DRAINAGE REPORT

UTOPIA ROAD

EAST FORK CAVE CREEK TO 32nd STREET

Flood Control District of
Maricopa County

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Project No. FCD 93-20

Registered Professional Engineer (Civil)
CERTIFICATE NO. 4234
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Date Signed 4/10/95
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Revised April 10, 1995

Erikson & Salmon, Inc.
Consulting Civil Engineers

Rolf Erikson, P.E.
Michael D. Salmon, P.E.

April 10, 1995
Mr. Michael Lopez
Project Coordinator
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009

RE: Final Submittal - Drainage Report
FCD 93-20 - Utopia Road Lateral
(Upper East Fork Cave Creek)

Dear Mr. Lopez:

Pursuant to Exhibit "A", Scope of Work, Section IV, Deliverables; Part F, Final Submittal, for the above-referenced project, we are herewith submitting six (6) copies of our final drainage design report.

Please contact me if you have any questions or need additional information regarding this submittal.

Sincerely,

Rolf Erikson

Rolf Erikson, P.E.
ERIKSON & SALMON, INC.

FLOOD CONTROL DISTRICT
RECEIVED
APR 19 1995

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INTRODUCTION

On November 4, 1993, this firm entered into a contract with the Flood Control District of Maricopa County to develop plans and specifications for a storm drain in Utopia Road from the Upper East Fork of Cave Creek Wash to just east of 32nd Street within the City of Phoenix. As part of the contract Scope of Work, the hydrology of the contributing watersheds was to be detailed to a greater extent and re-evaluated in accordance with the parameters given in Upper East Fork Cave Creek Master Study and Preliminary Design (NBS/Lowry - See Reference 12 in Bibliography). This report, besides presenting the more-detailed runoff values, was developed to address the hydraulic design requirements for the project, provide alternatives for the proposed storm drain and make recommendations for the final storm drain design.

DESCRIPTION OF AREA AND HYDROLOGIC HISTORY

The original natural watershed for the project included a narrow elongated area of indeterminate size extending several miles in a northeast direction flowing through a complicated series of intertwined braided washes.

The terrain in its natural state was typical Sonoran Desert and Lower Colorado Subdivision, dominated by creosote brush, with salt bush, desert thorn, and mesquite in the vicinity of the washes. The percentage of vegetative cover was originally very low - generally around 10%, with the thicker concentrations being in the vicinity of the washes and the poorly-drained areas.

The watershed soil is of the Gilman-Estrella-Avondale Association. According to Item 2 in the Bibliography, this soil belongs to Soil Conservation Service (S.C.S.) Soil Group "B".

With the urbanization that has occurred in the area over the past 40 years, the natural drainage patterns have been changed and considerably simplified. With the construction of the Central Arizona Project (C.A.P.) Canal from 0.5 to 1.0 mile north of Utopia Road in the 1970's , the bulk of the natural watershed was impounded behind the flood control retention system for the canal - reducing the total area draining onto Utopia Road from the Upper East Fork of Cave Creek to 32nd Street to about 430 acres. In addition, the construction during 1990 of a subdivision called Utopia Estates Two (roughly north of Utopia Road between 28th and 30th Streets) included a detention basin (termed "Det 07" in Appendices I and III) with a storage capacity of about 5.6 acre-feet further mitigated the runoff. During 1993 yet another detention basin with 1.74 acre-feet capacity (termed "Det 06" in Appendices I and III) was constructed south of Beardsley Road at approximately 30th Street in connection with the Whittier

Park subdivision. With the proposed construction of the Kaufman & Broad At Desert Canyon development on the east side of 32nd Street between Utopia and Beardsley Road, another five detention basins will be added with a total of 13.9 acre-feet (termed "Det 01" through "Det 05" in Appendices I and III). The future construction of the Pima Freeway about one-quarter mile north of Beardsley Road will divert another 48 acres (0.075 square miles) westerly from the project watershed through a detention basin and then into a more upper reach of the East Fork of Cave Creek. As a consequence of the aforementioned urbanization, the entire watershed now lies within the corporate limits of the City of Phoenix and has generally been zoned R1-8 and R1-10 (Single Family Residential).

In addition to the mitigation of runoff through the use of detention basins, there have also been some drainage improvements through the addition of channelization and culverts. The development of Utopia Estates One and Two during 1990 included the construction of a drainage channel along its easterly edge (roughly on an alignment of 30th Street) and its southerly border (parallel to Utopia Road from 28th to 30th Steets) to provide for the major identifiable wash for the watershed. At the junction with Utopia Road this drainage channel was provided with a mortared bottom and sides at a right angle bend and with 10' X 4' box culverts at the crossings with 29th Street and 29th Place. At approximately 28th Street this channel was provided with three 43" X 27" Corrugated Metal Pipe Arches (CMPA), which were installed diagonally in a southwest direction across Utopia Road and had an outlet in the roadway ditch that, in turn, connected with the East Fork of Cave Creek. Further north of the Utopia Estates development the major identifiable wash had two branches - one which continued northerly and crossed Beardsley Road about 1000 feet westerly of 32nd Street through a 12" Corrugated Metal Culvert and another which extended in a somewhat more easterly direction and crossed 32nd Street about 600 feet southerly of Beardsley Road in a 36" Corrugated Metal Culvert. With the construction of the Whittier Park subdivision in 1993, the 12" Culvert was abandoned and replaced with two 18" Reinforced Concrete Pipes at a "ford" section in Beardsley Road about 300 feet to the west (i.e. at the westerly edge of the Whittier Park development). At this same time, a channel section was constructed along the entire west edge of the development (i.e connecting further downstream to the channel built with Utopia Estates) and, since the runoff from the east side of 32nd Street would be accommodated by the five aforementioned detention basins of the the Kaufman & Broad At Desert Canyon development, the 36" culvert crossing of 32nd Street was abandoned. Near the lower extremity of the watershed, upon the recent construction of the double 10' X 5' box culvert across Utopia Road for the realignment of the East Fork of Cave Creek, the existing single 36" Concrete and double 48" Corrugated Metal Culverts (i.e. 200 feet to the east) essentially became non-functional and now drain only a 16-acre nursery.

PROCEDURES

The watershed has been investigated in the field and also on 1" = 400' horizontal and 2-foot contour interval maps (provided by the flood control district through the engineering firm of Kaminski-Hubbard) - with the latter being supplemented by 1"=200' and 1"=100' horizontal (both 2-foot contour interval) City of Phoenix quarter section topographic maps. Other data used included 1"=100' City of Phoenix quarter section aerial photo maps, "as-built" documents available at the City of Phoenix, and preliminary grading plans and drainage reports provided by the engineers for private developers. The watershed was divided into 31 sub-areas (see Map in APPENDIX I) for the purpose of the final HEC-I computer model. In order to test the compatibility of using the HEC-I method with the TR-20 procedures used in the original NBS/Lowry master study and preliminary design for the watershed (see Bibliography), the SCS values (i.e. curve numbers and time to peak) were entered into the HEC-1 procedure with the identical rainfall values and drainage areas used in the original study (1987) and the modification that appeared some years later to provide for the westerly diversion of flow north of the freeway (see Description of Area and Hydrologic History above). The results were, as follows:

Study	Discharge at East Fork	Discharge East of 32nd Street
Original		
TR-20	532 cfs	431 cfs
HEC-I	532 cfs	427 cfs
Modification		
TR-20	410 cfs	306 cfs
HEC-1	404 cfs	301 cfs

With the compatibility of the original study procedures to HEC-I procedures verified, SCS curve numbers and time of concentration (and, consequently, time to peak) for each of the 31 sub-areas were developed. Based upon City of Phoenix Criteria (Page 15 of reference 16 in Bibliography), Type "B" soils, and R1-8 zoning, SCS curve number 82 was selected for all of the subareas - except those which included roadway paving only (for which SCS curve number 98 was used). In the course of investigating the watershed, several locations of possible runoff diversions were considered. The first of these, at a "ford" section about 1300 feet west of 32nd Street on Beardsley Road (i.e. where the two 18" culverts were installed with the Whittier Park development - see Description of Area and Hydrologic History), some runoff could flow westerly - and out of the study watershed. At this point the northerly half of Beardsley Road was reconstructed with the Autumn Hills development - with the established north gutter elevation being below the lowest crown elevation at the existing sag.

However, for the purposes of a conservative design, the entire runoff at this point was considered to flow in the historical pattern southerly across Beardsley Road. During the evaluation of the flows within Utopia Estates Two, diversions were analyzed at three sites - just east of 29th Street on Tonto Lane (termed "Divrt1"), on 29th Street south of Tonto Lane (termed "Divrt2") and on 29th Street south of Sequoia Drive ("Divrt3"). At the first of these, two MAG Std. 532 Catch Basins (Type "C") were found to intercept only a portion of the gutter flow on the continuous grade of Tonto Lane. In the second, two MAG Std. 530 Catch Basins (Type "A") could likewise intercept only a portion of the runoff southerly on the continuous grade of 29th Street. At the third, a MAG Std. 533-1 Catch Basin (L=10' with a double wide grate) at the intersection of Sequoia Drive and 29th Street constructed in a "sump" condition could intercept only a portion of the concentrated flows - with some overflowing southerly on 29th Street. The computations for these diversions, which all flowed into a detention basin ("Det 07") are included in Appendix II. Yet another diversion ("Divrt8") occurs further south on 29th Street and just north of the intersection with Utopia Road - as the spillway at this site, upon field measurements, has been determined to be inadequate to convey all the roadway drainage into the channel at the southerly edge of the Utopia Estates subdivision. For the purposes of mitigating flows seven detention basins were considered. The capacity of two of these which have already been constructed ("Det 06" and "Det 07") were based upon the "as-built" dimensions and elevations and the capacities of the other five ("Det 01" to "Det 05") were based upon the data provided by the developer's consultant engineer (Reference 14 in Bibliography). On those developments in which retention was to be obtained on the individual lots, since there is no effective means of enforcement - this was not considered in the HEC-1 modelling. This type of retention had been planned on only two developments - on all 92 lots of Paradise Valley Horizon Unit III (north of Utopia Road between roughly 33rd Street and 34th Street) and on the easterly 89 lots of Kaufman & Broad At Desert Canyon development between both 33rd and 34th Streets and Behrend Drive and Beardsley Road.

The hydrology for the design of the roadway catch basins was developed on the basis of the rational method as given in Reference 5 in "Bibliography". This procedure was adapted since the HEC-1 procedure yields too small values due to the very small watersheds and also because the values are rounded to the nearest cfs. The hydraulic and energy grade line of the storm drain were generally calculated in accordance with the procedures given in Reference 6 in "Bibliography" - but in some cases (i.e. open channel flow and interception points with small discharges in "T" connections) those given in Reference 18 in "Bibliography" were also used. The water surface profile for the East Fork of Cave Creek Wash was computed by HEC-2 procedures and utilized the same stations show on the plans (P81-194-016) for the project by the Flood Control District of Maricopa County. This computation developed a water surface elevation of 1474.29 (with an energy line elevation of 1474.74) at the outlet of

the proposed storm drain in Utopia Road. Since the critical depth of the storm drain at its outlet was calculated at a higher elevation (1476.20 with the energy gradient at 1478.54), the latter was used for starting the hydraulic and energy gradient computations for the storm drain. Water surface profiles for the existing channel to the right (south) of Utopia Road from Station 32+06 to 35+77 and for the existing channel to the left (north) of the roadway from Station 36+75 to 49+36 were also calculated on the basis of HEC-2 procedure to determine their adequacy. These are also included in Appendix VI of this report with the computation stations corresponding to those of the main roadway as shown on the project Plan and Profile in Appendix IV.

HYDROLOGIC RESULTS

Hydrologic values, based upon a City of Phoenix 100-yr storm (4.04 inches in a 24-hour period), were originally developed using two possible storm drain concepts along Utopia Road - termed Alternate "C-1" and Alternate "C-2". Both of these envision utilizing the channel constructed in connection with Utopia Estates One north of Utopia Road between roughly 28th and 30th Streets (i.e. Roadway Stations 36+50 and 49+40) - with a major drainage interception (233 cfs) being at 28th Street. Alternate "C-1" provides for approximately 133 cfs to be intercepted by the new storm drain at this point (with the remainder crossing below Utopia Road to an existing channel on the south side through three existing 43" X 27" Corrugated Metal Pipe Arches) and being conveyed to the East Fork of Cave Creek Wash where discharge would be through the southeasterly headwall of the new double 10' X 5' Box Culverts installed across Utopia Road. Alternate "C-2" envisions intercepting the entire flows (existing channel and storm drain) at approximately 28th Street into a cross culvert system consisting of a four barrel 5' X 3 ' Precast Box Culvert, which would discharge into the existing channel on the south side of the roadway and then flow into the East Fork of Cave Creek Wash. The total discharge into the East Fork of Cave Creek with both alternates would be 462 cfs. This value is higher than that (410 cfs) of the latest NBS/Lowry evaluation - since the latter did not include any of the watershed (i.e. about 90 acres) lying between the East Fork of Cave Creek Wash and a possible major interception at 30th Street. Both of these alternates, by excluding the foregoing watershed, would have a design discharge of 377 cfs. This somewhat lower value from that developed by NBS/Lowry can be attributed to the mitigating effects of the six detention basins (i.e. "Det 01" through "Det 05") in the HEC-1 analysis submitted with this report (Appendix III). Similarly, the discharge figure for the crossing of 32nd Street itself was computed to be 140 cfs - somewhat lower than the latest TR-20 evaluation by NBS/Lowry (172 cfs).

CONCLUSIONS AND DESIGN ALTERNATES

The most significant problem that will influence the ultimate storm drain design for the project are the various buried utilities that can be in conflict. The most important of these are the following:

1) Telephone cables located 16 and 22 feet to the right (south) of the Utopia Road centerline east of the crossing with the East Fork of Cave Creek Wash. These will interfer with any storm drain alignment near the centerline - if the latter crosses to the south side of the roadway near the outlet in the southeast headwall of the Utopia Road culvert crossing or into the nearby concrete lining adjacent to the roadway.

2) A 60" City of Phoenix waterline 20 feet to the west of the 32nd Street centerline.

3) Three 5" electrical ducts (A.P.S.) located 40 feet to the west of the 32nd Street centerline.

4) Fifteen 5" elecrical ducts located 47 feet to the east of the 32nd Street centerline.

5) Three telephone cables from 36 to 39 feet east of the 32nd Street centerline.

6) Two sanitary sewer taps extending to the south at Utopia Road Station 40+71 and 41+87.

In order to minimize the conflicts with the foregoing buried facilities, several alternate storm drain alignments were considered - among them the following are considered the most practical:

ALTERNATE C-1: This envisions the storm drain intercepting that portion of the drainage in the existing channel between 28th and 30th Streets (i.e. north of Roadway Stations 36+50 and 49+40), which cannot be accommodated by the existing three 43" X 27" CMP arches, and conveying it through 78" and 84" diameter pipes to the East Fork of Cave Creek Wash. With this alternate, the existing single 36" Concrete and the double 48" Corrugated Metal Pipes near Station 33+10 would confict with the storm drain and should be replaced with a single 36" diameter connector pipe and standard headwall, In addition, near the proposed outlet in the existing southeast headwall of the 10' X 5' Box Culvert recently constructed at that site, the storm drain would probably pass above the telephone cables cited in 1) above by shifting the "upsweep" of these plastic ducts to the east. Near 32nd Street the storm drain would be constructed in a

east-northeast direction at a shallow depth to pass above the waterline cited in 2), above, and avoid an Arizona Public Service (A.P.S.) manhole installed in connection with the ducts cited in 3), above. It is envisioned with this alignment some relocation of the elecrical ducts on the both sides of 32nd Street, a gas line and the telephone cables on the east side would be necessary. The total cost of this alternate was estimated to be $867,447 in the original concept report.

ALTERNATE C-2: This would essentially terminate the main storm drain construction at 28th Street by constructing a four-barrel 5' X 3' Box Culvert diagonally across Utopia Road to accommodate all the flows from the existing channel north of the roadway between 28th and 30th Streets and from the new storm drain. Two of these barrels would essentially connect the existing channels on the two sides of the roadway by replacing the existing inadequate 43" X 27" CMP Arches. The other two barrels would provide an outlet for the storm drain itself and also discharge into the existing channel on the south side of the roadway. This alternate envisions the storm drain to be constructed at a somewhat higher gradient than in Alternate "C-1". In order to provide for the sewer taps that would conflict with this gradient, south of the storm drain a new sanitary sewer would be required which would connect to the existing sanitary sewer north of the storm drain west of 28th Street (approximately at Sta.33 +70). However, with this alternate the storm drain could not gravity drain into the existing channel on the south side of the roadway. To overcome this problem, a 24" diameter "bleeder" line would be constructed from the junction of the storm drain with the two barrels of the quadruple 5' X 3' Box Culvert at 28th Street to the existing channel "drop" just below the weir constructed to the south of Roadway Station 31 +61. The total cost of this alternate was estimated to be $923,889 in the original concept report.

RECOMMENDATIONS

Of the above alternates for the storm drain configuration, Alternate "C-1" was selected on the basis of economics (see revised project cost in Appendix V) and ease of construction - since only one connection would be required into the existing channel (i.e. at 28th Street) and almost all the system could be constructed of standard circular pipe sections with no special junction structures (see Plan and Profile in Appendix IV of this report). Alternate "C-2", although envisioning a shallower profile for the main storm drain, has additional costs relating to the extensive box culvert installation at 28th Street, an expensive junction structure and the need to construct an additional 840-foot long sanitary sewer. Regardless of which of these two alternates is adapted a 35-foot wide drainage easement should be purchased to the south of Roadway Stations 32+55 to 36+03 in order that an existing channel (presently partially on private property) could be maintained by the Flood Control District or the City of

Phoenix. In the course of developing Alternate "C-1" for the preliminary construction plans, several variations were considered, as follows:

1) Daylighting the outfall through the concrete lining east of the existing box culvert in Utopia Road and west of the drop structure to the south of Station 31+60: The estimated relative costs of these options are as follows:

Through Lining		Through Existing Culvert Headwall	
New Headwall	8,000	Remove & Replace Wingwall	3,500
Remove & Replace Lining	1,850	Remove & Replace Lining	1,200
Additional Pipe Bends	6,000	Additional 84" Pipe	7,540
		Pipe Bend (22-1/2 degrees)	1,000
		Added Pavem't Replacement	700
TOTALS	$15,850		$13,940

Inasmuch as the difference in cost would be insignificant in relation to overall project, it is suggested that the selection of the option be based upon what can conveniently be done in resolving the conflict with the telephone ducts which are 16' to 22' south of the roadway centerline in this area.

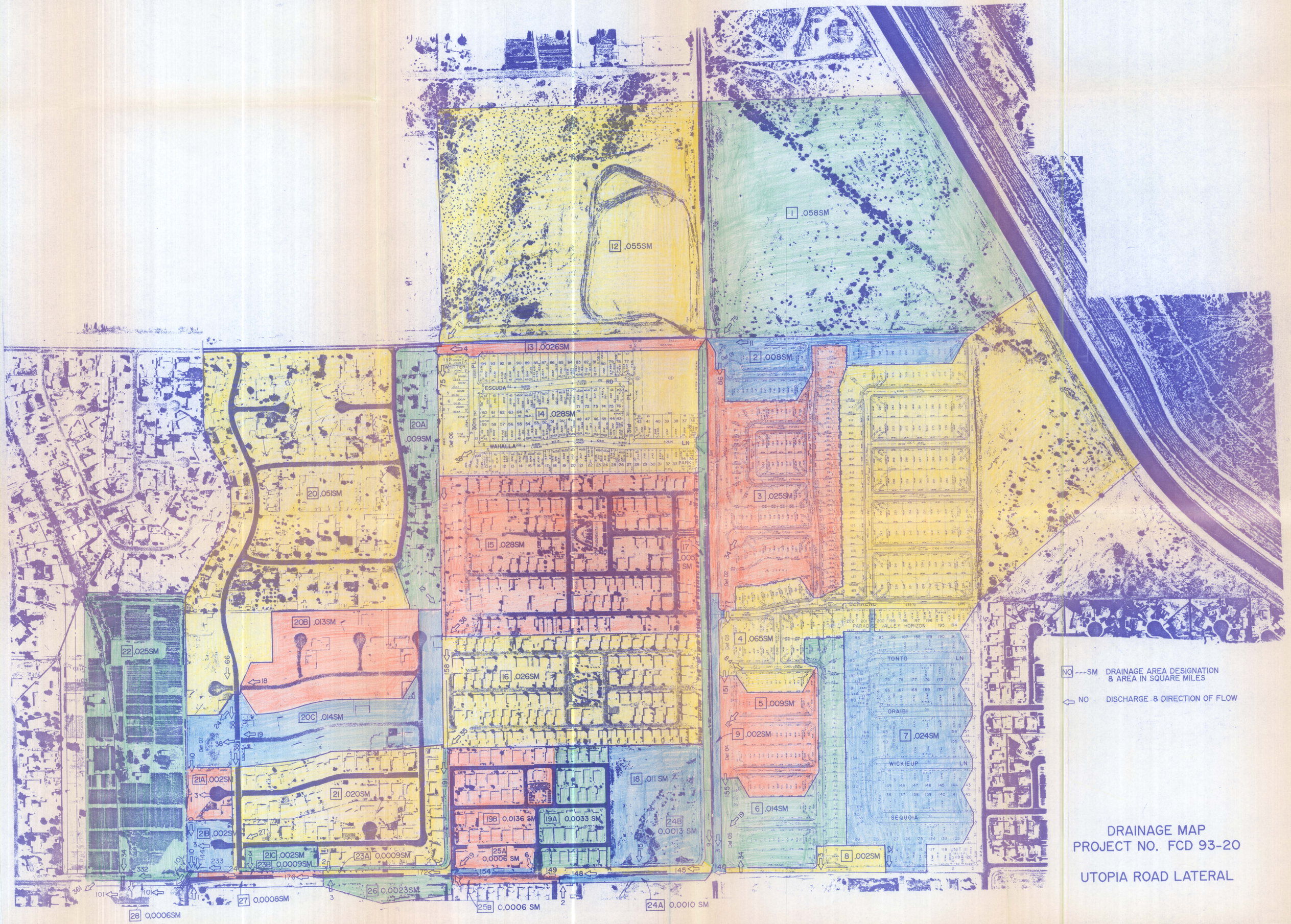
2) Modifying the existing wall to the left (north) of Station 36+70 to 37+45 with openings to allow the excess flows that cannot be accommodated by the three 43" X 27" CMPA's to outflow into a swale on the south side of wall in which a special inlet could be installed and also to allow some flow (up to 100 cfs) within the street Right-of-Way in an 100-year event: Evaluation of this option revealed that the water surface of the existing channel would have to be raised in the area of the openings about two feet above that occuring with the proposed 6' X 3' Box Culvert connection in order to provide adequate outlets above the existing channel lining north of the wall and the existing ground south of the wall. This rise in water surface would result in an even larger diversion from 29th Street (termed "Divrt8"- See Procedures) into Utopia Road. Under even ideal conditions (i.e. with the lowest possible water surface in the existing channel) this diversion (24 cfs), combined with roadway flows on Utopia Road itself (about 10 cfs), nearly will exceed the future capacity of the roadway with curb and gutter installed (less than 40 cfs). Any additional discharge onto Utopia Road would obviously overflow the roadway and reduce the effect of the storm drain as a flood control project.

3) Attempting to eliminate the area (Sub22) from being intercepted by the storm drain at Station 33+15 and allowing the area to drain through the existing culverts: Even by considering using the smallest possible diameter storm drain (78"), the storm drain will not clear any of the exist-

ing culverts at this site. Inasmuch as these are two old corrugated metal pipes and a concrete pipe (probably installed over 30 years ago), it is recommended that they be entirely removed by the new construction and replaced by a new 36" diameter pipe and a straight headwall.

The Right-of-Way and Easement requirements for the project are shown on the Plan and Profile of Alternate "C-1" in Appendix IV. The maintenance requirements for the project (besides manholes) would include the installation of City of Phoenix Standard Detail P-1562 and 1563 storm sewer outfall access barriers at the outlet into the East Fork of Cave Creek and at each headwall inlet with a connecting pipe of over 30" diameter. In addition, since the existing channel north of Utopia Road between 28th and 30th Streets has no means of access - some type of gated access should be provided adjacent to any new headwall constructed in this channel.

It is anticipated that the construction time for this project will be three months. Inasmuch as provisions should be made in the design for the installation of storm drain inlets to be constructed with future City of Phoenix improvements to Utopia Road and traffic on some City of Phoenix Streets must be rerouted during construction of the project, it is suggested that this report and all other plans relating to the project be submitted to that municipality for their comments and approval. In a field review of the project, the only potentially hazardous material noted was possibly some pesticides from the nursery to the left (north) of Roadway Station 31+40 to 36+50 which were being drained with irrigation water through the single 36" and double 48" culverts at Station 33+10 to the ditch on the south side of the roadway - which, in turn, flowed into the East Fork of Cave Creek Wash.



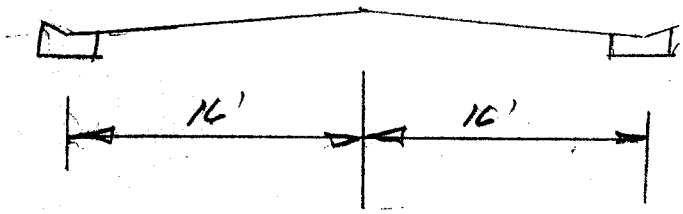
DRAINAGE MAP
PROJECT NO. FCD 93-20

UTOPIA ROAD LATERAL

DIVRT-1

DIVERSION ON TONTO LANE - EAST OF 29th STREET

MAG 532 Catch Basins, Type "C"



$S = 0.0025$

$n = 0.016$

$S_x = 0.02$

T	d	Q/gutter	ΣQ	Q_1/Q (Fig 3.12, Ref. 6 ×0.8)	Q_1	Q_p
5	0.1	0.18	0.36	0.8	0.29	0.07 .36
10	0.2	1.10	2.20	0.8	1.76	0.44 2.20
15	0.3	3.50	7.00	0.75	5.25	1.75 7.00
17.5-16	0.35	5.20-0	10.40	0.65	6.76	3.64 10.4
20-16	0.40	7.00-0.15	13.70	0.60	8.22	5.48 13.7
25-16	0.50	13.0-0.9	24.2	0.46	11.13	13.07 24.2
30-16	0.60	21.0-2.8	36.4	0.40	14.56	21.84 36.4

DIVRT-2

DIVERSION ON 29th STREET - South of TONTO LANE

MAG 530 Catch Basins, Type "A"

(Cross Section same as above)

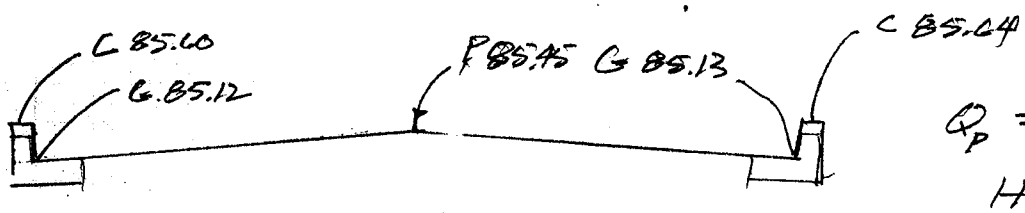
$S = 0.01\%$, $S_x = 0.02$, $n = 0.016$

T	d	Q/gutter	ΣQ	Q_1/Q (Fig 3.9, Ref. 6 × 0.8)	Q_1	Q_p
5	0.1	0.37	0.74	0.80	0.59	0.15
10	0.2	2.37	4.74	0.60	2.84	1.90
20-16	0.40	15.1-0.2	29.8	0.32	9.5	20.30
25-16	0.50	27.4-1.8	51.2	0.22	11.3	39.90
30-16	0.60	44.6-5.8	77.6	0.21	16.3	61.3
35-16	0.70	67.3-13.2	108.2	0.18	19.5	88.7
40-16	0.80	96.1-24.6	143.0	0.16	22.9	120.1

DIVRT-3

DIVERSION AT 29th STREET & SEQUOIA DRIVE

Overflow Street Section:



$Q_p = 3.0LH^{1.5}$

$H = Elev - 85.29$

32'

$Q_p = 96(Elev - 85.29)^{1.5} + 54(Elev - 85.64)^{1.5}$

A = 3.32

P = 2W + L

P = 2.33×2 + 3.5 = 8.16

P = L + 1.8W

P = 20 + 1.8×4.5 = 22.7

Elev	Q_p (weir overflow)	Q_i grate ●	Q_i curb ⊕	ΣQ_i	$\Sigma Q_i \times 0.65$	Q_T
85.12	0	9.2	20.4	29.6	19.2	19.2
85.30	1.46	14.9	33.7	48.6	31.6	33.1
85.40	4.40	16.0	36.1	52.1	33.8	38.2
85.50	9.24	16.9	38.3	55.1	35.9	45.1
85.60	16.6	*	*	*	36.0	52.6
85.70	25.2 + 0.8 = 26.0	*	*	*	37.0	63.0
85.80	35.0 + 3.5 = 28.5	*	*	*	38.0	66.5
85.90	45.8 + 7.2 = 53.0	*	*	*	39.0	92.0
86.00	57.4 + 11.7 = 69.1	*	*	*	39.5	108.6
86.10	70.0 + 16.8 = 86.8	*	*	*	40.0	126.8
86.20	83.3 + 22.6 = 105.9	*	*	*	40.5	146.4
86.30	97.4 + 28.9 = 126.3	*	*	*	41.0	167.3

↑ w/ plugging

* Inlet control on 30" Outlet pipe governs

● Fig 3.29, Ref. 6

⊕ Fig 3.24, Ref 6

Figure 4.42
Culvert Design Form

Project: UTOPIA ROAD DIVRT 5	Station: 36+50 Sheet _____ of _____	CULVERT DESIGN FORM Designer/Date: _____ / _____ Reviewer/Date: _____ / _____

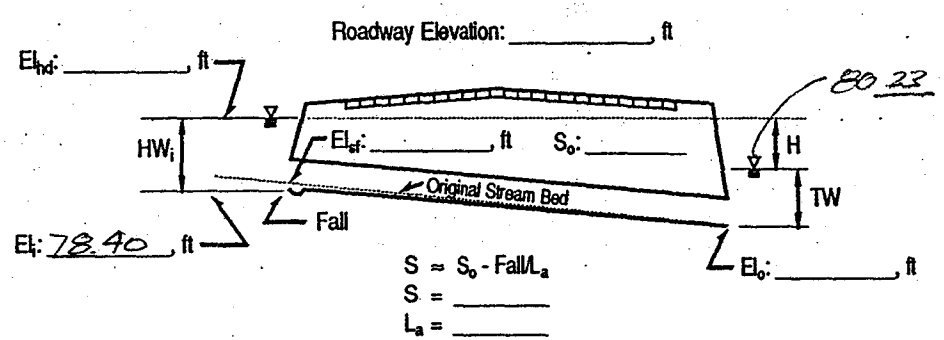
Hydrological Data

See Add'l shts

- ☐ Method: _____
- ☐ Drainage Area: _____ ☐ Stream Slope: _____
- ☐ Channel Shape: _____
- ☐ Routing: _____ ☐ Other: _____

Design Flows/Tailwater

R.I., years	Flow, cfs	TW, ft



Culvert Description: Material - Shape - Size - Entrance	Total Flow Q, cfs	Flow Per Barrel Q/N (1)	Headwater Calculations: Inlet Control: HW_i/D (2)	HW_i	Fall (3)	EL_{hi} (4)	Outlet Control: TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)	Control Headwater Elevation	Outlet Velocity	Comments
Cmc Box 6'x3' 7	42		0.59	1.77		80.17										
9.2	55		0.71	2.14		80.54										
12.5	75		0.88	2.65		81.05										
17	102		1.10	3.29		81.69										
22	132		1.38	4.13		82.53										
26	156		1.68	5.04		83.44										

Technical Footnotes:

(1) Use Q/NB for box culverts.
(2) HW_i/D = HW /D or HW_f/D from design charts
(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; Fall is zero for culverts on grade.
(4) $EL_{hi} = HW_i + EL_i$ (invert of inlet control section)
(5) TW based on downstream control or flow depth in channel.
(6) h_o = TW or $(d_c + D)/2$ (whichever is greater).
(7) $H = \left[1 + k_e + (29n^2L)/R^{1.33}\right] V^2/2g$
(8) $EL_{ho} = EL_o + H + h_o$

Subscript Definitions:

a. approximate
f. culvert fact
hd. Design Headwater
hj. Headwater in inlet control
he. Headwater in outlet control
i. inlet control section
o. Outlet
sf. Streambed at culvert face
TW. Tailwater

Comments / Discussion:

DI	62	95	135	182	232	276
DQ	20	40	60	80	100	120

Culvert Barrel Selected:

Size: _____
Shape: _____
Material: _____ n: _____
Entrance: _____

Figure 4.42
Culvert Design Form

Project: UTOPIA ROAD DIVRT 5	Station: 36+13 Sheet ____ of ____	CULVERT DESIGN FORM Designer/Date: ____ / ____ Reviewer/Date: ____ / ____

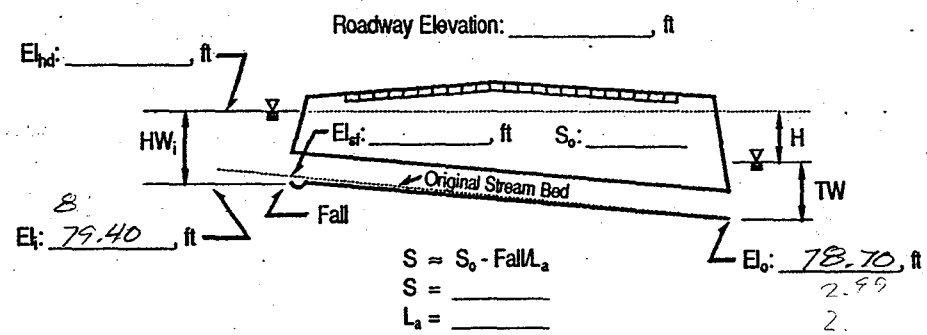
Hydrological Data

See Add'l shts

- ☐ Method: ____
- ☐ Drainage Area: ____ ☐ Stream Slope: ____
- ☐ Channel Shape: ____
- ☐ Routing: ____ ☐ Other: ____

Design Flows/Tailwater

R.I., years	Flow, cfs	TW, ft



Culvert Description: Material - Shape - Size - Entrance	Total Flow Q, cfs	Flow Per Barrel Q/N (1)	Inlet Control: HW_i/D (2)	HW_i	Fall (3)	EL_{hi} (4)	Outlet Control: TW (5)	d_c	$\frac{d_c + D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)	Control Headwater Elevation	Outlet Velocity	Comments
Triple CMPA 43"x27" Arch	20	6.67	0.41	0.92	—	80.52	0.74	0.52	1.39	1.39	0.4	0.08	80.17			
"	40	13.33	0.60	1.35	—	80.77	1.20	0.82	1.54	1.54	0.4	0.30	80.54			
"	60	20.00	0.76	1.71	—	81.11	1.50	1.04	1.65	1.65	0.4	0.70	81.05			
"	80	26.67	0.94	2.12	—	81.52	1.68	1.23	1.74	1.74	0.4	1.25	81.69			
"	100	33.33	1.13	2.54	—	81.94	1.82	1.41	1.83	1.83	0.4	2.00	82.53			
"	120	40.00	1.33	3.00	—	82.44	1.94	1.58	1.92	1.94	0.4	2.80	83.44			

Technical Footnotes:

(1) Use Q/NB for box culverts.
(2) HW_i/D = HW /D or HW_f/D from design charts
(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; Fall is zero for culverts on grade.
(4) $EL_{hi} = HW_i + EL_i$ (invert of inlet control section)
(5) TW based on downstream control or flow depth in channel.
(6) h_o = TW or $(d_c + D)/2$ (whichever is greater).
(7) $H = \left[1 + k_e + (29n^2L)/R^{1.33}\right] V^2/2g$
(8) $EL_{ho} = EL_o + H + h_o$

Subscript Definitions:

a.	approximate	i.	inlet control section
f.	culvert fact	o.	Outlet
hd.	Design Headwater	sf.	Streambed at culvert face
hi.	Headwater in inlet control	TW.	Tailwater
he.	Headwater in outlet control		

Comments / Discussion:

DQ values

2.80
1.54
0.74

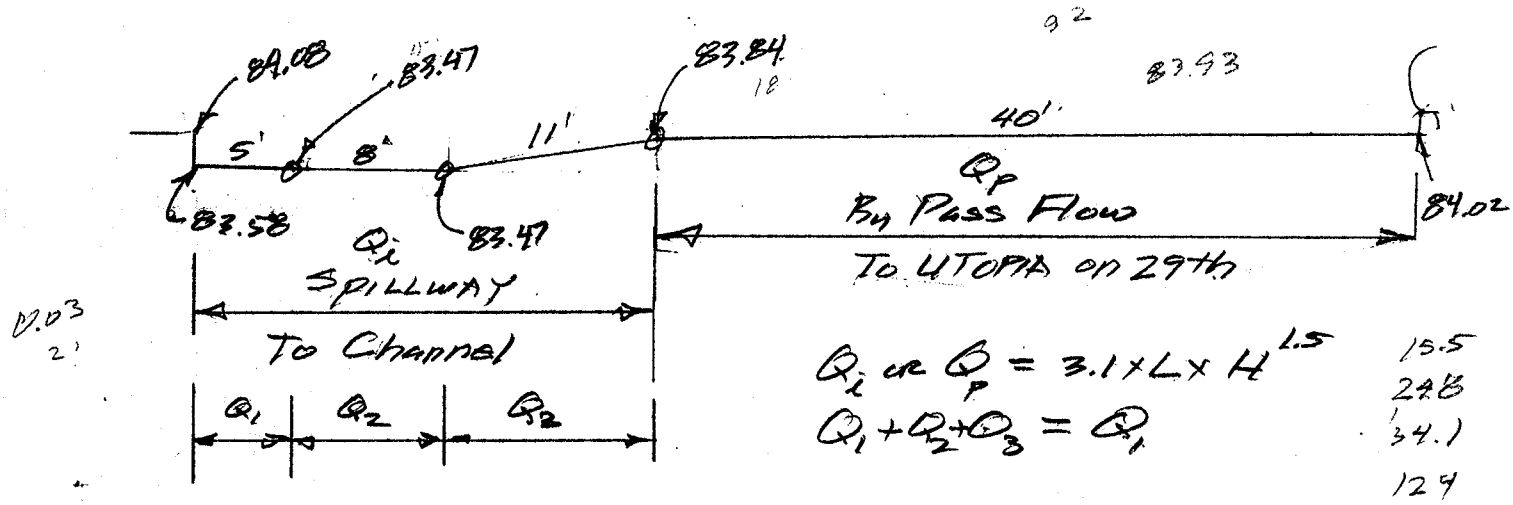
Culvert Barrel Selected:

Size: ____
Shape: ____
Material: ____ n: ____
Entrance: ____

DIVRT-8

DIVERSION ONTO UTOPIA – NORTH OF BOXCULV @ 29th ST.

WEIR SECTION



Q_i or $Q_P = 3.1 \times L \times H^{1.5}$

$Q_1 + Q_2 + Q_3 = Q_T$

Elev.	H_1	Q_1	H_2	Q_2	H_3	Q_3	Q_i	H_P	Q_P	Q_T
83.84	0.32	2.8	0.37	5.6	0.19	2.8	11.2	0	0	11.2
83.89	0.37	3.5	0.42	6.8	0.24	4.0	14.3	0.03	0.2	14.5
83.94	0.42	4.2	0.47	8.0	0.29	5.3	17.5	0.06	1.0	18.5
83.99	0.47	5.0	0.52	9.3	0.34	6.8	21.1	0.08	2.7	23.8
84.04	0.52	5.8	0.57	10.7	0.39	8.3	24.8	0.11	4.5	29.3
84.09	0.57	6.8	0.62	12.1	0.44	10.0	28.9	0.16	7.9	36.8
84.14	0.62	7.6	0.67	13.6	0.49	11.7	32.9	0.21	11.9	44.8
84.19	0.67	8.5	0.72	15.2	0.54	13.5	37.2	0.26	16.4	53.6
84.24	0.72	9.5	0.77	16.7	0.59	15.5	41.7	0.31	21.4	63.1
84.29	0.77	10.5	0.82	18.4	0.64	17.5	46.4	0.36	26.8	73.2

DIVRT 7 Sta. 36+91

Dummy diversion to force HEC-1 program to recall discharge from Sta. 36+91

DIVRT 9

Roadway capacity of North half to crown is 7 CFS, assumed all flows above 7 CFS will flow in north gutter with flows above 14 CFS being equally divided between the two gutters ∴

DI	7	9	11	14	16	18	20	22	24	26
DQ	7	7	7	7	8	9	10	11	12	13

HEC1 S/N: 1343000484 HMVersion: 6.33 Data File: utord8.hc1

```
****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*             MAY   1991               *
*           VERSION 4.0.1E             *
*                                      *
*  RUN DATE  04/10/1995  TIME  15:55:56 *
*                                      *
****************************************
```

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

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
```

```
::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::
:::                                      :::
:::  Full Microcomputer Implementation   :::
:::                  by                  :::
:::        Haestad Methods, Inc.         :::
:::                                      :::
::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

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

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

  1           ID     MARICOPA COUNTY UNIT HYDROGRAPH PROCEDURE
  2           ID     UTOPIA ROAD WATERSHED: 24 HR - 100 YR RAINFALL ALTERNATE "C-1"
  3           ID     RUNOFF PARTIALLY UTILIZING EXIST. CHANNEL S. OF ROADWAY STA 32+06 TO 35+77
  4           IT       1 11FEB94     1300          12FEB94     1300
  5           IO       5        0

  6           KK    SUB1
  7           BA    .058
  8           IN      30
  9           PB    4.04
 10           KM   24 HOUR RAINFALL CITY OF PHOENIX PATTERN
 11           KM   THIS BASIN USED A RAINFALL REDUCTION FACTOR OF 1.00
 12           PC    .000     .004     .008     .013     .018     .022     .026     .031     .035     .040
 13           PC    .044     .048     .053     .057     .062     .066     .071     .075      .08     .093
 14           PC    .107      .12      .14      .17       .5      .83      .86      .88     .893     .907
 15           PC     .92     .924     .928     .933     .937     .942     .947     .951     .956      .96
 16           PC    .964     .969     .973     .978     .982     .987     .991     .995     1.00
 17           LS              82
 18           UD     .20

 19           KK    SUB2
 20           KM    RUNOFF FROM SUB2
 21           BA    .008
 22           LS              82
 23           UD      .1

 24           KK   INTO01
 25           KM    COMBINE RUNOFF FROM SUB1 AND SUB2
 26           HC       2

 27           KK    DET01
 28           KM    ROUTE FLOWS THROUGH DETENTION BASIN 01
 29           RS       1     ELEV  1506.3
 30           SV       0     .085     .180     .287     .407
 31           SE  1506.3  1507.3  1508.3  1509.3  1510.3
 32           SS  1507.3     2.5     2.99      2.5

 33           KK    SUB3
 34           KM    RUNOFF FROM SUB3
 35           BA    .025
 36           LS              82
 37           UD      .1

 38           KK   INTO02
 39           KM    COMBINE RUNOFF FROM SUB3 AND DET01
 40           HC       2

 41           KK    DET02
 42           KM    ROUTE FLOWS THROUGH DETENTION BASIN 02
 43           RS       1     ELEV  1501.5
 44           SV       0   3.426   4.931   6.535
 45           SE  1501.5  1504.5  1505.5  1506.5
 46           SS  1504.5      15       3     1.5
```

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

  47          KK    SUB4
  48          BA    .065
  49          LS              82
  50          UD      .2

  51          KK   INTO3
  52          KM    COMBINE RUNOFF FROM SUB4 AND DETO2
  53          HC       2

  54          KK   DETO3
  55          KM    ROUTE FLOWS THROUGH DETENTION BASIN 03
  56          RS       1    ELEV    1498
  57          SV       0     .104    .181     .399     .653     .945
  58          SE    1498  1498.6    1499     1500     1501     1502
  59          SS  1498.5     2.5    2.99      2.5

  60          KK    SUB5
  61          BA    .009
  62          LS              82
  63          UD      .1

  64          KK   INTO4
  65          KM    COMBINE RUNOFF FROM SUB5 AND DETO3
  66          HC       2

  67          KK   DETO4
  68          KM    ROUTE FLOWS THROUGH DETENTION BASIN 04
  69          RS       1    ELEV    1494
  70          SV       0     .195    .329     .473     .627     .791    1.243
  71          SE    1494  1494.8  1495.3   1495.8   1496.3   1496.8   1498.0
  72          SS  1494.5     2.5    2.99      2.5

  73          KK    SUB6
  74          BA    .014
  75          LS              82
  76          UD     .10

  77          KK    SUB9
  78          BA   .0025
  79          LS              98
  80          UD     .10

  81          KK    SUB7
  82          BA    .024
  83          LS              82
  84          UD     .10

  85          KK   ROUTE
  86          KM    ROUTE THROUGH SUB 8 USING MUSKINGUM-CUNGE ROUTING
  87          RD
  88          RC    .015     .015     .015      800    .0065     1503
  89          RX      95     95.1      100    100.1      120      140    140.1      145
  90          RY    1503   1501.7  1501.68  1501.18  1501.38  1501.18  1501.68     1503
```

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

  91          KK    SUB8
  92          BA    .002
  93          LS              82
  94          UD      .1

  95          KK   INTO5
  96          KM   COMBINE RUNOFF FROM SUB6, SUB9, SUB7, SUB8 AND DETENTION BASIN 04
  97          HC       5

  98          KK   DET05
  99          KM  ROUTE FLOWS THROUGH DETENTION BASIN 05
 100          RS       1    ELEV 1489.00
 101          SV       0     .003   2.365   2.835   3.323   3.829
 102          SE  1489.0    1492    1496  1496.5    1497  1497.5
 103          SL  1489.0  12.566     .54     0.5
 104          SS    1496      30       3     1.5

 105          KK   SUB17
 106          BA    .005
 107          LS              98
 108          UD     .22

 109          KK   61.87
 110          KM   COMBINE RUNOFF FROM SUB 17 AND STA. 63.26
 111          HC       2

 112          KK   ROUTE
 113          KM   ROUTE RUNOFF THROUGH SUB 18 USING MUSKINGUM-CUNGE ROUTING
 114          RD     302   .0066    .012            CIRC     4.5

 115          KK   SUB18
 116          BA    .011
 117          LS              82
 118          UD      .1

 119          KK   58.85
 120          KM   COMBINE RUNOFF FROM SUB 18 AND STA 61.87
 121          HC       2

 122          KK   ROUTE
 123          KM   ROUTE RUNOFF TO STA 55+03
 124          RD     382   .0066    .012            CIRC     4.5

 125          KK  SUB24A
 126          BA   .0010
 127          LS              98
 128          UD     .10

 129          KK   55.03
 130          KM   COMBINE RUNOFF FROM STA 58+85 AND SUB 24A
 131          HC       2
```

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

 132          KK   ROUTE
 133          KM   ROUTE RUNOFF TO STA 53+18
 134          RD     185   .0066    .012            CIRC     4.5

 135          KK  SUB19A
 136          BA   .0033
 137          LS              82
 138          UD     .10

 139          KK  SUB24B
 140          BA   .0013
 141          LS              98
 142          UD     .10

 143          KK   53.18
 144          KM   COMBINE RUNOFF FROM STA 55+03, SUB 19A AND SUB 24B
 145          HC       3

 146          KK   53.18
 147          KM   ROUTE MAIN STORM DRAIN TO STA 49+22
 148          RD     396   .0066    .012            CIRC     4.5

 149          KK  SUB19B
 150          BA   .0136
 151          LS              82
 152          UD     .10

 153          KK  SUB25A
 154          BA   .0006
 155          LS              98
 156          UD     .10

 157          KK  SUB25B
 158          UD   .0006
 159          LS              98
 160          UD     .10

 161          KK   49.22
 162          KM  COMBINE RUNOFF FROM STA 53+40, SUB 19B, SUB 25A AND SUB 25B
 163          HC       4

 164          KK   ROUTE
 165          KM   ROUTE RUNOFF IN MAIN STORM DRAIN TO STA 42+85
 166          RD     637   .0106    .012            CIRC       5

 167          KK   SUB26
 168          BA   .0023
 169          LS              87
 170          UD      .1
```

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

 171          KK  SUB23A
 172          BA   .0009
 173          LS            98
 174          UD      .1

 175          KK   42.85
 176          KM    COMBINE RUNOFF FROM STA 49+17, SUB 26 AND SUB 23A
 177          HC       3

 178          KK   ROUTE
 179          KM   ROUTE RUNOFF IN MAIN STORM DRAIN TO STA 36+91
 180          RD     594    .001    .012            CIRC     5.0

 181          KK   36.91
 182          KM   DIVERT ALL FLOWS INTO STORM DRAIN
 183          DT  DIVRT7
 184          DI      20      40      60      80     100     120     140     160     180
 185          DQ      20      40      60      80     100     120     140     160     180

 186          KK   SUB12
 187          BA    .055
 188          LS            82
 189          UD     .20

 190          KK   SUB13
 191          BA   .0026
 192          LS            82
 193          UD      .1

 194          KK   BEGCH BEGIN EXISTING CHANNEL
 195          KM   COMBINE RUNOFF FROM SUB12 AND SUB13
 196          HC       2

 197          KK   ROUTE
 198          KM  ROUTE RUNOFF TO OUTLET DETENTION BASIN 06 USING MUSKINGUM-CUNGE ROUTING
 199          RD     600   .0023    .025            TRAP       8       3

 200          KK   SUB14
 201          BA    .028
 202          LS            82
 203          UD     .10

 204          KK   DET06
 205          KM   ROUTE FLOWS THROUGH DETENTION BASIN 06
 206          RS       1    ELEV    1495
 207          SV       0   .3487    .752  1.2137  1.7373
 208          SE    1495    1496    1497    1498    1499
 209          SS  1498.5      39     3.0     1.5
```

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

 210          KK    CHAN JUNCTION OF CHANNEL AND OVERFLOW FROM DETENTION BASIN 06
 211          KM   COMBINE CHANNEL FLOW WITH OVERFLOW FROM DETENTION BASIN 06
 212          HC       2

 213          KK   ROUTE
 214          KM   ROUTE RUNOFF TO JUNCTION WITH SUB15 AND SUB20A USING MUSKINGUM-CUNGE ROUTING
 215          RD     680    .008    .025            TRAP       6       3

 216          KK   SUB15
 217          BA    .028
 218          LS              82
 219          UD     .10

 220          KK  SUB20A
 221          BA    .009
 222          LS              82
 223          UD     .10

 224          KK    CHAN
 225          KM   COMBINE RUNOFF FROM SUB15, SUB20A AND CHANNEL FROM DETENTION BASIN 06
 226          HC       3

 227          KK   ROUTE
 228          KM  ROUTE RUNOFF IN EXISTING CHANNEL TO OUTLET SUB16 USING MUSKINGUM-CUNGE ROUTING
 229          RD
 230          RC    .025    .025    .025     570   .0035    1495
 231          RX      90    90.1     100     106     115   115.1   115.2   115.3
 232          RY    1495  1493.8  1493.8  1490.8  1490.8  1493.8  1493.8    1495

 233          KK   SUB16
 234          BA    .026
 235          LS              82
 236          UD     .10

 237          KK    CHAN
 238          KM   COMBINE RUNOFF FROM SUB16 WITH CHANNEL
 239          HC       2

 240          KK    CHAN
 241          KM   ROUTE THROUGH EXISTING CHANNEL TO STA 49.4 USING MUSKINGUM-CUNGE ROUTING
 242          RD
 243          RC    .025    .025    .025     700   .0036    1491
 244          RX      90    90.1     100     106     115   115.1   115.2   115.3
 245          RY    1491  1489.3  1489.3  1486.3  1486.3  1489.3  1489.3    1491

 246          KK    38.7
 247          KM   ROUTE THROUGH EXISTING CHANNEL TO STA 38.7 USING MUSKINGUM-CUNGE ROUTING
 248          RD
 249          RC    .025    .025    .025    1070   .0055    1490
 250          RX     100   100.1   100.2     106     117   117.1   117.2   117.3
 251          RY    1490    1489    1489    1486    1486    1489    1489    1490
```

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

 252          KK  SUB20B
 253          BA    .013
 254          LS              82
 255          UD      .1

 256          KK  SUB20B
 257          KM   DIVERT FLOW TO DETENTION BASIN 07
 258          DT  DIVRT1
 259          DI     .36     2.2       7    10.4    13.7    24.2    36.4
 260          DQ     .29    1.76    5.25    6.76    8.22   11.13   14.56

 261          KK   SUB20
 262          BA    .051
 263          LS              82
 264          UD     .20

 265          KK   SUB20 INCLUDING FLOW FROM SUB20B
 266          KM   COMBINE FLOW FROM SUB20 AND SUB20B
 267          HC       2

 268          KK   SUB20
 269          KM   DIVERT FLOW TO DETENTION BASIN 07
 270          DT  DIVRT2
 271          DI     .74    4.74    29.8    51.2    77.6   108.2     143
 272          DQ     .59    2.84     9.5    11.3    16.3    19.5    22.9

 273          KK   ROUTE
 274          KM   ROUTE TO SUB20C USING MUSKINGUM-CUNGE ROUTING
 275          RD
 276          RC    .016    .016    .016     220   .0077    1488
 277          RX     100   100.1   105.1   107.1     123     139     141     146
 278          RY    1488  1486.9  1486.8 1486.32 1486.64 1486.32  1486.8    1488

 279          KK  SUB20C
 280          BA    .014
 281          LS              82
 282          UD     .10

 283          KK  SUB20C
 284          KM   COMBINE RUNOFF FROM SUB20 AND SUB20C
 285          HC       2

 286          KK  SUB20C
 287          KM   DIVERT FLOW TO DETENTION BASIN 07
 288          DT  DIVRT3
 289          DI       0       5      10      15    19.2    33.1    38.2    45.1    52.6      63
 290          DI    66.5      92   108.6   126.8   146.4   167.3
 291          DQ       0       5      10      15    19.2    31.6    33.8    35.9      36      37
 292          DQ      38      39    39.5      40    40.5      41
```

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

 293          KK   ROUTE
 294          KM  ROUTE RUNOFF FROM SUB20C THROUGH SUB21 USING MUSKINGUM-CUNGE ROUTING
 295          RD
 296          RC    .016    .016    .016     500   .0035    1489
 297          RX     100   100.1     105     107     123     139     141     146
 298          RY    1489  1485.8 1485.68 1485.12 1485.45 1485.14 1485.68    1489

 299          KK   SUB21
 300          BA    .020
 301          LS              82
 302          UD     .10

 303          KK  SUB21C
 304          BA    .002
 305          LS              82
 306          UD      .1

 307          KK    38.7
 308          KM   COMBINE ROUTED RUNOFF FROM SUB20C WITH SUB21, AND SUB21C
 309          HC       3

 310          KK    38.7
 311          KM   DIVERT FLOW TO GUTTER SECTION OF UTOPIA ROAD
 312          DT  DIVRT8
 313          DI    11.2    14.5    18.5    23.8    29.3    36.8    44.8    53.6    63.1    73.2
 314          DQ       0      .2     1.0     2.7     4.5     7.9    11.9    16.4    21.4    26.8

 315          KK    38.7
 316          KM   COMBINE CHANNEL RUNOFF WITH ROUTED FLOW DOWN 29th STREET
 317          HC       2

 318          KK   ROUTE
 319          KM   ROUTE RUNOFF TO STA 36.5 USING MUSKINGUM-CUNGE ROUTING
 320          RD
 321          RC    .025    .025    .025     240   .0027  1484.2
 322          RX     100   100.1   100.2     106     117   117.1   117.2   117.3
 323          RY  1484.2 1483.15 1483.15 1480.15 1480.15 1483.15 1483.15  1494.2

 324          KK  STRMDR
 325          KM   RETRIEVE DIVERSION FROM DIVRT1
 326          DR  DIVRT1

 327          KK  STRMDR
 328          KM   RETRIEVE DIVERSION FROM DIVRT2
 329          DR  DIVRT2

 330          KK  INTO07
 331          KM   RETRIEVE DIVERSION FROM DIVRT3
 332          DR  DIVRT3
```

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

 333          KK  INTO07
 334          KM   COMBINE RUNOFF FROM STORM DRAIN WITH DIVRT3
 335          HC       3

 336          KK   DET07
 337          KM   ROUTE FLOWS THROUGH DETENTION BASIN 07
 338          RS       1    ELEV    1481
 339          SV       0    1.25   2.241   3.311   4.545   5.595
 340          SE    1481    1482    1483    1484    1485  1485.8
 341          SS  1484.6       4     2.5     2.5

 342          KK  SUB21A
 343          BA    .002
 344          LS              82
 345          UD      .1

 346          KK  SUB21B
 347          BA    .002
 348          LS              82
 349          UD      .1

 350          KK  SUB21B
 351          KM   COMBINE CHANNEL RUNOFF FROM SUB21A WITH SUB21B
 352          HC       3

 353          KK   ROUTE
 354          KM   ROUTE COMBINED RUNOFF FROM CHANNEL AND SUB21B To STA 36.5
 355          RD
 356          RC    .025    .025    .025     130    .003  1482.8
 357          RX     100   100.1     106     110   110.1     114   114.1   114.2
 358          RY  1482.8 1481.76 1481.76  1480.7  1480.7 1481.76 1481.76  1482.8

 359          KK    36.5
 360          KM   COMBINE EXIST NORTH CHANNEL WITH "V" DITCH (DET07, SUB21A AND 21B)
 361          HC       2

 362          KK    36.5
 363          KM   DIVERT FLOW TO EXIST CHANNEL LT. STA 35+77
 364          DT  DIVRT5
 365          DI      69      95     135     182     232     276
 366          DQ      20      40      60      80     100     120

 367          KK  SUB23B
 368          BA   .0009
 369          LS              98
 370          UD      .1

 371          KK   36.91
 372          KM   RETRIEVE RUNOFF FROM DIVRT8
 373          DR  DIVRT8
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```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 374          KK   36.91
 375          KM   COMBINE RUNOFF FROM SUB23B AND DIVRT8
 376          HC       2

 377          KK   36.91
 378          KM   DIVERT FLOW TO SUB27
 379          DT  DIVRT9
 380          DI       7       9      11      14      16      18      20      22      24      26
 381          DQ       7       7       7       7       8       9      10      11      12      13

 382          KK   36.91
 383          KM   COMBINE CHANNEL FLOW WITH RUNOFF FROM SUB23B AND REMAINING FLOW FROM DIVRT9
 384          HC       2

 385          KK   36.91
 386          KM   RETRIEVE DIVRT 7
 387          DR  DIVRT7

 388          KK   36.91
 389          KM   SUB27
 390          BA   .0008
 391          LS              98
 392          UD      .1

 393          KK   36.91
 394          KM   RETRIEVE DIVRT9
 395          DR  DIVRT9

 396          KK   36.91
 397          KM   COMBINE FLOW IN STORM DRAIN (DIVRT7) WITH DIVRT9 AND SUB27
 398          HC       4

 399          KK   ROUTE
 400          KM   ROUTE RUNOFF FROM STA 36+91 TO 33+24 USING MUSKINGUM-CUNGE ROUTING
 401          RD     367    .001    .012            CIRC     6.5

 402          KK   33.24
 403          BA    .025
 404          LS              82
 405          UD      .1

 406          KK   33.24
 407          KM   COMBINE HYDROGRAPHS IN STORM DRAIN WITH SUB22
 408          HC       2

 409          KK   ROUTE
 410          KM   ROUTE RUNOFF TO STA 30+98 USING MUSKINGUM-CUNGE ROUTING
 411          RD     226    .001    .012            CIRC     7.0
```

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

 412          KK   35.77
 413          KM   RETRIEVE DIVERSION FROM DIVRT5
 414          DR  DIVRT5

 415          KK   ROUTE
 416          KM   ROUTE RUNOFF TO STA 33+00 USING MUSKINGUM-CUNGE ROUTING
 417          RD     277   .0071     .03            TRAP     4.0

 418          KK   SUB28
 419          BA   .0004
 420          LS              98
 421          UD      .1

 422          KK    33.0
 423          KM   COMBINE HYDROGRAPHS FROM STA 35+77 AND SUB 28
 424          HC       2
 425          ZZ
```

HEC1 S/N: 1343000484 HMVersion: 6.33 Data File: utord8.hc1

```
****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*             MAY   1991               *
*           VERSION 4.0.1E             *
*                                      *
*  RUN DATE  04/10/1995  TIME  15:55:56 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*    U.S. ARMY CORPS OF ENGINEERS      *
*    HYDROLOGIC ENGINEERING CENTER     *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
*           (916) 756-1104             *
*                                      *
****************************************
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                    MARICOPA COUNTY UNIT HYDROGRAPH PROCEDURE
                    UTOPIA ROAD WATERSHED: 24 HR - 100 YR RAINFALL ALTERNATE "C-1"
                    RUNOFF PARTIALLY UTILIZING EXIST. CHANNEL S. OF ROADWAY STA 32+06 TO 35+77

  5 IO        OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT        HYDROGRAPH TIME DATA
                     NMIN          1  MINUTES IN COMPUTATION INTERVAL
                    IDATE    11FEB94  STARTING DATE
                    ITIME       1300  STARTING TIME
                       NQ       1441  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE    12FEB94  ENDING DATE
                   NDTIME       1300  ENDING TIME
                    ICENT         19  CENTURY MARK

                COMPUTATION INTERVAL    0.02 HOURS
                     TOTAL TIME BASE   24.00 HOURS

          ENGLISH UNITS
               DRAINAGE AREA          SQUARE MILES
               PRECIPITATION DEPTH    INCHES
               LENGTH, ELEVATION      FEET
               FLOW                   CUBIC FEET PER SECOND
               STORAGE VOLUME         ACRE-FEET
               SURFACE AREA           ACRES
               TEMPERATURE            DEGREES FAHRENHEIT
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	SUB1	75.	12.53	13.	3.	3.	0.06		
HYDROGRAPH AT	SUB2	11.	12.50	2.	0.	0.	0.01		
2 COMBINED AT	INTO01	86.	12.52	14.	4.	4.	0.07		
ROUTED TO	DET01	85.	12.53	14.	4.	4.	0.07	1509.95	12.53
HYDROGRAPH AT	SUB3	34.	12.50	5.	2.	2.	0.03		
2 COMBINED AT	INTO02	119.	12.52	20.	5.	5.	0.09		
ROUTED TO	DET02	77.	12.67	13.	4.	4.	0.09	1505.93	12.67
HYDROGRAPH AT	SUB4	84.	12.53	14.	4.	4.	0.06		
2 COMBINED AT	INTO3	153.	12.60	26.	7.	7.	0.16		
ROUTED TO	DET03	151.	12.63	26.	7.	7.	0.16	1501.83	12.63
HYDROGRAPH AT	SUB5	12.	12.50	2.	1.	1.	0.01		
2 COMBINED AT	INTO4	158.	12.62	28.	8.	8.	0.16		
ROUTED TO	DET04	155.	12.65	28.	8.	8.	0.16	1497.86	12.65
HYDROGRAPH AT	SUB6	19.	12.50	3.	1.	1.	0.01		
HYDROGRAPH AT	SUB9	4.	12.50	1.	0.	0.	0.00		
HYDROGRAPH AT	SUB7	32.	12.50	5.	1.	1.	0.02		
ROUTED TO	ROUTE	32.	12.55	5.	1.	1.	0.02		
HYDROGRAPH AT	SUB8	3.	12.50	0.	0.	0.	0.00		
5 COMBINED AT	INTO5	199.	12.58	37.	10.	10.	0.21		
ROUTED TO	DET05	140.	12.80	37.	10.	10.	0.21	1495.67	12.80
HYDROGRAPH AT	SUB17	9.	12.50	2.	1.	1.	0.00		
2 COMBINED AT	61.87	145.	12.75	39.	11.	11.	0.21		
ROUTED TO	ROUTE	145.	12.75	39.	11.	11.	0.21		
HYDROGRAPH AT	SUB18	15.	12.50	2.	1.	1.	0.01		
2 COMBINED AT	58.85	148.	12.60	41.	12.	12.	0.22		
ROUTED TO	ROUTE	147.	12.62	41.	12.	12.	0.22		
HYDROGRAPH AT	SUB24A	2.	12.50	0.	0.	0.	0.00		
2 COMBINED AT	55.03	149.	12.60	41.	12.	12.	0.22		
ROUTED TO	ROUTE	149.	12.60	41.	12.	12.	0.22		
HYDROGRAPH AT	SUB19A	4.	12.50	1.	0.	0.	0.00		
HYDROGRAPH AT	SUB24B	2.	12.50	0.	0.	0.	0.00		
3 COMBINED AT	53.18	154.	12.57	42.	12.	12.	0.23		
ROUTED TO	53.18	153.	12.58	42.	12.	12.	0.23		
HYDROGRAPH AT	SUB19B	18.	12.50	3.	1.	1.	0.01		
HYDROGRAPH AT	SUB25A	1.	12.42	0.	0.	0.	0.00		
HYDROGRAPH AT	SUB25B	1.	12.42	0.	0.	0.	0.00		
4 COMBINED AT	49.22	172.	12.55	46.	13.	13.	0.24		
ROUTED TO	ROUTE	171.	12.55	46.	13.	13.	0.24		
HYDROGRAPH AT	SUB26	3.	12.50	1.	0.	0.	0.00		
HYDROGRAPH AT	SUB23A	2.	12.47	0.	0.	0.	0.00		
3 COMBINED AT	42.85	176.	12.55	47.	13.	13.	0.25		
ROUTED TO	ROUTE	174.	12.55	47.	13.	13.	0.25		
DIVERSION TO	DIVRT7	174.	0.02	47.	13.	13.	0.25		
HYDROGRAPH AT	36.91	0.	0.02	0.	0.	0.	0.25		
HYDROGRAPH AT	SUB12	71.	12.53	12.	3.	3.	0.05		
HYDROGRAPH AT	SUB13	4.	12.50	1.	0.	0.	0.00		
2 COMBINED AT	BEGCH	75.	12.53	12.	3.	3.	0.06		
ROUTED TO	ROUTE	74.	12.57	12.	3.	3.	0.06		
HYDROGRAPH AT	SUB14	38.	12.50	6.	2.	2.	0.03		
ROUTED TO	DET06	36.	12.53	3.	1.	1.	0.03	1498.96	12.53
2 COMBINED AT	CHAN	111.	12.55	16.	4.	4.	0.09		

ROUTED TO	ROUTE	110.	12.57	16.	4.	4.	0.09		
HYDROGRAPH AT	SUB15	38.	12.50	6.	2.	2.	0.03		
HYDROGRAPH AT	SUB20A	12.	12.50	2.	1.	1.	0.01		
3 COMBINED AT	CHAN	158.	12.53	24.	7.	7.	0.12		
ROUTED TO	ROUTE	157.	12.55	24.	7.	7.	0.12		
HYDROGRAPH AT	SUB16	35.	12.50	6.	2.	2.	0.03		
2 COMBINED AT	CHAN	191.	12.53	29.	8.	8.	0.15		
ROUTED TO	CHAN	189.	12.55	29.	8.	8.	0.15		
ROUTED TO	38.7	189.	12.58	29.	8.	8.	0.15		
HYDROGRAPH AT	SUB20B	18.	12.50	3.	1.	1.	0.01		
DIVERSION TO	DIVRT1	9.	12.50	2.	1.	1.	0.01		
HYDROGRAPH AT	SUB20B	8.	12.50	1.	0.	0.	0.01		
HYDROGRAPH AT	SUB20	66.	12.53	11.	3.	3.	0.05		
2 COMBINED AT	SUB20	74.	12.52	12.	3.	3.	0.06		
DIVERSION TO	DIVRT2	16.	12.52	4.	1.	1.	0.06		
HYDROGRAPH AT	SUB20	58.	12.52	8.	2.	2.	0.06		
ROUTED TO	ROUTE	58.	12.53	8.	2.	2.	0.06		
HYDROGRAPH AT	SUB20C	19.	12.50	3.	1.	1.	0.01		
2 COMBINED AT	SUB20C	77.	12.52	11.	3.	3.	0.08		
DIVERSION TO	DIVRT3	38.	12.52	8.	2.	2.	0.08		
HYDROGRAPH AT	SUB20C	39.	12.52	3.	1.	1.	0.08		
ROUTED TO	ROUTE	39.	12.55	3.	1.	1.	0.08		
HYDROGRAPH AT	SUB21	27.	12.50	4.	1.	1.	0.02		
HYDROGRAPH AT	SUB21C	3.	12.50	0.	0.	0.	0.00		
3 COMBINED AT	38.7	67.	12.52	8.	2.	2.	0.10		
DIVERSION TO	DIVRT8	24.	12.52	2.	0.	0.	0.10		
HYDROGRAPH AT	38.7	44.	12.52	6.	2.	2.	0.10		
2 COMBINED AT	38.7	230.	12.57	36.	10.	10.	0.25		
ROUTED TO	ROUTE	229.	12.58	35.	10.	10.	0.25		
HYDROGRAPH AT	STRMDR	9.	12.50	2.	1.	1.	0.00		
HYDROGRAPH AT	STRMDR	16.	12.52	4.	1.	1.	0.00		
HYDROGRAPH AT	INTO07	38.	12.52	8.	2.	2.	0.00		
3 COMBINED AT	INTO07	63.	12.52	13.	4.	4.	0.00		
ROUTED TO	DET07	9.	13.20	4.	1.	1.	0.00	1485.57	13.22
HYDROGRAPH AT	SUB21A	3.	12.50	0.	0.	0.	0.00		
HYDROGRAPH AT	SUB21B	3.	12.50	0.	0.	0.	0.00		
3 COMBINED AT	SUB21B	10.	13.20	5.	2.	2.	0.00		
ROUTED TO	ROUTE	10.	13.20	5.	2.	2.	0.00		
2 COMBINED AT	36.5	233.	12.58	40.	12.	12.	0.25		
DIVERSION TO	DIVRT5	101.	12.58	22.	7.	7.	0.25		
HYDROGRAPH AT	36.5	133.	12.58	18.	5.	5.	0.25		
HYDROGRAPH AT	SUB23B	2.	12.47	0.	0.	0.	0.00		
HYDROGRAPH AT	36.91	24.	12.52	2.	0.	0.	0.00		
2 COMBINED AT	36.91	25.	12.52	2.	1.	1.	0.00		
DIVERSION TO	DIVRT9	13.	12.52	1.	0.	0.	0.00		
HYDROGRAPH AT	36.91	13.	12.52	1.	0.	0.	0.00		
2 COMBINED AT	36.91	144.	12.57	19.	5.	5.	0.25		
HYDROGRAPH AT	36.91	174.	12.55	47.	13.	13.	0.00		
HYDROGRAPH AT	36.91	1.	12.47	0.	0.	0.	0.00		
HYDROGRAPH AT	36.91	13.	12.52	1.	0.	0.	0.00		
4 COMBINED AT	36.91	332.	12.55	67.	18.	18.	0.25		
ROUTED TO	ROUTE	329.	12.55	67.	18.	18.	0.25		
HYDROGRAPH AT	33.24	34.	12.50	5.	2.	2.	0.03		
2 COMBINED AT	33.24	361.	12.55	73.	20.	20.	0.28		
ROUTED TO	ROUTE	359.	12.55	73.	20.	20.	0.28		

HYDROGRAPH AT	35.77	101.	12.58	22.	7.	7.	0.00
ROUTED TO	ROUTE	101.	12.58	22.	7.	7.	0.00
HYDROGRAPH AT	SUB28	1.	12.35	0.	0.	0.	0.00
2 COMBINED AT	33.0	101.	12.58	22.	7.	7.	0.00

SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

ISTAQ	ELEMENT	DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)	INTERPOLATED TO COMPUTATION INTERVAL DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)
ROUTE	MANE	1.00	32.38	753.00	2.23	1.00	32.38	753.00	2.23
CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2858E+01 EXCESS=0.0000E+00 OUTFLOW=0.2851E+01 BASIN STORAGE=0.9328E-02 PERCENT ERROR= -0.1									
ROUTE	MANE	0.36	144.82	765.14	1.91	1.00	144.81	765.00	1.91
CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2164E+02 EXCESS=0.0000E+00 OUTFLOW=0.2163E+02 BASIN STORAGE=0.4668E-02 PERCENT ERROR= 0.0									
ROUTE	MANE	0.45	147.49	756.98	1.92	1.00	147.49	757.00	1.93
CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2295E+02 EXCESS=0.0000E+00 OUTFLOW=0.2295E+02 BASIN STORAGE=0.6172E-02 PERCENT ERROR= 0.0									
ROUTE	MANE	0.22	148.52	756.15	1.93	1.00	148.50	756.00	1.93
CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2315E+02 EXCESS=0.0000E+00 OUTFLOW=0.2315E+02 BASIN STORAGE=0.3002E-02 PERCENT ERROR= 0.0									
53.18	MANE	0.47	153.45	754.66	1.95	1.00	153.44	755.00	1.95
CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2380E+02 EXCESS=0.0000E+00 OUTFLOW=0.2380E+02 BASIN STORAGE=0.6543E-02 PERCENT ERROR= 0.0									
ROUTE	MANE	0.60	171.60	753.59	1.97	1.00	171.49	753.00	1.97
CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2566E+02 EXCESS=0.0000E+00 OUTFLOW=0.2565E+02 BASIN STORAGE=0.9072E-02 PERCENT ERROR= 0.0									
ROUTE	MANE	1.00	174.37	753.00	1.98	1.00	174.37	753.00	1.98
CONTINUITY SUMMARY (AC-FT) - INFLOW=0.2617E+02 EXCESS=0.0000E+00 OUTFLOW=0.2610E+02 BASIN STORAGE=0.2199E-01 PERCENT ERROR= 0.2									
ROUTE	MANE	1.00	74.15	754.00	2.22	1.00	74.15	754.00	2.22
CONTINUITY SUMMARY (AC-FT) - INFLOW=0.6847E+01 EXCESS=0.0000E+00 OUTFLOW=0.6832E+01 BASIN STORAGE=0.1804E-01 PERCENT ERROR= -0.1									
ROUTE	MANE	1.00	110.32	754.00	1.90	1.00	110.32	754.00	1.90
CONTINUITY SUMMARY (AC-FT) - INFLOW=0.8676E+01 EXCESS=0.0000E+00 OUTFLOW=0.8666E+01 BASIN STORAGE=0.1607E-01 PERCENT ERROR= -0.1									
ROUTE	MANE	1.00	157.01	753.00	2.00	1.00	157.01	753.00	2.00
CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1307E+02 EXCESS=0.0000E+00 OUTFLOW=0.1306E+02 BASIN STORAGE=0.2716E-01 PERCENT ERROR= -0.1									
CHAN	MANE	1.00	189.43	753.00	2.04	1.00	189.43	753.00	2.04
CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1615E+02 EXCESS=0.0000E+00 OUTFLOW=0.1613E+02 BASIN STORAGE=0.3709E-01 PERCENT ERROR= -0.1									
38.7	MANE	1.00	188.63	755.00	2.03	1.00	188.63	755.00	2.03
CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1613E+02 EXCESS=0.0000E+00 OUTFLOW=0.1610E+02 BASIN STORAGE=0.4939E-01 PERCENT ERROR= -0.1									
ROUTE	MANE	0.80	58.42	751.56	1.27	1.00	58.41	752.00	1.27
CONTINUITY SUMMARY (AC-FT) - INFLOW=0.4340E+01 EXCESS=0.0000E+00 OUTFLOW=0.4339E+01 BASIN STORAGE=0.1564E-02 PERCENT ERROR= 0.0									
ROUTE	MANE	1.00	38.53	753.00	0.41	1.00	38.53	753.00	0.41
CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1702E+01 EXCESS=0.0000E+00 OUTFLOW=0.1703E+01 BASIN STORAGE=0.1221E-03 PERCENT ERROR= -0.1									
ROUTE	MANE	0.68	228.84	754.46	1.47	1.00	228.84	755.00	1.47
CONTINUITY SUMMARY (AC-FT) - INFLOW=0.1949E+02 EXCESS=0.0000E+00 OUTFLOW=0.1948E+02 BASIN STORAGE=0.1539E-01 PERCENT ERROR= 0.0									
ROUTE	MANE	0.95	9.54	792.32	15.96	1.00	9.54	793.00	15.96
CONTINUITY SUMMARY (AC-FT) - INFLOW=0.3409E+01 EXCESS=0.0000E+00 OUTFLOW=0.3406E+01 BASIN STORAGE=0.3555E-02 PERCENT ERROR= 0.0									
ROUTE	MANE	0.75	329.32	753.70	2.68	1.00	329.10	753.00	2.68
CONTINUITY SUMMARY (AC-FT) - INFLOW=0.3643E+02 EXCESS=0.0000E+00 OUTFLOW=0.3637E+02 BASIN STORAGE=0.1318E-01 PERCENT ERROR= 0.1									

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          ROUTE  MANE        0.45    359.06    752.80      2.64      1.00    358.95    753.00        2.64

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.3935E+02 EXCESS=0.0000E+00 OUTFLOW=0.3931E+02 BASIN STORAGE=0.8728E-02 PERCENT ERROR=   0.1

          ROUTE  MANE        0.43    100.63    755.07     -1.00      1.00    100.63    755.00       -1.00


*** NORMAL END OF HEC-1 ***
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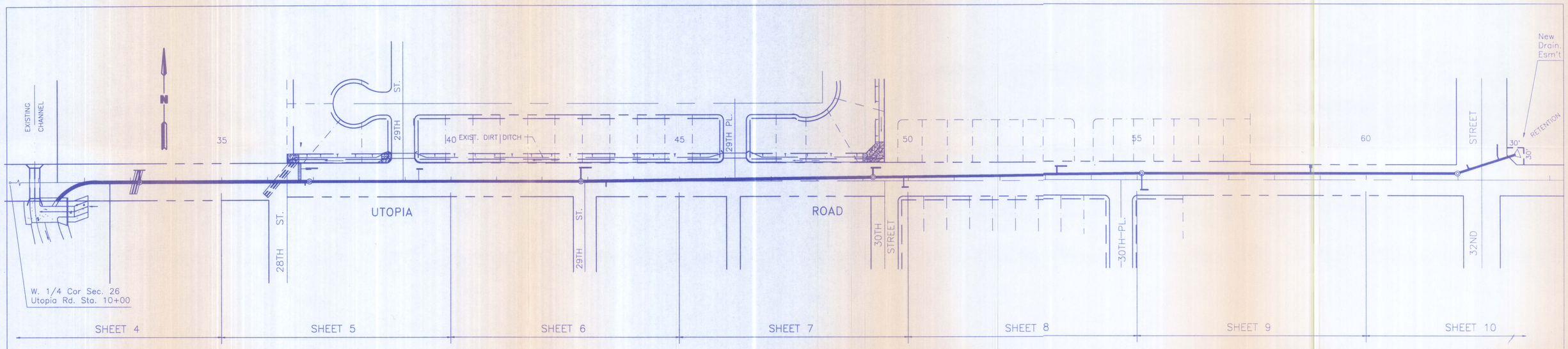
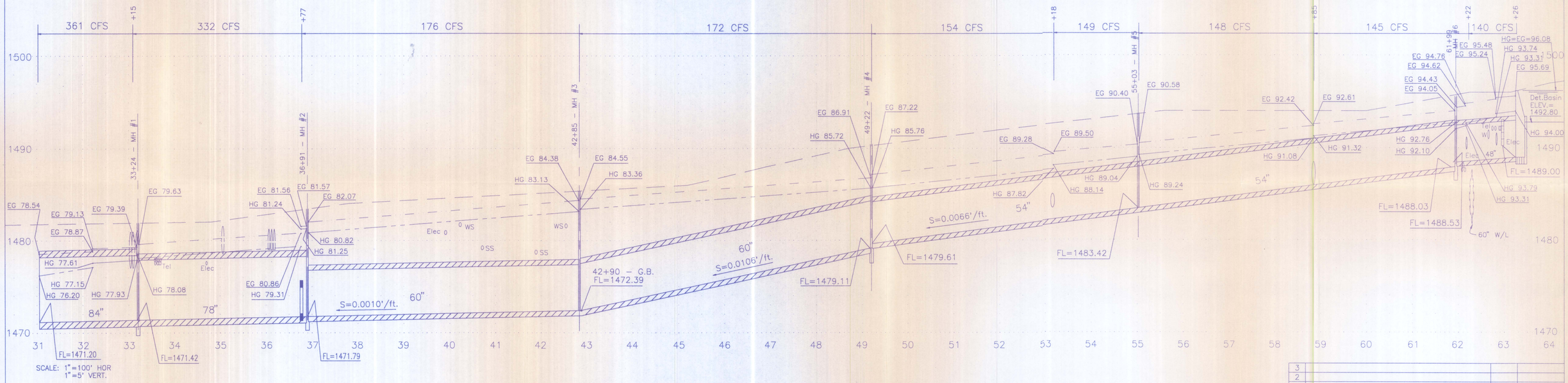


KEY MAP



SCALE: 1"=100' HOR
1"=5' VERT.

PROJECT PROFILE

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

UTOPIA ROAD LATERAL
(UPPER EAST FORK CAVE CREEK)
ST-930305

	BY	DATE
DESIGNED	R. ERIKSON	4/95
DRAWN	J. KRATOCHVIL	4/95
CHECKED	M. SALMON	4/95

Registered Professional Engineer (Civil) CERTIFICATE NO. 41918 ERIKSON ARIZONA, U.S.A.

ERIKSON & SALMON, INC.
Consulting Civil Engineers

PROJECT PROFILE AND KEY MAP

SHEET 3 OF 18

City of Phoenix,
Arizona

Revision Date: 3/29/95

ENGINEER'S ESTIMATE WORKSHEET

Index No. ST-930305

Item No. Item ID.	Description	Unit	Approximate Quantity	Unit Price	TOTAL
1-M3010001	Subgrade Preparation	Sq. Yd.	812	5.00	4,060.00
2-M3360115	Asph. Conc. for Permanent Pavement Replacement, Type C 3/4, 4" Thick	Sq. Yd.	3,996	20.00	79,920.00
3-M3400400	Concrete Sidewalk, Std. Detail P-1230	Sq. Ft.	293	5.00	1,465.00
4-M3402201	Combined Curb & Gutter, Std. Detail 220, Type "A", H=6"	Lin. Ft.	307	10.00	3,070.00
5-M3450020	Adjust Existing Manhole Frame & Cover, Standard Detail 422	Each	1	250.00	250.00
6-M3453001	Adjust Existing Type "A" Water Valve Standard Detail 391-1	Each	3	225.00	675.00
7-M3500010	Remove Portland Cement Concrete Single Curb and Curb and Gutter	Lin. Ft.	307	5.00	1,535.00
8-M3500020	Remove Portland Cement Concrete Sidewalk, Driveway, Valley Gutter & Slab	Sq. Ft.	1,016	5.00	5,080.00
9-M3500030	Remove Structures, Backfill & Compact	Job	1	1,000.00	1,000.00
10-M3500040	Remove Pipe, Backfill & Compact	Lin. Ft.	205	10.00	2,050.00
11-M3500055	Remove Existing 12" Thick Reinforced Concrete Channel Lining	Sq. Yd.	39	200.00	7,800.00
12-M3500300	Miscellaneous Removal and Other Work	Job	1	2,000.00	2,000.00
13-M4012000	Traffic Control Devices	Job	1	15,000.00	15,000.00
14-M4013000	Uniformed, Off-Duty Law Enforcement Officer	Hour	80	21.00	1,680.00
15-M4051201	Survey Marker, MAG Standard Det. 120-1 Type "A"	Each	1	300.00	300.00
16-M4051202	Survey Marker, MAG Standard Det 120-1, Type "B"	Each	4	200.00	800.00
17-M4153100	Guard Rail, ADOT Standard Details C-10 Series	Lin. Ft	25	10.00	250.00
18-M4200012	6-Foot Steel Gate with Wood Inserts and Locking Device	Each	1	1,500.00	1,500.00
19-M4201000	Relocate Chain Link Fence per Plans	L.F.	25	20.00	500.00
20-M5051530	Concrete Catch Basin, Type "M-1", L=3-Ft", Phx. Supp. Detail P-1569-1	Each	2	1,500.00	3,000.00

ENGINEER'S ESTIMATE WORKSHEET

Index No. ST-930305

Item No. Item ID.	Description	Unit	Approximate Quantity	Unit Price	TOTAL
21-M5051540	Concrete Catch Basin, Type "M-1, L=10-Ft", Phx. Supp. Detail P-1569-1	Each	1	2,500.00	2,500.00
22-M5051545	Concrete Catch Basin, Type "M-1, L=17-Ft", Phx. Supp. Detail P-1569-1	Each	5	3,000.00	15,000.00
23-M5051565	Concrete Catch Basin, Type "N-1", Phx. Supp. Detail P-1570	Each	1	1,500.00	1,500.00
24-M5051578	Concrete Catch Basin, Type "N-2 Mod" Phx. Supp. Detail P-1570	Each	1	2,500.00	2,500.00
25-M5052074	Concrete Channel Lining	Sq. Yd.	76	150.00	11,400.00
26-M5055015	Headwall for 36" Pipe, MAG Standard Detail 501-1 And Phx. Supp. P-1563	Each	1	2,000.00	2,000.00
27-M5056084	Outlet Headwall for 84" Pipe, per Special Detail	Each	1	15,000.00	15,000.00
28-M5057081	Outlet Structure for Detention Basin, per Special Detail	Each	1	10,000.00	10,000.00
29-M5057092	Inlet Headwall for 6' X 3' Box Culvert, per Special Detail	Each	1	20,000.00	20,000.00
30-M5057106	Box Culvert, 6' X 3', ADOT Std.B-02.10	L.F.	40	250.00	10,000.00
31-M6009900	Pipe Price Adjustment, +/-, per Project Specification	Job	1		
32-M6014030	Permanent Pipe Support, MAG Standard Details 403-1 and 403-2, or Alternate	Each	2	500.00	1,000.00
33-M6100341	3/4" and 1" Water Service Replacement per Special Provisions, Contingent Item	Lin. Ft.	15	20.00	300.00
34-M6101008	8" Water Pipe and Fittings, Furnish & Install	Lin. Ft.	69	40.00	2,760.00
35-M6101801	Relocate Existing Water Meter, Box, and Cover, Contingent Item	Each	1	100.00	100.00
36-M6103706	Waterline Realignment, 6" and 8" Contingent Item	Each	2	1,500.00	3,000.00
37-M6103710	Waterline Realignment, 10" and 12" Contingent Item	Each	1	2,000.00	2,000.00
38-M6104308	Cutting and Plugging Existing Water Line, 6" - 8"	Each	2	200.00	400.00
39-M6180048	48" Storm Drain Pipe	Lin. Ft.	127	100.00	12,700.00
40-M6180054	54" Storm Drain Pipe	Lin. Ft.	1,277	120.00	153,240.00

ENGINEER'S ESTIMATE WORKSHEET

Index No. ST-930305

Item No. Item ID.	Description	Unit	Approximate Quantity	Unit Price	TOTAL
41-M6180060	60" Storm Drain Pipe	Lin.Ft.	1,231	150	184,650.00
42-M6180078	78" Storm Drain Pipe	Lin. Ft.	367	240.00	88,080.00
43-M6180084	84" Storm Drain Pipe	Lin. Ft.	190	300.00	57,000.00
44-M6180427	Pipe Plug, Standard Detail 427	Each	3	200.00	600.00
45-M6180505	Concrete Pipe Collar for 24" Pipe and Larger, MAG Standard Detail	Each	1	500.00	500.00
46-M6181015	15" Catch Basin Connector Pipe	Lin. Ft.	106	40.00	4,240.00
47-M6181018	18" Catch Basin Connector Pipe	Lin. Ft.	38	50.00	1,900.00
48-M6181024	24" Catch Basin Connector Pipe	Lin. Ft.	32	60.00	1,920.00
49-M6181036	36" Catch Basin Connector Pipe	Lin. Ft.	34	80.00	2,720.00
50-M6186043	54" X 54" X 15" Prefabricated Tee	Each	2	500.00	1,000.00
51-M6186044	60" X 60" X 15" Prefabricated Tee	Each	2	500.00	1,000.00
52-M6186045	60" X 60" X 18" Prefabricated Tee	Each	1	500.00	500.00
53-M6186061	78" X 78" X 18" Prefabricated Tee	Each	1	500.00	500.00
54-M6186067	84" X 84" X 36" Prefabricated Tee	Each	1	1,000.00	1,000.00
55-M6186141	48" X 48" X 18" Prefabricated Tee	Each	1	500.00	500.00
56-M6186142	48" X 48" X 36" Prefabricated Tee	Each	1	750.00	750.00
57-M6186143	54" X 54" X 36" Prefabricated Tee	Each	1	750.00	750.00
58-M6187010	78" X 78" X 6' X 3' Tee, per Special Deta	Each	1	5,000.00	5,000.00
59-M6250010	Storm Sewer Manhole, MAG Standard Detail 521 and 522	Each	2	2,500.00	5,000.00
60-M6250015	Storm Sewer M.H. Base Transition, Phx. Supp. Det P-1560 & MAG Std. Det.522	Each	4	3,000.00	12,000.00

City of Phoenix
Arizona

ENGINEER'S ESTIMATE WORKSHEET

Index No. ST-930305

Item No. Item ID.	Description	Unit	Approximate Quantity	Unit Price	TOTAL
61-M6304030	8" X 8" Tapping Sleeve and Valve, Box & Cover, Furnish & Install	Each	1	2,000.00	2,000.00
62-M6304060	12" X 8" Tapping Sleeve and Valve, Box Cover, Furnish & Install	Each	1	2,500.00	2,500.00
TOTAL AMOUNT OF CONSTRUCTION ESTIMATE				$	771,445.00
	Index No. : ST-930305 UTOPIA RD: 27ST - 32ST				

HEC2 S/N: 1363000413 HMVersion: 6.52 Data File: UTORD3.hc2

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*******************************************
*  HEC-2 WATER SURFACE PROFILES           *
*                                         *
*  Version   4.6.2;  May 1991             *
*                                         *
*  RUN DATE    18AUG94    TIME    12:41:50 *
*******************************************
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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              *
****************************************
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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  XXXXXXX   XXXXX              XXXXXXX
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::::::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::::::
::::                                        ::::
::::   FULL MICRO-COMPUTER IMPLEMENTATION    ::::
::::                                        ::::
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H A E S T A D   M E T H O D S
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37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

THIS RUN EXECUTED 18AUG94 12:41:50

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

 Version   4.6.2:  May 1991
*************************************

T1 UTOPIA ROAD EAST FORK OF CAVE CREEK WASH
T2 Q = 1375 cfs
T3       EAST FORK CAVE CREEK
J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ
                 2        0        0       -1        0        0        0                 0
J3  VARIABLE CODES FOR SUMMARY PRINTOUT
    150      150
NC     .03      .03      .03       .3       .8
QT       1     1375
X1  122.98        4     1000     1096        0        0        0        0        0        0
GR   77.10     1000     70.1     1021     70.1     1075     77.1     1096
X1  123.13        4     1000   1156.3       15       15       15        0        0        0
GR    77.6     1000    70.12     1036    70.12   1120.3     76.1   1156.3
X1  123.23        5     1000   1192.5       10       10       10        0        0        0
GR      78     1000    70.65     1044    70.13   1096.3    70.65   1148.5       78   1192.5
NC    .017     .017     .017       .1       .3
X1  123.38        5     1000     1186       15       15       15        0        0        0
GR      78     1000    71.14     1041    70.14     1093    71.14     1145       78     1186
X1   123.5        5     1000     1185       12       12       12        0        0        0
GR      78     1000    71.15     1041    70.15   1092.6    71.15   1144.2       78     1185
X1  123.75        5     1000   1184.9       25       25       25        0        0        0
GR    78.2     1000    71.18     1042    70.18     1093    71.18   1143.9     78.2   1184.9
X1  124.00        5     1000   1186.8       25       25       25        0        0        0
GR    78.3     1000    71.21     1043    70.21   1093.9    71.21   1143.6     78.3   1186.8
```

X1	124.25	5	1000	1186	25	25	25	0	0	0
GR	78.4	1000	71.22	1043	70.23	1093.3	71.22	1143.7	78.4	1186
X1	124.5	5	1000	1186	25	25	25	0	0	0
GR	78.6	1000	71.24	1044	70.26	1093	71.24	1142	78.6	1186
X1	124.75	5	1000	1186.7	25	25	25	0	0	0
GR	78.7	1000	71.25	1045	70.28	1093.3	71.25	1141.7	78.7	1186.7
X1	125.00	5	1000	1185.3	25	25	25	0	0	0
GR	78.9	1000	71.26	1045	70.31	1092.7	71.26	1140.3	78.8	1185.3
X1	125.25	5	1000	1186	25	25	25	0	0	0
GR	79	1000	71.27	1046	70.33	1093	71.27	1140	79	1186
X1	125.5	5	1000	1186.6	25	25	25	0	0	0
GR	79	1000	71.28	1047	70.35	1092.7	71.28	1139.6	79.1	1186.6
X1	125.75	5	1000	1187.3	25	25	25	0	0	0
GR	79.3	1000	71.29	1048	70.38	1093.6	71.29	1139.3	79.3	1187.3
X1	126.00	5	1000	1188	25	25	25	0	0	0
GR	79.4	1000	71.31	1049	70.41	1094	71.31	1139	79.4	1188
X1	126.25	5	1000	1175	25	25	25	0	0	0
GR	79.6	1000	71.29	1045	70.43	1087.5	71.29	1130	79.6	1175
X1	126.5	5	1000	1164	25	25	25	0	0	0
GR	79.7	1000	71.26	1041.5	70.45	1082	71.26	1122.5	79.7	1164
X1	126.75	5	1000	1154.5	25	25	25	0	0	0
GR	79.8	1000	71.25	1039	70.48	1077.3	71.25	1115.5	79.8	1154.5
X1	127.00	5	1000	1142	25	25	25	0	0	0
GR	79.9	1000	71.22	1035	70.50	1071	71.22	1107	79.7	1142

X1	127.25	5	1000	1130	25	25	25	0	0	0
GR	80	1000	71.21	1031	70.53	1064.8	71.21	1098.5	80	1130
X1	127.50	5	1000	1115	25	25	25	0	0	0
GR	80	1000	71.18	1026	70.55	1057.5	71.18	1089	80	1115
NC	.030	.030	.030	.1	.3					
X1	127.75	6	1000	1098.1	25	25	25	0	0	0
GR	80	1000	71.17	1021	70.58	1050.2	71.17	1079.5	75.6	1098
GR	79	1098.1								
X1	127.90	7	1000	1094.2	15	15	15	0	0	0
GR	80	1000	71.16	1018	70.60	1046	71.16	1074	71.9	1094
GR	75.27	1094.1	80	1094.2						

```
   SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
   Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
   TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
   SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

*PROF 1


CCHV=    0.300 CEHV=    0.800
*SECNO 122.980
2096 WSEL NOT GIVEN, AVG OF MAX, MIN USED
3720 CRITICAL DEPTH ASSUMED
   122.980      2.58      72.68      72.68       0.00      73.84       1.16       0.00       0.00      77.10
    1375.0       0.0     1375.0        0.0        0.0      159.4        0.0        0.0        0.0      77.10
      0.00      0.00       8.63       0.00      0.000      0.030      0.000      0.000      70.10    1013.26
  0.010192        0.         0.         0.          0         14          0       0.00      69.49    1082.74

*SECNO 123.130

3301 HV CHANGED MORE THAN HVINS

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  3.21

   123.130      3.87      73.99       0.00       0.00      74.16       0.18       0.03       0.29      77.60
    1375.0       0.0     1375.0        0.0        0.0      406.2        0.0        0.1        0.0      76.10
      0.00      0.00       3.38       0.00      0.000      0.030      0.000      0.000      70.12    1017.42
  0.000989       15.        15.        15.          3          0          0       0.00     126.12    1143.54

*SECNO 123.230
   123.230      3.91      74.04       0.00       0.00      74.18       0.14       0.01       0.01      78.00
    1375.0       0.0     1375.0        0.0        0.0      450.6        0.0        0.2        0.1      78.00
      0.00      0.00       3.05       0.00      0.000      0.030      0.000      0.000      70.13    1023.69
  0.000842       10.        10.        10.          0          0          0       0.00     145.12    1168.81

CCHV=    0.100 CEHV=    0.300
*SECNO 123.380
3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.50

   123.380      3.88      74.02       0.00       0.00      74.20       0.18       0.01       0.01      78.00
    1375.0       0.0     1375.0        0.0        0.0      401.2        0.0        0.3        0.1      78.00
      0.00      0.00       3.43       0.00      0.000      0.017      0.000      0.000      70.14    1023.78
  0.000374       15.        15.        15.          2          0          0       0.00     138.44    1162.22
```

SECNO Q TIME SLOPE	DEPTH QLOB VLOB XLOBL	CWSEL QCH VCH XLCH	CRIWS QROB VROB XLOBR	WSELK AEOB XNL ITRIAL	EG ACH XNCH IDC	HV AROB XNR ICONT	HL VOL WTN CORAR	OLOSS TWA ELMIN TOPWID	L-BANK ELEV R-BANK ELEV SSTA ENDST
*SECNO 123.500									
123.500	3.87	74.02	0.00	0.00	74.21	0.19	0.00	0.00	78.00
1375.0	0.0	1375.0	0.0	0.0	398.1	0.0	0.5	0.2	78.00
0.00	0.00	3.45	0.00	0.000	0.017	0.000	0.000	70.15	1023.77
0.000380	12.	12.	12.	0	0	0	0.00	137.57	1161.34
*SECNO 123.750									
123.750	3.85	74.03	0.00	0.00	74.22	0.19	0.01	0.00	78.20
1375.0	0.0	1375.0	0.0	0.0	389.8	0.0	0.7	0.2	78.20
0.01	0.00	3.53	0.00	0.000	0.017	0.000	0.000	70.18	1024.93
0.000400	25.	25.	25.	0	0	0	0.00	135.63	1160.56
*SECNO 124.000									
124.000	3.82	74.03	0.00	0.00	74.23	0.20	0.01	0.00	78.30
1375.0	0.0	1375.0	0.0	0.0	383.3	0.0	0.9	0.3	78.30
0.01	0.00	3.59	0.00	0.000	0.017	0.000	0.000	70.21	1025.85
0.000421	25.	25.	25.	0	0	0	0.00	134.98	1160.83
*SECNO 124.250									
124.250	3.81	74.04	0.00	0.00	74.24	0.20	0.01	0.00	78.40
1375.0	0.0	1375.0	0.0	0.0	381.6	0.0	1.1	0.4	78.40
0.01	0.00	3.60	0.00	0.000	0.017	0.000	0.000	70.23	1026.09
0.000424	25.	25.	25.	0	0	0	0.00	134.25	1160.34
*SECNO 124.500									
124.500	3.79	74.05	0.00	0.00	74.26	0.21	0.01	0.00	78.60
1375.0	0.0	1375.0	0.0	0.0	371.0	0.0	1.3	0.5	78.60
0.01	0.00	3.71	0.00	0.000	0.017	0.000	0.000	70.26	1027.18
0.000454	25.	25.	25.	0	0	0	0.00	131.64	1158.82
*SECNO 124.750									
124.750	3.77	74.05	0.00	0.00	74.27	0.22	0.01	0.00	78.70
1375.0	0.0	1375.0	0.0	0.0	365.9	0.0	1.5	0.5	78.70
0.01	0.00	3.76	0.00	0.000	0.017	0.000	0.000	70.28	1028.05
0.000470	25.	25.	25.	0	0	0	0.00	130.60	1158.65

SECNO Q TIME SLOPE	DEPTH QLOB VLOB XLOBL	CWSEL QCH VCH XLCH	CRIWS QROB VROB XLOBR	WSELK ALOB XNL ITRIAL	EG ACH XNCH IDC	HV AROB XNR ICONT	HL VOL WTN CORAR	OLOSS TWA ELMIN TOPWID	L-BANK ELEV R-BANK ELEV SSTA ENDST
*SECNO 125.000									
125.000	3.75	74.06	0.00	0.00	74.29	0.23	0.01	0.00	78.90
1375.0	0.0	1375.0	0.0	0.0	359.2	0.0	1.8	0.6	78.80
0.02	0.00	3.83	0.00	0.000	0.017	0.000	0.000	70.31	1028.48
0.000490	25.	25.	25.	0	0	0	0.00	128.55	1157.04
*SECNO 125.250									
125.250	3.74	74.07	0.00	0.00	74.30	0.23	0.01	0.00	79.00
1375.0	0.0	1375.0	0.0	0.0	354.2	0.0	2.0	0.7	79.00
0.02	0.00	3.88	0.00	0.000	0.017	0.000	0.000	70.33	1029.33
0.000507	25.	25.	25.	0	0	0	0.00	127.34	1156.67
*SECNO 125.500									
125.500	3.73	74.08	0.00	0.00	74.32	0.24	0.01	0.00	79.00
1375.0	0.0	1375.0	0.0	0.0	349.7	0.0	2.2	0.8	79.10
0.02	0.00	3.93	0.00	0.000	0.017	0.000	0.000	70.35	1029.96
0.000524	25.	25.	25.	0	0	0	0.00	126.47	1156.43
*SECNO 125.750									
125.750	3.70	74.08	0.00	0.00	74.33	0.25	0.01	0.00	79.30
1375.0	0.0	1375.0	0.0	0.0	344.0	0.0	2.4	0.8	79.30
0.02	0.00	4.00	0.00	0.000	0.017	0.000	0.000	70.38	1031.23
0.000544	25.	25.	25.	0	0	0	0.00	124.84	1156.07
*SECNO 126.000									
126.000	3.68	74.09	0.00	0.00	74.35	0.26	0.01	0.00	79.40
1375.0	0.0	1375.0	0.0	0.0	338.3	0.0	2.6	0.9	79.40
0.02	0.00	4.06	0.00	0.000	0.017	0.000	0.000	70.41	1032.12
0.000568	25.	25.	25.	0	0	0	0.00	123.76	1155.88
*SECNO 126.250									
126.250	3.65	74.08	0.00	0.00	74.37	0.29	0.02	0.01	79.60
1375.0	0.0	1375.0	0.0	0.0	315.9	0.0	2.7	1.0	79.60
0.02	0.00	4.35	0.00	0.000	0.017	0.000	0.000	70.43	1029.89
0.000650	25.	25.	25.	2	0	0	0.00	115.22	1145.11

```
   SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
   Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
   TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
   SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

*SECNO 126.500
  126.500      3.62      74.07       0.00       0.00      74.40       0.33       0.02       0.01      79.70
   1375.0       0.0     1375.0        0.0        0.0      299.7        0.0        2.9        1.0      79.70
     0.03      0.00       4.59       0.00      0.000      0.017      0.000      0.000      70.45    1027.66
 0.000717       25.        25.        25.          2          0          0       0.00     108.68    1136.34

*SECNO 126.750
  126.750      3.58      74.06       0.00       0.00      74.43       0.37       0.02       0.01      79.80
   1375.0       0.0     1375.0        0.0        0.0      280.6        0.0        3.1        1.1      79.80
     0.03      0.00       4.90       0.00      0.000      0.017      0.000      0.000      70.48    1026.18
 0.000824       25.        25.        25.          2          0          0       0.00     102.15    1128.32

*SECNO 127.000
  127.000      3.54      74.04       0.00       0.00      74.47       0.43       0.02       0.02      79.90
   1375.0       0.0     1375.0        0.0        0.0      261.9        0.0        3.2        1.2      79.70
     0.03      0.00       5.25       0.00      0.000      0.017      0.000      0.000      70.50    1023.61
 0.000943       25.        25.        25.          2          0          0       0.00      95.05    1118.66

*SECNO 127.250
  127.250      3.48      74.01       0.00       0.00      74.52       0.51       0.03       0.02      80.00
   1375.0       0.0     1375.0        0.0        0.0      240.2        0.0        3.4        1.2      80.00
     0.03      0.00       5.72       0.00      0.000      0.017      0.000      0.000      70.53    1021.11
 0.001128       25.        25.        25.          2          0          0       0.00      87.44    1108.55

*SECNO 127.500
  127.500      3.42      73.97       0.00       0.00      74.59       0.61       0.03       0.03      80.00
   1375.0       0.0     1375.0        0.0        0.0      218.7        0.0        3.5        1.3      80.00
     0.03      0.00       6.29       0.00      0.000      0.017      0.000      0.000      70.55    1017.77
 0.001362       25.        25.        25.          2          0          0       0.00      79.46    1097.23

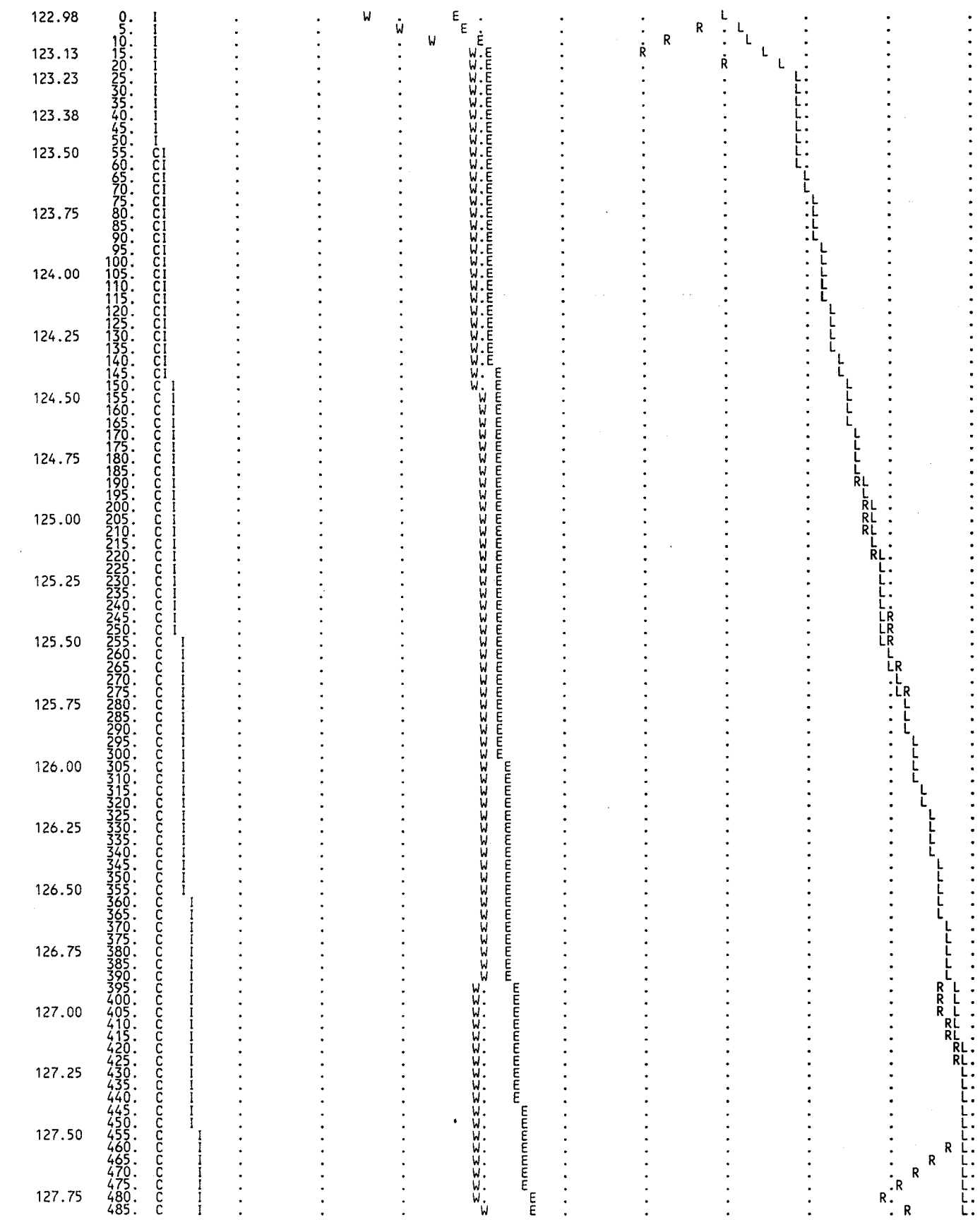
CCHV=     0.100 CEHV=     0.300
*SECNO 127.750
3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  0.54

  127.750      3.41      73.99       0.00       0.00      74.66       0.67       0.06       0.02      80.00
   1375.0       0.0     1375.0        0.0        0.0      208.7        0.0        3.6        1.3      79.00
     0.03      0.00       6.59       0.00      0.000      0.030      0.000      0.000      70.58    1014.28
 0.004754       25.        25.        25.          1          0          0       0.00      77.02    1091.30
```

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
*SECNO 127.900									
127.900	3.69	74.29	0.00	0.00	74.74	0.44	0.05	0.02	80.00
1375.0	0.0	1375.0	0.0	0.0	257.1	0.0	3.7	1.3	80.00
0.03	0.00	5.35	0.00	0.000	0.030	0.000	0.000	70.60	1011.61
0.002689	15.	15.	15.	2	0	0	0.00	82.47	1094.07

PROFILE FOR STREAM EAST FORK CAVE CREEK

PLOTTED POINTS (BY PRIORITY) E-ENERGY,W-WATER SURFACE,I-INVERT,C-CRITICAL W.S.,L-LEFT BANK,R-RIGHT BANK,M-LOWER END STA



	490.	C	I	:	:	:	.W	E	:	:	:	:	:	R	L.
127.90	495.	C	I	:	:	:	: W	E	:	:	:	:	:		L.

THIS RUN EXECUTED 18AUG94 12:41:54

****
HEC-2 WATER SURFACE PROFILES
Version 4.6.2: May 1991
****

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

EAST FORK CAVE CREEK

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
*	122.980	0.00	0.00	0.00	70.10	1375.00	72.68	72.68	73.84	101.92	8.63	159.37	136.20
*	123.130	15.00	0.00	0.00	70.12	1375.00	73.99	0.00	74.16	9.89	3.38	406.21	437.18
	123.230	10.00	0.00	0.00	70.13	1375.00	74.04	0.00	74.18	8.42	3.05	450.64	473.89
*	123.380	15.00	0.00	0.00	70.14	1375.00	74.02	0.00	74.20	3.74	3.43	401.25	711.31
	123.500	12.00	0.00	0.00	70.15	1375.00	74.02	0.00	74.21	3.80	3.45	398.12	705.02
	123.750	25.00	0.00	0.00	70.18	1375.00	74.03	0.00	74.22	4.00	3.53	389.79	687.07
	124.000	25.00	0.00	0.00	70.21	1375.00	74.03	0.00	74.23	4.21	3.59	383.35	670.46
	124.250	25.00	0.00	0.00	70.23	1375.00	74.04	0.00	74.24	4.24	3.60	381.55	667.60
	124.500	25.00	0.00	0.00	70.26	1375.00	74.05	0.00	74.26	4.54	3.71	371.03	645.58
	124.750	25.00	0.00	0.00	70.28	1375.00	74.05	0.00	74.27	4.70	3.76	365.86	633.98
	125.000	25.00	0.00	0.00	70.31	1375.00	74.06	0.00	74.29	4.90	3.83	359.15	621.19
	125.250	25.00	0.00	0.00	70.33	1375.00	74.07	0.00	74.30	5.07	3.88	354.16	610.74
	125.500	25.00	0.00	0.00	70.35	1375.00	74.08	0.00	74.32	5.24	3.93	349.69	600.68
	125.750	25.00	0.00	0.00	70.38	1375.00	74.08	0.00	74.33	5.44	4.00	343.98	589.45
	126.000	25.00	0.00	0.00	70.41	1375.00	74.09	0.00	74.35	5.68	4.06	338.34	576.79
	126.250	25.00	0.00	0.00	70.43	1375.00	74.08	0.00	74.37	6.50	4.35	315.87	539.22
	126.500	25.00	0.00	0.00	70.45	1375.00	74.07	0.00	74.40	7.17	4.59	299.72	513.42

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
	126.750	25.00	0.00	0.00	70.48	1375.00	74.06	0.00	74.43	8.24	4.90	280.57	479.09
	127.000	25.00	0.00	0.00	70.50	1375.00	74.04	0.00	74.47	9.43	5.25	261.86	447.65
	127.250	25.00	0.00	0.00	70.53	1375.00	74.01	0.00	74.52	11.28	5.72	240.18	409.34
	127.500	25.00	0.00	0.00	70.55	1375.00	73.97	0.00	74.59	13.62	6.29	218.71	372.58
*	127.750	25.00	0.00	0.00	70.58	1375.00	73.99	0.00	74.66	47.54	6.59	208.75	199.43
	127.900	15.00	0.00	0.00	70.60	1375.00	74.29	0.00	74.74	26.89	5.35	257.06	265.16

EAST FORK CAVE CREEK

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	122.980	1375.00	72.68	0.00	0.00	0.00	69.49	0.00
*	123.130	1375.00	73.99	0.00	1.31	0.00	126.12	15.00
	123.230	1375.00	74.04	0.00	0.05	0.00	145.12	10.00
*	123.380	1375.00	74.02	0.00	-0.02	0.00	138.44	15.00
	123.500	1375.00	74.02	0.00	0.00	0.00	137.57	12.00
	123.750	1375.00	74.03	0.00	0.00	0.00	135.63	25.00
	124.000	1375.00	74.03	0.00	0.01	0.00	134.98	25.00
	124.250	1375.00	74.04	0.00	0.01	0.00	134.25	25.00
	124.500	1375.00	74.05	0.00	0.00	0.00	131.64	25.00
	124.750	1375.00	74.05	0.00	0.01	0.00	130.60	25.00
	125.000	1375.00	74.06	0.00	0.01	0.00	128.55	25.00
	125.250	1375.00	74.07	0.00	0.01	0.00	127.34	25.00
	125.500	1375.00	74.08	0.00	0.01	0.00	126.47	25.00
	125.750	1375.00	74.08	0.00	0.01	0.00	124.84	25.00
	126.000	1375.00	74.09	0.00	0.01	0.00	123.76	25.00
	126.250	1375.00	74.08	0.00	-0.01	0.00	115.22	25.00
	126.500	1375.00	74.07	0.00	-0.01	0.00	108.68	25.00
	126.750	1375.00	74.06	0.00	-0.01	0.00	102.15	25.00
	127.000	1375.00	74.04	0.00	-0.02	0.00	95.05	25.00
	127.250	1375.00	74.01	0.00	-0.03	0.00	87.44	25.00
	127.500	1375.00	73.97	0.00	-0.04	0.00	79.46	25.00
*	127.750	1375.00	73.99	0.00	0.02	0.00	77.02	25.00
	127.900	1375.00	74.29	0.00	0.30	0.00	82.47	15.00

SUMMARY OF ERRORS AND SPECIAL NOTES

```
CAUTION SECNO=    122.980  PROFILE=  1  CRITICAL DEPTH ASSUMED
WARNING SECNO=    123.130  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=    123.380  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=    127.750  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
```

HEC2 S/N: 1363000413 HMVersion: 6.52 Data File: UTORD2.hc2

```
*****************************************
*  HEC-2 WATER SURFACE PROFILES         *
*                                       *
*  Version   4.6.2;  May 1991           *
*                                       *
*  RUN DATE    18AUG94    TIME   11:14:49 *
*****************************************
```

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

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::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::
:::                                      :::
:::   FULL MICRO-COMPUTER IMPLEMENTATION  :::
:::                                      :::
::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::
```

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============================
H A E S T A D   M E T H O D S
============================
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

THIS RUN EXECUTED 18AUG94 11:14:49

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

 Version  4.6.2:  May 1991
************************************

T1 EXIST CHANNEL SOUTH OF UTOPIA ROAD STA 32+06 TO 35+77 WITH PARTIAL FLOW
T2 Q = VARIOUS
T3      EXIST SOUTH SIDE CHANNEL ALTERNATE "C-1"

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ
                  7         0         0        -1         0         0         0                   0

J3  VARIABLE CODES FOR SUMMARY PRINTOUT

    150       150

NC      .03       .03       .03        .3        .8
QT        6        20        40        60        80       100       101       120
X1    32.06         4      1025      1065         0         0         0         0         0         1
GR    80.62      1025     75.72      1037      75.6      1053     79.82      1065

X1    32.10         4      1020      1067         4         4         4         0         0         1
GR     81.0      1020      75.8      1042      75.7      1051        80      1067

X1    32.20         4      1015      1067        10        10        10         0         0         1
GR     81.3      1015        76      1043      75.9      1049      80.1      1067

QT        6        20        40        60        80       100       101       120
X1     33.0         7      1013      1067        80        80        80         0         0         1
GR    81.54      1013     80.53      1014     78.08      1027     77.77      1038     76.58      1049
GR    78.24      1060     80.32      1067

X1     34.0         6      1014      1067       100       100       100         0         0         1
GR    81.11      1014     79.87      1019     77.58      1032     76.83      1053     77.37      1056
GR    80.63      1067

X1     35.0         6      1013      1067       100       100       100         0         0         1
GR    81.84      1013      78.5      1029     78.40      1045     77.45      1049     78.13      1059
GR    80.15      1067
```

X1	35.77	5	1013	1053	77	77	77	0	0	1
GR	82.94	1013	78.80	1015	78.56	1019	79.79	1023	81.01	1053

Run Date: 18AUG94 Run Time: 11:14:49 HMVersion: 6.52 Data File: UTORD2.hc2

```
   SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
   Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
   TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
   SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

*PROF 1


CCHV=    0.300 CEHV=    0.800
*SECNO 32.060
2096 WSEL NOT GIVEN, AVG OF MAX, MIN USED
3720 CRITICAL DEPTH ASSUMED
    32.060      1.07      76.67      76.67       0.00      77.11       0.44       0.00       0.00      80.62
     101.0       0.0      101.0       0.0        0.0       18.9        0.0        0.0        0.0      79.82
      0.00      0.00       5.34       0.00      0.000      0.030      0.000      0.000      75.60    1034.67
  0.014025        0.         0.         0.          0          7          0       0.00      21.37    1056.04

*SECNO 32.100
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    32.100      1.34      77.04      77.04       0.00      77.52       0.48       0.06       0.03      81.00
     101.0       0.0      101.0       0.0        0.0       18.2        0.0        0.0        0.0      80.00
      0.00      0.00       5.56       0.00      0.000      0.030      0.000      0.000      75.70    1036.76
  0.013893        4.         4.         4.         20         11          0       0.00      19.21    1055.98

*SECNO 32.200
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    32.200      1.48      77.38      77.38       0.00      77.85       0.47       0.14       0.00      81.30
     101.0       0.0      101.0       0.0        0.0       18.3        0.0        0.0        0.0      80.10
      0.00      0.00       5.51       0.00      0.000      0.030      0.000      0.000      75.90    1035.70
  0.013864       10.        10.        10.          0          8          0       0.00      19.64    1055.35

*SECNO 33.000

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.63

    33.000      1.84      78.42       0.00       0.00      78.59       0.16       0.64       0.09      81.54
     101.0       0.0      101.0       0.0        0.0       31.0        0.0        0.1        0.1      80.32
      0.01      0.00       3.26       0.00      0.000      0.030      0.000      0.000      76.58    1025.14
  0.005226       80.        80.        80.          1          0          0       0.00      35.51    1060.64
```

```
   SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
   Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
   TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
   SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

*SECNO 34.000

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.90

    34.000       1.96      78.79       0.00       0.00      78.86       0.08       0.25       0.03      81.11
     101.0        0.0      101.0        0.0        0.0       45.8        0.0        0.1        0.1      80.63
      0.02       0.00       2.21       0.00      0.000      0.030      0.000      0.000      76.83    1025.15
  0.001440       100.       100.       100.          3          0          0       0.00      35.63    1060.78

*SECNO 35.000

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  0.45

    35.000       1.59      79.04       0.00       0.00      79.23       0.19       0.27       0.09      81.84
     101.0        0.0      101.0        0.0        0.0       28.6        0.0        0.2        0.2      80.15
      0.03       0.00       3.54       0.00      0.000      0.030      0.000      0.000      77.45    1026.44
  0.007052       100.       100.       100.          2          0          0       0.00      36.15    1062.59

*SECNO 35.770
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    35.770       1.97      80.53      80.53       0.00      80.92       0.39       0.79       0.16      82.94
     101.0        0.0      101.0        0.0        0.0       20.2        0.0        0.3        0.3      81.01
      0.03       0.00       5.01       0.00      0.000      0.030      0.000      0.000      78.56    1014.17
  0.016028        77.        77.        77.          8         11          0       0.00      26.92    1041.09
```

CROSS SECTION 32.06
STREAM EXIST SOUTH SIDE CHANNEL
DISCHARGE= 101.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

```
ELEV   75.6      76.1      76.6      77.1      77.6      78.1      78.6      79.1      79.6      80.1      80.6

   STA-FEET

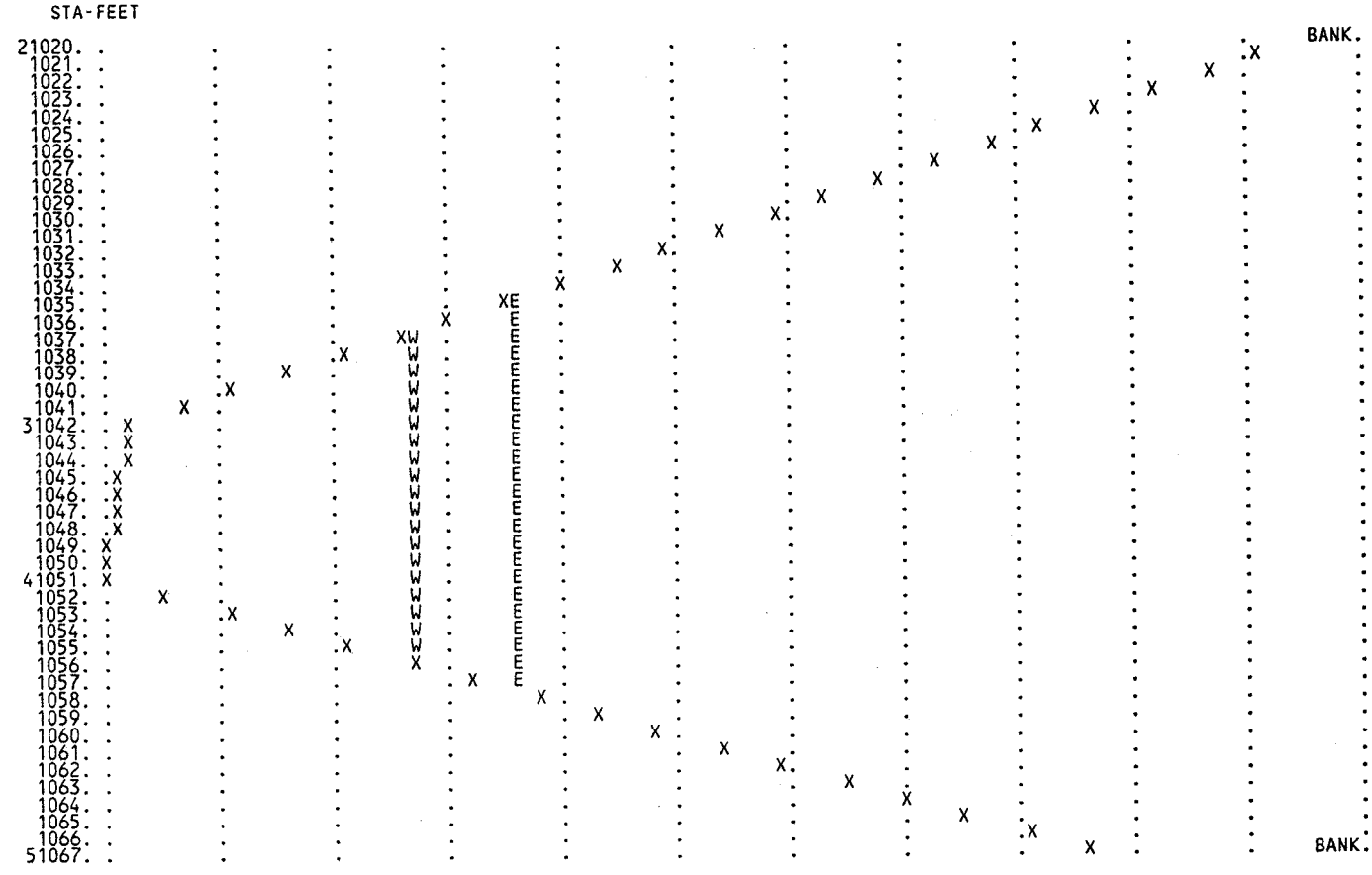
                                                                                                      X     BANK.
21025. .         .         .         .         .         .         .         .         .         .
 1026. .         .         .         .         .         .         .         .         .         .  X      .
 1027. .         .         .         .         .         .         .         .         .  X      .         .
 1028. .         .         .         .         .         .         .         .  X      .         .         .
 1029. .         .         .         .         .         .         .  X      .         .         .         .
 1030. .         .         .         .         .         .         X         .         .         .         .
 1031. .         .         .         .         .         .X        .         .         .         .         .
 1032. .         .         .         .         .  X      .         .         .         .         .         .
 1033. .         .         .         .         X         .         .         .         .         .         .
 1034. .         .         .         X  E      .         .         .         .         .         .         .
 1035. .         .         X.W       E         .         .         .         .         .         .         .
 1036. .         .X        .W        E         .         .         .         .         .         .         .
31037. . X       .         .W        E         .         .         .         .         .         .         .
 1038. . X       .         .W        E         .         .         .         .         .         .         .
 1039. . X       .         .W        E         .         .         .         .         .         .         .
 1040. . X       .         .W        E         .         .         .         .         .         .         .
 1041. . X       .         .W        E         .         .         .         .         .         .         .
 1042. . X       .         .W        E         .         .         .         .         .         .         .
 1043. . X       .         .W        E         .         .         .         .         .         .         .
 1044. .X        .         .W        E         .         .         .         .         .         .         .
 1045. .X        .         .W        E         .         .         .         .         .         .         .
 1046. .X        .         .W        E         .         .         .         .         .         .         .
 1047. .X        .         .W        E         .         .         .         .         .         .         .
 1048. .X        .         .W        E         .         .         .         .         .         .         .
 1049. .X        .         .W        E         .         .         .         .         .         .         .
 1050. X         .         .W        E         .         .         .         .         .         .         .
 1051. X         .         .W        E         .         .         .         .         .         .         .
 1052. X         .         .W        E         .         .         .         .         .         .         .
41053. X         .         .W        E         .         .         .         .         .         .         .
 1054. .      X  .         .W        E         .         .         .         .         .         .         .
 1055. .         .  X      .W        E         .         .         .         .         .         .         .
 1056. .         .         .X        E         .         .         .         .         .         .         .
 1057. .         .         .         X E       .         .         .         .         .         .         .
 1058. .         .         .                   X         .         .         .         .         .         .
 1059. .         .         .                   .  X      .         .         .         .         .         .
 1060. .         .         .                   .         X.        .         .         .         .         .
 1061. .         .         .                   .         .         X         .         .         .         .
 1062. .         .         .                   .         .         .         X         .         .         .
 1063. .         .         .                   .         .         .         .         X         .         .
 1064. .         .         .                   .         .         .         .         .         X         .
51065. .         .         .                   .         .         .         .         .         .         .  BANK.
```

NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I),STA(I)
80.62 1025.00 75.72 1037.00 75.60 1053.00 79.82 1065.00

CROSS SECTION 32.10
STREAM EXIST SOUTH SIDE CHANNEL
DISCHARGE= 101.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

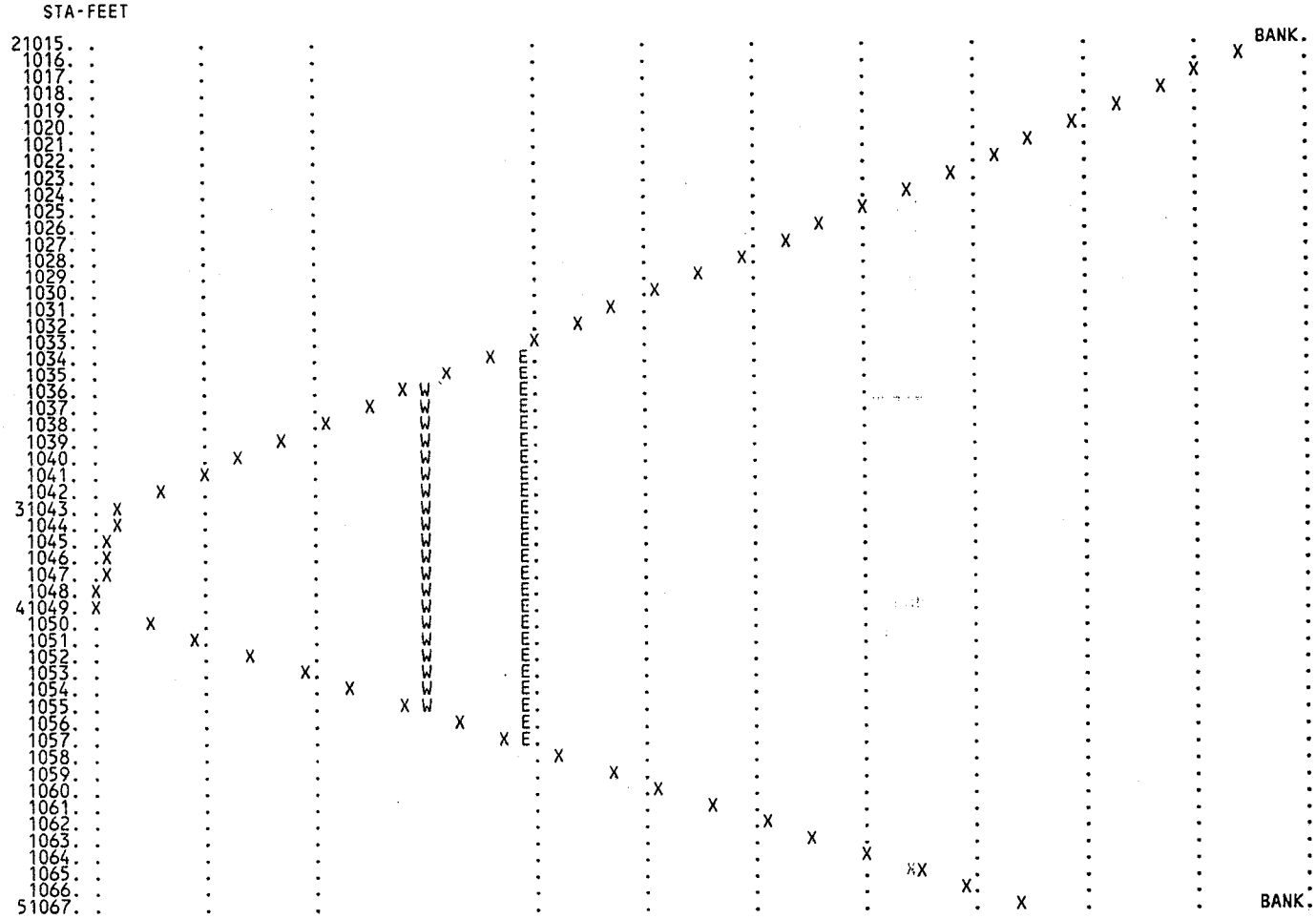


NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I),STA(I)
81.00 1020.00 75.80 1042.00 75.70 1051.00 80.00 1067.00

CROSS SECTION 32.20
STREAM EXIST SOUTH SIDE CHANNEL
DISCHARGE= 101.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL



NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

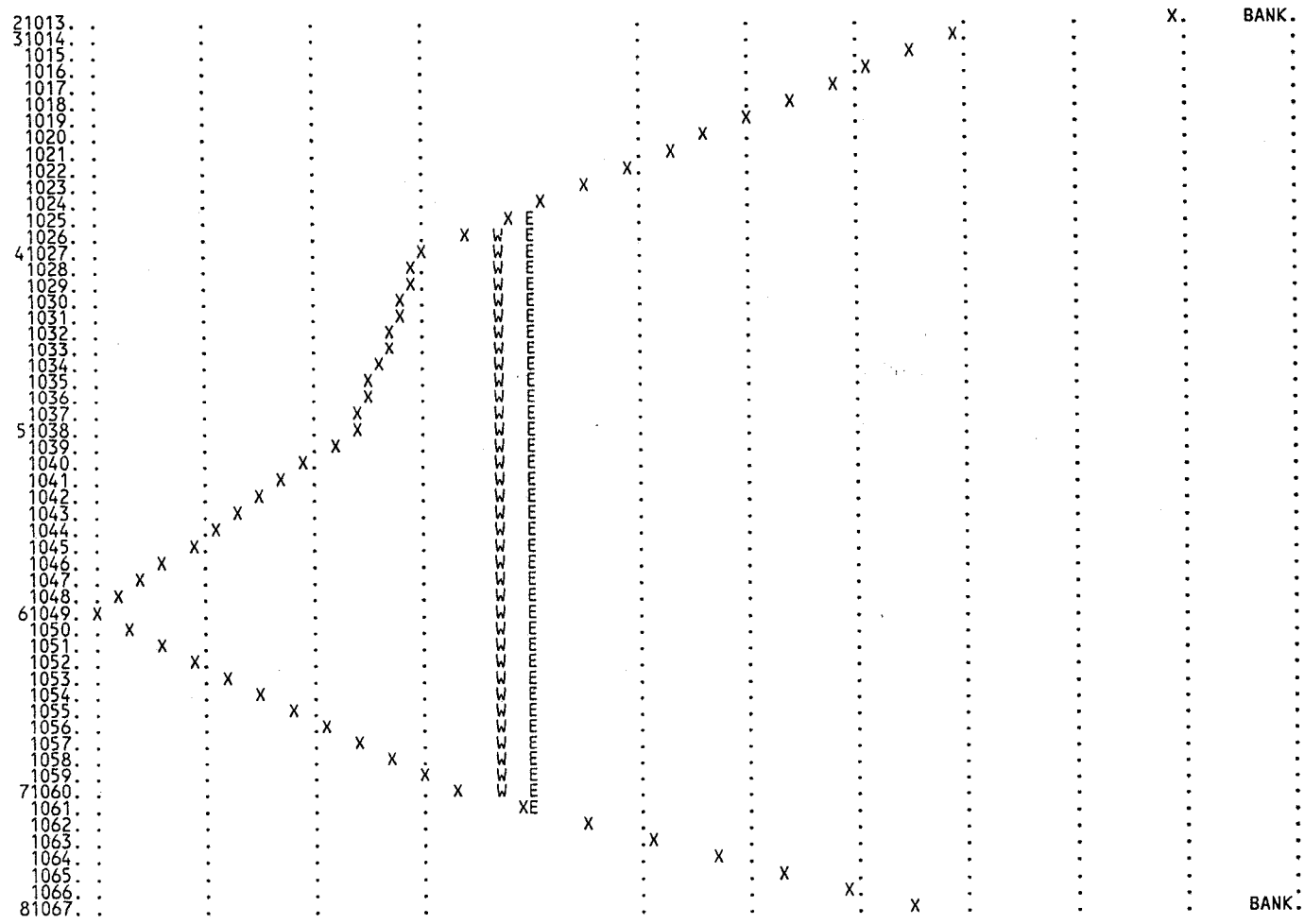
EL(I),STA(I)
81.30 1015.00 76.00 1043.00 75.90 1049.00 80.10 1067.00

CROSS SECTION 33.00
STREAM EXIST SOUTH SIDE CHANNEL
DISCHARGE= 101.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

ELEV 76.6 77.1 77.6 78.1 78.6 79.1 79.6 80.1 80.6 81.1 81.6

STA-FEET



NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

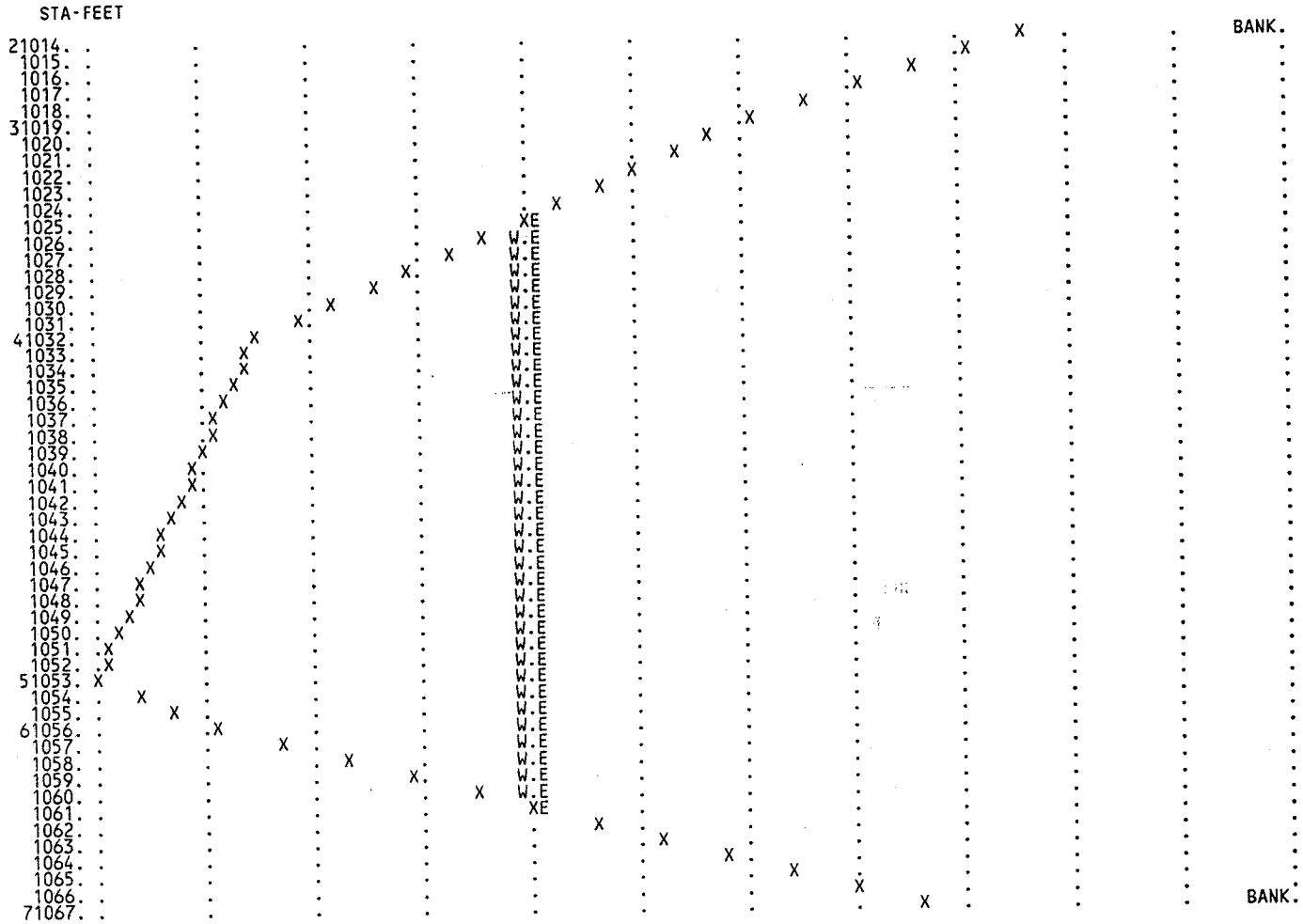
EL(I),STA(I)

81.54	1013.00	80.53	1014.00	78.08	1027.00	77.77	1038.00	76.58	1049.00
78.24	1060.00	80.32	1067.00						

CROSS SECTION 34.00
STREAM EXIST SOUTH SIDE CHANNEL
DISCHARGE= 101.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

ELEV 76.8 77.3 77.8 78.3 78.8 79.3 79.8 80.3 80.8 81.3 81.8

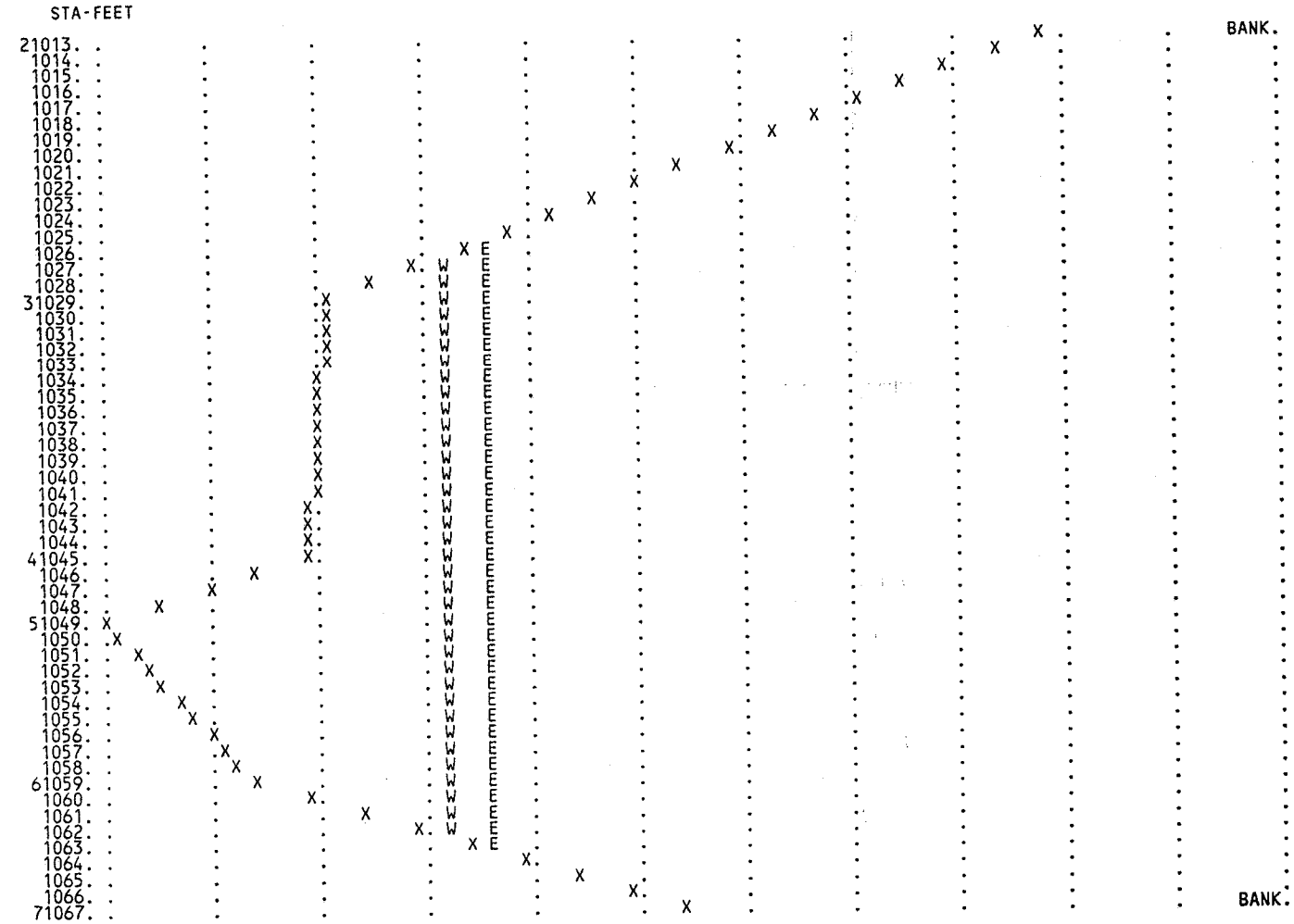


NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I)	STA(I)								
81.11	1014.00	79.87	1019.00	77.58	1032.00	76.83	1053.00	77.37	1056.00
80.63	1067.00								

CROSS SECTION 35.00
STREAM EXIST SOUTH SIDE CHANNEL
DISCHARGE= 101.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL



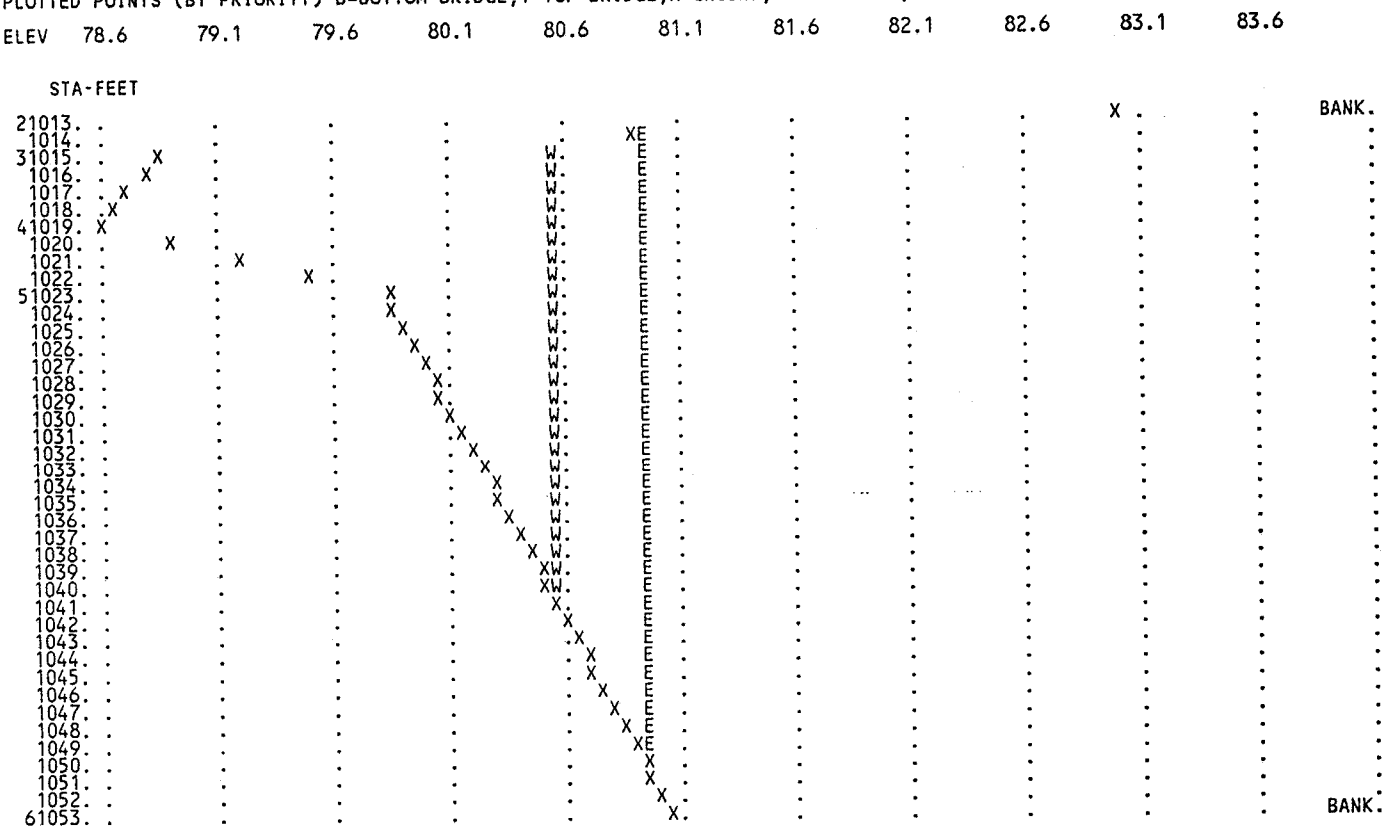
NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I),STA(I)

81.84	1013.00	78.50	1029.00	78.40	1045.00	77.45	1049.00	78.13	1059.00
80.15	1067.00								

CROSS SECTION 35.77
STREAM EXIST SOUTH SIDE CHANNEL
DISCHARGE= 101.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

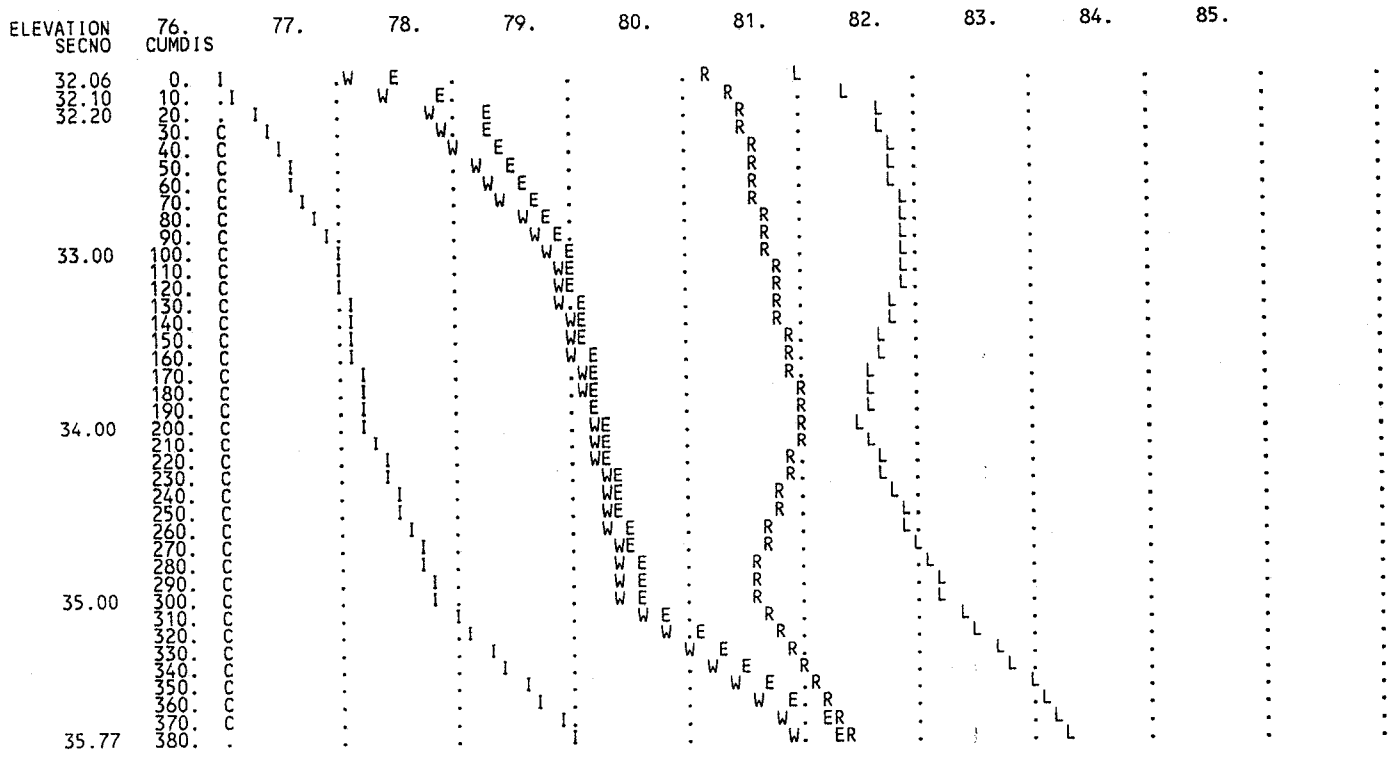


NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I)	STA(I)								
82.94	1013.00	78.80	1015.00	78.56	1019.00	79.79	1023.00	81.01	1053.00

PROFILE FOR STREAM EXIST SOUTH SIDE CHANNEL

PLOTTED POINTS (BY PRIORITY) E-ENERGY,W-WATER SURFACE,I-INVERT,C-CRITICAL W.S.,L-LEFT BANK,R-RIGHT BANK,M-LOWER END STA



THIS RUN EXECUTED 18AUG94 11:14:54

****
HEC-2 WATER SURFACE PROFILES

Version 4.6.2: May 1991
****

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

EXIST SOUTH SIDE CHANNEL

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
*	32.060	0.00	0.00	0.00	75.60	101.00	76.67	76.67	77.11	140.25	5.34	18.90	8.53
*	32.100	4.00	0.00	0.00	75.70	101.00	77.04	77.04	77.52	138.93	5.56	18.16	8.57
*	32.200	10.00	0.00	0.00	75.90	101.00	77.38	77.38	77.85	138.64	5.51	18.32	8.58
*	33.000	80.00	0.00	0.00	76.58	101.00	78.42	0.00	78.59	52.26	3.26	31.02	13.97
*	34.000	100.00	0.00	0.00	76.83	101.00	78.79	0.00	78.86	14.40	2.21	45.78	26.61
*	35.000	100.00	0.00	0.00	77.45	101.00	79.04	0.00	79.23	70.52	3.54	28.57	12.03
*	35.770	77.00	0.00	0.00	78.56	101.00	80.53	80.53	80.92	160.28	5.01	20.15	7.98

EXIST SOUTH SIDE CHANNEL

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	32.060	101.00	76.67	0.00	0.00	0.00	21.37	0.00
*	32.100	101.00	77.04	0.00	0.37	0.00	19.21	4.00
*	32.200	101.00	77.38	0.00	0.34	0.00	19.64	10.00
*	33.000	101.00	78.42	0.00	1.04	0.00	35.51	80.00
*	34.000	101.00	78.79	0.00	0.36	0.00	35.63	100.00
*	35.000	101.00	79.04	0.00	0.25	0.00	36.15	100.00
*	35.770	101.00	80.53	0.00	1.49	0.00	26.92	77.00

SUMMARY OF ERRORS AND SPECIAL NOTES

CAUTION SECNO=	32.060	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	32.100	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	32.100	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	32.100	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=	32.200	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	32.200	PROFILE=	1	MINIMUM SPECIFIC ENERGY
WARNING SECNO=	33.000	PROFILE=	1	CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=	34.000	PROFILE=	1	CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=	35.000	PROFILE=	1	CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
CAUTION SECNO=	35.770	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	35.770	PROFILE=	1	MINIMUM SPECIFIC ENERGY

HEC2 S/N: 1363000413 HMVersion: 6.52 Data File: UTORD5.hc2

```
*******************************************
*  HEC-2 WATER SURFACE PROFILES           *
*                                         *
*  Version   4.6.2;  May 1991             *
*                                         *
*  RUN DATE     5APR94    TIME   11:34:27 *
*******************************************
```

```
****************************************
*  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  XXXXXXX   XXXXX              XXXXXXX
```

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::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::
:::                                      :::
:::   FULL MICRO-COMPUTER IMPLEMENTATION  :::
:::                                      :::
::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::
```

```
============================
H A E S T A D   M E T H O D S
============================
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

THIS RUN EXECUTED 5APR94 11:34:27

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

 Version   4.6.2:  May 1991
************************************

T1 EXISTING CHANNEL NORTH OF UTOPIA ROAD STA.36+75 TO 49+36
T2 Q = 189 cfs to 233 cfs
T3      EXIST NORTH SIDE CHANNEL ALTERNATE "C-1"

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ
                2         0         0         0         0         0         0      82.6         0

J3  VARIABLE CODES FOR SUMMARY PRINTOUT

    150       150

NC     .020      .020      .020        .2        .4
QT       1       233
X1   36.75         7       999      1022         0         0         0         0         0         1
GR      84       999     83.32      1000     82.69      1001     79.72      1010     79.59      1015
GR   83.55      1021        84      1022

X1   37.00         6       999      1022        25        25        25         0         0         1
GR      84       999     83.55      1000     80.16      1007     79.63      1014     83.68      1021
GR      84      1022

X1   38.00         7       999      1018       100       100       100         0         0         1
GR      86       999     85.00      1000     81.31      1001     80.21      1005     80.15      1009
GR   83.99      1017        86      1018

X1   38.55         6       999      1021        55        55        55         0         0         1
GR      85       999     83.93      1000     79.98      1006     79.98      1015     83.89      1020
GR      85      1022

X1   38.67         6       999      1013        12        12        12         0         0         1
GR      85       999     83.71      1000     79.98      1001     79.98      1011     83.89      1012
GR      85      1013
```

```
   SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
   Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
   TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
   SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

*PROF 1


CCHV=    0.200 CEHV=    0.400
*SECNO 36.750
    36.750      3.01      82.60       0.00      82.60      83.32       0.72       0.00       0.00      84.00
     233.0       0.0      233.0        0.0        0.0       34.2        0.0        0.0        0.0      84.00
      0.00      0.00       6.82       0.00      0.000      0.020      0.000      0.000      79.59    1001.27
  0.004035        0.         0.         0.          0          0          0       0.00      18.29    1019.56

*SECNO 37.000
    37.000      3.12      82.75       0.00       0.00      83.43       0.67       0.09       0.01      84.00
     233.0       0.0      233.0        0.0        0.0       35.4        0.0        0.0        0.0      84.00
      0.00      0.00       6.58       0.00      0.000      0.020      0.000      0.000      79.63    1001.64
  0.003464       25.        25.        25.          2          0          0       0.00      17.76    1019.40

*SECNO 38.000
    38.000      2.84      82.99      82.98       0.00      83.99       1.01       0.43       0.13      86.00
     233.0       0.0      233.0        0.0        0.0       28.9        0.0        0.1        0.0      86.00
      0.00      0.00       8.06       0.00      0.000      0.020      0.000      0.000      80.15    1000.55
  0.005539      100.       100.       100.          4         11          0       0.00      14.37    1014.91

*SECNO 38.550

3301 HV CHANGED MORE THAN HVINS

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  2.62

    38.550      4.01      83.99       0.00       0.00      84.24       0.25       0.09       0.15      85.00
     233.0       0.0      233.0        0.0        0.0       58.6        0.0        0.1        0.1      83.89
      0.01      0.00       3.98       0.02      0.000      0.020      0.020      0.000      79.98     999.94
  0.000806       55.        55.        55.          3          0          0       0.00      20.24    1020.18

*SECNO 38.670

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  0.69

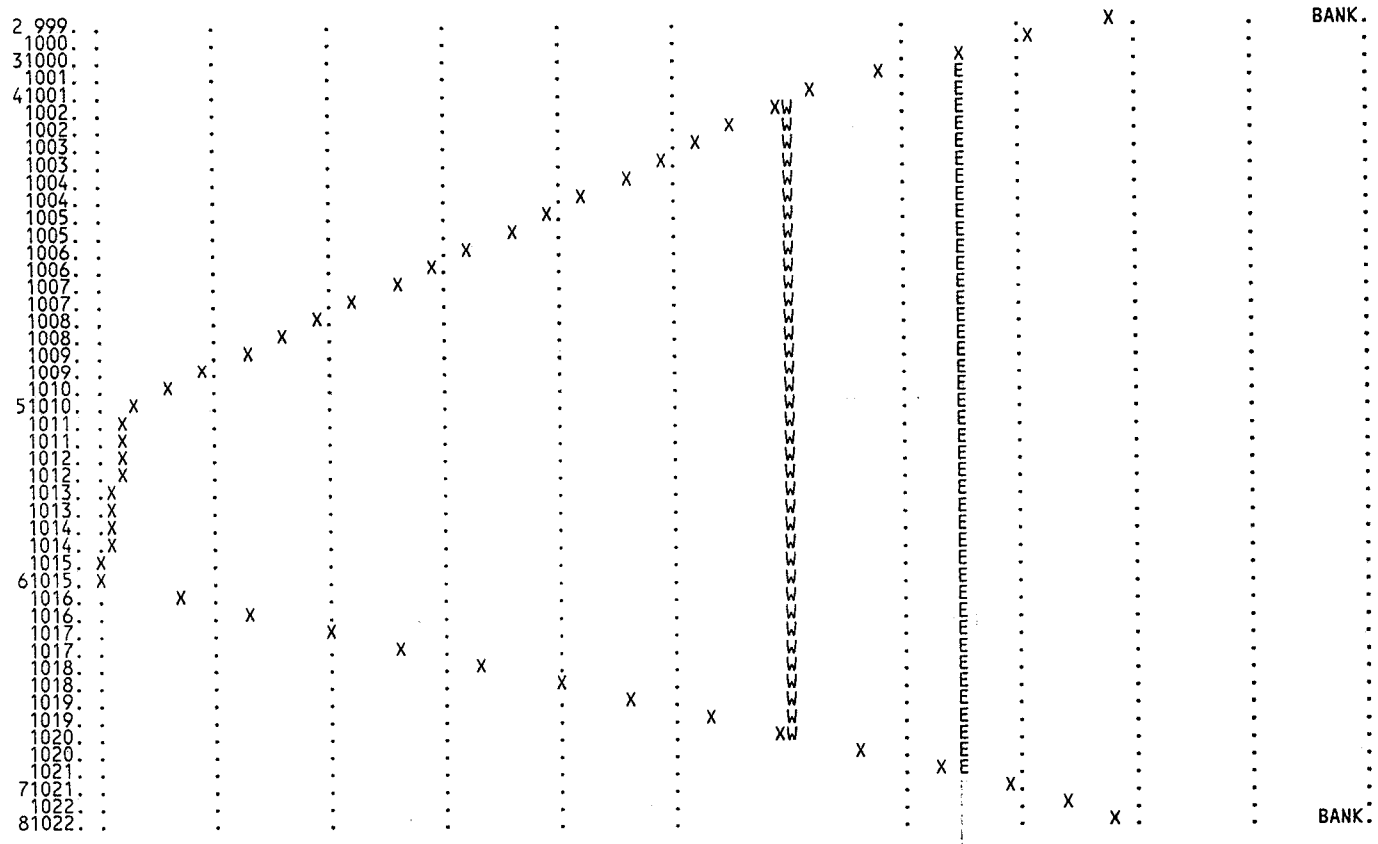
    38.670      3.90      83.88       0.00       0.00      84.34       0.46       0.01       0.08      85.00
     233.0       0.0      233.0        0.0        0.0       43.0        0.0        0.2        0.1      85.00
      0.01      0.00       5.42       0.00      0.000      0.020      0.000      0.000      79.98     999.87
  0.001679       12.        12.        12.          2          0          0       0.00      12.13    1012.00
```

CROSS SECTION 36.75
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 233.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

ELEV 79.6 80.1 80.6 81.1 81.6 82.1 82.6 83.1 83.6 84.1 84.6

STA-FEET



NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I),STA(I)

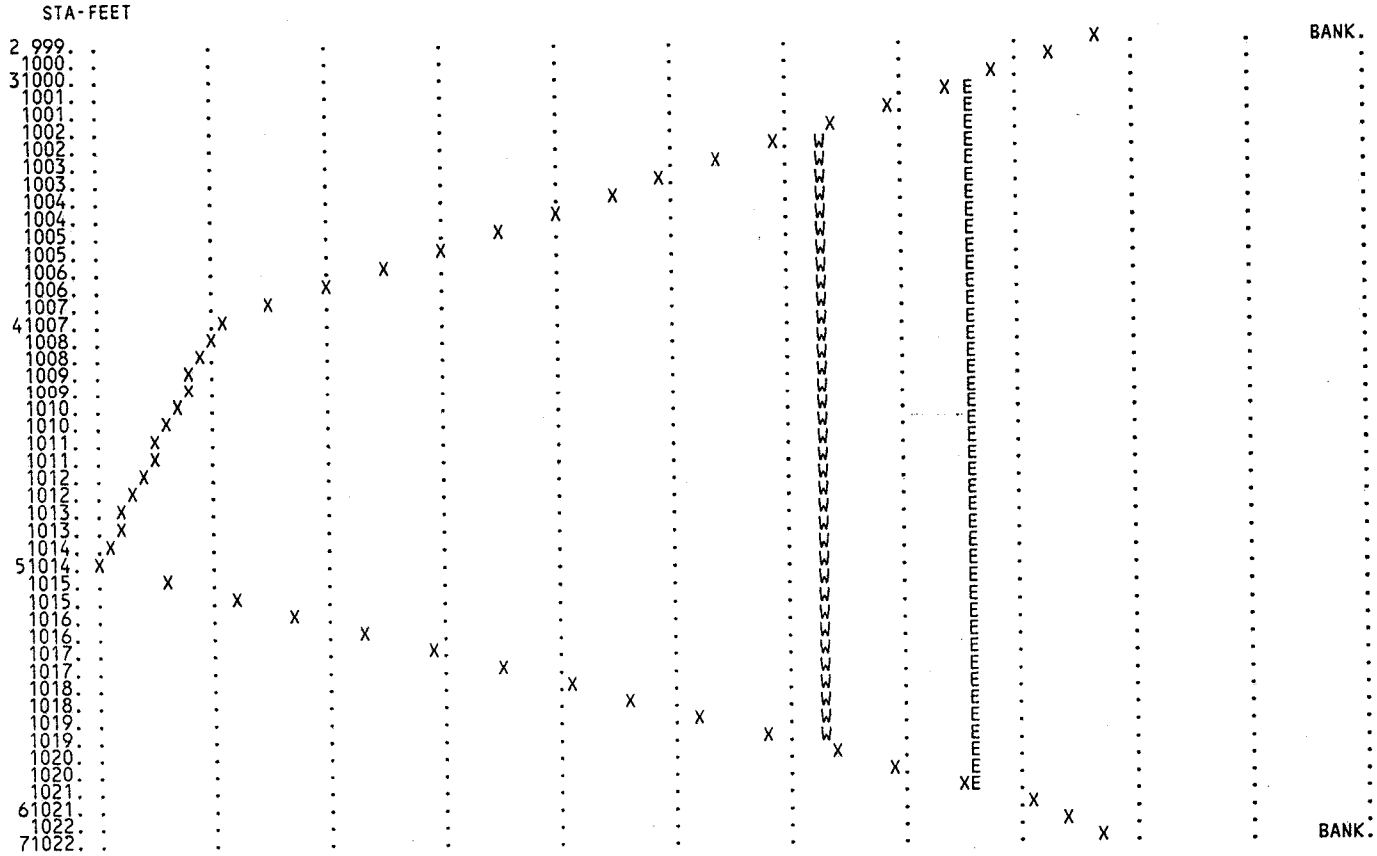
84.00	999.00	83.32	1000.00	82.69	1001.00	79.72	1010.00	79.59	1015.00
83.55	1021.00	84.00	1022.00						

CROSS SECTION 37.00
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 233.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

ELEV 79.6 80.1 80.6 81.1 81.6 82.1 82.6 83.1 83.6 84.1 84.6

STA-FEET

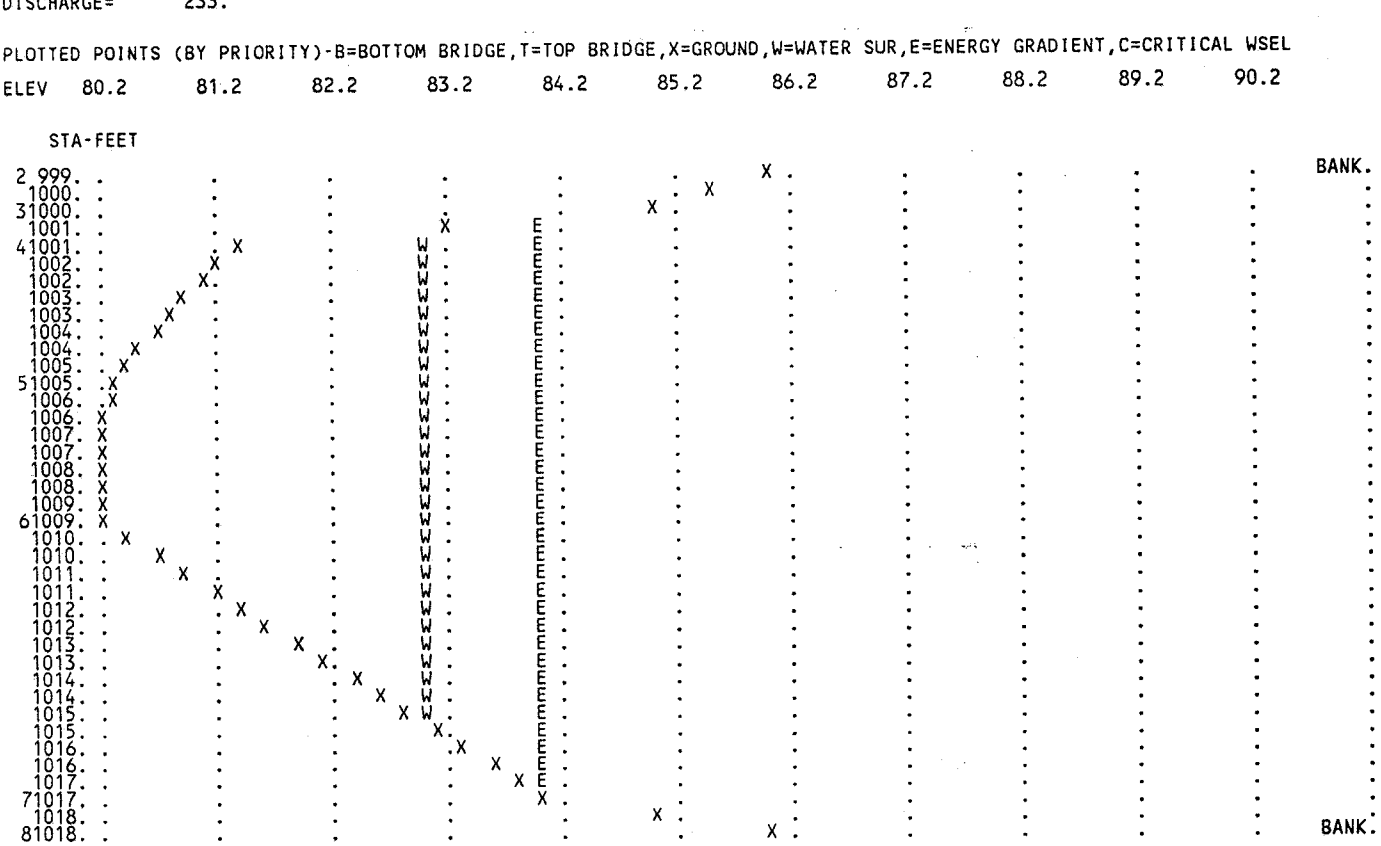


NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I),STA(I)
84.00 999.00 83.55 1000.00 80.16 1007.00 79.63 1014.00 83.68 1021.00
84.00 1022.00

CROSS SECTION 38.00
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 233.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL



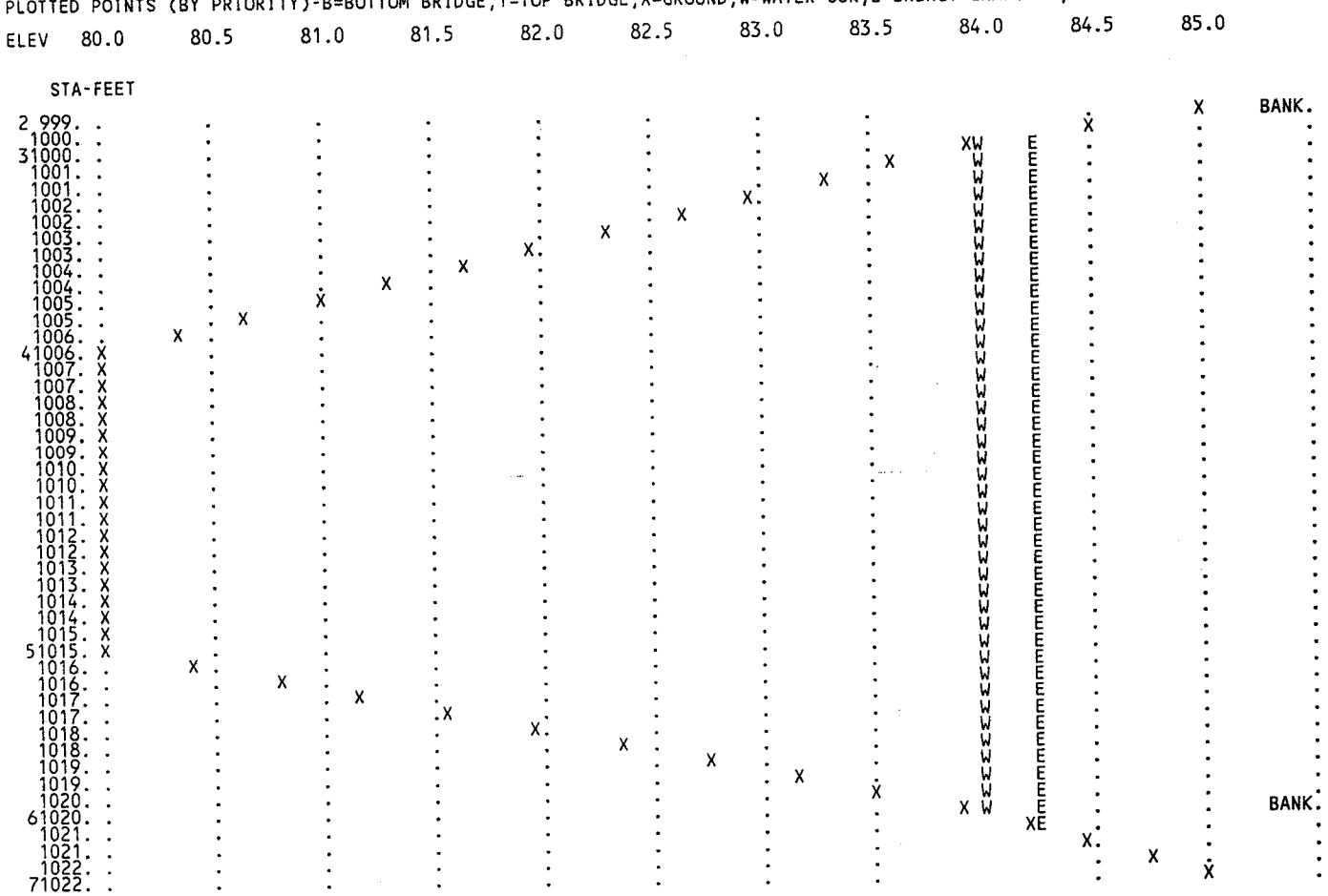
NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I),STA(I)

86.00	999.00	85.00	1000.00	81.31	1001.00	80.21	1005.00	80.15	1009.00
83.99	1017.00	86.00	1018.00						

CROSS SECTION 38.55
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 233.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL



NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I)	STA(I)								
85.00	999.00	83.93	1000.00	79.98	1006.00	79.98	1015.00	83.89	1020.00
85.00	1022.00								

CROSS SECTION 38.67
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 233.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

```
ELEV   80.0      80.5      81.0      81.5      82.0      82.5      83.0      83.5      84.0      84.5      85.0

   STA-FEET

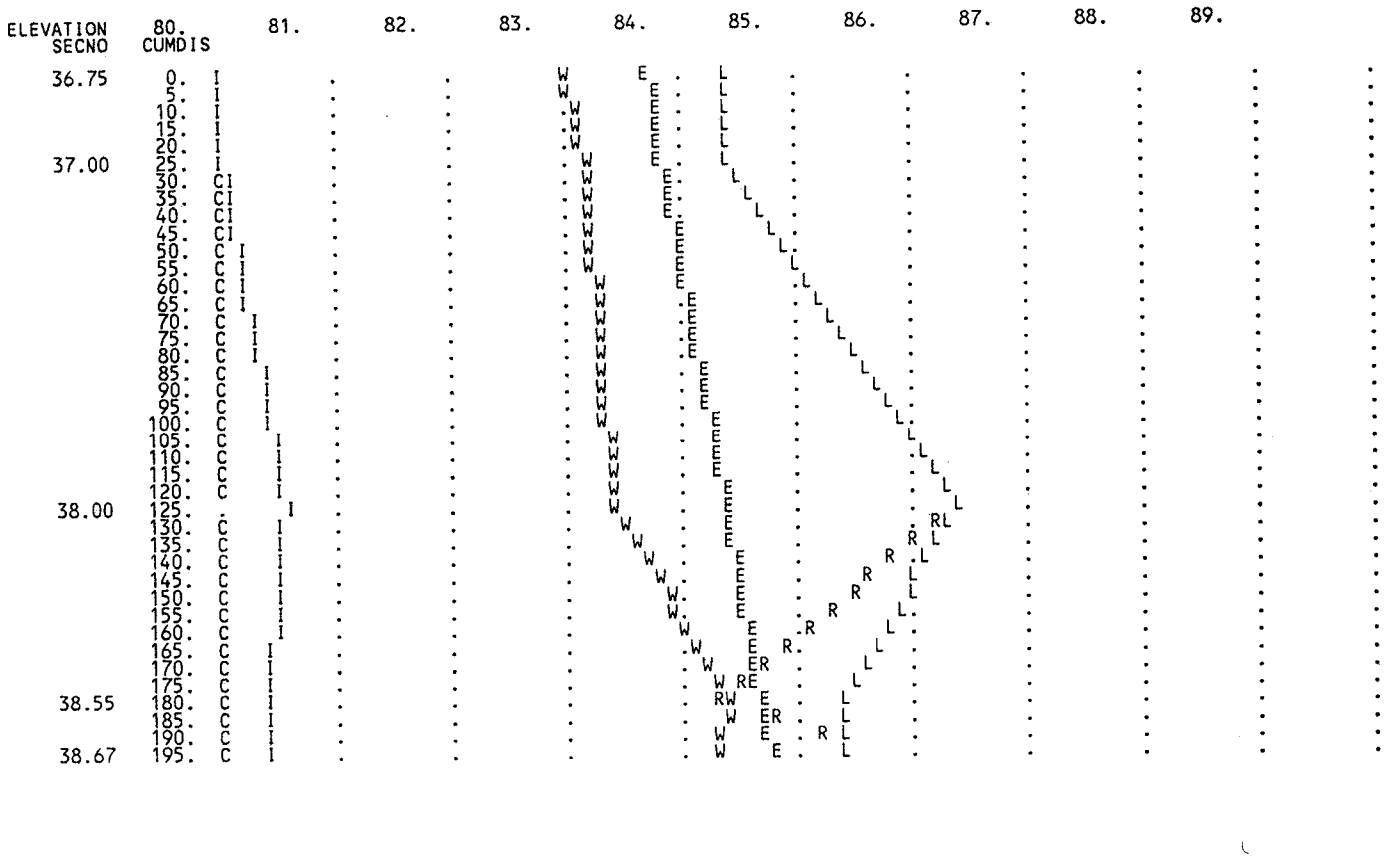
                                                                                                          X     BANK.
 2 999. .         .         .         .         .         .         .         .         .         .         .         .
  1000. .         .         .         .         .         .         .         .         .         X         .         .
 31000. .         .         .         .         .         .         .         .     X   W     E         .         .         .
  1001. .         .         .         .         X         .         .         .         W     E         .         .         .
 41001. X         .         .         .         .         .         .         .         W     E         .         .         .
  1002. X         .         .         .         .         .         .         .         W     E         .         .         .
  1002. X         .         .         .         .         .         .         .         W     E         .         .         .
  1003. X         .         .         .         .         .         .         .         W     E         .         .         .
  1003. X         .         .         .         .         .         .         .         W     E         .         .         .
  1004. X         .         .         .         .         .         .         .         W     E         .         .         .
  1004. X         .         .         .         .         .         .         .         W     E         .         .         .
  1005. X         .         .         .         .         .         .         .         W     E         .         .         .
  1005. X         .         .         .         .         .         .         .         W     E         .         .         .
  1006. X         .         .         .         .         .         .         .         W     E         .         .         .
  1006. X         .         .         .         .         .         .         .         W     E         .         .         .
  1007. X         .         .         .         .         .         .         .         W     E         .         .         .
  1007. X         .         .         .         .         .         .         .         W     E         .         .         .
  1008. X         .         .         .         .         .         .         .         W     E         .         .         .
  1008. X         .         .         .         .         .         .         .         W     E         .         .         .
  1009. X         .         .         .         .         .         .         .         W     E         .         .         .
  1009. X         .         .         .         .         .         .         .         W     E         .         .         .
  1010. X         .         .         .         .         .         .         .         W     E         .         .         .
  1010. X         .         .         .         .         .         .         .         W     E         .         .         .
  1011. X         .         .         .         .         .         .         .         W     E         .         .         .
 51011. X         .         .         .         .         .         .         .         W     E         .         .         .
  1012. .         .         .         .         X         .         .         .         W     E         .         .         .
 61012. .         .         .         .         .         .         .         .         X     E         .         .         .
  1013. .         .         .         .         .         .         .         .               .     X   .         .         .
 71013. .         .         .         .         .         .         .         .               .         .         X     BANK.
```

NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

```
 EL(I),STA(I)
    85.00      999.00      83.71     1000.00      79.98     1001.00      79.98     1011.00      83.89     1012.00
    85.00     1013.00
```

PROFILE FOR STREAM EXIST NORTH SIDE CHANNEL

PLOTTED POINTS (BY PRIORITY) E-ENERGY,W-WATER SURFACE,I-INVERT,C-CRITICAL W.S.,L-LEFT BANK,R-RIGHT BANK,M-LOWER END STA



THIS RUN EXECUTED 5APR94 11:34:31

****
HEC-2 WATER SURFACE PROFILES
Version 4.6.2: May 1991
****

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

EXIST NORTH SIDE CHANNEL

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
	36.750	0.00	0.00	0.00	79.59	233.00	82.60	0.00	83.32	40.35	6.82	34.16	36.68
	37.000	25.00	0.00	0.00	79.63	233.00	82.75	0.00	83.43	34.64	6.58	35.43	39.59
	38.000	100.00	0.00	0.00	80.15	233.00	82.99	82.98	83.99	55.39	8.06	28.92	31.31
*	38.550	55.00	0.00	0.00	79.98	233.00	83.99	0.00	84.24	8.06	3.98	58.58	82.09
*	38.670	12.00	0.00	0.00	79.98	233.00	83.88	0.00	84.34	16.79	5.42	42.99	56.87

EXIST NORTH SIDE CHANNEL

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	36.750	233.00	82.60	0.00	0.00	0.00	18.29	0.00
	37.000	233.00	82.75	0.00	0.15	0.00	17.76	25.00
	38.000	233.00	82.99	0.00	0.23	0.00	14.37	100.00
*	38.550	233.00	83.99	0.00	1.01	0.00	20.24	55.00
*	38.670	233.00	83.88	0.00	-0.11	0.00	12.13	12.00

SUMMARY OF ERRORS AND SPECIAL NOTES

```
WARNING SECNO=     38.550  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=     38.670  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
```

Figure 4.42
Culvert Design Form

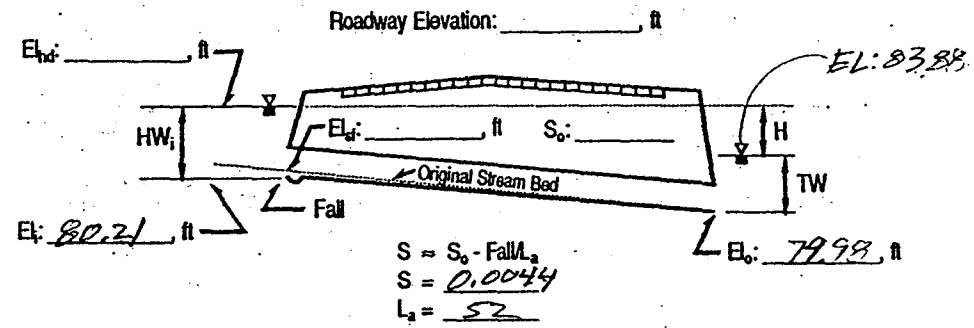
Project: UTOPIA ROAD ALTERNATE "C-1"	Station: 38+67 to 35+19 Sheet _____ of _____	CULVERT DESIGN FORM Designer/Date: _____ / _____ Reviewer/Date: _____ / _____

Hydrological Data

See Add'l sht:
- ☐ Method: _____
- ☐ Drainage Area: _____ ☐ Stream Slope: _____
- ☐ Channel Shape: _____
- ☐ Routing: _____ ☐ Other: _____

Design Flows/Tailwater

R.I., years	Flow, cfs	TW, ft
	189	



Culvert Description: Material - Shape - Size - Entrance	Total Flow Q, cfs	Flow Per Barrel Q/N (1)	Headwater Calculations: Inlet Control HW_i/D (2)	HW_i	Fall (3)	EL_{hi} (4)	Outlet Control TW (5)	d_c	$\frac{d_c + D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)	Control Headwater Elevation	Outlet Velocity	Comments
Conc. Box 10'x4'	189	18.9	0.86	3.44		83.65	4.28	2.25	3.13	4.28	0.4	0.54	84.92			

Technical Footnotes:

(1) Use Q/NB for box culverts.
(2) HW_i/D = HW /D or HW_f/D from design charts
(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; Fall is zero for culverts on grade.
(4) $EL_{hi} = HW_i + EL_i$ (invert of inlet control section)
(5) TW based on downstream control or flow depth in channel.
(6) h_o = TW or $(d_c + D)/2$ (whichever is greater).
(7) $H = \left[1 + k_e + (29n^2L)/R^{1.33}\right] V^2/2g$
(8) $EL_{ho} = EL_o + H + h_o$

Subscript Definitions:

a. approximate
f. culvert fact
hd. Design Headwater
hi. Headwater in inlet control
ho. Headwater in outlet control
i. Inlet control section
o. Outlet
sf. Streambed at culvert face
TW. Tailwater

Comments / Discussion:

Culvert Barrel Selected:

Size: _____
Shape: _____
Material: _____ n: _____
Entrance: _____

HEC2 S/N: 1363000413 HMVersion: 6.52 Data File: UTORD6.hc2

```
*******************************************
*  HEC-2 WATER SURFACE PROFILES           *
*                                         *
*  Version   4.6.2;  May 1991             *
*                                         *
*  RUN DATE    13APR94    TIME   10:12:26 *
*******************************************
```

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

```
::::::::::::::::::::::::::::::::::::::::::::::
::                                          ::
::   FULL MICRO-COMPUTER IMPLEMENTATION     ::
::                                          ::
::::::::::::::::::::::::::::::::::::::::::::::
```

```
============================
H A E S T A D   M E T H O D S
============================
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

THIS RUN EXECUTED 13APR94 10:12:26

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

 Version   4.6.2:  May 1991
************************************

T1 EXISTING CHANNEL NORTH OF UTOPIA ROAD STA.36+75 TO 49+36
T2 Q = 189 cfs to 233 cfs
T3      EXIST NORTH SIDE CHANNEL ALTERNATE "C-1"

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ
                2         0         0         0         0         0         0     84.42         0

J3  VARIABLE CODES FOR SUMMARY PRINTOUT
    150       150

NC     .020      .020      .020       .2        .4
QT        1       189

X1    39.19         6       999      1013         0         0         0         0         0         1
GR       86       999      83.9      1000     80.21      1001     80.21      1011     83.65      1012
GR       86      1013

X1    39.30         6       999      1020        11        11        11         0         0         1
GR       86       999     83.65      1000     80.62      1006     80.56      1013       83.9      1019
GR       86      1020

X1     40.0         6       999      1019        70        70        70         0         0         1
GR       86       999     83.58      1000     80.54      1006     80.78      1012     83.27      1018
GR       86      1019

X1     41.0         6       999      1020       100       100       100         0         0         1
GR       86       999     84.57      1000     81.32      1008     81.15      1014     84.01      1019
GR       86      1020

X1     42.0         6       999      1022       100       100       100         0         0         1
GR       86       999     84.24      1000     81.24      1007     81.68      1013     85.29      1021
GR       86      1022
```

X1	43.0	6	999	1022	100	100	100	0	0	1
GR	86	999	85.14	1000	81.77	1009	81.81	1014	84.52	1021
GR	86	1022								
X1	44.0	6	999	1021	100	100	100	0	0	1
GR	86	999	84.96	1000	82.02	1007	82.17	1012	85.17	1020
GR	86	1022								
X1	45.0	6	999	1021	100	100	100	0	0	1
GR	87	999	85.18	1000	82.97	1005	83.00	1013	83.44	1015
GR	86.47	1020	87	1021						
X1	45.80	7	999	1019	80	80	80	0	0	1
GR	87	999	86.04	1000	82.20	1006	82.23	1008	83.12	1012
GR	86.74	1018	87	1019						
X1	45.93	6	999	1013	13	13	13	0	0	1
GR	87	999	86.04	1000	82.25	1001	82.25	1011	86.74	1012
GR	87	1013								

```
   SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
   Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
   TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
   SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

*PROF 1

CCHV=    0.200 CEHV=    0.400
*SECNO 39.190
   39.190     4.21       84.42      0.00       84.42      84.67      0.25       0.00       0.00       86.00
   189.0      0.0        189.0      0.0        0.0        47.1       0.0        0.0        0.0        86.00
   0.00       0.00       4.01       0.00       0.000      0.020      0.000      0.000      80.21      999.75
 0.000856     0.         0.         0.         0          0          0          0.00       12.58      1012.33

*SECNO 39.300
   39.300     3.95       84.51      0.00       0.00       84.69      0.18       0.01       0.01       86.00
   189.0      0.0        189.0      0.0        0.0        55.7       0.0        0.0        0.0        86.00
   0.00       0.00       3.39       0.00       0.000      0.020      0.000      0.000      80.56      999.63
 0.000613     11.        11.        11.        2          0          0          0.00       19.66      1019.29

*SECNO 40.000
   40.000     4.01       84.55      0.00       0.00       84.74      0.19       0.04       0.00       86.00
   189.0      0.0        189.0      0.0        0.0        54.1       0.0        0.1        0.0        86.00
   0.01       0.00       3.50       0.00       0.000      0.020      0.000      0.000      80.54      999.60
 0.000654     70.        70.        70.        1          0          0          0.00       18.88      1018.47

*SECNO 41.000
   41.000     3.43       84.58      0.00       0.00       84.87      0.30       0.09       0.04       86.00
   189.0      0.0        189.0      0.0        0.0        43.2       0.0        0.2        0.1        86.00
   0.01       0.00       4.38       0.00       0.000      0.020      0.000      0.000      81.15      1000.00
 0.001333     100.       100.       100.       2          0          0          0.00       19.29      1019.28

*SECNO 42.000
   42.000     3.48       84.72      0.00       0.00       85.01      0.29       0.13       0.00       86.00
   189.0      0.0        189.0      0.0        0.0        43.6       0.0        0.3        0.1        86.00
   0.02       0.00       4.34       0.00       0.000      0.020      0.000      0.000      81.24      999.73
 0.001331     100.       100.       100.       2          0          0          0.00       19.99      1019.72

*SECNO 43.000
   43.000     3.07       84.84      0.00       0.00       85.19      0.35       0.16       0.02       86.00
   189.0      0.0        189.0      0.0        0.0        39.7       0.0        0.4        0.2        86.00
   0.03       0.00       4.77       0.00       0.000      0.020      0.000      0.000      81.77      1000.79
 0.001838     100.       100.       100.       1          0          0          0.00       20.42      1021.22
```

SECNO Q TIME SLOPE	DEPTH QLOB VLOB XLOBL	CWSEL QCH VCH XLCH	CRIWS QROB VROB XLOBR	WSELK ALOB XNL ITRIAL	EG ACH XNCH IDC	HV AROB XNR ICONT	HL VOL WTN CORAR	OLOSS TWA ELMIN TOPWID	L-BANK ELEV R-BANK ELEV SSTA ENDST
*SECNO 44.000									
44.000	2.98	85.00	0.00	0.00	85.43	0.44	0.21	0.03	86.00
189.0	0.0	189.0	0.0	0.0	35.6	0.0	0.5	0.2	85.17
0.03	0.00	5.30	0.00	0.000	0.020	0.000	0.000	82.02	999.97
0.002464	100.	100.	100.	0	0	0	0.00	19.56	1019.53
*SECNO 45.000									
45.000	2.22	85.19	0.00	0.00	85.81	0.62	0.31	0.07	87.00
189.0	0.0	189.0	0.0	0.0	29.9	0.0	0.6	0.3	86.47
0.03	0.00	6.32	0.00	0.000	0.020	0.000	0.000	82.97	999.99
0.003928	100.	100.	100.	1	0	0	0.00	17.92	1017.91
*SECNO 45.800									
45.800	3.34	85.54	0.00	0.00	86.09	0.55	0.26	0.01	87.00
189.0	0.0	189.0	0.0	0.0	31.7	0.0	0.6	0.3	87.00
0.04	0.00	5.97	0.00	0.000	0.020	0.000	0.000	82.20	1000.78
0.002809	80.	80.	80.	2	0	0	0.00	15.23	1016.01
*SECNO 45.930									
45.930	3.52	85.77	0.00	0.00	86.15	0.38	0.03	0.03	87.00
189.0	0.0	189.0	0.0	0.0	38.3	0.0	0.6	0.3	87.00
0.04	0.00	4.94	0.00	0.000	0.020	0.000	0.000	82.25	1000.07
0.001525	13.	13.	13.	2	0	0	0.00	11.72	1011.79

CROSS SECTION 39.19
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 189.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

```
ELEV   80.2      81.2      82.2      83.2      84.2      85.2      86.2      87.2      88.2      89.2      90.2

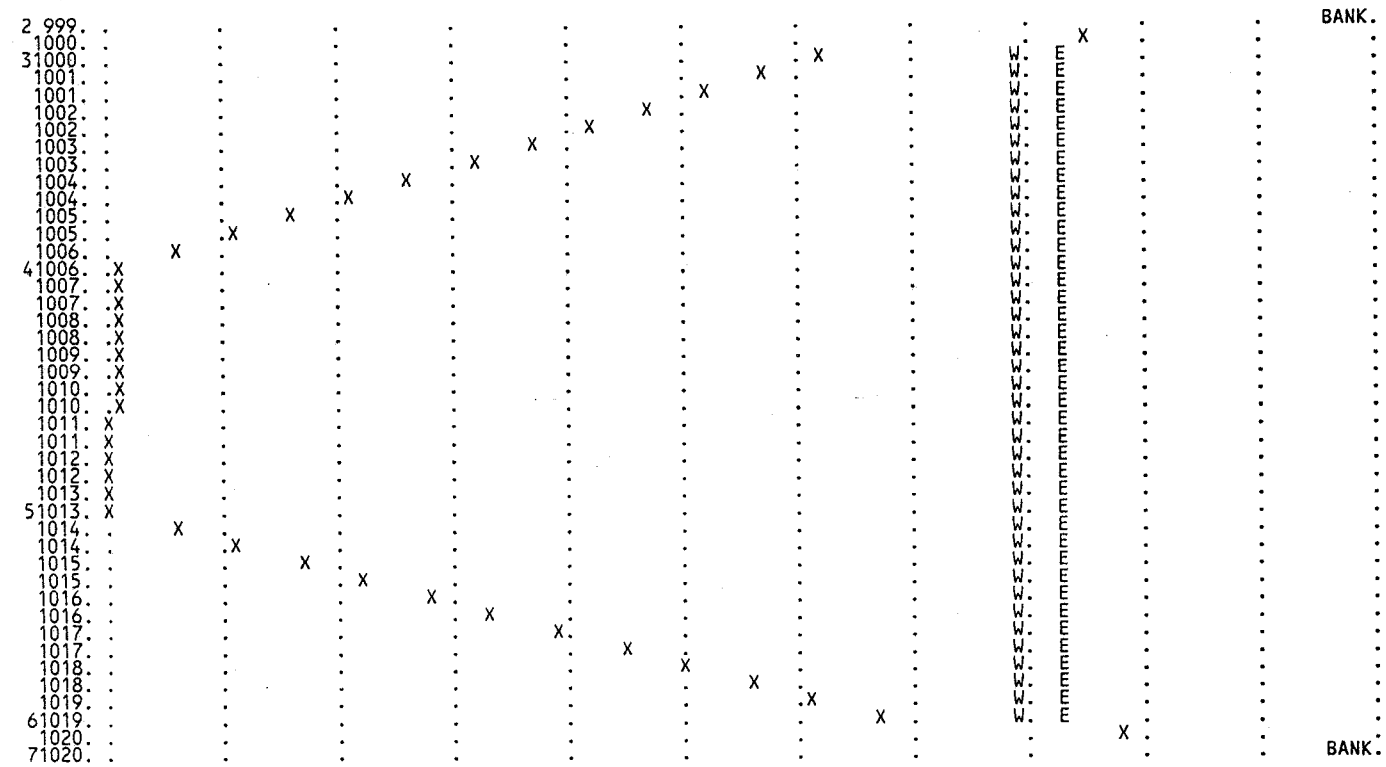
   STA-FEET
                                                                                                                BANK.
 2 999. .         .         .         .         .         .         X .         .         .         .         .
  1000. .         .         .         .         .         X         .         .         .         .         .
 31000. .         .         .         .         X . W   E         .         .         .         .         .
  1001. .         .         X         .         . W   E         .         .         .         .         .
 41001. X         .         .         .         . W   E         .         .         .         .         .
  1002. X         .         .         .         . W   E         .         .         .         .         .
  1002. X         .         .         .         . W   E         .         .         .         .         .
  1003. X         .         .         .         . W   E         .         .         .         .         .
  1003. X         .         .         .         . W   E         .         .         .         .         .
  1004. X         .         .         .         . W   E         .         .         .         .         .
  1004. X         .         .         .         . W   E         .         .         .         .         .
  1005. X         .         .         .         . W   E         .         .         .         .         .
  1005. X         .         .         .         . W   E         .         .         .         .         .
  1006. X         .         .         .         . W   E         .         .         .         .         .
  1006. X         .         .         .         . W   E         .         .         .         .         .
  1007. X         .         .         .         . W   E         .         .         .         .         .
  1007. X         .         .         .         . W   E         .         .         .         .         .
  1008. X         .         .         .         . W   E         .         .         .         .         .
  1008. X         .         .         .         . W   E         .         .         .         .         .
  1009. X         .         .         .         . W   E         .         .         .         .         .
  1009. X         .         .         .         . W   E         .         .         .         .         .
  1010. X         .         .         .         . W   E         .         .         .         .         .
  1010. X         .         .         .         . W   E         .         .         .         .         .
  1011. X         .         .         .         . W   E         .         .         .         .         .
 51011. X         .         .         .         . W   E         .         .         .         .         .
  1012. .         .         X         .         . W   E         .         .         .         .         .
 61012. .         .         .         .         X . W   E         .         .         .         .         .
  1013. .         .         .         .         .         X         .         .         .         .         .
 71013. .         .         .         .         .         .         X .         .         .         .         BANK.
```

NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

```
 EL(I),STA(I)
     86.00      999.00      83.90     1000.00      80.21     1001.00      80.21     1011.00      83.65     1012.00
     86.00     1013.00
```

CROSS SECTION 39.30
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 189.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL



NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I),STA(I)									
86.00	999.00	83.65	1000.00	80.62	1006.00	80.56	1013.00	83.90	1019.00
86.00	1020.00								

```
CROSS SECTION      40.00
STREAM  EXIST NORTH SIDE CHANNEL
DISCHARGE=       189.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

ELEV   80.5      81.0      81.5      82.0      82.5      83.0      83.5      84.0      84.5      85.0      85.5

    STA-FEET
 2 999. .         .         .         .         .         .         .         .                   .         .      BANK.
  1000. .         .         .         .         .         .         .         .            X      .         .         .
 31000. .         .         .         .         .         .         .X        .            W      .         .         .
  1001. .         .         .         .         .         .         .         .            W      .         .         .
  1001. .         .         .         .         .         .X        .         .            W      .         .         .
  1002. .         .         .         .         .         .         .         .            W      .         .         .
  1002. .         .         .         .         .X        .         .         .            W      .         .         .
  1003. .         .         .         .         .         .         .         .            W      .         .         .
  1003. .         .         .         .         .         .         .         .            W      .         .         .
  1004. .         .         .         .         .         .         .         .            W      .         .         .
  1004. .         .         .         .         .         .         .         .            W      .         .         .
  1005. .         .         .         .         .         .         .         .            W      .         .         .
  1005. .         .         .         .         .         .         .         .            W      .         .         .
  1006. .         .         .         .         .         .         .         .            W      .         .         .
 41006. .         .         .         .         .         .         .         .            W      .         .         .
  1007. .         .         .         .         .         .         .         .            W      .         .         .
  1007. .         .         .         .         .         .         .         .            W      .         .         .
  1008. .         .         .         .         .         .         .         .            W      .         .         .
  1008. .         .         .         .         .         .         .         .            W      .         .         .
  1009. .         .         .         .         .         .         .         .            W      .         .         .
  1009. .         .         .         .         .         .         .         .            W      .         .         .
  1010. .         .         .         .         .         .         .         .            W      .         .         .
  1010. .         .         .         .         .         .         .         .            W      .         .         .
  1011. .         .         .         .         .         .         .         .            W      .         .         .
  1011. .         .         .         .         .         .         .         .            W      .         .         .
  1012. .         .         .         .         .         .         .         .            W      .         .         .
 51012. .         .         .         .         .         .         .         .            W      .         .         .
  1013. .         .         .         .         .         .         .         .            W      .         .         .
  1013. .         .         .         .         .         .         .         .            W      .         .         .
  1014. .         .         .         .         .         .         .         .            W      .         .         .
  1014. .         .         .         .         .         .         .         .            W      .         .         .
  1015. .         .         .         .         .         .         .         .            W      .         .         .
  1015. .         .         .         .         .         .         .         .            W      .         .         .
  1016. .         .         .         .         .         .         .         .            W      .         .         .
  1016. .         .         .         .         .         .         .         .            W      .         .         .
  1017. .         .         .         .         .         .         .         .            W      .         .         .
  1017. .         .         .         .         .         .         .         .            W      .         .         .
  1018. .         .         .         .         .         .         .         .            W      .         .         .
 61018. .         .         .         .         .         .         .         .            W      .         .         .
  1019. .         .         .         .         .         .         .         .         X  E      .         .         .
 71019. .         .         .         .         .         .         .         .                   .         .      BANK.

NRD=       0 ELLC=  9999999.00 ELTRD=  9999999.00

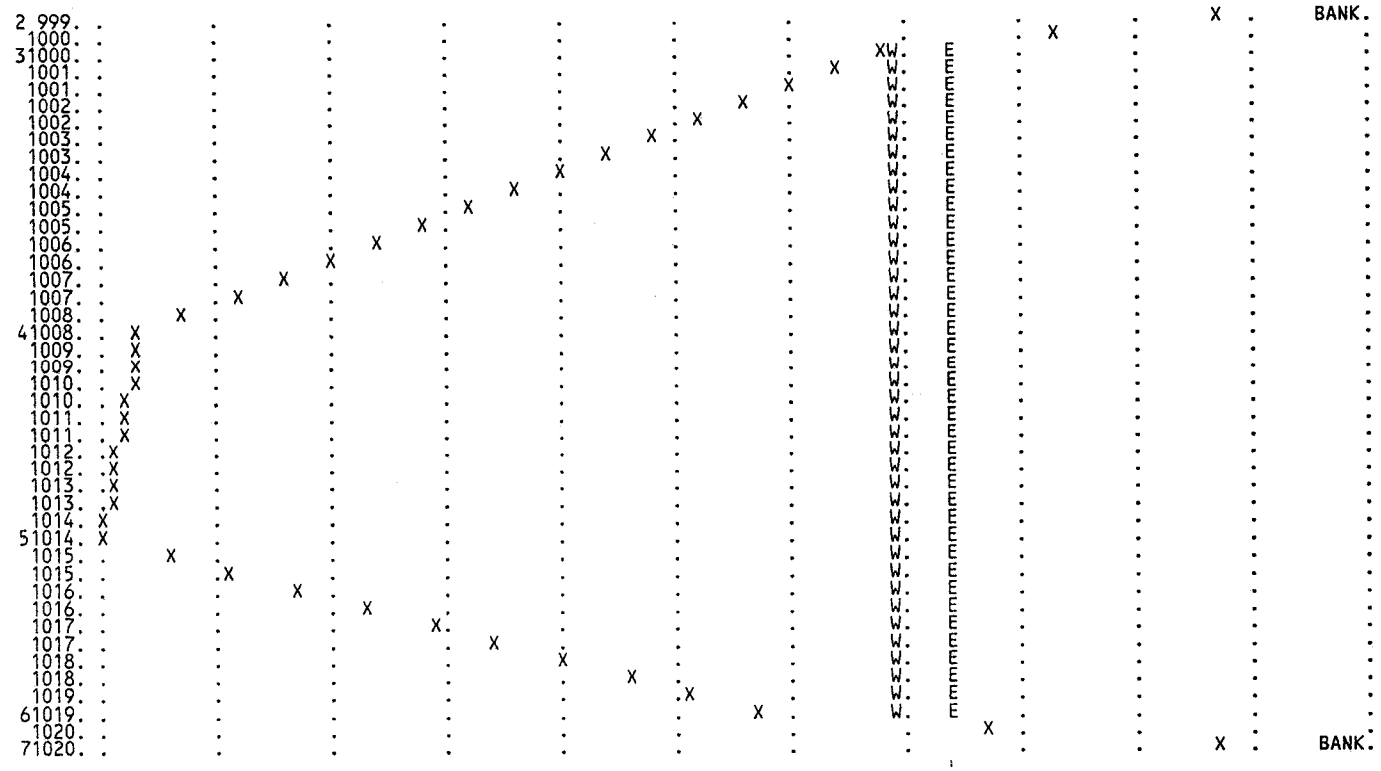
 EL(I),STA(I)
     86.00      999.00      83.58     1000.00      80.54     1006.00      80.78     1012.00      83.27     1018.00
     86.00     1019.00
```

CROSS SECTION 41.00
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 189.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

ELEV 81.2 81.7 82.2 82.7 83.2 83.7 84.2 84.7 85.2 85.7 86.2

STA-FEET

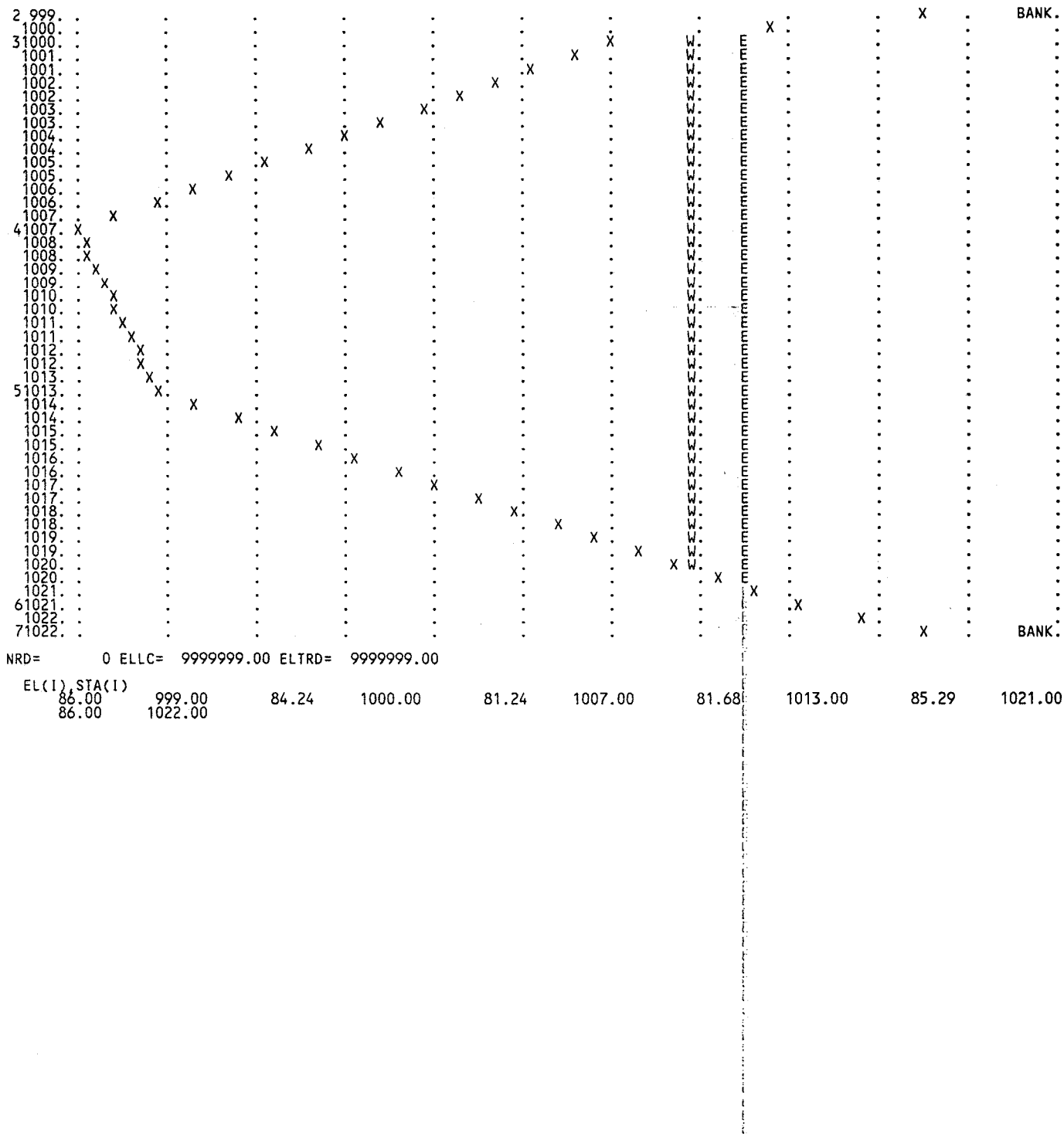


NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I)	STA(I)								
86.00	999.00	84.57	1000.00	81.32	1008.00	81.15	1014.00	84.01	1019.00
86.00	1020.00								

CROSS SECTION 42.00
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 189.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL



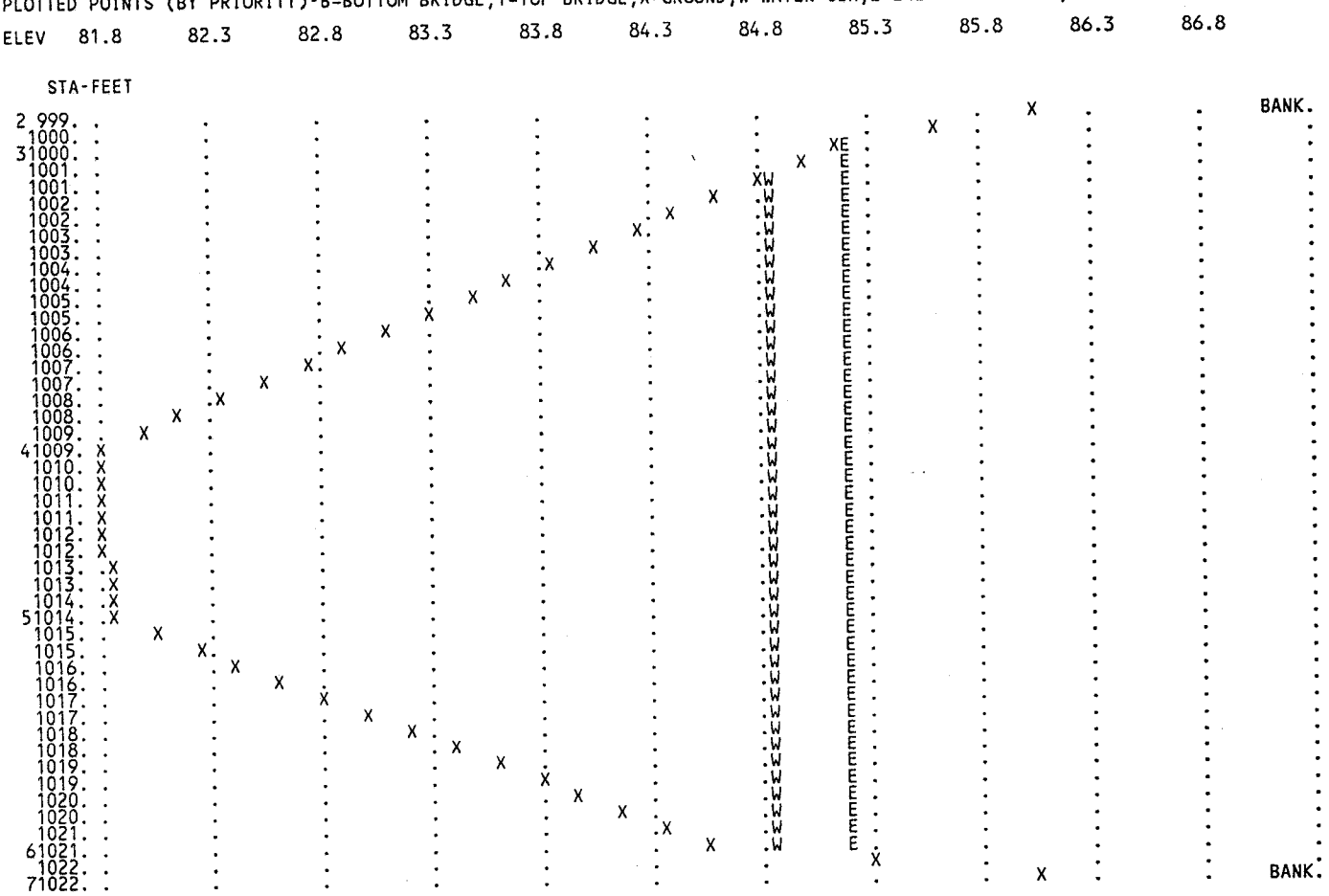
NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I),STA(I)

86.00	999.00	84.24	1000.00	81.24	1007.00	81.68	1013.00	85.29	1021.00
86.00	1022.00								

CROSS SECTION 43.00
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 189.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

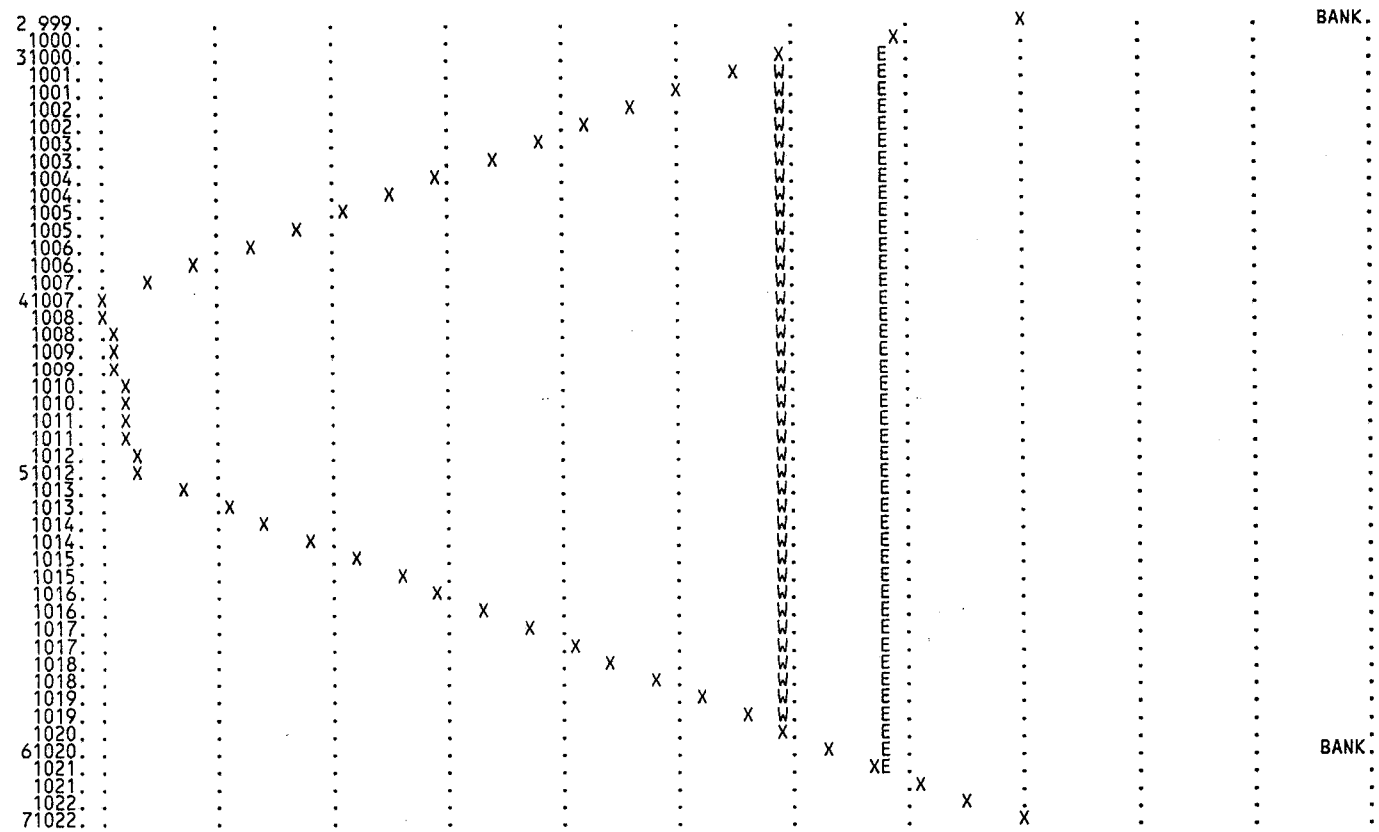


NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I)	STA(I)							
86.00	999.00	85.14	1000.00	81.77	1009.00	81.81	1014.00	84.52	1021.00
86.00	1022.00								

CROSS SECTION 44.00
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 189.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

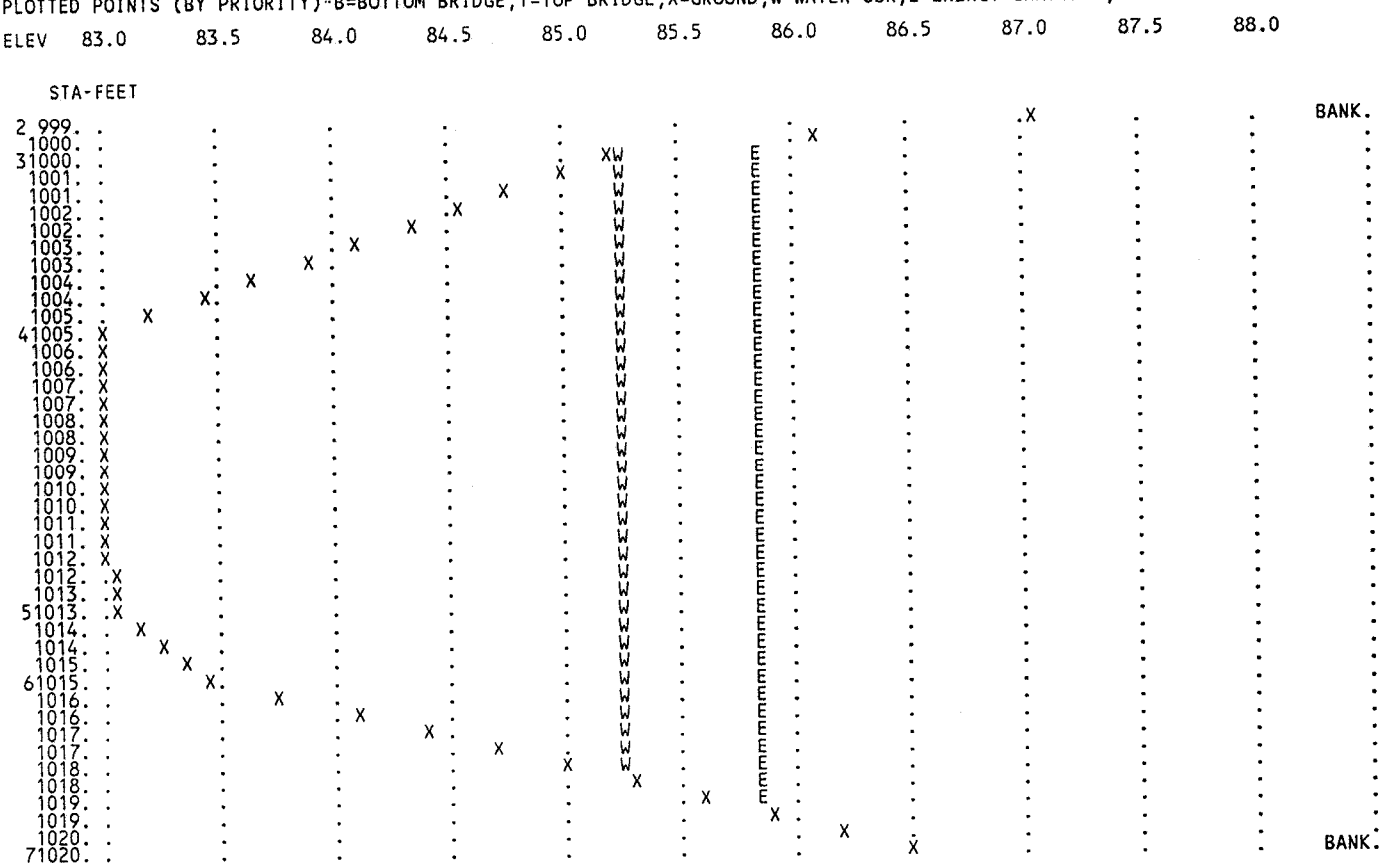


NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I)	STA(I)								
86.00	999.00	84.96	1000.00	82.02	1007.00	82.17	1012.00	85.17	1020.00
86.00	1022.00								

CROSS SECTION 45.00
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 189.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL



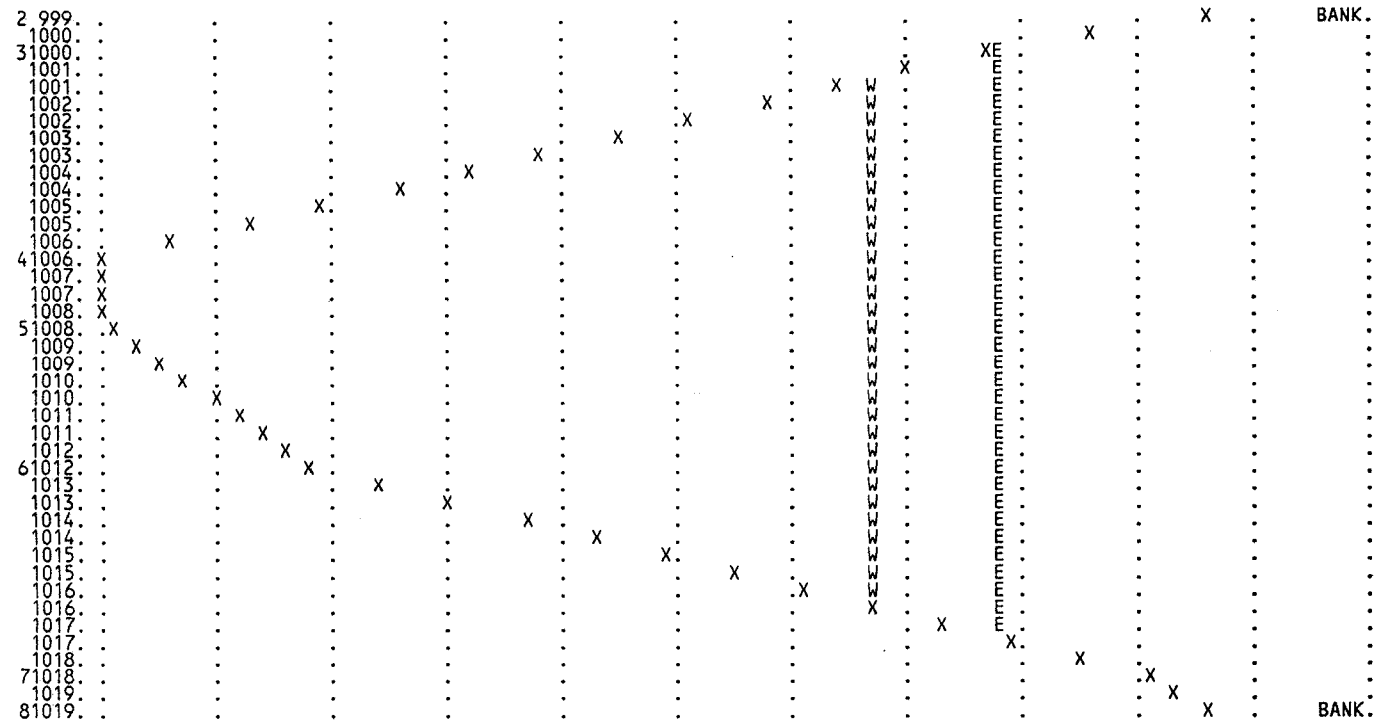
NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I),STA(I)

87.00	999.00	85.18	1000.00	82.97	1005.00	83.00	1013.00	83.44	1015.00
86.47	1020.00								

CROSS SECTION 45.80
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 189.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL



NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I),STA(I)

87.00	999.00	86.04	1000.00	82.20	1006.00	82.23	1008.00	83.12	1012.00
86.74	1018.00	87.00	1019.00						

CROSS SECTION 45.93
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 189.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

```
ELEV   82.3      82.8      83.3      83.8      84.3      84.8      85.3      85.8      86.3      86.8      87.3

   STA-FEET

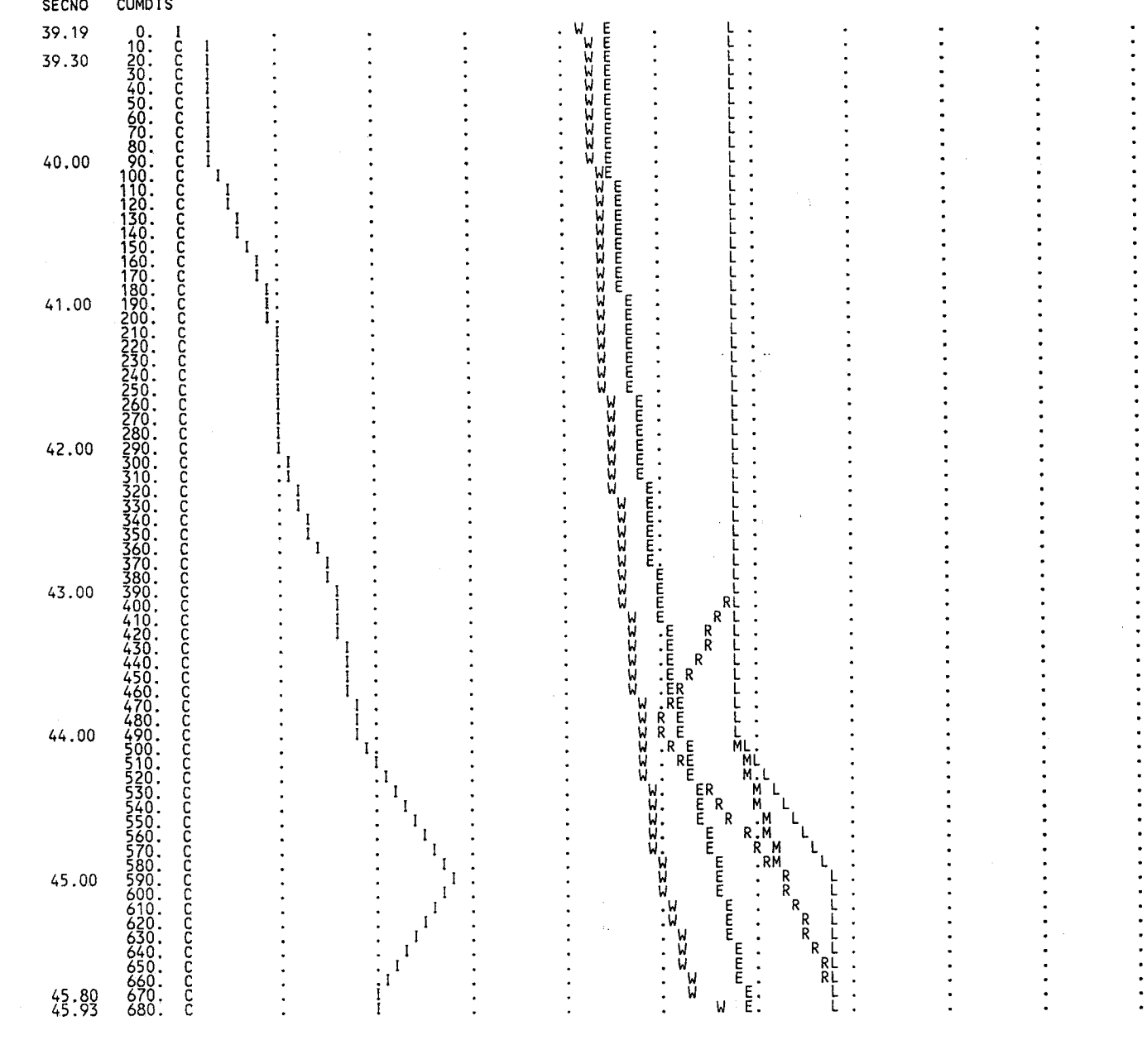
 2 999. .         .         .         .         .         .         .         .         .         .         .         X         .         BANK.
  1000. .         .         .         .         .         .         .         .         .         X         .         .         .         .
 31000. .         .         .         .         .         .         .         .         X E       .         .         .         .         .
  1001. .         .         .         .         X         .         .         .W        E         .         .         .         .         .
 41001. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1002. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1002. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1003. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1003. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1004. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1004. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1005. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1005. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1006. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1006. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1007. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1007. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1008. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1008. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1009. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1009. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1010. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1010. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1011. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
 51011. X         .         .         .         .         .         .         .W        E         .         .         .         .         .
  1012. .         .         .         .         X         .         .         .         E         .         X         .         .         .
 61012. .         .         .         .         .         .         .         .                   .         .X        .         .         .
  1013. .         .         .         .         .         .         .         .                   .         .         X         .         BANK.
 71013. .         .         .         .         .         .         .         .                   .         .         .         .         .
```

NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I),STA(I)
87.00 999.00 86.04 1000.00 82.25 1001.00 82.25 1011.00 86.74 1012.00
87.00 1013.00

PROFILE FOR STREAM EXIST NORTH SIDE CHANNEL

PLOTTED POINTS (BY PRIORITY) E-ENERGY,W-WATER SURFACE,I-INVERT,C-CRITICAL W.S.,L-LEFT BANK,R-RIGHT BANK,M-LOWER END STA



THIS RUN EXECUTED 13APR94 10:12:32

****
HEC-2 WATER SURFACE PROFILES
Version 4.6.2: May 1991
****

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

EXIST NORTH SIDE CHANNEL
SUMMARY PRINTOUT TABLE 150

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
39.190	0.00	0.00	0.00	80.21	189.00	84.42	0.00	84.67	8.56	4.01	47.15	64.62
39.300	11.00	0.00	0.00	80.56	189.00	84.51	0.00	84.69	6.13	3.39	55.67	76.35
40.000	70.00	0.00	0.00	80.54	189.00	84.55	0.00	84.74	6.54	3.50	54.06	73.93
41.000	100.00	0.00	0.00	81.15	189.00	84.58	0.00	84.87	13.33	4.38	43.16	51.77
42.000	100.00	0.00	0.00	81.24	189.00	84.72	0.00	85.01	13.31	4.34	43.59	51.80
43.000	100.00	0.00	0.00	81.77	189.00	84.84	0.00	85.19	18.38	4.77	39.65	44.09
44.000	100.00	0.00	0.00	82.02	189.00	85.00	0.00	85.43	24.64	5.30	35.65	38.08
45.000	100.00	0.00	0.00	82.97	189.00	85.19	0.00	85.81	39.28	6.32	29.92	30.16
45.800	80.00	0.00	0.00	82.20	189.00	85.54	0.00	86.09	28.09	5.97	31.67	35.66
45.930	13.00	0.00	0.00	82.25	189.00	85.77	0.00	86.15	15.25	4.94	38.29	48.40

EXIST NORTH SIDE CHANNEL

SUMMARY PRINTOUT TABLE 150

SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
39.190	189.00	84.42	0.00	0.00	0.00	12.58	0.00
39.300	189.00	84.51	0.00	0.09	0.00	19.66	11.00
40.000	189.00	84.55	0.00	0.04	0.00	18.88	70.00
41.000	189.00	84.58	0.00	0.03	0.00	19.29	100.00
42.000	189.00	84.72	0.00	0.14	0.00	19.99	100.00
43.000	189.00	84.84	0.00	0.12	0.00	20.42	100.00
44.000	189.00	85.00	0.00	0.16	0.00	19.56	100.00
45.000	189.00	85.19	0.00	0.20	0.00	17.92	100.00
45.800	189.00	85.54	0.00	0.34	0.00	15.23	80.00
45.930	189.00	85.77	0.00	0.24	0.00	11.72	13.00

SUMMARY OF ERRORS AND SPECIAL NOTES

Figure 4.42
Culvert Design Form

Project: UTOPIA ROAD ALTERNATE "C-1"	Station: 45+93 to 46+43 Sheet _____ of _____	CULVERT DESIGN FORM Designer/Date: _____ / _____ Reviewer/Date: _____ / _____

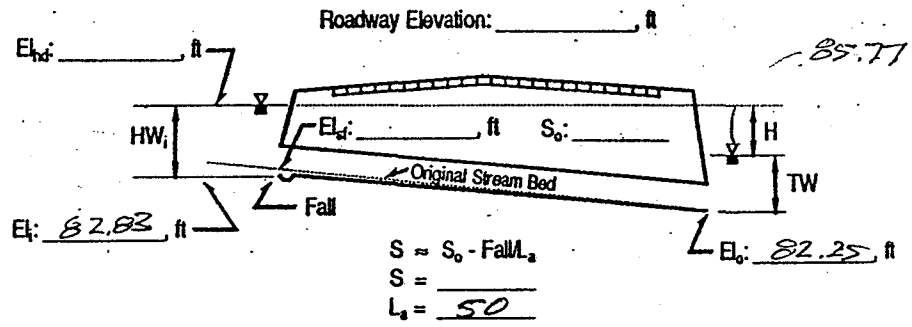
Hydrological Data

See Add'l shts

- ☐ Method: _____
- ☐ Drainage Area: _____ ☐ Stream Slope: _____
- ☐ Channel Shape: _____
- ☐ Routing: _____ ☐ Other: _____

Design Flows/Tailwater

R.I., years	Flow, cfs	TW, ft
	189	



Culvert Description: Material - Shape - Size - Entrance	Total Flow Q, cfs	Flow Per Barrel Q/N (1)	Headwater Calculations: Inlet Control HW_i/D (2)	HW_i	Fall (3)	EL_{hi} (4)	Outlet Control TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)	Control Headwater Elevation	Outlet Velocity	Comments
Cmc Box- 10'x4'	189	18.9	0.84	3.44	83.15		4.09	2.25	3.13	4.09	0.4	0.54	86.32	86.32		

Technical Footnotes:

(1) Use Q/NB for box culverts.
(2) HW_i/D = HW /D or HW_i/D from design charts
(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; Fall is zero for culverts on grade.
(4) $EL_{hi} = HW_i + EL_i$ (invert of inlet control section)
(5) TW based on downstream control or flow depth in channel.
(6) h_o = TW or $(d_c + D)/2$ (whichever is greater).
(7) $H = \left[1 + k_e + (29n^2L)/R^{1.33}\right] V^2/2g$
(8) $EL_{ho} = EL_o + H + h_o$

Subscript Definitions:

a. approximate
f. culvert fact
hd. Design Headwater
hi. Headwater in inlet control
ho. Headwater in outlet control
i. inlet control section
o. Outlet
sf. Streambed at culvert face
TW. Tailwater

Comments / Discussion:

Culvert Barrel Selected:

Size: _____
Shape: _____
Material: _____ n: _____
Entrance: _____

HEC2 S/N: 1363000413 HMVersion: 6.52 Data File: UTORD7.hc2

```
*****************************************
*  HEC-2 WATER SURFACE PROFILES         *
*                                       *
*  Version   4.6.2;  May 1991           *
*                                       *
*  RUN DATE    13APR94    TIME   10:17:39 *
*****************************************
```

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

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::::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::::
::::                                      ::::
::::   FULL MICRO-COMPUTER IMPLEMENTATION  ::::
::::                                      ::::
::::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::::
```

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============================
H A E S T A D   M E T H O D S
============================
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

THIS RUN EXECUTED 13APR94 10:17:39

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

 Version   4.6.2:  May 1991
************************************

T1 EXISTING CHANNEL NORTH OF UTOPIA ROAD STA.36+75 TO 49+36
T2 Q = 189 cfs to 233 cfs
T3       EXIST NORTH SIDE CHANNEL

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ
              2        0        0        0        0        0        0        86.32    0

J3  VARIABLE CODES FOR SUMMARY PRINTOUT
    150       150

NC     .02       .02       .02       .2        .4
QT       1       189

X1   46.43         6       999      1012         0         0         0         0         0         1
GR      87       999     86.83      1000     82.83      1001     82.83      1011     86.83      1011
GR      87      1012

X1    47.0         6       999      1020        57        57        57         0         0         1
GR      89       999     88.64      1000     83.53      1007     83.51      1013     87.99      1019
GR      89      1020

X1    48.0         6       999      1020       100       100       100         0         0         1
GR      91       999     89.17      1000     84.44      1005     84.63      1010     90.01      1019
GR      91      1020

X1   48.96         8       999      1020        96        96        96         0         0         1
GR      91       999     89.57      1000     86.24      1006     86.24      1008     86.09      1009
GR   86.62      1012     90.22      1019        91      1020

X1   49.26         6       999      1015        30        30        30         0         0         1
GR      91       999     89.60      1000     86.67      1004     86.99      1010     90.28      1014
GR      91      1015
```

X1	49.36	6	999	1018	10	10	10	0	0	1
GR	91	999	89.48	1000	86.79	1005	86.89	1011	90.71	1017
GR	91	1018								

```
   SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
   Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
   TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
   SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

*PROF 1


CCHV=    0.200 CEHV=    0.400
*SECNO 46.430
    46.430      3.49      86.32       0.00      86.32      86.74       0.42       0.00       0.00      87.00
     189.0       0.0      189.0       0.0        0.0       36.4        0.0        0.0        0.0      87.00
      0.00      0.00       5.19       0.00      0.000      0.020      0.000      0.000      82.83    1000.13
  0.001778        0.         0.         0.          0          0          0       0.00      10.87    1011.00

*SECNO 47.000

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  0.64

    47.000      2.74      86.25       0.00       0.00      87.04       0.79       0.15       0.15      89.00
     189.0       0.0      189.0       0.0        0.0       26.5        0.0        0.0        0.0      89.00
      0.00      0.00       7.13       0.00      0.000      0.020      0.000      0.000      83.51    1003.27
  0.004379       57.        57.        57.          2          0          0       0.00      13.41    1016.67

*SECNO 48.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    48.000      2.84      87.28      87.28       0.00      88.25       0.98       0.50       0.07      91.00
     189.0       0.0      189.0       0.0        0.0       23.8        0.0        0.1        0.0      91.00
      0.01      0.00       7.93       0.00      0.000      0.020      0.000      0.000      84.44    1002.00
  0.005753      100.       100.       100.         20          8          0       0.00      12.43    1014.43

*SECNO 48.960
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    48.960      2.68      88.77      88.77       0.00      89.65       0.87       0.54       0.02      91.00
     189.0       0.0      189.0       0.0        0.0       25.2        0.0        0.2        0.1      91.00
      0.01      0.00       7.49       0.00      0.000      0.020      0.000      0.000      86.09    1001.43
  0.005528       96.        96.        96.         20         11          0       0.00      14.76    1016.19

*SECNO 49.260
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
```

```
   SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
   Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
   TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
   SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    49.260      2.74      89.41      89.41       0.00      90.36       0.95       0.17       0.03      91.00
     189.0       0.0      189.0        0.0        0.0       24.1        0.0        0.2        0.1      91.00
      0.01      0.00       7.83       0.00      0.000      0.020      0.000      0.000      86.67    1000.26
  0.005605       30.        30.        30.         20          5          0       0.00      12.68    1012.94

*SECNO 49.360

3301 HV CHANGED MORE THAN HVINS

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.80

    49.360      3.32      90.11       0.00       0.00      90.50       0.39       0.03       0.11      91.00
     189.0       0.0      189.0        0.0        0.0       37.9        0.0        0.2        0.1      91.00
      0.01      0.00       4.99       0.00      0.000      0.020      0.000      0.000      86.79     999.58
  0.001730       10.        10.        10.          5          0          0       0.00      16.49    1016.07
```

```
CROSS SECTION      46.43
STREAM  EXIST NORTH SIDE CHANNEL
DISCHARGE=      189.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL
ELEV   82.8      83.3      83.8      84.3      84.8      85.3      85.8      86.3      86.8      87.3      87.8

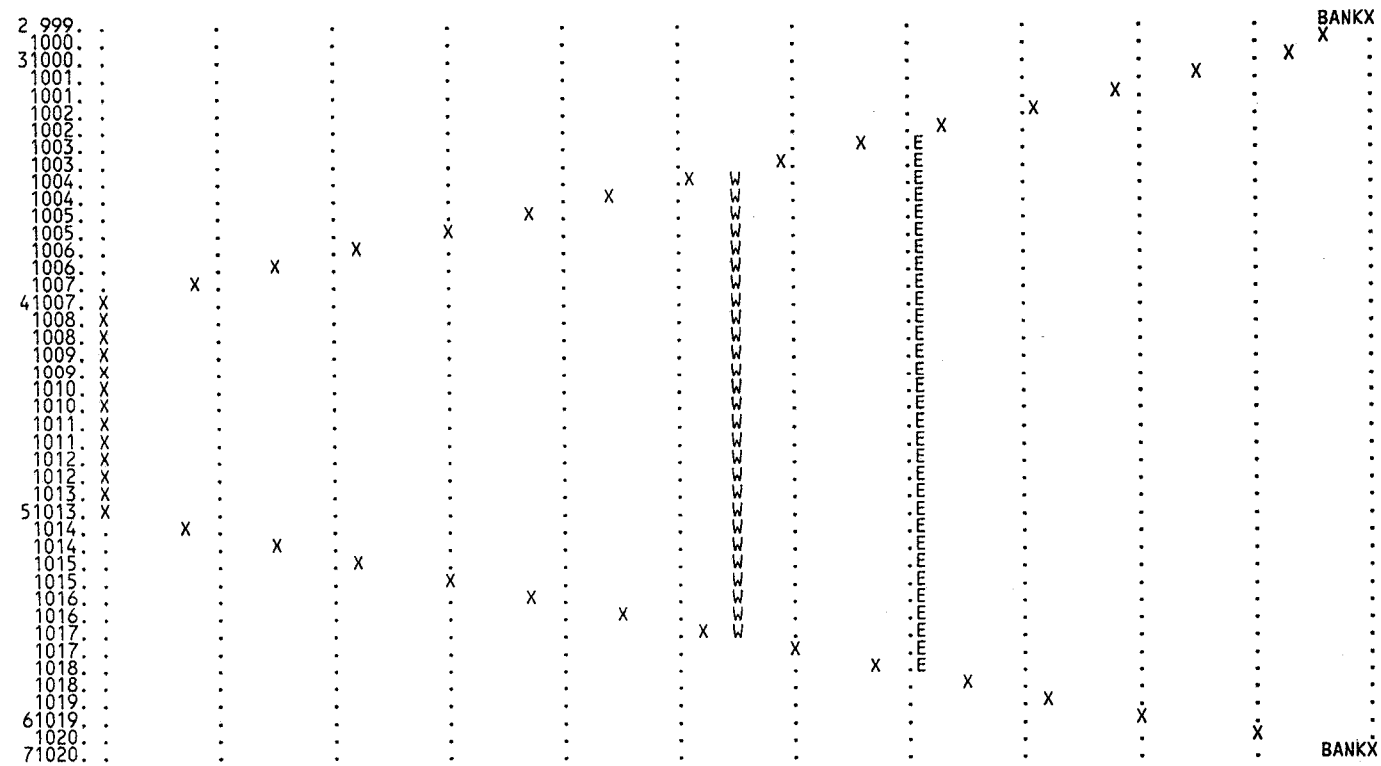
    STA-FEET
 2 999. .         .         .         .         .         .         .         .         . X         .         .         BANK.
  1000. .         .         .         .         .         .         .         .         .X          .         .             .
 31000. .         .         .         .         .         .         .         .         X           .         .             .
  1001. .         .         .         .         X         .         .         W       E .           .         .             .
 41001. X         .         .         .         .         .         .         W       E .           .         .             .
  1002. X         .         .         .         .         .         .         W       E .           .         .             .
  1002. X         .         .         .         .         .         .         W       E .           .         .             .
  1003. X         .         .         .         .         .         .         W       E .           .         .             .
  1003. X         .         .         .         .         .         .         W       E .           .         .             .
  1004. X         .         .         .         .         .         .         W       E .           .         .             .
  1004. X         .         .         .         .         .         .         W       E .           .         .             .
  1005. X         .         .         .         .         .         .         W       E .           .         .             .
  1005. X         .         .         .         .         .         .         W       E .           .         .             .
  1006. X         .         .         .         .         .         .         W       E .           .         .             .
  1006. X         .         .         .         .         .         .         W       E .           .         .             .
  1007. X         .         .         .         .         .         .         W       E .           .         .             .
  1007. X         .         .         .         .         .         .         W       E .           .         .             .
  1008. X         .         .         .         .         .         .         W       E .           .         .             .
  1008. X         .         .         .         .         .         .         W       E .           .         .             .
  1009. X         .         .         .         .         .         .         W       E .           .         .             .
  1009. X         .         .         .         .         .         .         W       E .           .         .             .
  1010. X         .         .         .         .         .         .         W       E .           .         .             .
  1010. X         .         .         .         .         .         .         W       E .           .         .             .
  1011. X         .         .         .         .         .         .         W       E .           .         .             .
 61011. XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX            .         .             .
  1012. .         .         .         .         .         .         .         .         . X         .         .             .
 71012. .         .         .         .         .         .         .         .         .  X        .         .         BANK.

NRD=        0 ELLC=  9999999.00 ELTRD=   9999999.00

  EL(I),STA(I)
     87.00       999.00        86.83      1000.00        82.83      1001.00        82.83      1011.00        86.83      1011.00
     87.00      1012.00
```

CROSS SECTION 47.00
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 189.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

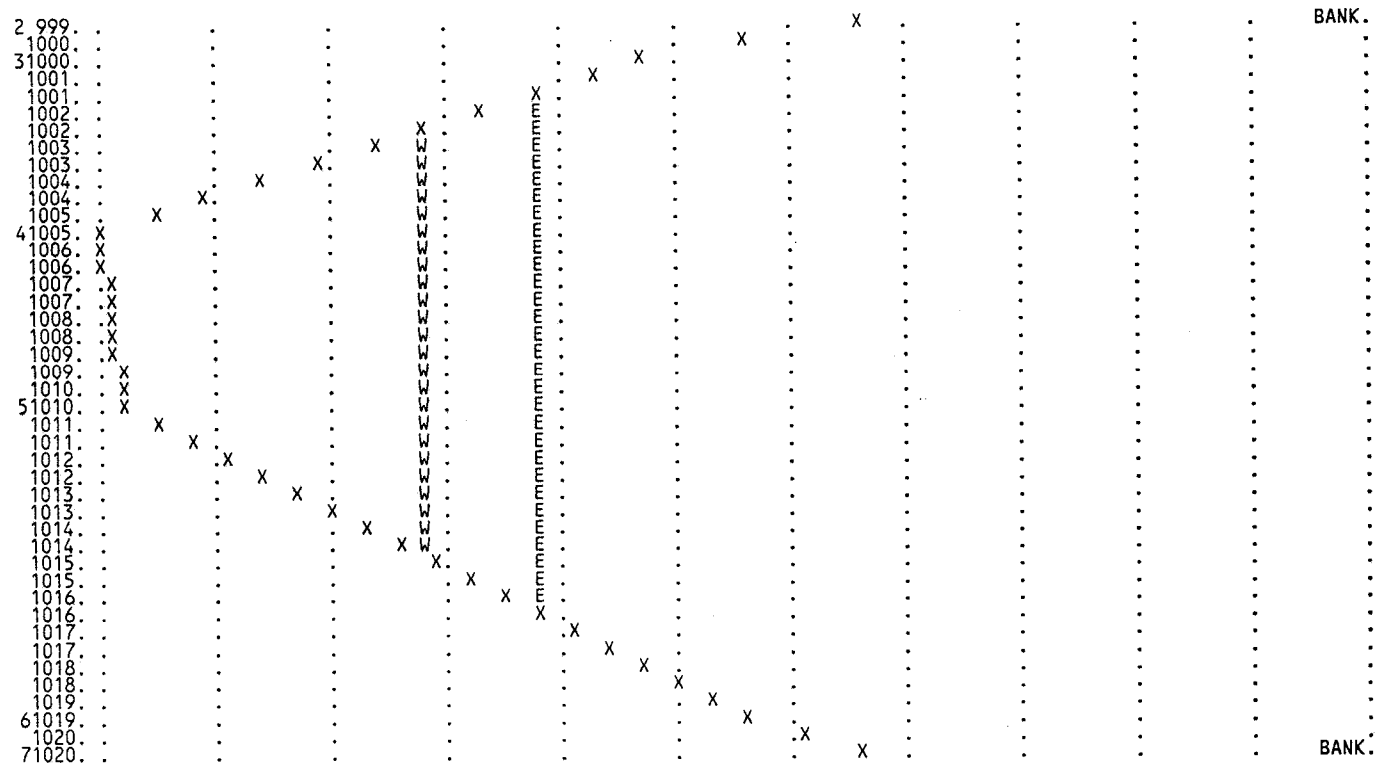


NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I)	STA(I)								
89.00	999.00	88.64	1000.00	83.53	1007.00	83.51	1013.00	87.99	1019.00
89.00	1020.00								

CROSS SECTION 48.00
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 189.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

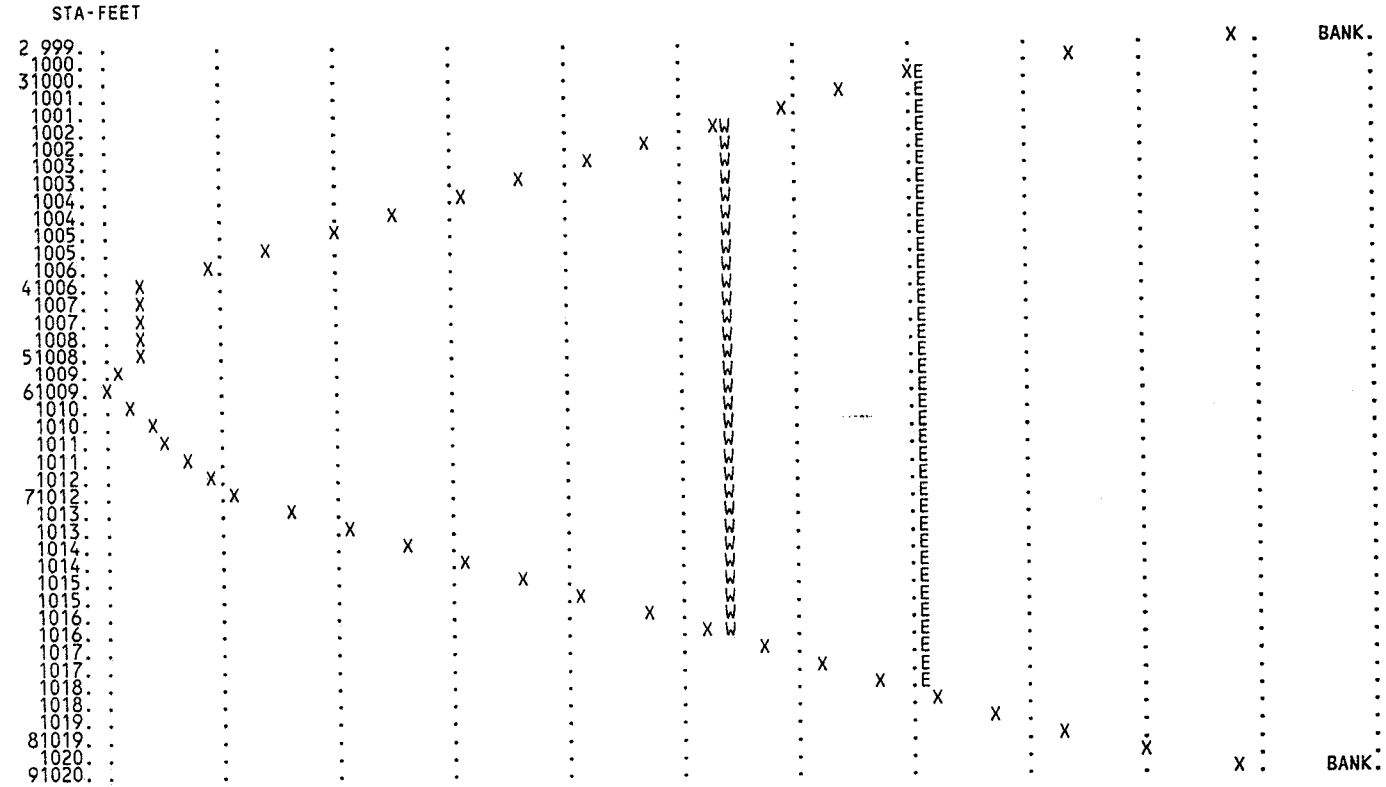


NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I)	STA(I)								
91.00	999.00	89.17	1000.00	84.44	1005.00	84.63	1010.00	90.01	1019.00
91.00	1020.00								

CROSS SECTION 48.96
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 189.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

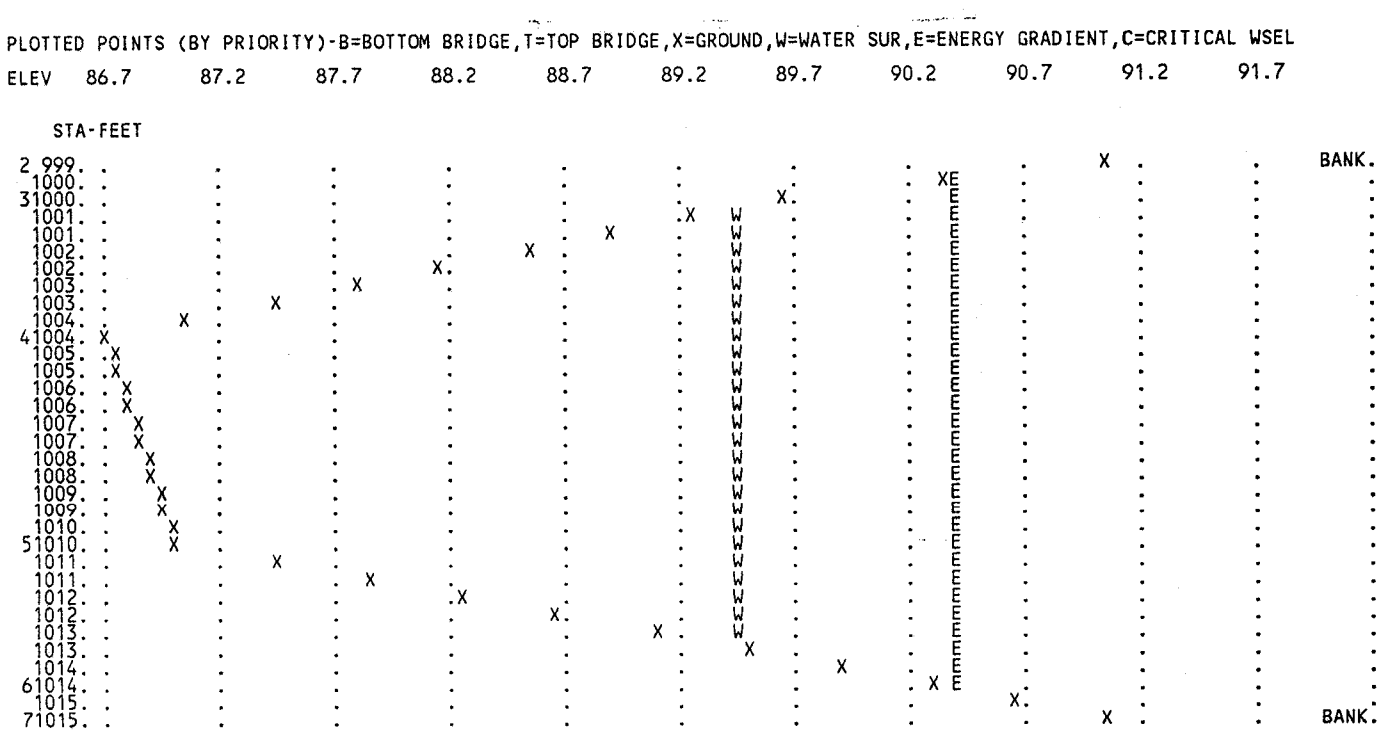


NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I)	STA(I)								
91.00	999.00	89.57	1000.00	86.24	1006.00	86.24	1008.00	86.09	1009.00
86.62	1012.00	90.22	1019.00	91.00	1020.00				

CROSS SECTION 49.26
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 189.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL



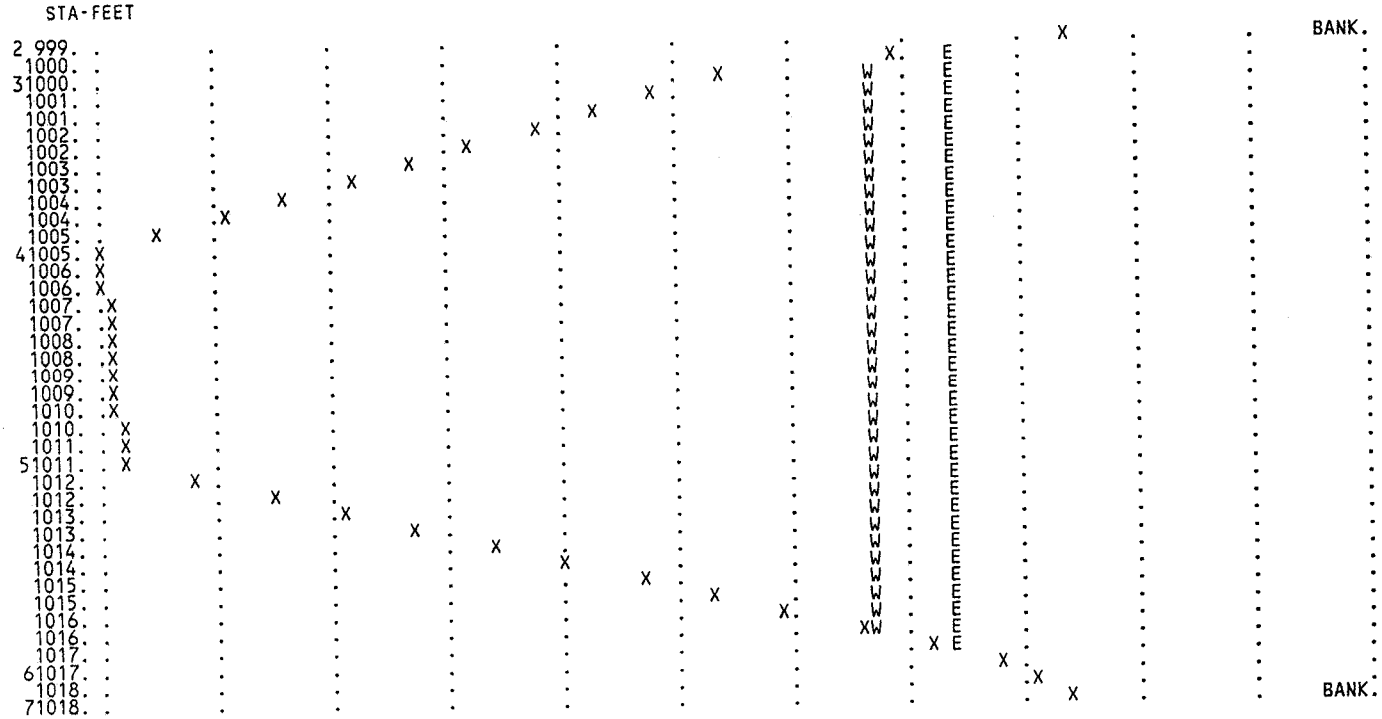
NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I)	STA(I)								
91.00	999.00	89.60	1000.00	86.67	1004.00	86.99	1010.00	90.28	1014.00
91.00	1015.00								

CROSS SECTION 49.36
STREAM EXIST NORTH SIDE CHANNEL
DISCHARGE= 189.

PLOTTED POINTS (BY PRIORITY)-B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

ELEV 86.8 87.3 87.8 88.3 88.8 89.3 89.8 90.3 90.8 91.3 91.8

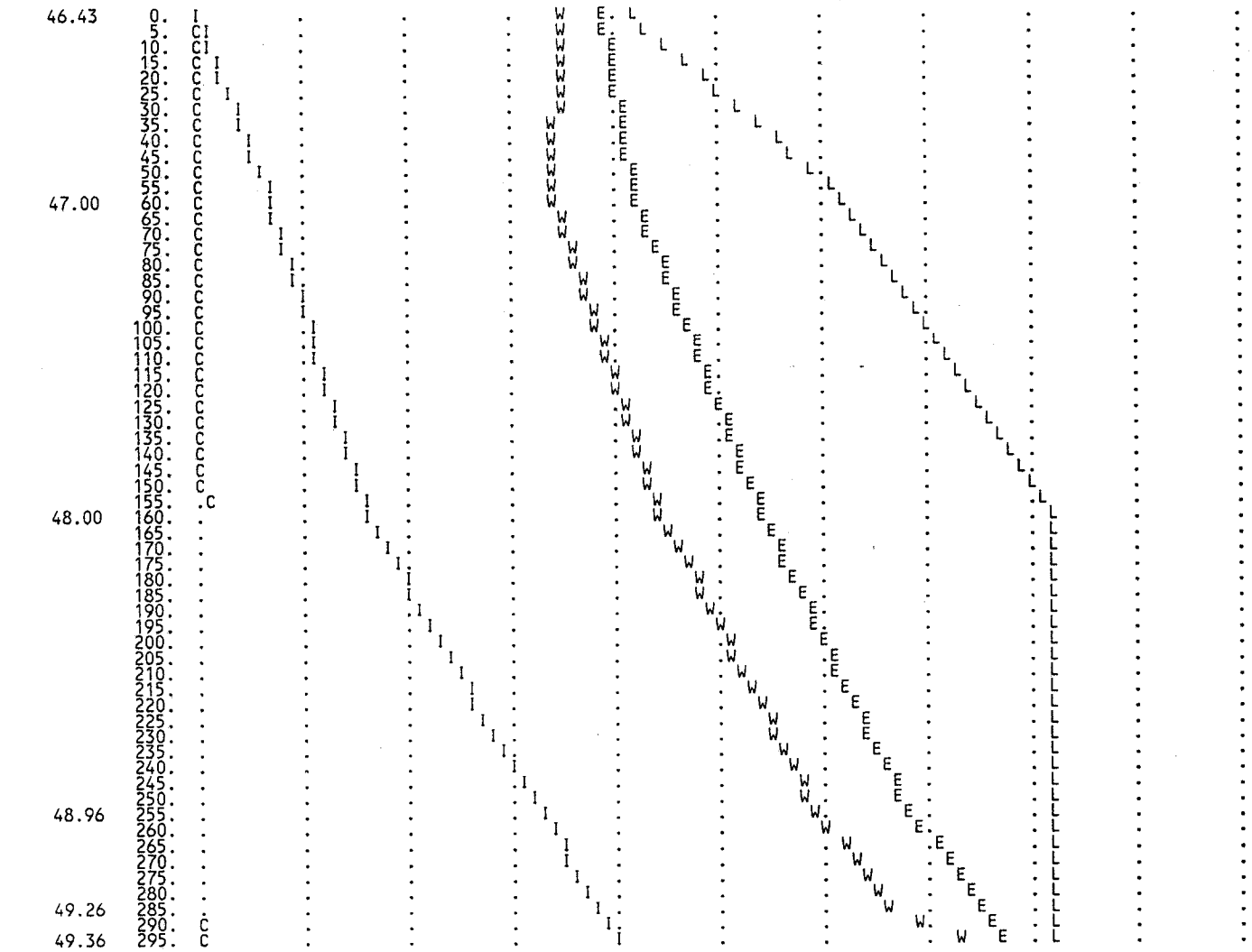


NRD= 0 ELLC= 9999999.00 ELTRD= 9999999.00

EL(I)	STA(I)								
91.00	999.00	89.48	1000.00	86.79	1005.00	86.89	1011.00	90.71	1017.00
91.00	1018.00								

PROFILE FOR STREAM EXIST NORTH SIDE CHANNEL

PLOTTED POINTS (BY PRIORITY) E-ENERGY,W-WATER SURFACE,I-INVERT,C-CRITICAL W.S.,L-LEFT BANK,R-RIGHT BANK,M-LOWER END STA



THIS RUN EXECUTED 13APR94 10:17:44

****
HEC-2 WATER SURFACE PROFILES
Version 4.6.2: May 1991
****

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

EXIST NORTH SIDE CHANNEL

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
	46.430	0.00	0.00	0.00	82.83	189.00	86.32	0.00	86.74	17.78	5.19	36.42	44.82
*	47.000	57.00	0.00	0.00	83.51	189.00	86.25	0.00	87.04	43.79	7.13	26.53	28.56
*	48.000	100.00	0.00	0.00	84.44	189.00	87.28	87.28	88.25	57.53	7.93	23.85	24.92
*	48.960	96.00	0.00	0.00	86.09	189.00	88.77	88.77	89.65	55.28	7.49	25.24	25.42
*	49.260	30.00	0.00	0.00	86.67	189.00	89.41	89.41	90.36	56.05	7.83	24.13	25.25
*	49.360	10.00	0.00	0.00	86.79	189.00	90.11	0.00	90.50	17.30	4.99	37.87	45.44

EXIST NORTH SIDE CHANNEL

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	46.430	189.00	86.32	0.00	0.00	0.00	10.87	0.00
*	47.000	189.00	86.25	0.00	-0.07	0.00	13.41	57.00
*	48.000	189.00	87.28	0.00	1.03	0.00	12.43	100.00
*	48.960	189.00	88.77	0.00	1.50	0.00	14.76	96.00
*	49.260	189.00	89.41	0.00	0.63	0.00	12.68	30.00
*	49.360	189.00	90.11	0.00	0.71	0.00	16.49	10.00

SUMMARY OF ERRORS AND SPECIAL NOTES

```
WARNING SECNO=     47.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=     48.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     48.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     48.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=     48.960  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     48.960  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     48.960  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=     49.260  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     49.260  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     49.260  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

WARNING SECNO=     49.360  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
```

HYDRAULIC GRADE LINE – ALTERNATE C-1 (REVISED)

CRITICAL DEPTH @ OUTLET OF 84" PIPE Q = 361 CFS

d	d/D	x	A	V	$V^2/2g$	E
4.98	0.7114	0.5977	29.2873	12.3262	2.3592	7.3392
4.99	0.7124	0.5990	29.3510	12.2994	2.3490	7.3390
→ 5.00	0.7143	0.6003	29.4147	12.2707	2.3388	7.3388
5.01	0.7157	0.6015	29.4735	12.2482	2.3295	7.3395
5.02	0.7171	0.6028	29.5372	12.2219	2.3195	7.3395

M.H @ Sta 33+15

$\Sigma P = \Sigma M$

$Q_1 = 332$ $Q_2 = 361$

$d_1 = 6.5$ $D_2 = d_2 = 7.0$

$S = 0.001$ $S_2 = 0.001$

$A_1 = 33.183$ $d_{2n} = 6.51$

$V_1 = 10.01$ $A_{2n} = 37.299$

$V_2 = 9.68$

$$\Delta y = \frac{Q_2V_2 - Q_1V_1}{g\,(A_1 + A_2)\,1/2} = \frac{361\,(9.68) - 332\,(10.01)}{16.1\,(37.299 + 33.183)} = 0.15$$

$D_1 = 6.51 + 0.15 = 6.66$

See Water Surface Calc's

	H.G.	E.G.
	71.42	
	6.66	
	78.08 + 1.55 =	79.63

Sta. 33+15

$$\left(\frac{332}{5679}\right)^2 = 0.0034 \times 362 = 1.23$$

	1.23	1.23
	79.31 + 1.55 =	80.86

Sta. 36+77

$Q_u/Q_o = 170/332 = 0.53$

$D_o/D_u = 6.5/6.5 = 1.00$

$0.53 \times 1.00 = 0.53$

$M_u = 0.72$ (Fig. 4.14)

6'x3' Box ≙ Round 4.79' = D_L

ARIZONA HIGHWAY DEPARTMENT
STRUCTURES SECTION
HYDRAULICS BRANCH

ALTERNATE C-1 OUTLET

HIGHWAY Utopia Road
LOCATION
PROJECT NO.

WATER SURFACE PROFILE COMPUTATION SHEET

CHANNEL TYPE Round

$n = 0.012$, $C^2 = (1.486/n)^2 = 15,335$, $Q = 361$, $S_0 = 0.001$, $b = 7.0$, $d_c = 5.00$, $d_n =$

STA	Y	A	WP	R	$R^{4/3}$	V	$V^2/2g$	h_e	E	S_f $\frac{V^2}{(C^2R^{4/3})}$	S_{fm}	$S_0 - S_{fm}$	ΔE $E_2 - (E_1 - h_e)$	ΔL	$\Sigma\Delta L$
30+98	5.00	29.415		2.235	(44,810) 2.922	(150.62) 12.273	2.3388		7.339	0.0034					
											0.0033	0.0023	0.032	13.9	
31+12	5.30	31,262		2.1154	(41,442) 2.715	(133.35) 11.547	2.0706		7.371	0.0032					
											~~0.0029~~	~~0.0019~~	~~0.110~~	~~89.5~~	
32+01	~~5.80~~	~~34.094~~		~~2.1287~~	~~(41,582) 2.738~~	~~(112.11) 10.588~~	~~1.7409~~		~~7.541~~	~~0.0026~~					
											0.0026	0.0016	0.019	99 ≅ 98	OK
32+10	5.84	34.3205		2.1280	(41,973) 2.7371	(110.74) 10.523	1.7195		7.560	0.0026					
	Bend Loss: $K_b = 0.15$ (Fig 4.20) $h_b = 0.15 \times 1.7195 = 0.26$														
32+10	6.30	36.481		2.086	(40,872) 2.665	(97.92) 9.896	1.5205		7.821	0.0024					
											0.0024	0.0014	0.144	103 ≅ 105	OK
33+15	6.51	37.299		2.045	(39,782) 2.5946	(93.07) 9.679	1.4546		7.965	0.0024					

COMPUTED BY CHECKED BY DATE

Fig 5

	H.G.	E.G.
	79.31	80.86

Sta. 36+77

$4.79/6.50 = 0.74$

$K_u^* = 1.73 \quad V_u^2/2g = 0.32$

$h_L = 1.73 \times 0.72 \times 1.55 \quad = \quad 1.93$

81.24 + 0.32 = 81.56

Sta. 36+77

$\left(\frac{176}{5279}\right)^2 = 0.0010 \times 14 \quad = \quad 0.01$

81.25 + 0.32 = 81.57

Sta. 36+91

$D_u/D_o = 5/6.5 = 0.77$
(Fig 4.8)
$K_u = -1.35 \quad V_o^2/2g = 0.32$

$h_L = -1.35 \times 0.32 \quad = \quad -0.43$

$V_u^2/2g = 1.25$

80.82 + 1.25 = 82.07

Sta. 36+91

$\left(\frac{176}{2821}\right)^2 = 0.0039 \times 594 \quad = \quad 2.31$

83.13 + 1.25 = 84.38

Sta. 42+85

$Q_u/Q_o = 172/176 = 0.98$

$D_u/D_o = 1.00$ (Fig. 4.15)

$K_u = 0.18 \quad V_u^2/2g = 1.19$

$h_L = 0.18 \times 1.25 \quad = \quad 0.23$

83.36 + 1.19 = 84.55

Sta. 42+85

$\left(\frac{176}{2821}\right)^2 = 0.0037 \times 637 \quad = \quad 2.36$

85.72 + 1.19 = 86.91

Sta. 49+22 0.96

$Q_u/Q_o = 154/172 = 0.90$

$D_u/D_o = 4.5/5.0 = 0.9$ (Fig. 4.15)

$K_u = 0.03 \quad V_u^2/2g = 1.46$

$h_L = 0.03 \times 1.19 \quad = \quad 0.04$

Sta. 49+22

85.76 + 1.46 = 87.22

	H.G.		E.G.
Sta. 49+22	85.76 + 1.46	=	87.22
$\left(\frac{154}{2131}\right)^2 = 0.0052 \times 396$ =	2.06		2.06
Sta. 53+18	87.82 + 1.46	=	89.28

$Q_u/Q_o = 149/154 = 0.97$

$D_u/D_o = 1.00$

(Fig. 4.15)

$K_u = 0.22 \quad V_o^2/2g = 1.36$

$h_L = 0.22 \times 1.46$ = 0.32

Sta. 53+18	88.14 + 1.36	=	89.50
$\left(\frac{149}{2131}\right)^2 = 0.0049 \times 185$ =	0.90 + 1.36	=	
Sta. 55+03	89.04	=	90.40

$Q_u/Q_o = 148/149 = 0.99$

$D_u/D_o = 1.00$

(Fig 4.15)

$K_u = 0.15 \quad V_o^2/2g = 1.34$

$h_L = 0.15 \times 1.36$ = 0.20

Sta. 55+03	89.24 + 1.34	=	90.58
$\left(\frac{148}{2131}\right)^2 = 0.0048 \times 382$ =	1.84		
Sta. 58+85	91.08 + 1.34	=	92.42

$Q_u/Q_o = 145/148 = 0.98$

$D_u/D_o = 1.00$

(Fig. 4.15)

$K_u = 0.18 \quad V_o^2/2g = 1.29$

$h_L = 0.18 \times 1.34$ 0.24

Sta. 58+85	91.32 + 1.29	=	92.61

	61+99 58+85 3 14	H.G.	E.G.
Sta. 58+85		91.32	92.61
$\left(\frac{145}{2131}\right)^2 = 0.0046 \times 314 =$		1.44	
Sta. 61+99 (downstream)		92.76 + 1.29 = 94.05	

$Q_u/Q_o = 1.00$ $D_u/D_o = 4/4.5 = 0.89$

(Fig. 4.15.)

$K_u = -0.48$

$h_L = -0.48 \times 1.29 = -0.62$

92.10

$\cancel{E} = -98.45$

3.65 < 4.00 invalid computation becomes open-channel flow

(See Water Surface computation sheet)

	H.G.	E.G.
$\cancel{E} =$	88.53	
$d_c =$	3.57	
Sta. 61+99 (upstream)	92.10 + 2.33 = 94.43	

$\cancel{E} = 88.59$

3.95

Sta. 62+22 (downstream) = 92.54 + 2.08 = 94.62

$\Sigma P = \Sigma M$

$Q_1 = 140$	$Q_2 = 145$
$D_1 = 4.0$ (Assumed)	$D_2 = 3.95$
$A_1 = 12.566$	$A_2 = 12.536$
$V_1 = 11.141$	$V_2 = 11.567$

$$\Delta y = \frac{Q_2V_2 - Q_1V_1}{g(A_1 + A_2)^{1/2}} = \frac{145 \times 11.567 - 140 \times 11.141}{16.1\,(12.566 + 12.536)} = 0.29$$

92.54

0.29

Sta. 62+22 (upstream)	92.83 + 1.93 = 94.76

ARIZONA HIGHWAY DEPARTMENT
STRUCTURES SECTION
HYDRAULICS BRANCH

ALTERNATE C-1 @ 32nd ST.

HIGHWAY UTOPIA ROAD
LOCATION
PROJECT NO.

WATER SURFACE PROFILE COMPUTATION SHEET

CHANNEL TYPE Circular

n = 0.012, $C^2 = (1.486/n)^2$ = 15,335, Q = 145, S_0 = 0.0066, b = 4.5, d_c = , d_n = .
S = 0.125 4.0

	Y	A	WP	R	$R^{4/3}$	V	$V^2/2g$	h_e	E	S_f $\frac{V^2}{(C^2R^{4/3})}$	S_{fm}	$S_0 - S_{fm}$	ΔE $E_2 - (E_1 - h_e)$	ΔL	$\Sigma\Delta L$
C1+05	4.50	15.904		1.00	(15,335) 1.00	9.117	(83.12) 1.291		5.791	0.0059					
											0.0051	+0.0015	0.086	57	
C1+62	4.40	15.815		1.099	(17,388) 1.139	9.1685	(84.06) 1.305		5.705	0.0048					
											~~0.0044~~	~~+0.0022~~	~~0.037~~	~~17~~	
	~~4.35~~	~~19.740~~		~~1.260~~	~~1.3615~~	~~9.2177~~	(84.86) 1.318		~~5.668~~	~~0.0041~~					
											0.0044	+0.0022	0.073	33	
	4.30	15.653		1.280	(21,318) 1.390	9.2634	(85.41) 1.332		5.632	0.0040					
											0.0044	+0.0022	0.052	24 ≠ 23	OK
C1+85	4.33	15.707		1.269	(21,068) 1.374	9.2315	(85.22) 1.323		5.653	0.0040					
											0.0059	+0.1191	0.055	0.46 ≠ 4.00	
C1+89	3.57	11.844		1.196	(19,479) 1.270	12.2425	(149.88) 2.3273	0.30	5.898	0.0077					
											∴ Flow is supercritical w/ hydraulic jump inside M.H.				

COMPUTED BY CHECKED BY DATE

Fig. 5

	H.G.	E.G.
Sta. 62+22 (upstream)	92.83	94.76

$$\left(\frac{140}{1556}\right)^2 = 0.0081 \times 72 = 0.58$$

Sta. 62+94 (downstream) = 93.31 + 1.93 = 95.24

1.93

$Q_2 = 140$ $\quad Q_1 = 131$

$A_2 = 12.566$ $\quad A_1 = 12.566$

$V_2 = 11.142$ $\quad V_1 = 10.425$

$$\Delta y = \frac{Q_2 V_2 - Q_1 V_1}{g\,(A_1 + A_2) \times 1/2} \qquad V_1^2/2g = 1.69$$

1559.88 $\quad$ 1365.68 $\quad$ 1283.59

$$\Delta y = \frac{140(11.142) - 131(10.425)}{16.1\,(12.566 + 12.566)} = 0.48$$

404.23

Sta. 62+94 (upstream) $\quad$ 93.79 + 1.69 = 95.48

$$\left(\frac{131}{1556}\right)^2 = 0.0071 \times 30 = 0.21$$

Sta. 63+26 (inside Hdwl) = 94.00 + 1.69 = 95.69

Figure 4.42
Culvert Design Form

Project: UTOPIA ROAD ALTERNATE C-1	Station: 62+94 to 63+26 Sheet _____ of _____	CULVERT DESIGN FORM Designer/Date: _____ / _____ Reviewer/Date: _____ / _____

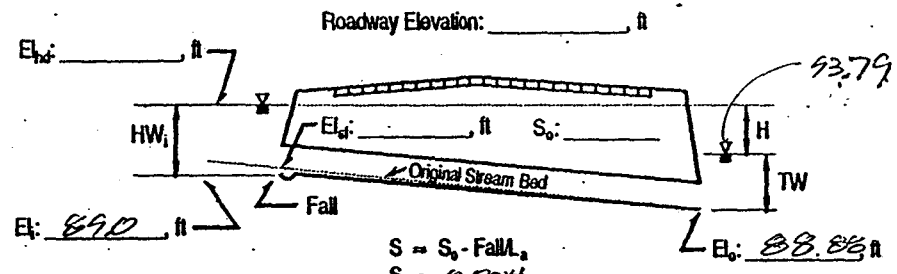
Hydrological Data

See Add'l sits

- ☐ Method: _____
- ☐ Drainage Area: _____ ☐ Stream Slope: _____
- ☐ Channel Shape: _____
- ☐ Routing: _____ ☐ Other: _____

Design Flows/Tailwater

R.I., years	Flow, cfs	TW, ft



Culvert Description: Material - Shape - Size - Entrance	Total Flow Q, cfs	Flow Per Barrel Q/N (1)	Headwater Calculations: Inlet Control: HW_i/D (2)	HW_i	Fall (3)	EL_{hi} (4)	Outlet Control: TW (5)	d_c	$\frac{d_c + D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)	Control Headwater Elevation	Outlet Velocity	Comments
Conc Round 48" Hdwl	131		1.5	6.00		95.00	4.90	—	—	—	0.2	2.25	96.04	96.04		Assumes 9 cfs in roadway catch basin
											approx spillway elev: 96.00 ok					

Technical Footnotes:

(1) Use Q/NB for box culverts.
(2) HW_i/D = HW/D or HW_f/D from design charts
(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; Fall is zero for culverts on grade.
(4) $EL_{hi} = HW_i + EL_i$ (invert of inlet control section)
(5) TW based on downstream control or flow depth in channel.
(6) h_o = TW or $(d_c + D)/2$ (whichever is greater).
(7) $H = \left[1 + k_e + (29n^2L)/R^{1.33}\right] V^2/2g$
(8) $EL_{ho} = EL_o + H + h_o$

Subscript Definitions:

a. approximate
f. culvert fact
hd. Design Headwater
hi. Headwater in inlet control
ho. Headwater in outlet control
i. Inlet control section
o. Outlet
sf. Streambed at culvert face
TW. Tailwater

Comments / Discussion:

HEC-1 analysis shows that using a headwater depth of 96.04 in detention basin (rather than 95.67 in enclosed HEC-1) will reduce discharge to 132 cfs = 130 cfs ≅ 131 cfs

Culvert Barrel Selected:

Size: _____
Shape: _____
Material: _____ n: _____
Entrance: _____

Figure 4.42
Culvert Design Form

Project: UTOPIA ROAD	Station: 33+15 Sheet ____ of ____	CULVERT DESIGN FORM Designer/Date: ____ / ____ Reviewer/Date: ____ / ____

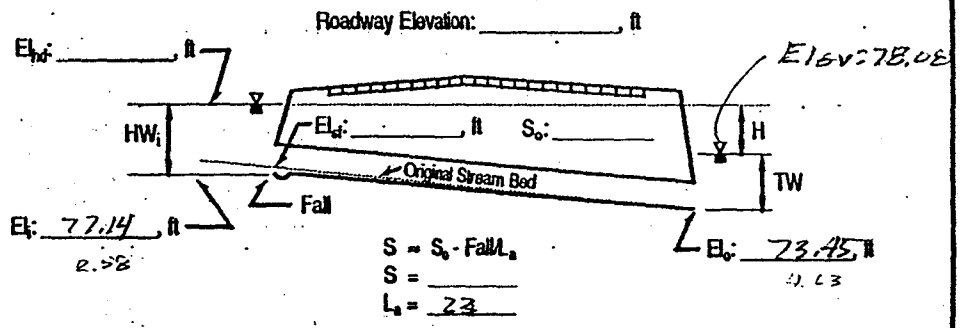
Hydrological Data

See Add'l shts

- ☐ Method: ____
- ☐ Drainage Area: ____ ☐ Stream Slope: ____
- ☐ Channel Shape: ____
- ☐ Routing: ____ ☐ Other: ____

Design Flows/Tailwater

R.I., years	Flow, cfs	TW, ft



Culvert Description: Material - Shape - Size - Entrance	Total Flow Q, cfs	Flow Per Barrel Q/N (1)	Headwater Calculations: Inlet Control: HW_i/D (2)	HW_i	Fall (3)	EL_{hi} (4)	Outlet Control: TW (5)	d_c	$\frac{d_c + D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)	Control Headwater Elevation	Outlet Velocity	Comments
Conc. Round 36" HdwL	34		0.86	2.58		79.72	4.63	—	—	4.63	0.4	0.52	78.60	79.72	—	

Technical Footnotes:

(1) Use Q/NB for box culverts.
(2) HW_i/D = HW/D or HW_i/D from design charts
(3) FALL = $HW_i - (EL_{hd} - EL_{st})$; Fall is zero for culverts on grade.
(4) $EL_{hi} = HW_i + EL_i$ (invert of inlet control section)
(5) TW based on downstream control or flow depth in channel.
(6) h_o = TW or $(d_c + D)/2$ (whichever is greater).
(7) $H = \left[1 + k_e + (29n^2L)/R^{1.33}\right] V^2/2g$
(8) $EL_{ho} = EL_o + H + h_o$

Subscript Definitions:

a. approximate
i. culvert fact
hd. Design Headwater
hi. Headwater in inlet control
ho. Headwater in outlet control
I. Inlet control section
o. Outlet
st. Streambed at culvert face
TW. Tailwater

Comments / Discussion:

Culvert Barrel Selected:

Size: ____
Shape: ____
Material: ____ n: ____
Entrance: ____

Figure 4.42
Culvert Design Form

Project: UTOPIA ROAD ALTERNATE "C-1"	Station: 36+13 Sheet ____ of ____	CULVERT DESIGN FORM Designer/Date: ____ / ____ Reviewer/Date: ____ / ____

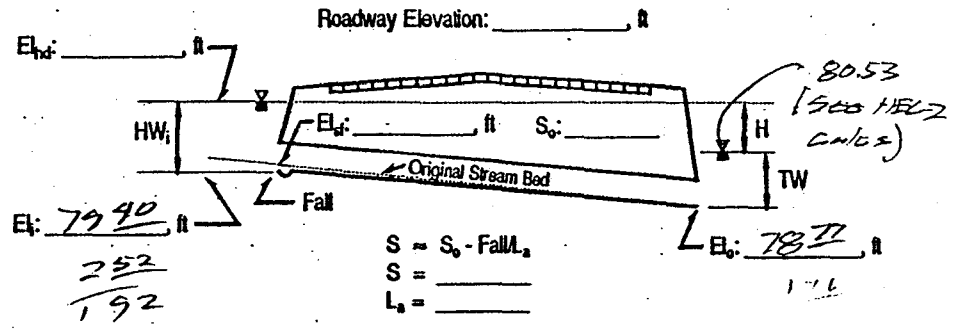
Hydrological Data

See Add'l shts

- ☐ Method: ____
- ☐ Drainage Area: ____ ☐ Stream Slope: ____
- ☐ Channel Shape: ____
- ☐ Routing: ____ ☐ Other: ____

Design Flows/Tailwater

R.I., years	Flow, cfs	TW, ft



Culvert Description: Material - Shape - Size - Entrance	Total Flow Q, cfs	Flow Per Barrel Q/N (1)	Headwater Calculations: Inlet Control HW_i/D (2)	HW_i	Fall (3)	EL_{hi} (4)	Outlet Control TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)	Control Headwater Elevation	Outlet Velocity	Comments
TRIPLE CMPA 48"x27" ARCH	101	34	1.12	2.52	.	81.92	1.76	1.44	1.85	1.85	0.4	2.00	82.62	≅	82.60	OK

Technical Footnotes:

(1) Use Q/NB for box culverts.
(2) HW_i/D = HW /D or HW_i/D from design charts
(3) FALL ≐ $HW_i - (EL_{hd} - EL_{sf})$; Fall is zero for culverts on grade.
(4) $EL_{hi} = HW_i + EL_i$ (invert of inlet control section)
(5) TW based on downstream control or flow depth in channel.
(6) h_o = TW or $(d_c + D)/2$ (whichever is greater).
(7) $H = \left[1 + k_e + (29n^2L)/R^{1.33}\right] V^2/2g$
(8) $EL_{ho} = EL_o + H + h_o$

Subscript Definitions:

a. approximate
f. culvert fact
hd. Design Headwater
hi. Headwater in inlet control
ho. Headwater in outlet control
i. Inlet control section
o. Outlet
sf. Streambed at culvert face
TW. Tailwater

Comments / Discussion:

Culvert Barrel Selected:

Size: ____
Shape: ____
Material: ____ n: ____
Entrance: ____

Figure 4.42
Culvert Design Form

Project: UTOPIA ROAD ALTERNATE 'C-1'	Station: 36+77 Sheet _____ of _____	CULVERT DESIGN FORM Designer/Date: _____ / _____ Reviewer/Date: _____ / _____

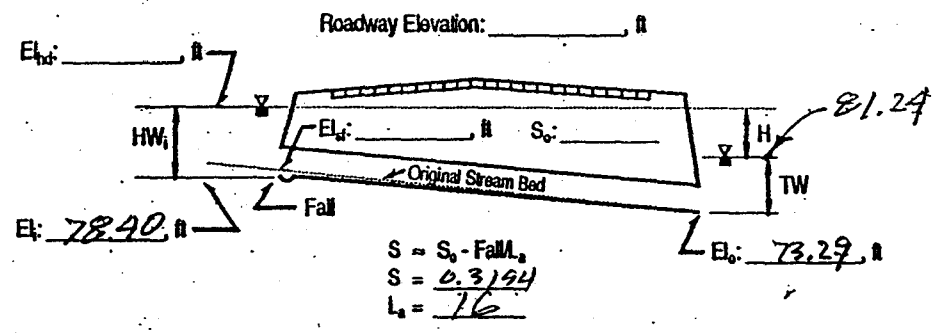
Hydrological Data

See Add'l shts

- ☐ Method: _____
- ☐ Drainage Area: _____ ☐ Stream Slope: _____
- ☐ Channel Shape: _____
- ☐ Routing: _____ ☐ Other: _____

Design Flows/Tailwater

R.I., years	Flow, cfs	TW, ft



Culvert Description: Material - Shape - Size - Entrance	Total Flow Q, cfs	Flow Per Barrel Q/N (1)	Headwater Calculations: Inlet Control HW_i/D (2)	HW_i	Fall (3)	El_{hi} (4)	Outlet Control TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	El_{ho} (8)	Control Headwater Elevation	Outlet Velocity	Comments
Conc Box 6'x3'	133	22	1.40	4.20			7.86	1.50	3.75	6.50	0.2	1.25	82.99	82.60		

81.15
73.29
7.86

Technical Footnotes:

(1) Use Q/NB for box culverts.
(2) HW_i/D = HW/D or HW_i/D from design charts
(3) FALL = $HW_i - (El_{hd} - El_{sf})$; Fall is zero for culverts on grade.
(4) $El_{hi} = HW_i + El_i$ (invert of inlet control section)
(5) TW based on downstream control or flow depth in channel.
(6) h_o = TW or $(d_c + D)/2$ (whichever is greater).
(7) $H = \left[1 + k_e + (29n^2L)/R^{1.33}\right] V^2/2g$
(8) $El_{ho} = El_o + H + h_o$

Subscript Definitions:

a. approximate
f. culvert fact
hd. Design Headwater
hi. Headwater in inlet control
ho. Headwater in outlet control
i. Inlet control section
o. Outlet
sf. Streambed at culvert face
TW. Tailwater

Comments / Discussion:

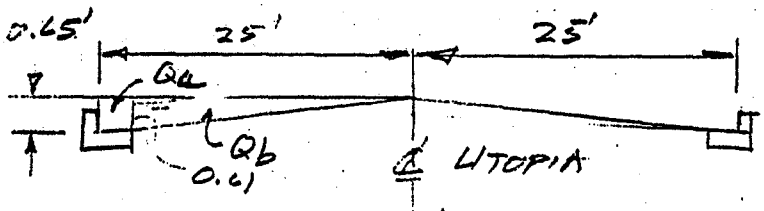
Culvert Barrel Selected:

Size: _____
Shape: _____
Material: _____ n: _____
Entrance: _____

CATCH BASIN HYDRAULICS

Exist Catch Basin Lt. Sta. 63+69.60

C.O.P. Std. 1569
M-2, L = 17'



$S = 0.0060'/'$

$n = 0.016$

$S_x = 0.025'/'$

$Q_{100} = 34$ cfs

$$z/n = \frac{1}{0.025 \times 0.016} = 2500$$

From page 27 of reference 17 $y = 0.65'$

$Q_a = Q_{100} - Q_b$ $Q_b = 30$ (d=0.61) $Q_a = 4$

From pages 3-16 & 3-17 of reference 6

$E_o = \frac{4}{34} = 0.12$ $S_w = \frac{0.166}{1.5} = 0.11$

$S_e = S_x + S_w E_o = 0.025 + 0.12(0.11) = 0.038'/'$

$$L_T = 0.6 Q^{0.42} S^{0.3} \left(\frac{1}{n S_e}\right)^{0.6} = 0.6 \times 34^{0.42} \times 0.006^{0.3} \times \left(\frac{1}{0.016 \times 0.038}\right)^{0.6} = 48.2$$

$$E = 1 - \left(1 - \frac{L}{L_T}\right)^{1.8} = 0.93$$ $Q_1 = 0.93 \times 0.80 \times 34 = 25.3$

$Q_p = 34 - 25.3 = 8.7$

Check 2-yr Runoff

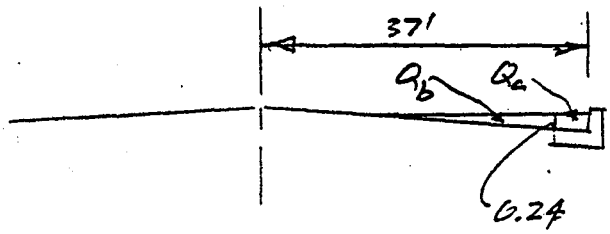
$Q_2 = 6$ cfs

From Fig 12 (Page 28) of reference 17

$y = 0.34$ $T = \frac{0.34}{.025} = 13.6$ $Clear = 25.0 - 13.6 = 11.4'$ Lane say OK

Exist Catch Basin 100' Lt. Sta. 62+86

C.O.P. Std 1569
M-2, L = 17'



$S = 0.0070'/'$

$n = 0.016$

$S_x = 0.024'/'$

$Q_{100} = 4$ cfs

$$z/n = \frac{1}{0.024 \times 0.016} = 2600$$

From page 27 of reference 17: $y = 0.28$

$Q_a = Q_{100} - Q_b$ $Q_b = 1.5$ (d=0.24) $Q_a = 2.5$

From pages 3-16 & 3-17 of reference 6

$E_o = \frac{2.5}{4.0} = 0.63$ $\quad S_w = 0.11$

$S_e = S_x + S_w E_o = 0.026 \times 0.63(0.11) = 0.095$

$L_T = 0.6 \times \left(\frac{4}{0.8}\right)^{0.42} \times 0.007^{0.3} \times \left(\frac{1}{0.016 \times 0.095}\right)^{0.6} = 13.0 < 20$

∴ will intercept all of gutter flow

<u>New Catch Basin 52' Lt. Sta. 62+82</u> (Sump Conditions)

$Q_T = 8.7$ cfs $\quad$ Design $= \frac{8.7}{0.8} = 10.9$

Try C.O.P. Std 1569 M-1 $L = 17'$

$\bar{d} = 0.45 - 15(\underbrace{0.004}_{\text{street slope}}) = 0.39$

$Q_i = 2.3(L + 1.8W)\, d^{1.5}$ (page 3-18 of reference 6)

$Q_i = 2.3(20 + 1.8 \times 1.5)\, 0.39^{1.5} = 12.7$ cfs > 10.9 (ok)

<u>New Catch Basin 32' Lt. Sta. 58+85</u>

$Q_T = \underbrace{15}_{\text{Area 18}} + \underbrace{9}_{\text{Area 17}} = 24$ (HEC-1)

Try Double ADOT Type 4 catch basin, Std C-15.30 w/P.C. Apron.

ADOT Std C-15.70

$\bar{d} = \underbrace{93.07}_{\text{Edge Pave}} - \underbrace{92.30}_{\text{Grate}} = 0.77$ $\quad$ Perimeter $= 14 + 4 = 18$ ft

From page 3-21 of reference 6 $\quad$ Area $= 2 \times 3.78 = 7.56$

$Q_i = C_w P d^{1.5} = 3 \times 18 \times 0.77 = 36.4$ cfs

w/ clogging $Q_i = 36.4 \times 0.8 = 29.2$ cfs > 24 cfs (ok)

$Q_i = C_o A (2gd)^{0.5} = 0.67 \times 7.56 (64.4 \times 0.77)^{0.5} = 35.7$ cfs

w/ clogging $Q_i = 35.7 \times 0.8 = 28.6$ cfs > 24 cfs (ok)

<u>New Catch Basin Rt. Sta. 55+03</u> (Area 24 A)

$Q_{100} = 2$ cfs (HEC-1) $\quad Q_{100} = 0.55(0.9)\,7.00 = 3.5$ cfs (Rational)

$S = 0.0058 \quad n = 0.016 \quad S_x = 0.018 \quad Z/n = 3472$

From Page 28 of reference 17: $\quad y = 0.25$, $y_1 = 0.21$ $\quad Q_b = 2.5$

From pages 3-16 & 3-17 of reference C

$E_o = \frac{3.5-2.5}{3.5} = 0.29$ $\quad S_w = 0.11$

$S_e = S_x + S_w E_o = 0.018 \times 0.29(0.11) = 0.052$

$L_T = 0.6\left(\frac{3.5}{0.8}\right)^{0.42} \times 0.0058^{0.3} \times \left(\frac{1}{0.016 \times 0.052}\right)^{0.6} = 16.7$

1.86 $\quad$ 1.213 $\quad$ 74.9

$E = 1 - \left(1 - \frac{L}{L_T}\right)^{1.8} = 1 - \left(1 - \frac{6}{16.7}\right)^{1.8} = 0.55$

$Q_i = 3.5(0.55) = 1.9$ cfs $\quad Q_p = 3.5 - 1.9 = 1.6$ cfs

<u>Check 2-yr runoff</u> $\quad i_2 = 2.9$"/hr.

$Q_2 = 0.55(0.9)\,2.9 = 1.4$ cfs

From Page 28 of reference 17: $y = 0.17$

$T = \frac{0.17}{0.018} = 9.4'$ $\quad$ Clear $= 19.5 - 9.4 = 10.1' < 12'$

∴ An additional catch basin should be installed to the Right of Sta. 58+85 upon Future reconstruction of the roadway to Limit the Flow spread to Less than 12 Feet.

<u>New Catch Basin Lt. Sta. 53+18 (Area 19A + 24B)</u>

$Q_{100} = 2$ cfs (HEC-1, Area 24B) $\quad Q_{100} = 4$ cfs (HEC-1, Area 19A)

$Q_{100} = 0.85 \times 0.9 \times 7 = 5.3$ cfs (Area 24B, rational)

$\Sigma Q_{100} = 4.00 + 5.3 = 9.3$ cfs

$S = 0.0052$ ft/ft $\quad S_x = 0.016 \quad n = 0.016 \quad z/n = 3406$

From Page 28 of reference 17: $\quad y = 0.35$

$y' = 0.32 \quad Q_b = 7.5$

From page 3-16 & 3-17 of ref. C

$E_o = \frac{9.3-7.5}{9.3} = 0.19$ $\quad S_w = 0.11$ $\quad$ Use C.O.P Std 1569 M-1 $L = 17'$

$S_e = S_x + S_w E_o = 0.016 \times 0.19(0.11) = 0.037$

$L_T = 0.6\left(\frac{9.3}{0.8}\right)^{0.42} \times 0.0052^{0.3} \times \left(\frac{1}{0.016 \times 0.037}\right)^{0.6} = 29.9$

$E = 1 - \left(1 - \frac{20}{29.9}\right)^{1.8} = 0.86$

$Q_1 = 9.3(0.86) = 8.00$ $\quad Q_p = 9.3 - 8.0 = 1.3$ cfs

<u>Check 2-yr runoff</u> $\quad i_2 = 2.9$

$Q_2 = 1$ cfs (HEC-1, Area 19A) $\quad Q_2 = 0.85 \times 0.9 \times 2.9 = 2.2$ cfs (rational, Area 24B)

$\Sigma Q_2 = 3.2$ cfs

From Page 28 of reference 17: $y = 0.23$

$T = \frac{0.23}{0.016} = 14.4$ $\quad$ Clear $= 23.5 - 14.4 = 9.1 > 12'$

∴ An additional roadway catch basin should be installed to the left of Sta. 58+85 upon future reconstruction of the roadway to limit the flow spread to less than 12 feet. This will also eliminate the by pass flow ($Q_p = 1.3$ cfs) during the 100-year event.

<u>New Catch Basin Rt. Sta. 49+85</u> (Area 25B)

$Q_{100} = 1$ cfs (HEC-1) $\quad Q_{100} = 0.39(0.9)7 = 2.5$ cfs (Rational)

$S = 0.0049 \quad n = 0.016 \quad S_x = 0.019 \quad z/n = 3289$

$Q_T = 2.5 + 2.1 = 4.6$ cfs

From Page 28 of reference 17: $y = 0.29$

$y_1 = 0.26 \quad Q_b = 3.5$

$E_o = \frac{4.6 - 3.5}{4.6} = 0.24 \quad S_w = 0.11$ $\quad$ Use C.O.P. Std 1569 M-1 $L = 10'$

$S_e = S_x + S_w E_o = 0.019 \times 0.24(0.11) = 0.045$

$L_T = 0.6\left(\frac{4.6}{0.8}\right)^{0.42} \times 0.0058^{0.3} \times \left(\frac{1}{0.016 \times 0.045}\right)^{0.6} = 20.4$

$E = 1 - \left(1 - \frac{13}{20.4}\right)^{1.8} = 0.84$

$Q_i = 4.6(0.84) = 3.9$ cfs $\quad Q_p = 4.6 - 3.9 = 0.7$ cfs

<u>Check 2-yr runoff</u> $\quad i_2 = 29'/hr$

$Q_2 = 0.39(0.9)2.9 = 1.0$

From Page 28 of reference 17: $y = 0.16$

$y_1 = 0.13 \quad Q_b = 0.55$

$T = \frac{0.16}{0.019} = 8.42$ Clear = 19.5 − 8.4 = 11.4 ≅ 12 say (ok)

$E_o = \frac{1.00 - 0.55}{1.00} = 0.45$ $S_w = 0.11$

$S_e = S_x + S_w E_o = 0.019 + 0.45(0.11) = 0.069$

$L_T = 0.6 \left(\frac{1.00}{0.8}\right)^{0.42} \times 0.0052 \times \left(\frac{1}{0.016 \times 0.069}\right)^{0.6} = 8.1' > 13'$

∴ All flow will be intercepted in a 2-year storm.

New Catch Basin @ 49+22 (Area 19B + 25A)

$Q_{100} = 18$ cfs (HEC-1, Area 19B) $Q_{100} = 1$ cfs (HEC-1, Area 25A)

$Q_{100} = 0.37(0.9)7 = 3.0$ (Area 25A, rational)

$Q_{100} = 3.0 + 18 = 21$ cfs

$S = 0.0080$ $S_x = 0.017$ $n = 0.016$ $z/n = 3676$

From Page 28 of reference 17: $y_1 = 0.45$ = crown height

$y_1 = 0.42$ $Q_b = 19$

From Pages 3-16 & 3-17 of reference 6

$E_o = \frac{21 - 19}{21} = 0.10$ $S_w = 0.11$ Use C.O.P. Std 1525 M-1 L = 17'

$S_e = S_x + S_w E_o = 0.017 + 0.10(0.11) = 0.028$

$L_T = 0.6 \left(\frac{21}{0.8}\right)^{0.42} \times 0.0080 \times \left(\frac{1}{0.016 \times 0.028}\right)^{0.6} = 56.8$

$E = 1 - \left(1 - \frac{20}{56.8}\right)^{1.8} = 0.54$

$Q_1 = 21(0.54) = 11.3$ $Q_p = 21 - 11.3 = 9.7$ cfs

Check 2-yr runoff

$Q_2 = 3$ cfs (HEC-1, Area 19B) $Q_2 = 0$ cfs (HEC-1, Area 25B)

$Q_2 = 0.37(0.9)2.9 = 1.00$ cfs $Q_T = 3 + 1 = 4$ cfs

From Page 28 of reference 17: $y = 0.24$

$y_1 = 0.21$ $Q_b = 2.8$

$T = \frac{0.24}{0.017} = 14.1'$ Clear $= 23.5 - 14.1 = 9.1 > 12'$

It is not practical to add a catch basin between Sta. 49+17 and 53+18 to intercept less than 1 cfs in the 2-year event to keep a 12' wide open traffic lane to the left of the centerline free of flooding.

$E_o = \frac{4.0 - 2.8}{4.0} = 0.3$ $S_w = 0.11$

$S_e = S_x + S_w E_o = 0.017 + 0.30(0.11) = 0.05$

$L_T = 0.6 \left(\frac{4.00}{0.8}\right)^{0.42} \times 0.0052^{0.3} \times \left(\frac{1}{0.016 \times 0.05}\right)^{0.6} = 17.56 > 20$

∴ will intercept all flow in 2-year event

<u>New Catch Basin Rt. 43+34 (Area 26)</u> Future

$Q_{100} = 3$ cfs (HEC-1, Area 26).

A	C	CA
0.49	0.9	0.44
1.01	0.45	0.45
1.50		0.89

$Q_{100} = 0.89 \times 7 = 6.2$ cfs (rational) $+ 0.7 = 6.9$ cfs

$S = 0.0024$ $S_x = 0.02$ $n = 0.016$ $z/n = 3125$

From Page 28 of reference 17: $y = 0.38$

$y_1 = 0.35$ $Q_b = 5.2$

From Page 3-16 & 3-17 of reference 5

$E_o = \frac{6.9 - 5.2}{6.9} = 0.25$ $S_w = 0.11$ Use C.O.P. Std 1529 14-1 $L = 17'$

$S_e = S_x - S_w E_o = 0.020 + 0.25(0.11) = 0.048$

$L_T = 0.6 \left(\frac{6.9}{0.8}\right)^{0.42} \times 0.0058^{0.3} \times \left(\frac{1}{0.016 \times 0.048}\right)^{0.6} = 23.3$

$E = 1 - \left(1 - \frac{20}{23.3}\right)^{1.8} = 0.97$ $Q_i = 0.97 \times 6.9 = 6.7$ cfs

$Q_p = 6.9 - 6.7 = 0.2$ cfs

Check 2-yr runoff

$Q_2 = 0.89 \times 2.9 = 2.6$ cfs (rational)

From Page 28 of reference 17 $\quad y = 0.27 \quad y_1 = 0.24$

$T = \frac{0.27}{0.019} = 14.2 \quad Clear = 19.5 - 14.2 = 5.3 < 12' \quad Q_b = 2.0$

$E_o = \frac{2.6 - 2.0}{2.6} = 0.23 \quad S_w = 0.11$

$S_e = S_x - S_w E_o = 0.019 + 0.23(0.11) = 0.044$

$L_T = 0.6\left(\frac{2.6}{0.8}\right)^{0.42} \times \underset{.213}{0.0058}^{0.3} \times \left(\frac{\overset{77.9}{V}}{0.016 \times 0.044}\right)^{0.6} = 16.3 < 20$

∴ will intercept all flow in 2-yr event - but a 12 foot lane will not be free of flooding to the right of the centerline without adding an additional catch basin between Sta. 43+34 and 44+85 in the future

New Catch Basin Lt. Sta. 42+85 (Area 23A)

$Q_{100} = 2$ cfs (HEC-1) $\quad Q_{100} = 0.58(0.9)7 = 3.7$ cfs (rational)

$\Sigma Q_{100} = 3.7 + 9.7 = 13.4$ cfs

$S = 0.0024 \quad S_x = 0.02 \quad n = 0.016 \quad z/n = 3125$

From Page 28 of reference 17: $\quad y = 0.47 \quad Q = 11$ cfs

$y_1 = 0.44 \quad Q_b = 9$ cfs

13.4 - 11.0 = 2.4 cfs will overflow crown to area 27

From Page 3-16 & 3-17 of reference 6

$E_o = \frac{11 - 9}{11} = 0.18 \quad S_w = 0.11$ $\quad$ Use C.O.P. Std 1569 M-1 $\quad L = 17'$

$S_e = S_x - S_w E_o = 0.02 + 0.18(0.11) = 0.040$

$L_T = 0.6\left(\frac{\overset{2.0}{11.0}}{0.8}\right)^{0.42} \times \overset{0.164}{0.0024}^{0.3} \times \left(\frac{\overset{82.5}{1}}{0.016 \times 0.040}\right)^{0.6} = 24.4$

$E = 1 - \left(1 - \frac{20}{24.4}\right)^{1.8} = 0.95 \quad Q_i = 0.95 \times 11.0 = 10.5$

$Q_p = 11 - 10.5 = 0.5$ cfs

Check 2-yr runoff

$Q_2 = 0.58(0.9)2.9 = 1.5$ cfs (rational)

From Page 28 of reference 17: $y = 0.22$

$y_1 = 0.19 \quad Q_b = 1.0$

$T = \frac{0.22}{0.02} = 11 \quad$ clear $= 23.5 - 11.0 = 12.5' > 12'$ OK

will intercept all flow in 2-year storm by inspection.

New Catch Basin Lt. Sta. 36+91 (Area 23B)

$Q_{100} = 24$ cfs (HEC-1, From 29th Street)

$Q_{100} = 0.55(0.9)7 = 3.5$ cfs (Area 23B, rational)

$Q_{100} = 0.49(0.9)7 = 3.1$ cfs (Area 27, rational)

By Pass $= 0.2$ (Area 2C) $+ 2.4$ (Area 23A) $+ 0.5$ (Area 23A)

$\Sigma Q_{100} = 24 + 3.5 + 3.1 + 0.2 + 2.4 + 0.5 = 33.7$ cfs (Both gutters)

$S = 0.0029'/'$ $\quad S_x = 0.015 \quad n = 0.016 \quad z/n = 4167$

From Page 27 of reference 17: $y = 0.48 \quad Q = 17.5$

$y_2 = 0.48 - 0.35 \quad Q_b = 0.6$

$Q = 17.5 - 0.6 = 16.9$ cfs (Each gutter)

$Q_T = 33.8 \cong 33.7$ cfs OK

From Page 28 of reference 17: $y = 0.48 \quad Q = 17.5$

$y_1 = 0.45 \quad Q_a = 15.9$

$E_o = \frac{17.5 - 15}{16.9} = 0.15 \qquad S_w = 0.11$ Use C.O.P. Std. 1509

$M = 1 \quad L = 17'$

$S_e = S_x - S_w E_o = 0.015 + 0.15(0.11) = 0.032$

$L_T = 0.6\left(\frac{16.9}{0.8}\right)^{0.42} \times 0.0029^{0.3} \times \left(\frac{1}{0.016 \times 0.032}\right)^{0.6} = 35.2'$

$E = 1 - \left(1 - \frac{20}{35.2}\right)^{1.8} = 0.78 \qquad Q_i = 16.9 \times 0.78 = 13.1$

$Q_p = 16.9 - 13.1 = 3.8$ cfs By Pass

Check 2-yr runoff

$Q_2 = 0$ cfs (HEC-1, From 29th Street)

$Q_2 = 0.55(0.9)2.9 = 1.4$ cfs (Area 23B, rational)

From Page 28 of reference 17: $y = 0.18$

$y_1 = 0.15$ $Q_b = 0.8$

$T = \frac{0.18}{0.015} = 12$ clear $= 23.5 - 12 = 11.5' \cong 12'$ ok

will intercept all flow in a 2-year storm by inspection

New Catch Basin Rt. Sta. 36+82 (Area 27) (Future)

Computations identical to new Catch Basin to the Left of Sta. 36+91 (Area 23B) since entire roadway is flooded from curb to curb in 100-yr. storm

$Q_2 = 0.49(0.9)2.9 = 1.3$ cfs (Area 27, rational)

From Page 28 of reference 17: $y = 0.18$

$y = 0.15$ $Q_b = 0.8$

$T = \frac{0.18}{0.015} = 12$ clear $= 23.5 - 12 = 11.5 \cong 12'$ ok

will intercept all flow in a 2-year storm by inspection

Existing spillway Rt. Sta. 33+87 (Area 28)

$Q_{100} = 0.27(0.9)7.0 = 1.7$ cfs (rational)

$\Sigma Q_{100} = 1.7 + 3.8$ (By-Pass) $= 5.5$ cfs

From page 3-18 of reference 6:

$Q_1 = 2.3(L + 1.8W)d^{1.5}$

$Q_1 = 2.3(4 + 1.8 \times 1.5)0.5^{1.5} = 5.4$ cfs $\cong 5.5$ cfs say ok

Check 2-yr runoff.

$Q_2 = 0.27(0.9)2.9 = 0.7$ cfs (rational)

$d = \left[\frac{Q}{2.3(L+1.8W)}\right]^{2/3} = \left[\frac{0.7}{2.3(4+1.8\times1.5)}\right]^{2/3} = 0.13$ $T = \frac{0.13}{0.025} = 5.2$

Clear $= 23.5 - 5.2 = 18.3 > 12'$ ok

Spillway or Catch Basin Rt. Sta 33+87 (Area 22) (Future)

Computations identical to the existing spillway to the right of the roadway at this station

Detention Basin outlet structure Lt Sta. 63+19.2

Gross area = $\frac{15.75 + 10.50}{2} \times 4.54 = 59.59$ □'

Area of 1/2" Thick Bearing bars

$22 \times 3.90 \times 0.0417 = 3.58$

$10 \times 2.30 \times 0.0417 = 0.96$

$2 \times 4.70 \times 0.0417 = 0.39$

4.93 □'

Area 1/2" diameter bars

$23 (13 - 0.25) \times 0.0417 = 12.23$ □'

Area 3" diameter pipe

$2 \times 5.042 \times 0.25 = 2.52$ □'

Area 6" x 3 1/2 x 1/2" Angle

$15.50 \times 0.291 = 4.51$ □'

Net Area = $59.59 - (4.93 + 12.23 + 2.52 + 4.51) \times 50\%$ clogging = 17.65

Max. Detention Basin Water Surface = 1496.00

Average grate Elev = 1493.25 + 0.54 − 0.13 = 1493.66

Average head = 1496 − 1493.66 = 2.34

Capacity $Q = CA\sqrt{2gh} = 0.6 \times 17.65\sqrt{64.4 \times 2.34} = 130$ cfs $\cong$ 131 cfs

OK

CONNECTOR PIPES

Sta. 33+15

Let $B = 7.5$ ∴ $B/D_o = 1.00$ $\quad D_o/D_u = \frac{7.0}{6.5} = 1.08$

$Q_u/Q_o = \frac{332}{361} = 0.92$ $\quad D_L/D_o = \frac{3}{7} = 0.43$ $\quad D_o/D_L = 2.33$

$D_u/D_o = 0.93$

$$M_L = 1 - \left[\left(\frac{Q_u}{Q_o}\right)\left(\frac{D_o}{D_u}\right)\right]^{2(D_o/D_L)}$$

4.66

$$M_L = 1 - \left[(0.92)(1.08)\right]^{2(2.33)} = 0.03$$

$Q_u/Q_o\,(D_o/D_u) = 0.92\,(1.08) = 0.99$

(Falls outside range of Figure 4.13 & 4.14 – Use 4.15)

$K_L = 0.1$ $\quad h_L = 0.1 \times \left(\frac{6.68}{14.4}\right)^2 = 0.15$

pressure elev = 6.51 + 0.15 + 71.42 = 78.08

(See Culvert Design Form)

Sta. 36+77

Let $B = 7.5$ ∴ $B/D_o = 1.00$ $\quad D_o/D_u = \frac{6.5}{6.5} = 1.0$

$Q_u/Q_o = 176/332 = 0.53$ $\quad D_L/D_o = \frac{4.79}{6.5} = 0.74$

$0.53 \times 1.00 = 0.53$

$M_L = 0.82$ (Fig. 4.13)

H.G.	E.G.
79.31	
1.37'	
80.68	81.67

$K_L = 1.08$ $\quad h_L = 0.82 \times 1.08 \times 1.55 = 1.37'$

$V_L = \frac{144}{18} = 8.0$ $\quad V_L^2/2g = 0.99$

80.68 + 0.99 = 81.67

36' Lt. Sta. 36+77

$C_1 = \frac{1.486}{0.012} \times 18 \times 1^{2/3} = 2229$

$\left(\frac{144}{2229}\right)^2 = 0.0042 \times 22 = 0.09$

downstream ⟶ 80.77 + 0.99 = 81.76

	H.G.	E.G.
26' Lt. Sta. 36+77	80.77	81.76

$Q_u/Q_o = 133/144 = 0.92$

$D_u/D_o = 1.00 \qquad D_L/D_o = \frac{1.50}{4.79} = 0.31$

Fig 4.15 $\qquad V_u = \frac{133}{18} = 7.39 \qquad V_u^2/2g = 0.85$

$K_u = K_L = 0.38$

$h_L = 0.38 \times 0.99 =$ 0.38

26' Lt. Sta. 36+77 (upstream & Lateral) = 81.15 + 0.85 = 82.00

(See Culvert Design Form)

Catch Basin Lt. Sta. 36+91

$V_6 = \frac{13.1}{3.142} = 4.17 \qquad V_6^2/2g = \frac{(4.17)^2}{64.4} = 0.27$

24"

$d/D_o = \frac{5.70}{2.0} = 2.85$

From Fig. 4.7: $K_g = 3.9$

$h_G = 3.9 \times 0.27 =$ 1.05

82.20 < 82.75 = Gutter Elev. OK

Catch Basin Lt. Sta. 42+85 $\qquad$ HG.

$V_6 = \frac{10.5}{3.142} = 3.34 \qquad V_6/2g = 0.17$ $\qquad$ 83.36

24"

$\left(\frac{10.5}{24/5}\right)^2 = 0.0018 \times 22 =$ 0.04

$d/D_o = \frac{7.25}{2.00} = 3.63$ $\qquad$ 83.40

From Fig. 4.7: $K_g = 2.7$

$h_g = 2.7 \times 0.17 =$ 0.46

83.86 < 84.17 = Gutter Elev. OK

Catch Basin Lt. Sta. 49+22 — H.6.

$V_6 = \frac{11.3}{1.767} = 6.40$ $V_6^2/2g = 0.635$ — 85.76

(18") $\left(\frac{11.3}{245}\right)^2 = 0.0021 \times 14 =$ 0.03

85.79

$d/D_0 = \frac{2.75}{1.50} = 1.83$

89.09
86.34
2.75

From Fig. 4.7: $K_q = 5.2$

$h_q = 5.2 \times 0.635 =$ 3.30

89.09 < 89.72 = Gutter Elev. (ok)

Catch Basin Rt. Sta. 49+85 — 85.76

$0.0052 \times 63 =$ 0.33

86.09

$V_6 = \frac{3.9}{1.227} = 3.17$ $V_6^2/2g = 0.16$

(15") $\left(\frac{3.9}{20.1}\right)^2 = 0.0031 \times 26 =$ 0.08

86.17

$d/D_0 = \frac{2.14}{1.25} = 1.73$

87.07
84.91
2.16

From Fig. 4.7: $K_q = 5.6$

$h_q = 5.6 \times 0.16$ 0.90

87.07 < 90.24 = Gutter Elev. (ok)

Catch Basin Lt. Sta. 53+18 — 88.14

$V_6 = \frac{8.0}{1.767} = 4.53$ $V_6^2/2g = 0.32$

(18") $\left(\frac{8.0}{245}\right)^2 \times 0.0011 \times 11 =$ 0.01

88.15

90.37
88.27
2.10

$d/D_0 = \frac{2.10}{1.50} = 1.40$

From Fig. 4.7: $K_q = 6.8$

$h_q = 6.8 \times 0.32 =$ 2.18

90.33 < 91.60 = Gutter Elev (ok)

Catch Basin Rt. Sta. 55+03 89.24

$V_c = \frac{1.9}{1.227} = 1.55$ $V_c^2/2g = 0.04$

(15") $\left(\frac{1.55}{70.1}\right)^2 = 0.0005 \times 33 = 0.02$

89.26 < 89.75 Floor of Catch Basin

Will Flow at critical depth out of Catch Basin

$d_c = 0.5$

89.75
0.50
90.25

Catch Basin Lt. Sta. 58+85 91.32

$V_c = \frac{24}{7.069} = 3.395$ $V_c^2/2g = 0.179$ 0.007

(36") $\left(\frac{24}{727}\right)^2 = 0.0011 \times 18 = 0.02$

91.34

92.25
86.30
5.95

$d/D_o = \frac{5.95}{3.00} = 1.98$ 1.83

91.33 From Fig 4.7: $K_q = 4.90$

$h_q = 4.90 \times 0.179 = 0.88$

92.22 < 82.30 Grate Elev.

Although there will not be 0.5 Feet between hydraulic gradient and grate under the existing conditions, once 32nd Street and Utopia Road are developed 9 cfs from Area 17 will be intercepted at the Northwest curb return at the intersection and the remaining 15 cfs at Sta. 58+85 will produce a hydraulic gradient of 91.75 < 92.30 = grate elev.

Catch Basin 52' Lt. Sta. 62+86 H.6.

93.79

24" Pipe

$V_o = \frac{8.7}{3.142} = 2.77$ $V_o^2/2g = 0.12$

Assume 94.94
31.98
2.96

$d/D_o = \frac{2.96}{2.00} = 1.48$

From Fig 4.7: $K_G \cong 9.6$

$h_g = 9.6 \times 0.12 = 1.15$

94.94 < 95.48 Gutter Elev. OK

BIBLIOGRAPHY

1. Arizona Resources Information System, "The Natural Vegetation of Arizona", Aris Cooperative Publication No.2, (1973)

2. United States Department of Agriculture, Soil Conservation Services, "General Soil Map", Maricopa County Arizona (March 1973)

3. United States Department of Agriculture, Soil Conservation Service and University of Arizona Agricultural Experiment Station, "Arizona Soil Map" (July 1975)

4. United States Department of Agriculture, Soil Conservation Service and Arizona Agricultural Experiment Station, "Soil Survey, Eastern Maricopa and Northern Pinal Counties, Arizona" (November 1974)

5. Flood Control District of Maricopa County, "Drainage Design Manual for Maricopa County, Arizona, Volume I, Hydrology (June 1, 1992)

6. Flood Control District of Maricopa County, "Drainage Design Manual for Maricopa County, Arizona, Volume II, Hydraulics" (September 1, 1992)

7. U.S. Department of Transportation, Federal Highway Administration, "Hydraulic Design Of Energy Dissipators for Culverts and Channels" (Hydraulic Engineering Circular No. 14, November 1975)

8. U.S. Army Corps of Engineers, Hydrologic Engineering Center, "HEC-1, Flood Hydrographic Package, User's Manual" (September 1990)

9. U.S. Army Corps of Engineers, Hydrologic Engineering Center, "Introduction and Applications of Kinematic Wave Routing Techniques Using HEC-1", Training Document No. 10 (May 1979)

10. U.S. Army Corps Of Engineers, Hydrologic Engineering Center, "HEC-2, Water Surface Profiles, User's Manual" (September 1990)

11. Bureau of Engineering, City of Los Angeles, "Hydraulic Analysis of "Junctions" (Office Standard No.115, Storm Drain Design Division, 1988)

12. NBS/Lowry Engineers, "Upper East Fork Cave Creek Area Drainage Master Study and Preliminary Design" (1987 with amendments)

13. Wood, Patel & Associates, "Drainage Report for Detention Basin No.1" (City of Phoenix Index Numbers ST-896811 & P-901793, July 1991, as amended October 4, 1991)

14. Clouse Engineering, Inc.,"Hydrology and Hydraulics Report For Kaufman & Broad at Desert Canyon" (September 28, 1993)

15. Clouse Engineering, Inc., "Hydrology and Hydraulics Report For Whittier Park" (February 24, 1993)

16. City of Phoenix, "Storm Drain Design Manual - Subdivision Drainage Design" (September 1985)

17. City of Phoenix, "Storm Drain Design Manual - Storm Drains With Paving of Major Streets" (July 1987)

18. Bureau of Engineering, City of Los Angeles, "Hydraulic Analysis of Junctions", (Office Standard No.115, Storm Drain Design Division, 1968)