FINAL HYDRAULICS REPORT FOR EAST FORK SAND CREEK AT POWERS BOULEVARD

US-24 PHASE II BYPASS PROJECT

COLORADO SPRINGS, COLORADO

Kiowa Engineering Corporation

FINAL HYDRAULICS REPORT
FOR
EAST FORK SAND CREEK
AT POWERS BOULEVARD

US-24 PHASE II
BYPASS PROJECT

COLORADO SPRINGS, COLORADO

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EXECUTIVE SUMMARY

This report summarizes the final results of the hydrologic and hydraulic analyses for the East Fork Sand Creek which crosses the proposed US-24 Bypass, Phase II roadway alignment in Colorado Springs, Colorado.

The construction of the proposed US-24 Bypass (interim condition) will be completed in two phases. The information contained herein has been prepared for the interim roadway configuration. The interim roadway project extends along Powers Boulevard from Fountain Boulevard on the South to Platte Avenue (US-24), on the North. Along Powers Boulevard, new major drainageway structures are needed over the East Fork Sand Creek and over the Center Tributary of Sand Creek. This report contains the final hydraulic analysis for the East Fork Sand Creek at Powers Boulevard.

Hydrologic Analysis

Peak flow data used in the sizing of the bridge/channel structures was obtained from various sources. Peak flow data from the East Fork Sand Creek Drainage Basin Planning Study and the City of Colorado Springs and El Paso County Flood Insurance Study (FIS) was reviewed for applicability. The 100-year discharge of 5330 cubic feet per second as reported in the FIS is recommended for the sizing of the bridge and channel. The 500-year discharge reported in the FIS was used in determining the maximum scour depths for the bridge.

Hydraulic Analysis

The bridge opening was analyzed in accordance with City of Colorado Springs and the Colorado Department of Transportation (CDOT) criteria. During this analysis, alternative structures and alignments were evaluated in order to determine the most efficient structure at the crossing.

Seven alternative structures were analyzed for the crossing. Six bridges ranging in span from 100 feet to 150 feet were hydraulically analyzed and the associated costs compared. Various alternative channel sections were evaluated using the HEC-2 water surface profile program. These channel sections had side slopes varying from 1.5 to 1, to 2 to 1, and had bottom widths varying from 24- to 60-feet. A multiple span box culvert was also evaluated at this location. As a result of the alternative evaluation a 35-foot bottom width channel was selected. Channel improvements up- and downstream of the East Fork Sand Creek/Powers Boulevard bridge are required to safely transition the East Fork of Sand Creek through the recommended bridge section. A riprap trapezoidal section is recommended, along with drop structures sited approximately 200 feet up- and downstream of the proposed frontage road bridges. The drops are required in order to provide the required freeboard and clearance beneath the low chord of the bridges. The U. S. Army Corps of Engineers HEC-2 Water Surface profile program was used in this analysis. Velocities and flow depths were obtained from the HEC-2 model, and used in the sizing of riprap and in the determination of potential scour depths for the 100- and 500-year frequencies. Since a trapezoidal channel will be carried through the bridge, no bridge abutment scour was estimated as per HEC-18.

The costs of the bridge/channel structures have been summarized herein. Costs have been based upon unit prices for construction projects in the Colorado Springs area. Maintenance of the channel has typically been the responsibility of the County or the City. Maintenance trails will be provided by others as part of a planned trail system. Recommendations contained herein will be incorporated into the final design and the ongoing drainage basin planning study for the Sand Creek Drainage basin.

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I. INTRODUCTION

The Colorado Department of Transportation (CDOT) has proposed the construction of the US-24 Bypass, Phase II in Colorado Springs and El Paso County, Colorado. Shown on Figure 1 is a vicinity map and the proposed roadway alignment. The US-24 Bypass will connect US-24 between I-25 and existing US-24 at Powers Boulevard. Phase I construction is currently underway. The limits of the Phase II portion are from Quivera Street to Powers Boulevard.

The purpose of this report is to identify the hydrologic and hydraulic design constraints associated with the major drainageways which cross the proposed alignment for the interim condition. Final sizing of the bridge over East Fork Sand Creek and associated channel improvements are the primary focus of this report. Roadway and local drainage improvements for the project will be presented in a separate report.

Summary of Information

The following technical reports and plans have been collected and reviewed as part of this study effort.

1. Soil Survey for El Paso County, Colorado, dated June 1981.
2. "City of Colorado Springs/El Paso County Drainage Criteria Manual", prepared by City of Colorado Springs, El Paso County, and HDR Infrastructure, Inc., dated May 1987.
3. "Flood Insurance Studies for Colorado Springs, and El Paso County, Colorado", prepared by the Federal Emergency Management Agency (FEMA), revised 1989.
4. Sand Creek Drainage Basin Planning Study prepared by Simons, Li & Associates, Inc., dated July, 1985.
5. Flood Hazard Analysis, Sand Creek, City of Colorado Springs and El Paso County, Colorado, prepared by the Soil Conservation Service, dated December, 1973.
6. Sand Creek Drainage Basin Study, prepared by United Planning and Engineering Company, October, 1977.
7. Roadway Design Manual, Colorado Department of Highways, with current revisions.
8. Draft East Fork Sand Creek Drainage Basin Planning Study, prepared by Kiowa Engineering Corporation, 1989.
9. Preliminary Hydrology Report, City of Colorado Springs Flood Insurance Study Update, prepared by Resource Consultants, Inc.
10. Scour Around Bridge Piers, Federal Highway Administration, Report No. FHWA-RD-79-103, February 1980.
11. Evaluating Scour at Bridges, Hydraulic Engineering Circular No. 18, February, 1991.

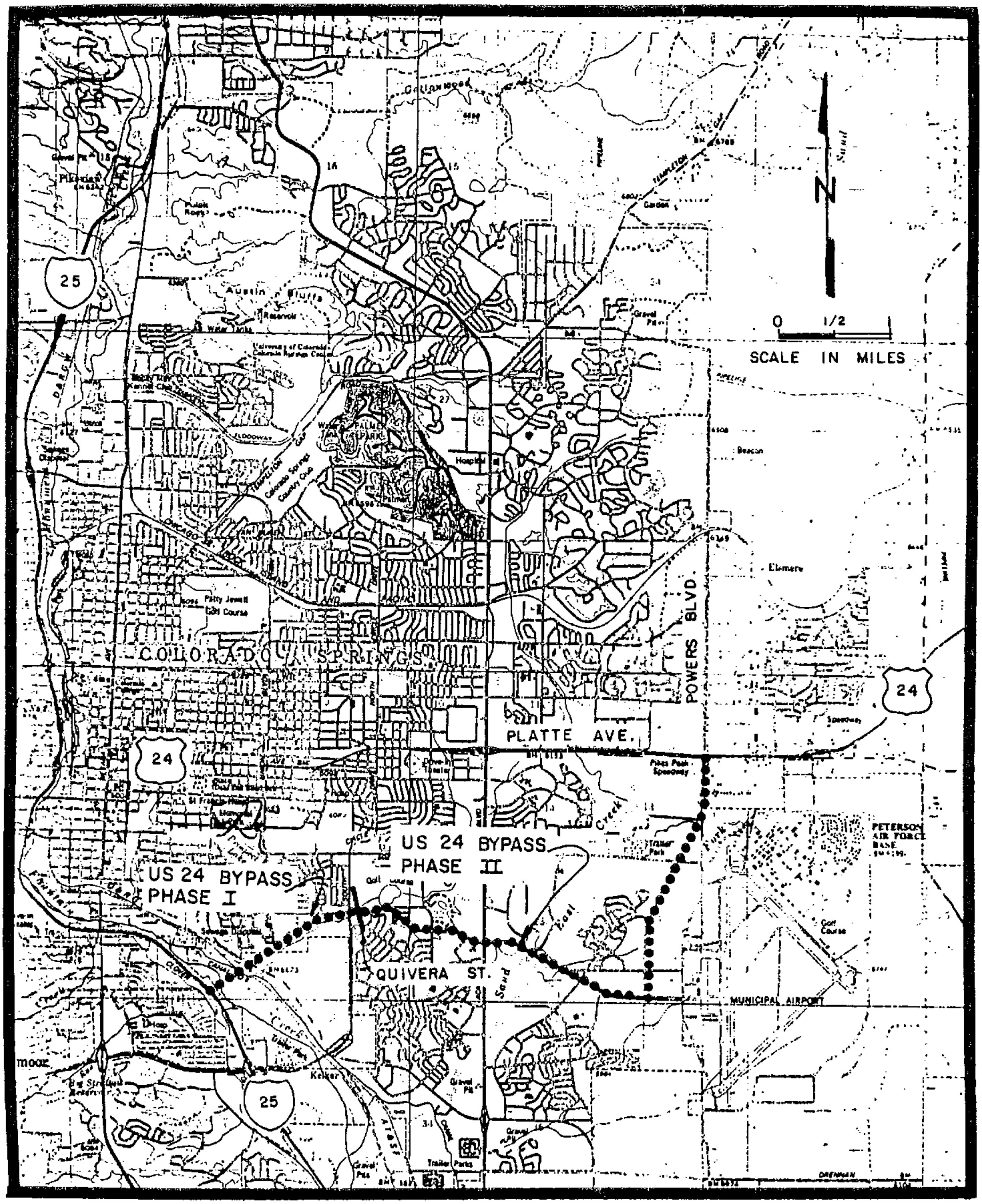


FIGURE I
VICINITY MAP

In addition to the above listed reports there were a number of drainage study reports, sketch plans, preliminary and final design drawings, land use maps, proposed development plans, and existing drainage facility maps that were collected from the client, City, County, local agencies, private entities, and individuals for the use in this project.

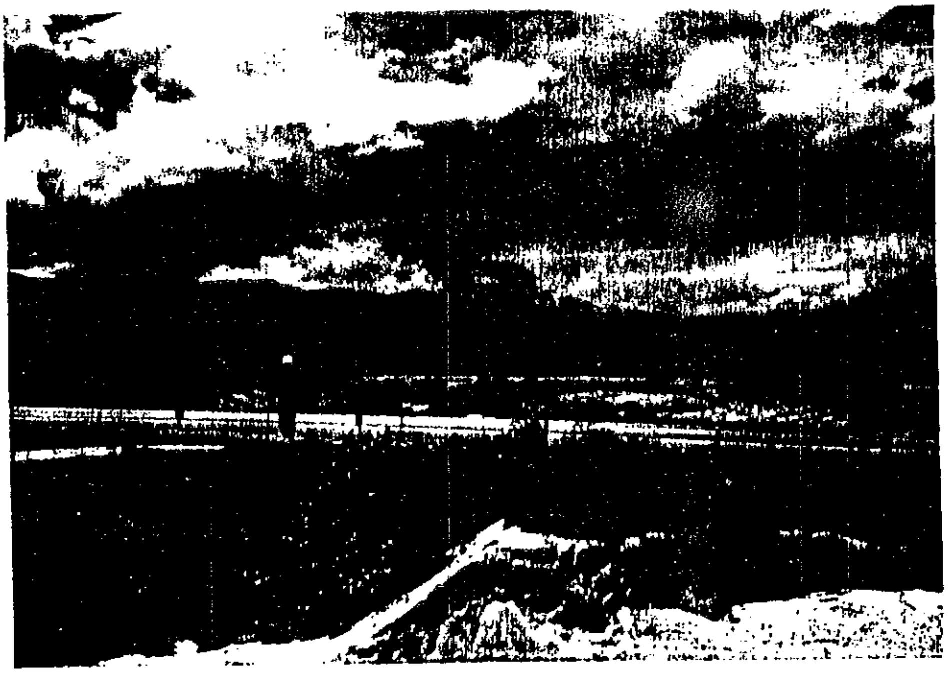
II. STUDY AREA DESCRIPTION

The proposed bypass alignment for the interim condition and its relationship to the major drainage basins is presented on Figure 2. The alignment is located mainly within the Sand Creek Basin, and within a small portion of the Spring Creek and Peterson Field Basins. The alignment is proposed to cross over East Fork Sand Creek, and twice over the Sand Creek Center Tributary. A brief discussion of the East Fork Sand Creek crossing follows.

Sand Creek, as its name implies, and its tributaries are typical of sand bed channels. In their unconfined, or natural state, the channels are wide and shallow, and are prone to channel aggradation and lateral migration in the mildly sloping reaches. Along the steep portions of the natural drainageway, invert and bank degradation is common, particularly at the outlet of roadway crossing culverts.

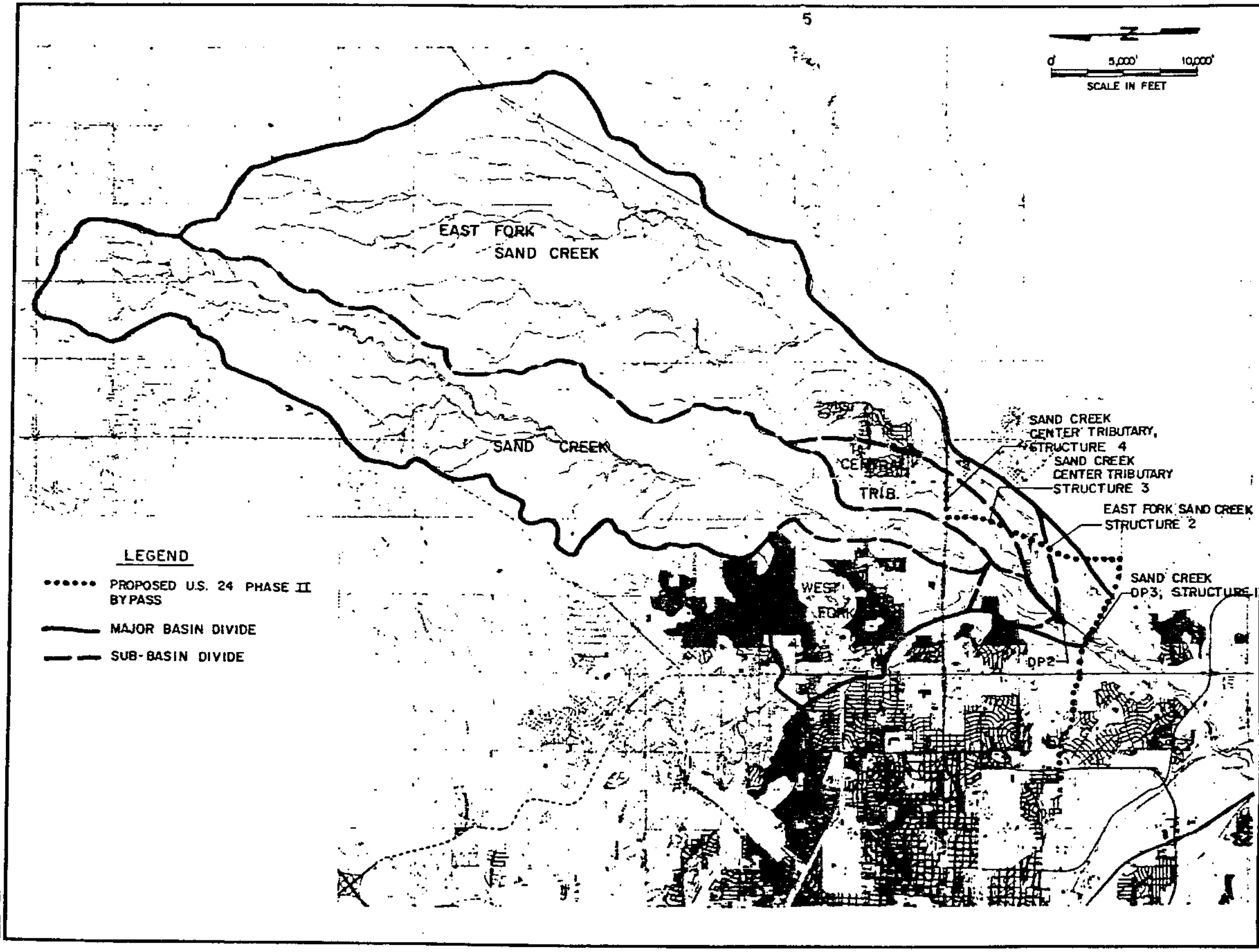
As can be seen from Figure 2, the East Fork Sand Creek is a major tributary to Sand Creek. Currently, two 48-inch metal culverts pass under the existing roadway. The estimated flow capacity of these culverts is 180 cfs. The 100-year design flow is estimated at 5300 cfs. The 100-year flood would overtop the roadway at this location. The existing 100-year floodplain is approximately 250-feet wide. The channel adjacent to the roadway is in poor condition, and has limited erosion protection on the banks. At the outlet of the existing culverts the channel has degraded, leaving a four-foot drop out of the culverts. A new crossing is needed to pass the 100-year flow without overtopping the roadway or diverting the 100-year flow from its historic path. The existing crossing is shown on Figure 3.

Photograph 3 : Outlet of existing 48-inch cmp at East Fork Sand Creek and Powers Boulevard.



Photograph 4: Inlet to existing 48-inch cmp's at East Fork Sand Creek and Powers Boulevard.

FIGURE 3



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U.S. 24 BYPASS-PHASE II
QUIVIRA STREET to PLATTE AVENUE
PRELIMINARY DRAINAGE REPORT
SAND CREEK BASIN BOUNDARIES

Project No. 89-06.14
Date 10/89

FIGURE 2

III. HYDROLOGIC SETTING

Study Area Description

The Sand Creek drainage basin is a left-bank tributary to the Fountain Creek lying on the west-central portions of El Paso County. Sand Creek's drainage area above Fountain Creek is approximately 56 square miles of which approximately 18.8 square miles are inside the City of Colorado Springs corporate limits. The basin is divided into five major sub-basins, the Sand Creek mainstem, the East Fork Sand Creek, the Central Tributary to East Fork, the West Fork, and the East Fork Subtributary. The major drainageway crossings proposed for the US-24 Bypass Phase II project are in the Sand Creek, East Fork Sand Creek, and Center Tributary basins.

The Sand Creek basin is currently experiencing development pressure in areas immediately upstream of the present City of Colorado Springs corporate limits. Most of the development calls for single- and multi-family residential building, mixed with office-park, commercial and light industrial areas. The majority of the existing development, similar to that described above, is within the City of Colorado Springs. Current development in the County consists largely of 2-1/2 and 5-acre subdivisions. Development along the project alignment is currently business and industrial areas, and a limited amount of rural residences. Future development will be mostly business and industrial in nature.

Climate

This area of El Paso County can be described, in general as high plains, with total precipitation amounts typical of a semi-arid region. Winters are generally cold and dry, and summers relatively cool and dry. Precipitation ranges from 14 to 16 inches per year, with the majority of this precipitation occurring in spring and summer in the form of rainfall. Thunderstorms are common during the summer months, and are typified by quick-moving low pressure cells which draw moisture from the Gulf of Mexico into the region. Average temperatures range from about 30 degrees F in the winter to 75 degrees F in the summer. The relative humidity ranges from about 25 percent in the summer to 45 percent in the winter.

Soils and Geology

Soils within the Sand Creek basin vary between soil types A through D, as identified by the U. S. Department of Agriculture, Soil Conservation Service (SCS). The predominant soil groupings are in the Truckton and Bresser soil associations. The soils consist of deep, well drained soils that formed in alluvium and residium, derived from sedimentary rock. The soils have high to moderate infiltration rates, and are extremely susceptible to wind and water erosion where poor vegetation cover exists. In undeveloped areas, the predominance of Type A and B soils give this basin a lower runoff per unit area as compared to basins with soil dominated by Types C and D.

Flood History

The eastern portions of El Paso County have a history of severe flooding, with several events directly impacting the Sand Creek basin. Flooding along Sand Creek has occurred as a result of both short- and long-duration rainfall events. The June, 1965, flood could be classified a long-duration event, with several days of moderate to intense rainfall followed by a day of intense, localized rainfalls. The 1965 flood caused extensive damages to range and farmland due to heavy deposition of sand along the floodplain. Structural damages were limited to roadway crossings and embankments, particularly downstream of Fountain Boulevard.

The July, 1970, flood event on Sand Creek was caused by a brief but intense rainfall. Estimates were that 1-1/4 inches fell in a two hour period. Damage included culvert washouts, and damage to roadway embankments at Powers and Fountain Boulevards. One life was lost in this flood.

Both of these events clearly show that the potential for severe flooding is present in the Sand Creek basin. Long-duration events will have the ability to cause extensive transport of sediment. The cost of clean up of such sediment flows will be substantially higher (assuming the same size of storm event), as the basin moves towards full development.

The potential for flash flooding will increase as urbanization continues in the Sand Creek basin. Urban development tends to shorten the time to peak and increase the volume of runoff as compared to existing conditions. Conversely, the potential for widespread sediment deposition in a brief, but intense rainfall event, is high with the basin in its current condition. As urban development continues, the sediment supply will tend to decrease. This change in the development characteristics may result in channel degradation and bank erosion being the most common type of failures in the future.

Previous Studies

Various drainage basin planning and flood hazard analysis studies have been prepared for the Sand Creek Basin. These studies are referenced in Section I. Each of these studies utilized the SCS method for the determination of peak discharges. Over the years, the assumptions regarding soils data, land use planning, and drainage criteria have resulted in the peak discharges to vary from one report to the next. For the purposes of the US-24 Bypass Project, the most current hydrologic information has been gathered and reviewed, and suggested for use in this study.

The most current hydrologic data for this study is contained within the Preliminary Colorado Springs Flood Insurance Study (FIS) Restudy, and the draft East Fork Sand Creek Drainage Basin Planning Study. Both of these study efforts are ongoing, however, the hydrologic anlaysis portions of these studies have been completed and have been presented to the City of Colorado Springs and El Paso County for review and approval. This report has been generally accepted by the City and County for use in the delineation of floodplains in the FIS Restudy. In order to obtain peak flow data for this study, it was necessary to combine the hydrologic analyses prepared in these studies referenced above. Peak flow data for the existing and future basin development conditions were analyzed. Presented on Table 1 is a summary of peak flow data for the East Fork Sand Creek at Powers Boulevard. It is recommended that the peak flow data shown in Table 1 be used in the sizing of the bridge and channel. These flows represent future development conditions, and have been determined using locally excepted drainage criteria. The 500-year flow of 6,120 cfs used for the "super-flood" scour calculation was obtained from the City of Colorado Springs Flood Insurance Study.

Table 1. Summary of Peak Discharges.

Structure	Location	Creek	Area (sm)	100-Yr. Discharge 24-Hour Duration (cfs)	
				Existing	Future
2	(2) Powers Boulevard *	East Fork	26.3	5330**	4760

* East Fork Sand Creek Drainage Basin Planning Study, prepared by Kiowa Engineering Corporation, 1989.

** City of Colorado Springs Flood Insurance Study, revised 1989.

IV. HYDRAULIC ANALYSIS

The hydraulic characteristics of existing and proposed roadway crossing at East Fork Sand Creek is summarized in this section. Hydraulic capacity of the existing structure was evaluated, and if necessary, a new structure sized to convey the future condition 100-year discharge presented on Table 1. Alternate plans were evaluated in order to identify the most effective sections to be proposed for final design. The horizontal and vertical alignment of the roadway was considered in the layout of all structures, based upon information provided by the project team.

Floodplain Considerations

A detailed hydraulic analysis has been prepared by the Federal Emergency Management Agency (FEMA) and is summarized in the City of Colorado Springs Flood Insurance Study (FIS). Profiles for the 10-, 50-, 100-, and 500-year frequency floods have been determined for East Fork of Sand Creek. Alterations in the floodplain and floodway boundaries and elevations will occur as a result of the bypass construction. It is recommended that floodplain map revisions and 404 permit application be processed through FEMA and the Corps of Engineers (COE) during the final design phase. Existing condition 100-year floodplains have been presented on the conceptual plans contained herein.

Alternative Evaluation

A brief discussion of the East Fork Sand Creek/Powers Boulevard alternative hydraulic evaluation process follows:

A new crossing will be required for the bypass project at this location. Accordingly, various combinations of bridge opening and channel shape were evaluated. Bottom widths ranging from 24 to 60 feet were analyzed. Clear-, two- and three-span bridges were hydraulically compared. A multiple-bay box culvert was also sized at this location. All comparisons were made using the HEC-2 water surface profile program.

The channel section assumed for the purposes of the alternative evaluation was obtained from the East Fork of Sand Creek Drainage Basin Planning Study report. A 100-year riprap-lined channel with a 80-foot wide natural invert is suggested for this segment of the East Fork. The existing channel section upstream of Powers Boulevard has bottoms ranging from 50- to 60-feet. A pilot channel of approximately 5- to 10-year capacity is contained within the channel section. Depending upon the type of bridge and its length, drop structures and channel transitions will be required upstream and downstream of the bridge.

The proposed roadway alignment was assumed to remain in the same general horizontal configuration as the existing roadway. A skew of approximately 20 degrees was assumed. The bridge deck elevation assumed was 6127.3 for each alternative crossing. For the hydraulic bridge evaluation a 5.5 foot structure depth was used in the analysis. Presented on Table 2 is a summary of hydraulic data for the various alternatives evaluated. Contained in Appendix B is the computer output for the selected bridge alternative.

Each alternate bridge opening was modelled using the HEC-2 water surface profile program. From the HEC-2 model, the depths and velocity of the 100-year flow was noted. Using the velocities and depths obtained, the freeboard, riprap size and abutment berm size were compared. Through discussions with CDOH staff, a riprap channel section with 2 to 1 side slopes and a bottom width of 35-feet was selected as the desired bridge opening. This section was detailed in the preliminary hydraulics report. The bridge opening must be transitioned to a 50-foot bottom width up- and downstream of the bridge(s). A 10 to 1 transition was assumed. Scour calculations using the methodology outlined in HEC-18, Evaluating Scour at Bridges were conducted for the 35-foot bottom width section.

In order to provide for adequate headroom under the Powers Boulevard proposed structure, channel drops will be required. Two drop structures, with a vertical height of three- and four-feet each are proposed and are shown on Figure 4. The construction of these drops must proceed when the new bridge is constructed. It is suggested that these drops be constructed using either sheetpiling or soil cement. The location of the drop structures have been determined using the ultimate roadway section, which includes the ramps associated with the Airport Road interchange.

The construction of the bypass project is to be phased. It was assumed in this report that the bridges over the East Fork Sand Creek would be constructed during the interim phase of the Bypass project. The existing culverts are inadequate to prevent overtopping of the roadway at East Fork Sand Creek. Raising the roadway without increasing the capacity of the existing culverts would force the 100-year floodplain to the south along the bypass alignment, away from the East Fork Sand Creek drainageway.

TABLE 2

U.S. 24 BYPASS
HYDRAULIC ANALYSIS
EAST FORK SAND CREEK

ALTERNATIVE STRUCTURE ANALYSIS

BRIDGE ALTERNATIVE	COMPARISON OF 100-YEAR FLOW ,5330 cfs. (2)				
	WATER SURFACE ELEVATION (5)	AVG VEL (FPS)	FREEBOARD REQUIRED (4)	ACTUAL FREEBOARD (1)	ESTIMATED COST (3)
FEMA - EXIST.	6118.41	7.55	1.77	N/A	N/A
150' 2-SPAN	6113.93	11.30	2.33	7.82	$3,060,000
140' 2-SPAN	6114.40	11.30	2.33	7.35	$2,856,000
130' 2-SPAN	6114.98	11.30	2.33	6.77	$2,652,000
120' 2-SPAN	6115.63	11.30	2.33	6.12	$2,448,000
120' CLEAR SPAN	6116.00	10.70	2.23	5.75	$2,160,000
98' CLEAR SPAN	6116.00	12.30	2.2	6.80	$937,500
6 - 10 x 10 CBC	6118.00	8.88	N/A	N/A	$945,000

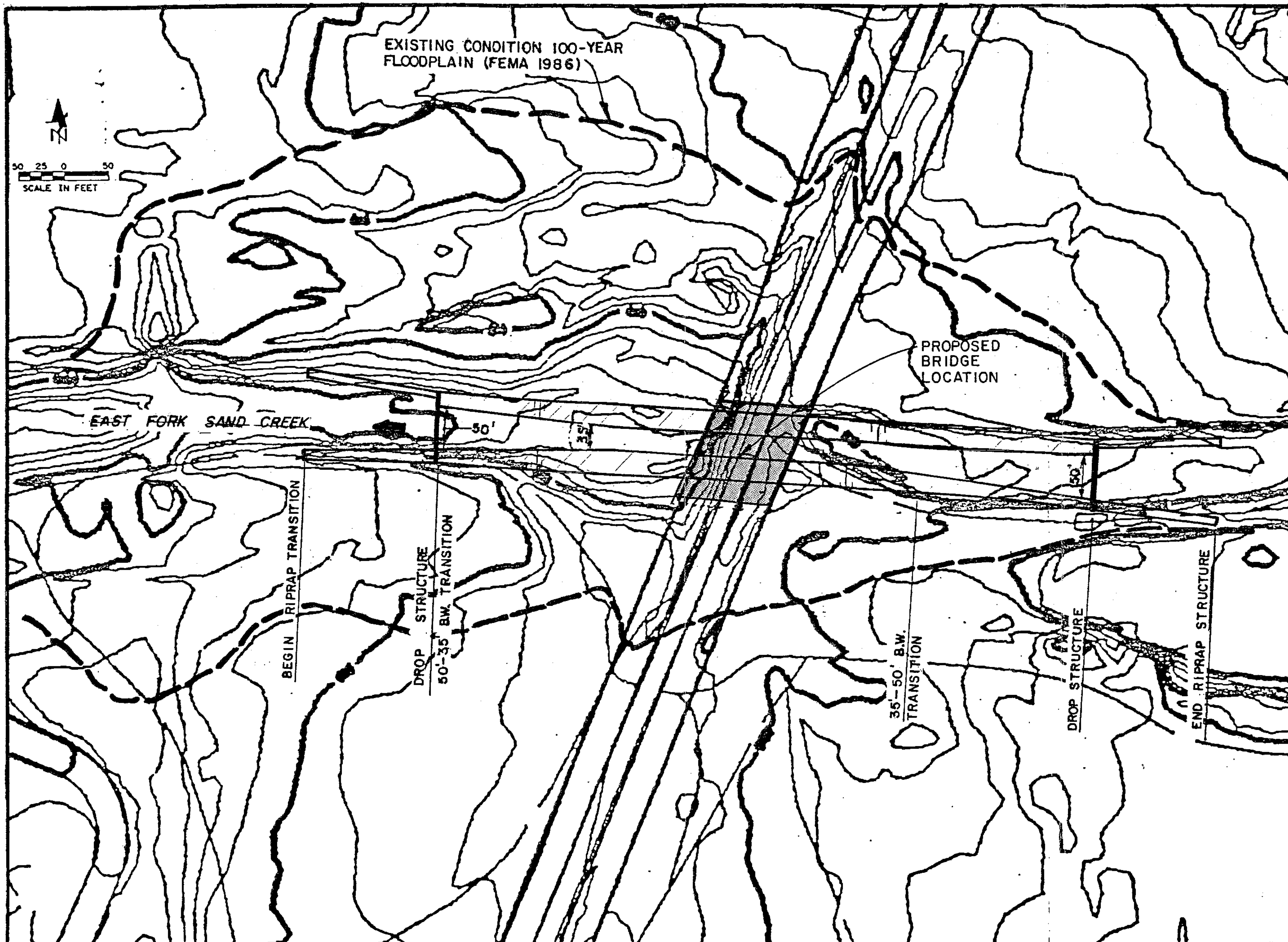
(1) ASSUMED BRIDGE ELEVATIONS — TOP OF ROAD ELEVATION = 6128.2 (5); LOW CHORD ELEVATION = 6122.9 (5)

(2) SOURCE: CITY OF COLORADO SPRINGS FLOOD INSURANCE STUDY, 1989 REVISION.

(3) COST PRESENTED IS FOR THE MAINLINE POWERS BOULEVARD BRIDGE ONLY. CHANNEL COSTS INCLUDED.
UNIT COSTS APPLIED : $75 / SQUARE FOOT OF BRIDGE DECK, NO PIERS;
$85/ SQUARE FOOT OF BRIDGE DECK WITH 1 PIER (2-SPAN).

(4) FREEBOARD CALCULATED USING CDOH DRAINAGE CRITERIA.

(5) ALL ELEVATIONS AT UPSTREAM FACE OF MAINLINE POWERS BOULEVARD.



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U.S. 24 BYPASS-PHASE II
PACKAGE I
EAST FORK SAND CREEK CHANNEL CONCEPT PLAN

FIG. 4

V. PRELIMINARY DRAINAGE RECOMMENDATIONS

Summarized in this section are the results of the preliminary hydrology and hydraulics analysis for the East Fork Sand Creek which crosses the US-24 Phase II alignment. Recommendations have been made to assist in the design of the drainageway crossings. The improvements identified herein are subject to further refinement in the final design phase.

Basis of Design

The drainage criteria summarized in the CDOT Roadway Design Manual and the City of Colorado Springs/El Paso County Drainage Criteria Manual was applied in the development of this study. The results of the calculations are summarized below. The sizing of riprap for bank and invert protection was conducted using the City/County Drainage Criteria Manual and the CDOT criteria. Scour calculations were performed using the empirical equations identified in References 10 and 11. Freeboard requirements for channels and bridge decks was determined using the CDOT criteria.

The hydraulic analysis have been conducted assuming that the roadway is in its ultimate configuration. Certain design modifications may be required during the final design phase for the interim roadway conditions.

East Fork Sand Creek and Powers Boulevard

Presented previously on Figure 4 is the conceptual layout of the roadway and channel improvements. The recommended bridge opening (normal to the drainageway) is a 35-foot bottom width, 2 to 1 side slope riprap trapezoidal channel. This results in a bridge span top width of approximately 103 feet, normal to the drainageway. A minimum low chord clearance of 15-feet above the upstream channel invert is required. Channel transitions will be required at both the upstream and downstream faces of the bridge. Three- and four-foot drop structure have been sited approximately 100-feet downstream and 150 feet upstream of the bridge, respectively. These drops are necessary to achieve adequate clearances under the bridge, provide for a milder drainageway slope through the bridge, and to stabilize the channel transitions and the existing banks. The location of the drops has been based upon the ultimate roadway section. The material to be used in the construction of the drop ranges from riprap to soil cement. Soil cement drop structures have been used in other locations on Sand Creek, and are currently being proposed for use in the Sand Creek stabilization project upstream of Fountain Boulevard discussed above. Access to the channel bottom should be considered at the up- and downstream channel transitions. The East Fork Sand Creek has been identified as a trail corridor by the City. The minimum low chord specified will provide for sufficient headroom to accommodate a multiple-use trail as requested by the City in the future. The trail should be constructed of concrete beneath the bridge, and should provide for at least ten-feet of clearance below the low-chord of the bridge at the trail crossing. Presented on Figure 5 is the typical section for the bridge opening at the East Fork of Sand Creek.

Slopes beneath the bridge should be protected with three-foot thick grouted riprap linings. The median stone size should be 18-inches, and bedded upon a six-inch thickness of native sand/gravel filter, underlain by a filter fabric material or upon 12-inches of native sand bedding meeting the CDOT specifications for riprap bedding. General contraction and long-term degradation along the channel is estimated at four-feet assuming a natural sand invert. It is recommended that a riprap invert be considered under the bridge. It is estimated that a riprap invert, in combination with channel drops, will reduce the long-term scour potential. Toe-down protection for the channel banks should extend below the channel invert a minimum of five-feet in depth which is one-foot below the long-term scour depth. The 500-year long-term and general scour depth was also estimated at four-feet. It is recommended that if a drilled caisson or piling foundation is used to support the bridge abutments, they should extend no less than to elevation 6,086. This elevation has been determined assuming no riprap bank or invert material in-place. This assumption adds approximately 14 additional feet to the total scour due to abutment scouring. The HEC-2 computer output for the recommended 35-foot bottom width bridge opening is contained within Appendix B of this report.

It is understood that the Bypass improvements may be constructed in phases. At East Fork Sand Creek, it has been assumed that only the interim roadway bridge section will be constructed initially with three lanes in each direction. As can be seen in Figure 4, the existing roadway embankment acts to spread on the 100-year floodplain and floodway boundary over the road. It is recommended that a Conditional Letter of Map Revision (CLOMR) be obtained from the Federal Emergency Management Agency (FEMA) during the final design of the bridge. The new structure will affect a lowering of the 100-year water surface elevation from the elevations currently published in the FIS. Drop structures should be constructed a sufficient distance up- and downstream of the interim road section so that the drops will not have to be disturbed when the ultimate road section is constructed. The ultimate road section will require two additional bridges of 80-foot spans (normal to the drainageway) for the ramps associated with the Airport Road interchange. A Flood Plain Development Permit will also be required and can be obtained through the Regional Building Department prior to commencing with the construction.

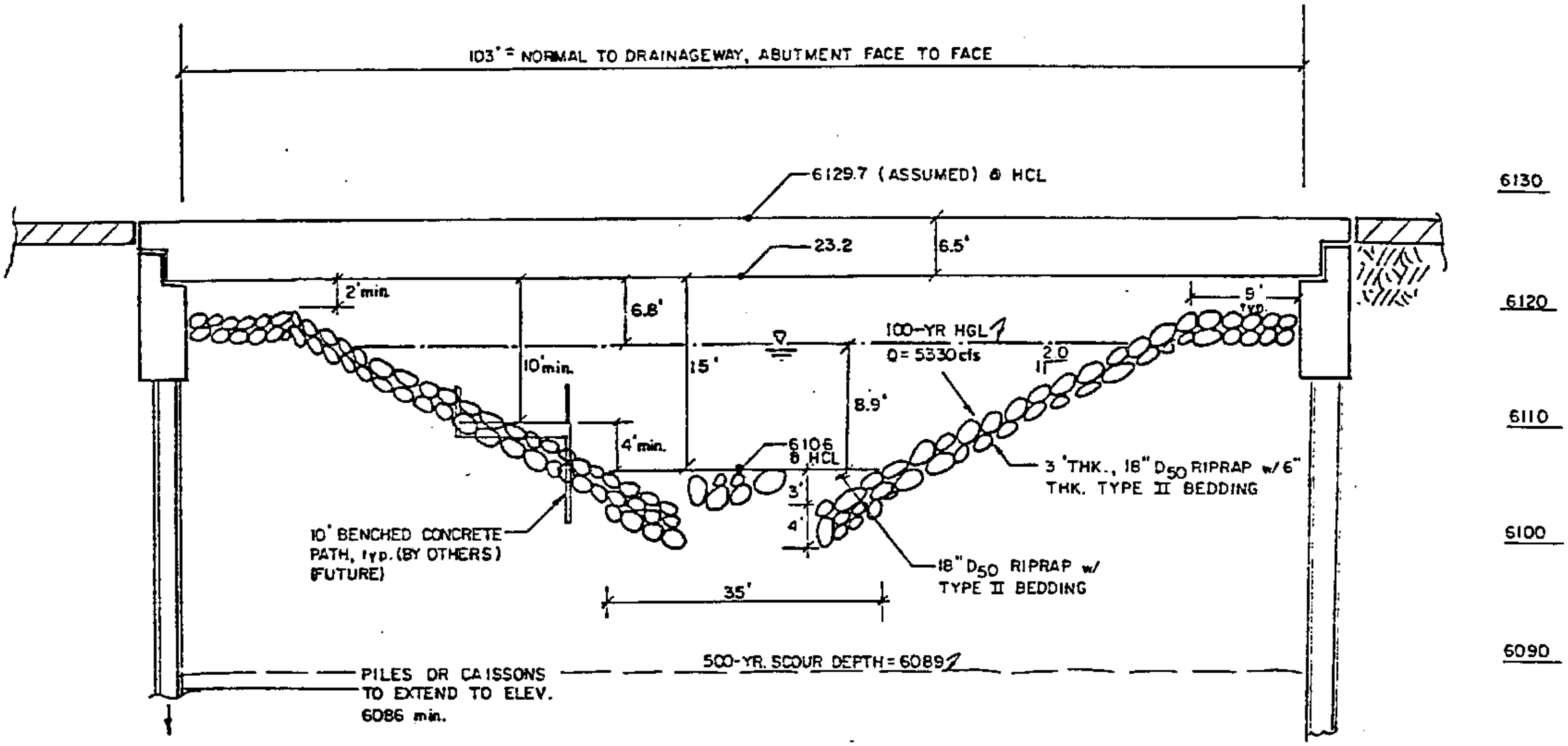

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FIGURE 5
TYPICAL BRIDGE OPENING
MAINLINE POWERS BLVD.

TABLE 3: CONCEPTUAL DESIGN COST ESTIMATE
MAJOR DRAINAGEWAY STRUCTURES
US 24 PHASE II BYPASS PROJECT

	QUANTITY	UNIT	UNIT COST	TOTAL (2)
EAST FORK SAND CREEK AND POWERS BLVD.				
ROADWAY				
98 ' CLEAR SPAN BRIDGES	29640	SF	$45	$1,333,800
CHANNEL IMPROVEMENTS				
GROUTED RIPRAP LININGS	550	LF	$350	$192,500
RIPRAP CHANNEL LININGS	330	LF	$290	$95,700
DROP STRUCTURES	2	EA	$65,000	$130,000
INVERT RIPRAP	7590	CY	$24	$182,160
	SUBTOTAL			$1,934,160
	20 % CONTINGENCY			$386,832
	13 % ENGINEERING			$301,729
	TOTAL			$2,622,721

NOTES: (1) COSTS DO NOT REFLECT RIGHT-OF-WAY ACQUISITION COSTS AT ANY OF THE STRUCTURES IDENTIFIED.
(2) TOTALS ARE FOR ULTIMATE ROADWAY CONFIGURATION.

Conceptual Design Cost Estimates

Presented on Table 5 is a cost estimate for the East Fork Sand Creek Bridge/Channel improvements shown on the drawings. Unit costs have been developed using the typical cross-sections and applying unit costs from recently completed projects in the Colorado Springs area.

Typically, if designed to City and County drainage standards, channel improvements will be maintained by the City and/or County. Maintenance responsibilities must be resolved to provide for hydraulically efficient and aesthetically pleasing crossing drainageway. The City or County will require that a permanent easement or right-of-way be granted for the purpose of accessing the drainageway for maintenance.

The cost of the channel improvements are generally reimbursable through the City/County drainage fee system, if the structure(s) have been incorporated into the fee calculation in the Drainage Basin Planning Study for the basin. The Sand Creek drainage basin is currently undergoing a restudy effort, whereby the basin fees will be re-evaluated. It is recommended that a funding agreement be considered between the City, County, and CDOT so that the costs of the drainage and bridge improvements can be accurately accounted for between the various funding agencies. In the East Fork Sand Creek Drainage Basin Planning Study, currently under review by the City and County, no reimbursement has been considered for the proposed Powers Boulevard Bridge over East Fork Sand Creek, however, the channel improvements on either side of the bridge have been accounted for in the fee calculation. Funding requirements may prohibit the use of federal funds in the construction of channel improvements adjacent to the proposed crossings of the major drainageways identified in this report.

VI. FINAL DRAINAGE RECOMMENDATIONS

As a result of preliminary analysis and design, the final drainage recommendations for East Fork Sand Creek Bridge at Powers Boulevard and associated channel improvements at both upstream and downstream from the bridge are summarized in the following sections:

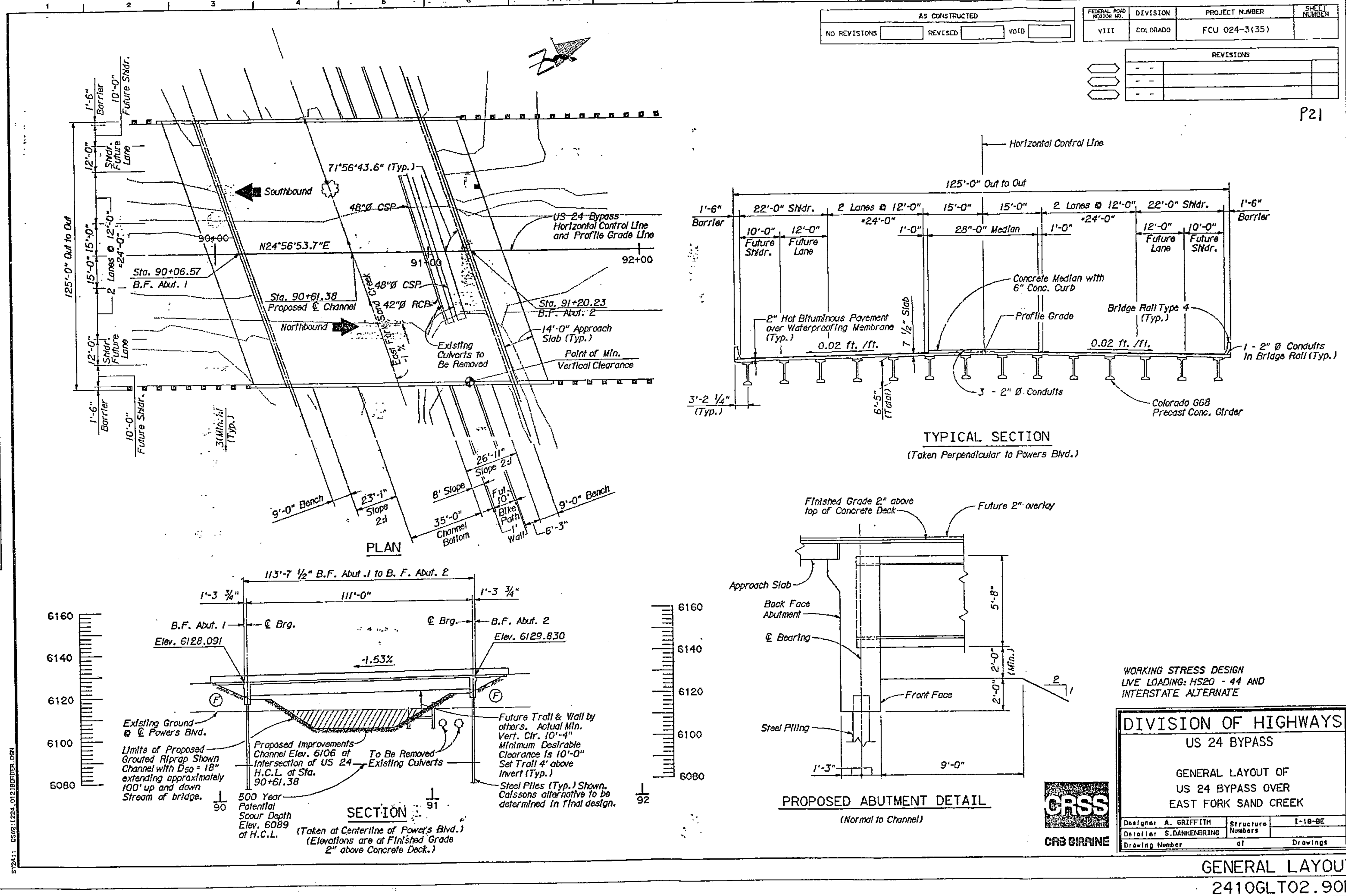
Bridge

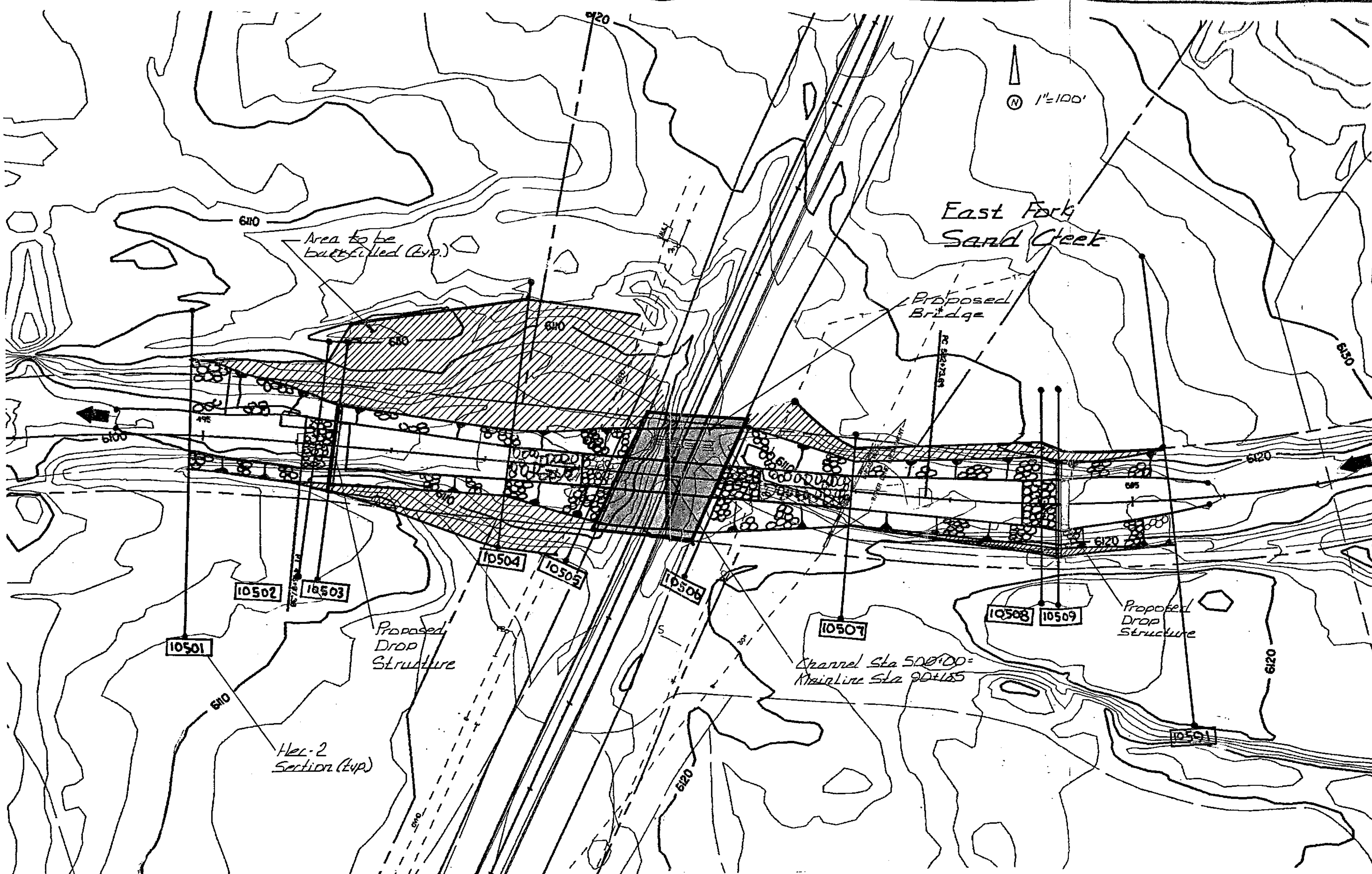
As shown in Figure 6, the proposed bridge will consist of a precast-prestressed concrete I-girders, a composite concrete slab with stubby abutments utilizing a single-row deep foundation, possibly supported with a combination of friction and end bearing steel pilings or caissons. The proposed dimensions as shown, are subject to minor refinement during the final roadway design stage. A nine-foot bench in front of each abutment is required according to CDOT design standards. A future ten-foot wide concrete path with a ten-foot minimum clearance above the path to the girder flanges will be provided by others. This ten-foot minimum clearance is generally preferred and accepted by the City's Park and Recreation Department. The bridge abutments will be protected with grouted riprap consisting of a median size of 18-inches and bedded upon a six-inch Type II bedding. Total riprap thickness will be three-foot on a slope of 2 to 1. The bridge invert will be protected by using the same dimension and type of material without the application of grout.

East Fork Sand Creek Channel

As shown in Figures 7 through 9 (see Map Pocket at the end of this report), the channel will be improved for conveying the 100-year design flow. Two drop structures are needed at the location as shown in Figure 8. These drops can be designed by using either steel sheet pile, reinforced concrete wall, or soil cement. A typical drop structure section is shown on Figure 10. A cost analysis for these three types of materials reveals that soil cement type drops are economical and effective. The channel needs to be protected with riprap at specified locations as shown on Figure 8. Channel bottom width and side slopes are varied according to the needed transition. Channel transitions from natural channel to riprap channel are shown in Figure 8. Generally, the channel is to be aligned to conform closely with the existing channel. Freeboard for the improved channel sections are provided according to the CDOT criteria and shown in Figure 8.

All engineering analysis pertinent to the water surface calculations, hydraulic jump analysis, riprap protection requirements, bridge information, etc., and cost estimates are contained in the Appendix.


AS CONSTRUCTED
NO REVISIONS REVISED VOID
FEDERAL ROAD REGION NO. VIII
DIVISION COLORADO
PROJECT NUMBER FCU 024-3(35)
SHEET NUMBER
REVISIONS
P21
PLAN
Southbound
Northbound
71°56'43.6" (Typ.)
48"Ø CSP
US 24 Bypass Horizontal Control Line and Profile Grade Line
90+00
N24°56'53.7"E
91+00
92+00
Sta. 90+06.57 B.F. Abut. 1
Sta. 90+61.38 Proposed ℄ Channel
48"Ø CSP
42"Ø RCP
East Fork Sand Creek
Sta. 91+20.23 B.F. Abut. 2
14'-0" Approach Slab (Typ.)
Existing Culverts to Be Removed
Point of Min. Vertical Clearance
125'-0" Out to Out
1'-6" Barrier
10'-0" Future Shldr.
12'-0" Shldr. Future Lane
2 Lanes @ 12'-0" =24'-0"
15'-0"
3(Min.) (Typ.)
9'-0" Bench
23'-1"
Slope 2:1
8' Slope
35'-0" Channel Bottom
26'-11" Slope 2:1
Fut. 10' Bike Path
1' Wall
6'-3"
9'-0" Bench
TYPICAL SECTION
(Taken Perpendicular to Powers Blvd.)
Horizontal Control Line
125'-0" Out to Out
1'-6" Barrier
22'-0" Shldr.
2 Lanes @ 12'-0" =24'-0"
15'-0"
15'-0"
10'-0" Future Shldr.
12'-0" Future Lane
1'-0"
28"-0" Median
1'-0"
Concrete Median with 6" Conc. Curb
2" Hot Bituminous Pavement over Waterproofing Membrane (Typ.)
Profile Grade
Bridge Rail Type 4 (Typ.)
7 1/2" Slab
0.02 ft./ft.
1 - 2" Ø Conduits In Bridge Rail (Typ.)
3'-2 1/4" (Typ.)
6'-5" (Total)
3 - 2" Ø Conduits
Colorado G68 Precast Conc. Girder
SECTION
(Taken at Centerline of Powers Blvd.)
(Elevations are at Finished Grade 2" above Concrete Deck.)
113'-7 1/2" B.F. Abut. 1 to B. F. Abut. 2
111'-0"
1'-3 3/4"
B.F. Abut. 1
℄ Brg.
B.F. Abut. 2
Elev. 6128.091
Elev. 6129.830
-1.53%
6160
6140
6120
6100
6080
Existing Ground @ ℄ Powers Blvd.
Limits of Proposed Grouted Riprap Shown Channel with D50 = 18" extending approximately 100' up and down Stream of bridge.
Proposed Improvements Channel Elev. 6106 at Intersection of US 24 H.C.L. at Sta. 90+61.38
To Be Removed Existing Culverts
500 Year Potential Scour Depth Elev. 6089 at H.C.L.
Future Trail & Wall by others. Actual Min. Vert. Clr. 10'-4" Minimum Desirable Clearance is 10'-0" Set Trail 4' above Invert (Typ.)
Steel Piles (Typ.) Shown. Caissons alternative to be determined in final design.
90
91
92
PROPOSED ABUTMENT DETAIL
(Normal to Channel)
Finished Grade 2" above top of Concrete Deck
Future 2" overlay
Approach Slab
Back Face Abutment
℄ Bearing
Front Face
Steel Piling
5'-8"
2'-0" (Min.)
2'-0"
1'-3"
9'-0"
WORKING STRESS DESIGN
LIVE LOADING: HS20 - 44 AND INTERSTATE ALTERNATE
CRSS
CRS SIRRINE
DIVISION OF HIGHWAYS
US 24 BYPASS
GENERAL LAYOUT OF
US 24 BYPASS OVER
EAST FORK SAND CREEK
Designer A. GRIFFITH
Detailer S. DANKENBRING
Structure Numbers I-18-BE
Drawing Number of Drawings
Designed By / Checked By / Detailed By
INITIAL DATE
Checked By / Quantities By / Checked By
GENERAL LAYOUT
2410GLT02.90B



Kiowa Engineering Corporation

DESIGNED JYC DATE
CHECKED DATE
DRAWN KD DATE /91
REVISED DATE

U.S. 24 BYPASS

PROPOSED BRIDGE/CHANNEL PLAN

Figure 7

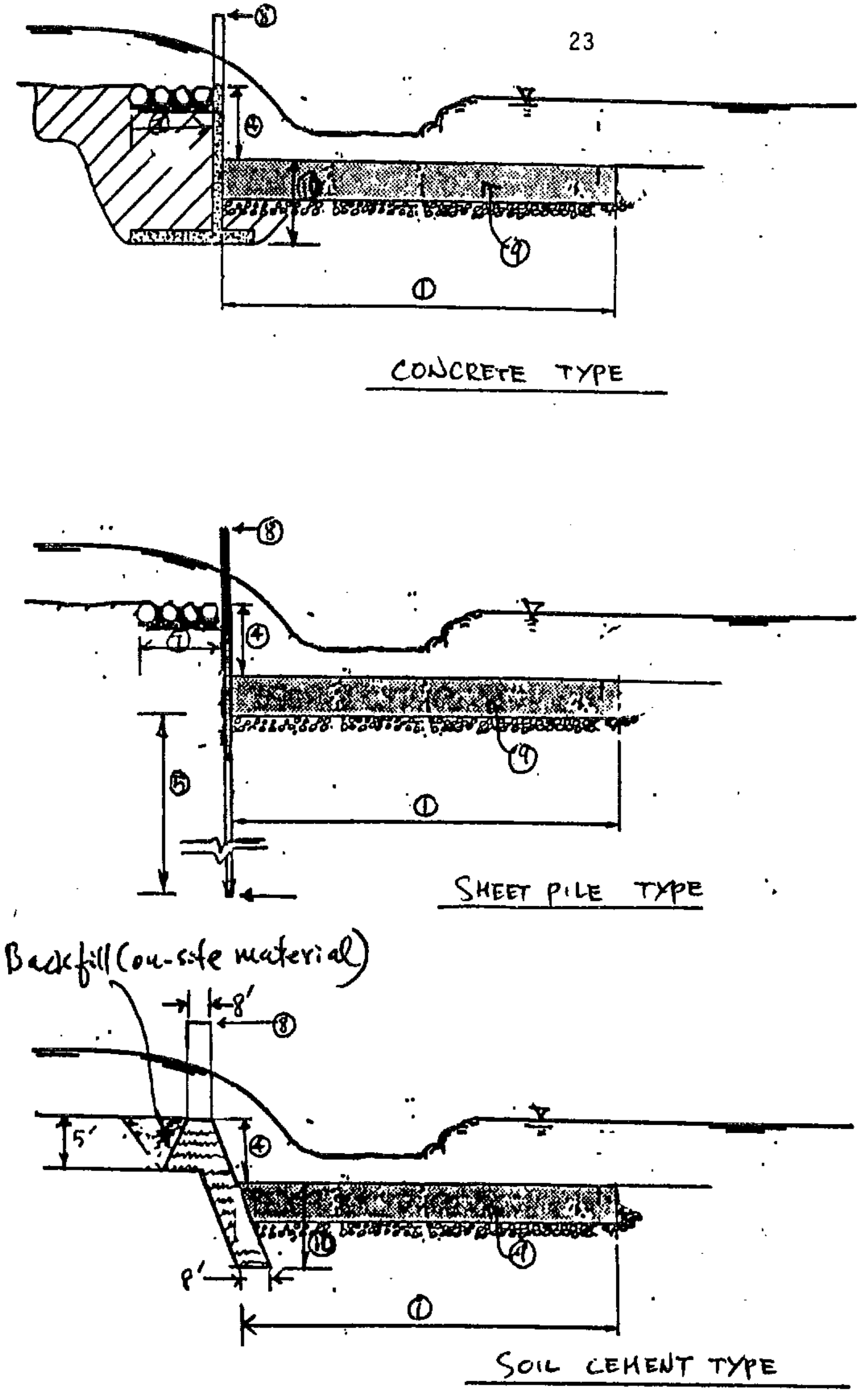


Fig 10: TYPICAL DROP STRUCTURE SECTION

Notes:

① : POOL LENGTH
(40' u/s , 35' d/s)

② SILL DEPTH
(1.6' u/s, 1.5' d/s

④ DROP DEPTH
(3.9' u/s , 2.6' d/s)

⑤ SHEET PILE DEPTH
(TO BED ROCK or 14'
BELOW CREST)

⑥ NATURAL CHANNEL
BED MATERIAL

⑦ GROUTED RIPRAP
(L = 10')

⑧ TO 100-YR WATER
SURFACE ELEVATION

⑨ TYPE "H" RIPRAP w/
TYPE "II" BEDDING.
RIPRAP THICKNESS = 3'
BEDDING THICKNESS = 6"

⑩ DEPTH = 5'

APPENDIX A

HEC-2 Computer Output (Preliminary Design)

```
C
C      4
C  17550 DOWNSTREAM 2-FOOT DROP STRUCTURE
C  17720 DOWNSTREAM BRIDGE FACE
C  17880 UPSTREAM BRIDGE FACE
C  18031 UPSTREAM 4-FOOT DROP STRUCTURE
T1      ALTERNATIVE NO. 6,   98' CLEAR SPAN     W/ 2 DROPS
T2      10-YEAR FLOW   KIOWA ENGINEERING CORPORATION  12/89
T3      EAST FORK SAND CREEK   FILE NAME US24ALT6.DAT  89.06.14
J1   -10       2.      0.      0.      1.      0.      0.      0.
J2     1       0.     -1.
J3    38        1      50      27      53      21       4      22      54      28
NC  .030    .030    .025      .1      .3
QT   5.0  1980.0  4250.0  5420.0  8240.0  5420.0
X1  18.0      23  1739.0  1851.0  1110.0  1070.0  1100.0
X3                        1654.0  9999.9  1864.0  9999.9
GR6052.2  1000.0  6051.8  1050.0  6151.1  1077.0  6048.0  1121.0  6048.1  1184.0
GR6047.2  1239.0  6046.0  1286.0  6044.8  1296.0  6043.9  1427.0  6042.9  1510.0
GR6042.5  1563.0  6042.1  1624.0  6042.2  1654.0  6041.8  1694.0  6040.5  1739.0
GR6033.6  1758.0  6033.6  1832.0  6040.0  1851.0  6041.2  1864.0  6040.0  1941.0
GR6050.8  1968.0  6049.8  1985.0  6050.4  2001.0
NC   .05     .03    .025      .1      .3
X1 101.0      33  2303.0  2428.0  1270.0  1330.0  1300.0
GR6064.8  1000.0  6064.1  1126.0  6064.5  1200.0  6063.5  1252.0  6063.8  1286.0
GR6064.7  1293.0  6064.2  1329.0  6065.0  1351.0  6067.0  1365.0  6064.2  1399.0
GR6065.3  1421.0  6064.4  1466.0  6062.8  1494.0  6063.8  1526.0  6062.8  1576.0
GR6062.2  1608.0  6061.7  1614.0  6062.0  1664.0  6061.7  1708.0  6060.1  1757.0
GR6060.8  1846.0  6060.3  1911.0  6060.2  1962.0  6059.2  2090.0  6059.1  2162.0
GR6057.6  2228.0  6057.3  2289.0  6057.5  2303.0  6049.0  2329.0  6049.0  2398.0
GR6061.3  2428.0  6073.7  2462.0  6072.8  2500.0
X1 102.0      60  1934.0  2062.0   920.0   930.0   930.0
X3                        1909.0  9999.9  2062.0  9999.9
GR6073.4  1000.0  6072.4  1014.0  6071.5  1073.0  6072.2  1082.0  6073.1  1131.0
GR6072.4  1158.0  6073.5  1175.0  6072.3  1216.0  6070.7  1280.0  6073.0  1313.0
GR6074.2  1344.0  6073.7  1379.0  6073.2  1419.0  6072.7  1422.0  6072.5  1458.0
GR6073.6  1462.0  6075.1  1474.0  6076.3  1489.0  6076.9  1505.0  6074.0  1543.0
GR6073.5  1558.0  6071.1  1572.0  6067.4  1579.0  6071.4  1587.0  6075.0  1596.0
GR6073.5  1615.0  6073.1  1636.0  6074.3  1665.0  6073.4  1695.0  6073.3  1696.0
GR6073.5  1730.0  6075.9  1761.0  6077.5  1772.0  6075.2  1795.0  6073.8  1821.0
GR6073.7  1874.0  6074.7  1889.0  6072.9  1901.0  6076.2  1909.0  6072.3  1918.0
GR6072.1  1934.0  6069.0  1949.0  6064.5  1961.0  6064.5  2030.0  6075.7  2062.0
GR6076.9  2095.0  6077.8  2111.0  6077.3  2117.0  6078.7  2133.0  6081.1  2194.0
GR6083.6  2255.0  6084.9  2302.0  6086.2  2375.0  6086.8  2430.0  6087.9  2510.0
GR6088.8  2626.0  6089.6  2697.0  6090.3  2786.0  6091.4  2870.0  6094.2  3000.0
X1 103.0      51  1945.0  2060.0   900.0   920.0   910.0
GR6095.7  1000.0  6096.5  1042.0  6094.4  1085.0  6094.0  1115.0  6093.8  1154.0
GR6092.2  1202.0  6092.2  1257.0  6091.7  1283.0  6092.0  1321.0  6092.1  1336.0
GR6094.2  1355.0  6092.9  1371.0  6092.0  1453.0  6092.0  1480.0  6091.8  1520.0
GR6090.0  1546.0  6089.4  1553.0  6089.9  1571.0  6089.5  1585.0  6091.0  1618.0
GR6090.6  1665.0  6092.4  1695.0  6091.0  1731.0  6089.1  1747.0  6090.9  1803.0
GR6089.1  1833.0  6088.2  1862.0  6088.1  1906.0  6087.9  1945.0  6081.8  1956.0
GR6080.0  1965.0  6080.0  2038.0  6090.2  2060.0  6089.5  2078.0  6091.3  2096.0
GR6090.5  2153.0  6091.1  2192.0  6089.5  2207.0  6090.7  2258.0  6090.1  2300.0
GR6090.9  2326.0  6091.3  2383.0  6092.2  2432.0  6092.7  2462.0  6092.7  2524.0
GR6093.1  2613.0  6092.8  2675.0  6093.4  2747.0  6094.1  2823.0  6094.4  2897.0
GR6096.3  3000.0
X1 104.0      37  1943.0  2077.0   640.0   630.0   630.0
GR6108.8  1000.0  6108.2  1088.0  6107.5  1203.0  6107.5  1302.0  6106.7  1371.0
GR6104.7  1441.0  6103.3  1464.0  6101.6  1481.0  6101.4  1564.0  6100.5  1626.0
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GR6102.5  1657.0  6103.2  1680.0  6104.7  1695.0  6108.5  1708.0  6105.0  1717.0
GR6100.8  1762.0  6100.0  1796.0  6102.7  1809.0  6099.9  1819.0  6097.9  1836.0
GR6098.3  1880.0  6098.0  1935.0  6098.5  1943.0  6089.8  1965.0  6090.3  2039.0
GR6103.1  2077.0  6101.5  2186.0  6101.1  2281.0  6100.4  2391.0  6098.1  2560.0
GR6098.7  2669.0  6099.8  2735.0  6100.9  2770.0  6102.1  2784.0  6099.4  2873.0
GR6103.4  2904.0  6104.4  3000.0
QT    5.  1940.0  4180.0  5330.0  6120.0  5330.0
NC  .035    .035    .035      .3      .5
X1 17550       4    1000    1098     550     550     550
GR  6112    1000  6100.2    1024  6100.2    1074    6112    1098
X1 17600       4    1000    1098      10      10      10
GR6112.0    1000  6102.2    1024  6102.2    1074  6112.0    1098
X1 17720       8    1000    1098     200     200     200
GR6117.2    1000  6117.2    1005  6104.2  1024.5  6104.2 1059.75  6108.2 1065.25
GR6108.2 1077.25  6118.7    1093  6118.7    1098
SB  1.05     1.5     2.6       0   34.75       0    1150     1.5  6107.8  6104.2
X1 17880       0       0       0     370     370     370             3.6
X2     0       0       1  6123.2  6128.2
BT     4    1000  6128.2  6128.2    1000  6128.2  6121.7    1098  6129.8  6123.2
BT  1098  6129.8  6129.8
X1 18030       4    1000    1092     200     200     200
GR  6124    1000  6109.8    1028  6109.8    1064    6124    1092
X1 18031       4    1000    1092      10      10      10
GR  6124    1000  6113.8    1020  6113.8    1070    6124    1092
NC  .035    .035   0.025      .1      .3
X1 106.0      40  1802.0  2007.0     470     470     470
X3                        1769.0  9999.9  2115.0  9999.9
GR6128.7  1000.0  6129.7  1090.0  6130.5  1147.0  6130.7  1218.0  6131.0  1326.0
GR6131.6  1416.0  6134.2  1554.0  6132.2  1641.0  6133.6  1734.0  6134.8  1769.0
GR6126.8  1783.0  6126.0  1802.0  6124.8  1809.0  6125.4  1855.0  6125.2  1900.0
GR6125.6  1953.0  6127.5  2007.0  6132.6  2115.0  6131.6  2127.0  6130.8  2153.0
GR6129.4  2201.0  6129.8  2223.0  6130.9  2267.0  6137.7  2330.0  6138.3  2363.0
GR6140.2  2370.0  6138.9  2388.0  6140.9  2398.0  6141.0  2412.0  6140.3  2429.0
GR6141.2  2442.0  6140.8  2480.0  6145.4  2596.0  6148.4  2669.0  6152.4  2742.0
GR6156.8  2819.0  6159.6  2902.0  6160.6  2975.0  6158.0  2989.0  6158.5  3000.0
X1 107.0      35  1470.0  1952.0  1020.0  1150.0  1340.0
X3    10
GR6160.0  1000.0  6158.0  1150.0  6156.0  1260.0  6154.0  1440.0  6152.0  1460.0
GR6150.0  1470.0  6148.2  1514.0  6148.5  1575.0  6148.9  1620.0  6149.6  1674.0
GR6150.8  1732.0  6151.7  1781.0  6153.5  1833.0  6154.9  1878.0  6155.2  1920.0
GR6156.1  1952.0  6156.4  1991.0  6156.8  2029.0  6157.3  2054.0  6157.9  2083.0
GR6159.5  2108.0  6164.6  2134.0  6162.6  2160.0  6160.8  2209.0  6160.8  2261.0
GR6161.3  2322.0  6162.2  2375.0  6162.8  2459.0  6163.9  2538.0  6164.8  2609.0
GR6165.6  2675.0  6166.2  2740.0  6167.1  2848.0  6168.5  2958.0  6168.9  3000.0
X1 108.0      45  1676.0  1850.0  1220.0   890.0  1050.0
X3                        1615.0  9999.9  1914.0  9999.9
GR6174.4  1000.0  6173.8  1089.0  6173.0  1212.0  6173.4  1331.0  6173.4  1400.0
GR6173.6  1468.0  6174.4  1523.0  6174.9  1553.0  6174.7  1577.0  6178.0  1604.0
GR6178.8  1615.0  6178.4  1625.0  6175.6  1659.0  6175.5  1676.0  6164.6  1710.0
GR6164.7  1739.0  6164.7  1770.0  6165.5  1821.0  6169.5  1850.0  6176.1  1893.0
GR6179.0  1914.0  6178.8  1923.0  6174.7  1969.0  6172.4  1993.0  6172.9  2010.0
GR6171.9  2036.0  6168.9  2057.0  6169.4  2070.0  6170.3  2087.0  6168.5  2110.0
GR6169.5  2121.0  6168.9  2159.0  6168.1  2240.0  6167.9  2298.0  6168.8  2334.0
GR6168.1  2344.0  6169.6  2353.0  6169.5  2369.0  6168.8  2379.0  6168.9  2420.0
GR6170.0  2439.0  6170.6  2456.0  6168.4  2471.0  6169.4  2483.0  6169.8  2500.0
X1 109.0      50  1999.0  2260.0  1000.0  1000.0  1010.0
X3                        1968.0  9999.9  2260.0  9999.9
GR6189.4  1000.0  6187.3  1116.0  6186.9  1186.0  6187.3  1219.0  6189.7  1252.0
GR6188.6  1270.0  6188.4  1336.0  6187.7  1374.0  6188.1  1392.0  6188.0  1402.0
GR6189.2  1433.0  6186.8  1467.0  6184.6  1523.0  6185.6  1581.0  6187.2  1656.0
GR6187.7  1713.0  6188.3  1771.0  6188.9  1812.0  6189.8  1843.0  6194.4  1940.0
GR6195.9  1958.0  6196.0  1968.0  6195.9  1977.0  6193.1  1999.0  6190.0  2022.0
GR6189.5  2085.0  6189.5  2115.0  6189.9  2125.0  6182.6  2144.0  6182.6  2205.0
GR6186.2  2211.0  6192.8  2260.0  6192.8  2274.0  6187.2  2332.0  6181.2  2386.0
GR6181.7  2409.0  6181.2  2420.0  6182.6  2429.0  6181.2  2445.0  6181.0  2556.0
GR6181.1  2701.0  6183.7  2816.0  6184.7  2889.0  6184.2  2921.0  6184.6  2945.0
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GR6185.6  2960.0  6186.3  2979.0  6186.7  2988.0  6186.8  2994.0  6186.8  3000.0
X1 110.0      55  1558.0  1699.0   900.0   890.0   890.0
X3    10
GR6201.2  1000.0  6201.7  1054.0  6201.4  1084.0  6203.5  1125.0  6203.4  1154.0
GR6203.2  1168.0  6201.4  1183.0  6201.4  1196.0  6203.4  1211.0  6202.8  1230.0
GR6202.7  1252.0  6201.8  1271.0  6201.8  1281.0  6203.8  1299.0  6202.4  1311.0
GR6201.6  1323.0  6201.5  1334.0  6202.8  1358.0  6200.9  1376.0  6201.7  1386.0
GR6201.5  1396.0  6202.8  1406.0  6205.0  1432.0  6208.2  1457.0  6208.6  1478.0
GR6208.4  1501.0  6206.8  1526.0  6201.4  1558.0  6190.9  1574.0  6190.9  1590.0
GR6190.9  1607.0  6191.6  1620.0  6192.1  1647.0  6192.7  1663.0  6199.8  1699.0
GR6204.9  1734.0  6206.1  1755.0  6206.1  1768.0  6203.0  1818.0  6203.3  1878.0
GR6203.7  1947.0  6204.6  2009.0  6205.6  2055.0  6205.1  2112.0  6203.5  2248.0
GR6202.5  2324.0  6203.4  2363.0  6203.3  2393.0  6202.4  2419.0  6203.1  2447.0
GR6202.9  2454.0  6202.1  2460.0  6204.9  2477.0  6205.0  2487.0  6205.1  2500.0
EJ
T1       COLORADO SPRINGS, COLORADO
T2       SAND CREEK EAST FORK ZONE
T3       50 YEAR FLOOD
J1   -10       3                       1
J2     2               -1
T1       COLORADO SPRINGS, COLORADO
T2       SAND CREEK EAST FORK ZONE
T3       100 YEAR FLOOD
J1   -10       4                       1
J2     3               -1
T1       COLORADO SPRINGS, COLORADO
T2       SAND CREEK EAST FORK ZONE
T3       500 YEAR FLOOD
J1   -10       5                       1
J2    15               -1


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1*****************************************************                  **************************************
 *  WATER SURFACE PROFILES                            *                  *  U.S. ARMY CORPS OF ENGINEERS       *
 *  VERSION OF NOVEMBER 1976                          *                  *  THE HYDROLOGIC ENGINEERING CENTER  *
 *  UPDATED MAY 1984                                  *                  *  609 SECOND STREET, SUITE D         *
 *  IBM-PC-XT VERSION                                 *                  *  DAVIS, CALIFORNIA 95616            *
 *  RUN DATE  01/04/91  TIME  06:02:52                *                  *  (916) 440-2105 (FTS) 448-2105      *
 *****************************************************                  **************************************
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```
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
```

1
01/04/91   06:02:54   PAGE   1

THIS RUN EXECUTED 01/04/91   06:02:55

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**************************************************
 HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
 ERROR CORR -  01,02,03,04,05,06
 MODIFICATION -  50,51,52,53,54,55,56
 IBM-PC-XT VERSION 1.1
**************************************************
```

```
C
T1      ALTERNATIVE NO. 6,   98' CLEAR SPAN     W/ 2 DROPS
T2      10-YEAR FLOW   KIOWA ENGINEERING CORPORATION  12/89
T3      EAST FORK SAND CREEK   FILE NAME US24ALT6.DAT  89.06.14

J1  ICHECK    INQ      NINV      IDIR      STRT     METRIC    HVINS      Q        WSEL      FQ

     -10.       2.        0.        0.  1.000000      .00        .0       0.      .000      .000

J2  NPROF    IPLOT     PRFVS     XSECV     XSECH      FN      ALLDC     IBW      CHNIM     ITRACE

     1.000     .000    -1.000      .000      .000     .000     .000     .000      .000      .000

J3  VARIABLE CODES FOR SUMMARY PRINTOUT

    38.000    1.000    50.000    27.000    53.000    21.000    4.000    22.000    54.000    28.000
```

1
01/04/91   06:02:54   PAGE   2

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


*PROF 1

CCHV=     .100 CEHV=     .300
*SECNO 18.000
2096 WSEL NOT GIVEN,AVG OF MAX,MIN USED
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=     1654.0     1864.0  TYPE=      1  TARGET=      210.000
 ELENCL=   9999.90  ELENCR=   9999.90
     18.00      2.70  6036.30  6036.30       .00  6037.55      1.25       .00       .00  6040.50
     1980.        0.    1980.       0.        0.     221.        0.        0.        0.   6040.00
       .00       .00     8.97      .00      .030     .025      .030      .000   6033.60  1750.56
   .006925     1110.    1100.    1070.         0       17         0       .00     89.45  1840.02
0
CCHV=     .100 CEHV=     .300
*SECNO 101.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    101.00      2.82  6051.82  6051.82       .00  6053.12      1.30      8.96       .01  6057.50
     1980.        0.    1980.       0.        0.     216.        0.        7.        3.   6061.30
       .04       .00     9.15      .00      .050     .025      .030      .000   6049.00  2320.37
   .006863     1270.    1300.    1330.         4        8         0       .00     84.51  2404.88
0
*SECNO 102.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=     1909.0     2062.0  TYPE=      1  TARGET=      153.000
 ELENCL=   9999.90  ELENCR=   9999.90
    102.00      2.82  6067.32  6067.32       .00  6068.62      1.30      6.37       .00  6072.10
     1980.        0.    1980.       0.        0.     217.        0.       11.        4.   9999.90
       .07       .00     9.14      .00      .050     .025      .030      .000   6064.50  1953.47
   .006843      920.     930.     930.        20        5         0       .00     84.59  2038.06
0
*SECNO 103.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    103.00      2.70  6082.70  6082.70       .00  6083.94      1.24      6.21       .01  6087.90
     1980.        0.    1980.       0.        0.     222.        0.       16.        6.   6090.20
       .10       .00     8.92      .00      .050     .025      .030      .000   6080.00  1954.38
   .006805      900.     910.     920.        20        8         0       .00     89.45  2043.82
0
1
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   SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
   Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
   TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
   SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST


*SECNO 104.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    104.00      2.96  6092.76  6092.76       .00  6094.01      1.25      4.32       .01  6098.50
     1980.        0.    1980.       0.        0.     220.        0.       19.        8.   6103.10
       .12       .00     8.99      .00      .050     .025      .030      .000   6089.80  1957.52
   .006904      640.     630.     630.        20        8         0       .00     88.77  2046.29
0
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CCHV=    .300 CEHV=    .500
*SECNO 17550.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
        DOWNSTREAM 2-FOOT DROP STRUCTURE
 17550.00     3.43  6103.63  6103.63     .00  6105.16     1.53     5.03      .14  6112.00
    1940.       0.    1940.       0.      0.     195.       0.      22.       8.  6112.00
      .13      .00     9.93      .00    .035     .035     .035     .000  6100.20  1017.03
  .012761     550.     550.     550.      20        8        0      .00    63.95  1080.97
0
*SECNO 17600.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
 17600.00     3.38  6105.58  6105.58     .00  6107.09     1.51      .13      .01  6112.00
    1940.       0.    1940.       0.      0.     197.       0.      22.       8.  6112.00
      .13      .00     9.85      .00    .035     .035     .035     .000  6102.20  1015.72
  .012995      10.      10.      10.      20        5        0      .00    66.56  1082.28
0
*SECNO 17720.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
        DOWNSTREAM BRIDGE FACE
 17720.00     4.44  6108.64  6108.64     .00  6110.26     1.61     2.61      .05  6117.20
    1940.       0.    1940.       0.      0.     190.       0.      22.       9.  6118.70
      .14      .00    10.19      .00    .035     .035     .035     .000  6104.20  1017.83
  .013141     200.     200.     200.       2       11        0      .00    60.08  1077.92
0
1
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   SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS    BANK ELEV
   Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA   LEFT/RIGHT
   TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN      SSTA
   SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST



SPECIAL BRIDGE

SB  XK       XKOR     COFQ     RDLEN    BWC      BWP      BAREA     SS       ELCHU    ELCHD
     1.05     1.50     2.60      .00    34.75      .00  1150.00     1.50  6107.80  6104.20

*SECNO 17880.000

6070,LOW FLOW BY NORMAL BRIDGE

EGPRS=     .000  EGLWC=  6113.856  ELLC=  6123.200  PCWSE=  6108.645  ELTRD=  6128.200

3370 NORMAL BRIDGE,NRD=  4 MIN ELTRD= 6128.20 MAX ELLC= 6123.20

        UPSTREAM BRIDGE FACE
 17880.00     5.08  6112.88      .00     .00  6114.00     1.12     3.59      .15  6120.80
    1940.       0.    1940.       0.      0.     229.       0.      24.       9.  6122.30
      .15      .00     8.47      .00    .035     .035     .035     .000  6107.80  1016.89
  .007455     370.     370.     370.       1        0        0      .00    61.98  1078.86
0
*SECNO 18030.000
 18030.00     4.56  6114.36      .00     .00  6115.75     1.39     1.62      .14  6124.00
    1940.       0.    1940.       0.      0.     205.       0.      25.      10.  6124.00
      .15      .00     9.45      .00    .035     .035     .035     .000  6109.80  1019.01
  .008806     200.     200.     200.       3        0        0      .00    53.99  1072.99
0
*SECNO 18031.000
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3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
       UPSTREAM 4-FOOT DROP STRUCTURE
 18031.00    3.42  6117.22 6117.22    .00  6118.76    1.54     .11     .08  6124.00
    1940.      0.    1940.      0.      0.    195.      0.     25.     10.   6124.00
      .15     .00     9.95     .00    .035    .035    .035    .000  6113.80  1013.30
  .012882     10.      10.     10.      20      15       0     .00    64.07  1077.37
0
CCHV=    .100 CEHV=    .300
*SECNO 106.000

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY
1
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   SECNO    DEPTH   CWSEL   CRIWS   WSELK   EG      HV      HL      OLOSS   BANK ELEV
   Q        QLOB    QCH     QROB    ALOB    ACH     AROB    VOL     TWA   LEFT/RIGHT
   TIME     VLOB    VCH     VROB    XNL     XNCH    XNR     WTN     ELMIN     SSTA
   SLOPE    XLOBL   XLCH    XLOBR   ITRIAL  IDC     ICONT   CORAR   TOPWID    ENDST


3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=     1769.0    2115.0  TYPE=     1  TARGET=     346.000
 ELENCL=   9999.90  ELENCR=   9999.90
   106.00    2.16  6126.96 6126.96    .00  6127.68     .71    4.65     .08  6126.00
    1940.     27.    1913.      0.     11.    280.      0.     28.     11.   6127.50
      .17    2.55     6.83     .00    .035    .025    .035    .000  6124.80  1782.72
  .007844    470.     470.    470.       3      14       0     .00   208.95  1991.66
0
*SECNO 107.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=     6150.00 ELREA=     6156.10

   107.00    2.04  6150.25 6150.25    .00  6150.90     .65   11.00     .01  6150.00
    1940.      0.    1940.      0.      0.    299.      0.     37.     18.   6156.10
      .23     .96     6.48     .00    .035    .025    .035    .000  6148.20  1468.77
  .008623   1020.    1340.   1150.       4      11       0     .00   236.41  1705.18
0
*SECNO 108.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=     1615.0    1914.0  TYPE=     1  TARGET=     299.000
 ELENCL=   9999.90  ELENCR=   9999.90
   108.00    2.35  6166.95 6166.95    .00  6167.91     .96    8.39     .09  6175.50
    1940.      0.    1940.      0.      0.    246.      0.     44.     22.   6169.50
      .27     .00     7.87     .00    .035    .025    .035    .000  6164.60  1702.68
  .007422   1220.    1050.    890.       3       8       0     .00   128.79  1831.48
0
*SECNO 109.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=     1968.0    2260.0  TYPE=     1  TARGET=     292.000
 ELENCL=   9999.90  ELENCR=   9999.90
   109.00    3.03  6185.63 6185.63    .00  6187.03    1.40    7.13     .13  6193.10
    1940.      0.    1940.      0.      0.    205.      0.     49.     25.   9999.90
      .30     .00     9.49     .00    .035    .025    .035    .000  6182.60  2134.11
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0
1
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   SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS   BANK ELEV
   Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA   LEFT/RIGHT
   TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN      SSTA
   SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST


 *SECNO 110.000
 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=     6201.40 ELREA=     6199.80

    110.00     3.03  6193.93  6193.93      .00  6195.07     1.14     6.15      .03  6201.40
     1940.       0.    1940.       0.       0.     226.       0.      53.      26.  6199.80
       .33      .00     8.58      .00     .035     .025     .035     .000  6190.90  1569.39
   .007104     900.     890.     890.       10        5        0      .00    99.84  1669.23
0
1
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                                                                          THIS RUN EXECUTED 01/04/91    06:04:15
 *************************************************
   HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
   ERROR CORR -  01,02,03,04,05,06
   MODIFICATION -  50,51,52,53,54,55,56
   IBM-PC-XT VERSION 1.1
 *************************************************


 T1      COLORADO SPRINGS, COLORADO
 T2      SAND CREEK EAST FORK ZONE
 T3      50 YEAR FLOOD

 J1  ICHECK     INQ       NINV      IDIR       STRT      METRIC    HVINS     Q         WSEL      FQ

      -10.        3.        0.        0.  1.000000       .00        .0        0.      .000      .000

 J2  NPROF     IPLOT     PRFVS     XSECV     XSECH      FN        ALLDC     IBW       CHNIM     ITRACE

       2.000      .000    -1.000      .000      .000      .000      .000      .000      .000      .000

1
 01/04/91    06:02:54                                                                                        PAGE    8


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


 *PROF 2

 CCHV=     .100 CEHV=     .300
 *SECNO 18.000
 2096 WSEL NOT GIVEN,AVG OF MAX,MIN USED
 3720 CRITICAL DEPTH ASSUMED
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```
3470 ENCROACHMENT STATIONS=     1654.0     1864.0  TYPE=      1  TARGET=      210.000
 ELENCL=   9999.90  ELENCR=    9999.90
    18.00      4.39  6037.99  6037.99       .00  6039.93      1.94       .00        .00  6040.50
    4250.        0.    4250.        0.        0.     380.        0.        0.         0.  6040.00
      .00       .00    11.18       .00      .030     .025      .030      .000   6033.60  1745.90
  .006004     1110.    1100.     1070.        0        11        0        .00     99.14  1845.04
0
CCHV=    .100 CEHV=    .300
*SECNO 101.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
   101.00      4.58  6053.58  6053.58       .00  6055.59      2.01      7.79       .02  6057.50
    4250.        0.    4250.        0.        0.     373.        0.       11.        3.  6061.30
      .03       .00    11.38       .00      .050     .025      .030      .000   6049.00  2315.00
  .005978     1270.    1300.     1330.       20         8        0        .00     94.16  2409.16
0
*SECNO 102.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=     1909.0     2062.0  TYPE=      1  TARGET=      153.000
 ELENCL=   9999.90  ELENCR=    9999.90
   102.00      4.58  6069.08  6069.08       .00  6071.09      2.00      5.55       .00  6072.10
    4250.        0.    4250.        0.        0.     374.        0.       19.        5.  9999.90
      .05       .00    11.35       .00      .050     .025      .030      .000   6064.50  1948.59
  .005951      920.     930.      930.       20         5        0        .00     94.51  2043.10
0
*SECNO 103.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
1
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   SECNO     DEPTH    CWSEL    CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
   Q         QLOB     QCH      QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
   TIME      VLOB     VCH      VROB      XNL       XNCH      XNR       WTN       ELMIN      SSTA
   SLOPE     XLOBL    XLCH     XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST


   103.00      4.38  6084.38  6084.38       .00  6086.35      1.96      5.40       .00  6087.90
    4250.        0.    4250.        0.        0.     378.        0.       27.        7.  6090.20
      .08       .00    11.24       .00      .050     .025      .030      .000   6080.00  1951.34
  .005909      900.     910.      920.       20         8        0        .00     96.11  2047.45
0
*SECNO 104.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
   104.00      4.65  6094.45  6094.45       .00  6096.41      1.96      3.76       .00  6098.50
    4250.        0.    4250.        0.        0.     378.        0.       33.        8.  6103.10
      .09       .00    11.24       .00      .050     .025      .030      .000   6089.80  1953.25
  .006037      640.     630.      630.       20         8        0        .00     98.06  2051.31
0
CCHV=    .300 CEHV=    .500
*SECNO 17550.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
          DOWNSTREAM 2-FOOT DROP STRUCTURE
 17550.00      5.53  6105.73  6105.73       .00  6108.10      2.36      4.42       .20  6112.00
    4180.        0.    4180.        0.        0.     339.        0.       37.        9.  6112.00
```

```
   .10      .00    12.33     .00    .035     .035     .035    .000  6100.20  1012.74
 .011302    550.    550.    550.      20       11        0     .00    72.51  1085.26
0
 *SECNO 17600.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
  17600.00     5.44  6107.64  6107.64     .00  6109.93     2.29     .11      .02  6112.00
     4180.      0.    4180.      0.      0.     344.      0.      37.       9.   6112.00
       .11      .00    12.14     .00    .035     .035     .035    .000  6102.20  1010.68
   .011445     10.      10.     10.      20        5        0     .00    76.63  1087.32
0
 *SECNO 17720.000
 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
         DOWNSTREAM BRIDGE FACE
  17720.00     6.63  6110.83  6110.83     .00  6113.34     2.51    2.30      .11  6117.20
     4180.      0.    4180.      0.      0.     329.      0.      39.      10.   6118.70
       .11      .00    12.71     .00    .035     .035     .035    .000  6104.20  1014.55
   .011545    200.     200.    200.       2       11        0     .00    66.64  1081.20
0
1
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```
    SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS   BANK ELEV
    Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA   LEFT/RIGHT
    TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN      SSTA
    SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST


 SPECIAL BRIDGE

 SB  XK        XKOR      COFQ      RDLEN      BWC       BWP      BAREA      SS       ELCHU     ELCHD
     1.05      1.50      2.60       .00      34.75      .00    1150.00     1.50    6107.80   6104.20

 *SECNO 17880.000

 6070,LOW FLOW BY NORMAL BRIDGE

 EGPRS=      .000  EGLWC=  6116.938  ELLC=  6123.200  PCWSE=  6110.831  ELTRD=  6128.200

 3301 HV CHANGED MORE THAN HVINS


 3370 NORMAL BRIDGE,NRD=  4 MIN ELTRD= 6128.20 MAX ELLC= 6123.20

         UPSTREAM BRIDGE FACE
  17880.00     7.27  6115.07      .00     .00  6117.03     1.96    3.53      .16  6120.80
     4180.      0.    4180.      0.      0.     372.      0.      42.      10.   6122.30
       .12      .00    11.24     .00    .035     .035     .035    .000  6107.80  1013.60
   .008000    370.     370.    370.       3        0        0     .00    68.55  1082.15
0
 *SECNO 18030.000
  18030.00     6.81  6116.61      .00     .00  6119.00     2.39    1.76      .21  6124.00
     4180.      0.    4180.      0.      0.     337.      0.      43.      11.   6124.00
       .12      .00    12.40     .00    .035     .035     .035    .000  6109.80  1014.56
   .009725    200.     200.    200.       2        0        0     .00    62.89  1077.44
0
 *SECNO 18031.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
         UPSTREAM 4-FOOT DROP STRUCTURE
  18031.00     5.52  6119.32  6119.32     .00  6121.68     2.36     .10      .01  6124.00
```

```
    4180.       0.     4180.       0.       0.      559.       0.      43.      11.   6124.00
      .12      .00     12.33      .00     .035      .035     .035     .000  6113.80  1009.17
   .011348     10.       10.      10.       20        15        0      .00    72.74  1081.91
0
 CCHV=    .100 CEHV=     .300
 *SECNO 106.000
1
  01/04/91    06:02:54                                                                                          PAGE   11


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



  3301 HV CHANGED MORE THAN HVINS

  7185 MINIMUM SPECIFIC ENERGY
  3720 CRITICAL DEPTH ASSUMED

  3470 ENCROACHMENT STATIONS=     1769.0     2115.0  TYPE=     1  TARGET=      346.000
   ELENCL=   9999.90  ELENCR=    9999.90
     106.00      3.12  6127.92  6127.92       .00  6129.03      1.11      4.06       .13  6126.00
      4180.      136.     4042.       2.       30.      473.       2.       48.       12.   6127.50
        .14      4.53      8.54     1.24     .035      .025     .035      .000  6124.80  1781.04
    .006780      470.      470.     470.       11        11        0       .00   234.89  2015.92
0
 *SECNO 107.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      6150.00 ELREA=      6156.10

     107.00      2.95  6151.15  6151.15       .00  6152.10       .95      9.46       .02  6150.00
      4180.        8.     4172.       0.       3.      532.       0.       64.       20.   6156.10
        .19      2.50      7.84      .00     .035      .025     .035      .000  6148.20  1464.25
    .007417     1020.     1340.    1150.       20        11        0       .00   286.83  1751.08
0
 *SECNO 108.000

 3301 HV CHANGED MORE THAN HVINS

 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3470 ENCROACHMENT STATIONS=     1615.0     1914.0  TYPE=     1  TARGET=      299.000
  ELENCL=   9999.90  ELENCR=    9999.90
     108.00      3.65  6168.25  6168.25       .00  6169.76      1.51      7.28       .17  6175.50
      4180.        0.     4180.       0.       0.      424.       0.       75.       25.   6169.50
        .22       .00      9.87      .00     .035      .025     .035      .000  6164.60  1698.61
    .006487     1220.     1050.     890.       20        11        0       .00   142.34  1840.95
0
1
  01/04/91    06:02:54                                                                                          PAGE   12


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

*SECNO 109.000
3280 CROSS SECTION 109.00 EXTENDED .81 FEET

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS= 1968.0 2260.0 TYPE= 1 TARGET= 292.000
ELENCL= 9999.90 ELENCR= 9999.90

109.00	5.01	6187.61	6187.61	.00	6189.65	2.03	6.27	.16	6193.10
4180.	0.	4180.	0.	0.	365.	0.	85.	28.	9999.90
.24	.00	11.44	.00	.035	.025	.035	.000	6182.60	2130.95
.005941	1000.	1010.	1000.	20	11	0	.00	90.55	2221.50

0
*SECNO 110.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA= 6201.40 ELREA= 6199.80

110.00	4.58	6195.48	6195.48	.00	6197.27	1.79	5.40	.02	6201.40
4180.	0.	4180.	0.	0.	389.	0.	92.	30.	6199.80
.26	.00	10.75	.00	.035	.025	.035	.000	6190.90	1567.02
.006197	900.	890.	890.	2	11	0	.00	110.07	1677.09

0
1

THIS RUN EXECUTED 01/04/91 06:05:07

****
HEC2 RELEASE DATED NOV 76 UPDATED MAY 1984
ERROR CORR - 01,02,03,04,05,06
MODIFICATION - 50,51,52,53,54,55,56
IBM-PC-XT VERSION 1.1
****

T1 COLORADO SPRINGS, COLORADO
T2 SAND CREEK EAST FORK ZONE
T3 100 YEAR FLOOD

J1 ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
-10.	4.	0.	0.	1.000000	.00	.0	0.	.000	.000

J2 NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
3.000	.000	-1.000	.000	.000	.000	.000	.000	.000	.000

1

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

*PROF 3

```
CCHV=    .100 CEHV=    .300
*SECNO 18.000
2096 WSEL NOT GIVEN,AVG OF MAX,MIN USED
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=    1654.0    1864.0  TYPE=     1  TARGET=     210.000
 ELENCL=  9999.90  ELENCR=   9999.90
    18.00      5.11  6038.71  6038.71      .00  6040.93     2.23      .00      .00  6040.50
    5420.        0.    5420.       0.       0.     453.       0.       0.       0.  6040.00
      .00       .00    11.97      .00     .030     .025     .030     .000  6033.60  1743.93
  .005779     1110.    1100.    1070.        0       14        0      .00   103.23  1847.17
0
 CCHV=    .100 CEHV=    .300
 *SECNO 101.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
   101.00      5.33  6054.33  6054.33      .00  6056.62     2.30     7.48      .02  6057.50
    5420.        0.    5420.       0.       0.     446.       0.      13.       3.  6061.30
      .03       .00    12.16      .00     .050     .025     .030     .000  6049.00  2312.70
  .005723     1270.    1300.    1330.       20        8        0      .00    98.29  2410.99
0
 *SECNO 102.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3470 ENCROACHMENT STATIONS=    1909.0    2062.0  TYPE=     1  TARGET=     153.000
  ELENCL=  9999.90  ELENCR=   9999.90
   102.00      5.36  6069.86  6069.86      .00  6072.11     2.25     5.31      .00  6072.10
    5420.        0.    5420.       0.       0.     450.       0.      23.       5.  9999.90
      .05       .00    12.05      .00     .050     .025     .030     .000  6064.50  1944.84
  .005700      920.     930.     930.       20        5        0      .00   100.47  2045.31
0
 *SECNO 103.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
1
  01/04/91    06:02:54                                                                                      PAGE   15


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


   103.00      5.11  6085.11  6085.11      .00  6087.37     2.27     5.17      .00  6087.90
    5420.        0.    5420.       0.       0.     449.       0.      32.       7.  6090.20
      .07       .00    12.08      .00     .050     .025     .030     .000  6080.00  1950.04
  .005665      900.     910.     920.       20        8        0      .00    98.98  2049.02
0
 *SECNO 104.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
   104.00      5.38  6095.18  6095.18      .00  6097.42     2.24     3.59      .00  6098.50
    5420.        0.    5420.       0.       0.     452.       0.      39.       9.  6103.10
      .09       .00    12.00      .00     .050     .025     .030     .000  6089.80  1951.39
  .005748      640.     630.     630.       20        8        0      .00   102.09  2053.49
0
 CCHV=    .300 CEHV=    .500
 *SECNO 17550.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
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3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
      DOWNSTREAM 2-FOOT DROP STRUCTURE
 17550.00    6.42  6106.62  6106.62     .00  6109.31    2.69    4.24     .23  6112.00
   5330.       0.    5330.       0.      0.     405.      0.     44.     10.  6112.00
     .10      .00    13.17      .00    .035     .035    .035    .000 6100.20  1010.95
  .010920    550.     550.     550.      20       11       0     .00   76.10  1087.05
0
*SECNO 17600.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
 17600.00    6.29  6108.49  6108.49     .00  6111.10    2.61     .11     .03  6112.00
   5330.       0.    5330.       0.      0.     411.      0.     44.     10.  6112.00
     .10      .00    12.96      .00    .035     .035    .035    .000 6102.20  1008.60
  .011088     10.      10.      10.      20        5       0     .00   80.79  1089.40
0
*SECNO 17720.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
      DOWNSTREAM BRIDGE FACE
 17720.00    7.56  6111.76  6111.76     .00  6114.63    2.87    2.22     .13  6117.20
   5330.       0.    5330.       0.      0.     392.      0.     46.     10.  6118.70
     .10      .00    13.59      .00    .035     .035    .035    .000 6104.20  1013.16
  .011101    200.     200.     200.       2       11       0     .00   69.43  1082.59
0
1
 01/04/91    06:02:54                                                     PAGE   16


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



 SPECIAL BRIDGE

 SB  XK       XKOR     COFQ     RDLEN    BWC      BWP      BAREA     SS      ELCHU    ELCHD
     1.05     1.50     2.60      .00    34.75      .00   1150.00    1.50   6107.80  6104.20

 *SECNO 17880.000

 6070,LOW FLOW BY NORMAL BRIDGE

 EGPRS=     .000  EGLWC=  6118.229  ELLC=  6123.200  PCWSE=  6111.762  ELTRD=  6128.200

 3301 HV CHANGED MORE THAN HVINS


 3370 NORMAL BRIDGE,NRD=  4 MIN ELTRD= 6128.20 MAX ELLC= 6123.20

       UPSTREAM BRIDGE FACE
 17880.00    8.16  6115.96      .00     .00  6118.30    2.34    3.51     .16  6120.80
   5330.       0.    5330.       0.      0.     434.      0.     50.     11.  6122.30
     .11      .00    12.27      .00    .035     .035    .035    .000 6107.80  1012.26
  .008213    370.     370.     370.       3        0       0     .00   71.23  1083.49
0
*SECNO 18030.000
 18030.00    7.73  6117.53  6117.37     .00  6120.34    2.81    1.81     .23  6124.00
   5330.       0.    5330.       0.      0.     397.      0.     52.     11.  6124.00
     .12      .00    13.44      .00    .035     .035    .035    .000 6109.80  1012.75
  .009965    200.     200.     200.       4       11       0     .00   66.51  1079.25
0
*SECNO 18031.000
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3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
        UPSTREAM 4-FOOT DROP STRUCTURE
 18031.00     6.41  6120.21  6120.21      .00  6122.90     2.69      .10      .04  6124.00
    5330.       0.    5330.       0.       0.     405.       0.      52.      11.   6124.00
      .12      .00    13.15      .00     .035     .035     .035     .000  6113.80  1007.43
  .010917      10.      10.      10.       20       15        0      .00    76.40  1083.83
0
 CCHV=     .100 CEHV=     .300
 *SECNO 106.000
1
  01/04/91    06:02:54                                                                   PAGE   17


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



 3301 HV CHANGED MORE THAN HVINS

 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3470 ENCROACHMENT STATIONS=     1769.0     2115.0  TYPE=     1  TARGET=     346.000
   ELENCL=   9999.90  ELENCR=    9999.90
    106.00     3.51  6128.31  6128.31      .00  6129.61     1.29     3.88      .14  6126.00
     5330.     196.    5121.      13.      38.     553.       7.      57.      13.   6127.50
       .13     5.11     9.25     1.87     .035     .025     .035     .000  6124.80  1780.35
   .006451     470.     470.     470.       18       11        0      .00   243.88  2024.23
0
 *SECNO 107.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=     6150.00 ELREA=     6156.10

    107.00     3.32  6151.52  6151.52      .00  6152.59     1.07     9.06      .02  6150.00
     5330.      17.    5313.       0.       6.     639.       0.      76.      21.   6156.10
       .17     2.95     8.31      .00     .035     .025     .035     .000  6148.20  1462.41
   .007170    1020.    1340.    1150.       20       11        0      .00   308.62  1771.04
0
 *SECNO 108.000

 3301 HV CHANGED MORE THAN HVINS

 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3470 ENCROACHMENT STATIONS=     1615.0     1914.0  TYPE=     1  TARGET=     299.000
   ELENCL=   9999.90  ELENCR=    9999.90
    108.00     4.22  6168.82  6168.82      .00  6170.54     1.72     6.97      .20  6175.50
     5330.       0.    5330.       0.       0.     506.       0.      90.      27.   6169.50
       .20      .00    10.53      .00     .035     .025     .035     .000  6164.60  1696.84
   .006159    1220.    1050.     890.       20       11        0      .00   148.23  1845.07
0
1
  01/04/91    06:02:54                                                                   PAGE   18


    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
```

Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 109.000
3280 CROSS SECTION 109.00 EXTENDED 1.62 FEET

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS= 1968.0 2260.0 TYPE= 1 TARGET= 292.000
ELENCL= 9999.90 ELENCR= 9999.90

109.00	5.82	6188.42	6188.42	.00	6190.68	2.26	6.01	.16	6193.10
5330.	0.	5330.	0.	0.	442.	0.	101.	30.	9999.90
.23	.00	12.07	.00	.035	.025	.035	.000	6182.60	2128.85
.005758	1000.	1010.	1000.	20	11	0	.00	98.63	2227.48

0
*SECNO 110.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA= 6201.40 ELREA= 6199.80

110.00	5.24	6196.14	6196.14	.00	6198.20	2.05	5.20	.02	6201.40
5330.	0.	5330.	0.	0.	464.	0.	110.	32.	6199.80
.25	.00	11.50	.00	.035	.025	.035	.000	6190.90	1566.01
.005925	900.	890.	890.	8	11	0	.00	114.46	1680.47

0
1

THIS RUN EXECUTED 01/04/91 06:06:01

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HEC2 RELEASE DATED NOV 76 UPDATED MAY 1984
ERROR CORR - 01,02,03,04,05,06
MODIFICATION - 50,51,52,53,54,55,56
IBM-PC-XT VERSION 1.1
****

T1 COLORADO SPRINGS, COLORADO
T2 SAND CREEK EAST FORK ZONE
T3 500 YEAR FLOOD

J1 ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
-10.	5.	0.	0.	1.000000	.00	.0	0.	.000	.000

J2 NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
15.000	.000	-1.000	.000	.000	.000	.000	.000	.000	.000

1

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT

```
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN      SSTA
     SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST


 *PROF 4

 CCHV=    .100 CEHV=     .300
 *SECNO 18.000
 2096 WSEL NOT GIVEN,AVG OF MAX,MIN USED
 3720 CRITICAL DEPTH ASSUMED

 3470 ENCROACHMENT STATIONS=     1654.0     1864.0  TYPE=      1  TARGET=      210.000
  ELENCL=   9999.90  ELENCR=    9999.90
     18.00      6.61  6040.21  6040.21       .00  6043.01      2.80       .00       .00  6040.50
     8240.        0.    8240.       0.        0.     614.        0.        0.        0.  6040.00
       .00       .00    13.42      .80      .030      .025      .030      .000   6033.60  1739.80
   .005365     1110.    1100.    1070.         0        17         0       .00    113.45  1853.25
0
 CCHV=    .100 CEHV=     .300
 *SECNO 101.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
    101.00      6.89  6055.89  6055.89       .00  6058.76      2.87      6.96       .02  6057.50
     8240.        0.    8240.       0.        0.     606.        0.       18.        3.  6061.30
       .03       .00    13.60      .00      .050      .025      .030      .000   6049.00  2307.92
   .005335     1270.    1300.    1330.        20         8         0       .00    106.88  2414.81
0
 *SECNO 102.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3470 ENCROACHMENT STATIONS=     1909.0     2062.0  TYPE=      1  TARGET=      153.000
  ELENCL=   9999.90  ELENCR=    9999.90
    102.00      6.94  6071.44  6071.44       .00  6074.20      2.76      4.96       .01  6072.10
     8240.        0.    8240.       0.        0.     618.        0.       31.        6.  9999.90
       .05       .00    13.33      .00      .050      .025      .030      .000   6064.50  1937.21
   .005334      920.     930.     930.        20         5         0       .00    112.61  2049.82
0
 *SECNO 103.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
1
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     SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
     Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN      SSTA
     SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST


    103.00      6.64  6086.64  6086.64       .00  6089.52      2.88      4.83       .04  6087.90
     8240.        0.    8240.       0.        0.     605.        0.       44.        8.  6090.20
       .06       .00    13.62      .00      .050      .025      .030      .000   6080.00  1947.27
   .005275      900.     910.     920.        20         8         0       .00    105.04  2052.32
0
 *SECNO 104.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
    104.00      6.89  6096.69  6096.69       .00  6099.50      2.82      3.36       .01  6098.50
     8240.        0.    8240.       0.        0.     612.        0.       53.        9.  6103.10
       .08       .00    13.47      .00      .050      .025      .030      .000   6089.80  1947.59
```

```
  .003384     640.      650.      650.        20          8         0       .00   110.38  2037.78
0
 CCHV=    .300 CEHV=    .500
 *SECNO 17550.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
          DOWNSTREAM 2-FOOT DROP STRUCTURE
  17550.00     7.01  6107.21  6107.21       .00  6110.08      2.87      3.84       .03  6112.00
     6120.       0.     6120.       0.       0.      450.       0.       60.       11.   6112.00
       .09      .00    13.60      .00     .035      .035      .035      .000  6100.20  1009.75
   .010548     550.      550.     550.        20         5         0       .00    78.50  1088.25
0
 *SECNO 17600.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
  17600.00     6.86  6109.06  6109.06       .00  6111.83      2.77       .11       .03  6112.00
     6120.       0.     6120.       0.       0.      459.       0.       60.       11.   6112.00
       .09      .00    13.34      .00     .035      .035      .035      .000  6102.20  1007.19
   .010655      10.       10.      10.        20         8         0       .00    83.62  1090.81
0
 *SECNO 17720.000
 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
          DOWNSTREAM BRIDGE FACE
  17720.00     8.16  6112.36  6112.36       .00  6115.44      3.09      2.15       .16  6117.20
     6120.       0.     6120.       0.       0.      434.       0.       62.       11.   6118.70
       .09      .00    14.10      .00     .035      .035      .035      .000  6104.20  1012.27
   .010851     200.      200.     200.         3        11         0       .00    71.22  1083.48
0
1
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```
    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN      SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST


 SPECIAL BRIDGE

 SB  XK         XKOR       COFQ       RDLEN      BWC        BWP        BAREA      SS         ELCHU      ELCHD
      1.05       1.50       2.60        .00      34.75        .00    1150.00       1.50    6107.80    6104.20

 *SECNO 17880.000

 6070,LOW FLOW BY NORMAL BRIDGE

 EGPRS=     .000  EGLWC=  6119.043  ELLC=  6123.200  PCWSE=  6112.355  ELTRD=  6128.200

 3301 HV CHANGED MORE THAN HVINS


 3370 NORMAL BRIDGE,NRD=  4 MIN ELTRD= 6128.20 MAX ELLC= 6123.20

          UPSTREAM BRIDGE FACE
  17880.00     8.72  6116.52      .00       .00  6119.10      2.58      3.51       .15  6120.80
     6120.       0.     6120.       0.       0.      474.       0.       66.       12.   6122.30
       .10      .00    12.90      .00     .035      .035      .035      .000  6107.80  1011.43
   .008356     370.      370.     370.         3         0         0       .00    72.89  1084.32
0
 *SECNO 18030.000
  18030.00     8.31  6118.11  6118.00       .00  6121.18      3.07      1.83       .24  6124.00
```

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       .10       .00     14.06       .00      .035      .035      .035      .000  6109.80  1011.61
    .010088     200.      200.      200.         4        11         0       .00    68.77  1080.39
0
 *SECNO 18031.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
           UPSTREAM 4-FOOT DROP STRUCTURE
   18031.00     6.97   6120.77   6120.77       .00   6123.66      2.89       .10      .05  6124.00
      6120.       0.     6120.        0.        0.      449.        0.       68.      12.  6124.00
        .10      .00     13.64       .00      .035      .035      .035      .000  6113.80  1006.33
    .010678      10.       10.       10.        20        15         0       .00    78.72  1085.04
0
 CCHV=    .100 CEHV=     .300
 *SECNO 106.000
1
  01/04/91    06:02:54                                                                        PAGE   23


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



 3301 HV CHANGED MORE THAN HVINS

 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3470 ENCROACHMENT STATIONS=    1769.0    2115.0  TYPE=     1  TARGET=     346.000
  ELENCL=   9999.90  ELENCR=   9999.90
     106.00     3.77   6128.57   6128.57       .00   6129.97      1.41      3.77      .15  6126.00
      6120.     239.     5854.       27.       44.      606.       12.       74.      14.  6127.50
        .12     5.44      9.66      2.21      .035      .025      .035      .000  6124.80  1779.90
    .006238     470.      470.      470.        13        11         0       .00   249.73  2029.63
0
 *SECNO 107.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=     6150.00 ELREA=     6156.10

     107.00     3.54   6151.74   6151.74       .00   6152.89      1.15      8.86      .03  6150.00
      6120.      24.     6096.        0.        8.      706.        0.       95.      22.  6156.10
        .16     3.21      8.63       .00      .035      .025      .035      .000  6148.20  1461.32
    .007097    1020.     1340.     1150.        20        11         0       .00   320.71  1782.03
0
 *SECNO 108.000

 3301 HV CHANGED MORE THAN HVINS

 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3470 ENCROACHMENT STATIONS=    1615.0    1914.0  TYPE=     1  TARGET=     299.000
  ELENCL=   9999.90  ELENCR=   9999.90
     108.00     4.57   6169.17   6169.17       .00   6171.03      1.86      6.86      .21  6175.50
      6120.       0.     6120.        0.        0.      559.        0.      110.      28.  6169.50
        .19      .00     10.95       .00      .035      .025      .035      .000  6164.60  1695.74
    .006025    1220.     1050.      890.        20        11         0       .00   151.88  1847.62
0
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SECNO   DEPTH   CWSEL   CRIWS   WSELK   EG      HV      HL      OLOSS   BANK ELEV
Q       QLOB    QCH     QROB    ALOB    ACH     AROB    VOL     TWA   LEFT/RIGHT
TIME    VLOB    VCH     VROB    XNL     XNCH    XNR     WTN     ELMIN     SSTA
SLOPE   XLOBL   XLCH    XLOBR   ITRIAL  IDC     ICONT   CORAR   TOPWID    ENDST


*SECNO 109.000
3280 CROSS SECTION    109.00 EXTENDED     2.09 FEET


3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=    1968.0    2260.0  TYPE=     1  TARGET=     292.000
 ELENCL=   9999.90  ELENCR=    9999.90
   109.00      6.29  6188.89  6188.89      .00  6191.32     2.43     5.94      .17  6193.10
    6120.        0.    6120.       0.       0.     489.       0.     122.      31.  9999.90
      .21       .00    12.52      .00     .035     .025     .035     .000  6182.60  2127.63
  .005752     1000.    1010.    1000.       20       11        0      .00   103.34  2230.97
0
*SECNO 110.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=     6201.40 ELREA=     6199.80

   110.00      5.67  6196.57  6196.57      .00  6198.78     2.22     5.13      .02  6201.40
    6120.        0.    6120.       0.       0.     512.       0.     132.      33.  6199.80
      .23       .00    11.94      .00     .035     .025     .035     .000  6190.90  1565.37
  .005785      900.     890.     890.        4       11        0      .00   117.24  1682.60
0
```


THIS RUN EXECUTED 01/04/91 06:06:55

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**************************************************
 HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
 ERROR CORR -  01,02,03,04,05,06
 MODIFICATION -  50,51,52,53,54,55,56
 IBM-PC-XT VERSION 1.1
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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

EAST FORK SAND CREEK   F

SUMMARY PRINTOUT

	SECNO	CWSEL	DIFWSP	STENCL	SSTA	STCHL	TOPWID	STCHR	ENDST	STENCR
*	18.000	6036.30	.00	1654.00	1750.56	1739.00	89.45	1851.00	1840.02	1864.00
*	18.000	6037.99	1.69	1654.00	1745.90	1739.00	99.14	1851.00	1845.04	1864.00
*	18.000	6038.71	.72	1654.00	1743.93	1739.00	103.23	1851.00	1847.17	1864.00

*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
*	101.000	6051.82	.00	.00	2320.37	2303.00	84.51	2428.00	2404.88	.00
*	101.000	6053.58	1.76	.00	2315.00	2303.00	94.16	2428.00	2409.16	.00
*	101.000	6054.33	.75	.00	2312.70	2303.00	98.29	2428.00	2410.99	.00
*	101.000	6055.89	1.56	.00	2307.92	2303.00	106.88	2428.00	2414.81	.00
*	102.000	6067.32	.00	1909.00	1953.47	1934.00	84.59	2062.00	2038.06	2062.00
*	102.000	6069.08	1.76	1909.00	1948.59	1934.00	94.51	2062.00	2043.10	2062.00
*	102.000	6069.86	.77	1909.00	1944.84	1934.00	100.47	2062.00	2045.31	2062.00
*	102.000	6071.44	1.58	1909.00	1937.21	1934.00	112.61	2062.00	2049.82	2062.00
*	103.000	6082.70	.00	.00	1954.38	1945.00	89.45	2060.00	2043.82	.00
*	103.000	6084.38	1.68	.00	1951.34	1945.00	96.11	2060.00	2047.45	.00
*	103.000	6085.11	.73	.00	1950.04	1945.00	98.98	2060.00	2049.02	.00
*	103.000	6086.64	1.53	.00	1947.27	1945.00	105.04	2060.00	2052.32	.00
*	104.000	6092.76	.00	.00	1957.52	1943.00	88.77	2077.00	2046.29	.00
*	104.000	6094.45	1.69	.00	1953.25	1943.00	98.06	2077.00	2051.31	.00
*	104.000	6095.18	.73	.00	1951.39	1943.00	102.09	2077.00	2053.49	.00
*	104.000	6096.69	1.51	.00	1947.58	1943.00	110.38	2077.00	2057.96	.00
*	17550.000	6103.63	.00	.00	1017.03	1000.00	63.95	1098.00	1080.97	.00
*	17550.000	6105.73	2.11	.00	1012.74	1000.00	72.51	1098.00	1085.26	.00
*	17550.000	6106.62	.88	.00	1010.95	1000.00	76.10	1098.00	1087.05	.00
*	17550.000	6107.21	.59	.00	1009.75	1000.00	78.50	1098.00	1088.25	.00
*	17600.000	6105.58	.00	.00	1015.72	1000.00	66.56	1098.00	1082.28	.00
*	17600.000	6107.64	2.06	.00	1010.68	1000.00	76.63	1098.00	1087.32	.00
*	17600.000	6108.49	.85	.00	1008.60	1000.00	80.79	1098.00	1089.40	.00
*	17600.000	6109.06	.58	.00	1007.19	1000.00	83.62	1098.00	1090.81	.00

	SECNO	CWSEL	DIFWSP	STENCL	SSTA	STCHL	TOPWID	STCHR	ENDST	STENCR
*	17720.000	6108.64	.00	.00	1017.83	1000.00	60.08	1098.00	1077.92	.00
*	17720.000	6110.83	2.19	.00	1014.55	1000.00	66.64	1098.00	1081.20	.00
*	17720.000	6111.76	.93	.00	1013.16	1000.00	69.43	1098.00	1082.59	.00
*	17720.000	6112.36	.59	.00	1012.27	1000.00	71.22	1098.00	1083.48	.00
	17880.000	6112.88	.00	.00	1016.89	1000.00	61.98	1098.00	1078.86	.00
	17880.000	6115.07	2.19	.00	1013.60	1000.00	68.55	1098.00	1082.15	.00
	17880.000	6115.96	.90	.00	1012.26	1000.00	71.23	1098.00	1083.49	.00
	17880.000	6116.52	.56	.00	1011.43	1000.00	72.89	1098.00	1084.32	.00
	18030.000	6114.36	.00	.00	1019.01	1000.00	53.99	1092.00	1072.99	.00
	18030.000	6116.61	2.25	.00	1014.56	1000.00	62.89	1092.00	1077.44	.00
	18030.000	6117.53	.92	.00	1012.75	1000.00	66.51	1092.00	1079.25	.00
	18030.000	6118.11	.57	.00	1011.61	1000.00	68.77	1092.00	1080.39	.00
*	18031.000	6117.22	.00	.00	1013.30	1000.00	64.07	1092.00	1077.37	.00
*	18031.000	6119.32	2.11	.00	1009.17	1000.00	72.74	1092.00	1081.91	.00
*	18031.000	6120.21	.89	.00	1007.43	1000.00	76.40	1092.00	1083.83	.00
*	18031.000	6120.77	.56	.00	1006.33	1000.00	78.72	1092.00	1085.04	.00
*	106.000	6126.96	.00	1769.00	1782.72	1802.00	208.95	2007.00	1991.66	2115.00
*	106.000	6127.92	.96	1769.00	1781.04	1802.00	234.89	2007.00	2015.92	2115.00
*	106.000	6128.31	.39	1769.00	1780.35	1802.00	243.88	2007.00	2024.23	2115.00
*	106.000	6128.57	.26	1769.00	1779.90	1802.00	249.73	2007.00	2029.63	2115.00
*	107.000	6150.25	.00	.00	1468.77	1470.00	236.41	1952.00	1705.18	.00
*	107.000	6151.15	.91	.00	1464.25	1470.00	286.83	1952.00	1751.08	.00
*	107.000	6151.52	.37	.00	[illegible]	1470.00	[illegible]	1952.00	1771.04	.00

*	107.000	6151.74	.22	.00	1461.32	1470.00	320.71	1952.00	1782.03	.00
*	108.000	6166.95	.00	1615.00	1702.68	1676.00	128.79	1850.00	1831.48	1914.00
*	108.000	6168.25	1.31	1615.00	1698.61	1676.00	142.34	1850.00	1840.95	1914.00
*	108.000	6168.82	.57	1615.00	1696.84	1676.00	148.23	1850.00	1845.07	1914.00
*	108.000	6169.17	.35	1615.00	1695.74	1676.00	151.88	1850.00	1847.62	1914.00
*	109.000	6185.63	.00	1968.00	2136.11	1999.00	73.94	2260.00	2210.05	2260.00
*	109.000	6187.61	1.98	1968.00	2130.95	1999.00	90.55	2260.00	2221.50	2260.00
*	109.000	6188.42	.81	1968.00	2128.85	1999.00	98.63	2260.00	2227.48	2260.00
*	109.000	6188.89	.47	1968.00	2127.63	1999.00	103.34	2260.00	2230.97	2260.00
*	110.000	6193.93	.00	.00	1569.39	1558.00	99.84	1699.00	1669.23	.00
*	110.000	6195.48	1.55	.00	1567.02	1558.00	110.07	1699.00	1677.09	.00
*	110.000	6196.14	.67	.00	1566.01	1558.00	114.46	1699.00	1680.47	.00
*	110.000	6196.57	.42	.00	1565.37	1558.00	117.24	1699.00	1682.60	.00

SUMMARY OF ERRORS AND SPECIAL NOTES

CAUTION SECNO= 18.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 18.000 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 18.000 PROFILE= 3 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 18.000 PROFILE= 4 CRITICAL DEPTH ASSUMED

CAUTION SECNO= 101.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 101.000 PROFILE= 1 MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 101.000 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 101.000 PROFILE= 2 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 101.000 PROFILE= 2 20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO= 101.000 PROFILE= 3 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 101.000 PROFILE= 3 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 101.000 PROFILE= 3 20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO= 101.000 PROFILE= 4 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 101.000 PROFILE= 4 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 101.000 PROFILE= 4 20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO= 102.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 102.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 102.000 PROFILE= 1 20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO= 102.000 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 102.000 PROFILE= 2 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 102.000 PROFILE= 2 20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO= 102.000 PROFILE= 3 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 102.000 PROFILE= 3 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 102.000 PROFILE= 3 20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO= 102.000 PROFILE= 4 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 102.000 PROFILE= 4 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 102.000 PROFILE= 4 20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO= 103.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 103.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 103.000 PROFILE= 1 20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO= 103.000 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 103.000 PROFILE= 2 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 103.000 PROFILE= 2 20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO= 103.000 PROFILE= 3 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 103.000 PROFILE= 3 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 103.000 PROFILE= 3 20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO= 103.000 PROFILE= 4 CRITICAL DEPTH ASSUMED

APPENDIX B

HEC-2 Computer Output (Final Design)

```
C
C      6
C  10502 DOWNSTREAM 2.6 FT DROP STRUCTURE
C  10503 UPSTREAM 2.6 FT DROP STRUCTURE
C  10505 DOWNSTREAM BRIDGE FACE
C  10506 UPSTREAM BRIDGE FACE
C  10508 DOWNSTREAM 3.9 FT DROP STRUCTURE
C  10509 UPSTREAM 3.9 FT DROP STRUCTURE
T1       FINAL ANALYSIS.      98' CLEAR SPAN     W/ 2 DROPS
T2       100-YR  FLOW   KIOWA ENGINEERING CORPORATION  10/91
T3       EAST FORK SAND CREEK   FILE NAME:EFSF.DAT      (91.08.18)
J1    -10       4.       0.       0.       1.       0.       0.       0.
J2      1       0.      -1.
J3     38       43       1        3        8       26        4       23       24       42
NC   .030     .030    .025       .1       .3
QT    5.0   1980.0  4250.0   5420.0   8240.0   5420.0
X1   18.0       23  1739.0   1651.0
X3                           1654.0   9999.9   1864.0   9999.9
GR6052.2   1000.0  6051.8   1050.0   6051.1   1077.0   6048.0   1121.0   6048.1   1184.0
GR6047.2   1239.0  6046.0   1286.0   6044.8   1296.0   6043.9   1427.0   6042.9   1510.0
GR6042.5   1563.0  6042.1   1624.0   6042.2   1654.0   6041.8   1694.0   6040.5   1739.0
GR6033.6   1758.0  6033.6   1832.0   6040.0   1851.0   6041.2   1864.0   6040.0   1941.0
GR6050.8   1968.0  6049.8   1985.0   6050.4   2001.0
NC    .05      .03    .025       .1       .3
X1  101.0       33  2303.0   2428.0   1270.0   1330.0   1300.0
GR6064.8   1000.0  6064.1   1126.0   6064.5   1200.0   6063.5   1252.0   6063.8   1286.0
GR6064.7   1293.0  6064.2   1329.0   6065.0   1351.0   6067.0   1365.0   6064.2   1399.0
GR6065.3   1421.0  6064.4   1466.0   6062.8   1494.0   6063.8   1526.0   6062.8   1576.0
GR6062.2   1608.0  6061.7   1614.0   6062.0   1664.0   6061.7   1708.0   6060.1   1757.0
GR6060.8   1846.0  6060.3   1911.0   6060.2   1962.0   6059.2   2090.0   6059.1   2162.0
GR6057.6   2228.0  6057.3   2289.0   6057.5   2303.0   6049.0   2329.0   6049.0   2398.0
GR6061.3   2428.0  6073.7   2462.0   6072.8   2500.0
X1  102.0       60  1934.0   2062.0    920.0    930.0    930.0
X3                           1909.0   9999.9   2062.0   9999.9
GR6073.4   1000.0  6072.4   1014.0   6071.5   1073.0   6072.2   1082.0   6073.1   1131.0
GR6072.4   1156.0  6073.5   1175.0   6072.3   1216.0   6070.7   1280.0   6073.0   1313.0
GR6074.2   1344.0  6073.7   1379.0   6073.2   1419.0   6072.7   1422.0   6072.5   1458.0
GR6073.6   1462.0  6075.1   1474.0   6076.3   1489.0   6076.9   1505.0   6074.0   1543.0
GR6073.5   1558.0  6071.1   1572.0   6067.4   1579.0   6071.4   1587.0   6075.0   1596.0
GR6073.5   1615.0  6073.1   1636.0   6074.3   1665.0   6073.4   1695.0   6073.3   1696.0
GR6073.5   1730.0  6075.9   1761.0   6077.5   1772.0   6075.2   1795.0   6073.8   1821.0
GR6073.7   1874.0  6074.7   1889.0   6072.9   1901.0   6076.2   1909.0   6072.3   1918.0
GR6072.1   1934.0  6069.0   1949.0   6064.5   1961.0   6064.5   2030.0   6075.7   2062.0
GR6076.9   2095.0  6077.8   2111.0   6077.3   2117.0   6078.7   2133.0   6081.1   2194.0
GR6083.6   2255.0  6084.9   2302.0   6086.2   2375.0   6086.8   2430.0   6087.9   2510.0
GR6088.8   2626.0  6089.6   2697.0   6090.3   2786.0   6091.4   2870.0   6094.2   3000.0
X1  103.0       51  1945.0   2060.0    900.0    920.0    910.0
GR6095.7   1000.0  6096.5   1042.0   6094.4   1085.0   6094.0   1115.0   6093.8   1154.0
GR6092.2   1202.0  6092.2   1257.0   6091.7   1283.0   6092.0   1321.0   6092.1   1336.0
GR6094.2   1355.0  6092.9   1371.0   6092.0   1453.0   6092.0   1480.0   6091.8   1520.0
GR6090.0   1546.0  6089.4   1553.0   6089.9   1571.0   6089.5   1585.0   6091.0   1618.0
GR6090.6   1665.0  6092.4   1695.0   6091.0   1731.0   6089.1   1747.0   6090.9   1803.0
GR6089.1   1833.0  6088.2   1862.0   6088.1   1906.0   6087.9   1945.0   6081.8   1956.0
GR6080.0   1965.0  6080.0   2038.0   6090.2   2060.0   6089.5   2078.0   6091.3   2096.0
GR6090.5   2153.0  6091.1   2192.0   6089.5   2207.0   6090.7   2258.0   6090.1   2300.0
GR6090.9   2326.0  6091.3   2383.0   6092.2   2432.0   6092.7   2462.0   6092.7   2524.0
GR6092.1   2612.0  6092.8   2675.0   6093.4   2747.0   6094.1   2822.0   6094.4   2897.0
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X1 104.0      37  1943.0  2077.0   640.0   630.0   630.0
GR6108.8  1000.0  6108.2  1088.0  6107.5  1203.0  6107.5  1302.0  6106.7  1371.0
GR6104.7  1441.0  6103.3  1464.0  6101.6  1481.0  6101.4  1544.0  6100.5  1626.0
GR6102.3  1637.0  6103.2  1660.0  6104.7  1693.0  6106.3  1706.0  6103.0  1717.0
GR6100.8  1762.0  6100.0  1796.0  6102.7  1809.0  6099.9  1819.0  6097.9  1836.0
GR6098.3  1880.0  6098.0  1935.0  6098.5  1943.0  6089.8  1965.0  6090.3  2039.0
GR6103.1  2077.0  6101.5  2186.0  6101.1  2281.0  6100.4  2391.0  6098.1  2560.0
GR6098.7  2669.0  6099.8  2735.0  6100.9  2770.0  6102.1  2784.0  6099.4  2873.0
GR6103.4  2904.0  6104.4  3000.0
QT    5.  1940.0  4180.0  5330.0  6120.0  5330.0
NC  .035    .035    .035      .3      .5
X1 10501       6       0     131     380     380     380
GR  6108       0  6102.0      20  6098.4      40  6098.4      60    6100      74
GR  6112     131
X1 10502       4       0    95.4     135     135     135
GR6109.7       0  6099.6    20.2  6099.6    75.2  6109.7    95.4
X1 10503       4       0    86.4      20      20      20
GR6111.5       0  6102.4    18.2  6102.4    68.2  6111.5    86.4
X1 10504       4       0      79     185     185     185
GR6115.2       0  6104.2    22.0  6104.2    57.0  6115.2      79
X1 10505       8       0     137     105     105     105
X3    10
GR6126.3       0  6118.2      15  6118.2      24  6105.3    49.8  6105.3    84.8
GR6119.5   113.2  6119.5   122.2  6128.4     137
SB  1.05     1.5     2.6       0      35       0    1080     2.0  6106.5  6105.3
X1 10506       8       0     137     136     136     136
X2     0       0       1  6122.5  6126.5
X3    10
BT     4       0  6126.5  6126.5      15  6126.5  6120.4   119.6  6129.0  6122.5
BT   137  6129.1  6129.1
GR6126.5       0  6118.3      15  6118.3      24  6106.5    47.6  6106.5    82.6
GR6120.5   110.6  6120.5   119.6  6129.1     137
X1 10507       4       0      79     133     133     133
GR  6119       0  6108.0    22.0  6108.0    57.0    6119      79
X1 10508       4       0   100.4     200     200     200
GR6122.6       0  6110.0    25.2  6110.0    75.2  6122.6  100.40
X1 10509       4       0    90.6      20      20      20
GR6123.0       0  6114.1    17.8  6114.1    72.8  6123.0    90.6
X1 10591       9       0     178     128     128     128
GR6124.4       0  6124.0      10  6118.0      22  6116.0      55  6114.5      65
GR  6116      78    6122     105    6124     136    6125     178
X1 106.0      40  1802.0  2007.0     360     360     360
X3                        1769.0  9999.9  2115.0  9999.9
GR6128.7  1000.0  6129.7  1090.0  6130.5  1147.0  6130.7  1218.0  6131.0  1326.0
GR6131.6  1416.0  6134.2  1554.0  6132.2  1641.0  6133.6  1734.0  6134.8  1769.0
GR6126.8  1783.0  6126.0  1802.0  6124.8  1809.0  6125.4  1855.0  6125.2  1900.0
GR6125.6  1953.0  6127.5  2007.0  6132.6  2115.0  6131.6  2127.0  6130.8  2153.0
GR6129.4  2201.0  6129.8  2223.0  6130.9  2267.0  6137.7  2330.0  6138.3  2363.0
GR6140.2  2370.0  6138.9  2388.0  6140.9  2398.0  6141.0  2412.0  6140.3  2429.0
GR6141.2  2442.0  6140.8  2480.0  6145.4  2596.0  6148.4  2669.0  6152.4  2742.0
GR6156.8  2819.0  6159.6  2902.0  6160.6  2975.0  6158.0  2989.0  6158.5  3000.0
X1 107.0      35  1470.0  1952.0  1020.0  1150.0  1340.0
X3    10
GR6160.0  1000.0  6158.0  1150.0  6156.0  1260.0  6154.0  1440.0  6152.0  1460.0
GR6150.0  1470.0  6148.2  1514.0  6148.5  1575.0  6148.9  1620.0  6149.6  1674.0
GR6150.8  1732.0  6151.7  1781.0  6153.5  1833.0  6154.9  1878.0  6155.2  1920.0
GR6156.1  1952.0  6156.4  1991.0  6156.8  2029.0  6157.3  2054.0  6157.9  2083.0
GR6159.5  2108.0  6164.6  2134.0  6162.6  2160.0  6160.8  2209.0  6160.8  2261.0
GR6161.3  2322.0  6162.2  2375.0  6162.8  2459.0  6163.9  2538.0  6154.8  2609.0
GR6165.6  2675.0  6166.2  2740.0  6167.1  2848.0  6168.5  2958.0  6168.9  3000.0
X1 108.0      45  1676.0  1350.0  1220.0   890.0  1050.0
X3                        1615.0  9999.9  1914.0  9999.9
GR6174.4  1000.0  6173.8  1089.0  6173.0  1212.0  6173.4  1331.0  6173.4  1400.0
GR6173.6  1468.0  6174.4  1523.0  6174.9  1553.0  6174.7  1577.0  6178.0  1604.0
GR6178.9  1615.0  6178.4  1625.0  6175.6  1659.0  6175.5  1676.0  6164.6  1710.0
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GR6179.0  1914.0  6178.3  1923.0  6174.7  1969.0  6172.4  1993.0  6172.9  2010.0
GR6171.9  2036.0  6168.9  2057.0  6169.4  2070.0  6170.3  2087.0  6168.5  2110.0
GR6169.5  2121.0  6168.9  2159.0  6168.1  2240.0  6167.9  2298.0  6168.8  2334.0
GR6168.1  2344.0  6169.6  2353.0  6169.5  2369.0  6168.8  2379.0  6168.9  2420.0
GR6170.0  2439.0  6170.6  2456.0  6168.4  2471.0  6169.4  2483.0  6169.8  2500.0
X1 109.0      50  1999.0  2260.0  1000.0  1000.0  1010.0
X3                        1968.0  9999.9  2260.0  9999.9
GR6189.4  1000.0  6187.3  1116.0  6186.9  1186.0  6187.3  1219.0  6189.7  1252.0
GR6188.6  1270.0  6188.4  1336.0  6187.7  1374.0  6188.1  1392.0  6188.0  1402.0
GR6189.2  1433.0  6186.8  1467.0  6184.6  1523.0  6185.6  1581.0  6187.2  1656.0
GR6187.7  1713.0  6188.3  1771.0  6188.9  1812.0  6189.8  1843.0  6194.4  1940.0
GR6195.9  1958.0  6196.0  1968.0  6195.9  1977.0  6193.1  1999.0  6190.0  2022.0
GR6189.5  2085.0  6189.5  2115.0  6189.9  2125.0  6182.6  2144.0  6182.6  2205.0
GR6186.2  2211.0  6192.8  2260.0  6192.8  2274.0  6187.2  2332.0  6181.2  2386.0
GR6181.7  2409.0  6181.2  2420.0  6182.6  2429.0  6181.2  2445.0  6181.0  2556.0
GR6181.1  2701.0  6183.7  2816.0  6184.7  2889.0  6184.2  2921.0  6184.6  2945.0
GR6183.6  2960.0  6186.5  2979.0  6186.7  2986.0  6186.8  2994.0  6186.8  3000.0
X1 110.0      55  1558.0  1699.0   900.0   890.0   890.0
X3    10
GR6201.2  1000.0  6201.7  1054.0  6201.4  1084.0  6203.5  1125.0  6203.4  1154.0
GR6203.2  1168.0  6201.4  1183.0  6201.4  1196.0  6203.4  1211.0  6202.8  1230.0
GR6202.7  1252.0  6201.8  1271.0  6201.8  1281.0  6203.8  1299.0  6202.4  1311.0
GR6201.6  1323.0  6201.5  1334.0  6202.8  1358.0  6200.9  1376.0  6201.7  1386.0
GR6201.5  1396.0  6202.3  1406.0  6205.0  1432.0  6208.2  1457.0  6208.6  1478.0
GR6208.4  1501.0  6206.3  1526.0  6201.4  1558.0  6190.9  1574.0  6190.9  1590.0
GR6190.9  1607.0  6191.6  1620.0  6192.1  1647.0  6192.7  1663.0  6199.8  1699.0
GR6204.9  1734.0  6206.1  1755.0  6206.1  1768.0  6203.0  1818.0  6203.3  1878.0
GR6203.7  1947.0  6204.6  2009.0  6205.6  2055.0  6205.1  2112.0  6203.5  2248.0
GR6202.5  2324.0  6203.4  2363.0  6203.3  2393.0  6202.4  2419.0  6203.1  2447.0
GR6202.9  2454.0  6202.1  2460.0  6204.9  2477.0  6205.0  2487.0  6205.1  2500.0
EJ


ER
T1        COLORADO SPRINGS, COLORADO
T2        SAND CREEK EAST FORK ZONE
T3        10 YEAR FLOOD
J1   -10        2                         1
J2     2                -1
T1        COLORADO SPRINGS, COLORADO
T2        SAND CREEK EAST FORK ZONE
T3         50 YEAR FLOOD
J1   -10        3                         1
J2     3                -1
T1        COLORADO SPRINGS, COLORADO
T2        SAND CREEK EAST FORK ZONE
T3        500 YEAR FLOOD
J1   -10        5                         1
J2    15                -1


ER
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1*****************************************************          **************************************
*  WATER SURFACE PROFILES                             *          *  U.S. ARMY CORPS OF ENGINEERS       *
*  VERSION OF SEPTEMBER 1988                          *          *  THE HYDROLOGIC ENGINEERING CENTER  *
*  ERROR: 01,02                                       *          *  609 SECOND STREET, SUITE D         *
*  UPDATED:  4 APRIL    1989                          *          *  DAVIS, CALIFORNIA 95616-4687       *
*  RUN DATE    12/ 8/91   TIME   15:23: 3             *          *  (916) 756-1104, (916) 551-1748     *
*****************************************************          **************************************


                                  X     X  XXXXXXX   XXXXX            XXXXX
                                  X     X  X        X     X          X     X
                                  X     X  X        X                      X
                                  XXXXXXX  XXXX     X         XXXXX   XXXXX
                                  X     X  X        X                X
                                  X     X  X        X     X          X
                                  X     X  XXXXXXX   XXXXX           XXXXXXX
END OF BANNER
1
    12/ 8/91      15:23: 4                                                                      PAGE    1


                                                                    THIS RUN EXECUTED 12/ 8/91    15:23: 4
 ****************************************************
  HEC2 RELEASE DATED SEP 88 UPDATED APR  1989


  ERROR CORR -  01,02
  MODIFICATION -
 ****************************************************


 T1      FINAL ANALYSIS.      98' CLEAR SPAN     W/ 2 DROPS
 T2      100-YR  FLOW   KIOWA ENGINEERING CORPORATION  10/91
 T3      EAST FORK SAND CREEK   FILE NAME:EFSF.DAT      (91.08.18)

 J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

      -10       4.        0.        0.        1.        0.        0.        0.

 J2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

       1        0.        -1.


 J3  VARIABLE CODES FOR SUMMARY PRINTOUT

      38        43         1         3         8        26         4        33        24        42
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  SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS   BANK ELEV
  Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA   LEFT/RIGHT
  TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN     SSTA
  SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID    ENDST


*PROF 1

CCHV=     .100 CEHV=     .300
*SECNO 18.000
2096 WSEL NOT GIVEN, AVG OF MAX, MIN USED
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=     1654.0    1564.0  TYPE=     1  TARGET=      210.000
 ELENCL=   9999.90  ELENCR=   9999.90
    18.00      5.11  6038.71  6038.71      .00  6040.93     2.22      .00      .00  6040.50
    5420.        0    5420.       0.       0.     453.       0.       0.       0.  6040.00
      .00      .00    11.96      .00     .000     .025     .000     .000  6033.60  1743.92
   .005762        0        0       0.        0       38        0      .00   103.26  1847.18
0
CCHV=     .100 CEHV=     .300
*SECNO 101.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
   101.00      5.33  6054.33  6054.33      .00  6056.62     2.30     7.47      .02  6057.50
    5420.       0.    5420.       0.       0.     446.       0.      13.       3.  6061.30
      .03      .00    12.16      .00     .000     .025     .000     .000  6049.00  2312.70
   .005723    1270.    1300.    1330.       20        8        0      .00    98.29  2410.99
0
*SECNO 102.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=     1409.0    2062.0  TYPE=     1  TARGET=      153.000
 ELENCL=   9999.90  ELENCR=   9999.90
   102.00      5.36  6069.86  6069.86      .00  6072.11     2.25     5.31      .00  6072.10
    5420.        0    5420       0.       0.     450.       0.      23.       5.  9999.90
      .05      .00    12.05      .00     .000     .025     .000     .000  6064.50  1944.84
   .005700     920      930      930       20        5        0      .00   100.47  2045.31
0
*SECNO 103.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
1
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  SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS   BANK ELEV
  Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA   LEFT/RIGHT
  TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN     SSTA
  SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID    ENDST


   103.00      5.11  6085.11  6085.11      .00  6087.37     2.27     5.17      .00  6087.90
    5420.        0    5420.       0.       0.     449.       0.      32       7.  6090.20
      .07      .00    12.08      .00     .000     .025     .000     .000  6080.00  1950.04
   .005665     900     910.     920.       20        3        0      .00    98.98  2049.02
0
*SECNO 104.000
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3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
   104.00      5.38  6095.18  6095.18      .00  6097.42     2.24     3.59      .00  6098.50
    5420.        0.    5420.       0.       0.     452.       0.      39.       9.  6103.10
      .09       .00    12.00      .00     .000     .025     .000     .000  6089.80  1951.39
  .005748      610.     630.     630.       20        8        0      .00   102.09  2053.49
0
 CCHV=      .300 CEHV=      .500
*SECNO  10501.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
 10501.00      7.13  6105.53  6105.53      .00  6107.90     2.37     2.94      .07  6108.00
    5330.        0.    5330.       0.       0.     431.       0.      43.      10.  6112.00
      .10       .00    12.36      .00     .000     .035     .000     .000  6098.40     8.23
  .011040      380.     380.     380.       20       11        0      .00    92.04   100.27
0
*SECNO  10502.000

3301 HV CHANGED MORE THAN HVINS


3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.67


         DOWNSTREAM 2.6 FT DROP STRUCTURE
 10502.00      8.15  6107.75      .00      .00  6109.06     1.31      .84      .32  6109.70
    5330.        0.    5330.       0.       0      581       0.      44.      10.  6109.70
       10       .00     9.17      .00     .000     .035      000     .000  6099.60     3.90
  .003964      135.     135.     135.        3        0        0      .00    87.60    91.50
0
*SECNO  10503.000
1
   12/ 8/91      15:23: 4                                                                    PAGE    4


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



3301 HV CHANGED MORE THAN HVINS


3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
         UPSTREAM 2.6 FT DROP STRUCTURE
 10503.00      5.43  6108.83  6108.83      .00  6111.53     2.70      .12      .70  6111.50
    5330.        0.    5330.       0.       0.     404.       0.      45.      10.  6111.50
       10        00    13.20      .00     .000     .035     .000     .000  6102.40     5.35
  .010971       20.      20.      20.       20       15        0      .00    75.70    81.05
0
*SECNO  10504.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
 10504.00      7.65  6111.85  6111.85      .00  6114.83     2.98     2.01      .14  6115.20
    5330.        0.    5330.       0.       0.     385.       0.      46.      10.  6115.20
       10       .00    13.85      .00     .000     .035     .000     .000  6104.20     6.70
  .010801       185     185.     185.        2       11        0      .00    65.60    72.30
0
*SECNO  10505.000

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA=      6126.30 ELREA=      6128.40
```

```
 10505.00     8.17  6113.47      .00      .00  6115.97     2.51     1.00      .14  6126.30
    5330.       0.    5330.       0.       0.     420.       0.      47.      10.  6128.40
      .11      .00    12.70      .00     .000     .035     .000     .000  6105.30    33.46
  .008466     105.     105.     105.        8        0        0      .00    67.68   101.14
0

SPECIAL BRIDGE

SB  XK       XKOR      COFQ      RDLEN     BWC       BWP      BAREA      SS      ELCHU     ELCHD
    1.05     1.50      2.60        .00     35.00       .00   1030.00    2.00   6106.50   6105.30

*SECNO  10506.000
1
  12/ 8/91      15:23: 4                                                                          PAGE    5


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



6070,LOW FLOW BY NORMAL BRIDGE

EGPRS=       .000  EGLWC=   6117.176  ELLC=   6122.500  PCWSE=   6113.465  ELTRD=   6126.500

3370 NORMAL BRIDGE, NRD=   4 MIN ELTRD=  6126.50 MAX ELLC=  6122.50


3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA=      6126.50 ELREA=      6129.10

           UPSTREAM BRIDGE FACE
 10506.00     8.11  6114.61      .00      .00  6117.17     2.56     1.17      .03  6126.50
    5330.       0.    5330.       0.       0.     415.       0.      48.      11.  6129.10
      .11      .00    12.84      .00     .000     .035     .000     .000  6106.50    31.39
  .008719      136      136.     136.        2        0        0      .00    67.43    98.81
0
*SECNO  10507.000
 10507.00     7.69  6115.69  6115.66      .00  6118.63     2.93     1.27      .19  6119.00
    5330.       0.    5330.       0.       0.     388.       0       50       11.  6119.00
      .11      .00    13.75      .00     .000     .035     .000     .000  6108.00     6.61
  .010578     133.     133.     133.        4       11        0      .00    65.78    72.39
0
*SECNO  10508.000

3301 HV CHANGED MORE THAN HVINS


3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.82

           DOWNSTREAM 3.9 FT DROP STRUCTURE
 10508.00     9.07  6119.07      .00      .00  6120.23     1.16     1.06      .53  6122.60
    5330.       0.    5330.       0.       0.     618.       0.      52.      11.  6122.60
      .12      .00     8.63      .00     .000     .035     .000     .000  6110.00     7.07
  .003194     200.     200.     200.        3        0        0      .00    86.26    93.33
0
*SECNO  10509.000

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
1
  12/ 8/91      15:23: 4                                                                          PAGE    6
```

```
   SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS   BANK ELEV
   Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA   LEFT/RIGHT
   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
         UPSTREAM 3 9 FT DROP STRUCTURE
  10509.00     6.11  6120.21  6120.21      .00  6122.83     2.61      .11      .73  6123.00
     5330.       0.    5330.       0.       0.     411.       0.      52.      11.  6123.00
      .12      .00    12.98      .00     .000     .035     .000     .000  6114.10     5.58
   .010953      20.      20.      20.      20       14        0      .00    79.44    35.02
0
 *SECNO  10591.000
 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
  10591.00     7.69  6122.19  6122.19      .00  6124.52     2.33     1.42      .08  6124.40
     5330.       0.    5330.       0.       0.     435.       0.      53       11.  6125.00
      .12      .00    12.26      .00     .000     .035     .000     .000  6114.50    13.62
   .011166     128.     128      128        2       11        0      .00    94.29   107.91
0
 *SECNO 106.000

 3301 HV CHANGED MORE THAN HVINS

 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3470 ENCROACHMENT STATIONS=     1769.0    2115.0  TYPE=       1  TARGET=       346.000
  ELENCL=   9999.90  ELENCR=   9999.90
    106.00     3.50  6128.30  6128.30      .00  6129.57     1.28     4.26      .32  6126.00
     5330.     269.    5044.      17.      38.     550.       7.      58.      13.  6127.50
      .13     7.09     9.17     2.57     .035     .035     .035     .000  6124.80  1780.38
   .012535     360.     360.      360        4       14        0      .00   343.47  2023.35
0
 *SECNO 107.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA=      6150.00 ELREA=      6156.10

    107.00     3.31  6151.52  6151.52      .00  6152.58     1.07    17.65      .06  6150.00
     5330.      24.    5306.       0.       6.     639.       0.      77.      21.  6156.10
      .18     4.13     8.31      .00     .035     .035     .000     .000  6148.20  1462.42
   .014054    1020.     1340    1150.       20       11        0      .00   308.50  1770.93
0
1
```



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


 *SECNO 108.000

 3301 HV CHANGED MORE THAN HVINS

 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
```

```
 ELENCL=   9999.90  ELENCR=   9999.90
   108.00      4.71  6168.81  6168.81       .00  6170.54     1.73    13.71       .33  6175.50
    5330.        0.    5330.       0.        0.     505.       0.      90.       27.   6169.50
      .20       .00    10.56      .00      .000     .035     .000     .000  6164.60  1696.86
   .012150    1220.    1050.     890.         4       11        0      .00   148.15  1845.01
0
 *SECNO 109.000
 3260 CROSS SECTION    109.00 EXTENDED      1.62 FEET


 3301 HV CHANGED MORE THAN HVINS

 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3470 ENCROACHMENT STATIONS=     1968.0    2260.0  TYPE=      1  TARGET=      292.000
  ELENCL=   9999.90  ELENCR=   9999.90
   109.00      5.82  6188.42  6188.42       .00  6190.68     2.26    11.31       .26  6193.10
    5330.        0.    5330.       0.        0.     442.       0.     101.       29.   9999.90
      .23       .00    12.06      .00      .000     .035     .000     .000  6182.60  2128.84
   .011266    1000.    1010.    1000.         9       11        0      .00    98.66  2227.51
0
 *SECNO 110.000

 3301 HV CHANGED MORE THAN HVINS


 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA=      6201.40 ELREA=      6199.80

   110.00      6.10  6197.00      .00       .00  6198.38     1.38     7.44       .26  6201.40
    5330.        0.    5330.       0.        0.     564.       0.     112.       32.   6199.80
      .25       .00     9.44      .00      .000     .035     .000     .000  6190.90  1564.70
   .006444     900.     890.     690.         3        0        0      .00   120.13  1684.33
0
1
    12/ 8/91      15:23: 4                                                                                PAGE    8
```

THIS RUN EXECUTED 12/ 8/91   15:23: 6

```
**************************************************
 HEC2 RELEASE DATED SEP 88 UPDATED APR  1989


  ERROR CORR - 01,02
  MODIFICATION -
**************************************************
```

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

EAST FORK SAND CREEK F

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	EG	DEPTH	VCH	TOPWID	XLBEL	RBEL	ELMIN
*	10.000	5420.00	6038.71	6040.93	5.11	11.96	103.26	6040.50	6040.00	6033.60
*	101.000	5420.00	6054.33	[illegible]	5.33	12.16	96.29	6057.50	6061.30	6049.00
*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12.05	100.41	[illegible]	[illegible]	[illegible]

*	103.000	5420.00	6085.11	6087.57	5.11	12.08	98.98	6087.90	6090.20	6080.00
*	104.000	5420.00	6095.18	6097.42	5.38	12.00	102.09	6098.50	6103.10	6089.80
*	10501.000	5330.00	6105.53	6107.90	7.13	12.36	92.04	6108.00	6112.00	6098.40
*	10502.000	5330.00	6107.75	6109.06	8.15	9.17	87.60	6109.70	6109.70	6099.60
*	10503.000	5330.00	6108.83	6111.53	6.43	13.20	75.70	6111.50	6111.50	61[illegible].40
*	10504.000	5330.00	6111.85	6114.83	7.65	13.85	65.60	6115.20	6115.20	6104.20
	10505.000	5330.00	6113.47	6115.97	8.17	12.70	67.68	6126.30	6128.40	6105.30
	10506.000	5330.00	6114.61	6117.17	8.11	12.84	67.43	6126.50	6129.10	6106.50
	10507.000	5330.00	6115.69	6118.63	7.69	13.75	65.78	6119.00	6119.00	6108.00
*	10508.000	5330.00	6119.07	6120.23	9.07	8.63	36.26	6122.60	6122.60	6110.00
*	10509.000	5330.00	6120.21	6122.83	6.11	12.98	79.44	6123.00	6123.00	6114.10
*	10591.000	5330.00	6122.19	6124.52	7.69	12.26	94.29	6124.40	6125.00	6114.50
*	106.000	5330.00	6128.30	6129.57	3.50	9.17	243.47	6126.00	6127.50	6124.80
*	107.000	5330.00	6151.52	6152.58	3.31	8.31	308.50	6150.00	6156.10	6148.20

	SECNO	Q	CWSEL	EG	DEPTH	VCH	TOPWID	XLBEL	RBEL	ELMIN
*	108.000	5330.00	6168.31	6170.54	4.21	10.56	148.15	6175.50	6169.50	6164.60
*	109.000	5330.00	6188.41	6190.68	5.82	12.06	98.66	6193.10	9999.90	6182.60
	110.000	5330.00	6197.00	6198.38	6.10	9.44	120.13	6201.40	6199.80	6190.90

SUMMARY OF ERRORS AND SPECIAL NOTES

CAUTION SECNO= 18.000 PROFILE= 1 CRITICAL DEPTH ASSUMED

CAUTION SECNO= 101.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 101.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 101.000 PROFILE= 1 20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO= 102.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 102.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 102.000 PROFILE= 1 20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO= 103.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 103.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 103.000 PROFILE= 1 20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO= 104.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 104.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY

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CAUTION SECNO=  10501.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  10501.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  10501.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

WARNING SECNO=  10502.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=  10503.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  10503.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  10503.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=  10504.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  10504.000  PROFILE=  1  MINIMUM SPECIFIC ENERGY

WARNING SECNO=  10508.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=  10509.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  10509.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=  10509.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=  10591.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=  10591.000  PROFILE=  1  MINIMUM SPECIFIC ENERGY

CAUTION SECNO=    106.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    106.000  PROFILE=  1  MINIMUM SPECIFIC ENERGY

CAUTION SECNO=    107.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    107.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    107.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=    108.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    108.000  PROFILE=  1  MINIMUM SPECIFIC ENERGY

CAUTION SECNO=    109.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
```


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CAUTION SECNO=    109.000  PROFILE=  1  MINIMUM SPECIFIC ENERGY
```
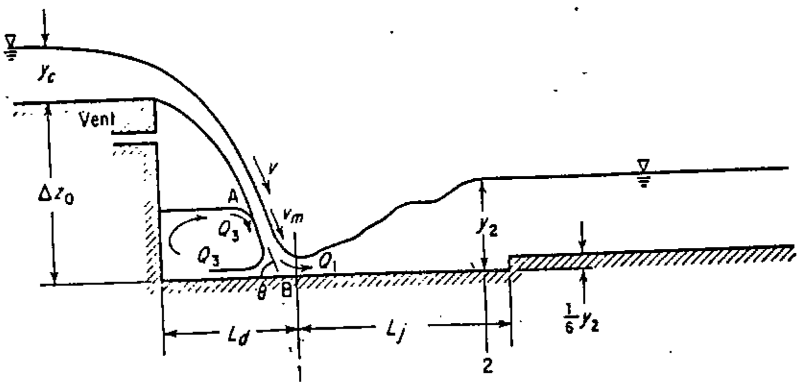

APPENDIX C

Engineering Analysis and Cost Estimate

HYDRAUCLI JUMP ANALYSIS

SECTION	Yc	ZO	Y1	Y2	Ld	Lj	1/6 Y2
10509	6.1	3.9	3.7	9.3	17.5	38.5	1.6
10503	6.4	2.6	4.5	9.0	12.1	31.3	1.5



CHANNEL FREEBOARD REQUIREMENT

NO	Q	V	FB	DEPTH	INVERT	TOTAL
10501	5330	12.36	2.53	7.13	6098.40	6108.1
10502	5330	9.17	1.98	8.15	6099.60	6109.7
10503	5330	13.20	2.71	6.43	6102.40	6111.5
10504	5330	13.85	2.85	7.65	6104.20	6114.7
10505	5330	12.70	2.60	8.17	6105.30	6116.1
10506	5330	12.84	2.63	8.11	6106.50	6117.2
10507	5330	13.75	2.82	7.69	6108.00	6118.5
10508	5330	8.63	1.91	9.07	6110.00	6121.0
10509	5330	12.98	2.66	6.11	6114.10	6122.9
10591	5330	12.26	2.51	7.69	6114.50	6124.7

Freeboard = $0.1\ Q^{0.3} + 0.008\ V^2$

where, Q is design discharge in cfs and

V is the mean velocity of flow in fps (18 fps max.)

RIPRAP REQUIREMENTS FOR
CHANNEL LININGS

SECTION	VELOCITY	SLOPE	Ss	CRITERIA
10501	12.36	0.01	2.65	4.1
10502	9.17	0.01	2.65	3.0
10503	13.20	0.01	2.65	4.3
10504	13.85	0.01	2.65	4.5
10505	12.70	0.01	2.65	4.2
10506	12.84	0.01	2.65	4.2
10507	13.75	0.01	2.65	4.5
10508	8.63	0.01	2.65	2.8
10509	12.98	0.01	2.65	4.3
10591	12.26	0.01	2.65	4.0

$VS^{0.17}/(S_s-1)^{0.66}$* $(ft^{1/2}/sec)$	Rock Type ***
1.4 to 3.2	VL
3.3 to 3.9	L
4.0 to 4.5	M
4.6 to 5.5	H
5.6 to 6.4	VH

Quantity Estimate for East Fork Sand Creek Channel

1. Riprap: $2 \times (22.4 \times 3) \times 950' / 27 = 4729$ cy (side)

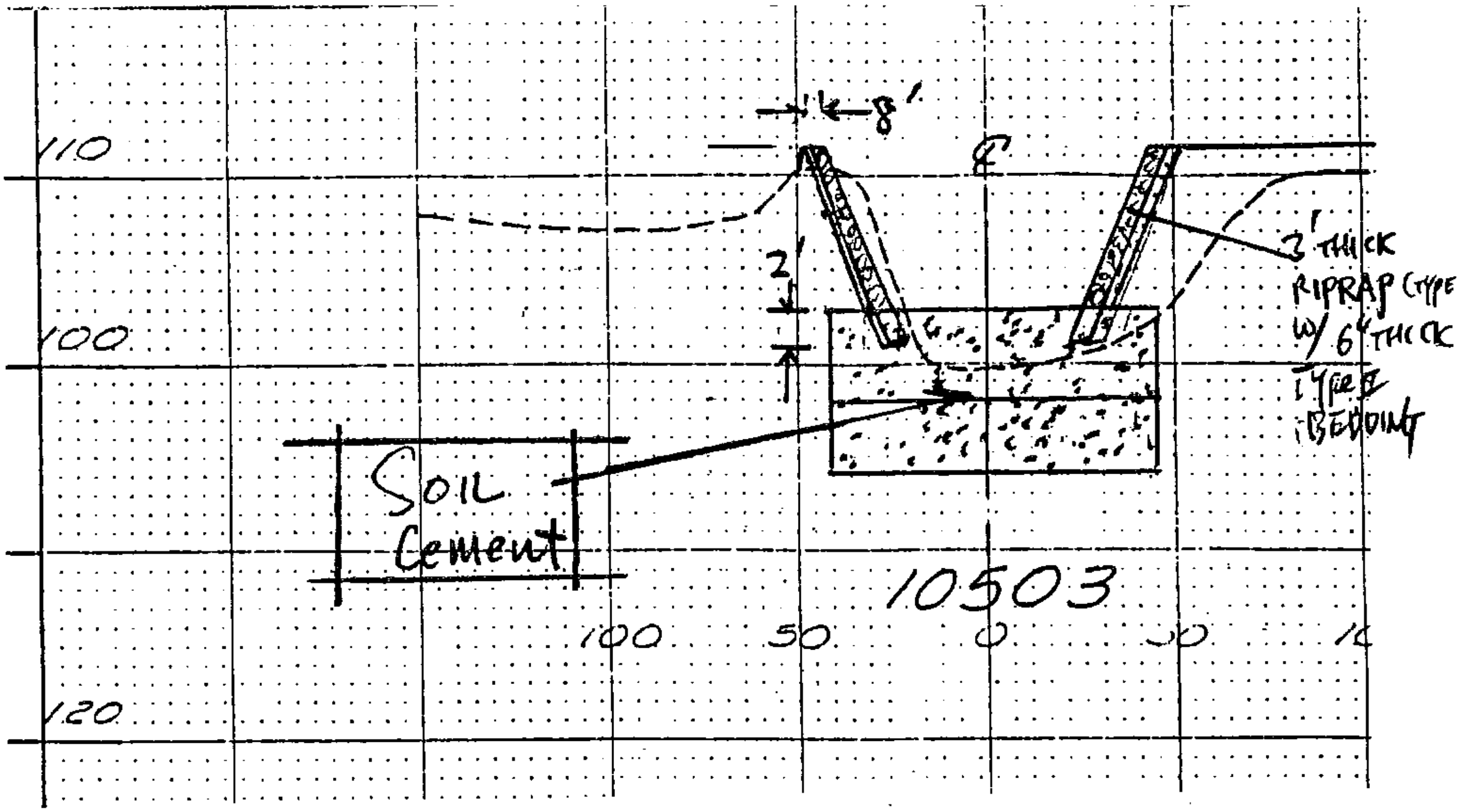
   $(375 + 35 + 40) \times 45' \times 3' / 27 = 2250$ cy (bottom)

3. Bedding: $(4729 + 2250) / 3 \times 0.5 = 1163$ cy

5. Soil Cement Structure (See Drop Structure Cost)

6. Excavation / Embankment (To be determined in final design)

7. Bridge Quantity (To be determined by others)



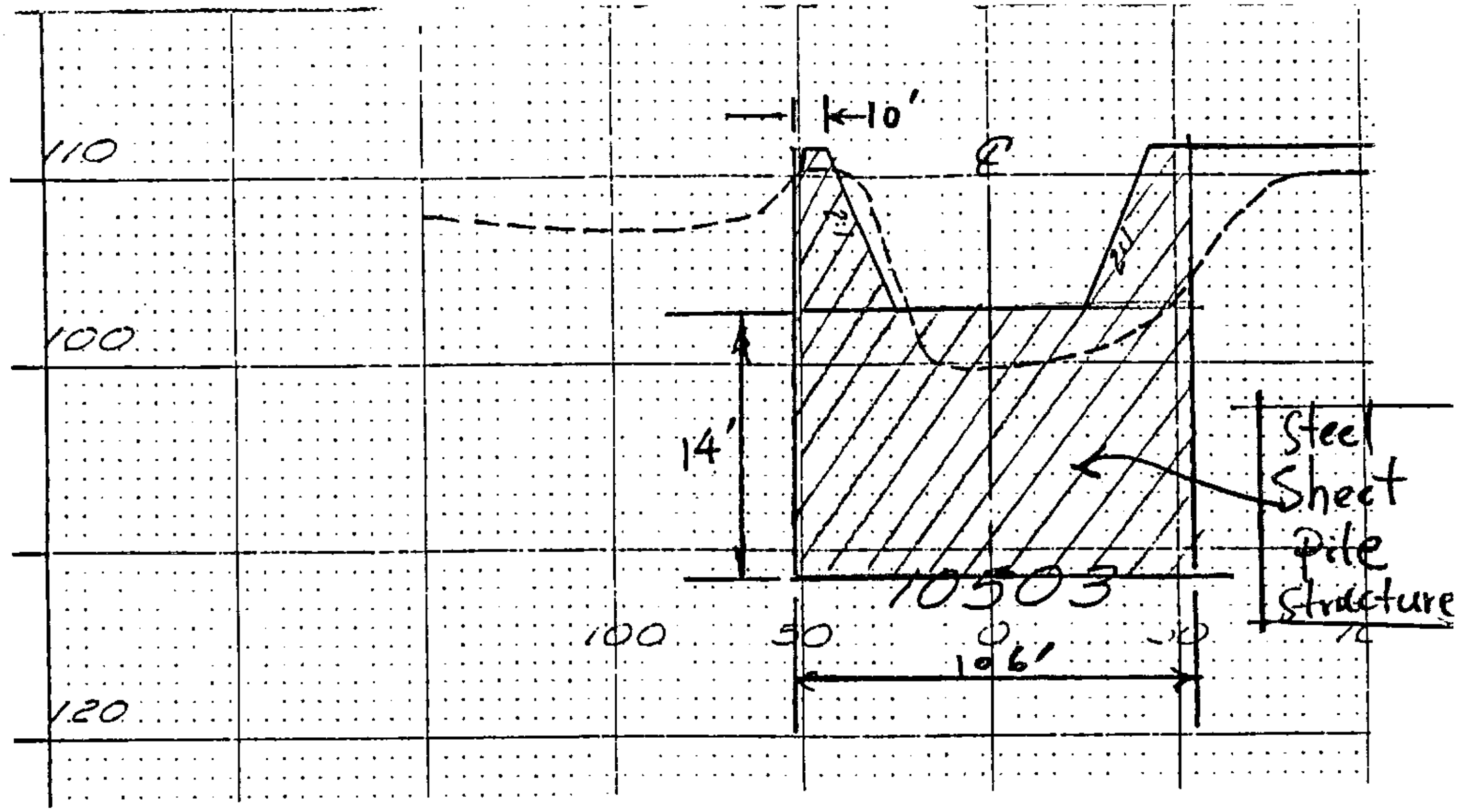
Vol $= \left[\left[(8' + 18') \times 5'/2\right] + (8' \times 3.8')\right] \times 85'/27$

$= 300^{cy}$ (Accross channel Invert)

\$ Soil cement $= 300^{cy} \times \$30/cy$

$= \$9000$

— Drop Structure Cost —



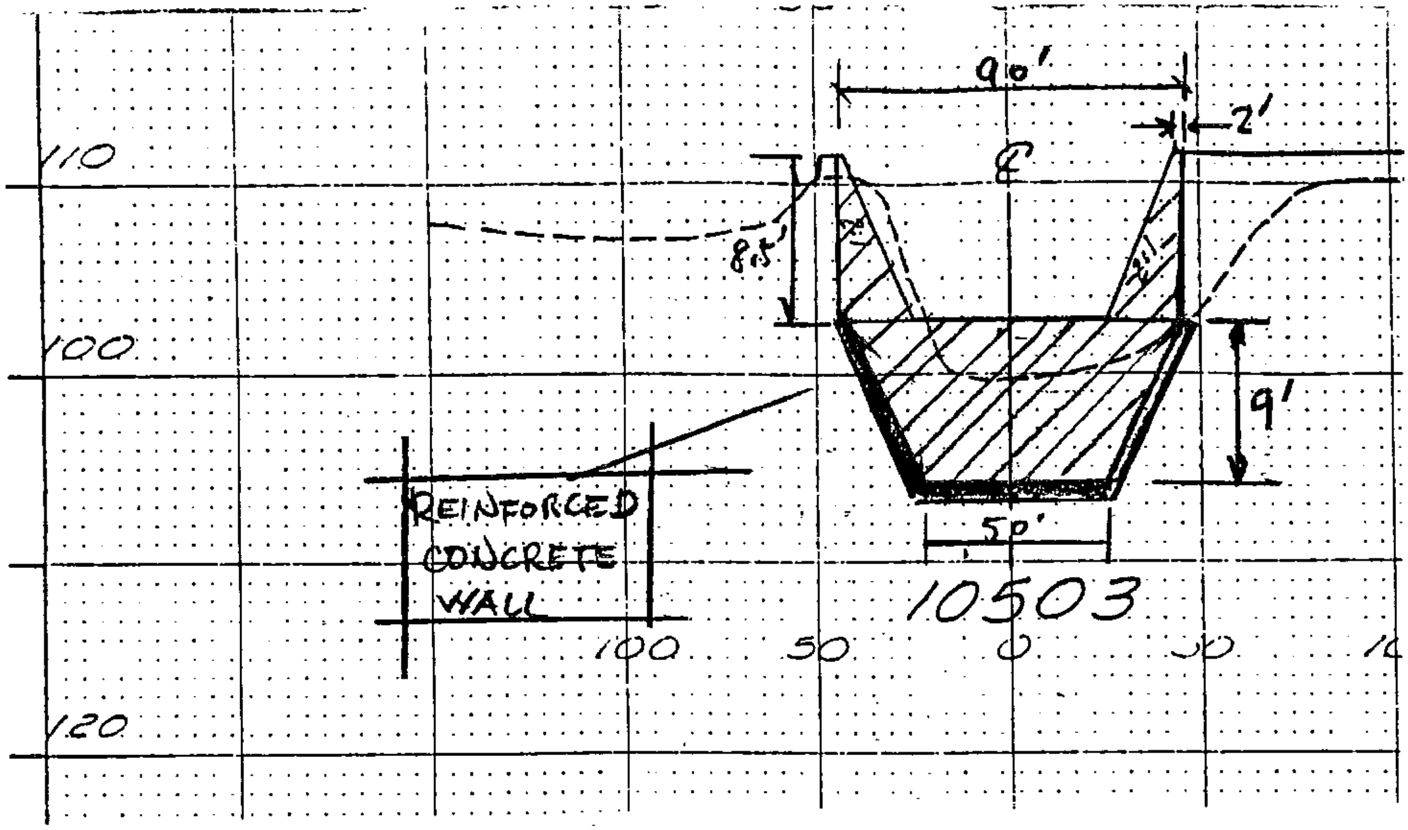
$$\text{Area} = 2 \times \left[(10' + 26') \times 8.5'/2 \right] + (14' \times 106')$$

$$= 1790 \text{ SF}$$

\$ Sheet pile structure = 1790 × 25

= \$44,750

— Drop Structure Cost —



WALL Area = $2\times\left[(2'+20')\times 8.5/2\right] + \left[(50'+90')\times 9/2\right]$

= 817 SF

Footing Area = $\left[(2\times 20.1')+50'\right]\times 9' = 812$ SF

Wall/Footing Thickness = 12"

VOL of Concrete = $(817+812)\times 1/27 = 60$ CY

\$ DROP STRUCTURE ≈ 60 CY × \$300/CY = 18,000.00

— Drop Structure Cost —

Kiowa Engineering Corporation

CLIENT ___ JOB NO. ___ PAGE ___
PROJECT ___ DATE CHECKED ___ DATE ___
DETAIL ___ CHECKED BY ___ COMPUTED BY ___

cost for channel improvements:
(not include Bridge)

1. Riprap
$ = (4729+2250) x $30/cy = $209,370

3. Bedding: $ = 1163 cy x $15/cy = $17,445

5. Soil Cement Structure = 2 x $9000/EA = $18,000

6. Earth work (not estimated)

Sub-Total $ = 244,815 (**not include:** earth work, bridge, and contongency)

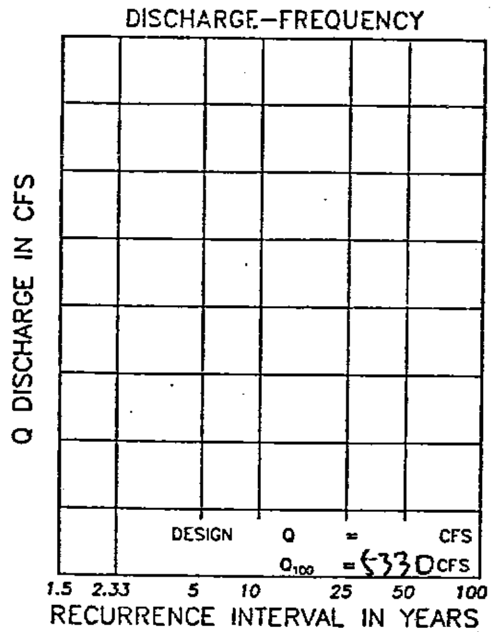
APPENDIX D

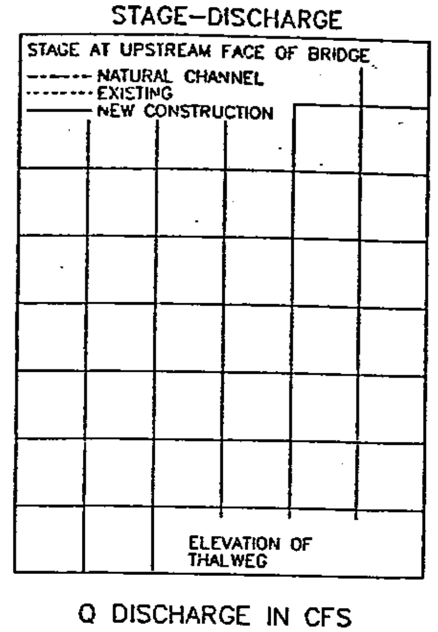
Bridge Information

STATE OF COLORADO
STATE DEPARTMENT OF HIGHWAYS
DIVISION OF HIGHWAYS
D.O.H. FORM NO. 117
REV. OCT. 1983

BRIDGE HYDRAULIC INFORMATION

AS CONSTRUCTED			FED. ROAD REGION	DIVISION	PROJ. NO.	SHEET NO.
NO REVISIONS	REVISED	VOID	VIII	COLO.		

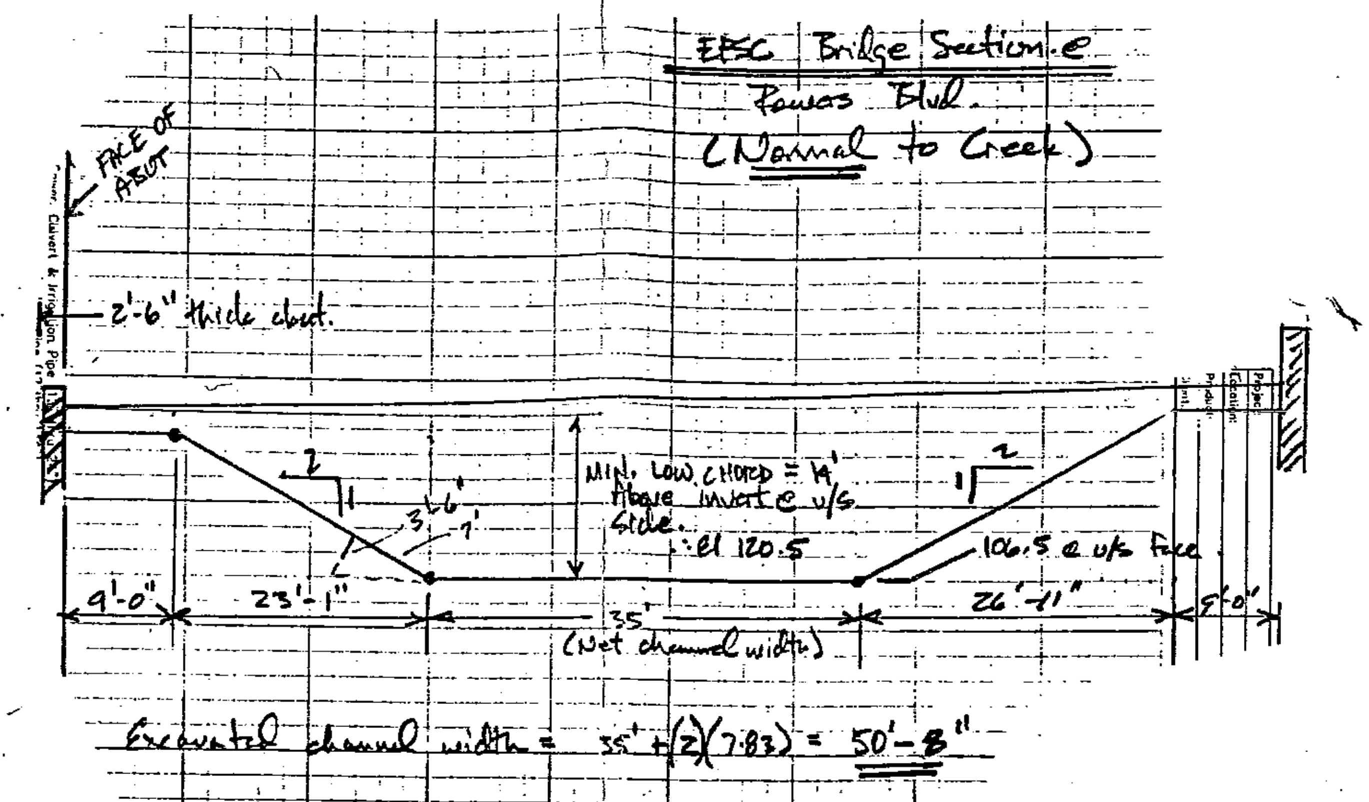


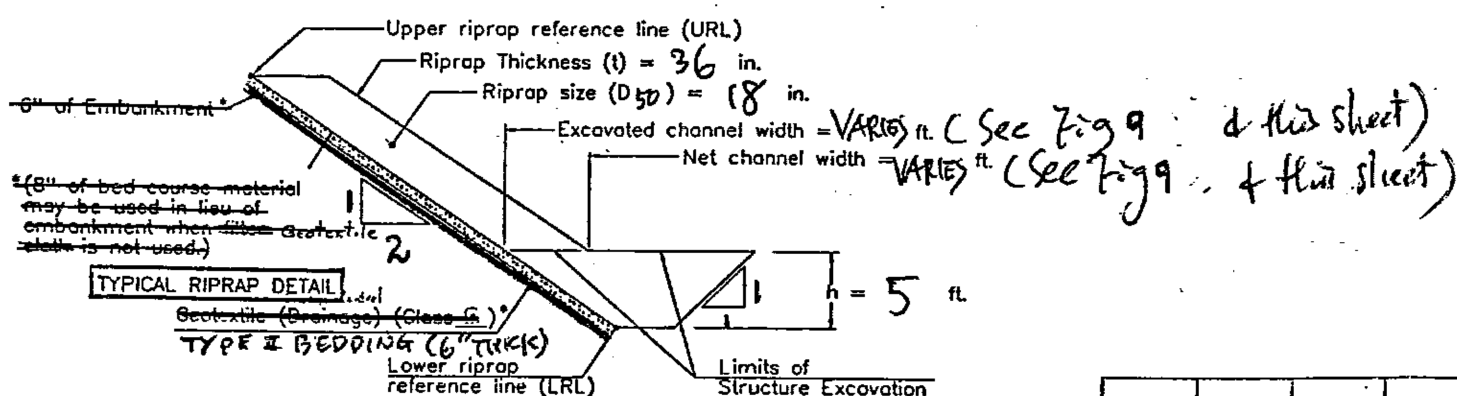


Q^{10}	Q^{50}	Q^{100}	Q^{500}
1940	4180	5330	6125

Stage at u/s face

10-YR	50-YR	100-YR	500-YR
6111.25	6114.55	6115.43	6116.24





LEGEND
Existing Contours
Proposed Contours
Revetment Protection

Drainage Area Sq. Mi.

CHANNEL DESCRIPTION

Bottom Material – Cohesive ☐ Non Cohesive ☑
Bottom Material Size – Clay ☐ Silt ☑ Sand ☑ Gravel ☐ Cobbles ☐ Other ☐
Stream Form – Straight ☐ Meandering ☐ Braided ☐
Mannings "n" for Design – Channel 0.035 Overbank 0.035
Debris – Brush ☐ Trees/Logs ☐ Ice ☐ Other ☐

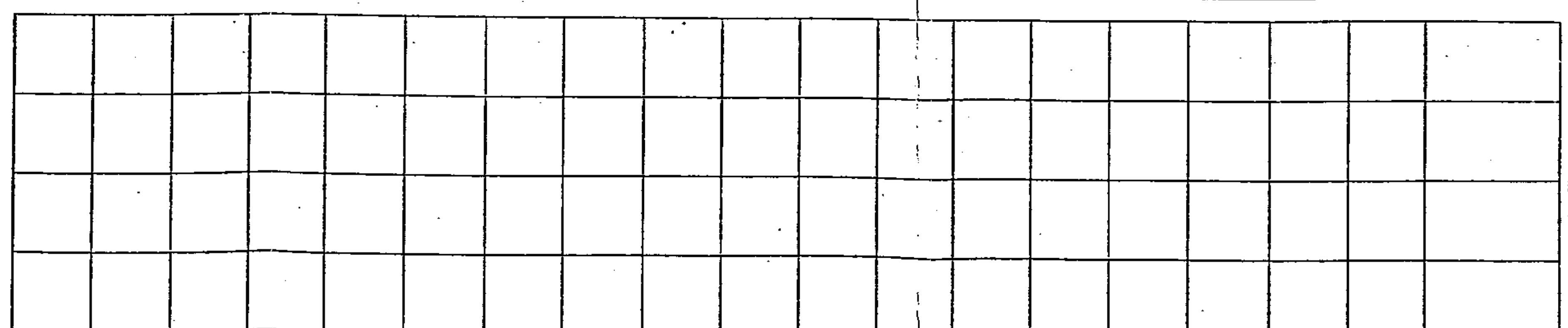
COMPARISION OF HYDRAULICS*

	Velocity*	Freeboard*	Max. Backwater*
Natural Channel	fps.	ft.	ft.
Existing	fps.	ft.	ft.
Proposed	fps.	ft.	ft.

*AT PROPOSED BRIDGE LOCATION DURING DESIGN DISCHARGE

COMMENTS

* Appendix



PROFILE OF WATER SURFACE & RIPRAP REFERENCE LINES

— Please See Figure 9 —

DESIGNED BY | CHECKED BY | DETAILED BY | INITIAL | DATE | CHECKED BY | QUANTITIES BY | CHECKED BY | INITIAL | DATE

DIVISION OF HIGHWAYS

BRIDGE HYDRAULIC INFORMATION

Across | Approved By | Date
DESIGNER
DETAILER | STRUCTURE NUMBERS
DRAWING NUMBER B OF DRAWINGS

APPENDIX E

Field Culvert Report

State of Colorado
Department of Highways
Division of Highways
DOH Form 283
Rev. Feb. 1980

FIELD CULVERT REPORT

Project US 24 PHASE II
Date 9-9-89
Party Wray / Fairley

Station 90+50 ; [illegible]
Drainage Area 23.5N Acres (Complete for all areas too small to determine on USGS 0°7-1/2' maps.)

EXISTING STRUCTURE

Station 90+50 Skew 10° ±
Size 48-2 Length 75' Type CMP
Condition: ☒ Poor ☐ Fair ☐ Good
Inlet Type Mitred End
Outlet Type Pipe exposed

DISTRICT RECOMMENDATION:

Station ______ Skew ______

	Yes	No
Channel Change	☐	☐
Dike Required	☐	☐
Stock Pass	☐	☐

Culvert Adequacy, High Water Elev., Etc. Road has been overtopped. [illegible] emb. has been backfilled w/ rubble + asphalt numerous times

Erosion (describe) Culverts eroded @ outlet; Roadway emb. eroded on outlet side.

Depth of Silt in Culvert Inlet 0 Outlet 0

DESCRIPTION OF CHANNEL:

Type of Soil in Channel Sand, rubble + debris

Type of Vegetation in Channel and Floodplain Willow & grasses on banks sand inlet

TYPE OF FLOW:

Continuous ☒ Intermittent ☐
Irrigation ☐

Irrigation Q ____ cfs (Water Right)
Q 1 cfs (At time of W.S.Profile)
Does Irrigation Ditch carry runoff: ______

DEBRIS:

☒ Insignificant ☐ Logs & Trees
☐ Brush & Trash

REMARKS Culvert capacity @ HW = [illegible] ⇒ 91 cfs [illegible] 180 cfs total. [illegible] Culverts need replacement

APPENDIX F

Scour Calculations

CARDER CONCRETE PRODUCTS
CARDER CONCRETE PRODUCTS
8311 West Carder Court
Littleton, Colorado 80125
303-791-1600
Fax: 303-791-1710
1-800-365-3096

Project:	US 24 Bypass II	Page:	1
Location:		Date:	12-6-91
Product:		By:	RWW
Client:	CDOT / CRSS	Checked:	

Scour Calculations EFSC Bridge @ Powers

1. Given: - Channel section as per attached figure.
   - Use HEC-18 for scour equations.

2. Assumptions:
   Q_{100} = 5920 cfs Q_{500} 6120 cfs
   Use HEC-2 output dated 12/6/91
   35' BW, channel slope = 1.0% through Bridge. XSECS 10505 & 10508 will be used for design velocities.

3. Hydraulic data:
   100yr Velocity @ XSEC 10505 13.0 fps
   " " " 10506 11.0 fps
   10508 8.6 fps
   use 13.0 fps for riprap design & scour calcs

		XSEC #
d_{100} =	8.9'	(10505)
	7.9	(10506)
	9.1	(10508)

(4.) Scour Calculations : 100 yr

(a) Long-Term Scour:

use same as preliminary design report calculations.

LT Scour depth ~ 1.5'

(b) General Scour due to contraction

use equation (6), page 42, HEC-18

$$\frac{y_2}{y_1} = \left(\frac{W_{c1}}{W_{c2}}\right)^{k_1}$$

y_2 = depth in contracted section (XSEC 10506)

y_1 = depth in main channel (XSEC 10508)

$W_{c1} = 50'$ $W_{c2} = 35'$ (@ bridge)

$$\therefore \left(\frac{50}{35}\right)^{k_1} = 1.43^{k_1}$$

use $k_1 = .69$ (suspended bed material)

$$\therefore \frac{y_2}{y_1} = (1.43)^{.69}$$ with $y_1 = 7.9'$ (XSEC 10507)

$$\therefore y_2 = (1.43)^{.69}(9.4') = ~~10.1'~~ 11.6'$$

Contraction Scour $y_s = y_2 - y_1$

$\therefore y_s = \overset{11.6}{\cancel{10.1}} - \overset{9.1}{\cancel{7.9}} = \overset{2.5}{\cancel{2.2}}'$

$\therefore$ Toe down for riprap = y_s + LTS

= ~~3.7~~' + 1.5' = 4.0'

Toe down ~~4~~5' minimum

5' toe down would match toe of drops; $\therefore$ use 5' toe down.

5. Abutment Scour:

As per HEC-18, if lined xsection is carried through the bridge, no abut scour is anticipated.

6. 500-year; "Super flood" scour estimates.

Q_{500} @ bridge = 6120 cfs (Source FEMA FIS).

CARDER CONCRETE PRODUCTS

CARDER CONCRETE PRODUCTS
8311 West Carder Court
Littleton, Colorado 80125
303-791-1600
Fax: 303-791-1710
1-800-365-3096

Project:	Page: 4
Location:	Date: 12/10
Product:	By: RWW
Client:	Checked:

6. 500-year scour cont'd

a) Selected opening: 35' BCW, 2to1 SS, Riprap channel

b) HEC 2 data: Run dated 12/10/91 ; $Q_{500} = 6120cfs$

	XSEC 10506	XSEC 10508
depth	8.9'	9.8'
Velocity	13.1 fps	9.0 fps

(c) Assume that all rock is gone. for Abut Scour.

(d) LT Scouring: use 1.5' as per 100-year calcs.

(e) General Contraction: use same equation as 100 year

$$\frac{y_2}{y_1} = \left(\frac{W_{c1}}{W_{c2}}\right)^{k_i} \quad \text{with } k_i = .69$$

$$\therefore y_2/y_1 = (50/35)^{.69} = 1.27$$

$$\therefore y_2 = 1.27 \times y_1 = 1.27(9.8) = 12.5$$

$$\therefore y_s = y_2 - y_1 = 12.5 - 9.8 = 2.7'$$

<u>500 year calc's cont'd.</u>

∴ LT + General = 2.7' + 1.5' = 4.2'

∴ Toedown of 5' ok for 500 year also.

(f) abut Scouring:
assume <u>all</u> rock washed away.
∴ use Froehlichs equation (Equ. # 8 pg 47, HEC-18)

$$y_s / y_a = 2.27 K_1 K_2 (a'/y_a)^{.43} Fr_e^{.61} + 1$$

K_1 = .55 (spill through) $K_2 = (\theta/90)^{.13} = (90/90)^{.13} = 1.$
a' = abutment length = ~~[illegible]~~ <1'; 500 year is contained ~~within~~ between abuts.

$A_e = 2(2.5)(8.9') = 44.5$ $y_a = 8.9$
∴ $A_e / y_a = 5$

$Fr_e = 13.1/\sqrt{g\,8.9}$ = ~~[illegible]~~ .77

$Q_e = V_e A_e = 13.1 \times 44.5 = 583$ cfs

$$\therefore y_s/y_a = 2.27(.55)(1)(1/y_a)^{.43}(.77)^{.61} + 1$$
$$= 1.25\left(\frac{1}{8.9'}\right)^{.43}(.86) + 1 = 1.5'$$

[redacted]

$y_s / y_a = 1.42$

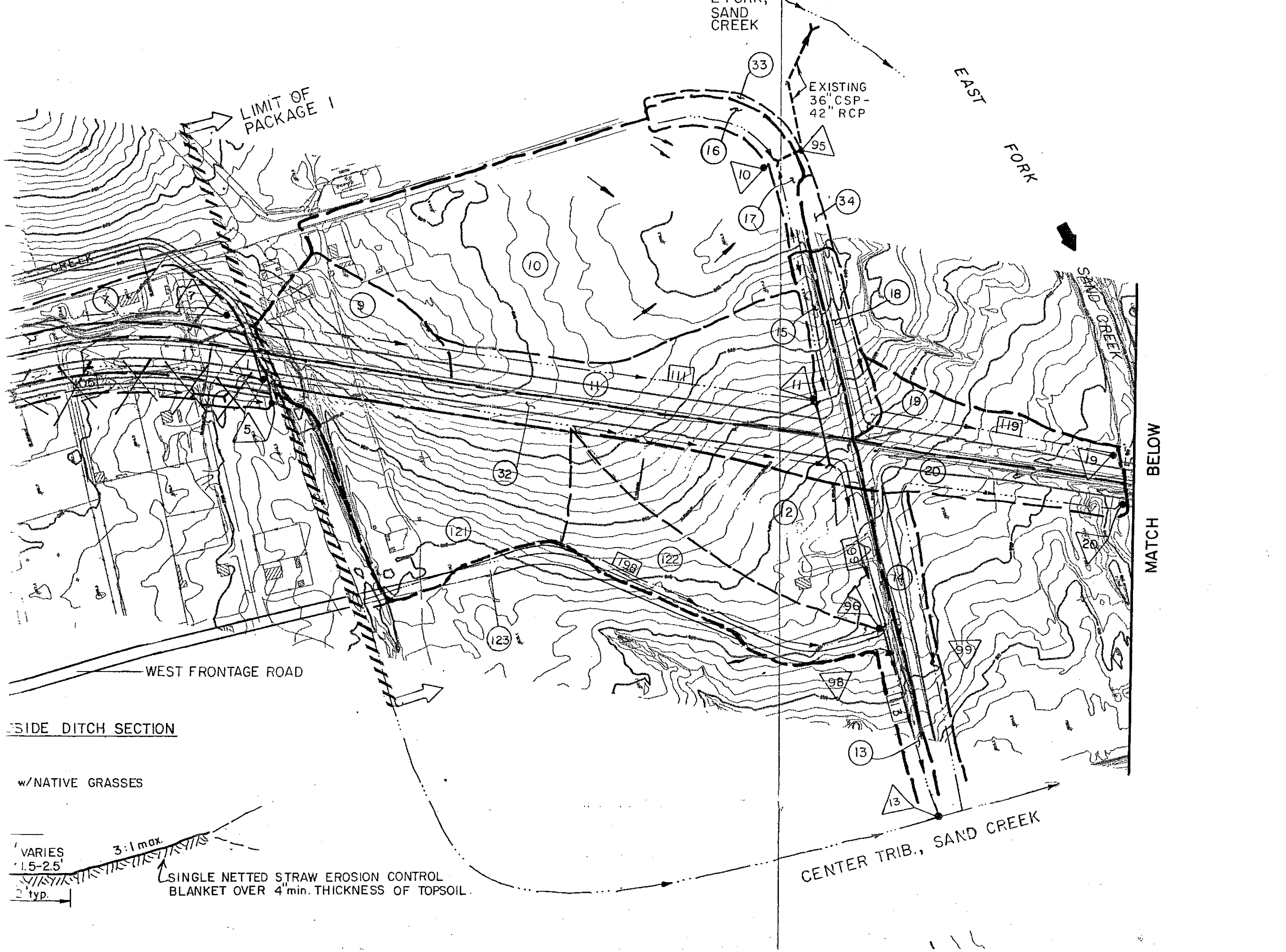
$y_s = (8.9)(1.4) = \underline{12.6}$

∴ Total Scour = LT + GS + Abut

= 1.5 + 2.7' + 12.6

Scour depth = 16.8'.

∴ piles must be below this depth minimum.
Since channel will be lined, this calc is really not relevant as per HEC-18.
Riprap for channel has been sized to withstand 100 year + 500 year velocities.
Abutment berm will add 9' horizontally in front of abut. 16.8' would appear very conservative is used for design.



Kiowa Engineering Corporation

419 W. Bijou Street
Colorado Springs, Colorado

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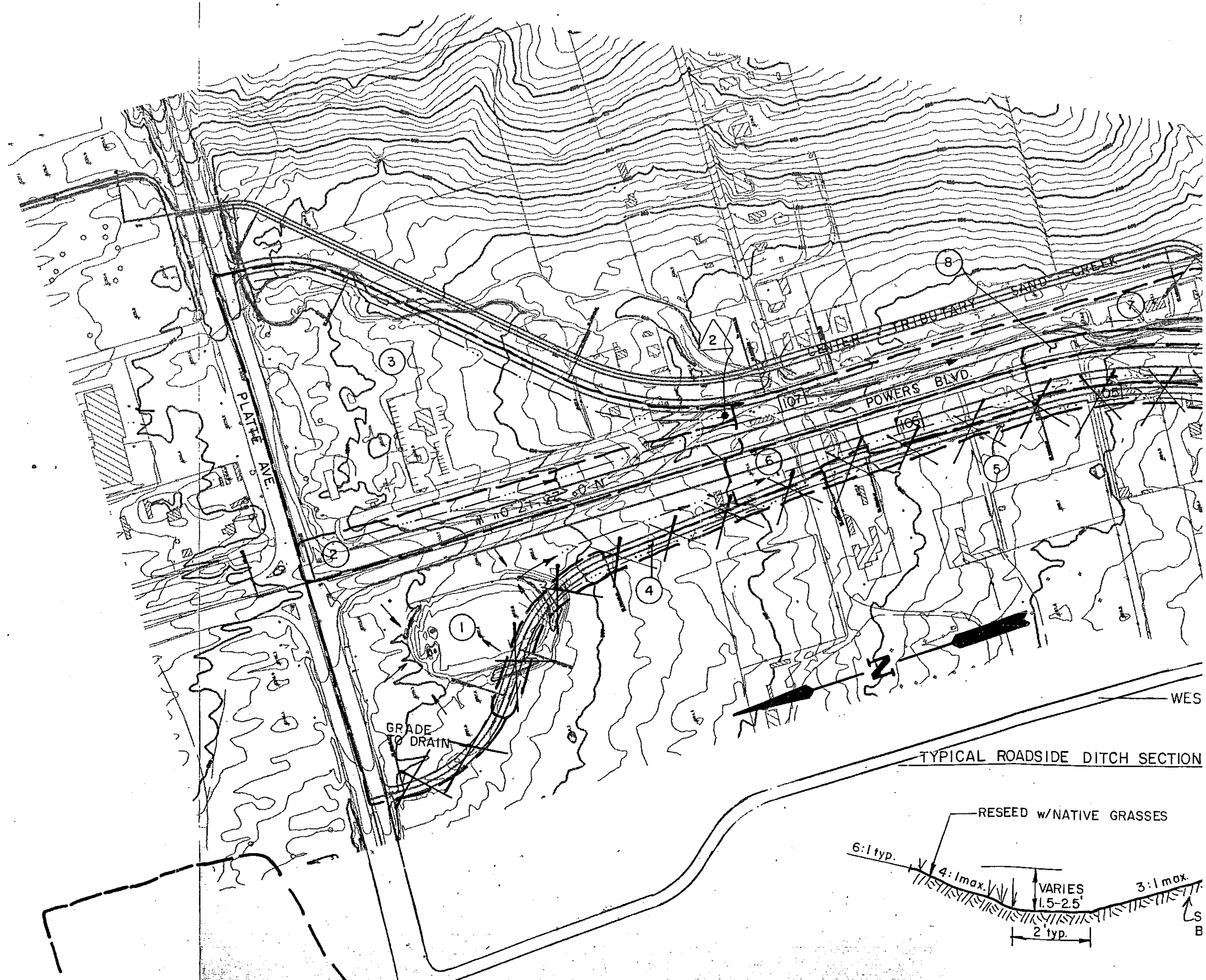

PLATTE AVE.
POWERS BLVD.
CENTER TRIBUTARY SAND CREEK
GRADE TO DRAIN
WES
TYPICAL ROADSIDE DITCH SECTION
RESEED w/NATIVE GRASSES
6:1 typ.
4:1 max.
VARIES 1.5-2.5'
3:1 max.
2' typ.

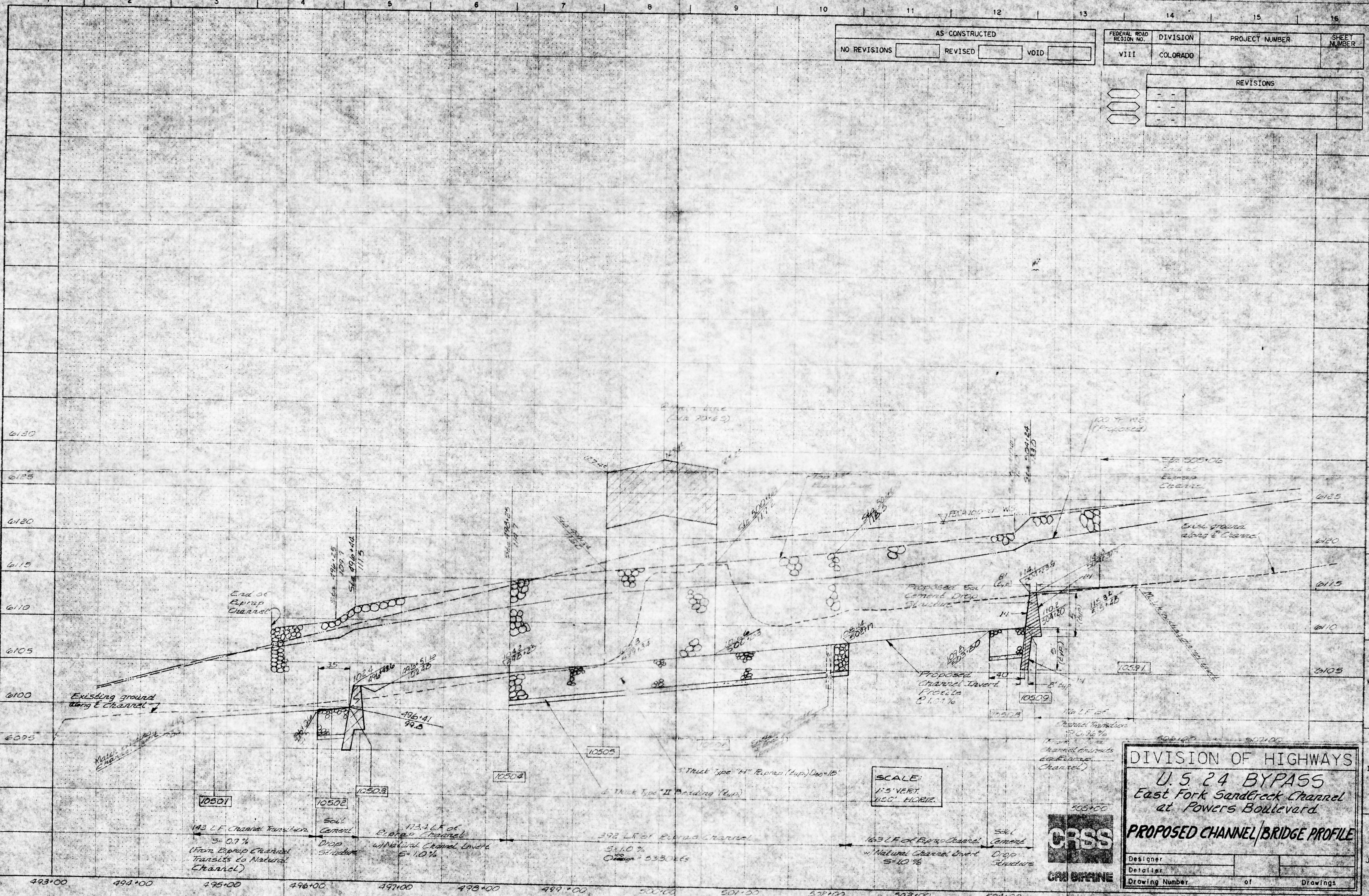

Figure 8

1FOR437.10N

SCANNED