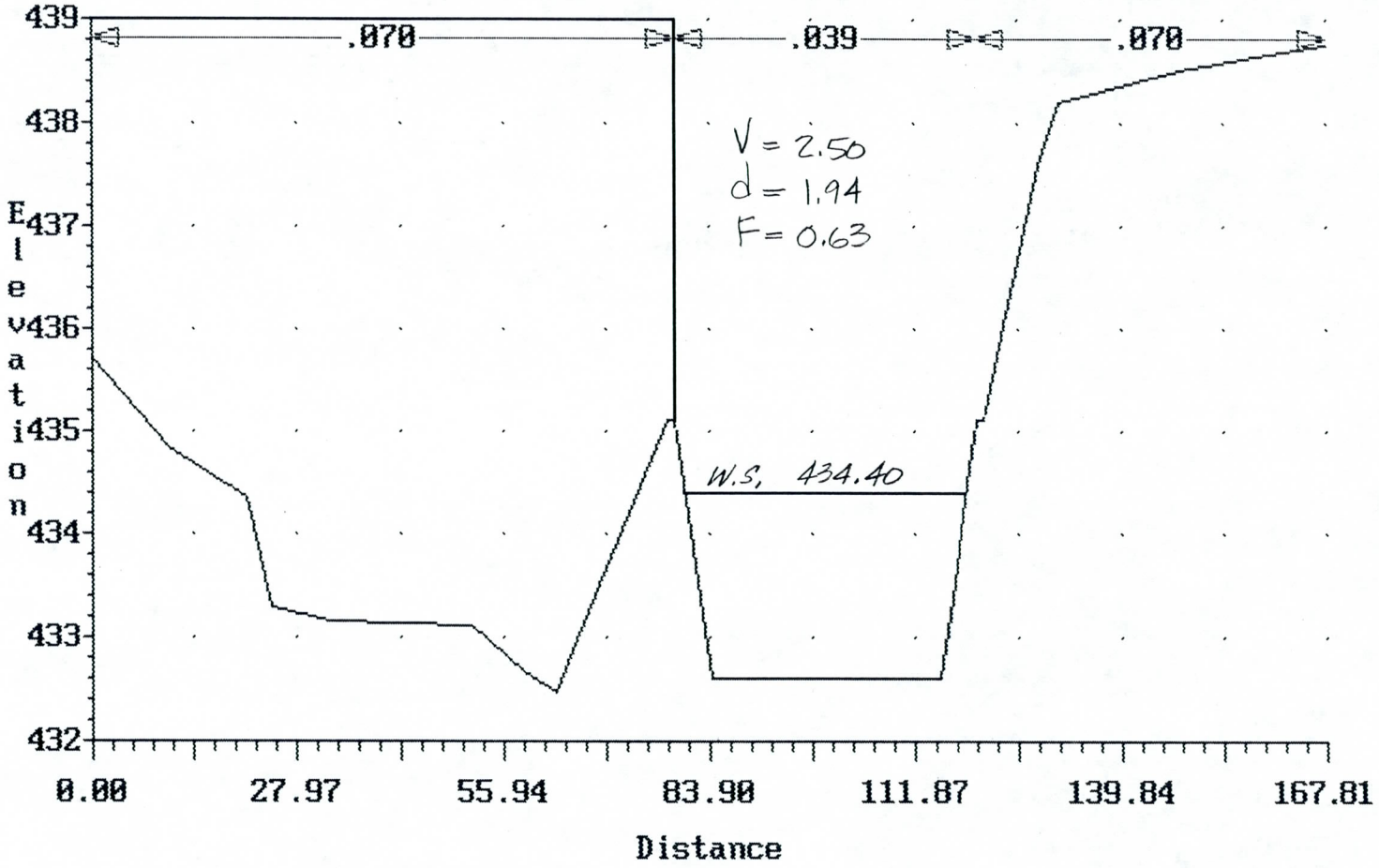



ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10050.000
.070
.055
.070
438
437
436
435
434
433
432
431
Elevation
0.00
28.63
57.27
85.90
114.53
143.17
171.80
Distance

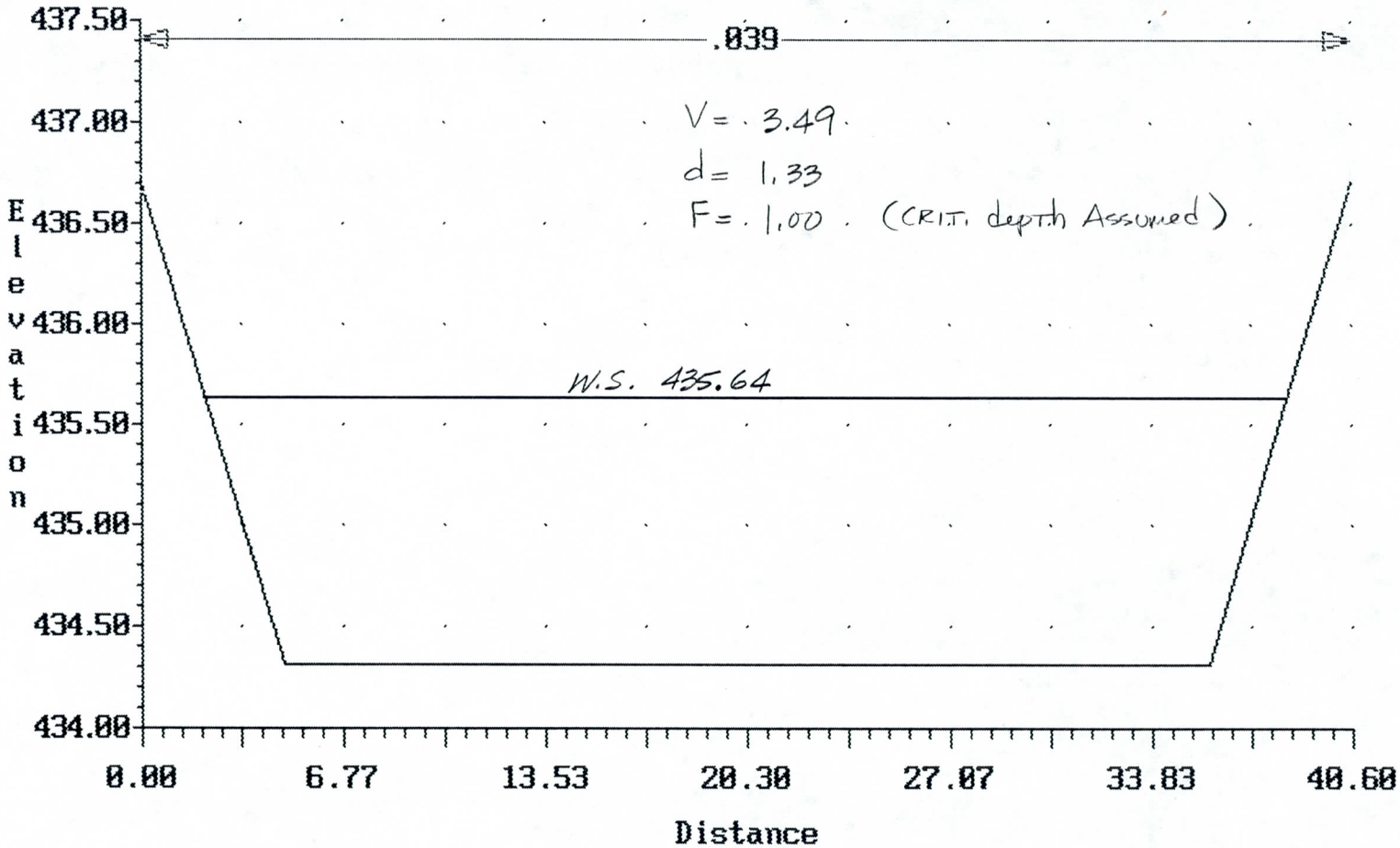

ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10090.000
.070
.055
.070
438
437
436
435
434
433
432
431
Elevation
0.00
26.39
52.77
79.15
105.54
131.92
158.31
Distance


ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10138.000
.070
.055
.070
439
438
437
436
435
434
433
432
Elevation
0.00
25.00
49.99
74.99
99.99
124.98
149.98
Distance

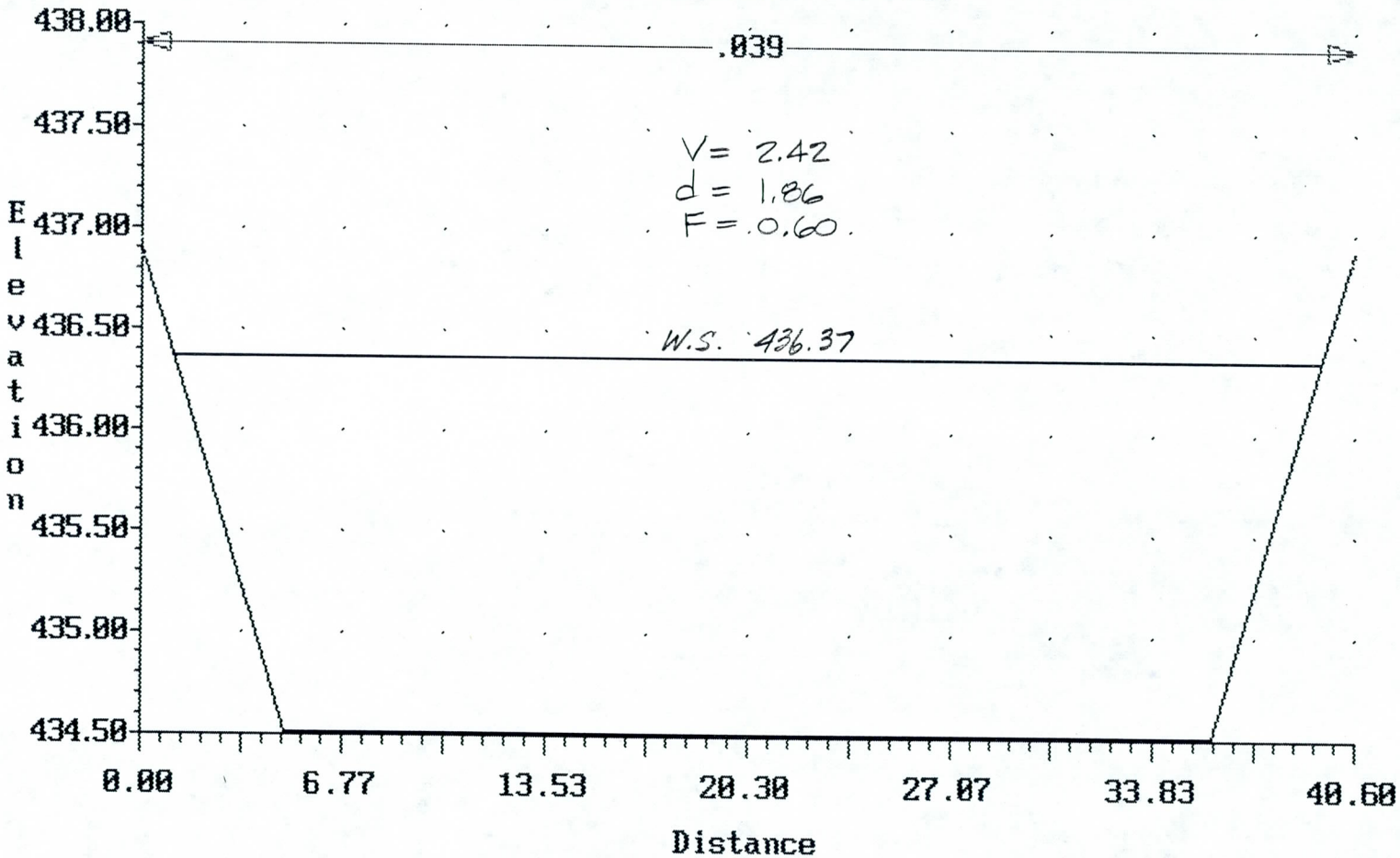
ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10180.000



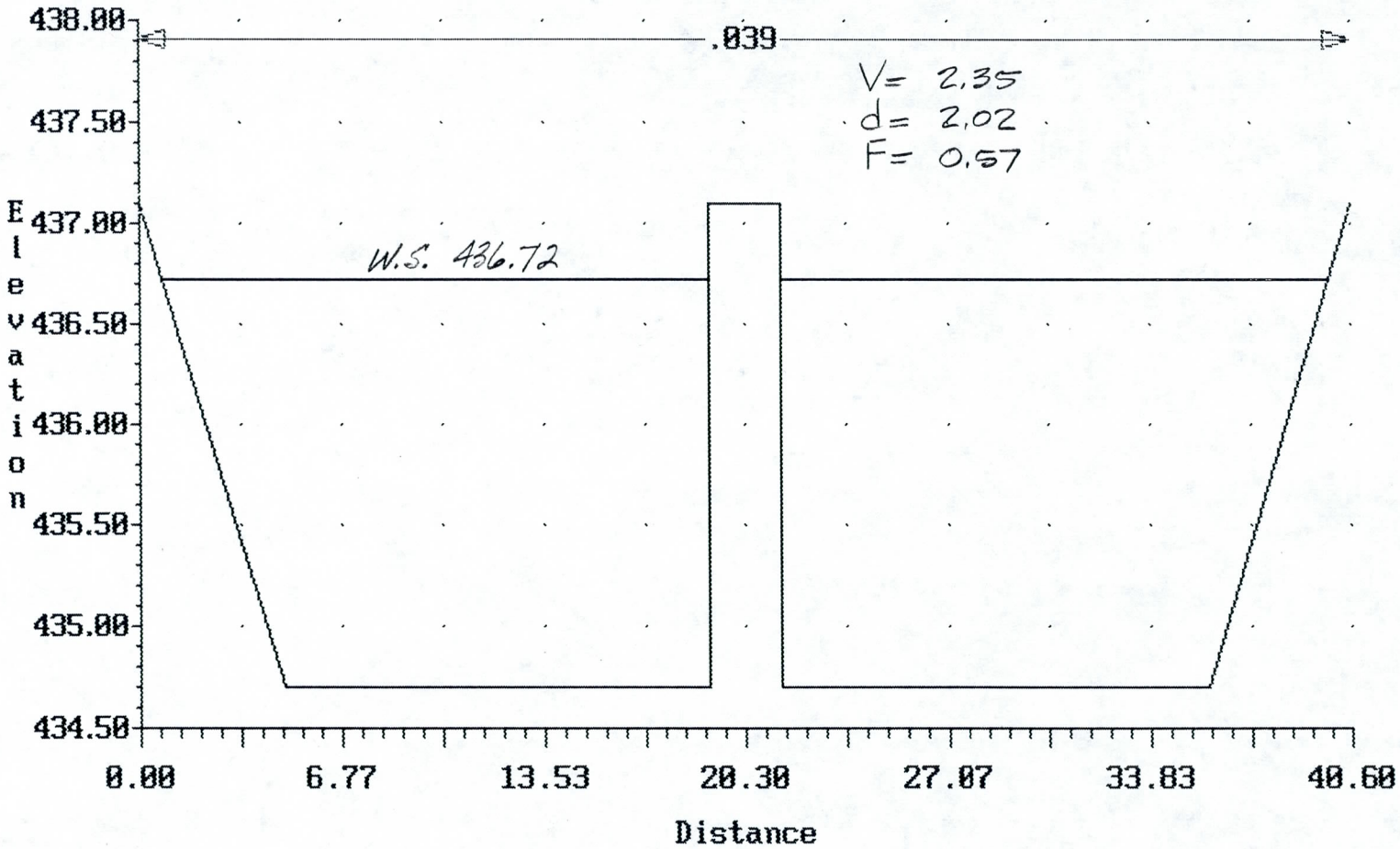
ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10197.000



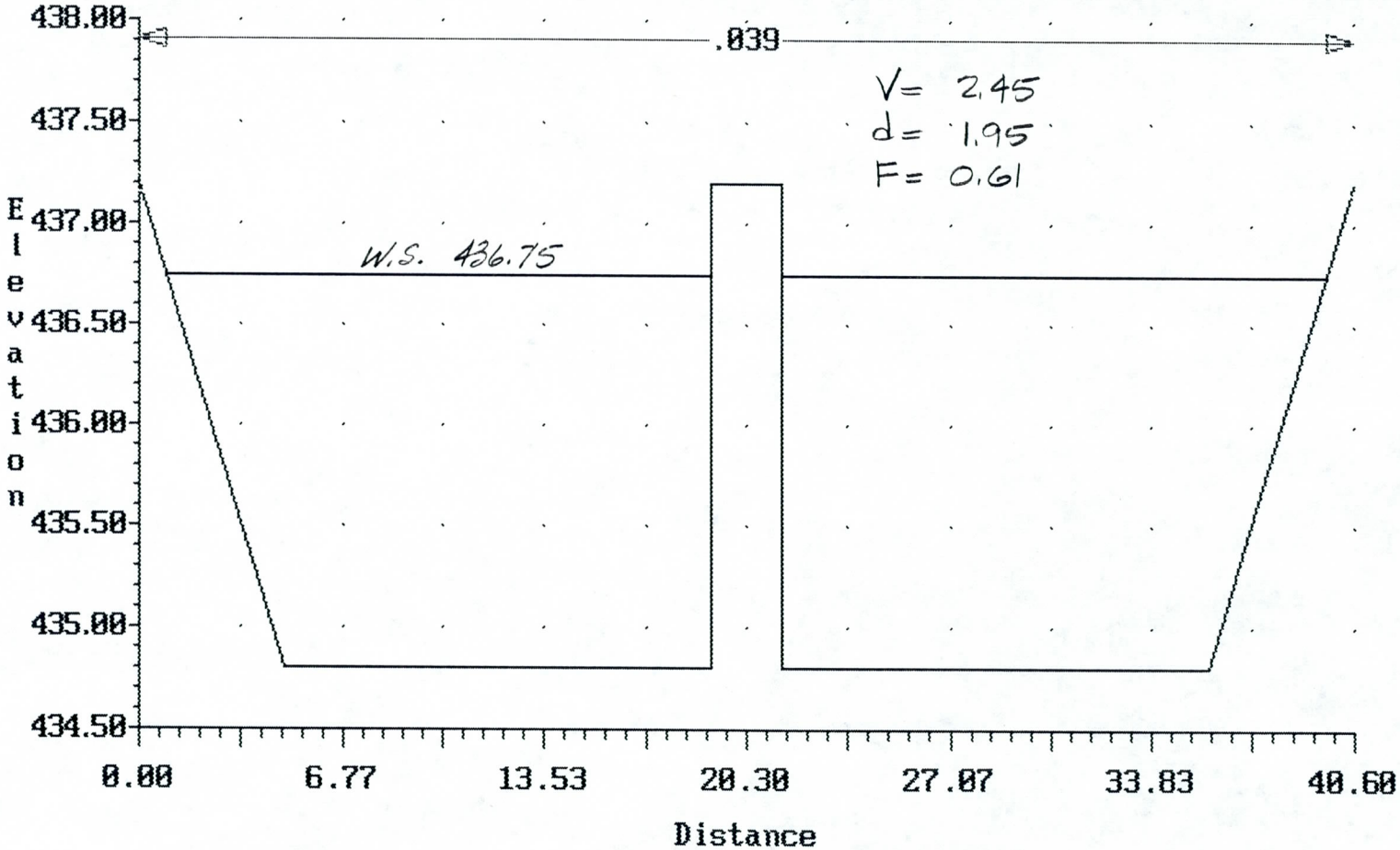
ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10230.000

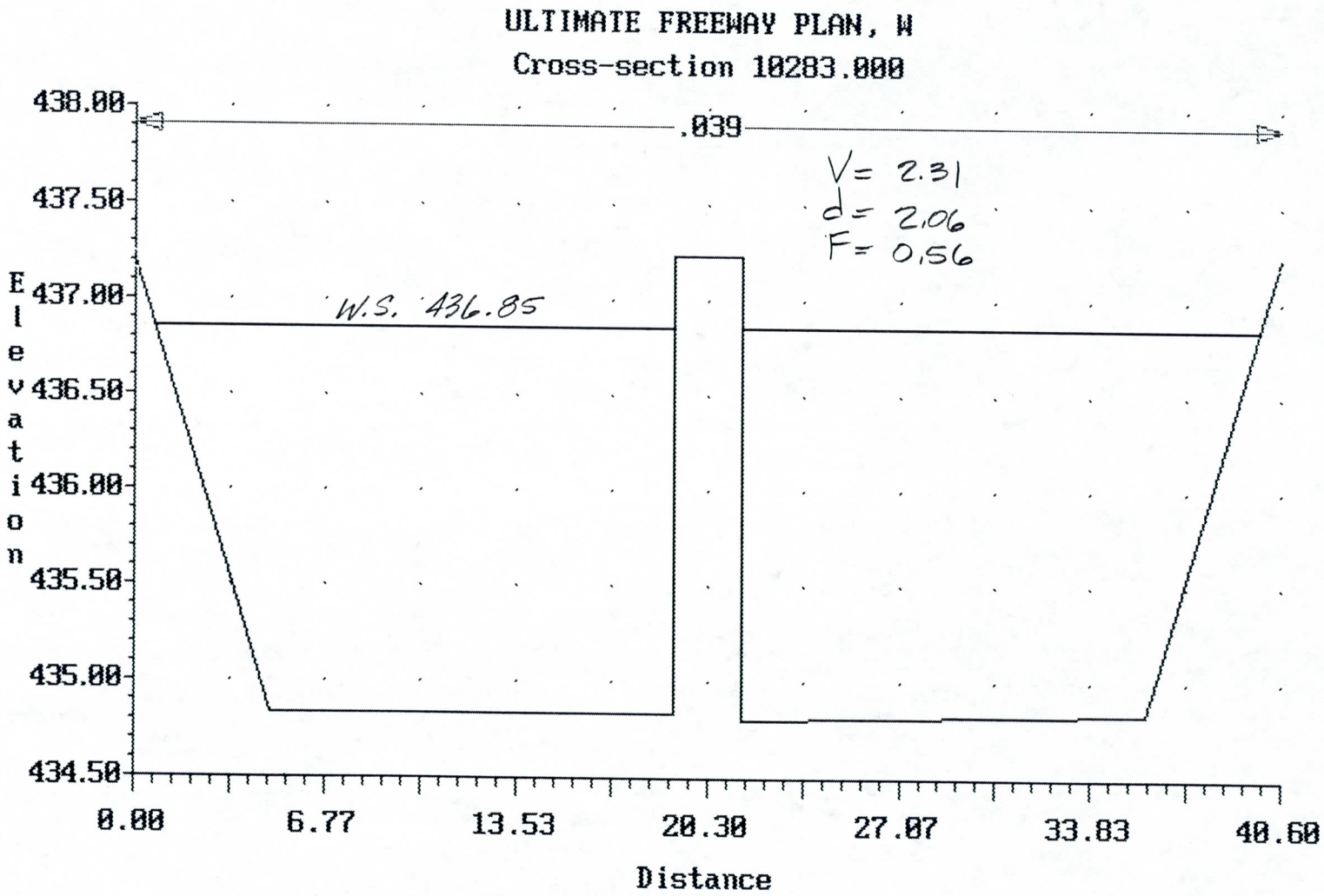


ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10263.000

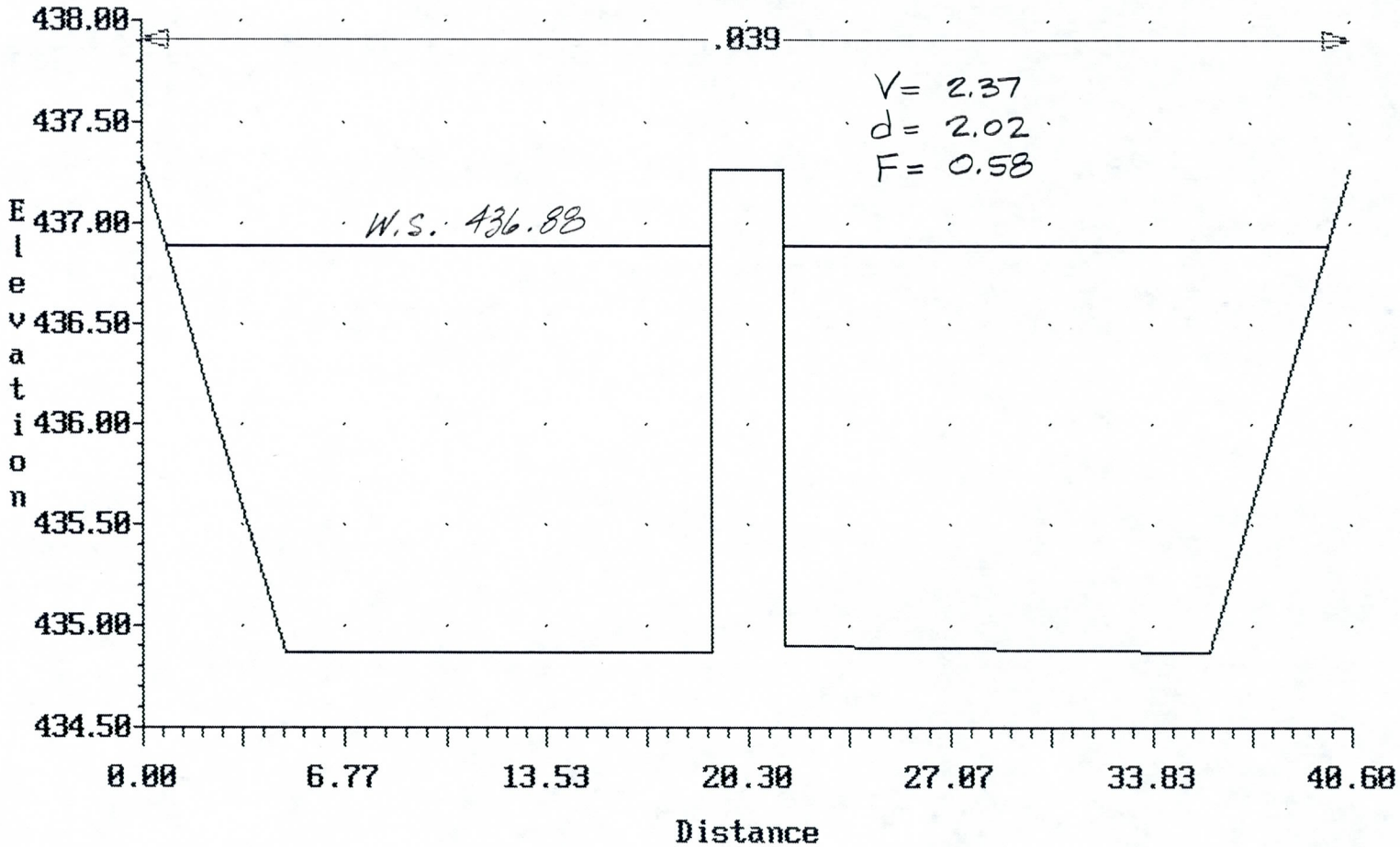


ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10269.000

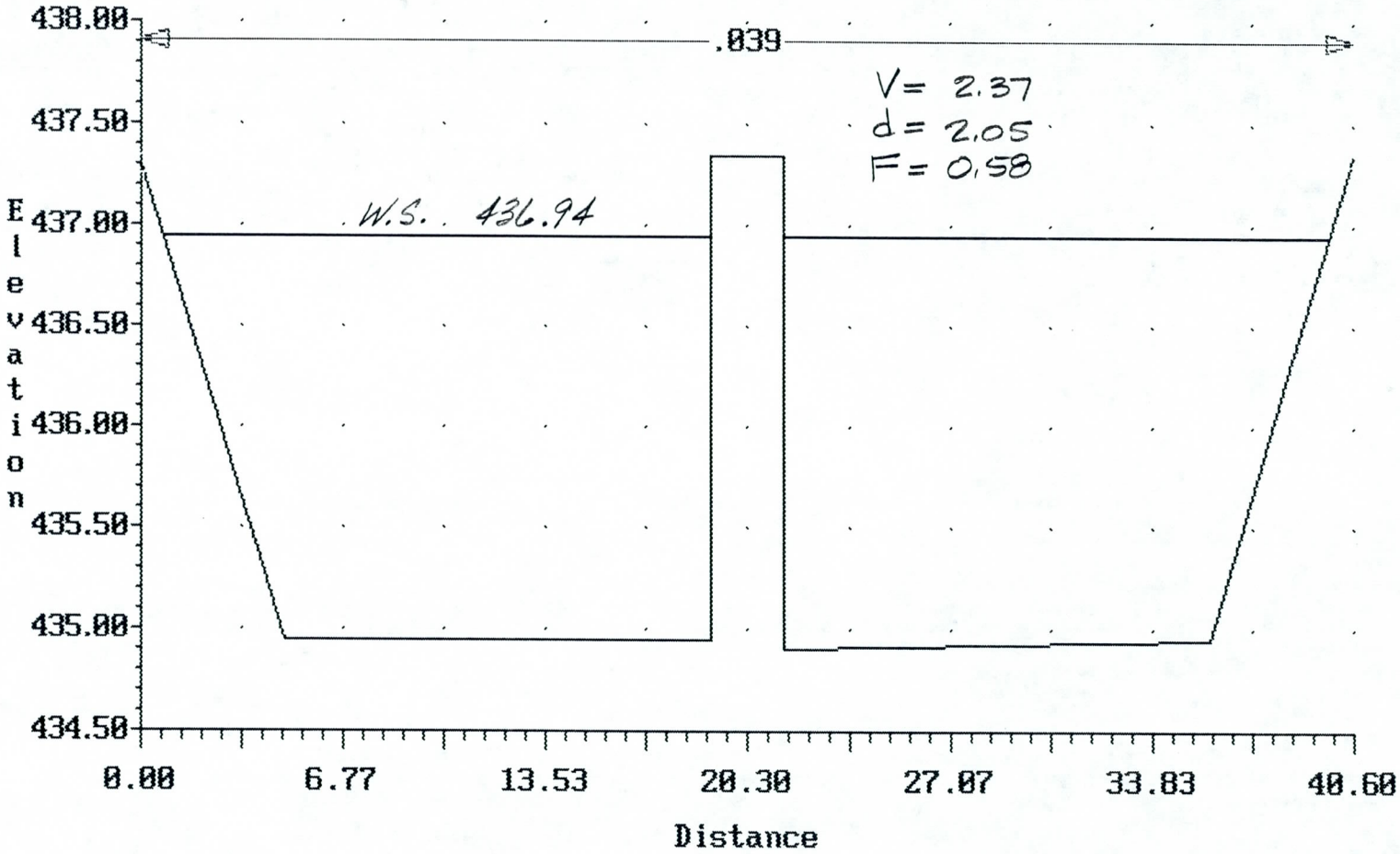



ULTIMATE FREEWAY PLAN, W
Cross-section 10283.000
.039
V= 2.31
d= 2.06
F= 0.56
W.S. 436.85
Elevation
438.00
437.50
437.00
436.50
436.00
435.50
435.00
434.50
0.00
6.77
13.53
20.30
27.07
33.83
40.60
Distance

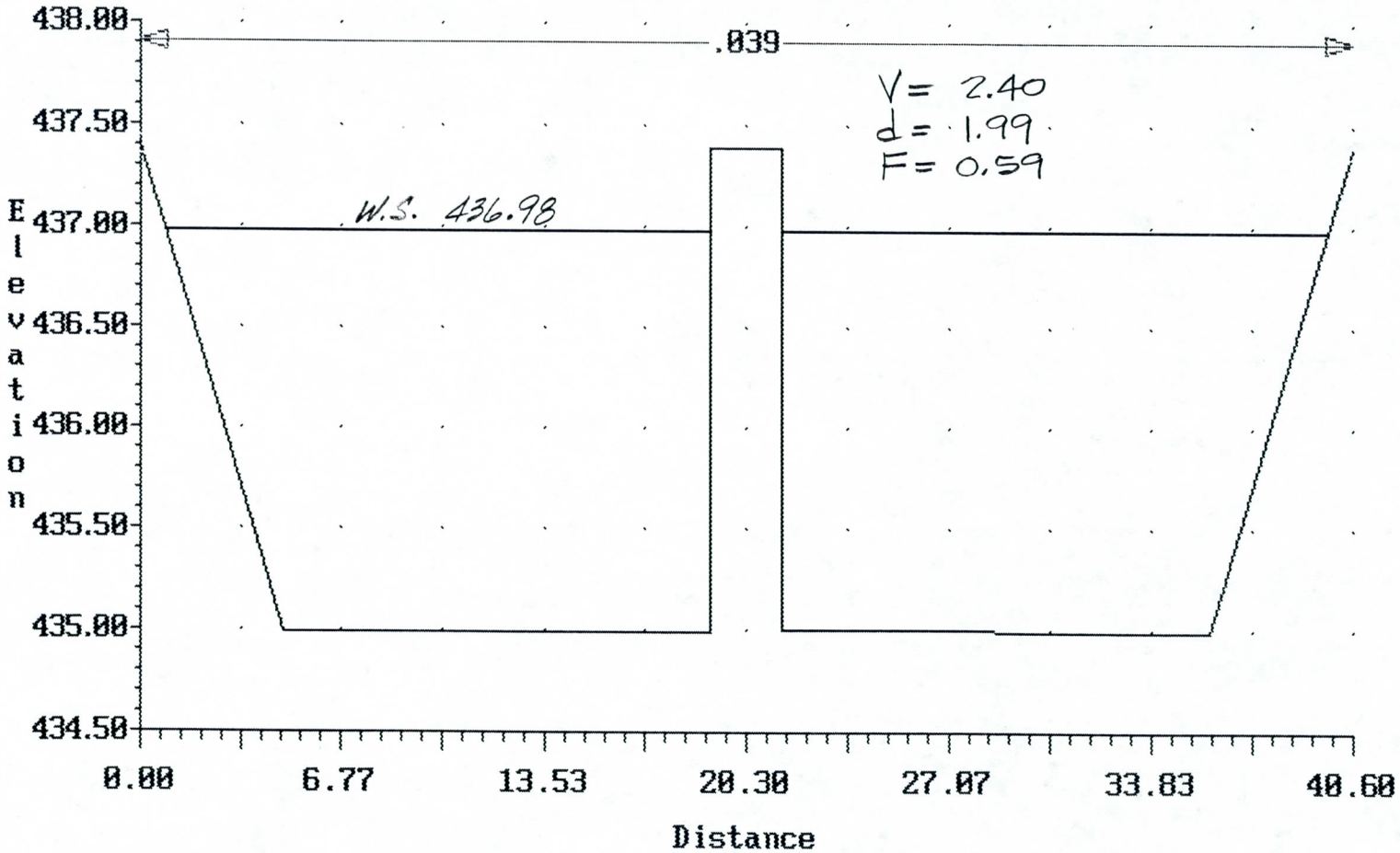
ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10290.000



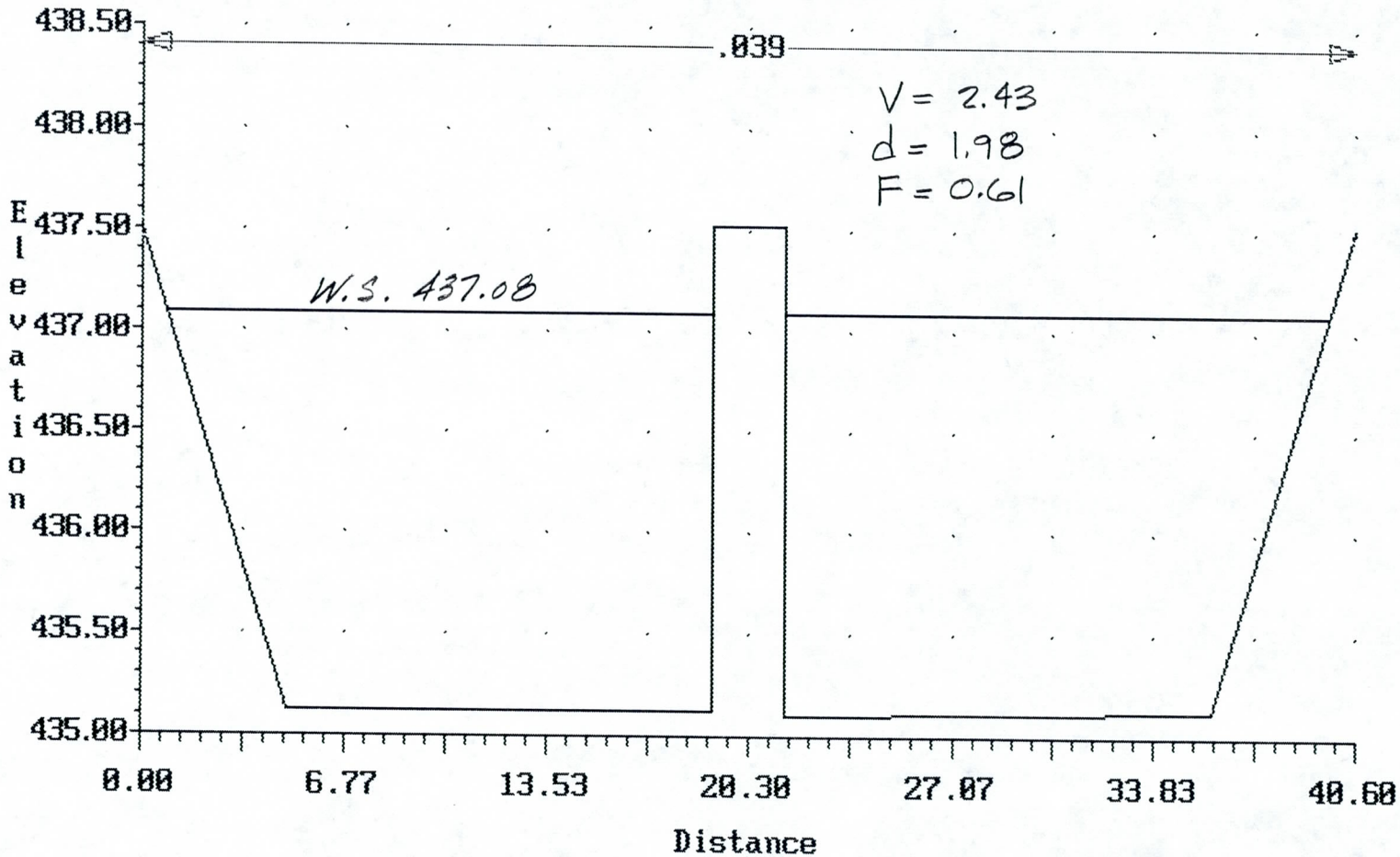
ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10302.000



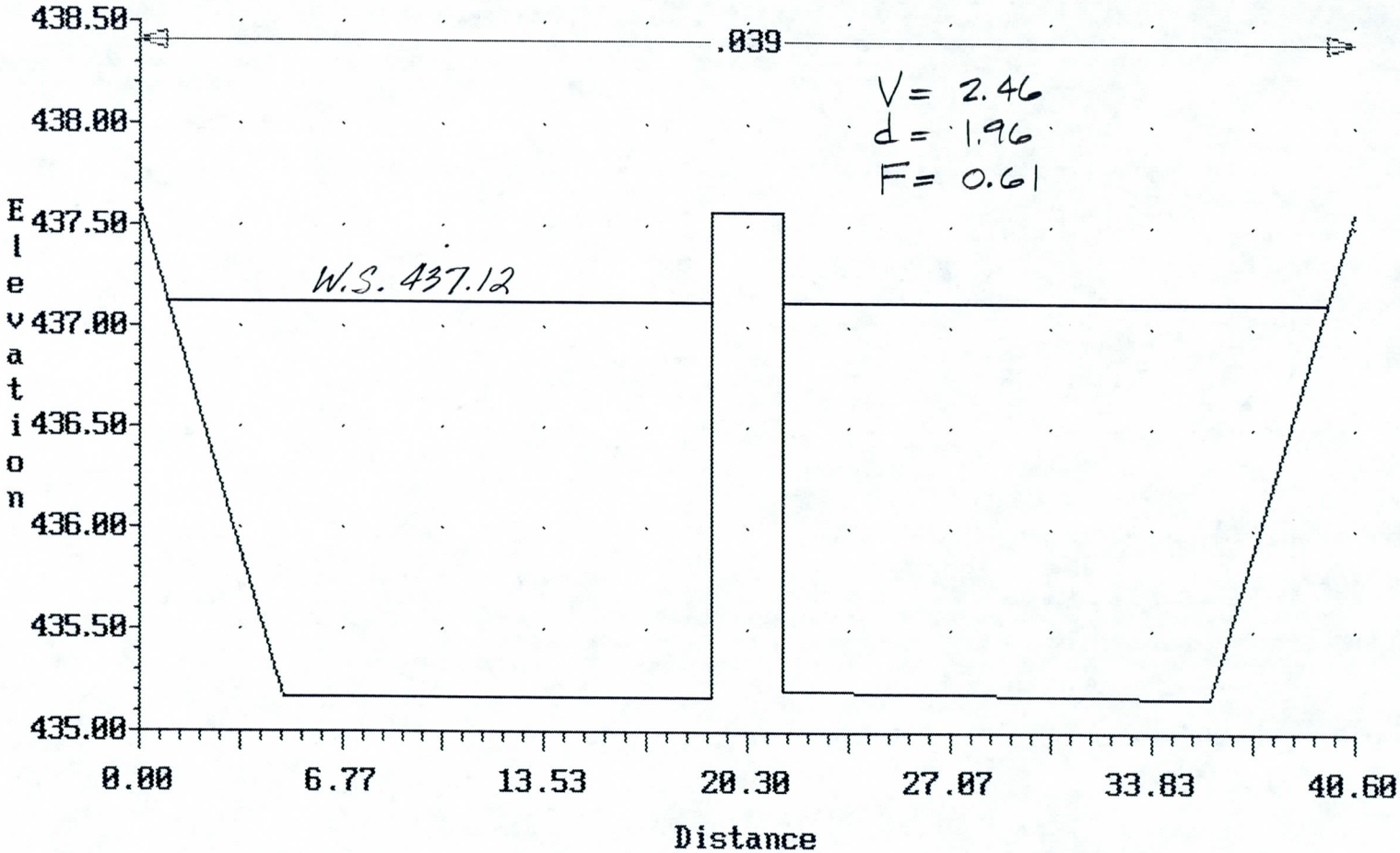
ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10310.000



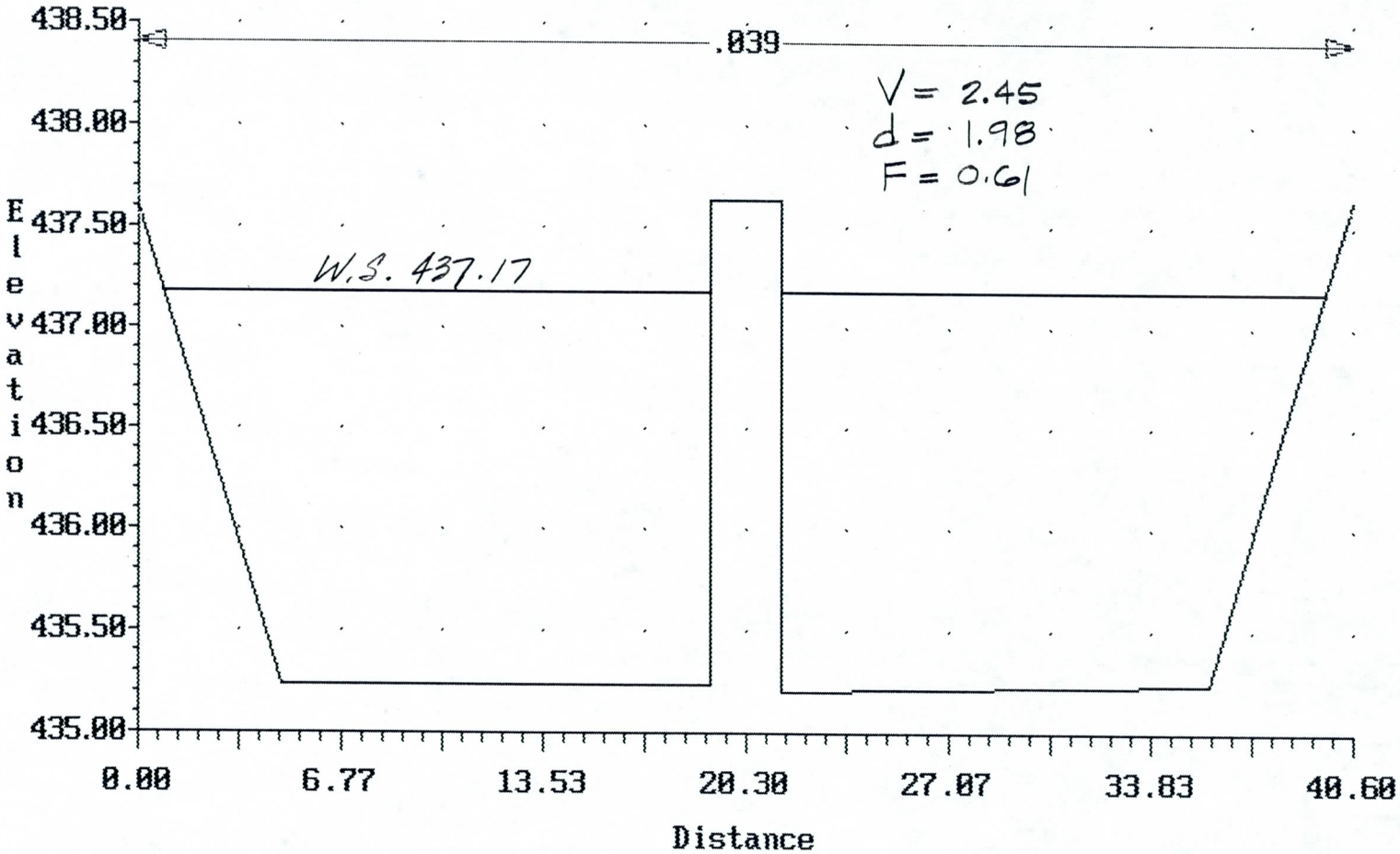
ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10331.000



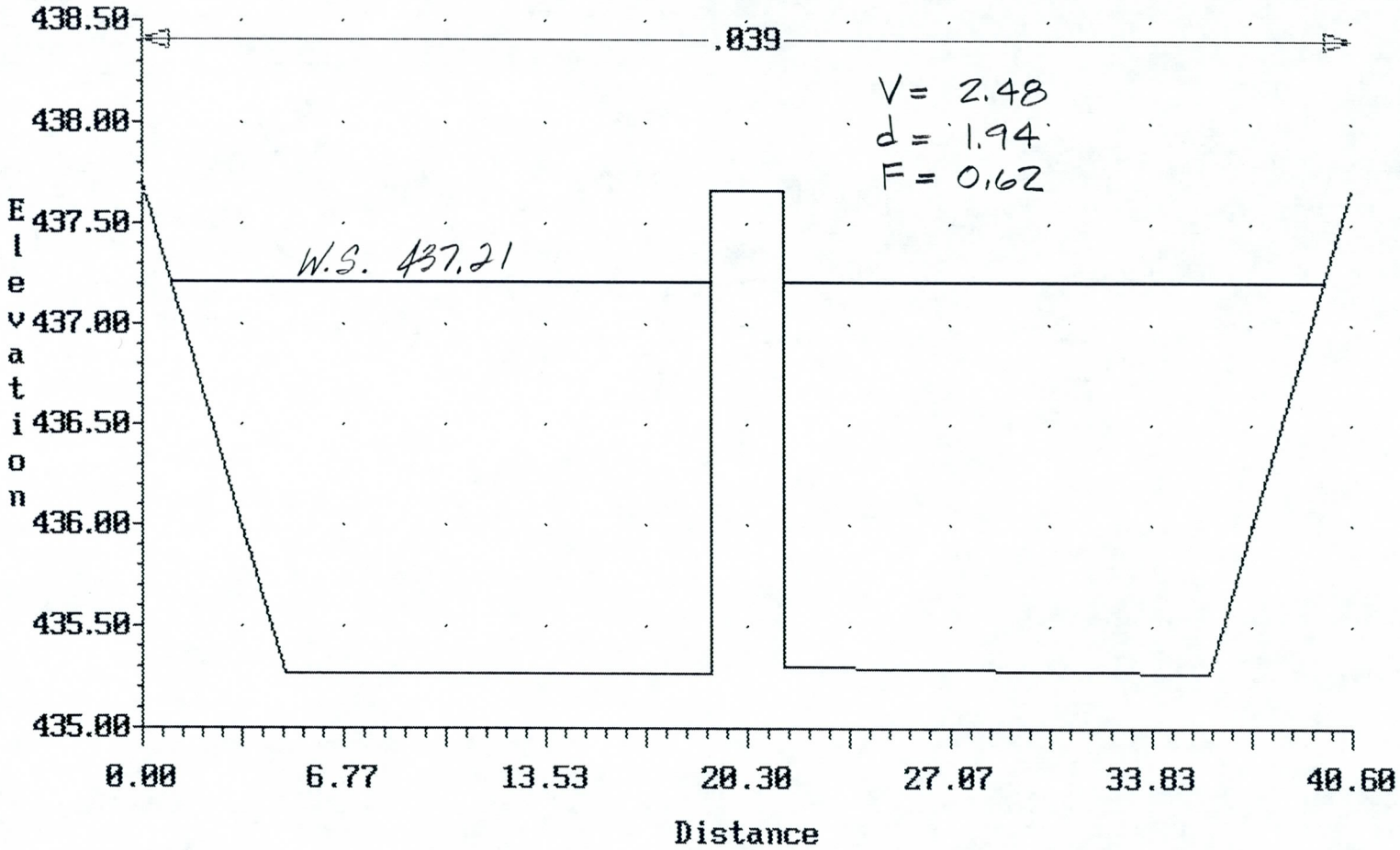
ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10340.000



ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10350.000



ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10356.000



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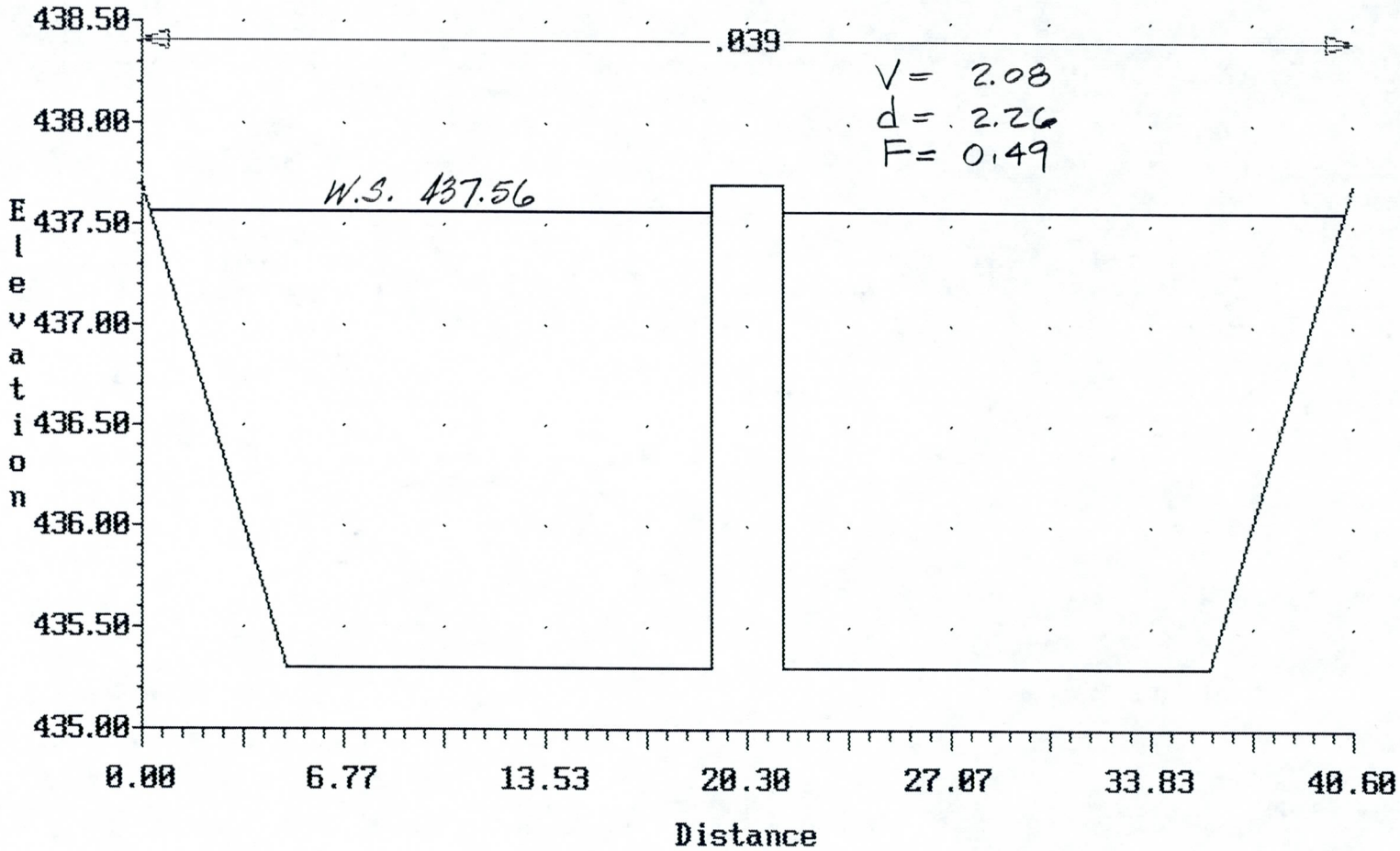
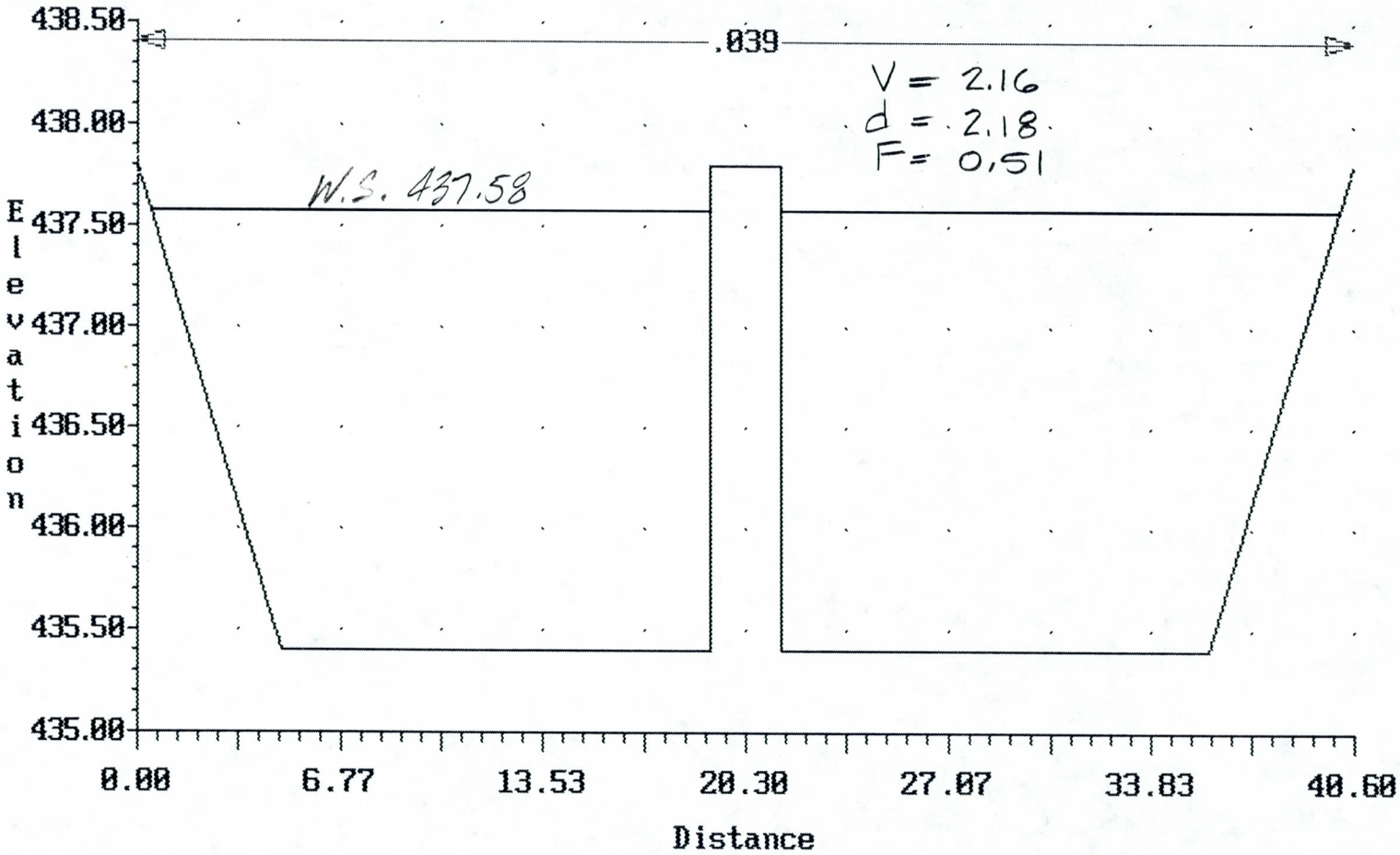
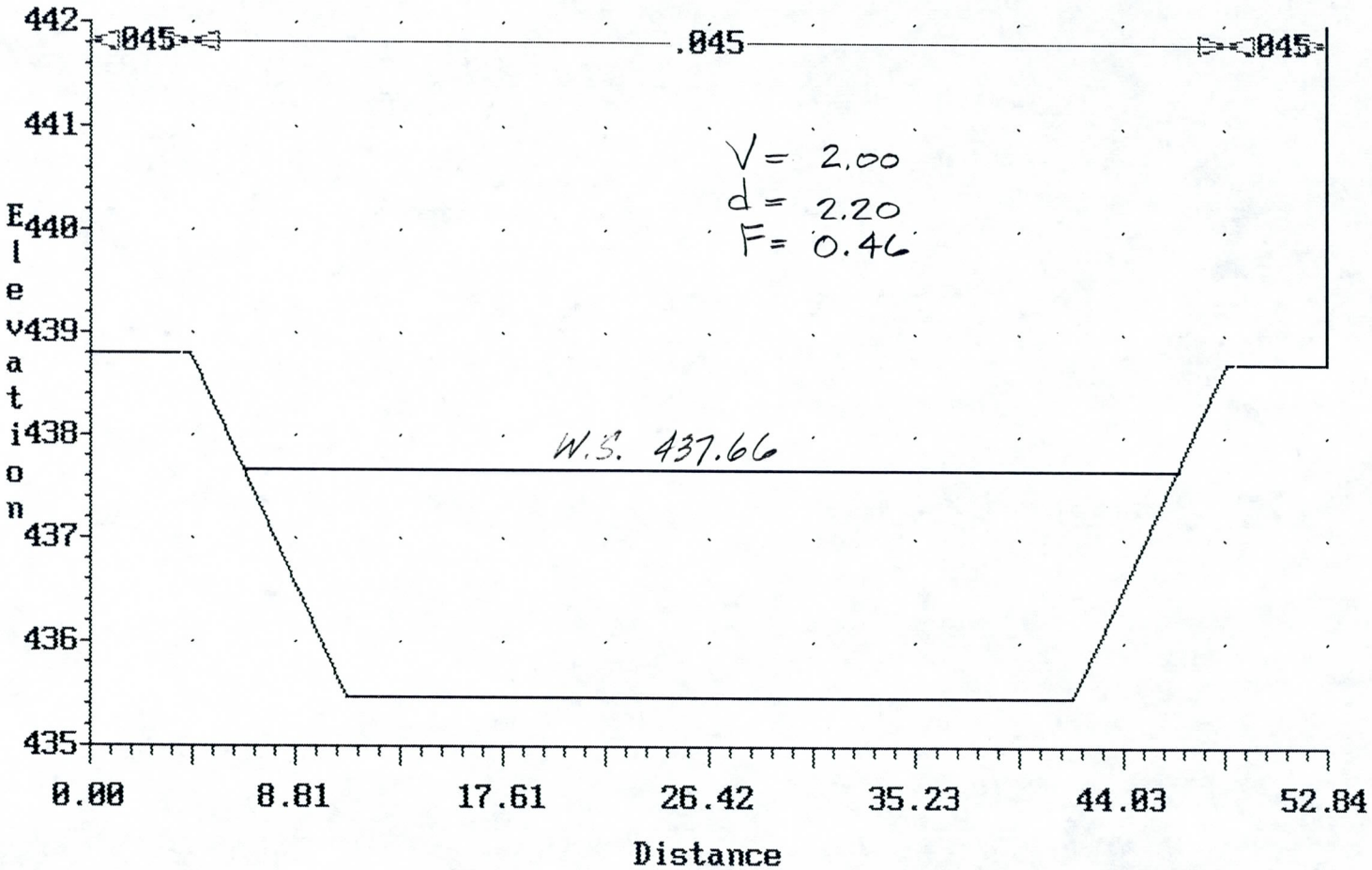
ALL FUTURE BRIDGES
Cross-section 10368.000



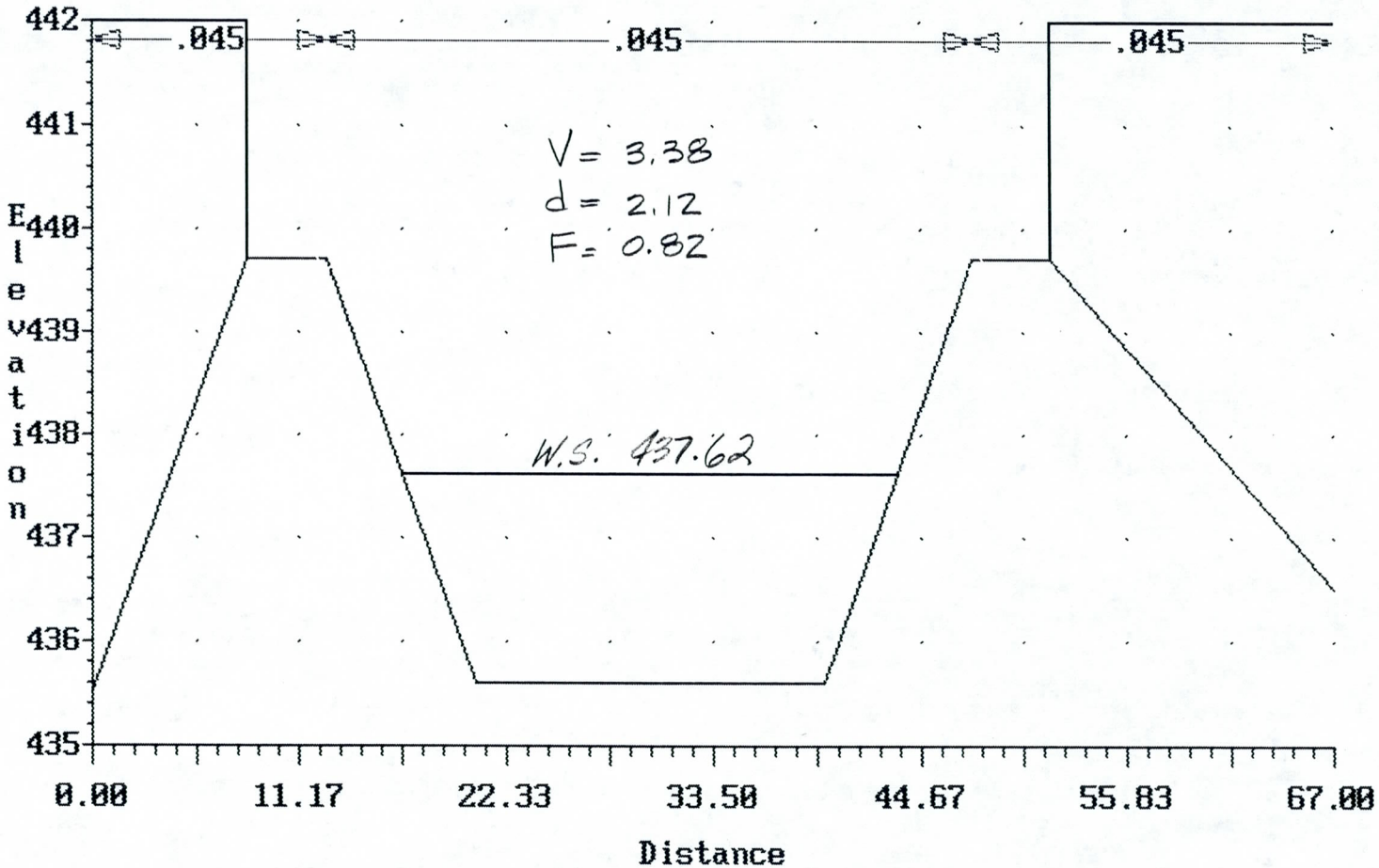
ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10374.000



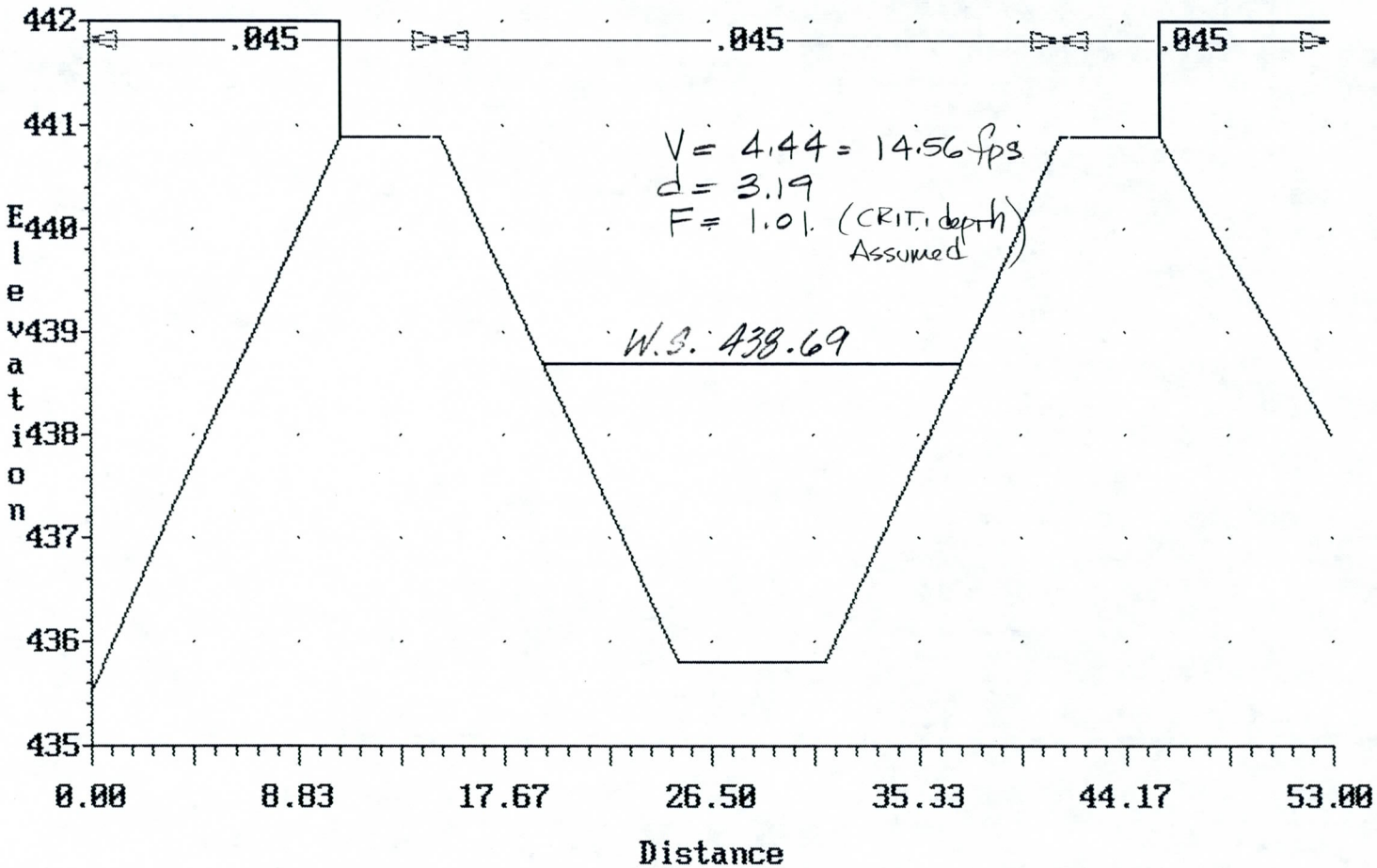
ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10384.000



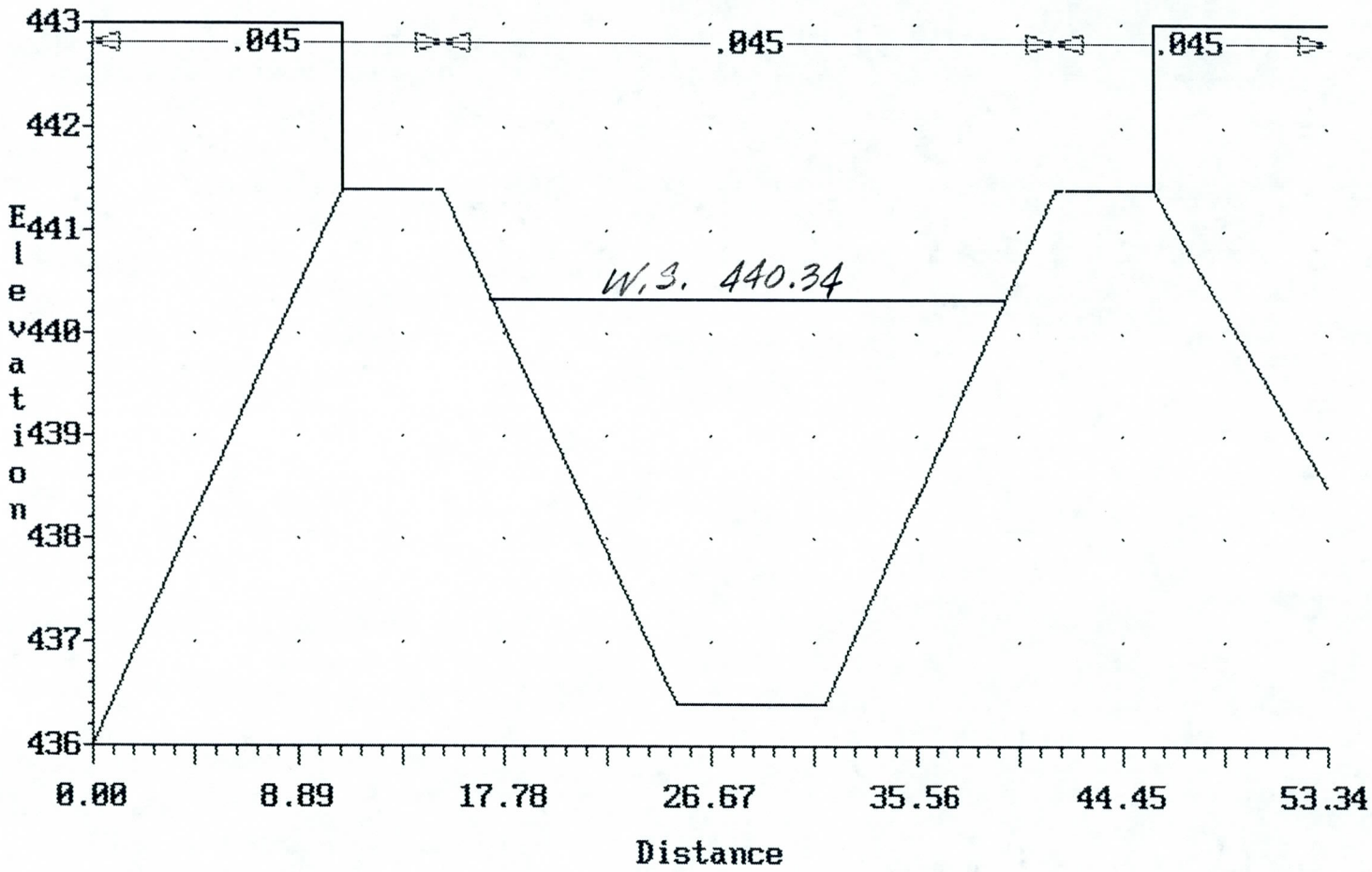
ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10472.000



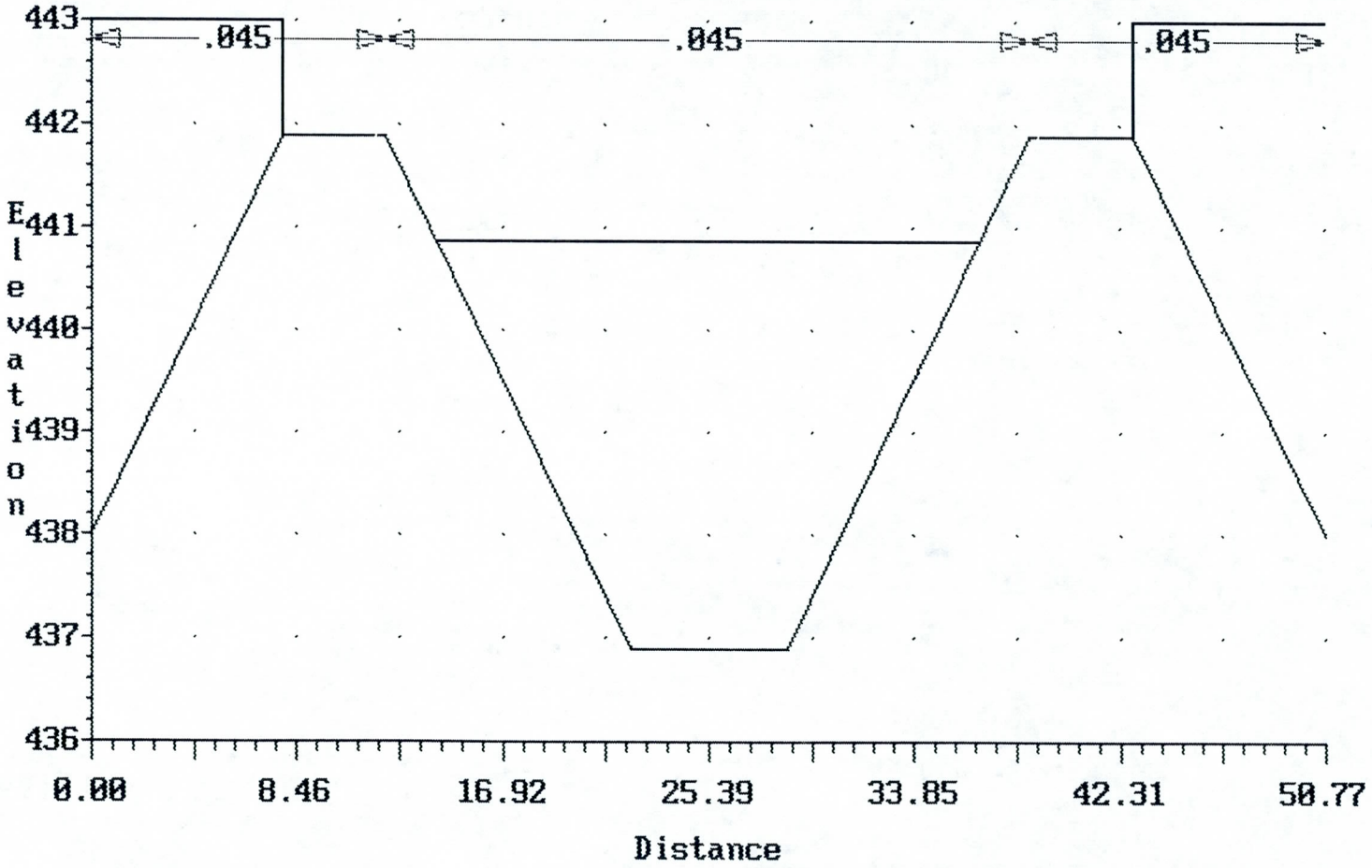
ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10511.000



ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10625.000



ULTIMATE FREEWAY PLAN,
ALL FUTURE BRIDGES
Cross-section 10731.000



PART C BRIDGE CLEARANCE COMPUTATIONS

Rev's. — B.B. 6/25/96

Parsons Brinckerhoff Computation Sheet

Page 1 of 6 | 110325

Made by M. Fulish

Date 3-15-96

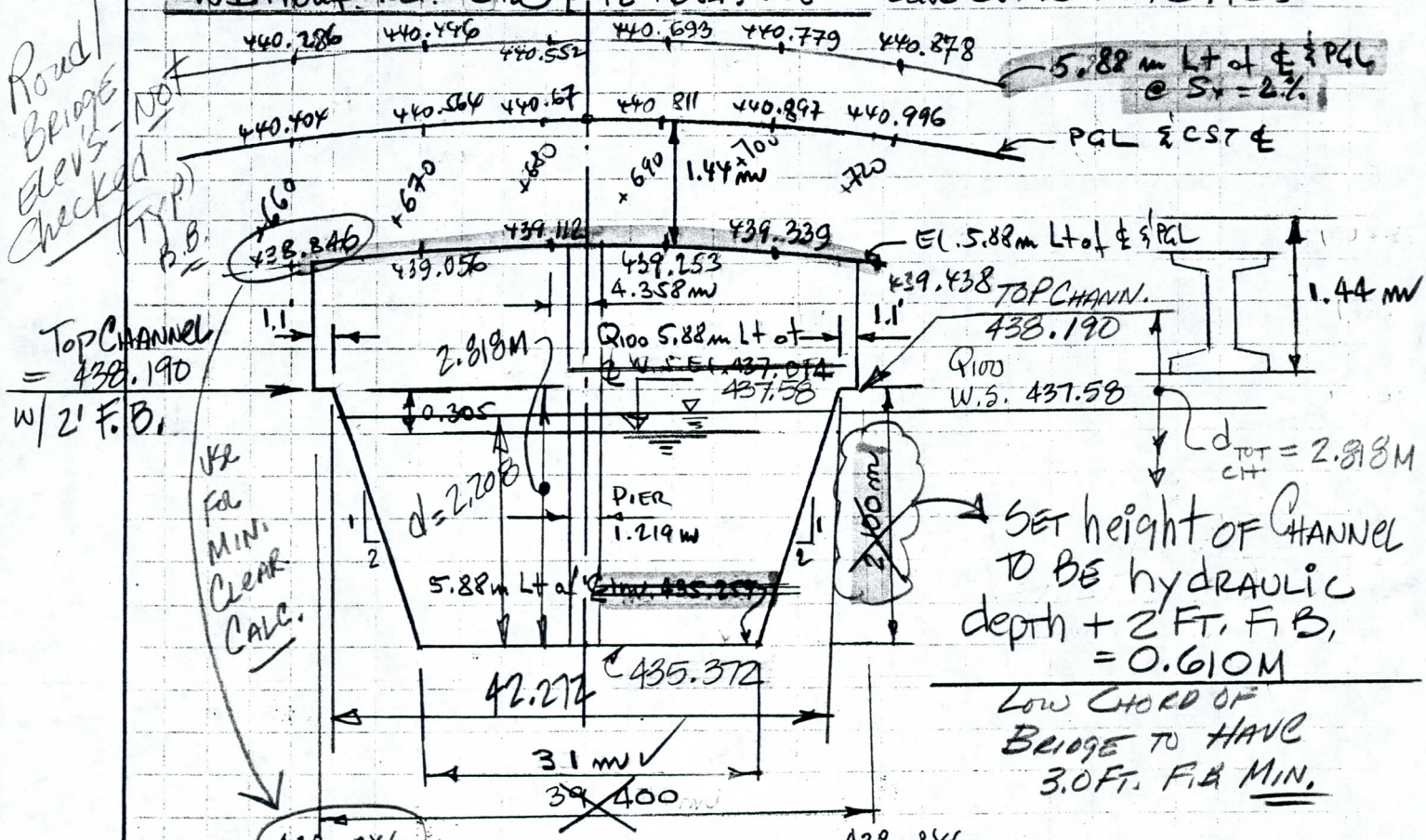
Checked by BOB B.

Date JUNE 25, 96

Subject PIMA FREEWAY - 101 Loop
BRIDGE CLEARANCE — CAVE CREEK WASH

RE-CHANNILIZED, UPSTM FACE, 10+374.015

WB Front. Rd. Sta. ℄ 42+684.538 - Cave Cr. 10+370.763



438.846
~~435.259~~ 435.372
~~3.587 m~~ = 11.77' > 10'
= 3.474 = 11.40 Ft. OK

TOTAL CLEARANCE

438.846
~~437.014~~ 437.58
~~1.832 m~~ = 6.01' > 3'
= 1.266 m = 4.15 Ft. > 3' OK

FREEBOARD

From HEC-2 Run: V = 2.16 m/s = 7.1 fps (OK)
F = 0.51 < 0.86 (OK)

See; File: CC1D.IN. ON 6/24/96 B.B.

Bridge Length = 50.6M
Overhang = 4.164 m/Side = 13.66 ft
(From Top Channel to ℄ Abt. Brg.

Parsons Brinckerhoff Computation Sheet

Page 2 of 6 | 110325

Made by M. Fulish

Date 3-15-96

Checked by Bob B.

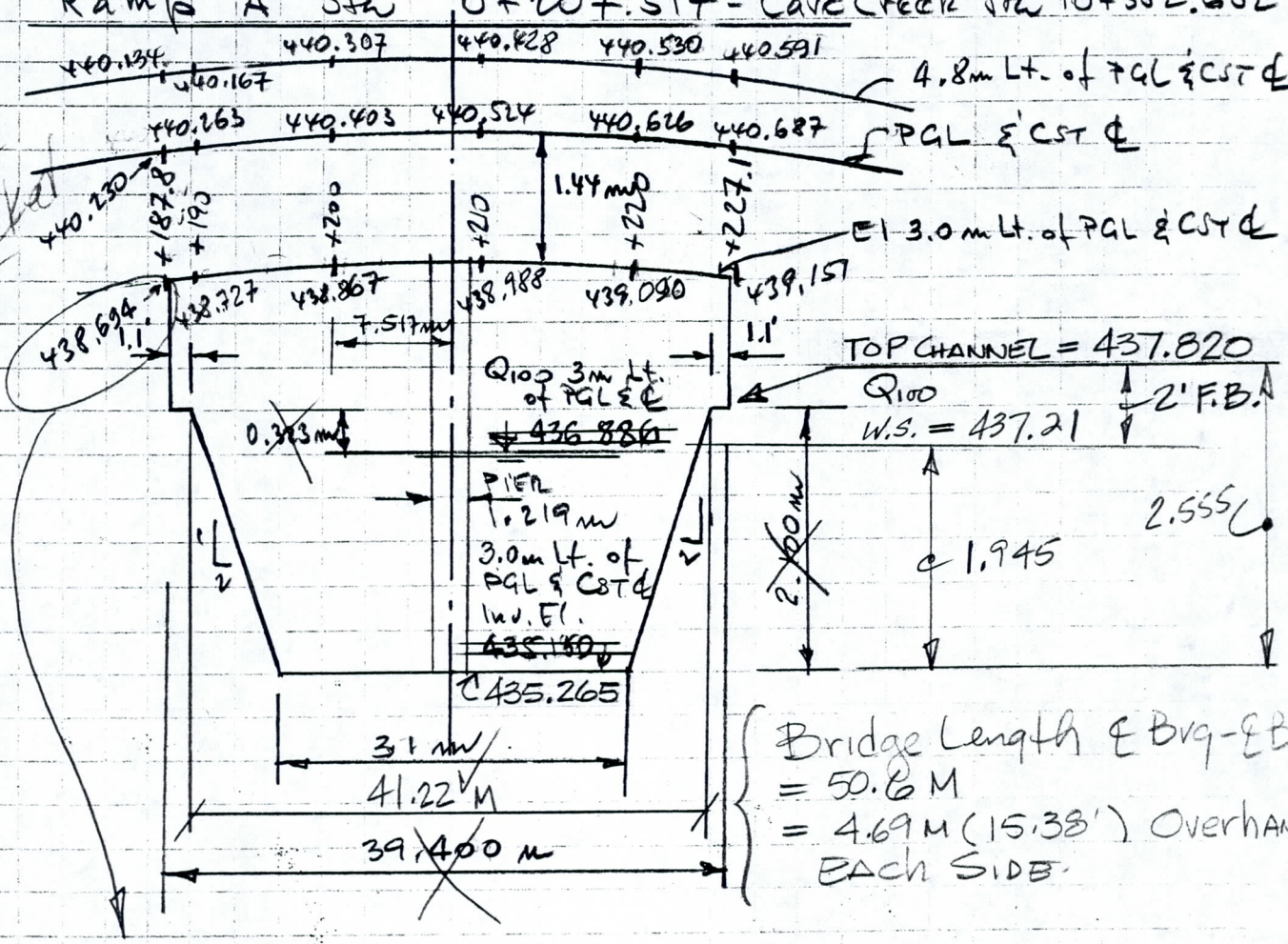
Date June 25, 96

Subject PIMA FREEWAY - 101 Loop
BRIDGE CLEARANCE — CAVE CREEK WASH

— RE-CHANNELIZED, UPST M. FACE, 10+356.1 —

Ramp A Sta 0+207.517 - Cave Creek Sta 10+352.602

Road & Bridge Elev's Not Checked P.B.



Bridge Length ℄ Brg - ℄ Brg
= 50.6 M
= 4.69 M (15.38') Overhang
EACH SIDE

438.694
− ~~435.150~~ 435.265
~~3.544 m~~ = 11.63' > 10'
= 3.429 M = 11.25' OK

TOTAL CLEARANCE

438.694
− ~~436.886~~ 437.21
~~1.808 m = 5.93'~~ > 3'
= 1.484 M = 4.87' > 3' OK

Freeboard

From HEC-2 RUN: V = 2.48 m/s = 8.14 fps
F = 0.62

Parsons Brinckerhoff Computation Sheet

Page 3 of 6 | 110325

Made by M. Fulish

Date 3-15-96

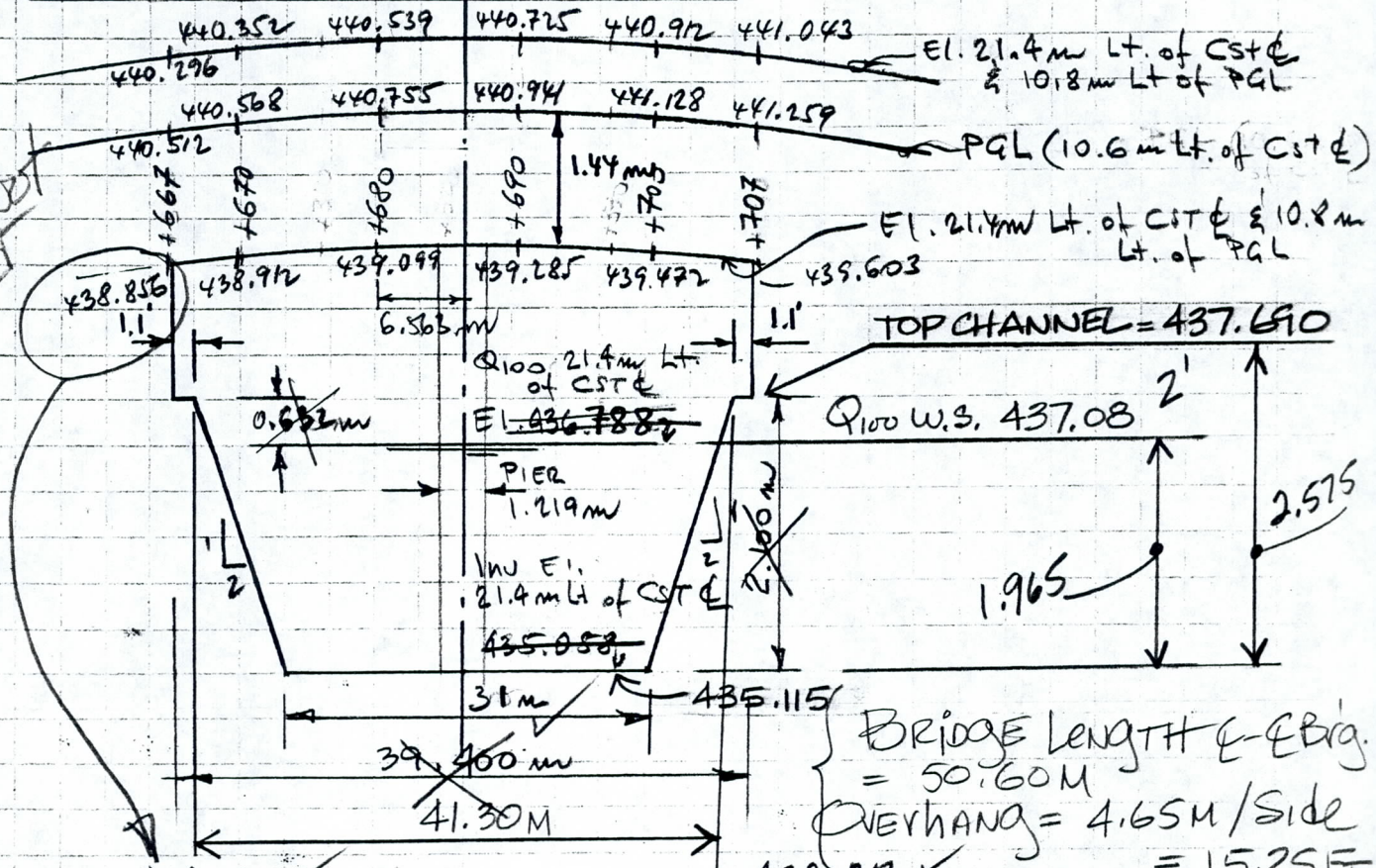
Checked by Bob B.

Date JUNE 25 96

Subject PIMA FREEWAY - 101 LOOP
BRIDGE CLEARANCE — CAVE CREEK WASH

Loop 101 M.L. Pier, Upst'm Inter. Pier, 10+331.2±
W.B ℄ Sta 42+686.563 - Cave Creek Sta 10+320.650

Road/Bridge Elev's Not Checked B.B.



BRIDGE LENGTH ℄-℄ Brg. = 50.60M
OVERHANG = 4.65M/Side = 15.25FT.

438.856
~~435.058~~ 435.115
~~3.798~~ m = 12.46' > 10'

= 3.741M = 12.27' OK

TOTAL CLEARANCE

438.856
~~436.788~~ 437.08
~~2.068m~~ = 6.78' > 3'

= 1.776M = 5.83' OK

FREEBOARD

From HEC-2: V = 2.43 M/S ≈ 8.0 fps
F = 0.61 OK < 0.86

Parsons Brinckerhoff Computation Sheet

Page 4 of 6 | 110325

Made by M. Fulish

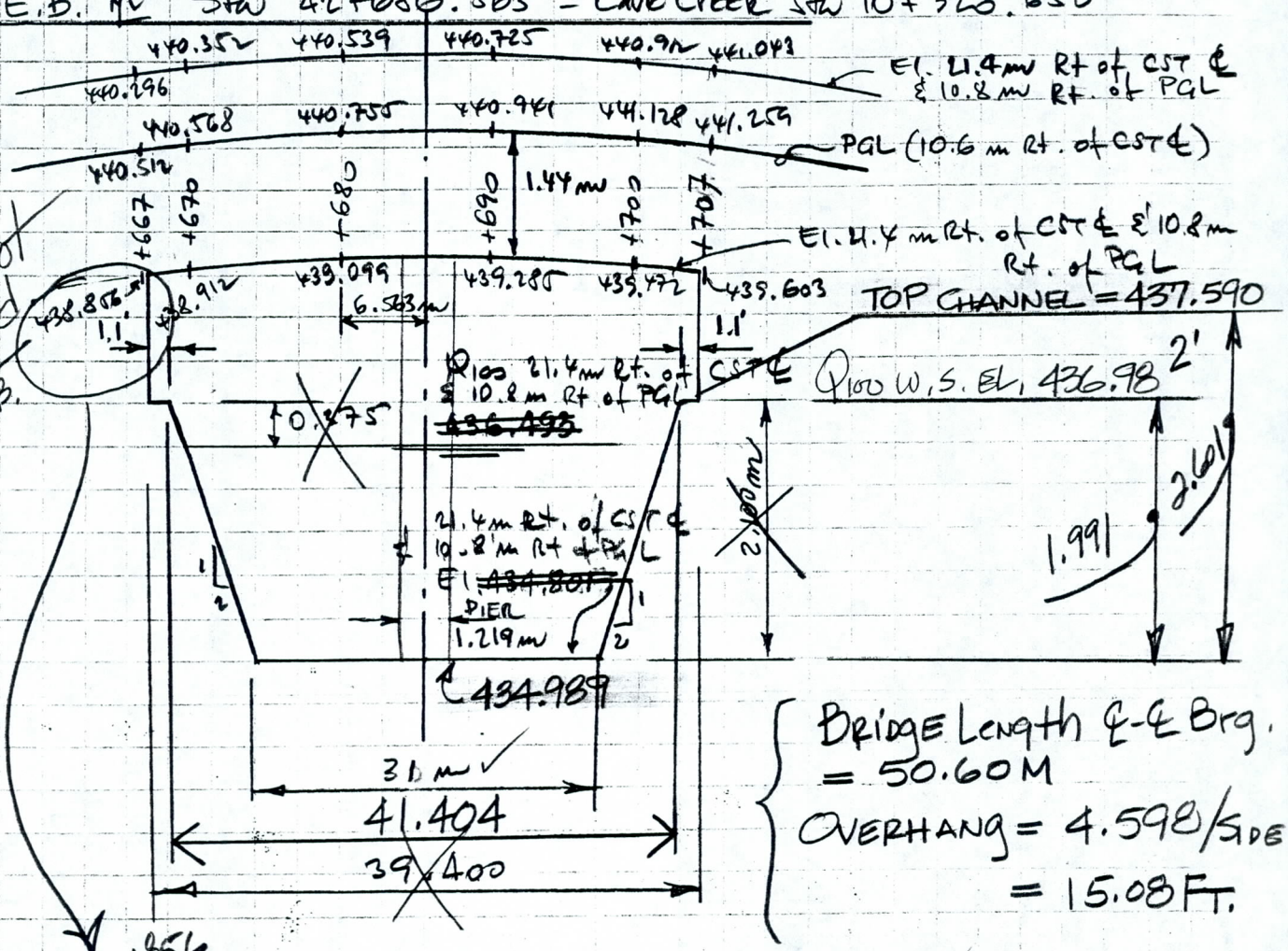
Date 3-15-96

Checked by BOB B.

Date JUNE 25, 96

Subject PIMA FREEWAY - 101 LOOP
BRIDGE CLEARANCE — CAVE CREEK WASH

LOOP 101 M.L. BRIDGE, DOWNSTM INTER PIER, 10+310.1 ±
E.B. ℄ STA 42+686.563 - CAVE CREEK STA 10+320.650



ROAD & BRIDGE ELEVS NOT CHECKED B.B.

BRIDGE LENGTH ℄-℄ BRG. = 50.60 M
OVERHANG = 4.598/SIDE = 15.08 FT.

438.856
~~434.801~~ 434.989
~~4.055m~~ = 13.304' > 10'
= 3.867 = 12.69' OK
TOTAL CLEARANCE

438.856
~~436.493~~ 436.98
~~2.363~~ m = 7.75' > 3'
= 1.876 = 6.16' OK
FREEBOARD

From HEC-2: V = 2.40 = 7.9 fps
F = 0.59

Parsons Brinckerhoff Computation Sheet

Page 5 of 6 | 110325

Made by M. Fulish

Date 3-15-96

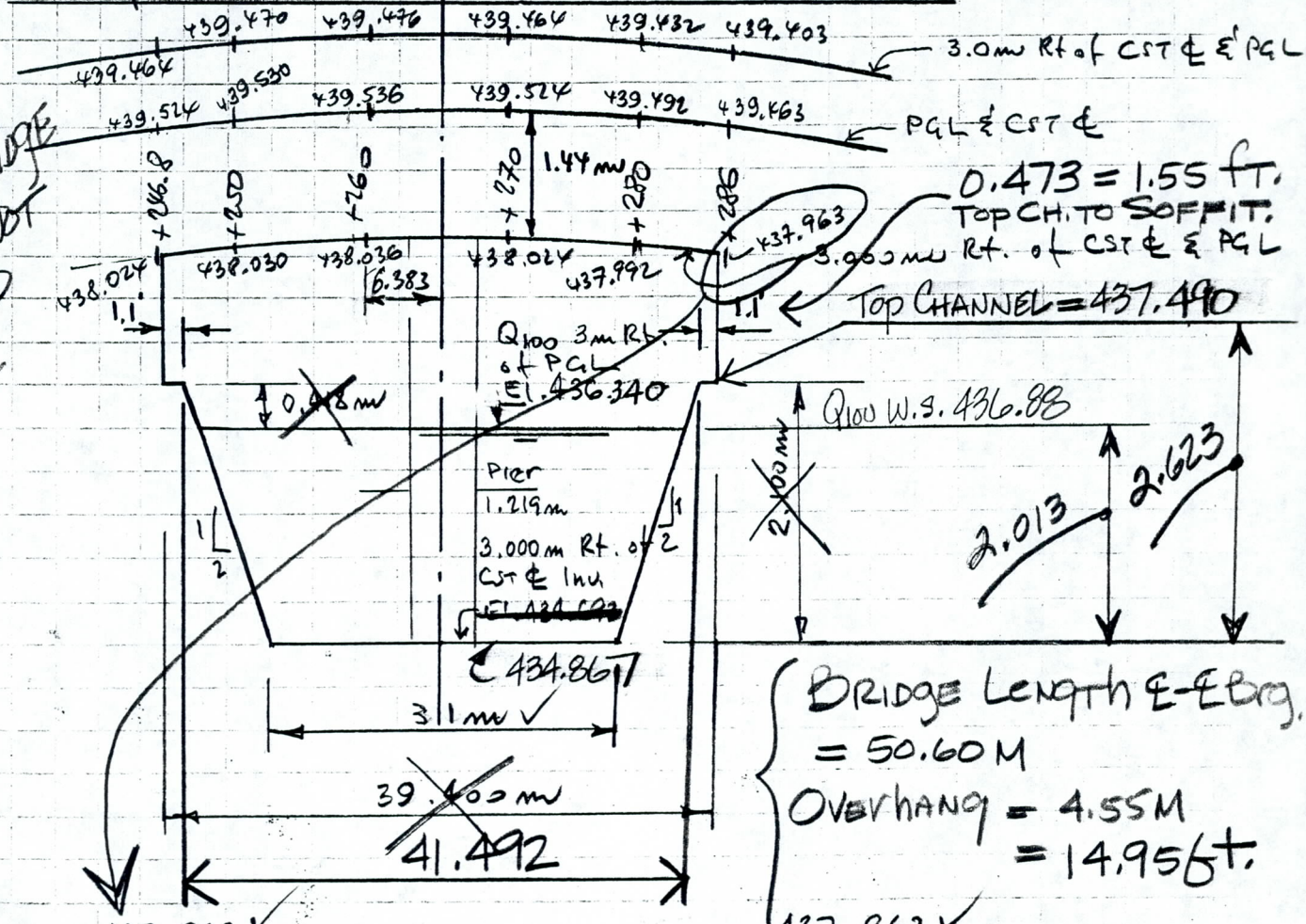
Checked by BOB B.

Date JUNE 25, 96

Subject PIMA FREEWAY - 101 Loop
BRIDGE CLEARANCE — CAVE CREEK WASH

RE-CHANNELIZED Upstm FACE, 10+289.8±

RAMP B Sta 0+266.383 - Cave Creek Sta 10+284.132



ROAD/BRIDGE ELEV'S. NOT CHECKED B.B.

0.473 = 1.55 ft. TOP CH. TO SOFFIT.

BRIDGE LENGTH ℄-℄ Brg. = 50.60 M

OVERHANG = 4.55M = 14.95 ft.

From HEC-2: V = 2.37 m/s = 7.78 fps

F = 0.58, OK

Parsons Brinckerhoff Computation Sheet

Page 6 of 6 | 110325

Made by M. Fulish

Date 3-15-96

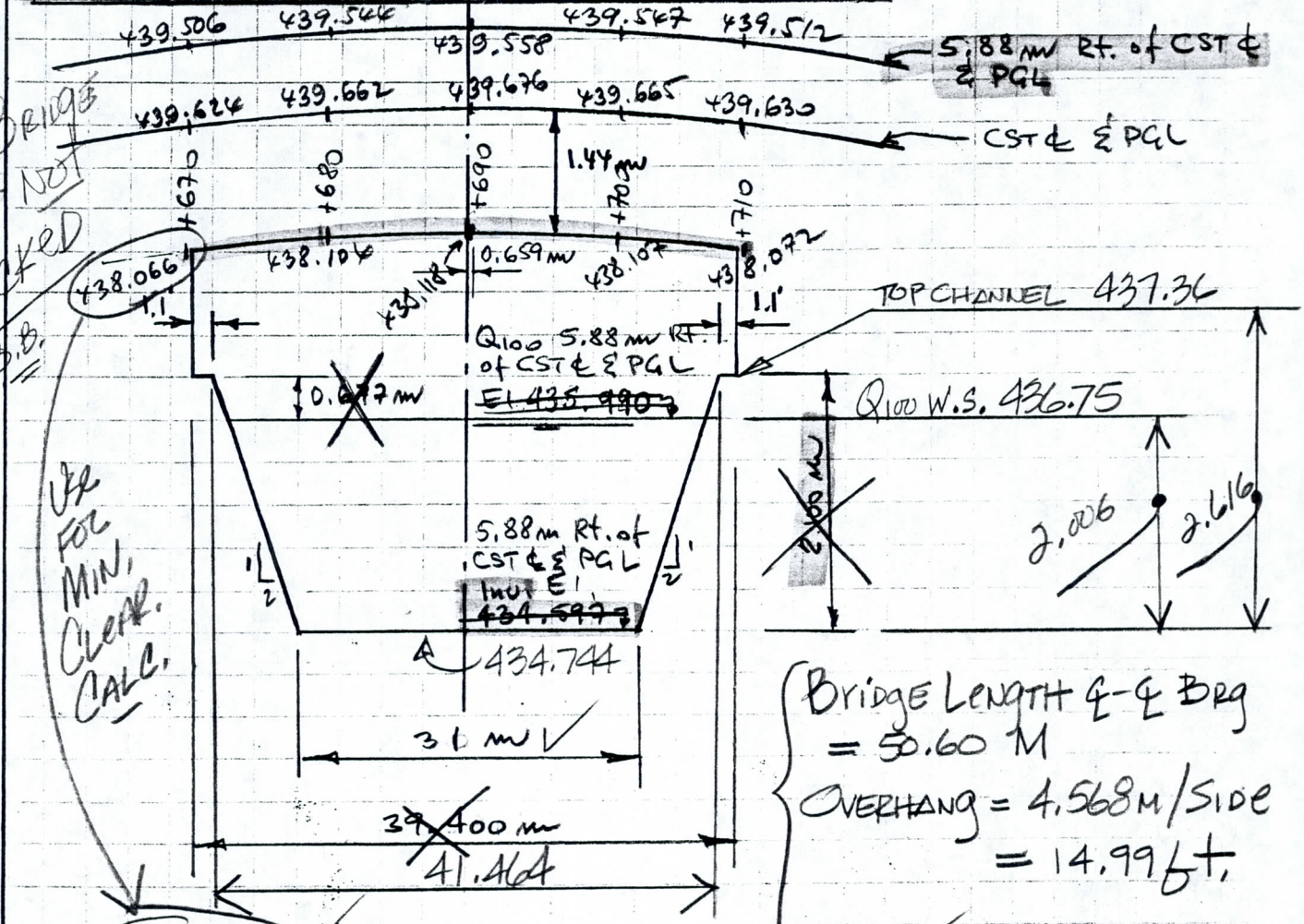
Checked by BOB D.

Date JUNE 25, 96

Subject PIMA FREEWAY - 101 LOOP
BRIDGE CLEARANCE — CAVE CREEK WASH

PRE-CHANNELIZATION UPST'M FACE = STA 10+269.341

E.B. Front Rd. Sta 42+689.341 - Cave Creek Sta 10+271.716



ROAD/BRIDGE ELEVS NOT CHECKED B.B.

USE FOR MIN. CLEAR. CALC.

Bridge Length ℄-℄ Brg = 50.60 M

Overhang = 4.568 M/Side = 14.99 ft.

438.066
~~434.597~~ 434.744
~~3.469~~ m = 11.38' > 10'

= 3.322 = 10.90' OK

TOTAL CLEARANCE

438.066
~~435.990~~ 436.75
~~2.076~~ m = 6.71' > 3'

= 1.316 M = 4.32' OK

FREEBOARD

From HEC-2:

V = 2.45 M/S = 8.038 fps

F = 0.61 OK

PART D SCOUR COMPUTATIONS

Parsons Brinckerhoff **Computation Sheet**

Page 0 of 4 | 110323

Made by BOB B.

Date JULY 01, 96

Checked by

Date

Subject RE-CHANNELIZATION OF CAVE CREEK WASH – SCOUR COMPUTATIONS

REFERENCE

RESULTS SUMMARY

100 YEAR FLOOD Q = 5500 cfs = 155.7 CMS	ABUTMENTS E & W	PIER
DEGRADATION	2.5'	2.5'
CONTRACTION SCOUR	0.5'	0.5'
BEND SCOUR	-0-	-0-
LOCAL SCOUR	6.5	13.5
TOTAL =	9.5 FT.	16.5 FT

* 500 YEAR SUPERFLOOD Q500 = 11,000 cfs = 311.5 CMS			
DEGRADATION	2.5'	2.5'	
CONTRACTION SCOUR	0.5'	0.5'	
BEND SCOUR	-0-	-0-	USE 18.5' MAX.
LOCAL SCOUR	9.5'	15.5'	
TOTAL	* 12.5'	18.5'	USE FOR ABUT. & PIERS

* NOTE: ADOT REQUIRES DESIGN SCOUR TO BE FOR THE 500YR – SUPERFLOOD EVENT. ALSO, POLICY FOR STRUCTURES IS TO DESIGN ABUTMENTS FOR THE SAME DEPTH AS PIERS WHEN ABUT. SCOUR COMPUTES LESS THAN PIER SCOUR.

Parsons Brinckerhoff **Computation Sheet**

Page 1 of 4 | 110325

Made by Bob B.

Date July 01, 96

Checked by

Date

Subject Re-Channelization of Cave Creek Wash — Scour Computations

Scour Computations will be done for the Q500, Superflood Event = 11,000 cfs or 311.5 cms in Accordance w/ ADOT Criteria

Reference: See Phone Corresp. w/ Amir Mohammadi @ FCDMC

Note: Pier Blockage has been Allowed for Both in Computing Water Surface Elev's. (HEC-2) And for Scour. Since Clear Spacing > 16 ft, 4 ft. will be Added to Pier. 4+4' = 8' total = 2.438 m →

Effective depth = 12' or = 3.65 m

The total Predicted Scour Depth Is = The Σ of:

1. Long term Aggradation / Degradation (qualitative analysis)
2. Contraction Scour
3. Local Bend Scour (if Applicable) — Not Applicable for Re-Alignment
4. Local Pier Scour
5. Local Abutment Scour.

Scour depths will be computed for 100 yr. and 500 yr. return periods — Even though Systems Design will be for the 500 yr. (Superflood) Event.

(1.) Long Term Degradation; Use 0.75 m or ≅ 2.5 ft. — 100 & 500 yr.

Since upstream Conditions are more Clear-Water in Nature due to Sanifill Installation of Rock Gabion Mattresses, The opportunity for a deficit in Sediment Supply Exist. This Alone would not be cause for great concern, But in addition the HEC-2 Model Reveals That Excessive Velocities occur Just 100 m Upstream of The W.B.F.R. Bridge (V = Almost 4 m/s) w/ Froude No's Approaching 1.0 or more, (See Section No's 10+472 Through 10+625)

Since the ADOT Installation will have Natural-Re-graded (Re-Channelized) Bottom w/ Bank Improvements Engineering Judgement Says we should account for Scour

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AGRA EARTH & ENVIRONMENTAL, INC.
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PHONE NO. (602) 272-6848
FAX NO. (602) 272-7239

TO: Bob Battistello, P.E.

COMPANY: PBQD

FAX NO.: 966-9234

SENDER: Keith Dahlen

FAX OPERATOR:

NO. OF PAGES: 2 (including this page)

FILE NO.: E95-35

DATE: 7/2/96

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Attached is adjusted gradation curve for C.C. Wash

Project No. 11032
Original To Central File
PM KM
Route To: B.B.

Remarks

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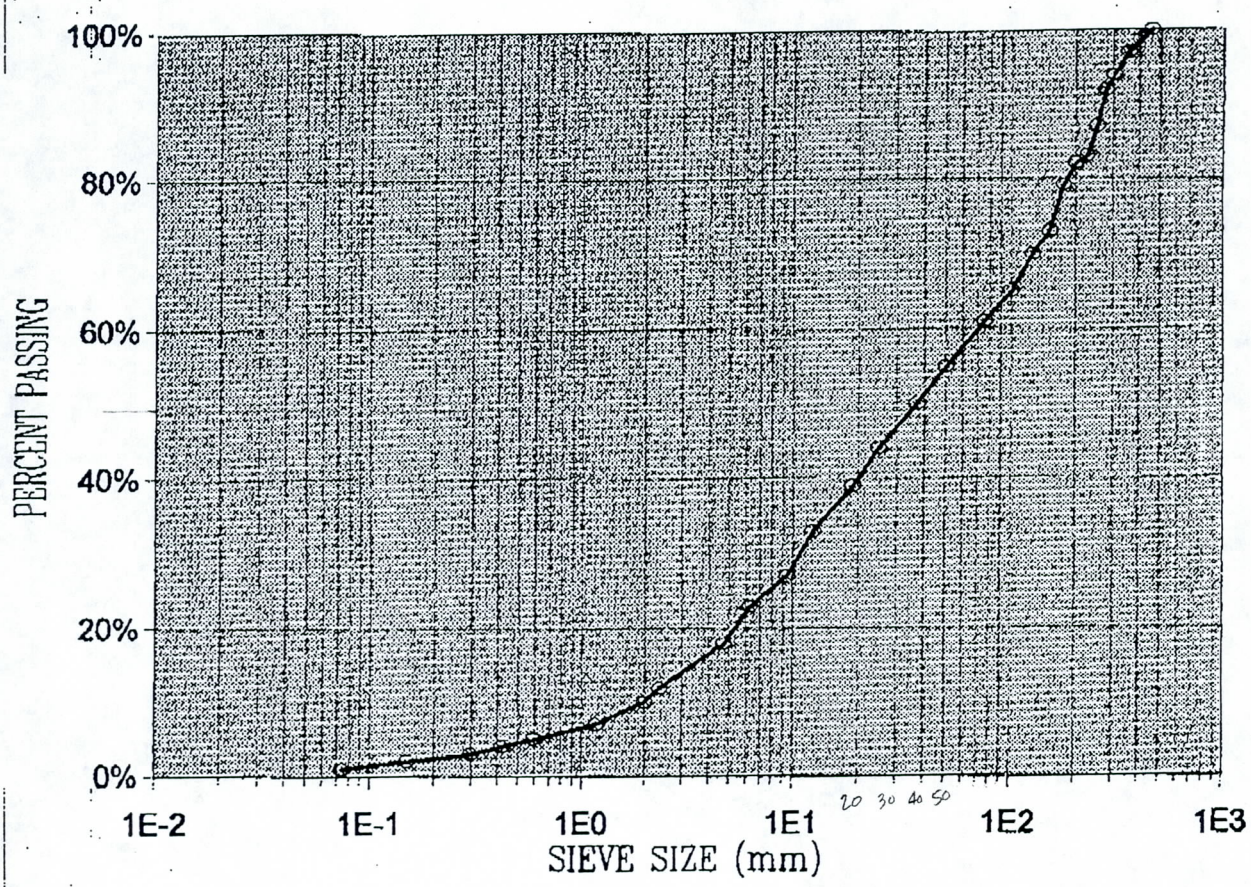

100%
80%
60%
40%
20%
0%
PERCENT PASSING
1E-2
1E-1
1E0
1E1
1E2
1E3
20 30 40 50
SIEVE SIZE (mm)

Subject Re-Channelization of Cave Creek Wash — Scour Computations

(2.) Contraction Scour:

Since the Flow Area of the Stream Is Only decreased By the Pier Width (4'ϕ) + 4' For debris blockage (Tot. = 8 Ft. or 2.44 m) — We Would expect Contraction Scour to be minimal.

Reference: → Since it a man-made channel, Both Upst'm & Downst'm. X-Sect's

Since velocities are high and sediment will be carried downstream — Live Bed Conditions Exist @ the Bridge

∴ Use the Modified Larson Equation Per HEC-18 Guidelines-

$$\frac{y_2}{y_1} = \left(\frac{Q_2}{Q_1}\right)^{6/7}\left(\frac{W_1}{W_2}\right)^{K_1}\left(\frac{n_2}{n_1}\right)^{K_2}$$ and $y_s = y_2 - y_1$ = (Ave. Scour depth)

(a.) 100 yr. Contraction Scour:

Calc. V_*/ω = To Compute K_1 Value Range V_* = Shear Vel. in Upst'm Sect.

Est. Bed Mat'l, D_{50} Size to be = 20 mm

From Fig. 3 ω, Fall Vel. ≅ 1.35 fps (Extrapolate from graph)

$\omega = 1.35$ "

Now $V_* = (g y_1 S_1)^{1/2} = (32.2 \times 6.35\text{ft.} \times 0.00477)^{1/2}$

$V_* = 0.988$ fps.

Now, $\frac{V_*}{\omega} = 0.988/1.35 = 0.73$ From Table Bot. Pg. 10 — See HEC-18

Falls in Range 0.5 to 2.0

So. $\frac{y_2}{y_1} = \left(\frac{Q_2}{Q_1}\right)^{6/7}\left(\frac{101.7}{93.7}\right)^{0.64}\left(\frac{0.039}{0.045}\right)^{0.21}$ ($Q_2/Q_1 = 1$) $K_1 = 0.64$ & $K_2 = 0.21$

$\frac{y_2}{y_1} = 1.023$ So, $y_2 = y_1(1.023) = 6.35(1.023) = 6.50$

$y_{s\,(100\,yr.)} = 6.50 - 6.35 = 0.15$ ft. Use 0.5 Ft. — Conserv.

(b.) 500 yr. Contraction Scour: Since $Q_1 = Q_2$ (No Spill out) only W_1, W_2, n_1 & n_2 Control. Therefore 100 yr & 500 yr. Scour Are the Same.

Contraction Scour.	100 yr. = 0.50' = 0.152 m
	500 yr. = 0.50' = 0.152 m

3. The Manning's n ratio can be significant for a condition of dune bed in the channel and a corresponding plane bed, washed out dunes or antidunes in the contracted channel. However, Laursen's equation does not correctly account for the increase in transport that will occur as the result of the bed planing out (which decreases resistance to flow, increases the velocity and the transport of bed material at the bridge). That is, Laursen's equation indicates a decrease in scour for this case, whereas in reality, there would be an increase in scour depth. In addition, at flood flows, a plane bedform will usually exist upstream and through the bridge waterway, and the values of Manning's n will be equal. Consequently, the n value ratio is not recommended or presented in the recommended Equation 16.

4. W_1 and W_2 are not always easily defined. In some cases, it is acceptable to use the top width of the main channel to define these widths. Whether top width or bottom width is used, it is important to be consistent so that W_1 and W_2 refer to either bottom widths or top widths.

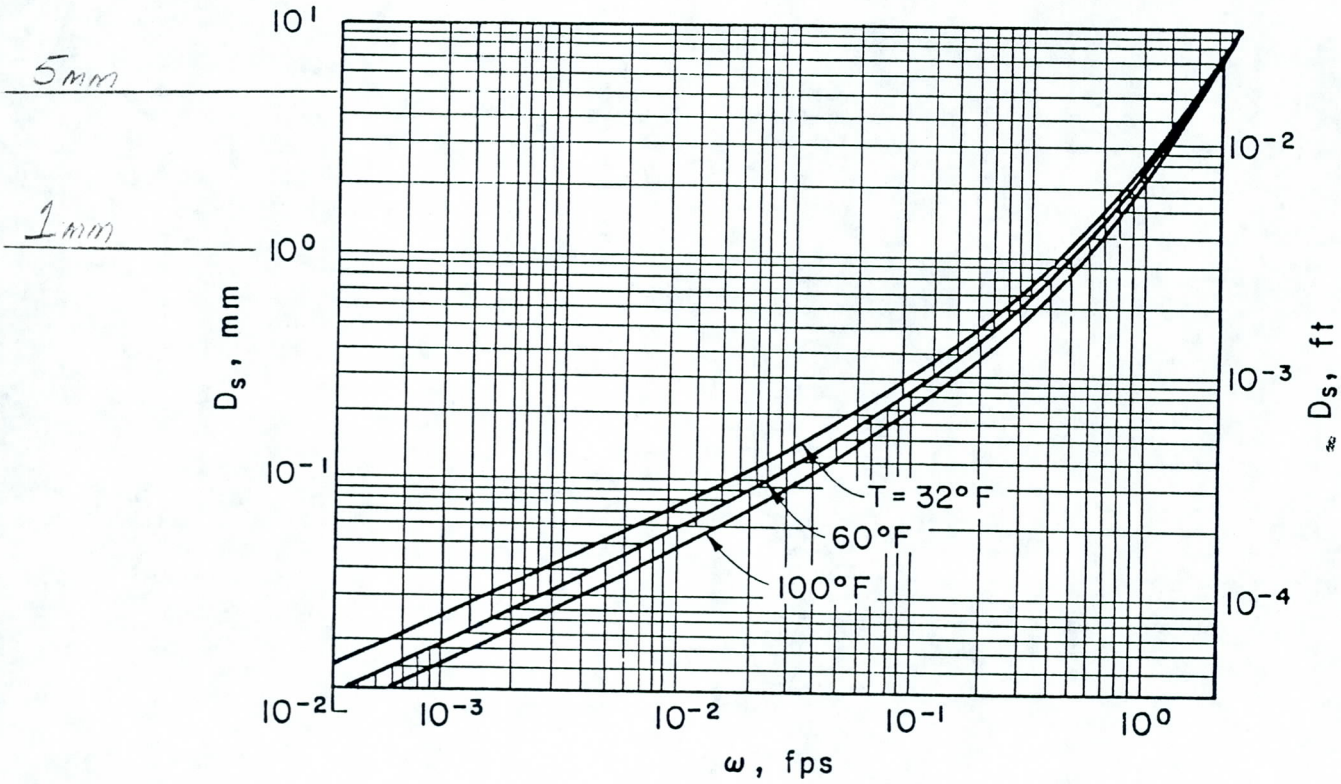


Figure 3. Fall Velocity of Sand-Sized Particles.

REFERENCE

(3.) LOCAL BEND SCOUR = 0, NOT APPLICABLE SINCE CHANNEL WILL BE RE-ALIGNED.

(4.) LOCAL PIER SCOUR USE CSU EQUATION - PER HEC-18

$$\frac{y_s}{y_1} = 2.0 K_1 K_2 K_3 \left(\frac{a}{y_1}\right)^{0.65} FR^{0.43}$$ (LIVE-BED APPLIES).

USE HEC-2 X-SECT. 10+374 @ THE UPST'M FACE OF THE W.B.F.R. BRIDGE (INTERIM COND. CONTROLS) → YIELDS HIGHEST V, FROUDE NO. SEE HEC-2 FILE: CCIC.IN

(a.) FOR 100 YR EVENT FOR $F \le 0.8$, $\frac{y_s}{a} \le 2.4$ ROUND (NOSE PIERS)

y_1 = DEPTH FLOW UPST'M. = 1.86

F = = 6.10 FT.

y_s 100 YR. = $6.10(2.0 \times 1.0 \times 1.0 \times 1.1)\left(\frac{8}{6.10}\right)^{0.65}(0.66)^{0.43}$

y_s 100 YR = 13.39 USE 13.5 FT.

y_s 100 YR = 13.5 FT ; $\frac{y_s}{a} = \frac{13.5}{8} = 1.69 < 2.4$, OK

USE 4' FOR DEBRIS BLOCKAGE + 4' PER WIDTH

(b.) FOR 500 YR. EVENT $F = 0.65$

$y_1 = 2.84 = 9.32$ FT.

$a = 4' + 4' = 8'$

y_s 500 YR. = $9.32(2.0 \times 1.0 \times 1.0 \times 1.1)\left(\frac{8}{9.32}\right)^{0.65}(0.65)^{0.43}$

y_s 500 YR = 15.43 USE 15.5 FT

y_s 500 YR. = 15.5 FT ; $\frac{y_s}{a} = \frac{15.5}{8} = 1.93 < 2.4$, OK

FOR LOCAL PIER SCOUR: W/ 4' DEBRIS BLOCKAGE @ PIERS

y_s 100 YR = 13.5 FT.

y_s 500 YR = 15.5 FT.

SEE PG. 4 FOR ABUTMENT SCOUR

(5.) Local Abutment Scour

REFERENCE

In Accordance w/ HEC-18 the Froehlich Equation for Live-Bed Scour @ Abutments will be used.

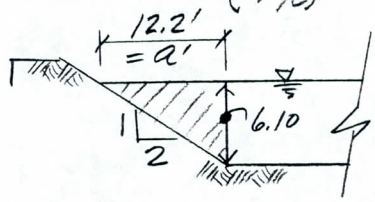
HEC-2 X-Sect. No. 10+374 @ the Upstream Face of the W.B.F.R. Bridge will be used (for Interim Cond's.) as Controling Sect w/ highest Froude No.

SEE FILE: CC1C.IN - HEC-2

- Abut. is Spill Through Type: e.g. $K_1 = 0.55$

$$\frac{ys}{ya} = 2.27 K_1 K_2 \left(\frac{a'}{ya}\right)^{0.43} Fr^{0.61} + 1 \qquad K_2 = \left(\theta/90\right)^{0.13} = 1.0 \quad = 0^\circ$$

∡ Attack



(a.) For 100 yr. Event

$F = 0.66$

$d = 1.86M$
$= 6.10 FT.$

$ya = \frac{Ae}{a'}$ where Ae = Area

ya = Ave depth.
$= 6.1/2 = 3.05$ Ft.

$$ys_{100yr.} = 3.05\left(2.27 \times 0.55 \times 1.0\right)\left(\frac{12.2}{3.05}\right)^{0.43}(0.66)^{0.61} + 1$$
$= 6.37$, Use 6.5.

Fig. 67 HEC-18

$ys_{100yr} = 6.5$ Ft.

(b.) For 500 yr. Event

$F = 0.65$ $\quad a' = 18.64'$

$d = 2.84M$
$= 9.32 FT.$

$ya = \frac{18.64(9.32)}{(2)18.64} = 4.66$ Ft.

$$ys_{500yr.} = 4.66\left(2.27 \times 0.55 \times 1.0\right)\left(\frac{18.64}{4.66}\right)^{0.43}(0.65)^{0.61} + 1$$

$ys_{500yr} = 9.12$, Use 9.5 Ft.

$ys_{500yr} = 9.5$ Ft.

Local Scour @ Abutments and for Toe of Bank Protection
(Either – Side – Man Made)

$ys_{100yr} = 6.5 FT = 1.98M$
$ys_{500yr} = 9.5 FT = 2.90M$

PART E BANK PROTECTION / STABILIZATION

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PHONE NO. (602) 272-6848
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TO: Bob Battistello, P.E.

COMPANY: PBQD

FAX NO.: 966-9234

SENDER: Keith Dahlen

FAX OPERATOR:

NO. OF PAGES: 7 (including this page)

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DJH
JRD
BJB

Remarks

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Earth & Environmental

16 July 1996
AEE Job No. E95-35
Report No. 5
Addendum No.1

Parsons Brinckerhoff Quade
& Douglas, Inc.
1501 West Fountainhead Parkway
Suite 400
Tempe, Arizona 85282

DRAFT

Attention: **N. Ali Seyedmadani, Ph.D., P.E.**
Lead Structural Engineer

Gentlemen:

RE: INTERIM DESIGN OF THE PIMA FREEWAY
I-17 FREEWAY TO 56TH STREET
ECS CONTRACT NO. 95-18
TRACS NO. H 3565 01D
PHOENIX, ARIZONA

Pursuant to the request of Robert Battistello, P.E., of Parsons Brinckerhoff Quade & Douglas, Inc. (PBQD), we have reviewed our Stabilization Design Report No. 5 dated 26 June 1996 for the above referenced project with respect to using riprap for temporary stabilization of channel embankments in lieu of soil-cement stabilization. Mr. Battistello indicated that even at relatively low design compressive strengths, the soil-cement would be difficult to remove in areas where new bridges ultimately will be constructed. At relatively high design flow velocities of about 3 meters per second (m/s), however, the methods for stabilization become more limited. Mr. Battistello requested that for the interim condition, riprapped embankments constructed at a 2H:1V (horizontal to vertical) slope be considered as an alternative. It is understood that soil-cement may still be considered for use as a permanent stabilization technique following construction of the ultimate bridges.

Included herein is a discussion relative to the use of and stability of riprapped slopes and design recommendations for riprap utilizing a geotextile filter. Also included are preliminary design recommendations for a grade control structure being considered downstream of the Cave Creek Wash bridge sites. A grain-size distribution curve for use in determination of scour estimates, is also attached. The curve is based on the compilation of samples collected within Cave Creek Wash during this project. Estimates of oversize materials (larger than 0.15 meters) are based on visual inspection of surficial materials in the vicinity of the proposed bridges.

1.0 EMBANKMENT STABILIZATION (RIPRAP)

Mr. Battistello indicated that due to various constraints, a 2H:1V channel side slope configuration (or steeper) is required for the section of Cave Creek Wash in the near vicinity of the new bridge structures. According to Maynord, (1978)*, riprapped slopes of 2H:1V can be utilized although 3H or 4H:1V slopes are more common. The required sizing of riprap materials and appropriate thickness of the riprap layer are based on methods presented in Maynord (1978) and Soil
Conservation Service (1983). Based on a design flow velocity of about 3 m/s, a channel side slope of 2H;1V, and an assumed channel depth of 3.7 meters, a D50 size of 0.25 m is determined. However, based on the Arizona Department of Transportation (ADOT) Design Procedures Manual (1989), a D50 size of 0.30 m is recommended. The minimum thickness of the riprap blanket calculated as the larger of 2D50 or 1.5D100. The gradation of the material to be used for riprap recommended in the Design Procedures Manual is as follows:

Particle Size (meters)	% Passing by Weight
0.60 (24 inches)	100
0.45	70 - 85
0.30	30 -50
0.20	5 - 15
0.10	0 - 5

From the above gradation, the larger of 2D50 or 1.5D100 is 0.90 m. Due to scour conditions, the riprap blanket must be buttressed in beneath the predicted depth of scour on the floor of the channel. It is recommended that the blanket be extended onto the channel floor bottom a minimum distance of 3.0 m. The layout of the riprap blanket is shown on the attached Figure 1. In order to prevent piping of the finer grained embankment soils through the open graded riprap materials, either a sand filter or a geotextile separation fabric should be provided between the riprap and the underlying materials.

A high survivability non-woven geotextile fabric as described in Section 1014 of the ADOT Standard Specifications for Road and Bridge Construction (ADOT, 1990) is recommended. The fabric should be secured at both the high and low ends within anchor trenches. A sand

*References are listed at the end of this letter.

filter layer could also be utilized to prevent piping however the fabric is likely less expensive and is easier to place on relatively steep slopes.

Sources for riprap in the general vicinity of the project site are unknown. Riprap materials and placement should conform to Section 913 of ADOT (1990). In general, the rock must be angular in shape, sound and durable and have a specific gravity of more than 2.4. The less weathered granite materials present in Union Hills to the east of the site likely would be suitable for use, if available.

Preliminary stability analysis using the computer program STABL5 (Carpenter, 1995) indicates that slopes of 2H:1V should remain stable (safety factor above 1.5) with the possibility of localized shallow surface failures immediately following storms due to drawdown conditions. In that regard soil-cement embankments would be more stable. Deep seated circular failures, that would cause the greatest damage are not anticipated for rapid drawdown conditions. Safety factors of more than 2.0 are determined for deep seated conditions.

2.0 GRADE CONTROL STRUCTURE

Grade control structures take the direct impact of flood waters and the materials transported. Concrete, either in the form of cast-in-place concrete, roller-compacted concrete or soil-cement stabilized alluvium (CSA) is typically used. Considering cost of the above described materials, and the fact that CSA likely will be used for the permanent treatment of embankment slopes at the bridges, CSA is recommended for use in the grade control structure. Material prices for both concrete and roller compacted concrete would be considerably more expensive than CSA as on-site materials could be used for CSA. Onsite materials could likely also be used for roller compacted concrete, however particles larger than about 40 mm would not be acceptable generating considerable waste.

Whatever material is utilized, the grade control structure should be constructed with a sloping upstream and downstream face. The base of the structure should extend a minimum of 1.0 m below the predicted depth of scour. The top width of the structure should be a minimum of 2.5 m with a bottom width sufficient to assure stability. The ends of the structure should either be extended upstream to channelize the water approaching the structure or be extended outward from the wash banks a sufficient distance to prevent blowout around the ends.

A relatively high design compressive strength would be required versus low 7-day compressive strength of 2,500 kilo Pascals (kPa) recommended for the embankments in Section 6.2 of Report No. 5. It is recommended that the CSA be designed to achieve a minimum 7-day compressive strength of 10,000 kPa. Construction quality control will be important relative to the success of the structure. Adequate bonding of successive CSA layers must be achieved as flood waters tend to lift slabs. It may be beneficial to place a layer

of shotcrete on the downstream face of the CSA to limit the potential for lifting of CSA lifts. Such a treatment could be utilized, if during inspection of the completed down stream face, unsuitable areas are observed.

Should you have any questions concerning the recommendations presented in this report, please do not hesitate in contacting us.

Respectfully submitted,

AGRA Earth & Environmental, Inc.

Reviewed by:

Keith H. Dahlen, P.E.
Senior Engineer

Nicholas J. LaFronz, P.E.
Senior Engineer

c: Addressee (9)
jgAJ96-2\7-15-96

REFERENCES

Arizona Department of Transportation (ADOT), 1989, Design Procedures Manual, November.

Arizona Department of Transportation (ADOT), 1990, Standard Specifications for Road and Bridge Construction.

Maynord, S.E., 1978, Practical Riprap Design, U.S. Army Waterways Experiment Station, Vicksburg, Mississippi, AD/A-058 837, June.

Soil Conservation Service, 1983, Riprap for Slope Protection Against Wave Action, Technical Release No. 69, February.

Sheet ____ of ____
Date: ____
By: ____
Ch. By: ____
Job/Proj. No. ____

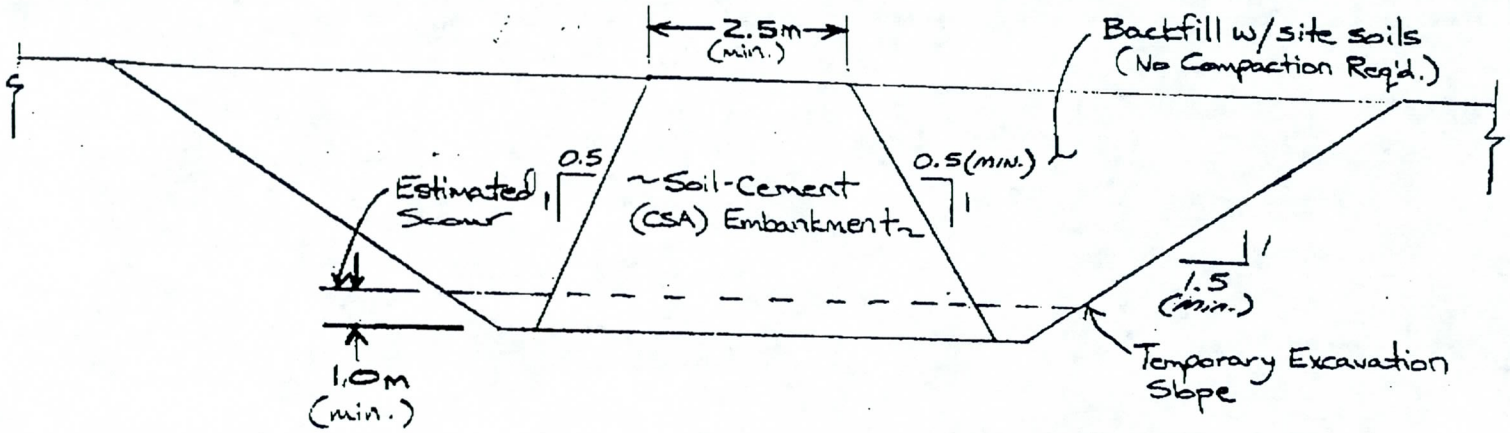

Figure 1

TYPICAL CSA EMBANKMENT
DETAIL FOR GRADE
CONTROL STRUCTURE

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COMPANY: PBQD

FAX NO.: 966-9234

SENDER: Keith Dahlen

FAX OPERATOR:

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Prel stability calcs indicate stable channel @ 2H:1V. and riprap can be used as shown on attached pages. I'll put letter together ASAP. Any thoughts - pls call

Thanks!
Keith

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Sheet ___ of ___
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Bob -

Calcs indicate that for:

$V = 11$ ft/s
$d = 12'$ (depth of water)
$S = 2H:1V$

$$F = \frac{V}{\sqrt{g \cdot d}} = \frac{11 \text{ ft/s}}{\sqrt{32.2 \text{ ft/s}^2 \cdot 12 \text{ ft}}} = 0.56$$

Fig 4-1 (Practical Riprap Design, 1978) for 2H:1V slope

$$\frac{D_{50}}{\text{depth}} = 0.07$$

For depth = 12'; $D_{50} = .84' = 10''$

From (Riprap for Slope Protection Against Wave Action, 1983)

Min Thickness = $2D_{50}$; = 20" ∴ use 2.0'

For gradation use

Particle size	% Passing by Weight
20"	100
18"	85-100
14"	50-75
11"	15-40
6"	0

* Will need high survive geotextile beneath riprap

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Date: 7/8/96
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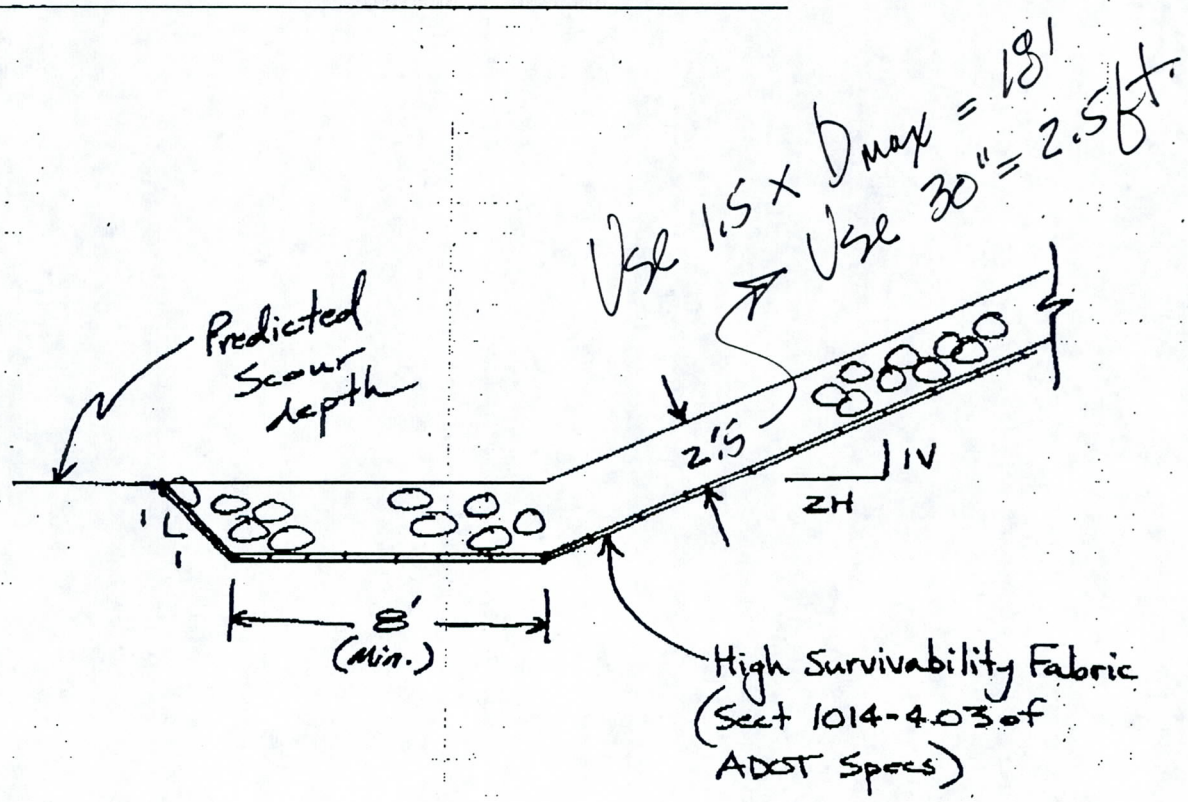

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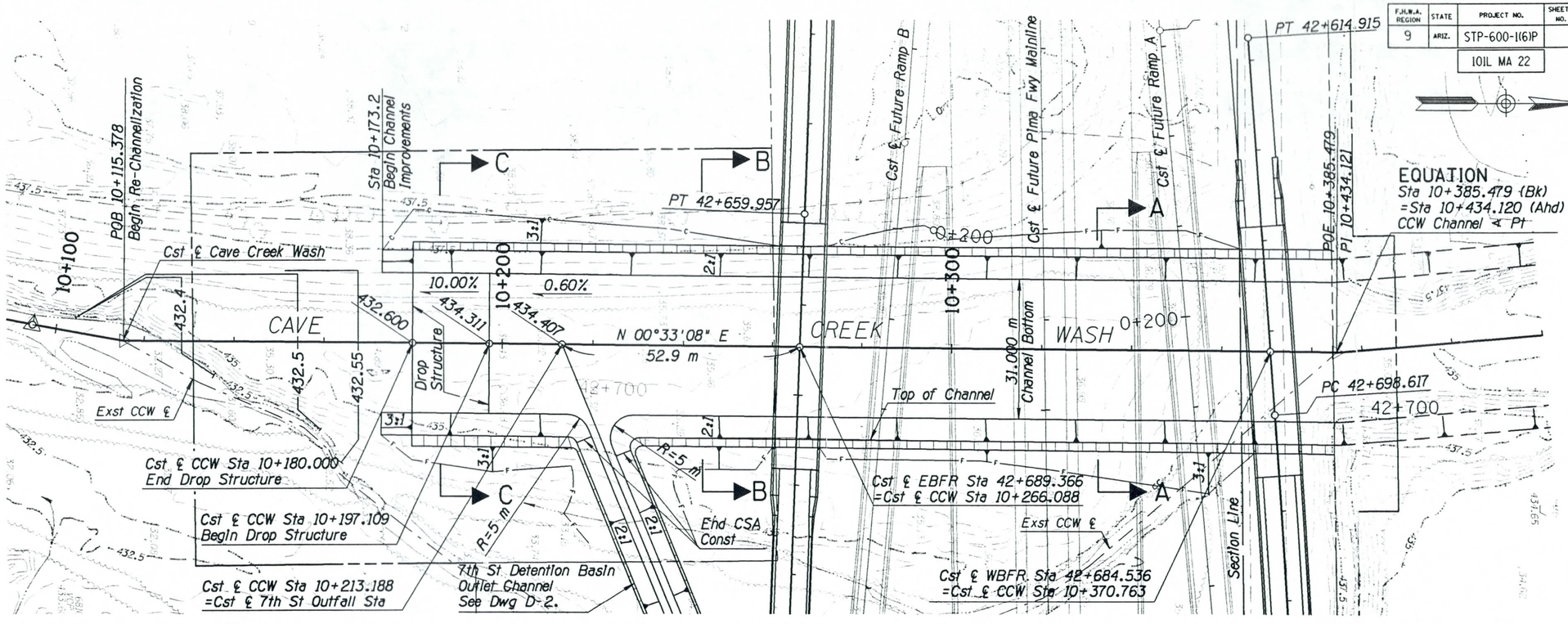
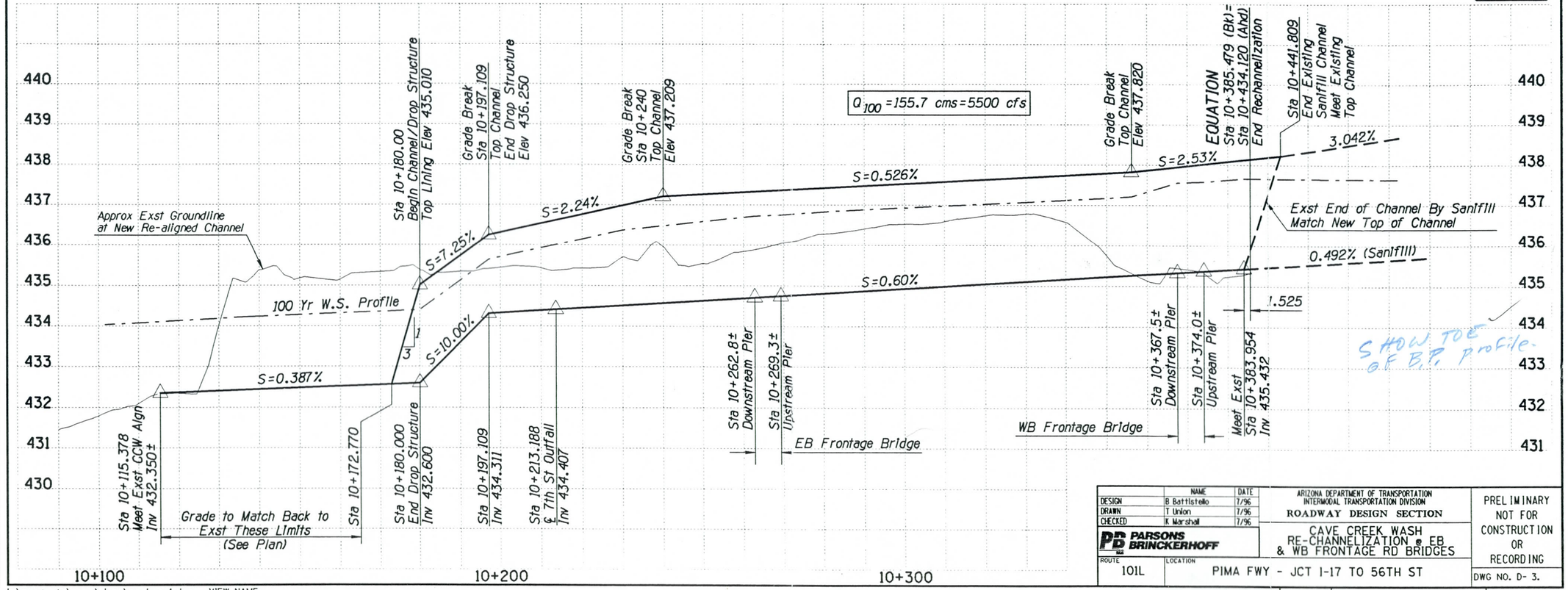
PRELIMINARY PLANS

PART F RE-CHANNELIZATION PLANS

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
9	ARIZ.	STP-600-1(6)P			
		101L MA 22			





SHOW TOE OF B.P. profile.

	NAME	DATE
DESIGN	B Battistello	7/96
DRAWN	T Union	7/96
CHECKED	K Marshall	7/96

PARSONS BRINCKERHOFF

ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
ROADWAY DESIGN SECTION

CAVE CREEK WASH
RE-CHANNELIZATION @ EB & WB FRONTAGE RD BRIDGES

ROUTE 101L
LOCATION PIMA FWY - JCT I-17 TO 56TH ST

PRELIMINARY NOT FOR CONSTRUCTION OR RECORDING

DWG NO. D- 3.

TRACS NO. H 3565 01C | STP-600-1(6)P | ___ OF ___

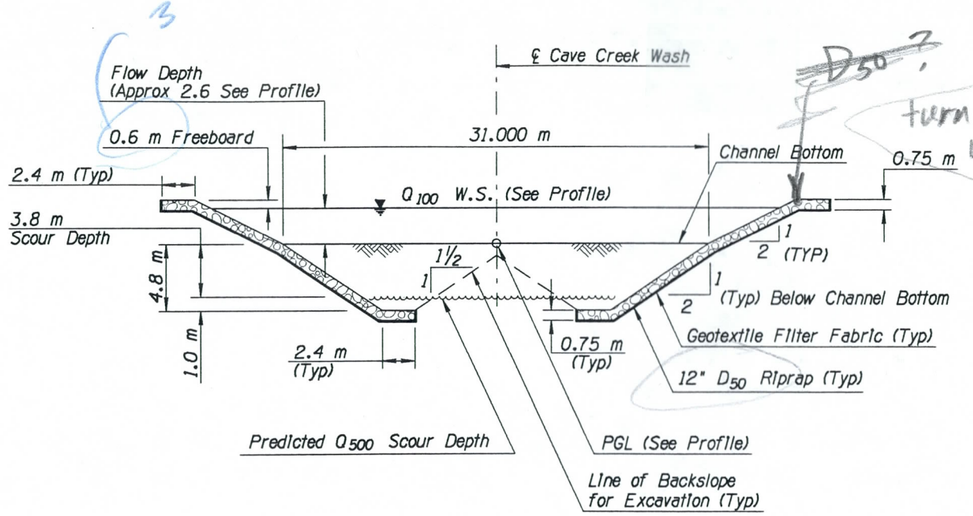
SURVEY NO. | FINISHED PLANS | REVISIONS | LOCATION | DATE

CALL TWO WORKING DAYS BEFORE YOU DIG 263-1100 WITHIN MARICOPA COUNTY

Metric

h:\projects\pima\drng\ppchccw1.dgn VIEW NAME:
Tue Jul 23 11:46:43 1996

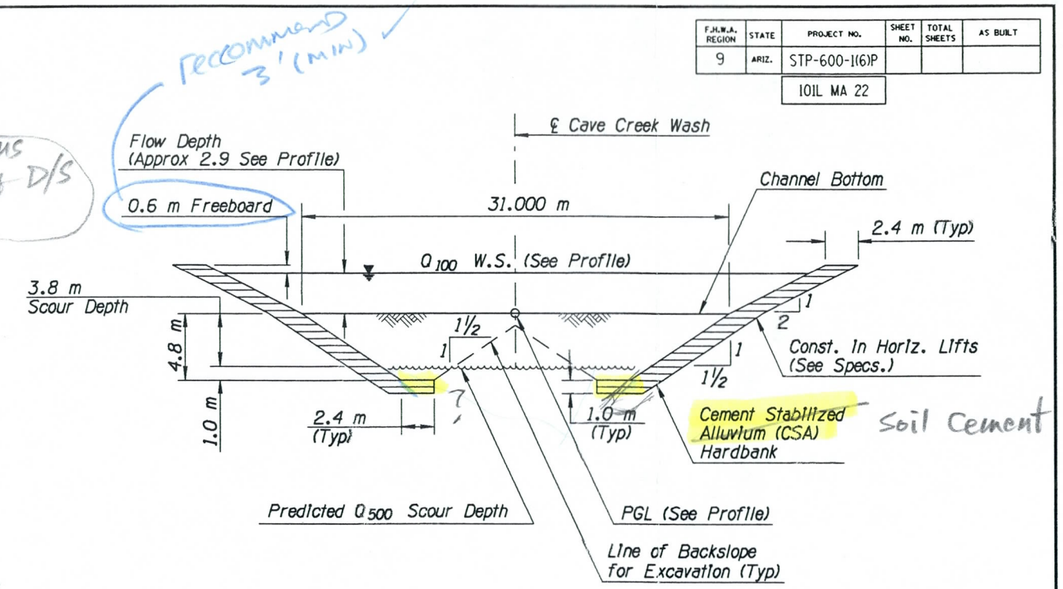
F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
9	ARIZ.	STP-600-1(6)P			
		101L MA 22			



SECTION A-A

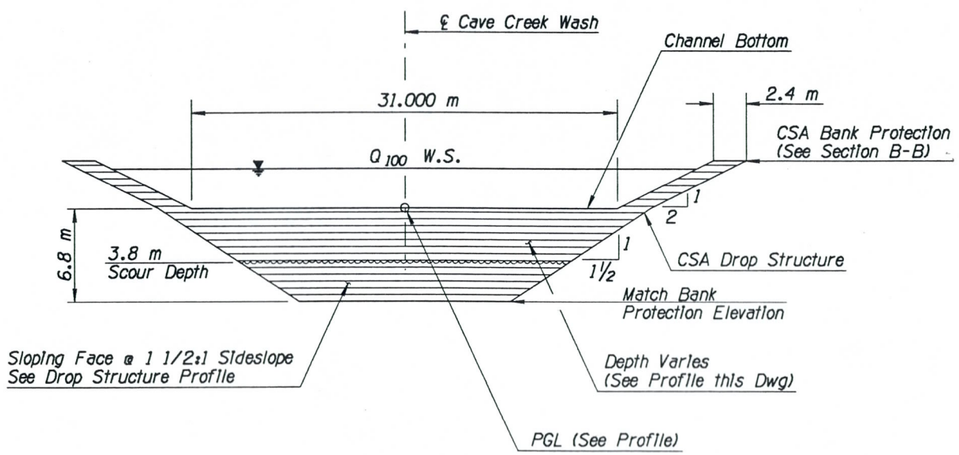
From Upstream Face of EB Frontage Road Bridge
To Sanifill Channel - Approx
Sta 10+271.3± to Sta 10+387.0±

Need ramp



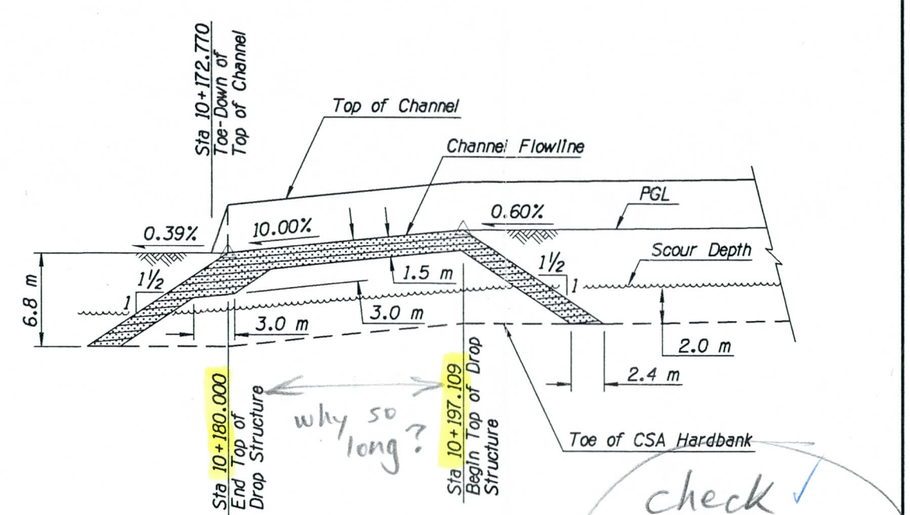
SECTION B-B

Sta 10+180 to Upstream Face of
EB Frontage Road Bridge Approx Sta 10+271.3±



SECTION C-C

GRADE CONTROL DROP STRUCTURE
(Sta 10+180.00 to Sta 10+197.109



check uplift !

DROP STRUCTURE PROFILE

	NAME	DATE
DESIGN	B Battistello	7/96
DRAWN	T Union	7/96
CHECKED	K Marshall	7/96

PARSONS BRINCKERHOFF

ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
ROADWAY DESIGN SECTION

CAVE CREEK WASH
TYPICAL SECTIONS

PRELIMINARY
NOT FOR
CONSTRUCTION
OR
RECORDING

ROUTE 101L | LOCATION PIMA FWY - JCT I-17 TO 56TH ST | DWG NO.

CALL TWO WORKING DAYS BEFORE YOU DIG 263-1100 (MARICOPA COUNTY)

Metric

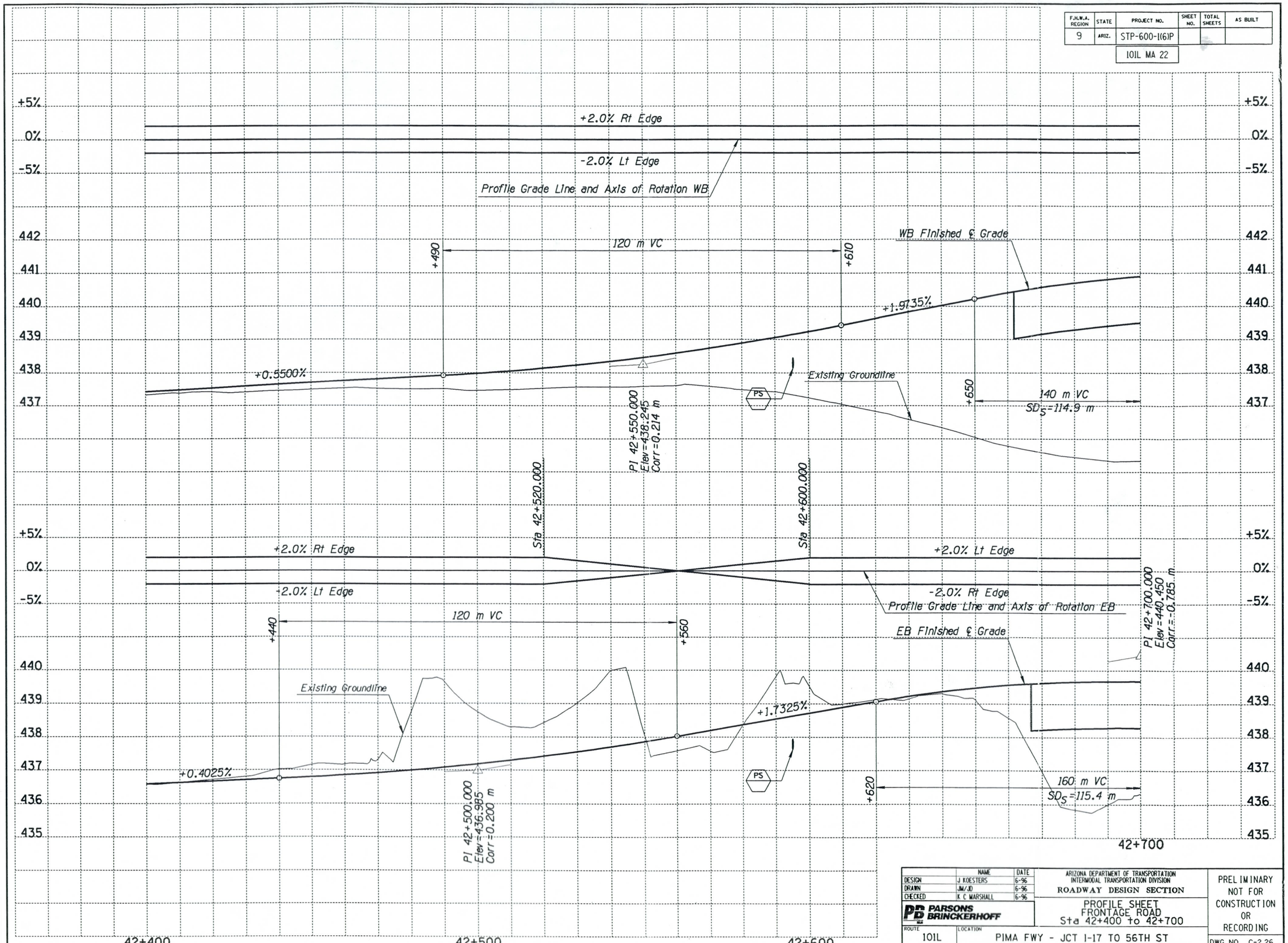
SURVEY NO.	FINISHED PLANS	REVISIONS	LOCATION	DATE

h:\projects\pima\drng\ddeta:12.dgn VIEW NAME:
Tue Jul 23 11:48:52 1996

TRACS NO. H 3565 01C | STP-600-1(6) | ___ OF ___

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
9	ARIZ.	STP-600-I(6)P			

101L MA 22



	NAME	DATE
DESIGN	J KOESTERS	6-96
DRAWN	JM/JD	6-96
CHECKED	K C MARSHALL	6-96

PARSONS BRINCKERHOFF

ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
ROADWAY DESIGN SECTION

PROFILE SHEET
FRONTAGE ROAD
Sta 42+400 to 42+700

PRELIMINARY
NOT FOR
CONSTRUCTION
OR
RECORDING

ROUTE: 101L
LOCATION: PIMA FWY - JCT I-17 TO 56TH ST

DWG NO. C-2.26

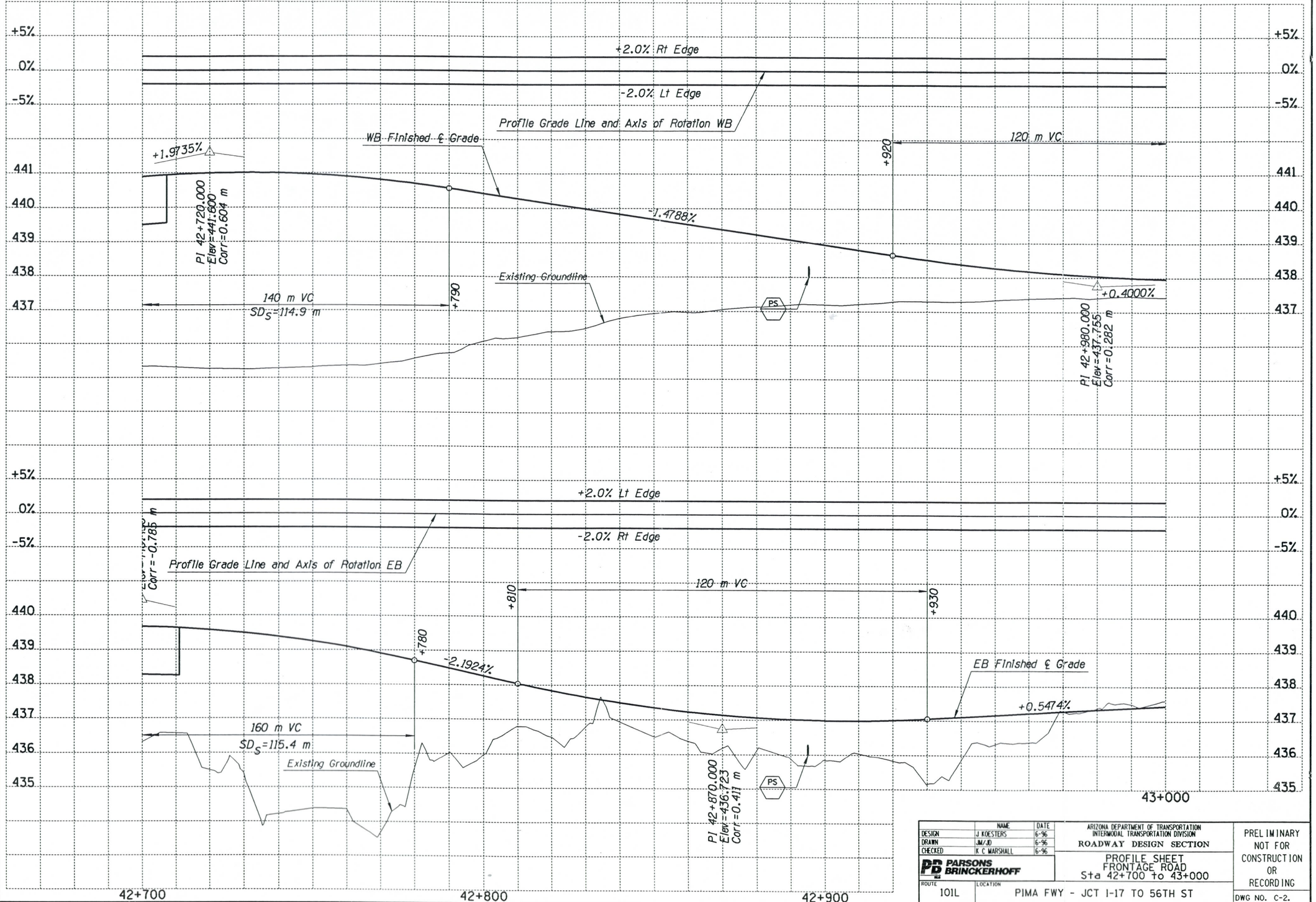
SURVEY NO.	FINISHED PLANS	REVISIONS	LOCATION	DATE

h:\projects\pima\civil\prwbeb08.dgn VIEW NAME:
Wed Jul 24 08:03:28 1996

TRACS NO. H 3565 01C | STP-600-I(6)P | ___ OF ___

Metric

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
9	ARIZ.	STP-600-1(6)P			
		101L MA 22			



	NAME	DATE
DESIGN	J KOESTERS	6-96
DRAWN	JM/JD	6-96
CHECKED	K C MARSHALL	6-96

PARSONS BRINCKERHOFF

ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
ROADWAY DESIGN SECTION

PROFILE SHEET
FRONTAGE ROAD
Sta 42+700 to 43+000

PRELIMINARY
NOT FOR
CONSTRUCTION
OR
RECORDING

ROUTE	LOCATION
101L	PIMA FWY - JCT I-17 TO 56TH ST

DWG NO. C-2.

Metric

SURVEY NO.	FINISHED PLANS	REVISIONS	LOCATION	DATE

h:\projects\pima\civil\prwbeb09.dgn VIEW NAME:
Wed Jul 24 08:04:18 1996

TRACS NO. H 3565 01C | STP-600-1(6)P | ___ OF ___

EAST CAVE CREEK WASH CHANNELIZATION AT LONE CACTUS LANDFILL (PHASE II)

GENERAL NOTES

1. Construction shall conform to the latest applicable Maricopa Association of Governments (MAG) Uniform Standard Details and Specifications and the latest City of Phoenix Supplementals to the MAG Uniform Standard Specification and Details.
2. Riprap shall conform to the following:
   a. Riprap shall be predominantly angular in shape.
   b. Not more than 25% of the stone reasonably distributed throughout the gradation shall have a length more than 2.5 times the breadth or thickness.
   c. No stone shall have a length exceeding 3 times its breadth or thickness.
3. The existing project channel is within a 100–year floodplain boundary.
4. A grading permit is required under Chapter 32A of the Phoenix City Code.
5. Haul permits, when required, must be obtained prior to or concurrently with the grading and drainage permit.
6. Excavating Contractor must give location for wasting excess excavation and a letter from owner giving permission for dumping prior to starting onsite construction. If excess excavation exceeds 100 cubic yards, the dumping site will also require a grading and drainage permit.
7. Development Services Department's Field Inspection Group shall be notified 48 hours before any onsite construction begins, telephone (602) 262–6931.
8. A separate permit is necessary for any offsite construction.
9. An approved grading and drainage plan shall be on the job site at all times. Deviations from the plan must be preceded by an approved plan revision.
10. Grading and drainage plan approval includes the construction of all surface improvements shown on the approved grading and drainage plan, including, but not limited to, retention areas and/or other drainage facilities, drainage patterns, wall, curbs, asphalt pavement, and building floor elevations.
11. Contractor is responsible for locating and confirming depths of all the existing utility lines. If the basin cannot be constructed as per plan because of conflict with underground utilities, the contractor should request modification of basin configuration by submittal of proposed plan revision.
12. "Approval of these plans shall not prevent the City from requiring correction of errors in the plans where such errors are subsequently found to be in violation of any law or ordinance."
13. All drainage protective devices such as swales, interceptor ditches, pipes, protective berms, barrier walls, concrete channels, or other measures designed to protect adjacent buildings or property from storm runoff must be completed prior to request for final inspection.
14. Construction must be phased so the newly aligned channel is fully operational before the existing drainage channel is filled. Flood water conveyance must be maintained at all times during construction.
15. Staking finish grade elevations is the responsibility of the Owner and his Engineer. The Owner's Engineer shall submit on sealed copy of this Grading and Drainage Plan designated as "Record Drawing" (bearing an original signature) prior to the request for final inspection.

RIPRAP GRADATION

% PASSING	SIZE
100 to 90	24"
85 to 70	18"
50 to 30	12"
15 to 5	8"
5 to 0	4"

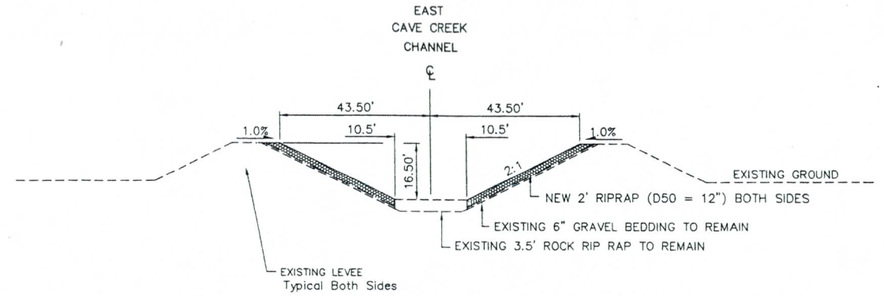
GRAVEL BEDDING GRADATION

% PASSING	SIZE
90 to 100	3"
20 to 90	3/4"
0 to 20	#4
0 to 3	#200

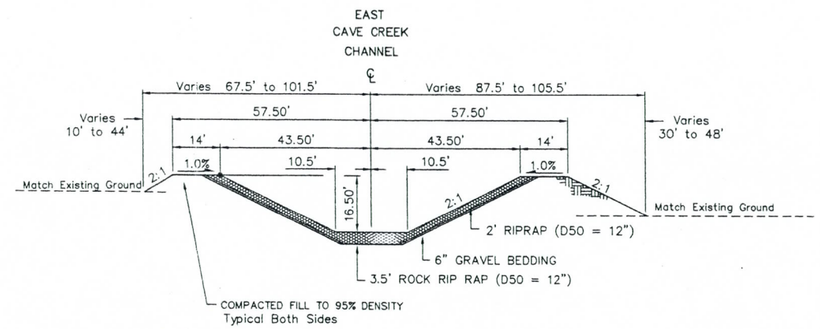
QUANTITIES

PHASE II: STA. 10+70 TO STA. 20+50

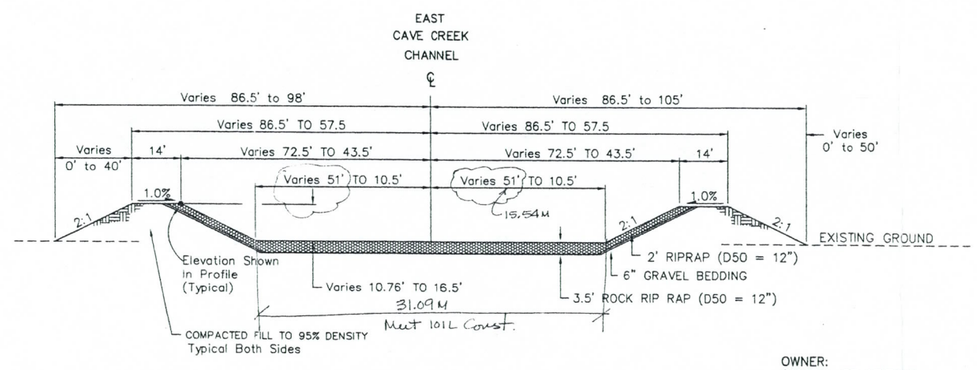
CUT	=	7,176 cu.yd.
FILL	=	37,569 cu.yd.
SHRINK	=	1,435 cu.yd.
IMPORT	=	31,828 cu.yd.
BEDDING	=	1,852 cu.yd.
ROCK RIPRAP	=	33,078 cu.yd.



TYPICAL SECTION STA. 20+50 TO 49+75



TYPICAL SECTION STA. 13+26.65 TO 20+50



TYPICAL SECTION STA. 10+70 TO 13+26.65

℄ 10+69.77
(See Plan)

SURVEY DATA
The existing topographic survey data shown herein was prepared by American Engineering Co., Job No. 95058, 10/11/95 from aerial mapping prepared by Cooper Aerial of Phoenix, Job No. 1310–030995, 03/20/95, and was furnshed by owner for use on this project.

BENCHMARK
CITY OF PHOENIX, Southeast corner of section 20, Township 1 North., Range 3 East, brass cap in hand–hole, Elevation 1438.40.

OWNER:
SANIFILL OF ARIZONA
P.O. BOX 9129
PHOENIX, ARIZONA 85068
(602) 780–9893

APPROVALS

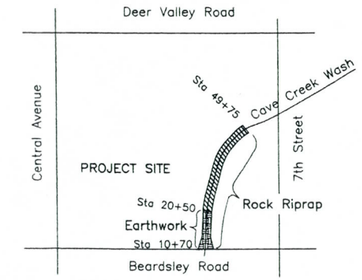
BY: _____
FLOODPLAIN MANAGEMENT ENGINEER

AS–BUILT CERTIFICATION

I HEREBY CERTIFY THAT THE "RECORD DRAWING" MEASUREMENTS AS SHOWN HEREON WERE MADE UNDER MY SUPERVISION OR AS NOTED AND ARE CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

_____
REGISTERED LAND SURVEYOR

_____
REGISTRATION NO.



VICINITY MAP

Two working days before you dig
CALL FOR THE BLUE STAKES
263-1100
Blue Stake Center
CALL COLLECT

NO.	DESCRIPTION	DATE	BY
	REVISIONS		

COPYRIGHT 1996
MORRISON MAIERLE/CSSA INC. HEREBY RESERVES ALL RIGHTS TO PROPERTY IN THIS DOCUMENT. THE IDEAS, DESIGNS INCORPORATED HEREIN AS AN INSTRUMENT OF PROFESSIONAL SERVICE WHICH SHALL NOT BE USED IN WHOLE OR IN PART FOR ANY PROJECT OR OTHER USE WITHOUT OUR EXPRESS WRITTEN AUTHORIZATION.

Morrison/Maierle/CSSA INC.
SINCE 1945
ENGINEERS
PLANNERS
SURVEYORS
4621 North 16th Street
Suite B-105
Phoenix, Arizona 85016
FAX: (602) 279-2554
Phone: (602) 277-2828

DRAWN BY: LMB
CHK'D. BY: BJF
APPR. BY: BJF
DATE: 3/96
Q.A. REVIEW
BY:
DATE:

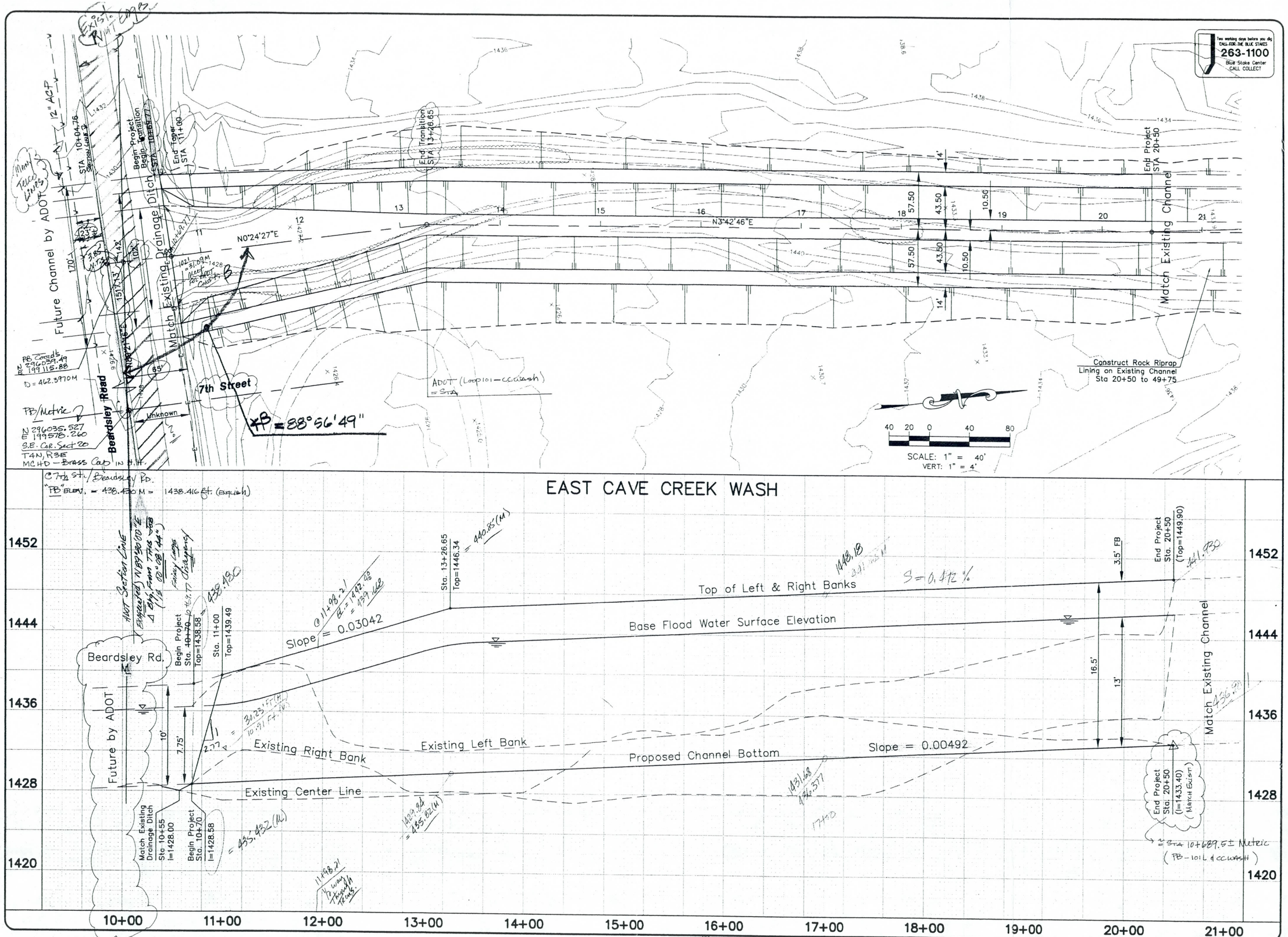
EAST CAVE CREEK WASH CHANNELIZATION AT LONE CACTUS LANDFILL (PHASE II)

PROJECT NO.
8194.001

SHEET NUMBER
1 of 2

FN 42644 & QS 41–28

Fri Mar 29 01 22 28 1996 (ENG)



NO.	DESCRIPTION	DATE	BY
	REVISIONS		

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ENGINEERS
PLANNERS
SURVEYORS
4621 North 16th Street
Suite D-401
Phoenix, Arizona 85016
FAX: (602) 279-2554
Phone: (602) 277-2828
Morrison/Maierle/CSSA INC.
SINCE 1945

DRAWN BY: BJF
CHK'D. BY:
APPR. BY: BJF
DATE: 3/96
Q.A. REVIEW
BY:
DATE:

EAST CAVE CREEK WASH CHANNELIZATION AT LONE CACTUS LANDFILL (PHASE II)

PROJECT NO.
8194.001

SHEET NUMBER
2 of 2

E Fri Mar 29 02:10:12 1996 (ENG)

Parsons Brinckerhoff Computation Sheet

PIMA FREEWAY I-17 TO 56TH ST.

Page 1 of 4 | 110328

Made by BOB B.

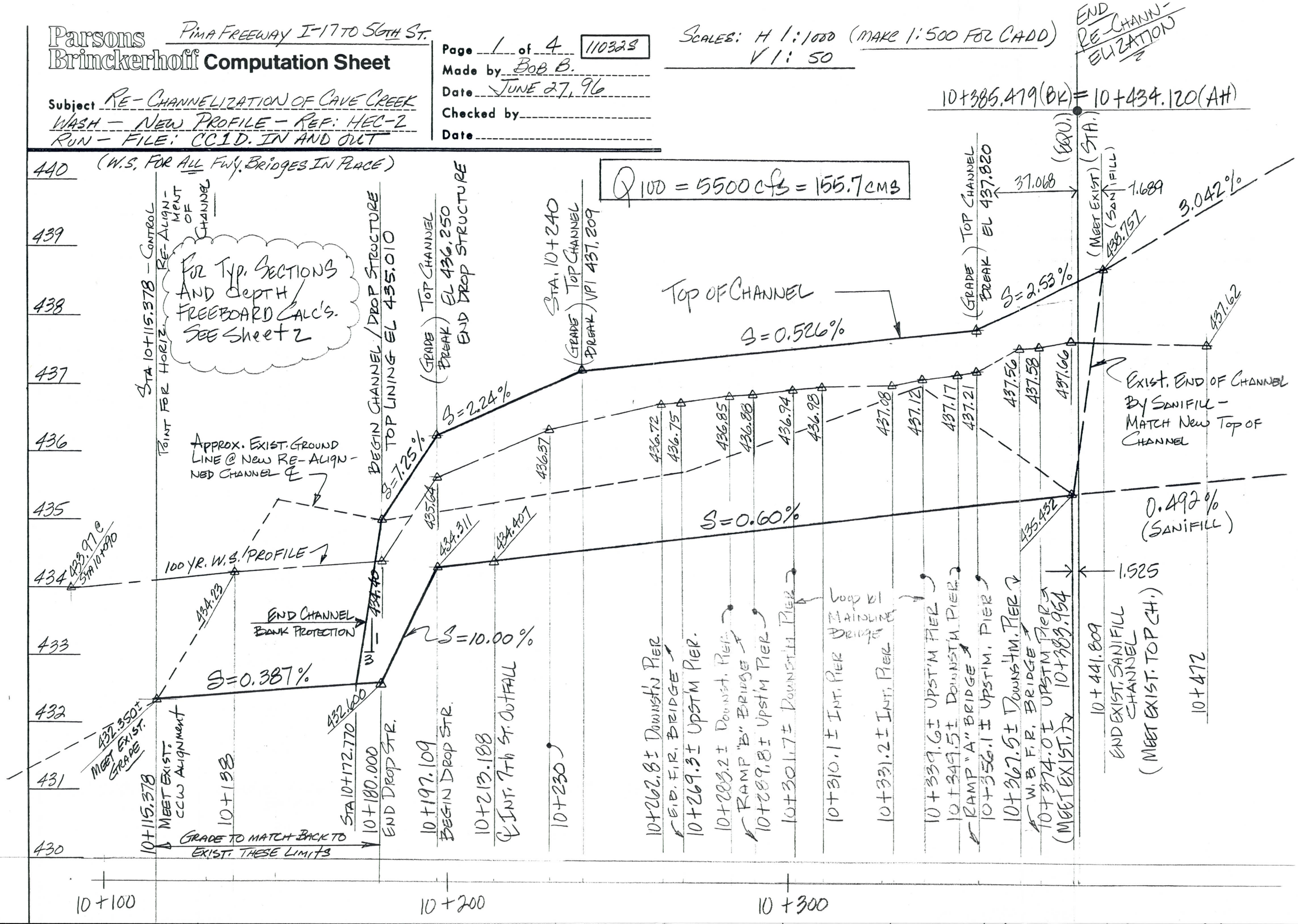
Date JUNE 27, 96

Checked by

Date

Subject RE-CHANNELIZATION OF CAVE CREEK WASH – NEW PROFILE – REF: HEC-2 RUN – FILE: CC1D.IN AND OUT

SCALES: H 1:1000 (MAKE 1:500 FOR CADD)
V 1:50



Parsons Brinckerhoff Computation Sheet

PIMA FREEWAY I-17 - 56TH ST.

Page 2 of 4 | 110325

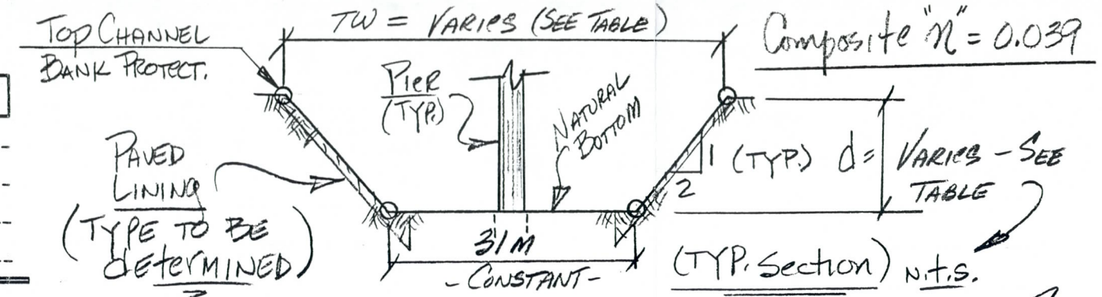
Made by BOB B.

Date JUNE 27, 96

Checked by

Date

Subject RE-CHANNELIZATION OF CAVE CREEK WASH - FREEBOARD CALC'S AND CHANNEL CALC'S. - W/ TYPICAL SECTION -



(SEE Sheet No. 1 FOR NEW CHANNEL PROFILE)

STATION	LOCATION	REMARKS	HEC-2 W.S. EL.	PROP. TOP OF CHANNEL	FREEBOARD (M)	INVERT OF CHANNEL	DEPTH OF CHANNEL	TOP WIDTH OF CHANNEL (NORMAL TO WASH)	SCOUR VELOCITY 500 YR. (m/s) SUPERFLOOD
10+180.000	Downst'm. END DROP	17.11 m ≈ 56' DROP - GRADE CONTROL STR. @ 10%	434.400	435.010	0.610	432.600	2.410	40.640	3.37
10+197.109	Upst'm END DROP		435.640	436.250	0.610	434.311	1.939	38.756	4.29
10+262.8±	Downst'm. FACE E.B.F.R. BRIDGE		436.720	437.329	0.609	434.705	2.624	41.496	3.01
10+269.3±	Upst'm. FACE E.B.F.R. BRIDGE		436.750	437.363	0.613	434.744	2.619	41.476	3.11
10+283.2±	Downst FACE RAMP "B" BRIDGE	FUTURE (ULT.)	436.850	437.436	0.586	434.827	2.609	41.436	USE AN AVE OF 3.10 m/s VEL. BETWEEN THESE BRIDGES SEE * (BELOW)
10+289.8±	Upst'm FACE RAMP "B" BRIDGE	FUTURE (ULT.)	436.880	437.471	0.591	434.867	2.604	41.416	
10+301.7±	Downst'm FACE LOOP 101 MAINLINE BRIDGE	FUTURE (ULT.)	436.940	437.534	0.594	434.938	2.596	41.384	
10+339.6±	Upst'm FACE, LOOP 101 MAINLINE BRIDGE	FUTURE (ULT.)	437.120	437.733	0.613	435.166	2.567	41.268	
10+349.5±	Downst'm FACE RAMP "A" BRIDGE	FUTURE (ULT.)	437.170	437.785	0.615	435.225	2.560	41.240	
10+356.1±	Upst'm FACE RAMP "A" BRIDGE	FUTURE (ULT.)	437.21	437.820	0.610	435.265	2.555	41.220	
10+367.5±	Downst'm FACE W.B.F.R. BRIDGE		437.560	438.108	0.548	435.333	2.775	42.100	3.08
10+374.0±	Upst'm. FACE W.B.F.R. BRIDGE		437.580	438.273	0.693	435.372	2.901	42.604	3.18

* MAX. VELOCITIES WERE FOUND TO BE OCCURING IN "INTERIM" CONDITION W/OUT RAMP & MAINLINE BRIDGES FOR SUPERFLOOD — e.g. Q500 YR.

FLOOD CONTROL DISTRICT
of
Maricopa County

2801 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5859

BOARD OF DIRECTORS
Betsey Bayless
Ed King
Tom Rawles
Don Stapley
Mary Rose Garrido Wilcox

SEP 11 1996

Mr. Robert Battistello, P.E.
Parsons Brinkerhoff
1501 W. Fountainhead Parkway, #400
Tempe, Arizona 85282

Subject: Pima Freeway Crossing, Cave Creek Wash

Dear Mr. Battistello:

Flood Control District staff have reviewed the Cave Creek Wash Bridge Hydraulics Report, dated July 1996, and the Agra Earth and Environmental geotechnical and design report and addendum dated June 26, 1996, and July 24, 1996, respectively. Although the District does not presently have flood plain management responsibility nor any projects in this reach of Cave Creek Wash, we may have future involvement with the City of Phoenix in improving the wash to Union Hills Drive. Some of our comments relate to the technical components of the design and others relate to the project compatibility with possible future improvements.

1. We did not review the HEC-2 analysis as it is our understanding that it will be provided to us in the near future after it has been updated.

2. The telephone conversation memo with Mr. Amir Motamedi should be corrected to reflect that "...Cave Buttes Dam is designed for a Standard Project Flood event, SPF.... Overtopping occurs through the emergency spillway beyond the SPF event."

3. Grade Control Structure:
   (a) The 17 meter top width of the structure appears to be excessive. What is the reason for this width?
   (b) We recommend, based on our experience, that the top three feet of the structure be replaced with a poured concrete cap set on a layer of bedding mortar to bond the concrete to the soil-cement. We also suggest that the retardant admixture be used in the mortar for all temperature conditions.
   (c) We recommend that a stilling basin or other energy dissipation feature be incorporated into the structure to negate the erosive flow over it.
   (d) Calculations should be provided that address the uplift potential of the structure.

(e) Maintenance traffic in the wash will not be able to drive up and downstream from the structure. A (10:1) ramp, 15 feet wide, should be provided along the west levee in the invert to pass over the drop structure. This could also facilitate the planned recreation trail system within the wash.

4. All soil-cement above the channel invert should be trimmed to a uniform surface to remove loose and un-compacted material. The eight foot (2.4 meter) minimum thickness should be kept.

5. To comply with FEMA requirements, the minimum freeboard for the levees should be three feet and not two feet as presently shown.

6. Detail drawings should be provided for the upstream terminus of the rip-rap for the present condition and for the connection to the Sanifll channel, if it is constructed prior to the ADOT project. Detail drawings should also be provided at the downstream soil-cement terminus and at the up-stream interface with the rip-rap.

7. Please show the toe protection profile on DWG D-3.

Thank you for the opportunity to review the draft report and design. As soon as the updated HEC-2 analysis is available, please send it to us. Should you have any questions concerning our comments, don't hesitate to call me.

Sincerely,

9/11/96.

Richard G. Perreault
Planning Branch Manager

cc: Bob Bortfeld, Phoenix
Ray Acuna, Phoenix

INFO: WFR KA PAC AAM EAR GR JSM TDJ RGP

FILE: LCC 3.1

Mail or Pick-up Slip (attach to faxes)

DATE/TIME STAMP: (before distributing)

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

96 SEP 16 AM 11:02

RCP x4774

Fax for RCP (initials) DEPT: Planning

Ext.

No Answer ✓ | Busy ____ 2nd Busy ____

Picking up ☐ | Comments:

Send thru mail ☐ | Comments: Mail Page

ENIX
N DEPARTMENT
AGEMENT
ON STREET
35003-1611
X: (602) 262-7322

Date 9/16/96.

To W ...ureault

Company: FCDMC

Fax Number: 506-4601

Sender: Ray Acuna

Telephone: 262-4026

Number of Pages (including cover): 2

Description/Comments:

CITY OF PHOENIX
STREET TRANSPORTATION DEPARTMENT
FLOODPLAIN MANAGEMENT
200 WEST WASHINGTON STREET
PHOENIX, ARIZONA 85003-1611
PHONE: (602) 262-4960 FAX: (602) 262-7322

Date: 9/16/96

To Whom: Dick Perreault 9/16/96

Company: FCDMC

Fax Number: 506-4601

Sender: Ray Acuna

Telephone: 262-4026

Number of Pages (including cover): 2

Description/Comments:

City of Phoenix

STREET TRANSPORTATION DEPARTMENT

Winner of the Carl Bertelsmann Prize

BEST RUN CITY IN THE WORLD

August 21, 1996

Mr. Bob Battistello, P.E.
1501 West Fountainhead Parkway
Suite 400
Tempe, Arizona 85282

Dear Mr. Battistello:

RE: BRIDGE HYDRAULICS REPORT FOR CAVE CREEK WASH CROSSING

I was given a copy of the Bridge Hydraulics Report for the Pima Freeway Cave Creek Wash Crossing by Mr. Cliff Bedell of our Department. I have not reviewed it for technical accuracy. The following requirements are related to the Cave Creek Wash Federal Special Flood Hazard Area designation.

Flood Insurance Rate Map (FIRM) Panel 1215 of 4350 (included with this correspondence) shows this area to be a zone AE with a floodway. 100 year base flood elevations are shown. A Letter of Map Revision (packet attached) should be prepared and sent to the Federal Emergency Management Agency for review and approval. Upon approval they will issue a revised FIRM that our community uses in our floodplain management program.

Our local floodplain management ordinance discourages a rise in the water surface elevation and increases in velocities. If we can be of assistance, please call me at 262-4026.

Very truly yours,

James H. Matteson, P.E.
Street Transportation Director

Raymond U. Acuña

Raymond U. Acuña, P.E.
Floodplain Manager

JHM/RUA/aff/960821a

Attachments

c: Mr. Bedell
Mr. Blakley

AMIR, 8/12/96

- Please review and coord. w/ WFR & PAC for their reviews.
- Can I get comments back by 8/27/96?

Thx,
Dick

Parsons Brinckerhoff

1501 West Fountainhead Parkway
Suite 400
Tempe, Arizona 85282
602-966-8295
Fax: 602-966-9234

to Mr. Richard G. Perreault - Chief, Planning Branch
Flood Control District of Maricopa County
Planning and Project Management
2801 West Durango - Phoenix, Arizona 85009

from

date

project Pima Freeway I-17 to 56th Street

project number 11032S - offsite drainage

via: ☒ mail 1ST CLASS ☐ messenger ☐ fedex

for your: ☐ information/use ☐ approval ☒ review/comment

the following: ☐ shop drawings ☐ copy of letter ☐ prints ☐ change order ☒ plans ☐ samples ☐ specifications ☒ other Report

drawing	rev. no.	description	copies	date
Report	Draft	Cave Creek Wash Bridge Hydraulics Report	1	07/25/96
Report	Draft	Cave Creek Wash Geotechnical Report w/ Addendum	1	07/25/96

AUG - 9 1996

RGP 8/12
2 AMM
3 WFR
4 PAC

If enclosures are not as noted, kindly notify us at once.

comments Hi Dick: Hope things are going well with you.. I'm submitting the Bridge hydraulics report to you for Cave Creek Wash and the Outer Loop. We are asking the agencies to have their review comments back to us by the end of this month. If that is not enough time or if you have any questions please feel free to call me. Take care, Bob B.

copies to KCM, Ron McCally - ADOT, file

signature Bob Battistello

Bob Battistello, P.E.

g:\bin\forns\transmit.doc

Over a Century of Engineering Excellence

MESSAGE DISPLAY FOR AMIR MOTAMEDI

To: RGP
Cc: PAC
AMM

From: Amir Motamedi:TALOS
Postmark: 08/20/96 12:52PM
Status: Previously read

Host: TALOS
Delivered: 08/20/96 12:52PM

Subject: Outer Loop at Cave Creek

Message:
I have reviewed the Report by Parsons Brinckerhoff re: Cave Creek crossing of the outer loop dated 7/96. I have only reviewed the material pertinent to the Hydrology. The design peak flow of 5500 is somewhat higher than the FEMA and the COE flow of 5400 (at Deer Valley) and therefore reasonable for floodplain and our 221 agreement.

The only comment I have is that in "Part A, Correspondences", the telephone conversation with FCD (AMIR), all referrences to "Probable Maximum Flood, PMF" should be changed to "Standard Project Flood, SPF". The Dam is designed to hold SPF and Pass PMF through its emegency Spillway.

I will forward the reports to Pedro's Group for Hydraulic and Scour calc. review.

Thanks

Pedro

Q_{100} are O.k., Slightly above FEMA's Q's. Please review for Hydraulics, Sediment, etc. and return to RGP. Thanks,

✓ Corp's 221 Agreement = 5,400 cfs

MESSAGE DISPLAY FOR AMIR MOTAMEDI

To: RGP
Cc: PAC
AMM

From: Amir Motamedi:TALOS
Postmark: 08/20/96 12:52PM
Status: Previously read

Host: TALOS
Delivered: 08/20/96 12:52PM

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I will forward the reports to Pedro's Group for Hydraulic and Scour calc. review.

Thanks

MESSAGE DISPLAY FOR AMIR MOTAMEDI

To: WFR
Cc: AMM

From: Dick Perreault:TALOS
Postmark: 08/26/96 01:37PM
Status: Previously read

Host: TALOS
Delivered: 08/26/96 01:37PM

Subject: Forwarded: PIMA FREEWAY BRIDGE AT CAVE CREEK WASH

Comments:
THANKS FOR YOUR MESSAGE, HERE'S KOFI'S COMMENTS FOR YOUR INFO; I'VE NOT HEARD FROM AMIR'S GROUP YET.

Previous Comments:
From: Kofi Awumah:TALOS
Date: 08/26/96 09:34AM
I have not received any HEC-2 models from the consultant to enable me provide a final evaluation of their hydraulic analyses. However, the following are my comments that need attention or a response. The consultant told me that some changes in the HEC-2 model are underway and we will be sent the updated models later.

1. The grade control structure as it is designed (with no abrupt drop surface or no stilling basin) would not ensure adequate energy dissipation. Erosive waves could be generated over the structure which would propagate downstream resulting in channel migration and bank erosion. To prevent this, the downstream of the grade control structure should be protected prefarably with rough lining to help break up the waves and dissipate some of the energy.

2. It was stated in the report that velocities are very high upstream of the bridge. The longterm degradation analysis would therefore have to be adequately analysed rather than guessed. The value for this degradation would be significantly higher than the 2.5 feet proposed in the report.

discussed w/ KA since scour is based on Q_{500} + Q_{100} + 1m, we will disregard the "predict" comment.

Dick

I realize you have been busy. Just to refresh your mind, please see attached!!!

Thanks

Ami

MESSAGE DISPLAY FOR DICK PERREAULT

To: rgp
Cc: mal
wfr

From: Warren Rosebraugh:TALOS
Postmark: 09/09/96 04:49PM
Status: Previously read

Host: TALOS
Delivered: 09/09/96 04:49PM

Subject: Pima Freeway Crossing of Cave Creek Wash

Message:

I have reviewed AGRA's geotechnical report no. 5, dated June 26, 1996, and their Addendum no. 1, dated July 24, 1996, as well the structural and materials portions of Parsons Brinckerhoff's draft report, dated July, 1996. I did not review the hydraulics portions of the report. I have the following comments:

PB REPORT

Page 4, Figure 2: The gravel bedding should extend under the 3.5 ft. thick invert rip rap. The bedding should be designed to act as a filter layer. N/A

Dwg. no D-3: Will a ramp be provided to facilitate maintenance access? ✓

Section A-Az: Provide turn-downs at U/S and D/S edges of the rip rap.

Section B-B: We recommend eliminating the horizontal extensions at the toes of the CSA bank protection. The CSA can be extended deeper if additional protection is desired. N/A

Profile: What is the reason for the 17 meter top width for the drop structure? In light of the District's experience with delamination problems, we recommend a more conventional top width and that the upper several lifts of CSA be replaced with a poured concrete cap at least 3 feet thick. ✓

AGRA REPORT NO. 5

Page 2: It is unlikely that the District would be willing to assume maintenance responsibilities for CSA with a 7 day strength of less than 750 psi plus the usual 2% cement "kicker". N/A

Page C-5: We recommend that a set-retarding admixture be used in the bedding mortar, regardless of the time of year. ✓

Page C-10: Also provide bedding mortar beneath the proposed concrete cap for the grade control structure. ✓

TRIM FACE TO UNIFORM CONSISTANT SURFACE. ✓

AMM, 8/12/96
- Please review and coord. w/ WFR & PAC for their reviews.
- Can I get comments back by 8/27/96?
Thx.
Dick

Internet

PB 100 YEARS ®

Parsons Brinckerhoff
1501 West Fountainhead Parkway
Suite 400
Tempe, Arizona 85282
602-966-8295
Fax: 602-966-9234

to Mr. Richard G. Perreault - Chief, Planning Branch
Flood Control District of Maricopa County
Planning and Project Management
2801 West Durango - Phoenix, Arizona 85009

from
date
project Pima Freeway I-17 to 56th Street
project number 11032S - offsite drainage

via: ☒ mail 1ST CLASS ☐ messenger ☐ fedex

for your: ☐ information/use ☐ approval ☒ review/comment

the following: ☐ shop drawings ☐ copy of letter ☐ prints ☐ change order ☒ plans ☐ samples ☐ specifications ☒ other Report

drawing	rev. no.	description	copies	date
Report	Draft	Cave Creek Wash Bridge Hydraulics Report	1	07/25/96
Report	Draft	Cave Creek Wash Geotechnical Report w/ Addendum	1	07/25/96

FLOOD CONTROL DIST.
AUG - 9 1996
REMARKS

URGP 8/12
2 AMM 8/20
3 WFR
4 PAC

If enclosures are not as noted, kindly notify us at once.

comments Hi Dick:: Hope things are going well with you.. I'm submitting the Bridge hydraulics report to you for Cave Creek Wash and the Outer Loop. We are asking the agencies to have their review comments back to us by the end of this month. If that is not enough time or if you have any questions please feel free to call me. Take care, Bob B.

copies to KCM, Ron McCally - ADOT, file

signature Bob Battistello

Bob Battistello, P.E.

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Transmittal

Parsons Brinckerhoff
1501 West Fountainhead Parkway
Suite 400
Tempe, Arizona 85282
602-966-8295
Fax: 602-966-9234

to Mr. Richard G. Perreault - Chief, Planning Branch
Flood Control District of Maricopa County
Planning and Project Management
2801 West Durango - Phoenix, Arizona 85009

from Bob Battistello
date August 05, 1996
project Pima Freeway I-17 to 56th Street
project number 11032S - offsite drainage

via:
- [x] mail 1ST CLASS
- [ ] messenger
- [ ] fedex

for your:
- [ ] information/use
- [ ] approval
- [x] review/comment

the following:
- [ ] shop drawings
- [ ] copy of letter
- [ ] prints
- [ ] change order
- [x] plans
- [ ] samples
- [ ] specifications
- [x] other Report

drawing	rev. no.	description	copies	date
Report	Draft	Cave Creek Wash Bridge Hydraulics Report	1	07/25/96
Report	Draft	Cave Creek Wash Geotechnical Report w/ Addendum	1	07/25/96

FLO... AUG - 9 1996 ... REMARKS

LRGP 8/12
2 ~~AMM~~ 8/20
3 ~~WFR~~ WR
4 PAC

If enclosures are not as noted, kindly notify us at once.

comments Hi Dick:: Hope things are going well with you.. I'm submitting the Bridge hydraulics report to you for Cave Creek Wash and the Outer Loop. We are asking the agencies to have their review comments back to us by the end of this month. If that is not enough time or if you have any questions please feel free to call me. Take care, Bob B.

copies to KCM, Ron McCally - ADOT, file

signature Bob Battistello

Bob Battistello, P.E.

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AGRA
Earth & Environmental

AGRA Earth &
Environmental, Inc.
3232 West Virginia Avenue
Phoenix, Arizona 85009-1502
Tel (602) 272-6848
Fax (602) 272-7239

24 July 1996
AEE Job No. E95-35
Report No. 5
Addendum No. 1

Parsons Brinckerhoff Quade
& Douglas, Inc.
1501 West Fountainhead Parkway
Suite 400
Tempe, Arizona 85282

Attention: **N. Ali Seyedmadani, Ph.D., P.E.**
Lead Structural Engineer

Gentlemen:

RE: INTERIM DESIGN OF THE PIMA FREEWAY
I-17 FREEWAY TO 56TH STREET
ECS CONTRACT NO. 95-18
TRACS NO. H 3565 01D
PHOENIX, ARIZONA

Pursuant to the request of Robert Battistello, P.E., of Parsons Brinckerhoff Quade & Douglas, Inc. (PBQD), we have reviewed our Stabilization Design Report No. 5 dated 26 June 1996 for the above referenced project with respect to using riprap for temporary stabilization of channel embankments in lieu of soil-cement stabilization. Mr. Battistello indicated that even at relatively low design compressive strengths, the soil-cement would be difficult to remove in areas where new bridges ultimately will be constructed. At relatively high design flow velocities of about 3 meters per second (m/s), however, the available methods for stabilization are more limited. Mr. Battistello requested that for the interim condition, riprapped embankments constructed at a 2H:1V (horizontal to vertical) slope be considered as an alternative. It is understood that soil-cement will still be considered for use as a permanent stabilization technique following construction of the bridges.

Included herein is a discussion relative to the use of and stability of riprapped slopes and design recommendations for riprap utilizing a geotextile filter. Also included are preliminary design recommendations for a grade control structure being considered for downstream of the Cave Creek Wash bridge sites. A grain-size distribution curve for use in determination of scour estimates also is attached. The curve is based on the compilation of samples collected within Cave Creek Wash during this project. Estimates of oversize materials (larger than 0.15 meters) are based on visual inspection of surficial materials in the vicinity of the proposed bridges.

1.0 EMBANKMENT STABILIZATION (RIPRAP)

Mr. Battistello indicated that due to various constraints, a 2H:1V channel side slope configuration (or steeper) is required for the section of Cave Creek Wash in the near vicinity of the new bridge structures. According to Maynord (1978)*, riprapped slopes of 2H:1V can be utilized although 3H or 4H:1V slopes are more common. The required sizing of riprap materials and appropriate thickness of the riprap layer are based on methods presented in Maynord (1978) and Soil Conservation Service (1983). Based on a design flow velocity of about 3 m/s, a channel side slope of 2H;1V, and an assumed channel depth of 3.7 meters, a D50 size of 0.25 m is determined. However, based on the Arizona Department of Transportation (ADOT) Design Procedures Manual (1989), a D50 size of 0.30 m is recommended. The minimum thickness of the riprap blanket is calculated as the larger of 2D50 or 1.5D100. The gradation of the material to be used for riprap, as recommended in the ADOT Design Procedures Manual, is as follows: 12"

Particle Size (meters)	% Passing by Weight
0.60 (24 inches)	100
0.45	70 - 85
0.30	30 -50
0.20	5 - 15
0.10	0 - 5

From the above gradation, the larger of 2D50 or 1.5D100 is 0.90 m. Due to scour conditions, the riprap blanket must be buttressed in beneath the predicted depth of scour on the floor of the channel. It is recommended that the blanket be extended onto the channel floor bottom a minimum distance of 3.0 m. The layout of the riprap blanket is shown on the attached Figure 1. In order to prevent piping of the finer grained embankment soils through the open graded riprap materials, either a sand filter or a geotextile separation fabric should be provided between the riprap and the underlying materials.

A high survivability non-woven geotextile fabric as described in Section 1014 of the ADOT Standard Specifications for Road and Bridge Construction (ADOT, 1990) is recommended. The fabric should be secured at both the high and low ends within anchor trenches. A sand

*References are listed at the end of this letter.

filter layer could also be utilized to prevent piping however the fabric likely is less expensive and is easier to place on relatively steep slopes.

Sources for riprap in the general vicinity of the project site are unknown. Riprap materials and placement should conform to Section 913 of ADOT (1990). In general, the rock must be angular in shape, sound and durable and have a specific gravity of more than 2.4. The less weathered granite materials present in Union Hills to the east of the site likely would be suitable for use, if available.

expensive ?

Preliminary stability analysis using the computer program STABL5 (Carpenter, 1995) indicates that slopes of 2H:1V should remain stable (safety factor above 1.5) with the possibility of localized shallow surface failures immediately following storms due to drawdown conditions. In that regard soil-cement embankments would be more stable. Deep seated circular failures, that would cause the greatest damage are not anticipated for rapid drawdown conditions. Safety factors of more than 2.0 are determined for potential deep seated failure surfaces.

2.0 GRADE CONTROL STRUCTURE

Grade control structures take the direct impact of flood waters and the materials transported. Concrete, either in the form of cast-in-place concrete, roller-compacted concrete or cement stabilized alluvium (CSA) is typically used. Considering the relative cost of the above described materials, and the fact that CSA likely will be used for the permanent treatment of embankment slopes at the bridges, CSA is recommended for use in the grade control structure. Material prices for both concrete and roller-compacted concrete would be considerably more expensive than CSA as on-site materials could be used for CSA. On-site materials likely also could be used for roller-compacted concrete, however particles larger than about 40 mm would not be acceptable, generating considerable waste.

Whatever material is utilized, the grade control structure should be constructed with a sloping upstream and downstream face. The base of the structure should extend a minimum of 1.0 m below the predicted depth of scour. The top width of the structure should be a minimum of 2.5 m with a bottom width sufficient to assure stability. Preliminary plans by PBQD indicate a top width of about 17 meters which slopes at a 10 percent grade. With such a large cross-section, the use of native channel soils within the core of the grade control structure is considered acceptable, as shown in the attached Figure 2. The ends of the structure should either be extended upstream to channelize the water approaching the structure, or be extended outward from the wash banks a sufficient distance to prevent blowout around the ends.

why 17m ?

A relatively high design compressive strength would be required versus the low 7-day compressive strength of 2,500 kilo Pascals (kPa) recommended for the embankments in Section 6.2 of Report No. 5. It is recommended that the CSA be designed to achieve a minimum 7-day compressive strength of 10,000 kPa. Construction quality control will be important relative to the success of the structure. Adequate bonding of successive CSA layers must be achieved as flood waters tend to lift slabs. It may be beneficial to place a layer of shotcrete on the downstream face of the CSA to limit the potential for lifting of CSA lifts. Such a treatment could be utilized, if during inspection of the completed downstream face, unsuitable areas are observed. In any case, it is recommended that a thickened section of CSA be utilized at the downstream toe, as indicated in Figure 2, to provide additional resistance to scour and uplifting of the CSA.

GCS

Should you have any questions concerning the recommendations presented in this report, please do not hesitate in contacting us.

Respectfully submitted,

AGRA Earth & Environmental, Inc.

Keith H. Dahlen, P.E.
Senior Engineer

Registered Professional Engineer (Civil) CERTIFICATE NO. 25151 KEITH H. DAHLEN Date Signed 7/24/96 ARIZONA, U.S.A.

Reviewed by:

Lawrence A. Hansen, Ph.D., P.E.
Executive Vice President

Registered Professional Engineer (Civil) CERTIFICATE NO. 13872 LAWRENCE A. HANSEN Date Signed 7/24/96 ARIZONA, U.S.A.

c: Addressee (10)
jgl\J96-2\7-24-96

REFERENCES

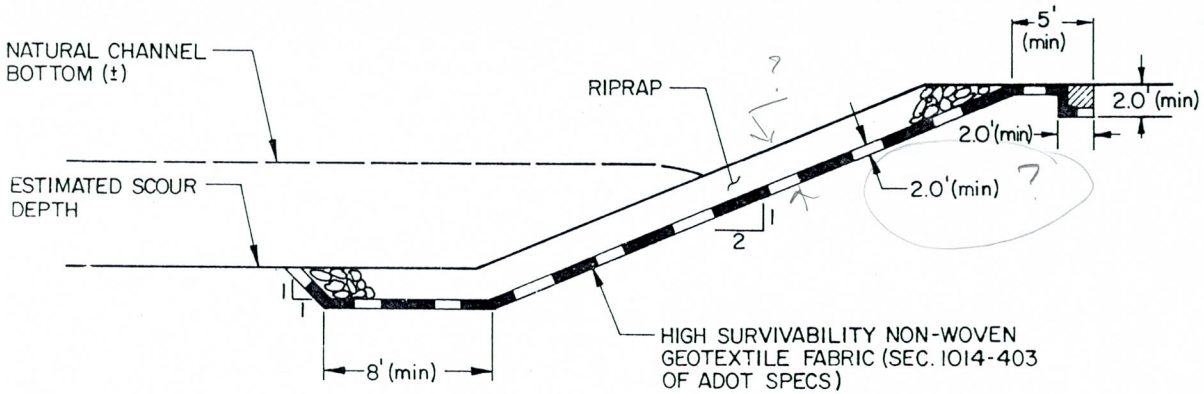
Arizona Department of Transportation (ADOT), 1989, Design Procedures Manual, November.

Arizona Department of Transportation (ADOT), 1990, Standard Specifications for Road and Bridge Construction.

Carpenter, J.R., 1985, Final Report: STABL5 - The Spencer Method of Slices, Report JHRP-85-17, Purdue University, West Lafayette, IN.

Maynord, S.E., 1978, Practical Riprap Design, U.S. Army Waterways Experiment Station, Vicksburg, Mississippi, AD/A-058 837, June.

Soil Conservation Service, 1983, Riprap for Slope Protection Against Wave Action, Technical Release No. 69, February.



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JOB NO. E95-35
DESIGN KHD
DRAWN SPG
DATE 7/96
SCALE N.T.S.

FIGURE 1
TYPICAL SECTION SHOWING RIPRAPPED EMBANKMENT SLOPE

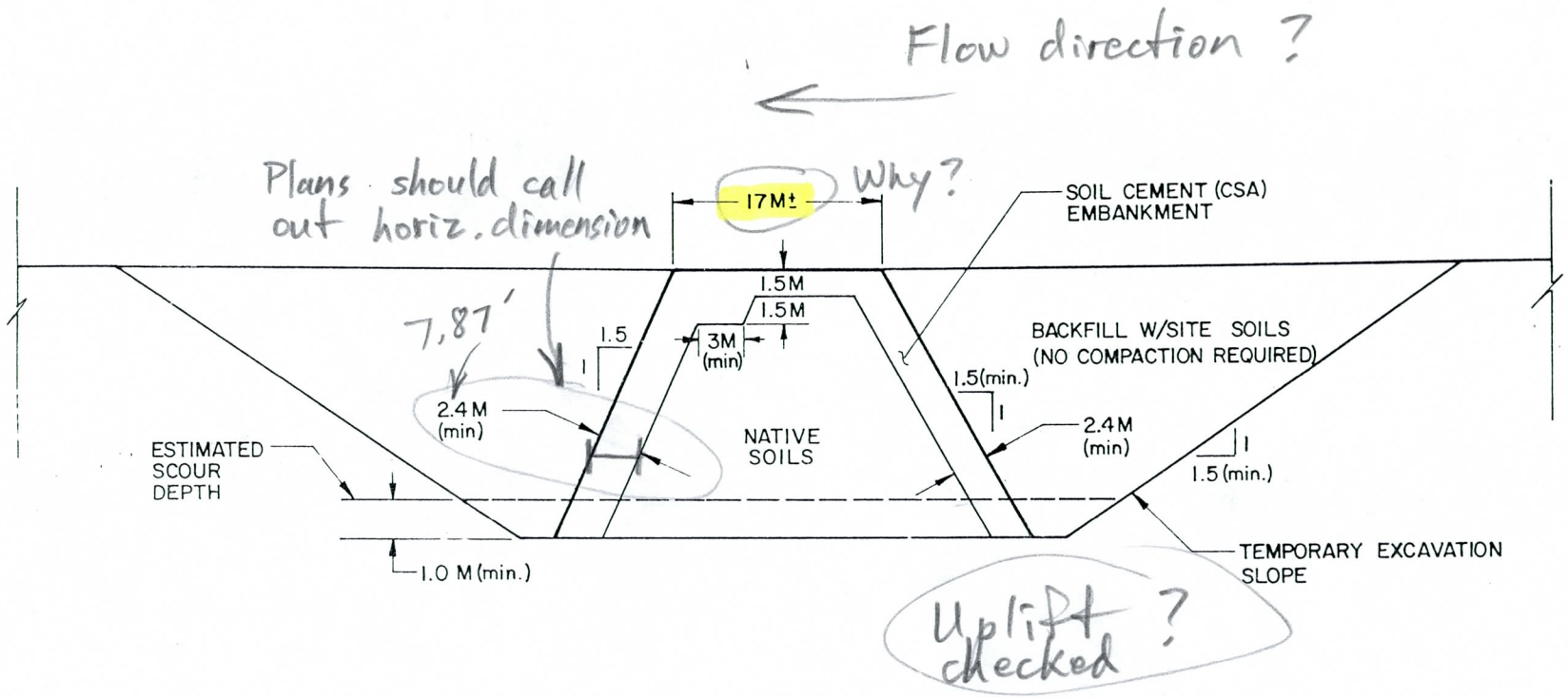

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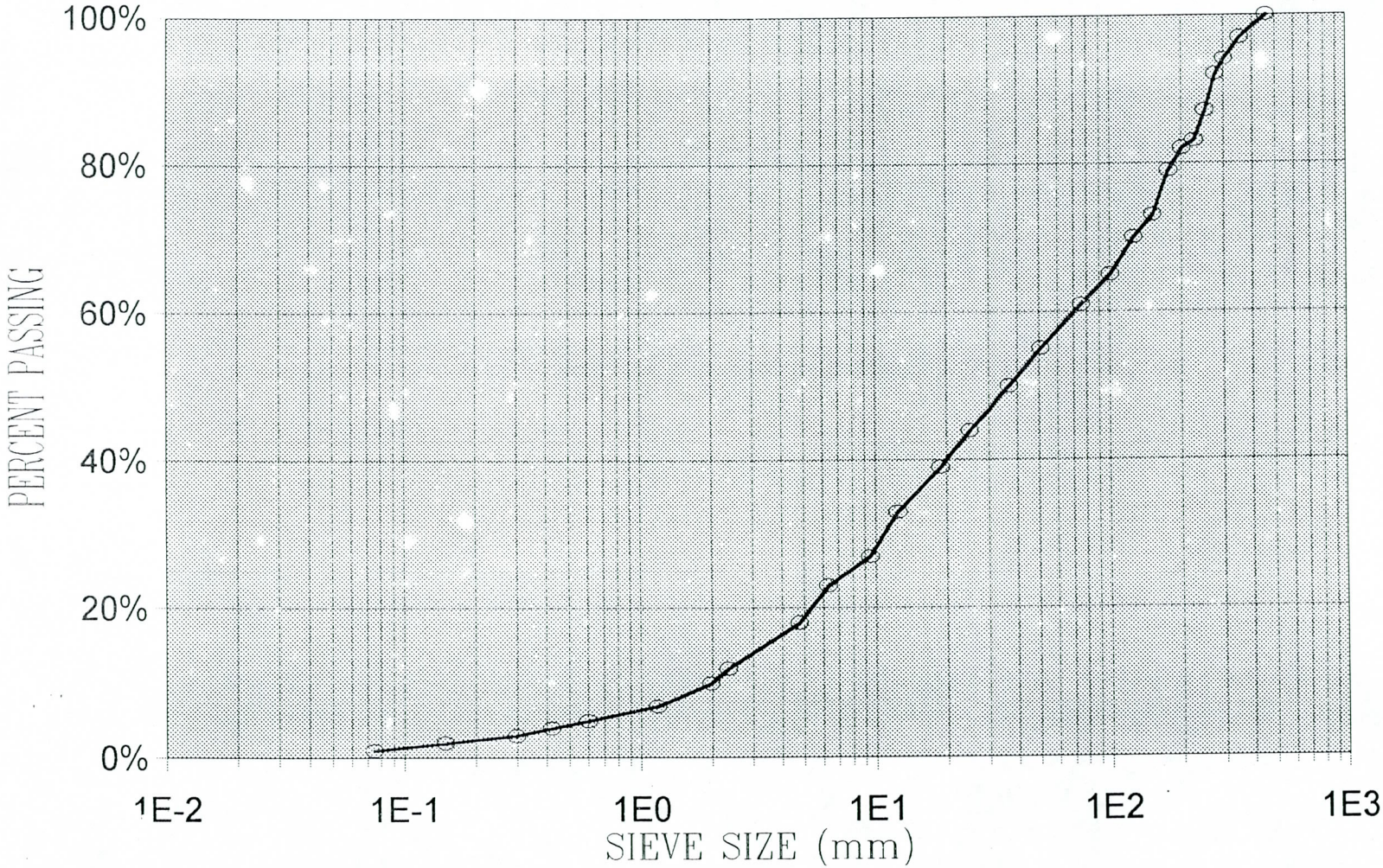
FIGURE 2
TYPICAL CSA EMBANKMENT DETAIL FOR GRADE CONTROL STRUCTURE

GRAIN SIZE DISTRIBUTION
CAVE CREEK WASH



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EMBANKMENT STABILIZATION DESIGN REPORT
INTERIM DESIGN OF THE PIMA FREEWAY
I-17 FREEWAY TO 56TH STREET
ECS CONTRACT NO. 95-13
TRACS NO. H 3565 01D
PHOENIX, ARIZONA

Submitted To:

Parsons Brinckerhoff Quade
& Douglas, Inc.
1501 West Fountainhead Parkway
Suite 400
Tempe, Arizona 85282

Submitted By:

AGRA Earth & Environmental, Inc.
3232 West Virginia Avenue
Phoenix, Arizona 85009-1502

26 June 1996

AEE Job No. E95-35
Report No. 5

AGRA
Earth & Environmental

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Geotechnical Profile	2
Soil Moisture & Groundwater Conditions	2
Discussion & Recommendations	2

APPENDICES

Appendix A - Field Investigation
Appendix B - Laboratory Test Results
Appendix C - Technical Specifications for
Embankment Cement Stabilized Alluvium (CSA)

1.0 INTRODUCTION

This report is submitted pursuant to a geotechnical investigation of proposed stabilized channel embankments adjacent to the Cave Creek Wash crossing bridges located just west of 7th Street along existing Beardsley Road in Phoenix, Arizona. The purposes of the investigation were to obtain a representative sample of surficial materials present on the site and to develop design recommendations and construction specifications for soil-cement stabilized embankments.

2.0 PROJECT DESCRIPTION

Details of the work scope were provided by Bob Battistello, P.E., of Parsons Brinckerhoff Quade & Douglas, Inc. (PBQD). It is understood that stabilization of the embankments will be required adjacent to the abutments of bridges planned for the Cave Creek Wash crossing. Flow velocities are anticipated to be in the range of about 3 meters per second (m/s) during storm events. Significant erosion of the native sandy soils would occur if left unprotected during high storm flow events. A relatively low strength soil-cement mix is desired in order that portions of the stabilized embankment can be removed during construction of the mainline freeway bridges at a later date. In order to maintain the natural look of the wash, the soil-cement would line only the channel banks and be embedded below the predicted depth of scour.

3.0 INVESTIGATION

3.1 FIELD INVESTIGATION

One hand-dug surface bulk sample (HD-1) was obtained from within the wash by Michael A. Hulst, G.I.T., of AEE . A log of the hand-dug test pit is presented in Appendix A along with a site plan showing the location where the sample was retrieved.

3.2 LABORATORY ANALYSIS

Testing performed on the retrieved sample included grain-size analysis, Atterberg limits and moisture-density (standard Proctor). A soil-cement mix design in accordance with Arizona Test Method 241A, as discussed in Section 5.0, was also performed. The results of the tests are presented in Appendix B.

4.0 GEOTECHNICAL PROFILE

In general, the surficial materials present within the active wash channel consist of gravelly sand and sand, gravel and cobbles. Based on deeper borings drilled at the site for the bridge structures, the coarse grained materials extend to depths of about 10 m below existing site grade. The soils generally are nonplastic to low in plasticity and tan to light brown in color.

5.0 GROUNDWATER CONDITIONS

No groundwater was encountered in any of the deeper test borings drilled for the bridges. Soil moisture contents of the near-surface materials (previously tested) are relatively low.

6.0 DISCUSSION & RECOMMENDATIONS

6.1 DESIGN CONSIDERATIONS

Due to estimated flow velocities of up to 3 m/s along Cave Creek Wash at the bridge sites, a stabilization technique such as soil-cement stabilized alluvium (CSA), shotcrete or concrete is required to prevent erosion of channel embankment soils. Considerable erosion of unprotected slopes could be expected during flood events. Other stabilization methods such as cellular concrete grids or vegetation mats likely would not survive flow velocities in excess of about 2 m/s. Another consideration is that construction of the mainline bridges for the ultimate freeway will occur between the frontage road structures that will be constructed for the interim condition. Therefore, a portion of the stabilized embankments will be removed to construct the new bridges.

Although concrete, shotcrete or CSA could be removed after construction, CSA could be constructed with a relatively low design compressive strength to facilitate removal, yet have adequate strength to resist erosive forces during flooding events. Concrete or shotcrete also likely would be significantly more expensive than CSA. ?

6.2 CSA EMBANKMENTS

750 psi

Generally, CSA is designed to have a minimum 7-day compressive design strength of 5,170 kilo Pascals (kPa). However, given that a portion of the material will require removal, and that exceptionally high flow velocities (in excess of about 5 m/s) are not anticipated, it is recommended that the CSA be designed to achieve a 7-day compressive strength of only 363 psi 2,500 kPa. It is further recommended that the requirement for adding an additional 2 percent of Portland cement to the mix (above the calculated percentage) be waived in order that excessive strengths are not developed. Removal of the embankment will be increasingly ?

difficult at higher compressive strengths. Without the additional 2 percent cement, it is recommended that fly ash not be added in order that tighter control of the CSA mixture be maintained.

Construction of the CSA embankment should be performed with conventional earth-moving equipment to minimize costs. Generally embankment widths of about 2.4 m are required to accommodate such equipment. Smaller embankment widths could be utilized if the contractor can provide the necessary equipment. A minimum embankment width of 1.5 m is recommended. All soil-cement embankments should extend a minimum of 1 m below the maximum predicted level of scour. CSA embankments can be constructed in a near-vertical orientation. However, given the generally non-cohesive nature of the near-surface soils present at the site, the materials on the back side of the CSA embankment will not stand at a slope steeper than about 1V:1.25H (vertical to horizontal) during construction. Therefore, a compacted CSA embankment slope of no steeper than 1V:1.25H is recommended.

It is anticipated that the near-surface materials present within or directly adjacent to Cave Creek Wash will be utilized for the CSA aggregate. Based on the CSA mix design results presented in Appendix B, it appears that about 5 percent by weight, of Portland cement will be required to achieve the desired strength of at least 2,500 kPa. It should be noted that testing of actual materials used will be required of the contractor during construction.

APPENDIX A

FIELD INVESTIGATION

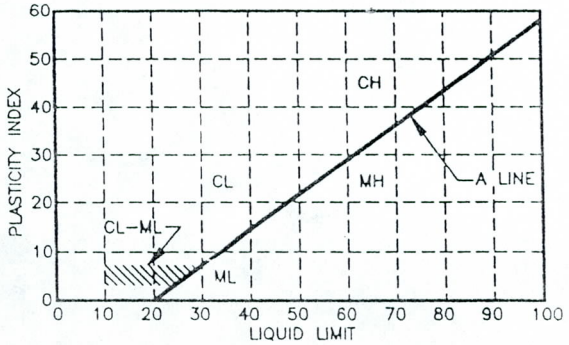
UNIFIED CLASSIFICATION SYSTEM FOR SOILS

Soils are visually classified by the Unified Soil Classification System on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see "The Unified Soil Classification System" ASTM Designation: D2487.

MAJOR DIVISION				GRAPH SYMBOL	GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel-sand mixtures or sand-gravel-cobble mixtures.
					GP	poorly graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity cnart		GM	Silty gravels, gravel-sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)			SW	Well graded sands, gravelly sands.
					SP	Poorly graded sands, gravelly sands.
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS (LIMITS PLOT BELOW "A" LINE & HATCH ZONE ON PLASTICITY CHART)	SILTS OF LOW PLASTICITY (Liquid Limit Less Than 50)			ML	Inorganic silts, clayey silts with slight plasticity.
		SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50)			MH	Inorganic silts of high plasticity, silty soils, elastic silts.
	CLAYS (LIMITS PLOT ABOVE "A" LINE & HATCH ZONE ON PLASTICITY CHART)	CLAYS OF LOW PLASTICITY (Liquid Limit Less Than 50)			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		CLAYS OF HIGH PLASTICITY (Liquid Limit More Than 50)			CH	Inorganic clays of high plasticity, fat clays, silty and sandy clays of high plasticity.

NOTE: Coarse-grained soils with between 5% & 12% passing the No. 200 sieve and fine-grained soils with limits plotting in the hatched zone on the plasticity chart to have dual symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Boulders	Above 300mm (12in.)
Cobbles	300mm to 75mm (12in. to 3in.)
Gravel	75mm (3in.) to No. 4 sieve
Coarse gravel	75mm to 19mm (3in. to 3/4in.)
Fine gravel	19mm (3/4in.) to No. 4 sieve
Sand	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Fines (silt or clay)	Below No. 200 sieve

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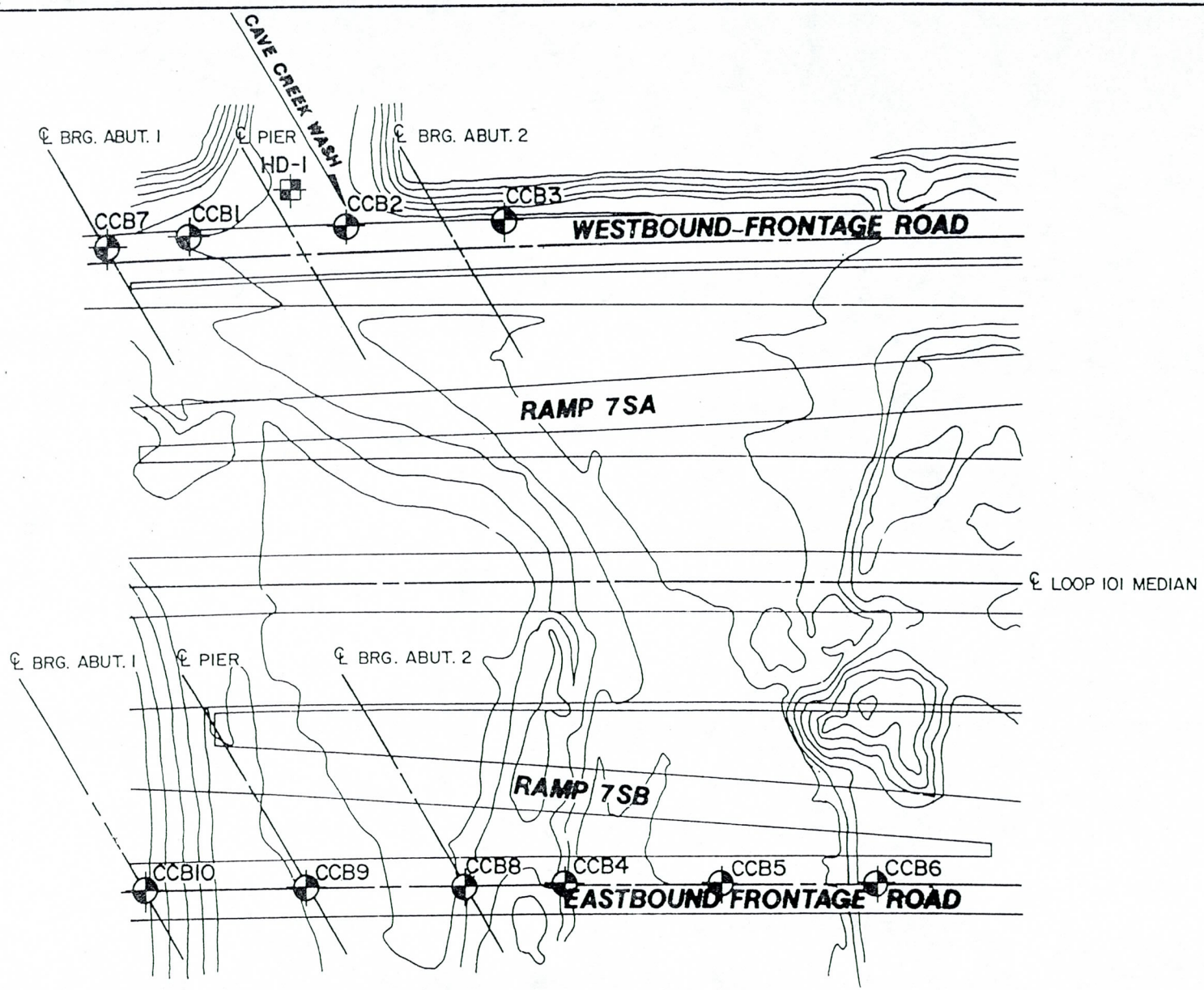

LEGEND

BORING LOCATION

TEST PIT LOCATION

AGRA
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3232 WEST VIRGINIA AVENUE
PHOENIX, AZ, U.S.A. 85009-1502

JOB NO.	E95-35
DESIGN	KHD
DRAWN	SPG
DATE	5/96
SCALE	N.T.S.

FIGURE 1 - SITE PLAN

SHOWING TEST BORING
AND TEST PIT LOCATIONS
CAVE CREEK WASH BRIDGES

AGRA
Earth & Environmental

PROJECT Interim Pima Freeway
I-17 to 56th St.

LOG OF TEST PIT NO. HD-1

JOB NO. E95-35 DATE 6-11-96

GROUNDWATER

DEPTH	HOUR	DATE
	none	

BACKHOE TYPE
LOCATION Hand Dug
ELEVATION
DATUM

Depth in Meters	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0.00			D		SP	slightly moist	**GRAVELLY SAND**, trace of silt, predominantly fine to medium grained, poorly graded gravel, nonplastic, tan to light brown
1.22							Stopped digging at 0.3m
2.44							
3.66							
4.88							
6.10							
7.32							
8.54							
9.76							
10.98							
12.20							
13.42							
14.64							

E95-35 GWH 06/24/96

SAMPLE TYPE

B - Undistured Block Sample.
D - Disturbed Bulk Sample.
U - 73mm O.D. 59mm I.D. Tube Sample

AGRA
Earth & Environmental

APPENDIX B

LABORATORY TEST RESULTS

AGRA Earth & Environmental, Inc.

PROJECT: PIMA FREEWAY
LOCATION: I-17 TO 56TH STREET

JOB NO: E95-35
WORK ORDER NO: 3
DATE SAMPLED: 06-11-96

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

				Silt or Clay	SAND								GRAVEL								COBBLES	
					Fine			Medium			Coarse		Fine				Coarse					
Location & Depth	USCS	LL	PI	#200	#100	#50	#40	#30	#16	#10	#8	#4	6.3mm	9.5mm	12.5mm	19mm	25mm	37.5mm	50mm	75mm	100mm	Lab #

PERCENT PASSING BY WEIGHT

BAGS 1 & 2	SP	NV	NP	0.9	2	8	13	18	31	44	49	65	72	84	88	94	96	100	100	100	100	11&12

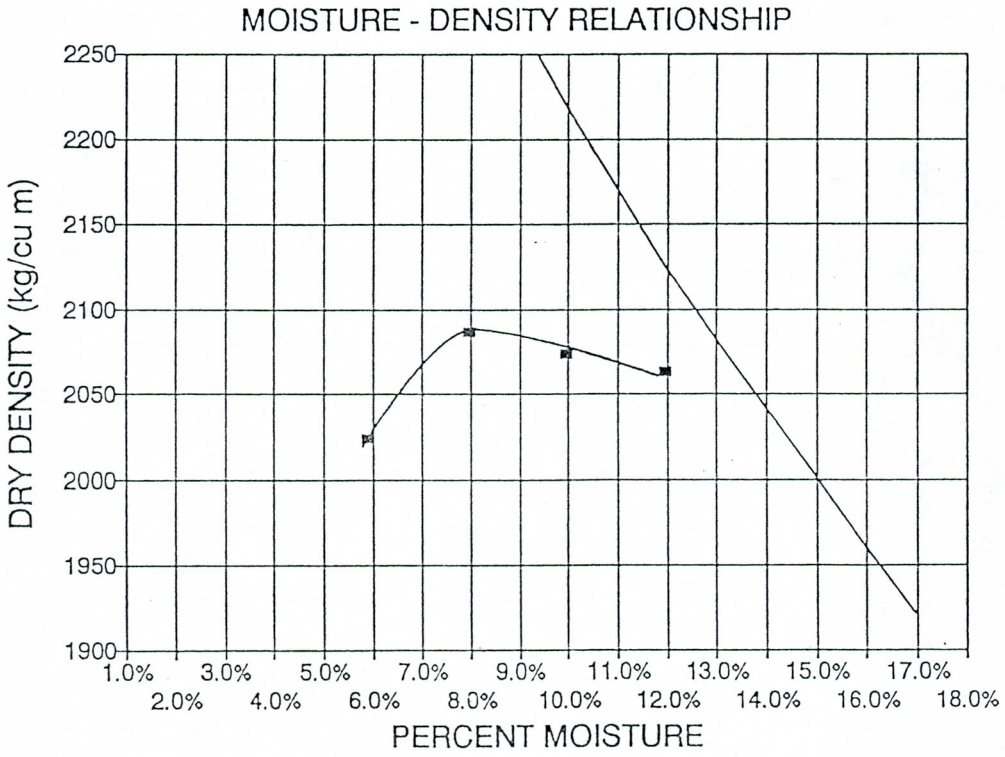
AGRA
Earth & Environmental Group

AGRA Earth & Environmental

PROJECT:	PIMA FREEWAY	JOB NO:	E95-35
LOCATION:	I-17 TO 56TH STREET	WORK ORDER NO:	3
MATERIAL:	SOIL CEMENT	LAB NO:	11 & 12
SAMPLE SOURCE:	COMPOSITE #11 & 12	SAMPLE DATE:	06-11-96

ASTM D698

MAXIMUM DRY DENSITY	2086 kg/cu m	METHOD	A
OPTIMUM MOISTURE CONTENT	8.0%		



AGRA Earth & Environmental

PROJECT:	PIMA FREEWAY	**JOB NO:**	E95-35
LOCATION:	I-17 TO 56TH STREET	**WORK ORDER NO:**	3
MATERIAL:	SOIL CEMENT	**LAB NO:**	11 & 12
SAMPLE SOURCE:	BAGS 1 & 2	**DATE SAMPLED:**	06-11-96

SOIL CEMENT PLUGS COMPRESSIVE STRENGTH
ARIZONA 241A

SAMPLE I	PERCENT CEMENT	LENGTH (cm)	DIAMETER (cm)	AREA (sq.cm)	MAX. LO (N)	STRESS (kPa)	AVG. STRESS FOR 3 SPECIMENS (kPa)
1	3	11.63	10.16	81.07	8972	1106.7	
2	3	11.63	10.16	81.07	10467	1291.1	
3	3	11.63	10.16	81.07	6859	846.0	1081
4	5	11.63	10.16	81.07	23918	2950.2	
5	5	11.63	10.16	81.07	20720	2555.7	
6	5	11.63	10.16	81.07	20497	2528.2	2678
7	7	11.63	10.16	81.07	32810	4047.0	
8	7	11.63	10.16	81.07	34042	4198.9	
9	7	11.63	10.16	81.07	39322	4850.2	4365

APPENDIX C

TECHNICAL SPECIFICATIONS FOR EMBANKMENT CEMENT STABILIZED ALLUVIUM (CSA)

APPENDIX C

TECHNICAL SPECIFICATIONS FOR EMBANKMENT CEMENT STABILIZED ALLUVIUM (CSA)

1.0 SCOPE OF WORK

The work shall consist of the construction of cement stabilized alluvium (CSA) embankment protection at the locations and in accordance with the details shown on the project plans and the requirements of these Special Provisions, including excavating, backfilling and grading the Cave Creek Wash bed and banks to the lines, grades and cross sections shown on the project plans or established by the Engineer; processing and mixing aggregate, cement and water; spreading and compacting the mixture.

This work shall include full responsibility for administration of a Quality Control Plan for cement stabilized alluvium which shall meet the same quality control requirements as for Class S or Class P concrete in Subsection 106.04(B) of the Standard Specifications and Subsection 1006-4.01(A) of the Special Provisions.

2.0 MATERIALS

2.1 AGGREGATE

Aggregate shall be obtained from Cave Creek Wash within the project limits and shall conform to the following requirements when tested in accordance with Arizona Test Method 201:

Sieve Size	Percent Passing
75 mm	100
No. 4	30-65
No. 200	0-8

The plasticity index shall be between 0 and 15 when tested in accordance with the requirements of AASHTO T 90.

Clay lumps larger than 25 millimeters (mm) shall be screened out of the raw soil prior to mixing.

Before placing aggregates upon a stockpile site, the site shall be cleared of vegetation, trees, stumps, brush, rocks and other debris, and the ground leveled to a smooth, firm, uniform

surface. The debris resulting from the clearing and preparing the site shall be disposed of as directed by the Arizona Department of Transportation (ADOT).

Stockpiles shall be constructed upon prepared sites. The piles when completed shall be neat and regular in shape. The stockpile height shall be limited to a maximum of 7 meters (m).

Stockpiles in excess of 150 cubic meters (m^3) shall be built up in layers not more than 1.2 m in height. Stockpile layers shall be constructed by trucks, "clamshells" or other methods approved by the Engineer. Pushing aggregates into piles with a bulldozer will not be permitted. Each layer shall be completed over the entire area of the pile before depositing aggregates in the succeeding layer. The aggregate shall not be dumped so that any part of it runs down and over the lower layers in the stockpile. The method of dropping from a bucket or spout in one location so as to form a cone shaped pile will not be permitted. Any method of placing aggregates in stockpiles, which, in the opinion of the Engineer, breaks, degrades or otherwise damages the aggregate will not be permitted.

No equipment other than pneumatic-tired equipment shall be used in constructing the stockpiles of processed or manufactured aggregates.

Aggregate shall not be deposited where traffic, vehicles or Contractor's equipment will either run over or through the piles, or cause foreign matter to become mixed with the other aggregates. Aggregates shall be removed from stockpile in a manner so as to avoid separation of sizes or admixture of dirt or foreign material.

No equipment other than pneumatic-tired equipment shall be used on stockpiles of processed or manufactured aggregates in removing the materials from the stockpiles. When removing materials from the face of the stockpile, the equipment shall be operated in such a manner as to face-load from the floor to the top of the stockpile to obtain maximum uniformity of material.

Stockpiling of aggregate shall conform with the requirements of Subsection 1006-2.03 of the Standard Specifications and these Special Provisions.

2.2 CEMENT

Cement shall conform to the requirements of Section 1006-2.01 for low alkali Type II Portland cement.

2.3 FLY ASH

The use of fly ash as an additive with cement will not be permitted for this project.

Higher strength for GCS

2.4 STRENGTH REQUIREMENTS

CSA shall have a minimum compressive strength of 2,500 kilo Pascals (kPa) at 7 days. The compressive strength shall be determined in accordance with the requirements of Arizona Test Method 2341. At least one compressive strength test (2 cylinders) shall be made for each 1,150 cubic meters of cement stabilized alluvium placed.

2.5 LIQUID MEMBRANE & CURING COMPOUND

Liquid membrane and curing compound shall conform to the requirements of Subsection 1006-2.05 of the Standard Specifications.

2.6 BEDDING MORTAR

Bedding mortar shall consist of a broomable, high Portland cement content, heavily sanded mortar, with a compressive strength of 20,500 kPa at 28 days, and shall have a slump of approximately 200 mm to 225 mm. The sand shall meet the following requirements when tested in accordance with Arizona Test Method 2.01.

Sieve Size	Percent Passing
10 mm	100
No. 4	9-100
No. 16	45-80
No. 50	0-30
No. 100	0-10
No. 200	0-4

The fraction passing the 200 screen shall be nonplastic.

3.0 CONSTRUCTION REQUIREMENTS

3.1 MIX DESIGN

The Contractor shall determine the mix proportions of the aggregate, cement and water, and shall furnish CSA conforming to the requirements specified herein. The job-mix design with the supporting test results shall be submitted to the Engineer for approval, prior to incorporating any of the material into the work. The mix design shall be performed in

accordance with Arizona Test Method 220 to determine the cement content necessary for the strength required for Class A CSA.

The Contractor shall follow the general provisions in accordance with Arizona Test Method 220 and AASHTO T99 Method D with the following exception. AASHTO T99 Method D shall be used in determining maximum dry density, modified to the extent that a rock correction will be calculated to correct for aggregate passing the 75 mm and retained on the 19 mm sieves. No correction will be used in determining the optimum moisture content.

The mix design objective is to provide the minimum cement content, water-cement ratio and mix proportions to meet the specified strengths. At the same time, the mix shall be dry (stiff) enough to support heavy placing and compaction equipment, yet wet enough to permit effective consolidation by adequate distribution of the paste binder throughout the CSA mass during the mixing and placing process. The job mix design shall be tested and the supporting test results shall be submitted to the Engineer for approval, prior to incorporating any of the material into the work. The cement content during CSA production shall not be decreased nor increased from that of the approved job-mix design unless approved by the Engineer.

Actual mix designs used on this project shall be determined from the Contractor's laboratory tests on material stockpiled after construction of stockpiles are completed in accordance with Subsection 1006-2.03(A) and these specifications.

Included in the job-mix design data shall be the grade of cement and source of aggregate. A new mix design shall be submitted for approval at least two weeks prior to use any time the Contractor requests a change in materials, or proportioning of the materials from that given in the approved mix designs.

3.2 PREPARATION OF SUBGRADE

CSA shall be placed on a prepared subgrade shaped to the lines and grades shown on the project plans or it shall be placed on existing CSA. When placed on a prepared subgrade, the subgrade shall be compacted to a minimum of 95 percent of the maximum density, as determined by Arizona Test Method 225 and rock corrected, as necessary, according to Arizona Test Method 227. Density determinations in the field shall be performed according to Arizona Test Methods 230 or 231, or according to AASHTO Designations T-238 and T-239. When the embankment material is composed predominantly of rock such that these compaction control procedures will not indicate the density achieved, the Engineer will determine the amount of compaction required and the adequacy of equipment used in obtaining the required compaction. Immediately prior to placement of the CSA mixture, the subgrade shall be uniformly moistened and maintained in an acceptable condition throughout the placement operation. Soft or yielding subgrade shall be corrected and made stable before

construction proceeds. Saturated or submerged subgrades shall be dewatered until the 7-day design strength has been achieved and in no case less than 48 hours.

When placed on existing CSA the surface receiving the new CSA will be cleaned to the satisfaction of the Engineer in the following manner. After exposing the existing CSA structure, the structure shall be thoroughly cleaned of all loose material or materials foreign to the concrete. The surface shall be cleaned by a sand-blast or hydro-blast (13,750 kPa maximum) to remove all foreign or loosened particles and hand scaled if necessary to provide a clean rough surface free of loose materials satisfactory to the Engineer.

The old CSA surface will be moist at the time of placement and a 6 mm layer of broomable bedding mortar (fc = 20,500 kPa) shall be used between the old and the new CSA. A set-retarding admixture shall be used in the mortar ~~during hot weather placement.~~

3.3 MIXING (GENERAL REQUIREMENTS)

Aggregate and cement shall be proportioned and mixed in a central mixing plant, unless otherwise permitted by the Engineer. The plant shall be either of the batch-mixing type (using revolving blade or rotary drum mixers), or a continuous mixing type. The aggregate and cement shall be proportioned by weight.

Cement shall be added in such a manner that it is uniformly distributed throughout the aggregate during the mixing operation. There shall be safe, convenient facilities for sampling the cement in the supply line to the weight hopper or pugmill. The charge in the batch mixer or the rate of feed to the continuous mixer shall not exceed that which will permit complete mixing of all the materials.

The water shall be proportioned by weight or volume and there shall be means by which the Engineer may readily verify the amount of water in each batch, or the rate of water flow for continuous mixing. The time of the addition of water or the points at which it is introduced into the mixer shall be as approved by the Engineer.

Control of water content in the field shall be accomplished in two ways. First, the moisture-density relationship for the CSA mixture shall be determined in accordance with AASHTO T134 Method B on a routine basis or when any significant shift in the gradation or rock content occurs. Second, the actual moisture content of the mixture at the time of compaction, or shortly thereafter, shall be determined in accordance with ASTM D2216 (oven dry) or AASHTO T239 (nuclear densimeter) to determine if the optimum moisture content as determined by AASHTO T134 Method B is being maintained. Water content in the aggregates is to be continuously monitored and the mixing water shall be adjusted as necessary to maintain proper moisture.

3.4 BATCH MIXING

The mixer shall be equipped with a sufficient number of paddles of a type and arrangement to produce a uniformly mixed batch. The mixer shall be equipped with a timing device which will indicate, by a definite audible or visual signal, the expiration for the mixing period. The devise shall be accurate to within 2 seconds. The time of mixing shall begin after all ingredients are in the mixer and shall end when the mixer is half emptied. Mixing shall continue until a homogenous mixture of unchanging appearance is produced. The allowable tolerance for weight batching of aggregates and cement shall be 2.0 percent and 0.5 percent, respectively, for each batch.

The batch-mixing plant shall provide sampling facilities which are satisfactory to the Engineer and which will allow representative samples of the CSA mixture to be obtained easily and safely.

3.5 CONTINUOUS MIXING

Aggregate shall be drawn from the storage facility by a feeder or feeders which will continuously supply the correct amount of aggregate in proportion to the cement.

A control system shall be provided that will automatically close down the plant when the material in any storage facility approaches the strike-off capacity of the feed gate. The plant will not be permitted to operate unless this automatic control system is in good working condition.

The feeder for the aggregate shall be mechanically or electrically driven.

The cement feeders and aggregate feeders shall be equipped with devices by which the rate of feed can be accurately determined while the plant is in full operation.

Continuous mix plants shall provide sampling facilities which are satisfactory to the Engineer, and which will allow representative samples of the aggregate and the CSA mixture to be obtained easily and safely.

3.6 TRANSPORTING/SPREADING

Mixed materials shall be transported from the plant to the construction site in vehicles and spread on the prepared subgrade or previously completed CSA. Spreading shall be accomplished by the use of approved motor graders or crawler type equipment. The compacted lifts of CSA shall not exceed 230 mm or be less than 100 mm in thickness.

CSA shall not be mixed or placed when the air temperature is below 45°F in the shade, unless the air temperature is at least 40°F and rising, or when the temperature is expected to drop below 45°F in the next 24 hours. CSA shall not be mixed or placed when the air temperature is greater than 110°F in the shade. Mixing and placing shall not proceed when the soil, aggregate or the area on which the CSA to be placed is frozen.

3.7 COMPACTION/FINISHING

All completed CSA surfaces that will be covered with succeeding layers of CSA shall be kept continuously moist until placement of the subsequent lift.

Cement stabilized alluvium shall be uniformly compacted to a minimum of 98 percent with an average of 100 percent of maximum density as monitored by nuclear density tests in accordance with AASHTO T238 and T239. Maximum density shall be determined in the lab in accordance with the requirements of AASHTO T99, Method D for minus 19 mm material only, with rock correction at each density test location according to AASHTO T224, Section 2.2.2. At least one density test will be taken for each 350 cubic meters of CSA.

At the start of compaction of each lift, the mixture shall be in a uniform, loose condition throughout its full depth. Its moisture content shall be as previously specified herein. No section shall be left undisturbed for longer than 30 minutes during compaction operations.

Compaction of each lift shall be accomplished in such a manner as to produce a dense surface free of compaction planes and shall be completed within one hour from the time water is added to the mixture. Whenever the Contractor's operation is interrupted for more than 2 hours, the top surface of the completed layer, if smooth, shall be scarified to a depth of at least 25 mm with a spike-tooth instrument prior to placement of the next lift. The surface, after scarifying, shall be swept using a power broom or other method approved by the Engineer, to completely free the surface of all loose material prior to placement of the next lift. After compaction, the CSA shall be shaped to the required grades and cross sections, and rolled to a reasonably smooth surface.

At the time of compaction, the moisture content shall not be more than 1 percent below optimum and shall not be more than 1 percent above optimum when the mean air temperature during construction hours does not exceed 90°F. When the mean air temperature does exceed 90°F, or there is a breeze or wind which could cause rapid drying of the CSA mixture, the moisture content of said mix shall be increased as needed at the direction of the Engineer, but shall be less than that quantity that will cause the CSA to become unstable during compaction and finishing operations.

Backfill shall not be placed against the CSA until it has achieved its full design strength. Construction joints shall be provided at the end of each day's work or when work is halted for 2 hours or more. The joints shall be trimmed to a straight line and vertical to the full depth of the lift. Before resuming placement of new material, the joints shall be roughened and loose material shall be removed by power broom or compressed air.

Self-propelled drum drive vibratory rollers shall be of a type which will transmit dynamic impact to the surface to be compacted through a steel drum by means of revolving weights, eccentric shaft or other equivalent methods. The compactor shall have a gross weight of not less than 102 kilo Newtons (kN) and shall produce a dynamic force of at least 59.5 kN per meter of drum width when operated at 2,400 cycles per minute (cpm). The dynamic force is defined as the force developed by revolving the eccentric weight at 2,400 cpm. The roller shall have a smooth drum or drums and the drum diameter shall be between 1.2 m and 1.7 m, and the width shall be between 1.65 m and 2.45 m. The frequency of vibration during operation shall be 2,400 cpm. The roller shall be operated at speeds not to exceed 2.4 km per hour and in the forward direction. The engine driving the eccentric mass shall have a rating of not less than 125 horsepower. Variation in speed, and frequency, and method of operation will be directed when found necessary to secure maximum compaction of the materials.

Heavier compacting units may be required to achieve the specified density of the embankment.

3.8 CONTROL STRIPS

A control strip shall be constructed at the beginning of work on the CSA to be compacted. The control strip construction shall be required to establish equipment and procedures required to attain densities for the specified course plus use of portable nuclear moisture/density testing equipment to determine in-place densities obtained during the construction process.

Compaction equipment shall be capable of obtaining specified compaction requirements without detrimentally affecting the compacted material. The equipment shall be modern, efficient compacting units approved by the Engineer. The compacting units shall be of a type that are capable of compacting each lift of material as specified, and meet the minimum requirements as presented herein.

Each control strip, constructed to acceptable density and surface tolerances, shall remain in place and become a section of the completed CSA. Unacceptable control strips shall be corrected or removed and replaced at the Contractor's expense. A control strip shall have an area of approximately 320 m^2 and shall be of the same dimensions specified for the construction of the course which it represents.

The materials used in the construction of the control strip shall conform to the specification requirements. They shall be furnished from the same source and shall be of the same type used in the remainder of the course represented by the control strip. The underlying surface upon which a control strip is to be constructed shall have the prior approval of the Engineer.

The equipment used in the construction of the control strip shall be approved by the Engineer and shall be of the same type and weight to be used on the remainder of the course represented by the control strip.

Compaction of control strips shall commence immediately after the course has been placed to the specified thickness, and shall be continuous and uniform over the entire surface. Compaction of the control strip shall be continued until no discernible increase in density can be obtained by additional compactive effort.

Upon completion of the compaction, the mean density of the control strip will be determined by averaging the results of 10 density tests taken at randomly selected sites within the control strip.

If the mean density of the control strip is less than 98 percent of the density of laboratory compacted specimens as determined by testing procedures appropriate for the arterial being placed, the Engineer may order the construction of another control strip.

A new control strip may also be ordered by the Engineer or requested by the Contractor when:

- A change in the material or mix design is made,
- There is reason to believe that a control strip density is not representative of the material being placed, or
- Ten days of production have been accepted without a new control strip.

3.9 POWER TAMPERS & SMALL VIBRATORY ROLLERS

Small vibratory rollers which are capable of operating within a few inches of a vertical face shall be used for compaction adjacent to the guide banks, next to utilities and drainage conduit; at transitions to constructed levee protection, adjacent to existing structures, and at other areas where the larger vibratory rollers specified above cannot maneuver. The dynamic force produced by the small rollers shall be at least 26.2 kN/m of drum width. Tampers shall be of a type capable of developing a force per blow of at least 6.2 kN. The amount of rolling and tamping required shall be whatever is necessary for the particular equipment to provide

the same degree of compaction as would be attained with 4 passes of the large self-propelled vibratory roller specified above. Standby replacement equipment shall be available within 1 hour's time if needed.

3.10 CURING

When the atmospheric temperatures are expected to drop below 30°F, the CSA shall be protected from freezing for 7 days after its construction by a covering of straw, earth or other suitable material approved by the Engineer.

Temporarily exposed surfaces shall be kept moist as previously set forth. Care must be exercised to ensure that no curing material other than water is applied to the surface that will be in contact with succeeding layers.

Permanently exposed surfaces shall be kept in a moist condition for 7 days. Any damage to the protective covering within 7 days shall be to the satisfaction of the Engineer.

The permanently exposed surfaces shall be kept moist until the protective cover is applied. Such protective cover is to be applied as soon as practicable, with a maximum time limit of 24 hours between the finishing of the surface and the application of the protective cover or membrane.

3.11 MAINTENANCE

The Contractor shall be required, within the limits of his contract, to maintain the CSA and curing seal in good condition until all work is completed and accepted. Maintenance shall include immediate repairs of any defects that may occur. This work shall be done by the Contractor at his own expense and repeated as often as necessary. Faulty work shall be replaced for the full depth of the layer.

3.12 BEDDING MORTAR

Bedding mortar, as specified in Subsection 2.6 of these specifications, shall be used between the existing CSA and the new CSA after the existing CSA has been properly cleaned. The bedding mortar is to be used specifically for achieving the bond between the old and new CSA layers and eliminating and preventing segregation or voids along margins of CSA placements. Adjustments to the described mix designs may be directed by the Engineer.

& upper lifts of GCS

4.0 METHOD OF MEASUREMENT

The work will be measured by the cubic meter of completed CSA bank protection constructed to the lines and grades and cross sections shown on the project plans. Cement will be measured by the kilogram (kg).

5.0 BASIS OF PAYMENT

The accepted quantities of CSA will be paid for at the contract unit price per cubic meter in accordance with Table 1. Such payment shall constitute full payment for all work necessary to construct the CSA, including excavating, dewatering, backfilling and grading the river bed and banks to the lines, grades and cross sections shown on the plans or established by the Engineer; preparation of subgrade, including the sawcutting and removal of existing CSA; furnishing and mixing aggregate, cement and water; spreading and compacting the mixture to the grades and cross sections specified; control strips; furnishing and applying bedding mortar; and curing. Cement will be paid for at the contract unit price per kg. No payment will be made for any CSA or cement wasted by the Contractor during handling, mixing and placing operations.

Limits of payment for CSA shall be to the neat lines shown on the project plans. Any quantity of placement beyond these limits will not be included in the price paid the Contractor and will be at the Contractor's expense.

TABLE 1

Percent of Specified Strength (to the nearest whole percent)	Percent of Contract Unit Price Allowed
Equal to or Greater Than 100	100
97 - 99	92
94 - 96	85
90 - 94	77
85 - 89	68
80 - 84	60
75 - 79	50
Less than 75	Remove and Replace or leave in place at no payment.

Material represented by lots attaining 7-day compressive strengths with a mean value less than 75 percent compressive strength will be evaluated as to acceptance. The Engineer will determine if the material can be left in place. CSA not allowed to remain in place shall be replaced at the Contractor's expense.