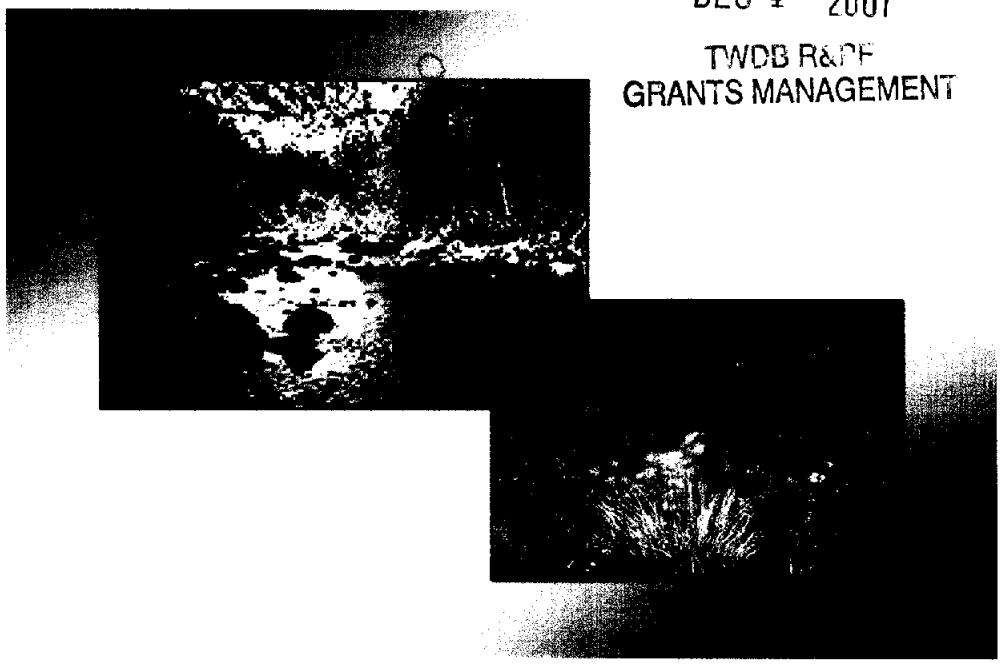
2000-483-360
Final

WOODCREEK MASTER DRAINAGE PLAN
Improvements to Hog Creek



City of Woodcreek, Texas

November 2001

Project No. 2000-33

Espey Consultants, Inc.
E C

WOODCREEK MASTER DRAINAGE PLAN
Improvements to Hog Creek

Prepared for:

City of Woodcreek
17 Wildwood Circle
Woodcreek, Texas 78676

Prepared by:

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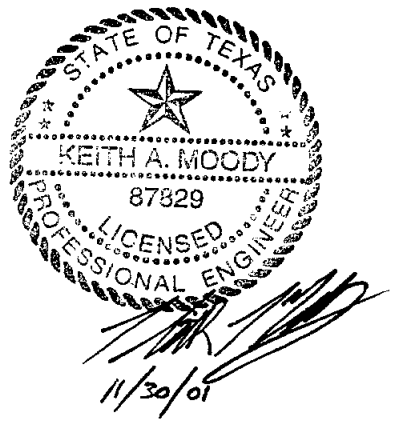

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1.0 INTRODUCTION

The City of Woodcreek currently comprises 586 housing units (single- and multi-family) and 346 vacant building lots spread over 686 acres. Woodcreek is bisected by a mile-long stretch of Hog Creek. Hog Creek originates about one mile northeast of Woodcreek in an unincorporated area of Hays County. It drains from the northeast to the southwest and empties into an amenity lake contained by an concrete covered dam which feeds into Cypress Creek.

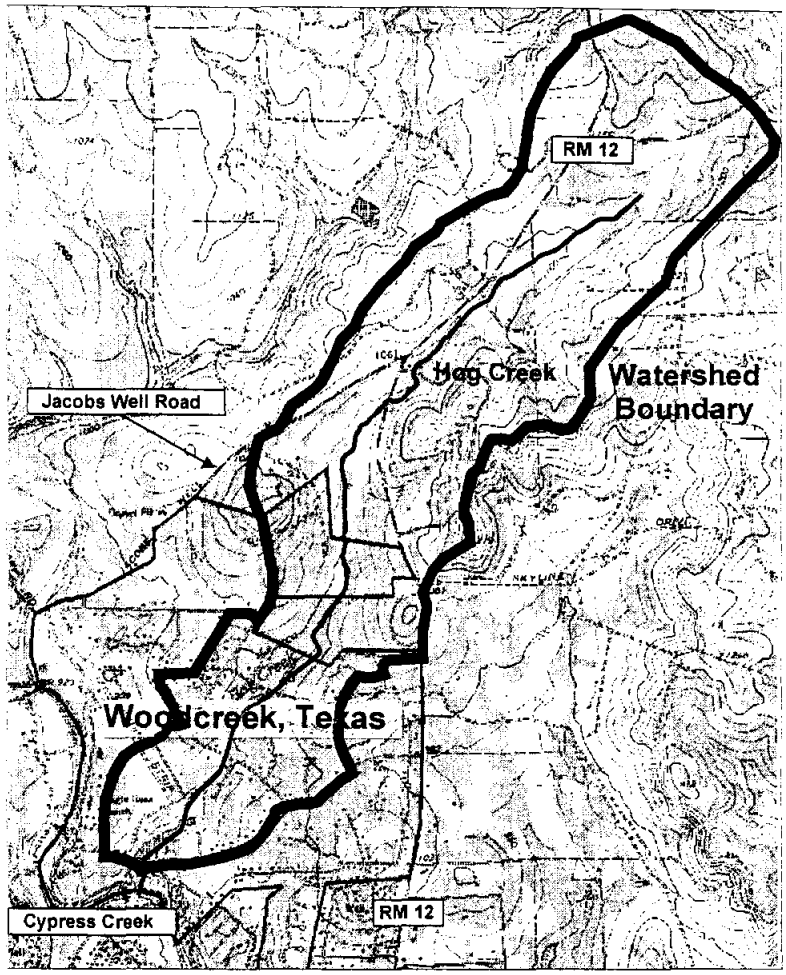


Figure 1 Site Location and Drainage Area Map

The flow of water through Hog Creek is obstructed, causing a serious threat of flooding to area homes in heavy rains. Concrete culverts, built over 20 years ago, are placed too high to be effective, and the openings are too small to move water through the creek in high water periods. There is also a series of low concrete dams along Hog Creek originally built to create holding ponds, which further impede the flow of water. During years of normal rainfall, the creek stays almost full. Regular monthly rains of two inches or more send the water over the creek's banks into adjacent streets and yards.

1.1 PURPOSE OF THIS REPORT

The purpose of this report is to identify and quantify the current flood conditions along Hog Creek, and prepare a cost effective plan to relieve flood prone areas along the creek. This report includes hydrologic analyses to estimate flow rates, hydraulic analyses to determine the water surface elevations, a cursory environmental survey of the area, preliminary construction cost estimates, and a recommended implementation plan.

This report does not include the evaluation of flooding in upland areas or local drainage ways including site grading, roadside ditches, etc.

A draft of this report was submitted to the Texas Water Development Board on August 17, 2001 and comments were received on November 27, 2001. The response to these comments can be found in ***Appendix D*** of this report.

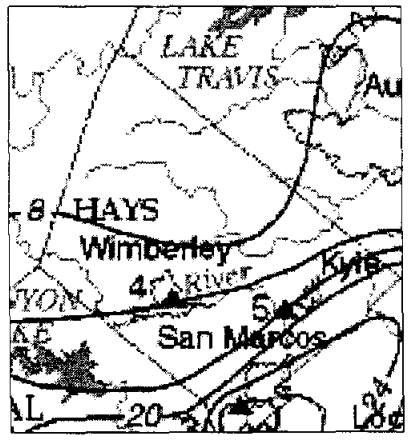
1.2 SPONSORS

Project sponsors include: City of Woodcreek, Hays County, Texas Water Development Board and Guadalupe Blanco River Authority. These sponsors contributed both financial and technical resources to development of this drainage plan.

1.3 HISTORICAL FLOODING

Historically, the City of Woodcreek has been subjected to extensive flooding from frequent four-inch or greater rain storms. Homes built just after the subdivision opened in the early 1970s were built before floodplain and flood way boundaries were defined. Although the City of Woodcreek does not allow construction in the floodplain now, there are many existing homes at risk of damage by high waters because of their low elevations.

During the heavy rains of June 1997 and October 1998, there was extensive street flooding and water damage to homes along the creek extending also into adjacent neighborhoods. A buildup of debris in the creek bed compounded by the ineffectiveness of the culverts and dams to keep the water moving caused the runoff to flood streets and homes. Access for most residents was completely blocked for the major part of the day during the October 1998 flooding. For the study area, the two-day rainfall totals for the June 1997 storm ranged from 3 to 4 inches, and the rainfall totals for the October 1998 storm range from 8 to 12 inches (Figure 2).



During the October 1998 storm event, Hog Creek was producing runoff depths over two feet deep across Brookhollow Drive, resulting in serious water damage to several nearby homes. Runoff was extensive on numerous city streets, with approximately one foot of water covering major routes and causing damage to streets and landscaping, washing away asphalt and lawns. Although no estimates of repair costs were accumulated, six homes suffered damage necessitating structural and/or interior repairs.

Figure 3 Photograph

The amount of runoff into Hog Creek has increased in volume during heavy rains since the surge in development upstream of a residential subdivision (Mountain Crest) in the unincorporated area of Hays County. Hog Creek is a deeply carved dry creek bed in this subdivision with occasional seepage from springs. There was no flooding of streets or homes in Mountain Crest during the heavy rains of 1997 and 1998. However, the runoff from the higher elevations in Mountain Crest resulted in

increased flow into the lower extension of Hog Creek across the Woodcreek community.

The city can only expect flooding to become more extensive due to the rapid rate of new home construction in the drainage area to the north. We can expect more frequent occurrences of flooding with less and less pervious soil remaining to absorb the water of even routine storms.

2.0 HYDROLOGIC ANALYSIS

2.1 METHOD OF ANALYSIS

Version 2.0.0 of the HEC-HMS computer program developed by the Hydrologic Engineering Center of the U. S. Army Corps of Engineers (USACE) is used in this analysis to estimate peak flow rates along Hog Creek. Peak flow rates are computed along the watercourse for the 10-year, 50-year, 100-year and 500-year frequency storm events. This section describes the input parameters used in this study and summarizes the results of the hydrologic analysis. Excerpts from the HEC-HMS model input and output are included in Appendix B.

2.2 PRECIPITATION

The design storms used in this analysis include a balanced rainfall distribution for a 24-hour duration. The precipitation depths for each design storm are taken from NOAA Technical Memorandum NWS Hydro-35 and Rainfall Frequency Atlas of the United States, Technical Paper 40 (TP 40).

Table 1 Precipitation Depths

	Frequency				
Duration	10-Year	50-Year	100-Year	500-Year	
5-min	0.64	0.80	0.88	1.04	HYDRO-35
15-min	1.40	1.75	1.90	2.15	
60-min	2.95	3.89	4.20	5.20	
2-hrs	3.60	4.75	5.40	6.50	TP 40
3-hrs	4.00	5.25	6.00	7.25	
6-hrs	4.80	6.50	7.20	8.80	
12-hrs	5.75	7.80	8.80	10.80	
24-hrs	6.75	8.90	10.00	12.30	

2.2.1 Drainage Area

The Hog Creek watershed is delineated using USGS 7 ½ minute quadrangle maps, and is subdivided into 2 subwatersheds: A and B (Exhibit 1). Subarea A extends to Mountain Crest Drive and includes a drainage area of 743.7 acres (1.162 square miles). Subarea B includes a drainage area of 336.6 acres (0.526 square miles). Subarea B extends to the #10 Tee box located near the upper end of a large amenity lake located near the end of the "landing strip."

2.2.2 Infiltration Losses

The U.S. Department of Agriculture Natural Resource Conservation Service (NRCS, formerly the Soil Conservation Service) has developed a rainfall runoff index, the runoff curve number (CN), which takes into account such factors as soil characteristics, land use/land condition, and antecedent soil moisture to derive a generalized rainfall runoff relationship for a given area. A

description of these components and the equation for calculating runoff depth from rainfall are provided below.

The NRCS classifies soils into four hydrologic soil groups: A, B, C and D. These groups indicate the runoff potential of a soil, ranging from a low runoff potential (group A) to a high runoff potential (group D). Based on the information provided in the Soil Surveys of Hays County, C and D soil groups are predominant throughout this study area. C soils within the study area primarily include Bolar (BrB) and Brackett (BtD and BtG), while D soils primarily include Anhalt (AnB) and Comfort (CrD). Exhibit 2 provided in Appendix A includes a soils map of the area.

The NRCS provides runoff curve numbers for three Antecedent Moisture Conditions (AMC): I, II and III. AMC I represents dry soil conditions and AMC III represents saturated soil conditions. AMC II, which represents average soil moisture conditions, is assumed for this analysis. Runoff curve numbers vary from 0 to 100, with the smaller values representing lower runoff potential and the larger values representing higher runoff potential. A CN value of 75 approximately represents runoff potential for the soil types within the study area. Impervious cover values are entered separately from CN values into HEC-HMS model. It is assumed that 100% runoff is generated from impervious areas, while runoff from pervious areas is estimated using the selected CN value and the following equations:

$$Q = (P - 0.2 \times S)^2 / (P + 0.8 \times S) \qquad \text{Equation 1}$$

and

$$CN = 1000 / (10 + S) \qquad \text{Equation 2}$$

where:

Q	=	depth of runoff (in),
P	=	depth of precipitation (in),
S	=	potential maximum retention after runoff begins, and
CN	=	runoff curve number.

2.2.3 Unit Hydrograph Method

A rainfall/runoff transformation is required to convert rainfall excess (total rainfall minus infiltration losses) into runoff from a particular subarea. The NRCS unit hydrograph option in HEC-HMS is used in this analysis to generate runoff hydrographs for each defined subarea within the Hog Creek watershed. This method requires only one input parameter, lag time (T_{LAG}).

The dimensionless unit hydrograph developed by the NRCS (Figure 4) was developed by Victor Mockus and presented in National Engineering Handbook, Section 4, Hydrology, published by the U. S. Natural Resource Conservation Service. The dimensionless unit hydrograph has its ordinate values expressed in a dimension less ratio q/qp and its abscissa values as t/Tp. This unit

hydrograph has a point of inflection approximately 1.7 times the time to peak (Tp), and the time-to-peak 0.2 of the time-of-base (Tb) (NRCS, 1985).

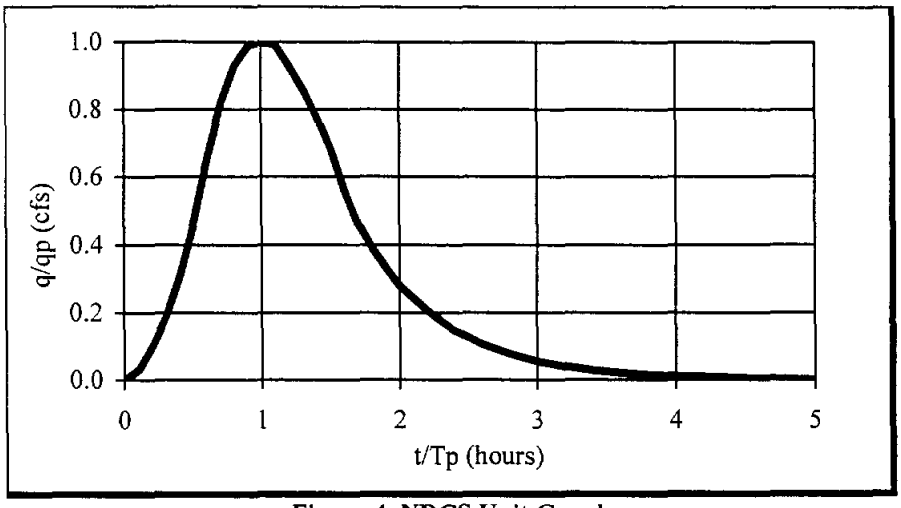


Figure 4 NRCS Unit Graph

Input data for this method consists of a single parameter, T_{LAG}, which is equal to the time (hours) between the center of mass of rainfall excess and the peak of the unit hydrograph. (NRCS, 1985)

The time to peak is computed using the following equation:

$$T_{PEAK} = \Delta t/2 + T_{LAG} \qquad \text{Equation 3}$$

where:

T_{PEAK} = time to peak of the unitgraph (hrs)
Δt = computation interval / duration of unit excess (hrs)

T_{LAG} = watershed lag (hrs)

The peak flow rate of the unitgraph is computed using the following equation:

$$qp = 484A/T_{PEAK} \qquad \text{Equation 4}$$

where:

qp = peak flow rate of the unitgraph (cfs/in)
A = watershed area (sq mi)

2.2.4 Time of Concentration and Lag Time Computation

The NRCS method assumes that the lag time of a watershed is 60% of the watershed's time of concentration. The time of concentration is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed (NRCS, 1985). It may be estimated by calculating and summing the travel time for each sub-reach defined by the

flow type: sheet flow, shallow concentrated flow, roadway and storm sewers and channelized flow. The methods prescribed in the NRCS' Technical Release 55 (TR55) are used to determine the time of concentrations for each flow segment in this analysis. The watershed parameter worksheet used to calculate time of concentration and lag time for each subarea is presented in Appendices B. A detailed discussion of the methods used to estimate travel times for each typical flow segment is presented below.

- **Sheet Flow (< 300 feet)**

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact, drag over the plane surface, obstacles such as litter, crop ridges, and rocks, and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. For sheet flow less than 300 feet, travel time is computed as follows:

$$Tt = (0.007 \times (n \times L)^{0.8}) \; / \; (P_2^{0.5} \times s^{0.4}) \qquad \text{Equation 5}$$

where

Tt	=	travel time (hr),
n	=	Manning's roughness coefficient,
L	=	flow length (ft),
P_2	=	2-year, 24-hour rainfall (in), and
s	=	slope of hydraulic grade line (land slope, ft/ft).

- **Shallow Concentrated Flow**

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from the following figure (Figure 5) in which average velocity is a function of watercourse slope and type of channel.

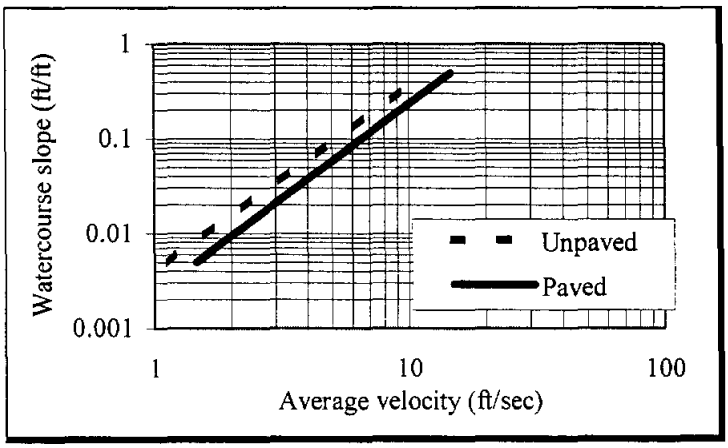


Figure 5 Average Velocities for Estimating Travel Time in Shallow Concentrated Flow Segments

After determining the average velocity, the following equation is used to compute travel time:

$$Tt = L / (3600 \times V) \qquad \text{Equation 6}$$

Where;

Tt	=	travel time (hr),
L	=	flow length (ft),
V	=	average velocity (ft/s), and
3600	=	conversion factor from seconds to hours.

- **Open Channel Flow**

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation. Both open channel and closed conduit systems can be included.

Manning's equation is

$$V = 1.49 \times r^{2/3} \times s^{0.5} / n \qquad \text{Equation 7}$$

where

V	=	average velocity (ft/sec),
r	=	hydraulic radius (ft) and is equal to a/p_w,
a	=	cross sectional flow area (ft^2),
p_w	=	wetted perimeter (ft),
s	=	slope of the hydraulic grade line (channel slope, ft/ft), and
n	=	Manning's roughness coefficient for open channel flow.

After determining the average velocity, equation 6 is used to compute travel time.

2.3 HYDROGRAPH ROUTING

The Kinematic Wave method of stream flow routing is used in this analysis to modify hydrographs to reflect the effects of translation and attenuation within a channel reach. The required input for this method includes: channel length (6,200 feet), channel slope (1.25%), Manning's roughness coefficient (0.04), channel bottom width (40 feet) and a representative channel side slope (10:1).

2.4 RESULTS

Tables 2 and 3 present the results of this hydrologic analysis for the existing conditions and the future full development conditions of the watershed. The existing conditions 100-year computed peak flow rate at Mountain Crest Drive (subarea A) is 2,708 cfs. The combined 100-year existing conditions flow near the project outfall (#10 Tee box) is 3,840 cfs. The corresponding

future 100-year computed peak flow rates at Mountain Crest Drive and the project outfall are 3,072 cfs and 4,376 cfs, respectively.

Table 2 Existing Conditions Computed Peak flow Rates

	Drainage Area	Computed Peak Flow Rates (cfs)				
	(sq mi)	10-Year	50-Year	100-Year	500-Year	Flow Location
Subbasin A	1.162	1,635	2,402	2,708	3,458	Mountain Crest Drive
Subbasin B	0.526	912	2,384	1,477	1,857	
Total	1.688	2,293	3,394	3,840	4,938	Outfall near #10 Tee

Table 3 Future Conditions Computed Peak flow Rates

	Drainage Area	Computed Peak Flow Rates (cfs)				
	(sq mi)	10-Year	50-Year	100-Year	500-Year	Flow Location
Subbasin A	1.162	2,004	2,777	3,072	3,819	Mountain Crest Drive
Subbasin B	0.526	1,072	1,472	1,626	1,998	
Total	1.688	2,826	3,947	4,376	5,466	Outfall near #10 Tee

Complete rainfall (depth and distribution) and peak flow rate information was not available for calibration in this study. However, the results of the analysis were reviewed by representatives of the Guadalupe-Blanco River Authority (GBRA), and compared with the values computed using the USGS regional regression equations published in WRIR 96-4307. The upper and lower confidence limits (67%) of the equations were computed to estimate a correlation and/or statistical expectation. The results are as follows for the 100 year design storm:

HEC-HMS 100-yr Design Storm: **4376 cfs**

100-yr regression equation upper limit: 5529 cfs
100-yr regression equation: 2731 cfs
100-yr regression equation lower limit: 1349 cfs

3.0 HYDRAULIC ANALYSIS

3.1 METHOD OF ANALYSIS

Version 2.2 (September 1998) of the HEC-RAS computer program developed by the Hydrologic Engineering Center (HEC) of the US Army Corps of Engineers is used in this analysis to compute water surface elevations along the existing channel reach. Water surface elevations are computed for the 10-year, 50-year, 100-year and 500-year frequency storm events. HEC-RAS model output is included in Appendix C. The following sections describe the primary model input parameters and the results of the analysis.

3.1.1 Starting Condition

The starting condition for the downstream boundary condition is set at critical depth for all profiles.

3.1.2 Peak Flow Rates

The computed peak flow rates presented in the previous section are used in this analysis to estimate the 10-year, 50-year, 100-year and 500-year water surface elevations along the creek.

3.1.3 Channel Geometry

Channel cross section data used in the model is based on field survey data collected along the creek specifically for this project. Survey data is tied to FEMA benchmarks and includes each culvert crossing, significant hydraulic features and representative channel sections.

3.1.4 Manning Roughness Coefficients

For open channel flow, the HEC-RAS computer program computes water surface elevations for each cross-section based on the energy equation and the standard step method. Typically, Manning's equation is used by the program to estimate head losses from one cross-section to the next. Channel roughness coefficients typically range from approximately 0.035 to 0.040 for grass lined channels, may increase to about 0.06 to 0.08 for poorly maintained channels with high weeds and small trees.

3.2 RESULTS

Tables 4 and 5 present the computed water surface elevations from the hydraulic analysis of the existing and future development conditions of the watershed, respectively. Exhibit 3a illustrates the current floodplain delineation along Hog Creek published by FEMA, and Exhibit 3b illustrates the floodplain delineations for the "revised" existing and future conditions of Hog Creek without improvements. Exhibit 4a and 4b illustrate the stream profiles for the "revised" existing and future conditions of the watershed, respectively.

Table 4 Existing Conditions Computed Water Surface Elevations

Station	500-Year		100-Year		50-Year		10-Year		
	Flow Rate	CWSEL	Flow Rate	CWSEL	Flow Rate	CWSEL	Flow Rate	CWSEL	
(feet)	(cfs)	(feet)	(cfs)	(feet)	(cfs)	(feet)	(cfs)	(feet)	Description
10+00	4,938	943.50	3,840	943.28	3,394	943.12	2,293	942.47	near outfall (#10 Tee)
10+67	4,938	944.56	3,840	944.22	3,394	944.07	2,293	943.69	
11+18	4,938	944.96	3,840	944.68	3,394	944.56	2,293	944.12	
11+19	4,938	945.91	3,840	945.60	3,394	945.46	2,293	945.09	
18+19	4,444	953.02	3,463	952.57	3,063	952.36	2,074	951.77	
18+84	4,444	953.53	3,463	952.90	3,063	952.90	2,074	952.90	
19+09									Brookhollow Dr.
19+34	4,444	955.43	3,463	955.11	3,063	954.96	2,074	954.57	
19+91	4,444	955.38	3,463	955.00	3,063	954.71	2,074	954.49	
20+92	4,444	953.62	3,463	955.55	3,063	955.49	2,074	954.90	
21+02	4,444	955.68	3,463	955.38	3,063	955.06	2,074	954.56	
22+26	4,444	956.80	3,463	956.33	3,063	956.14	2,074	955.38	
33+12	4,198	969.96	3,274	969.35	2,898	969.04	1,964	968.19	
33+35	4,198	970.70	3,274	970.15	2,898	969.87	1,964	969.03	
33+43									Brookmeadow Dr.
33+72	4,198	971.48	3,274	970.95	2,898	970.75	1,964	970.15	
34+44	4,198	970.22	3,274	969.55	2,898	970.62	1,964	970.17	
34+84	4,198	972.05	3,274	971.53	2,898	971.29	1,964	970.58	
34+95									driveway
35+05	4,198	973.02	3,274	972.51	2,898	972.28	1,964	971.62	
36+81	4,198	975.39	3,274	974.83	2,898	974.58	1,964	973.90	
36+96									Brookside Dr.
37+11	4,198	976.43	3,274	975.98	2,898	975.76	1,964	975.13	
37+41	4,198	976.47	3,274	976.06	2,898	975.85	1,964	975.24	
40+20	4,198	978.59	3,274	978.12	2,898	977.92	1,964	977.43	
40+48	4,198	979.19	3,274	978.71	2,898	978.48	1,964	977.76	
57+37	4,198	1,003.14	3,274	1,002.08	2,898	1,001.61	1,964	1,000.25	
57+68							Culvert		Mountain Crest Dr.
57+98	4,198	1,007.26	3,274	1,006.45	2,898	1,006.19	1,964	1,005.51	
58+27	3,458	1,007.32	2,708	1,006.49	2,401	1,006.23	1,635	1,006.02	

Table 5 Future Conditions Computed Water Surface Elevations

Station	500-Year		100-Year		50-Year		10-Year		
	Flow Rate	CWSEL	Flow Rate	CWSEL	Flow Rate	CWSEL	Flow Rate	CWSEL	
(feet)	(cfs)	(feet)	(cfs)	(feet)	(cfs)	(feet)	(cfs)	(feet)	Description
10+00	5,466	943.70	4,376	943.42	3,947	943.31	2,826	942.88	near outfall (#10 Tee)
10+67	5,466	944.73	4,376	944.39	3,947	944.26	2,826	943.82	
11+18	5,466	945.86	4,376	945.51	3,947	945.36	2,826	944.97	
11+19	5,466	946.05	4,376	945.76	3,947	945.63	2,826	945.28	
18+19	4,917	953.20	3,941	952.80	3,557	952.61	2,552	952.07	
18+84	4,917	953.83	3,941	953.19	3,557	952.94	2,552	952.90	
19+09									Brookhollow Dr.
19+34	4,917	955.58	3,941	955.27	3,557	955.14	2,552	954.77	
19+91	4,917	955.50	3,941	955.18	3,557	955.03	2,552	954.60	
20+92	4,917	955.91	3,941	955.68	3,557	955.58	2,552	955.22	
21+02	4,917	956.68	3,941	955.66	3,557	955.45	2,552	954.77	
22+26	4,917	958.39	3,941	956.50	3,557	956.36	2,552	955.78	
33+12	4,643	970.17	3,724	969.65	3,362	969.41	2,415	968.60	
33+35	4,643	970.93	3,724	970.43	3,362	970.21	2,415	969.46	
33+43									Brookmeadow Dr.
33+72	4,643	971.60	3,724	971.20	3,362	971.01	2,415	970.44	
34+44	4,643	971.02	3,724	970.88	3,362	970.79	2,415	970.41	
34+84	4,643	972.27	3,724	971.80	3,362	971.59	2,415	970.94	
34+95									driveway
35+05	4,643	973.23	3,724	972.76	3,362	972.56	2,415	971.96	
36+81	4,643	975.64	3,724	975.11	3,362	974.88	2,415	974.25	
36+96									Brookside Dr.
37+11	4,643	976.67	3,724	976.17	3,362	976.04	2,415	975.46	
37+41	4,643	976.68	3,724	976.23	3,362	976.11	2,415	975.56	
40+20	4,643	979.60	3,724	978.93	3,362	978.67	2,415	977.92	
40+48	4,643	980.43	3,724	979.59	3,362	979.28	2,415	978.21	
57+37	4,643	1,003.63	3,724	1,002.60	3,362	1,002.18	2,415	1,000.94	
57+68									Mountain Crest Dr.
57+98	4,643	1,004.23	3,724	1,006.82	3,362	1,006.52	2,415	1,005.20	
58+27	3,819	1,008.31	3,072	1,006.87	2,777	1,006.57	2,004	1,006.04	

4.0 PROPOSED IMPROVEMENTS

The proposed improvements to Hog Creek include four (4) primary components: a bridge upgrade at Brookhollow Drive, channel improvements downstream of Brookhollow Drive to outfall at the amenity lake, a roadside ditch along Cypress Point Road and the adoption of watershed management practices. The following sections describe these recommendations.

4.1 BRIDGE UPGRADE AT BROOKHOLLOW

The proposed low water crossing at Brookhollow Drive should be upgraded to include an all weather bridge crossing. The proposed bridge opening developed in this study includes a bottom width of 70 feet, and a top width of 120 feet. The depth of the proposed bridge opening is 5.0 feet. The road surface would be raised approximately 1.0 foot.

This all weather crossing is required at this location to provide connectivity for emergency vehicles during storm events.

4.2 CHANNEL IMPROVEMENTS DOWNSTREAM OF BROOKHOLLOW DRIVE

The channel downstream of Brookhollow Drive should be improved to include a bottom width of 40 feet, 3:1 side slopes (horizontal : vertical) and a channel slope of 1.0% (ft/ft). The proposed channel will lie within the channel bed of the existing waterway, and should only have minimal conflicts with existing trees. The downstream end of the channel improvement will begin at the upper edge of the existing amenity lake, just east of the #10 Tee box. The existing top of bank of the amenity lake will serve as the starting flowline of the proposed channel, and preserve this rock outcrop feature and provide erosion control at the proposed channel outfall.

4.3 ROADSIDE DITCH AT CYPRESS POINT ROAD

A roadside ditch extending from Hog Creek west of the #10 Tee box along Cypress Point Road is proposed to divert drainage from the landing strip and Doolittle Drive to the amenity lake. There is currently no defined outfall to the amenity lake for these areas. The roadside ditch will include a 'V' shape with 3:1 side slopes and a varying depth of 2.0 to 4.0 feet. This roadside ditch will include the replacement of two (2) driveway crossings.

4.4 WATERSHED MANAGEMENT

Watershed management will include the improvements described above; however, in order to be effective in the long term, it will also be necessary to regulate future development in the floodplain in accordance with the National Flood Insurance Program (NFIP) and perform routine maintenance on Hog Creek to preserve flood conveyance.

4.4.1 Permitting and Regulatory Compliance

The NFIP is a Federal program enabling property owners in participating communities to purchase insurance protection against losses from flooding. Participation in the NFIP is based on an agreement between local communities and the Federal Government, which enables flood insurance to the citizens of the community, provided the community adopts and enforces a floodplain management ordinance.

At a minimum, the City of Woodcreek should formally adopt and enforce the criteria established by the NFIP for regulating development in the floodplain. In order to effectively regulate development in the Hog Creek floodplain, a request for Letter of Map Revision (LOMR) should be submitted to the Federal Emergency Management Agency (FEMA) to better define the limits of the floodplain and floodway defined on FEMA's Flood Insurance Rate Maps (FIRM).

4.4.2 Maintenance

Creek maintenance is an important means of ensuring continued, adequate conveyance. Specifically in the heavily wooded areas upstream of Brookhollow Drive, dead trees and limbs, and debris should be removed routinely. Maintenance may also include mowing as needed throughout the year.

In addition, the rock wall guard rail located at Brookmeadow Drive impedes the flow of the creek and should be removed. A more compatible guard rail system can be installed if necessary for safety considerations.

5.0 IMPLEMENTATION PLAN

5.1 REGULATORY COMPLIANCE

Prior to commencement of construction, it will be necessary to submit the project and appropriate permit applications to regulatory agencies. A detailed review and acquisition of the necessary permits for the construction of these project(s) exceeds the scope of this contract. However, a partial list and brief discussion of permits is included in the following subsections. This following list of agencies and corresponding permit activities is intended to be general in nature, and is not intended to represent an exhaustive search of this issue.

5.1.1 Federal Emergency Management Agency (FEMA)

The Nation Flood Insurance Act of 1968 was enacted by Title XIII of the Housing and Urban Development Act of 1968 (Public Law 90-448, August 1, 1968) to provide previously unavailable flood insurance protection to property owners in flood prone areas. The Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program (NFIP), however, if a local community elects to participate in the NFIP, the local government is primarily responsible for enforcement. Participating communities are typically covered by flood insurance studies (FIS) which define water surface profiles and flood plain boundaries through their communities.

Hog Creek, a tributary to Cypress Creek, is a studied stream in the current Hays County Flood Insurance Study (FIS) dated February 18, 1998. The approximate limits of the 100-year floodplain boundary (Zone A) is illustrated on Flood Insurance Rate Map (FIRM) Panel No. 48209C0094 E.

The results of the existing conditions analysis presented in this study may be submitted to FEMA in order to obtain a revision to the current FIRM. This requires a formal submittal to FEMA in the form of a request for a letter of map revision (LOMR). The proposed improvements included in this study may be submitted to FEMA with the appropriate fee in the form of a conditional letter of map revision (CLOMR). The purpose of a CLOMR is to gain assurance from FEMA that the proposed improvements will be effective in reducing the limits of the 100-year floodplain as described in this study. Formal submittals to FEMA in the form of a LOMR or CLOMR request exceeds the scope of this project.

5.1.2 U. S. Army Corps of Engineers (USACOE)

Pursuant to Section 404 of the Clean Water Act and the Rules and Regulations promulgated thereunder by the United States Environmental Protection Agency (EPA) and the United States Army Corps of Engineers (USACE), the filling or excavation of waters of the United States, including wetlands, with dredged or fill material, requires the issuance of a permit from the USACE (33 CFR Parts 320-330). For purposes of administering the Section 404 permit program, the USACE defines wetlands as follows:

Those areas that are inundated or saturated by surface or groundwater at a

> *frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas. (33 CFR 328.3)*

The Corps of Engineers Wetlands Delineation Manual (Technical Report Y-87-1), issued by the USACE, in 1987, states that wetlands must possess three essential characteristics. These characteristics include, under normal circumstances: 1) the presence of hydrophytic (water-loving) vegetation, 2) hydric soils, and 3) wetland hydrology. If all three of these criteria are present on a particular property in areas larger than one-third acre in size, then a permit (general permit or nationwide permit) must be issued by the USACE in order to fill all or a portion of those areas.

All property owners within the United States and its territories must adhere to the provisions of the Clean Water Act. If any contemplated activity might impact waters of the United States, including adjacent or isolated wetlands. If jurisdictional wetlands are found to exist, then any activity which would involve filling, excavating, or dredging these wetlands would require the issuance of a permit.

Section 404 (b)(1) guidelines (40 CFR Part 230), established by the U. S. Environmental Protection Agency, constitute the substantive environmental criteria used in the evaluating activities regulated under Section 404 of the Clear Water Act. The purpose of these guidelines is to restore and maintain the chemical physical and biological integrity of waters of the United states through the control of discharge of dredged or fill material.

5.1.3 U. S. Environmental Protection Agency (EPA)

The Federal Clean Water Act of 1972 established several programs designed to protect and enhance the quality of the Nation's surface water. One of these programs, the National Pollutant Discharge Elimination Systems (NPDES) regulates construction activities disturbing more than five (5) acres of land. Any proposed project that involves clearing, grading, or excavating will be covered under the NPDES Storm Water Permit for Construction Activities as long as the project complies with the Storm Water Pollution Prevention Plan (SWPPP) and all other conditions associated with the NPDES storm water construction permit.

A Notice of Intent (NOI) must be filed with the U. S. Environmental Protection Agency at least 48 hours in advance of construction activities. Changes to the timing of the notification should be tracked to ensure that construction delays do not result from inadequate advance notification.

5.1.4 U. S. Fish and Wildlife Service (USFWS)

The U. S. Fish and Wildlife Service (USFWS), in the Department of the Interior, and the National Marine Fisheries Service (NMFS), in the Department of Commerce, share responsibility for administration of the Endangered Species Act (ESA). Generally the USFWS is responsible for terrestrial and freshwater species and migratory birds, while the NMFS deals with those species occurring in marine environments and anadromous fish.

Section 9 of the ESA prohibits take of federally listed endangered or threatened species without appropriate authorization. Take is defined in the ESA, in part as "killing, harming, or harassment" of a federally listed species, while incidental take is take that is "incidental to, and not the purpose of, otherwise lawful activities".

Section 10 of the ESA provides a means for non-Federal projects resulting in take of listed species to be permitted subject to carefully prescribed conditions. Application for an incidental take permit is subject to a number of requirements, including preparation of a Habitat Conservation Plan by the applicant. In processing an incidental take permit application, the USFWS must comply with appropriate environmental laws, including the National Environmental Policy Act. Review of the application under Section 7 of the ESA is also required to ensure that permit issuance is not likely to jeopardize listed species. Section 10 issuance criteria require the USFWS to issue and incidental take permit if, after opportunity for public comment, it finds that:

1. the taking will be incidental;
2. the applicant will, to the maximum extent practicable, minimizing and mitigate the impacts of the taking;
3. the applicant will ensure that adequate funding and means to deal with unforeseen circumstances will be provided;
4. the taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild; and
5. the applicant will ensure that other measures that the USFWS may require as being necessary or appropriate will be provided.

The U. S. Fish and Wildlife Service should be contacted to determine the potential occurrence of and consequent impacts to any federal threatened and endangered species. In addition, the Corps of Engineers will require USFWS review of the project to ensure the project is in compliance with the Endangered Species Act prior to the issuance of a Section 404 permit.

5.1.5 Texas Natural Resource Conservation Commission (TNRCC)

The Texas Natural Resource Conservation Commission (TNRCC) has regulatory authority over: dam safety, the Edwards Aquifer, water rights, Texas Pollutant Discharge System and Section 404(b)(1) guidelines for specification of disposal sites for dredged or fill material. The following sections briefly describe these regulations.

- Edwards Aquifer Rules

The Edwards Rules (30 TAC Chapter 213) regulate activities having the potential for polluting the Edwards Aquifer and associated surface waters. The goals of the rules are the protection of existing and potential uses of groundwater and the maintenance of Texas Surface Water Quality Standards. The activities addressed are those that pose a threat to water quality in the recharge and transition zones. The rules apply in the Edwards Aquifer recharge, transition, and

contributing zones. The limits of this project(s) lie within the Edwards Aquifer contributing zone, and will require compliance with the Edwards Rules published June 1, 1999.

Construction of any regulated activity will require the submission of an application to, and the approval of the TNRCC. Each application is required to include the following:

1. Name of the development;
2. A narrative description of the location of the project;
3. A technical report (includes information prepared for NPDES SWPPP, description of permanent BMP's, measured to control stream bank erosion, method of wastewater disposal from the site, measures that will be used to contain any spill of static hydrocarbons or hazardous substances such as on a roadway or from a pipeline or temporary aboveground storage tank and indicate placement of permanent aboveground storage tank facilities (§213.24)); and
4. Any additional information needed by the executive director for plan approval.

- Texas Pollutant Discharge Elimination System (TPDES)

On September 14, 1998, the U.S. Environmental Protection Agency (EPA) authorized Texas to implement its Texas Pollutant Discharge Elimination System (TPDES) program. TPDES is the state program to carry out the National Pollutant Discharge Elimination System (NPDES), a federal regulatory program to control discharges of pollutants to surface waters of the United States. The Texas Natural Resource Conservation Commission (TNRCC) will regulate the program. However, under terms of NPDES authorization, the EPA will retain administration of all EPA-issued storm water general permits until the existing permits expire. The expiration date for existing construction permits is July 7, 2003.

- Section 401 Water Quality Certification

Any activity requiring authorization under Section 404 of the Clean Water Act will also require a Section 401 water quality certification from the TNRCC. In Texas, these regulations are administered by the TNRCC.

- Texas Historical Commission

The Division of Antiquities Protection of the Texas Historical Commission coordinates the program by identifying and protecting important archeological and historic sites that may be threatened by public construction projects. This department coordinates the nomination of numerous sites as State Archeological Landmarks or for listing in the National Register of Historic Places. Designation is often sought by interested parties as the most effective way to protect archeological sites threatened by new development or vandalism. Applicable rules are found in the Texas Administrative Code, Title 13-Cultural Resources, Part II-Texas Historical Commission, Chapters 24-28.

The Corps of Engineers will require that the State Historical Preservation Officer (SHPO) review the project to ensure the project is in compliance with the National Historic Act prior to issuance of a Section 404 permit.

5.2 ENVIRONMENTAL INVENTORY

The environmental issues of this report have been developed by reference to existing information in published reports, maps, aerial photography, unpublished documents and communications from government agencies, individuals, and private organizations. These issues have been summarized to provide a general review level of the flora and fauna in the immediate area of Woodcreek beginning at the 10^{th} tee box on the Woodcreek Golf Course and proceeding in a northerly direction to the water gap, an area outside the Woodcreek city limits. Generally, this discussion presents a cursory, screening level perspective on the environmental issues which may affect the study area.

Important species may be considered the local dominant (most abundant) species, species having some economic or recreational importance, those exhibiting disproportionate habitat impacts (habitat formers) as well as species listed, or proposed for listing, by either the State of Texas or the federal government (protected species) or Texas Organization for Endangered Species (TOES). There are numerous unlisted species, which are still of concern (due to their rarity, restricted distribution direct exploitation, or habitat vulnerability) yet have not been included in the following discussions. Typically, the level of detail required to obtain the distribution and life history of these species, so as to produce a substantive evaluation, would be beyond the scope of this screening level survey.

5.2.1 Environmental Setting

Woodcreek is located about 12 miles northeast of Canyon Reservoir in Hays county on the Edwards Plateau. Woodcreek is located in a valley of the Blanco River at about 800 to 900 ft-msl. Land use in Woodcreek is rural residential, suburban residential and recreational. Most of the surrounding land use is rangeland, which is typical for the region.

5.2.2 Tree Survey

In order to establish a typical distribution of native tree species, a representative section of Hog Creek beginning at Brookhollow Drive and continuing to Brookmeadow Drive in the City of Woodcreek was surveyed. The following types, and quantities of trees were located immediately adjacent to the creek.

Table 6 Representative Tree Survey

Name	Qnty
Live Oak	10
Hackberry	1
Cedar Elm	50
Sycamore	13
Mountain Juniper	100
Willow	1
Red Oak	1
Bald Cypress	1
Sample taken between Brookhollow Dr. and Brookmeadow Dr.	

5.2.3 Wetlands Inventory

Developed areas around Woodcreek total 99 percent, primarily residential, with about 1 percent wetland area adjacent to the creek. Based on the information provided on the U. S. Fish and Wildlife Service (USFWS) Inventory Maps dated 1992 (based on 7 ½ minute USGS Quadrangle, Driftwood, Texas), the study area includes two (2) primary areas: Hog Creek and the amenity lake. The following table provides a breakdown of the wetland designations presented on the inventory map.

Table 7 Wetlands Inventory

Identified Feature	Symbol	System	Subsystem	Class	Subclass	Water Regime	Special Modifiers
Hog Creek	P FO 1 A	Palustrine	n/a	Forested	Broad-Leaved Deciduous	Temporarily Flooded	n/a
Amenity Lake	P UB H h	Palustrine	n/a	Unconsolidated Bottom	n/a	Permanently Flooded	diked/impounded

5.2.4 Wildlife Habitat

Important species known to occur in Hays County, and which may have habitat within the study area are listed in Table 8. Although the species listed in the table do not necessarily occur within Woodcreek proper, this is a comprehensive list of species and their preferred habitats that have the potential to be present, along with others known to Comal and Hays Counties.

Table 8 Important Species Having Habitat or Known to Occur

			Listing Entity			
Common Name	Scientific Name	Summary of Habitat Preference	USFWS1	TPWD1	TOES2,3	Potential Occurrence In County
American Peregrine Falcon	Falco peregrinus anatum	Open country: cliffs		E	E	Nesting/Migrant
Arctic Peregrine Falcon	Falco peregrinus tundrius	Open country: cliffs		T	T	Nesting/Migrant
Black-capped Vireo	Vireo atricapillus	Semi-open broad-leaved shrublands	E	E	T	Nesting/Migrant
Blanco Blind Salamander	Eurycea robusta	Troglobitic: Stream bed of the Blanco River		T	T	Resident
Blanco River Springs Salamander	Eurycea pterophila	Subaquatic: Springs and caves of the Blanco River				Resident
Blue Sucker	Cycleptus elongatus	Channels and flowing pools with exposed bedrock		T	WL	Resident
Bracted Twistflower	Streptanthus bracteatus	Endemic: Shallow clay soils over limestone; rocky slopes			E	Resident
Cagle's Map Turtle	Graptemys caglei	Waters of the Guadalupe River Basin	C		C	Resident
Canyon Mock-Orange	Philadelphus ernestii	Edwards Plateau			WL	Resident
Cascade Caverns Salamander	Eurycea latitans	Endemic: Subaquatic: Springs and caves		T	T	Resident
Cave Myotis Bat	Myotis velifer	Colonial & cave dwelling; hibernates in limestone caves of Edwards Plateau				Resident
Comal Blind Salamander	Eurycea tridentifera	Endemic: Semi-troglobitic: Springs and waters of caves		T	T	Resident
Comal Springs Dryopid Beetle	Stygoparnus comalensis	Cling to objects in streams; adults fly especially at night	E			Resident
Comal Springs Riffle Beetle	Heterelmis comalensis	Comal and San Marcos Springs	E			Resident
Comal Springs Salamander	Eurycea sp. 8	Endemic: Comal Springs				Resident
Dark Noseburn	Tragia nigricans	Deciduous woodlands, clay or clay loams, mesic canyons			WL	Resident
Edwards Aquifer Diving Beetle	Haideoporus texanus	Habitat poorly known; known from artesian well				Resident
Edwards Plateau Spring Salamander	Eurycea sp. 7	Troglobitic: Edwards Plateau				Resident
Flint's Net-Spinning Caddisfly	Cheumatopsyche flinti	"a spring"				Resident
Fountain Darter	Etheostoma fonticola	San Marcos and Comal rivers: springs and spring-fed streams	E	E	E	Resident
Golden-Cheeked Warbler	Dendroica chrysoparia	Woodlands with oaks and old juniper	E	E	E	Nesting/Migrant
Guadalupe Bass	Micropterus treculi	Streams of eastern Edwards Plateau			WL	Resident
Henslow's Sparrow	Ammodramus henslowii	Weedy fields or cut over areas; bare ground for running and walking				Nesting/Migrant
Hill Country Wild-Mercury	Argythamnia aphoroides	Shallow to moderately deep clays; live oak woodlands			WL	Resident
Horseshoe Liptooth	Polygyra hippocrepis	Steep, wooded hillsides of Land Park in New Braunfels				Resident
Keeled Earless Lizard	Holbrookia propinqua	Coastal dunes, Barrier islands and sandy areas				Resident
Lindheimer's Tickseed	Desmodium lindheimeri	Presumably flowers in mid-summer			WL	Resident
Peck's Cave Amphipod	Stygobromus pecki	Underground in Edwards aquifer	E			Resident
Plains Spotted Skunk	Spilogale putorius interrupta	Catholic: Wooded, brushy areas and tallgrass prairies				Resident
San Marcos Gambusia (extirpated)	Gambusia georgei	Endemic: upper San Marcos River	E	E	E	Resident
San Marcos Saddle-case Caddisfly	Protoptila arca	Swift; well-oxygenated warm water 1-2 m deep				Resident
San Marcos Salamander	Eurycea nana	Headwaters of the San Marcos River	T	T	T	Resident
Spot-tailed Earless Lizard	Holbrookia lacerata	Oak-juniper woodlands and mesquite-prickly pear				Resident
Texas Amorpha	Amorpha roemeriana					Resident
Texas Blind Salamander	Eurycea rathbuni	Troglobitic: Caverns along 6 mile stretch of San Marcos Springs Fault	E	E	T	Resident
Texas Garter Snake	Thamnophis sirtalis annectens	Varied, especially wet areas: bottomlands and pastures				Resident
Texas Horned Lizard	Phrynosoma cornutum	Varied, sparsely vegetated uplands		T	T	Resident
Texas Mock-Orange	Philadelphus texensis	Endemic: Limestone cliffs and boulders in mesic stream bottoms and canyons			WL	Resident
Texas Salamander	Eurycea neotenes	Edwards Aquifer creek gravel bottoms, emergent vegetation; underground & rock ledges				Resident
Texas Wild-Rice	Zizania texana	Upper 2.5 km of the San Marcos River	E	E	E	Resident
Warnock's Coral Root	Hexalectris warnockii	Oak-juniper woodlands in mountain canyons; terraces along creekbeds				Resident
Whooping Crane	Grus americana	Potential migrant	E	E	E	Migrant
Zone-tailed Hawk	Buteo albonotatus	Arid, open country including deciduous or pine-oak woodland; nests in various habitats and sites		T	T	Nesting/Migrant

1 Texas Parks and Wildlife Department. Unpublished 1999. September 1999, Data and map files of the Texas Biological and Conservation Data System maintained by TPWD Wildlife Diversity Branch, Resource Protection Division, Austin, Texas.
2 Texas Organization for Endangered Species (TOES). 1995. Endangered, threatened, and watch list of Texas vertebrates. TOES Publication 10. Austin, Texas. 22 pp.
3 Texas Organization for Endangered Species (TOES). 1993. Endangered, threatened, and watch list of Texas plants. TOES Publication 9. Austin, Texas. 32 pp.
4 Texas Organization for Endangered Species (TOES). 1988. Invertebrates of Special Concern. TOES Publication 7. Austin, Texas. 17 pp.

E = Endangered
T = Threatened
E/PT = Proposed Endangered or Threatened
C = Candidate Category, Substantial Information
WL = Conservation Watch List
Blank = Rare, but no regulatory listing status

5.3 CONSTRUCTION PHASING

The construction phasing of this project should generally move from downstream to upstream. The proposed roadside ditch improvement should be constructed first in order to provide immediate service of runoff areas in the west, and diversion of runoff of stormwater as the main channel is being constructed. Once the main channel has been improved, the proposed bridge at Brookhollow Drive can be constructed.

5.4 PRELIMINARY CONSTRUCTION COST ESTIMATE

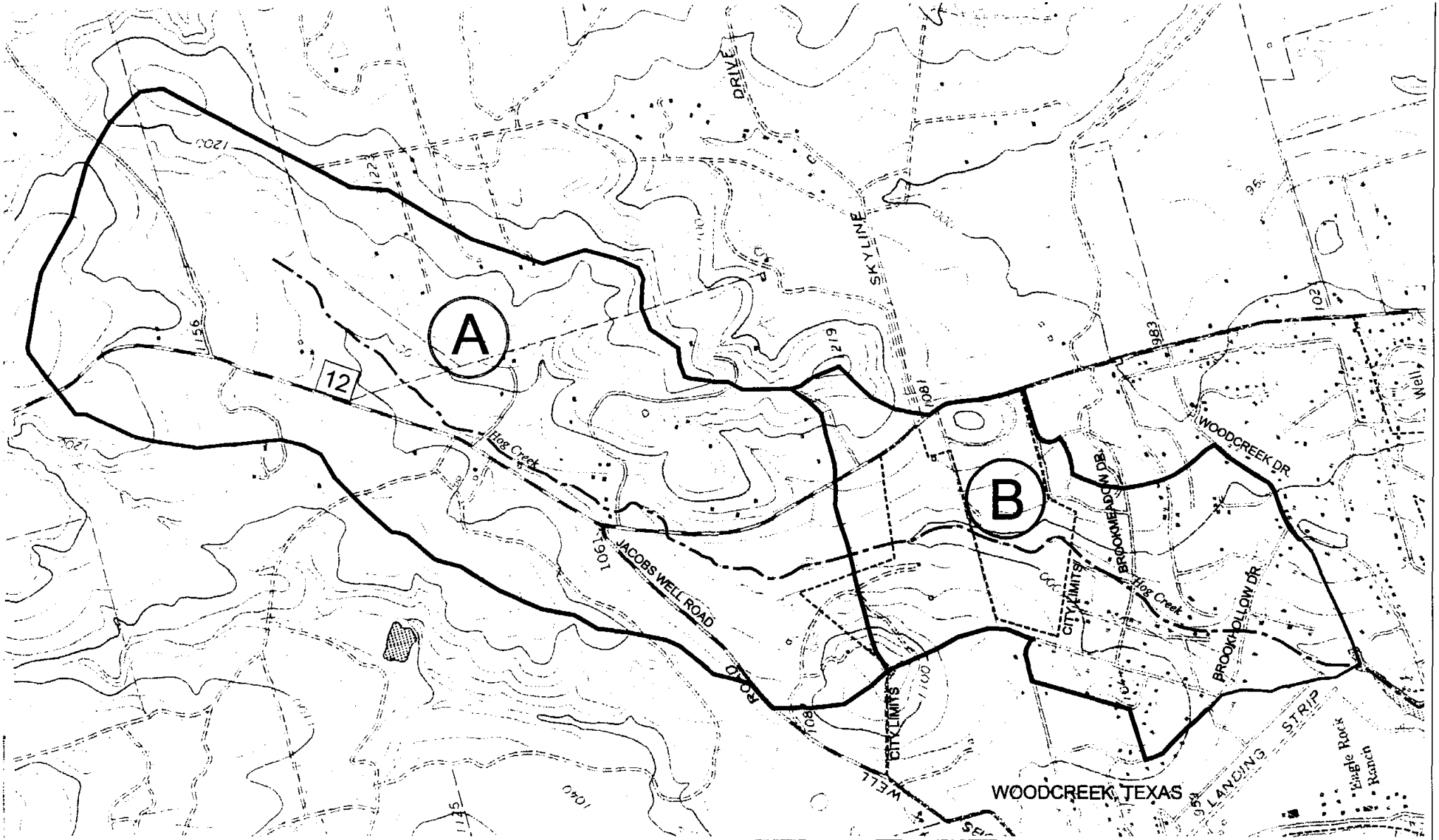
Table 9 presents the preliminary construction cost estimates for the improvements described in this report. These preliminary estimates are for planning purposes only, and are only intended to provide an order of magnitude of the actual construction cost. Once detailed field survey information has been collected and construction plans have been prepared for these improvements, a better estimate of the construction costs can be more accurately estimated.

Table 9 Preliminary Construction Cost Estimate

Channel Improvement	Unit	Quantity	Unit Price	Cost
mobilizaton	LS	1	$ 10,000.00	$ 10,000.00
excavation	CY	8,000	$ 10.00	$ 80,000.00
demolition of check dam	EA	2	$ 2,000.00	$ 4,000.00
erosion/sedimentation controls	LS	1	$ 6,000.00	$ 6,000.00
contingency	25%			$ 22,500.00
engineering and surveying	15%			$ 16,875.00
			Total	$ 139,375.00
Roadside Ditch Improvement				
mobilizaton	LS	1	$ 10,000.00	$ 10,000.00
excavation	CY	1,500	$ 10.00	$ 15,000.00
driveway culvert replacements	EA	2	$ 3,000.00	$ 6,000.00
revegitation	AC	1	$ 1,000.00	
outfall / transition stabilization	LS	1	$ 2,000.00	
erosion/sedimentation control	LS	1	$ 2,000.00	$ 2,000.00
contingency	25%			$ 5,750.00
engineering and surveying	15%			$ 4,312.50
			Total	$ 43,062.50
Bridge at Brookhollow Dr.				
mobilizaton	LS	1	$ 10,000.00	$ 10,000.00
demolition	LS	1	$ 10,000.00	$ 10,000.00
structure	LS	1	$ 240,000.00	$ 240,000.00
utilities	LS	1	$ 10,000.00	$ 10,000.00
erosion/sedimentation control	LS	1	$ 2,000.00	$ 2,000.00
contingency	25%			$ 52,400.00
engineering and surveying	15%			$ 47,160.00
			Total	$ 371,560.00

APPENDIX A - EXHIBITS

Exhibit 1	Drainage Area Map
Exhibit 2	Soil Map
Exhibit 3a	Floodplain: FEMA
Exhibit 3b	Floodplain: Revised Existing and Future
Exhibit 4a	Stream Profiles: Existing Conditions
Exhibit 4b	Stream Profiles: Future Conditions
Exhibit 5	Improvement Plan

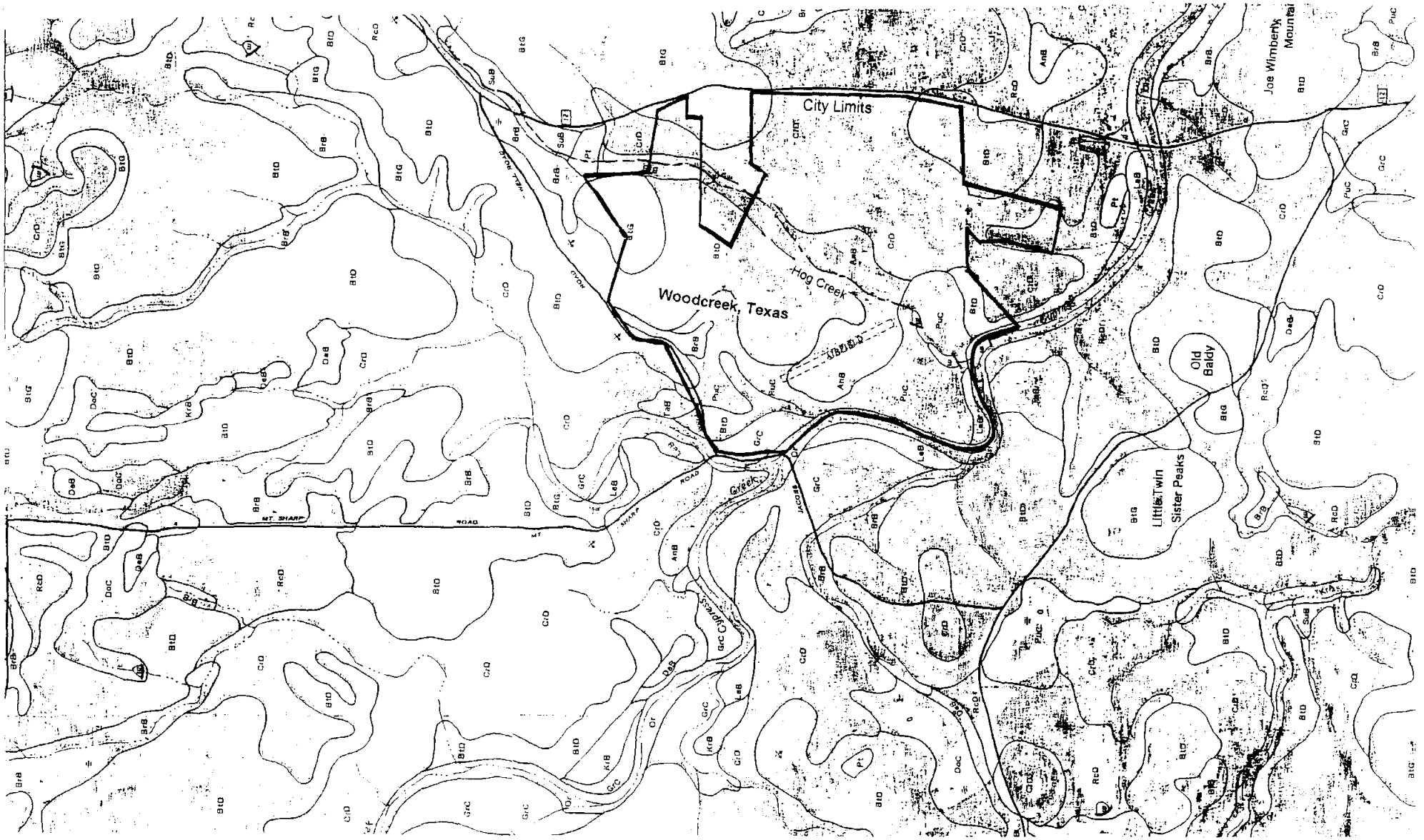


Espey Consultants, Inc.
Environmental & Engineering Services

EXHIBIT 1
DRAINAGE AREA MAP
WOODCREEK MASTER DRAINAGE PLAN

NOVEMBER, 2001

PROJECT NUMBER 200033

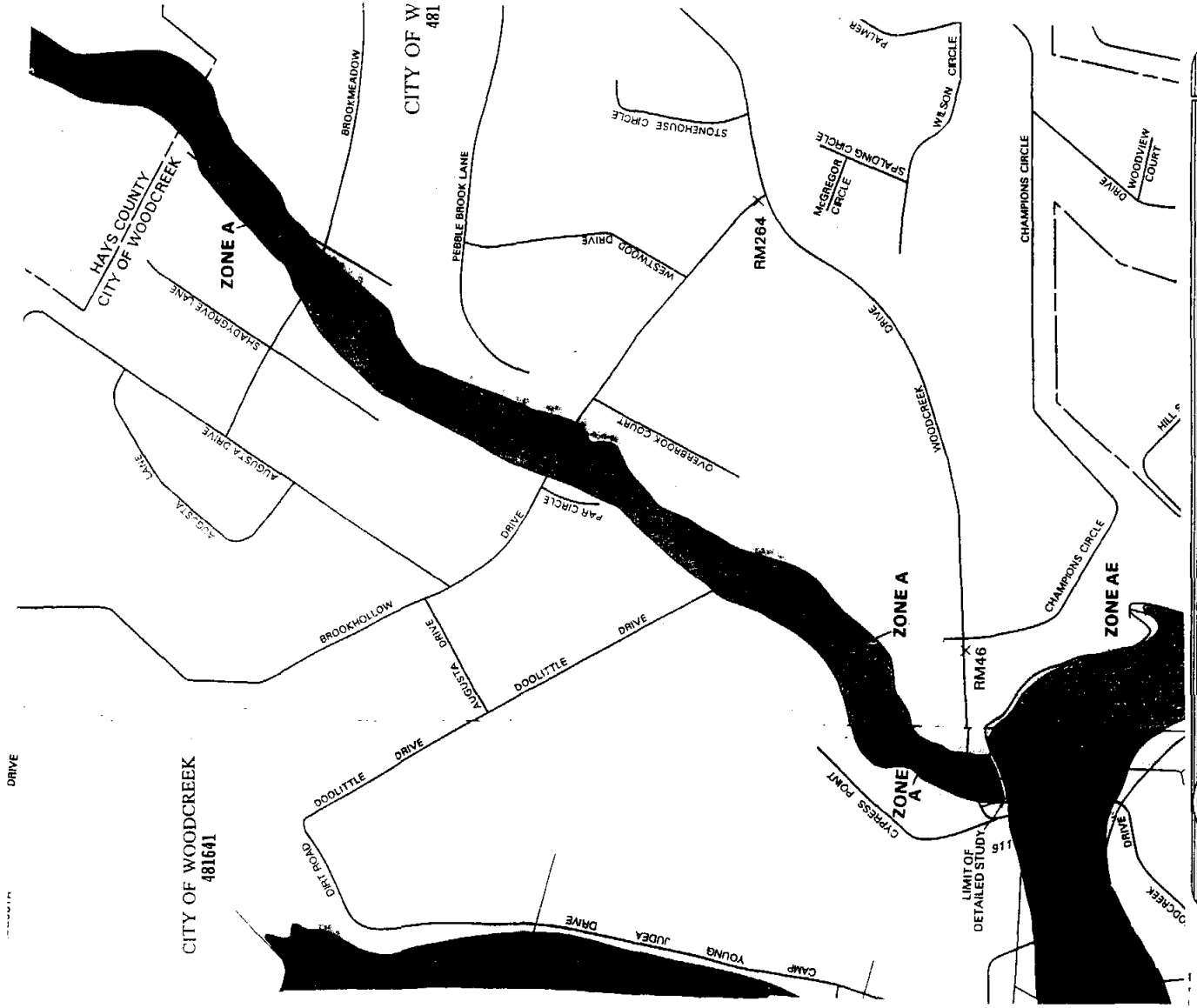


Espey Consultants, Inc.
Environmental & Engineering Services

EXHIBIT 2
SOILS MAP
WOODCREEK MASTER DRAINAGE PLAN

NOVEMBER, 2001

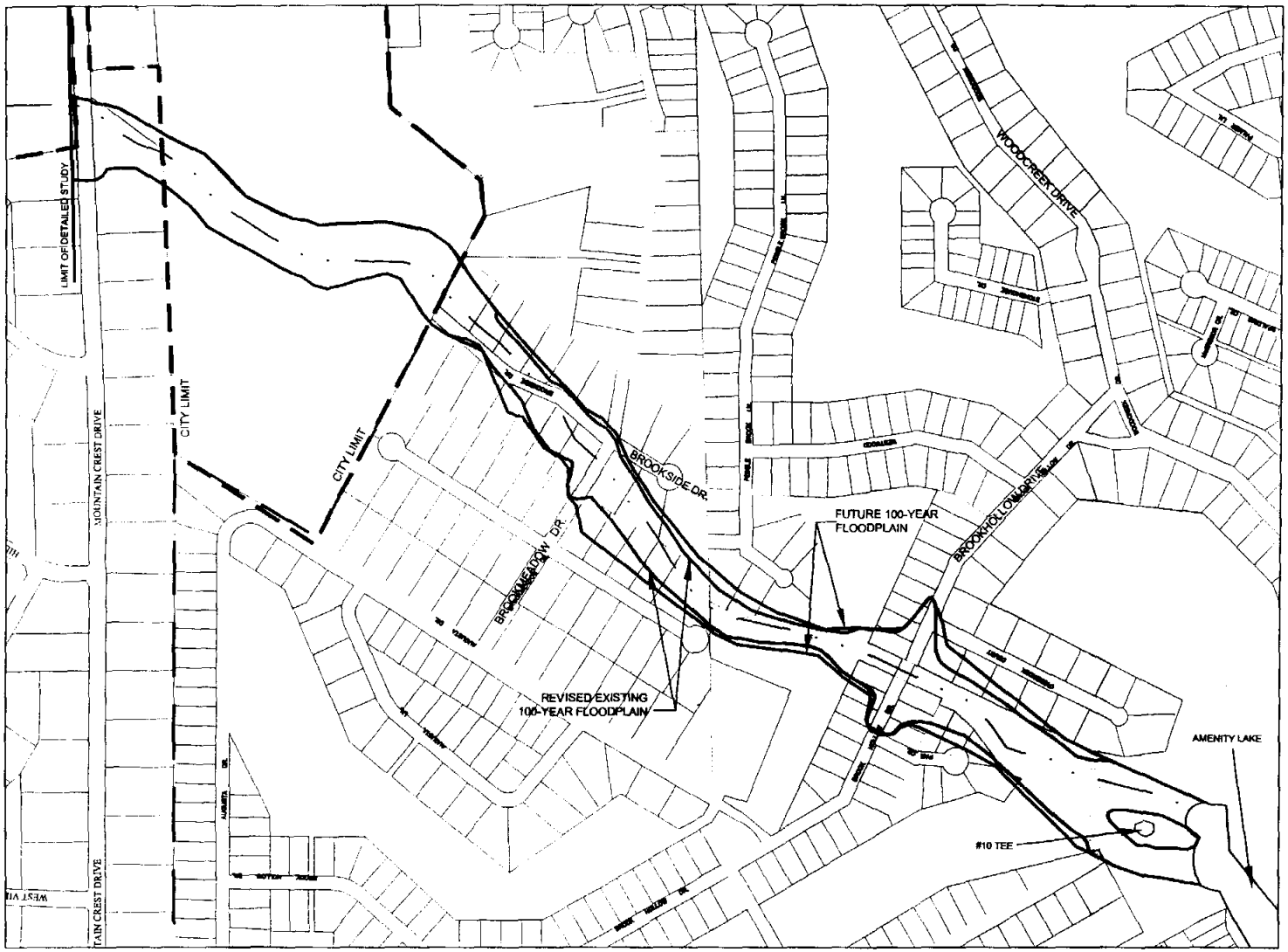
PROJECT NUMBER 2000-33



Note: Zone A floodplains indicate that no base flood elevations have been determined.

Espey Consultants, Inc.
Environmental & Engineering Services

EXHIBIT 3a
FLOODPLAIN : FEMA
WOODCREEK MASTER DRAINAGE PLAN
NOVEMBER, 2001
PROJECT NUMBER 2000-33



0 200 600

400 800

Espey Consultants, Inc.
Environmental & Engineering Services

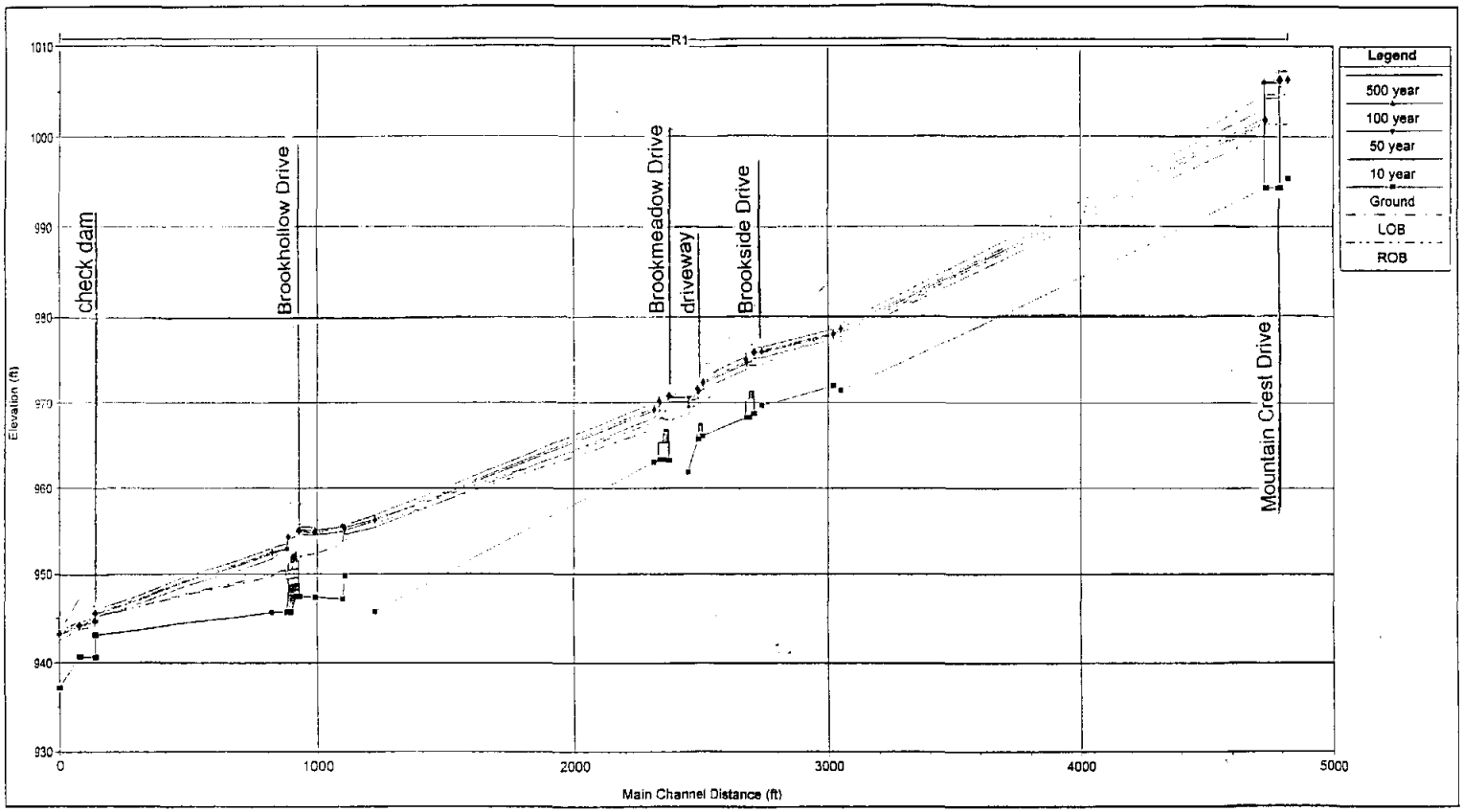
EXHIBIT 3b

FLOODPLAIN: REVISED EXISTING & FUTURE

WOODCREEK MASTER DRAINAGE PLAN

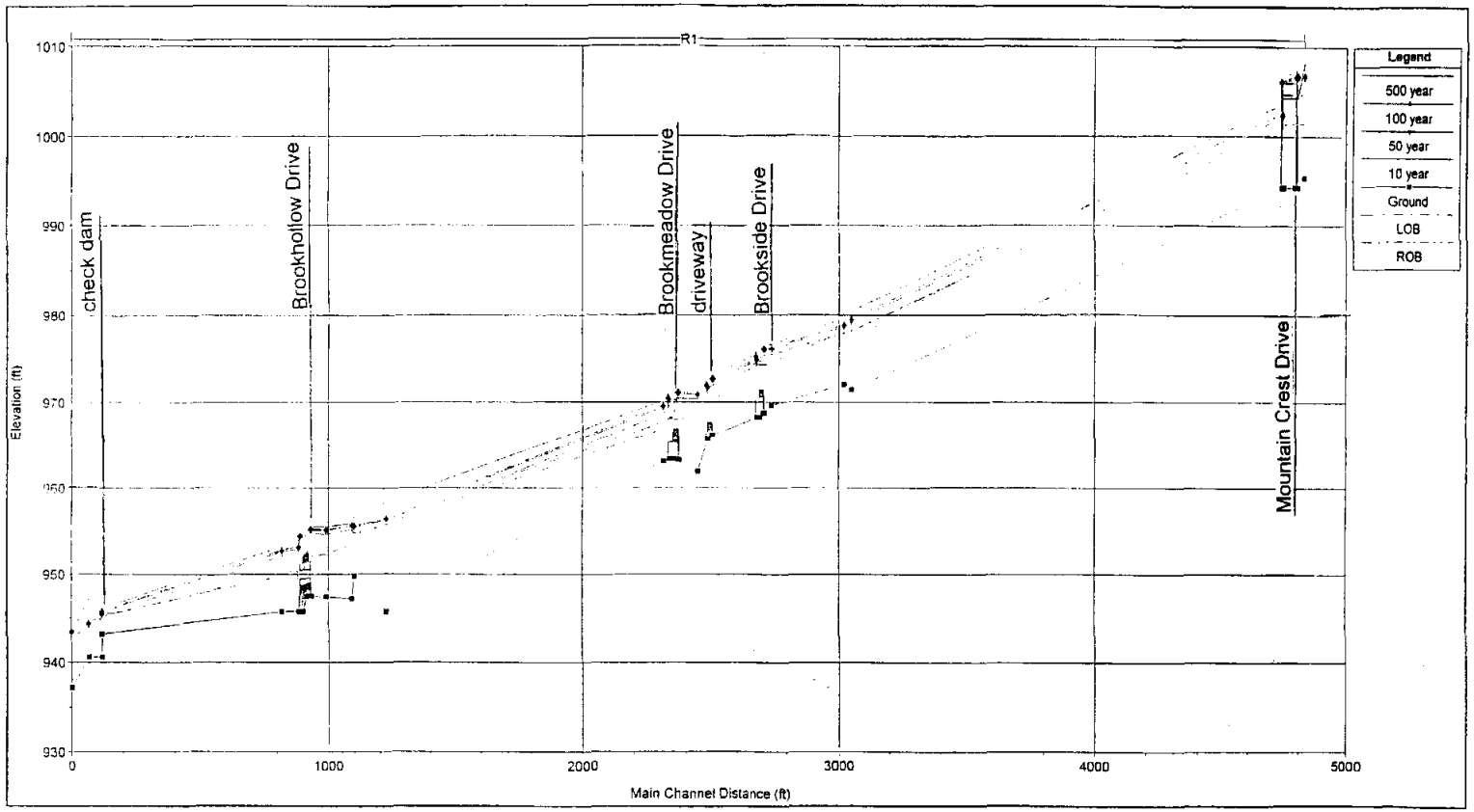
NOVEMBER, 2001

PROJECT NO. 2000-33



Espey Consultants, Inc.
Environmental & Engineering Services

EXHIBIT 4a
STREAM PROFILES: REVISED EXISTING CONDITIONS
WOODCREEK MASTER DRAINAGE PLAN
NOVEMBER, 2001
PROJECT NUMBER 2000-33



Note: Future watershed development conditions without channel improvements

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EXHIBIT 4b
STREAM PROFILES: FUTURE CONDITIONS
WOODCREEK MASTER DRAINAGE PLAN

NOVEMBER, 2001

PROJECT NUMBER 2000-33

Espey Consultants, Inc.
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EXHIBIT 5
HOG CREEK IMPROVEMENT PLAN
WOODCREEK MASTER DRAINAGE PLAN

NOVEMBER, 2001

PROJECT NO. 2000-33

APPENDIX B – HEC-HMS MODEL OUTPUT

Watershed Parameter Worksheet
Existing Conditions ..... HOG_CREEK.HMS
- 10-Year ..... EX_10.LOG
- 50-Year ..... EX_50.LOG
- 100-Year ..... EX_100.LOG
- 500-Year ..... EX_500.LOG

Future Conditions ..... HOG_CREEK.HMS
- 10-Year ..... ULT_10.LOG
- 50-Year ..... ULT _50.LOG
- 100-Year ..... ULT _100.LOG
- 500-Year ..... ULT _500.LOG

EXISTING CONDITION

TR-55 Method of Computing the Time of Concentration

			SUBAREA A	SUBAREA B
Sheet Flow	variable	units		
Manning's roughness coef.	n	n/a	0.3	0.3
Flow Length	L	feet	200	200
2-year, 24-hour rainfall	P2	inches	4.1	4.1
Slope	s	ft/ft	0.0500	0.0500
Travel time (equation 3-3)	Tt	hours	0.303	0.303
Shallow Concentrated Flow		min.	18.2	18.2
Flow Length	L	feet	2,300	2,000
Slope	s	ft/ft	0.02	0.1200
Surface (1=paved or 2=unpaved)		n/a	2	2
Velocity (figure 3-1)	V	ft/sec	2.29	5.61
Travel time	Tt	hours	0.279	0.099
Manning's Equation		min.	16.7	5.9
Flow Length	L	feet	8,600	5,500
Slope	S	ft/ft	0.0125	0.0125
roughness	n	n/a	0.04	0.04
Open Channel				
Bottom Width	BW	feet	10	40
Side Slopes (H:1)	H	feet	6	10
Depth	d	feet	5	4
...or Closed Conduit				
Rise / Diameter	R / D	feet	0	0
Span (0 if circular)	S	feet	0	0
Cross-Sectional Area	X-A	feet^2	200.00	320.00
Flow Rate	Q	cfs	1659.57	2550.24
Velocity (figure 3-1)	V	ft/sec	8.30	7.97
Travel time	Tt	hours	0.288	0.192
Flow Length	L	feet	-	-
Slope	S	ft/ft	0.0210	0.0164
roughness	n	n/a	0.015	0.05
Open Channel				
Bottom Width	BW	feet	0	2
Side Slopes (H:1)	H	feet	0	7
Depth	d	feet	0	4
...or Closed Conduit				
Rise / Diameter	R / D	feet	2.5	0
Span (0 if circular)	S	feet	0	0
Cross-Sectional Area	X-A	feet^2	4.91	120.00
Flow Rate	Q	cfs	51.51	736.77
Velocity (figure 3-1)	V	ft/sec	10.49	6.14
Travel time	Tt	hours	-	-
Total Travel Time	TC	hours	0.870	0.594
	TC	min.	52.2	35.6
Lag Time	TL	hours	0.5219	0.3563
	TL	min.	31.3	21.4

```
Basin: Hog Creek - Existing
     Description: Hog Creek Existing Conditions Model
     Last Modified Date: 4 June 2001
     Last Modified Time: 15:57:18
     Version: 2.0.0
     Unit System: English
     Default DSS File Name: P:\active\2000-33 Woodcreek MP\Hec-
hms\Hog_Creek\Hog_Creek.dss
End:

Junction: Landing Strip
     Canvas X: 442.961
     Canvas Y: 633.495
     Label X: -37
     Label Y: -38
End:

Reach: Reach-1
     Canvas X: 442.961
     Canvas Y: 633.495
     From Canvas X: 515.777
     From Canvas Y: 900.485
     Label X: -61
     Label Y: 0
     Downstream: Landing Strip

     Route: Kinematic Wave
     Shape: Trapezoid
     Length: 6200
     Energy Slope: 0.0125
     Width: 40
     Side Slope: 10
     Mannings n: 0.04
     Number of Increments: 5
End:

Subbasin: Subbasin A
     Description: Hog Creek Upper Watershed
     Canvas X: 515.777
     Canvas Y: 900.485
     Label X: 13
     Label Y: 27
     Area: 1.162
     Downstream: Reach-1

     LossRate: SCS
     Percent Impervious Area: 10
     Curve Number: 75

     Transform: SCS
     Lag: 31.300000

     Baseflow: Recession
End:

Subbasin: Subbasin B
     Canvas X: 637.136
```

```
     Canvas Y: 718.447
     Label X: 16
     Label Y: 0
     Area: 0.526
     Downstream: Landing Strip

     LossRate: SCS
     Percent Impervious Area: 15
     Curve Number: 75

     Transform: SCS
     Lag: 21.400000

     Baseflow: Recession
End:
```

```
Basin: Hog Creek - Ultimate
     Description: Hog Creek Ultimate Conditions Model
     Last Modified Date: 4 June 2001
     Last Modified Time: 16:07:46
     Version: 2.0.0
     Unit System: English
     Default DSS File Name: P:\active\2000-33 Woodcreek MP\Hec-
hms\Hog_Creek\Hog_Creek.dss
End:

Junction: Landing Strip
     Canvas X: 442.961
     Canvas Y: 633.495
     Label X: -37
     Label Y: -38
End:

Reach: Reach-1
     Canvas X: 442.961
     Canvas Y: 633.495
     From Canvas X: 515.777
     From Canvas Y: 900.485
     Label X: -61
     Label Y: 0
     Downstream: Landing Strip

     Route: Kinematic Wave
     Shape: Trapezoid
     Length: 6200
     Energy Slope: 0.0125
     Width: 40
     Side Slope: 10
     Mannings n: 0.04
     Number of Increments: 5
End:

Subbasin: Subbasin A
     Description: Hog Creek Upper Watershed
     Canvas X: 515.777
     Canvas Y: 900.485
     Label X: 13
     Label Y: 27
     Area: 1.162
     Downstream: Reach-1

     LossRate: SCS
     Percent Impervious Area: 50
     Curve Number: 75

     Transform: SCS
     Lag: 29.200000

     Baseflow: Recession
End:

Subbasin: Subbasin B
     Canvas X: 637.136
```

```
     Canvas Y: 718.447
     Label X: 16
     Label Y: 0
     Area: 0.526
     Downstream: Landing Strip

     LossRate: SCS
     Percent Impervious Area: 50
     Curve Number: 75

     Transform: SCS
     Lag: 20.600000

     Baseflow: Recession
End:
```

```
Precip: 10-Year
     Last Modified Date: 4 June 2001
     Last Modified Time: 16:31:12
     Version: 2.0.0
     Default DSS File Name: P:\active\2000-33 Woodcreek MP\Hec-
hms\Hog_Creek\Hog_Creek.dss
     Unit System: English
     Enable Evapotranspiration: No
     Precipitation Method: Frequency Based Hypothetical
End:

Method Parameters: Frequency Based Hypothetical
     Exceedence Frequency: 10
     Single Hypothetical Storm Size: Yes
     Convert to Annual Series: Yes
     Storm Size: 1.69
     Total Duration: 1440
     Time Interval: 5
     Percent of Duration Before Peak Rainfall: 50
     Depth: 0.64
     Depth: 1.4
     Depth: 2.95
     Depth: 3.6
     Depth: 4
     Depth: 4.8
     Depth: 5.75
     Depth: 6.75
End:

Subbasin: Subbasin A
End:

Subbasin: Subbasin B
End:
```

```
Precip: 50-Year
     Last Modified Date: 23 March 2001
     Last Modified Time: 08:56:49
     Version: 2.0.0
     Default DSS File Name: P:\active\2000-33 Woodcreek MP\Hec-
hms\Hog_Creek\Hog_Creek.dss
     Unit System: English
     Enable Evapotranspiration: No
     Precipitation Method: Frequency Based Hypothetical
End:

Method Parameters: Frequency Based Hypothetical
     Exceedence Frequency: 2
     Single Hypothetical Storm Size: Yes
     Convert to Annual Series: Yes
     Storm Size: 1.69
     Total Duration: 1440
     Time Interval: 5
     Percent of Duration Before Peak Rainfall: 50
     Depth: 0.8
     Depth: 1.75
     Depth: 3.89
     Depth: 4.75
     Depth: 5.25
     Depth: 6.5
     Depth: 7.8
     Depth: 8.9
End:

Subbasin: Subbasin A
End:

Subbasin: Subbasin B
End:
```

```
Precip: 100-Year
     Last Modified Date: 4 June 2001
     Last Modified Time: 16:08:15
     Version: 2.0.0
     Default DSS File Name: P:\active\2000-33 Woodcreek MP\Hec-
hms\Hog_Creek\Hog_Creek.dss
     Unit System: English
     Enable Evapotranspiration: No
     Precipitation Method: Frequency Based Hypothetical
End:

Method Parameters: Frequency Based Hypothetical
     Exceedence Frequency: 1
     Single Hypothetical Storm Size: Yes
     Convert to Annual Series: Yes
     Storm Size: 1.69
     Total Duration: 1440
     Time Interval: 5
     Percent of Duration Before Peak Rainfall: 50
     Depth: 0.875
     Depth: 1.9
     Depth: 4.2
     Depth: 5.4
     Depth: 6
     Depth: 7.2
     Depth: 8.8
     Depth: 10
End:

Subbasin: Subbasin A
End:

Subbasin: Subbasin B
End:
```

```
Precip: 500-Year
     Last Modified Date: 4 June 2001
     Last Modified Time: 16:15:13
     Version: 2.0.0
     Default DSS File Name: P:\active\2000-33 Woodcreek MP\Hec-
hms\Hog_Creek\Hog_Creek.dss
     Unit System: English
     Enable Evapotranspiration: No
     Precipitation Method: Frequency Based Hypothetical
End:

Method Parameters: Frequency Based Hypothetical
     Exceedence Frequency: 0.2
     Single Hypothetical Storm Size: Yes
     Convert to Annual Series: Yes
     Storm Size: 1.69
     Total Duration: 1440
     Time Interval: 5
     Percent of Duration Before Peak Rainfall: 50
     Depth: 1.04
     Depth: 2.15
     Depth: 5.2
     Depth: 6.5
     Depth: 7.25
     Depth: 8.8
     Depth: 10.8
     Depth: 12.3
End:

Subbasin: Subbasin A
End:

Subbasin: Subbasin B
End:
```

HMS * Summary of Results

Project : Hog Creek Run Name : Ex 10

Start of Run : 01Mar01 0600 Basin Model : Hog Creek - Existing
End of Run : 02Mar01 1200 Met. Model : 10-Year
Execution Time : 17Aug01 0955 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Subbasin A	1635.1	01 Mar 01 1835	256.49	1.162
Reach-1	1628.7	01 Mar 01 1845	256.49	1.162
Subbasin B	912.33	01 Mar 01 1825	120.05	0.526
Landing Strip	2292.6	01 Mar 01 1840	376.54	1.688

HMS * Summary of Results

Project : Hog Creek Run Name : Ex 50

Start of Run : 01Mar01 0600 Basin Model : Hog Creek - Existing
End of Run : 02Mar01 1200 Met. Model : 50-Year
Execution Time : 17Aug01 0956 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Subbasin A	2401.8	01 Mar 01 1835	380.89	1.162
Reach-1	2383.8	01 Mar 01 1845	380.91	1.162
Subbasin B	1316.7	01 Mar 01 1825	176.68	0.526
Landing Strip	3394.1	01 Mar 01 1835	557.59	1.688

HMS * Summary of Results

Project : Hog Creek Run Name : Ex 100

Start of Run : 01Mar01 0600 Basin Model : Hog Creek - Existing
End of Run : 02Mar01 1200 Met. Model : 100-Year
Execution Time : 17Aug01 0958 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Subbasin A	2708.1	01 Mar 01 1835	444.25	1.162
Reach-1	2683.2	01 Mar 01 1845	444.26	1.162
Subbasin B	1476.8	01 Mar 01 1825	205.47	0.526
Landing Strip	3839.5	01 Mar 01 1835	649.73	1.688

HMS * Summary of Results

Project : Hog Creek Run Name : Ex 500

Start of Run : 01Mar01 0600 Basin Model : Hog Creek - Existing
End of Run : 02Mar01 1200 Met. Model : 500-Year
Execution Time : 17Aug01 0958 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Subbasin A	3458.3	01 Mar 01 1835	578.94	1.162
Reach-1	3428.7	01 Mar 01 1840	579.15	1.162
Subbasin B	1856.5	01 Mar 01 1825	266.63	0.526
Landing Strip	4937.5	01 Mar 01 1835	845.78	1.688

HMS * Summary of Results

Project : Hog Creek Run Name : Ult 10

Start of Run : 01Mar01 0600 Basin Model : Hog Creek - Ultimate
End of Run : 02Mar01 1200 Met. Model : 10-Year
Execution Time : 17Aug01 0959 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Subbasin A	2004.3	01 Mar 01 1835	326.14	1.162
Reach-1	1998.2	01 Mar 01 1840	326.26	1.162
Subbasin B	1071.5	01 Mar 01 1825	147.63	0.526
Landing Strip	2825.5	01 Mar 01 1835	473.89	1.688

HMS * Summary of Results

Project : Hog Creek Run Name : Ult 50

Start of Run : 01Mar01 0600 Basin Model : Hog Creek - Ultimate
End of Run : 02Mar01 1200 Met. Model : 50-Year
Execution Time : 17Aug01 0959 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Subbasin A	2777.1	01 Mar 01 1835	456.19	1.162
Reach-1	2772.0	01 Mar 01 1840	456.27	1.162
Subbasin B	1472.4	01 Mar 01 1825	206.50	0.526
Landing Strip	3947.3	01 Mar 01 1835	662.77	1.688

HMS * Summary of Results

Project : Hog Creek Run Name : Ult 100

Start of Run : 01Mar01 0600 Basin Model : Hog Creek - Ultimate
End of Run : 02Mar01 1200 Met. Model : 100-Year
Execution Time : 17Aug01 0959 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Subbasin A	3072.4	01 Mar 01 1835	521.62	1.162
Reach-1	3068.6	01 Mar 01 1840	521.79	1.162
Subbasin B	1625.8	01 Mar 01 1825	236.12	0.526
Landing Strip	4376.2	01 Mar 01 1835	757.91	1.688

HMS * Summary of Results

Project : Hog Creek Run Name : Ult 500

Start of Run : 01Mar01 0600 Basin Model : Hog Creek - Ultimate
End of Run : 02Mar01 1200 Met. Model : 500-Year
Execution Time : 17Aug01 1000 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Subbasin A	3819.4	01 Mar 01 1835	659.65	1.162
Reach-1	3812.6	01 Mar 01 1840	659.95	1.162
Subbasin B	1997.9	01 Mar 01 1825	298.60	0.526
Landing Strip	5466.2	01 Mar 01 1835	958.56	1.688

HEC-RAS September 1998 Version 2.2
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street, Suite D
Davis, California 95616-4687
(916) 756-1104

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

PROJECT DATA
Project Title: Hog Creek Existing
Project File : HCexist.prj
Run Date and Time: 8/8/01 4:46:52 PM

Project in English units

Project Description:
Hog Creek Drainage Study

PLAN DATA

Plan Title: Hog Creek
Plan File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Existing\HCexist.p01

Geometry Title: Hog Creek
Geometry File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Existing\HCexist.g01

Flow Title : Flow Data
Flow File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Existing\HCexist.f01

Plan Summary Information:
Number of: Cross Sections = 25 Mulitple Openings = 0
Culverts = 5 Inline Weirs = 0
Bridges = 0

Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculaton tolerance = 0.01
Maximum number of interations = 20
Maximum difference tolerance = 0.3
Flow tolerance factor = 0.001

Computation Options
Critical depth computed only where necessary
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Mixed Flow

FLOW DATA

Flow Title: Flow Data
Flow File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Existing\HCexist.f01

Flow Data (cfs)

River	Reach	RS	PF 1	PF 2	PF 3	PF 4
Hog Creek	R1	5827	3458	2708	2401	1635
Hog Creek	R1	4084	4198	3274	2898	1964
Hog Creek	R1	2226	4444	3463	3063	2074
Hog Creek	R1	1119	4938	3840	3394	2293

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Hog Creek	R1	PF 1	Critical	Critical

GEOMETRY DATA

Geometry Title: Hog Creek
Geometry File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Existing\HCexist.g01

CROSS SECTION RIVER: Hog Creek
REACH: R1 RS: 5827

INPUT
Description:
Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	1015.89	122	1014.43	139	1009.46	150	1004.71	159	998.37
163	995.35	175	996.26	187	998.87	207	1000.93	241	1000.85
270	1001.42	303	1002.26	343	1003.08	378	1003.69	416	1004.94
452	1006.34	496	1008.35	531	1009.41				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	150	.04	270	.04

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
150	270	29	29	.1	.3

CROSS SECTION RIVER: Hog Creek
REACH: R1 RS: 5798

APPENDIX C – HEC-RAS MODEL OUTPUT

Existing Conditions ..... HCEXIST.PRJ
Future Conditions (without improvements)..... HCDEVELOPED.PRJ
Future Conditions (with improvements)..... HCPROPOSED.PRJ

```
INPUT
Description:
Station Elevation Data    num=      18
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
     100 1015.89      122 1014.43      139 1009.46      150 1004.71      159  996.92
     163  996.55      175  997.45      187  994.32      207 1000.93      241 1000.85
     270 1001.42      303 1002.26      343 1003.08      378 1003.69      416 1004.94
     452 1006.34      496 1008.35      531 1009.41

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     150     .04     270     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          150     270                  61      61      61             .1      .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     153  1010.4     193     531    1006

CULVERT                RIVER: Hog Creek
REACH: R1              RS: 5768

INPUT
Description:
Distance from Upstream XS =      10
Deck/Roadway Width        =      45
Weir Coefficient          =     2.6
Bridge Deck/Roadway Skew  =
Upstream  Deck/Roadway Coordinates
    num=       6
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     122 1014.43              175 1007.64              207 1004.96
     241 1004.92              303 1004.92              416 1004.94

Upstream Bridge Cross Section Data
Station Elevation Data    num=      18
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
     100 1015.89      122 1014.43      139 1009.46      150 1004.71      159  996.92
     163  996.55      175  997.45      187  994.32      207 1000.93      241 1000.85
     270 1001.42      303 1002.26      343 1003.08      378 1003.69      416 1004.94
     452 1006.34      496 1008.35      531 1009.41

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     150     .04     270     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          150     270             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     153  1010.4     193     531    1006

Downstream  Deck/Roadway Coordinates
    num=       6
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     122 1014.43              175 1007.64              207 1004.96
     241 1004.92              303 1004.92              416 1004.94

Downstream Bridge Cross Section Data
Station Elevation Data    num=      18
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
     100 1015.89      122 1014.43      139 1009.46      150 1004.71      159  996.28
     163  995.35      175  996.54      187   994.3      207 1000.93      241 1000.85
     270 1001.42      303 1002.26      343 1003.08      378 1003.69      416 1004.94
     452 1006.34      496 1008.35      531 1009.41

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     150     .04     270     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          150     270             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     153  1010.4     193     531    1006

Upstream Embankment side slope             =       3 horiz. to 1.0 vertical
Downstream Embankment side slope           =       3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins        =
Energy head used in spillway design        =
Spillway height used in design             =
Weir crest shape                           = Broad Crested

Number of Culverts =  3

Culvert Name      Shape      Rise    Span
Culvert #1       Circular      10
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    n Value   Entrance Loss Coef   Exit Loss Coef
                  5      60       .024                  .5                1
Upstream   Elevation =  996.92
           Centerline Station =  159
Downstream Elevation =  996.28
           Centerline Station =  159

Culvert Name      Shape      Rise    Span
Culvert #2       Circular      10
FHWA Chart # 1 - Concrete Pipe Culvert
FHWA Scale # 1 - Square edge entrance with headwall
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    n Value   Entrance Loss Coef   Exit Loss Coef
                  5      60       .024                  .5                1
Upstream   Elevation =  997.45
           Centerline Station =  175
Downstream Elevation =  996.54
           Centerline Station =  175

Culvert Name      Shape      Rise    Span
Culvert #3       Circular      10
FHWA Chart # 1 - Concrete Pipe Culvert
```

```
FHWA Scale # 1 - Square edge entrance with headwall
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    n Value   Entrance Loss Coef   Exit Loss Coef
                5       60       .024                  .5                1
Upstream   Elevation =  994.32
           Centerline Station =  187
Downstream Elevation =  994.3
           Centerline Station =  187

CROSS SECTION           RIVER: Hog Creek
REACH: R1                  RS: 5737

INPUT
Description:
Station Elevation Data     num=      18
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     100 1015.89      122 1014.43      139 1009.46      150 1004.71      159  996.28
     163  995.35      175  996.54      187   994.3      207 1000.93      241 1000.85
     270 1001.42      303 1002.26      343 1003.08      378 1003.69      416 1004.94
     452 1006.34      496 1008.35      531 1009.41

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      150     .04      270     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           150     270              1689    1689    1689             .1      .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     153  1010.4     193     531    1006

CROSS SECTION           RIVER: Hog Creek
REACH: R1                  RS: 4048

INPUT
Description:
Station Elevation Data     num=      13
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      90      980      135  977.42      155  977.13      166  973.67      170  972.76
     172  971.92      176  971.47      180  971.78      184  972.59      199   974.7
     209  978.13      248  979.93      290  980.47

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
      90     .04      155     .04      209     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           155     209               28      28      28             .1      .3

CROSS SECTION           RIVER: Hog Creek
REACH: R1                  RS: 4020

INPUT
Description:
Station Elevation Data     num=      10
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     100      981      129  978.08      153   976.4      175  973.06      179  972.06
     186  972.02      195  973.29      212   976.6      225   978.3      267   980.4

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      129     .04      225     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           129     225              279     279     279             .1      .3

CROSS SECTION           RIVER: Hog Creek
REACH: R1                  RS: 3741

INPUT
Description:
Station Elevation Data     num=      15
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     100      980      145  974.75      157  971.82      163  971.04      191  971.18
     197  969.69      200  969.62      203  969.87      207  971.13      219  971.52
     226  972.31      242  973.04      257   974.4      342  977.01      590     980

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      145     .04      257     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           145     257               30      30      30             .1      .3

CROSS SECTION           RIVER: Hog Creek
REACH: R1                  RS: 3711

INPUT
Description:
Station Elevation Data     num=      10
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     100      980      176  974.75      206  971.42      225  971.69      235  968.72
     238  968.72      248  971.58      290  973.04      305   974.4      590     980

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      176     .04      305     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           176     305               30      30      30             .1      .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     232   971.6     241     590   971.6

CULVERT                 RIVER: Hog Creek
REACH: R1                  RS: 3696

INPUT
Description:
Distance from Upstream XS =       4
Deck/Roadway Width        =      14
Weir Coefficient          =     2.6
Bridge Deck/Roadway Skew  =
Upstream  Deck/Roadway Coordinates
```

```
    num=       2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     225  971.69              248  971.58

Upstream Bridge Cross Section Data
Station Elevation Data    num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100     980     176  974.75     206  971.42     225  971.69     235  968.72
     238  968.72     248  971.58     290  973.04     305   974.4     590     980

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100    .04     176    .04     305    .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          176     305           .1        .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     232   971.6     241     590   971.6

Downstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     225  971.69              248  971.58

Downstream Bridge Cross Section Data
Station Elevation Data    num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100     980     176  974.75     206  971.42     225  971.69     235  968.26
     238  968.27     248  971.58     290  973.04     305   974.4     390  977.01

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100    .04     176    .04     305    .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          176     305           .1        .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     232   971.6     241     390   971.6

Upstream Embankment side slope              =       3 horiz. to 1.0 vertical
Downstream Embankment side slope            =       3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Culverts =  1

Culvert Name      Shape      Rise    Span
Culvert #1       Circular       2
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    n Value   Entrance Loss Coef   Exit Loss Coef
                  4      30       .024                  .5                1
Number of Barrels =  2
Upstream   Elevation =  968.72
Centerline Stations
    Sta.    Sta.
     235     238
Downstream Elevation =  968.26
Centerline Stations
    Sta.    Sta.
     235     238

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3681

INPUT
Description:
Station Elevation Data    num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100     980     176  974.75     206  971.42     225  971.69     235  968.26
     238  968.27     248  971.58     290  973.04     305   974.4     390  977.01

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100    .04     176    .04     305    .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          176     305              176     176     176              .1        .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     232   971.6     241     390   971.6

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3505

INPUT
Description:
Station Elevation Data    num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100     980     232  970.05     236  969.87     261  968.32     275  968.09
     288  966.15     315  968.68     339  970.06     539     977

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100    .04     232    .04     339    .04

Bank Sta: Left   Right    Lengths: Lefc Channel   Right     Coeff Contr.   Expan.
          232     339              21      21      21              .1        .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     284   967.7     292     539     968

CULVERT                RIVER: Hog Creek
REACH: R1                 RS: 3495

INPUT
Description:
Distance from Upstream XS =       5
```

```
Deck/Roadway Width        =      14
Weir Coefficient          =     2.6
Bridge Deck/Roadway Skew  =
Upstream  Deck/Roadway Coordinates
    num=        3
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     275  968.09              288  967.61              315  968.68

Upstream Bridge Cross Section Data
Station Elevation Data     num=        9
      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      100      980      232  970.05       236  969.87       261  968.32       275  968.09
      288  966.15       315  968.68       339  970.06       539      977

Manning's n Values         num=        3
      Sta    n Val      Sta    n Val      Sta    n Val
      100      .04      232      .04      339      .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
            232     339             .1       .3
Ineffective Flow      num=        2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
      100     284   967.7     292     539     968

Downstream  Deck/Roadway Coordinates
    num=        3
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     275  968.09              288  967.61              315  968.68

Downstream Bridge Cross Section Data
Station Elevation Data     num=        9
      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      100      980      232  970.05       236  969.87       261  968.32       275  968.09
      288  965.73       315  968.68       339  970.06       539      975

Manning's n Values         num=        3
      Sta    n Val      Sta    n Val      Sta    n Val
      100      .04      232      .04      339      .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
            232     339             .1       .3
Ineffective Flow      num=        2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
      100     284   967.7     292     539     968

Upstream Embankment side slope              =       3 horiz. to 1.0 vertical
Downstream Embankment side slope            =       3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Culverts =  1

Culvert Name      Shape      Rise    Span
Culvert #1      Circular      .67
FHWA Chart # 1 - Concrete Pipe Culvert
FHWA Scale # 3 - Groove end entrance; pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length     n Value   Entrance Loss Coef   Exit Loss Coef
                  5      21        .013                  .5                1
Number of Barrels =  2
Upstream   Elevation =  966.15
Centerline Stations
    Sta.    Sta.
     287     289
Downstream Elevation =  965.73
Centerline Stations
    Sta.    Sta.
     287     289

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3484

INPUT
Description:
Station Elevation Data     num=        9
      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      100      980      232  970.05       236  969.87       261  968.32       275  968.09
      288  965.73       315  968.68       339  970.06       539      975

Manning's n Values         num=        3
      Sta    n Val      Sta    n Val      Sta    n Val
      100      .04      232      .04      339      .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
            232     339                    40      40              .1       .3
Ineffective Flow      num=        2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
      100     284   967.7     292     539     968

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3444

INPUT
Description:
Station Elevation Data     num=       13
      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      100      980      232  968.93       252  967.01       271  965.85       278  961.89
      286  962.08       287  964.83       298  966.68       300  967.99       306  968.67
      329  968.97       340  971.19       540      973

Manning's n Values         num=        3
      Sta    n Val      Sta    n Val      Sta    n Val
      100      .04      232      .04      306      .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
            232     306                    72      72              .1       .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3372

INPUT
```

```
Description:
Station Elevation Data    num=      13
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
     100  980.02      124  977.45      158  972.83      184  970.89      244  966.41
     273   965.6      278  963.56      281  963.24      287  966.15      322   967.9
     452  970.32      490   971.6      590     976

Manning's n Values        num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      184     .04      322     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          184     322                  37      37      37            .1      .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     275  966.91     284     590  966.91

CULVERT                RIVER: Hog Creek
REACH: R1                 RS: 3343

INPUT
Description:
Distance from Upstream XS =       5
Deck/Roadway Width        =      16
Weir Coefficient          =     2.6
Bridge Deck/Roadway Skew  =
Upstream  Deck/Roadway Coordinates
    num=       6
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     184  970.89              250  966.93              296  966.91
     317  967.79              337  967.85              490   971.8

Upstream Bridge Cross Section Data
Station Elevation Data    num=      13
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
     100  980.02      124  977.45      158  972.83      184  970.89      244  966.41
     273   965.6      278  963.56      281  963.24      287  966.15      322   967.9
     452  970.32      490   971.6      590     976

Manning's n Values        num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      184     .04      322     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          184     322             .1      .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     275  966.91     284     590  966.91

Downstream  Deck/Roadway Coordinates
    num=       6
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     184  970.89              250  966.93              296  966.91
     317  967.79              337  967.85              490   971.8

Downstream Bridge Cross Section Data
Station Elevation Data    num=      13
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
     100  980.02      124  977.45      158  972.83      184  970.89      239  968.24
     250  966.42      274  965.97      290  963.37      303  963.37      317  967.35
     337  968.09      490   971.6      590     976

Manning's n Values        num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      239     .04      337     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          239     337             .1      .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     291  966.91     301     590  966.91

Upstream Embankment side slope              =       3 horiz. to 1.0 vertical
Downstream Embankment side slope            =       3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Culverts = 1

Culvert Name      Shape      Rise    Span
Culvert #1        Circular      2
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    n Value   Entrance Loss Coef   Exit Loss Coef
                  5      37       .024                  .5                1
Number of Barrels = 2
Upstream   Elevation = 963.24
Centerline Stations
    Sta.    Sta.
     278     281
Downstream Elevation = 963.37
Centerline Stations
    Sta.    Sta.
     293     298

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3335

INPUT
Description:
Station Elevation Data    num=      13
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
     100  980.02      124  977.45      158  972.83      184  970.89      239  968.24
     250  966.42      274  965.97      290  963.37      303  963.37      317  967.35
     337  968.09      490   971.6      590     976

Manning's n Values        num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      239     .04      337     .04
```

```
Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          239     337               23      23      23             .1      .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     291  966.91     301     590  966.91

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 3312

INPUT
Description:
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      40     971     100  968.72     112  966.86     127  965.42     145  964.93
     151  963.66     157  963.05     161  963.68     171  965.61     183  967.06
     189  967.64     206   967.8     351   971.6

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      40     .04     112     .04     189     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          112     189              1086    1086    1086             .1      .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 2226

INPUT
Description:
Station Elevation Data    num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100  957.52     156  957.86     185  959.14     218  959.14     251  958.17
     297  956.58     312  955.83     319  952.24     325  947.21     332  945.83
     338  945.74     342  946.06     344   947.1     347  949.85     348  952.32
     362  956.28     392  957.38     425  958.03     459  959.24     559  965.13

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     312     .04     362     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          312     362               124     124     124             .1      .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 2102

INPUT
Description:
Station Elevation Data    num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      20     958     100  955.76     130   955.9     161  956.02     191  955.76
     219  955.64     244  955.13     257  954.49     273  951.39     279  950.88
     286  949.79     298  949.81     311   949.9     316  950.06     331  953.82
     361  954.15     380  955.47     415   956.8     449  957.65     484  958.83

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      20     .04     257     .04     331     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          257     331                10      10      10             .1      .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 2092

INPUT
Description:
Station Elevation Data    num=      21
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      20     958     100  955.76     130   955.9     161  956.02     191  955.76
     219  955.64     244  955.13     259  954.06     272  951.02     274  949.55
     280  948.74     286  947.63     297  947.33     306  947.18     314  949.38
     331  953.46     362  954.15     381  955.47     416   956.8     450  957.65
     485  958.83

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      20     .04     244     .04     331     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          244     331               101     101     101             .1      .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 1991

INPUT
Description:
Station Elevation Data    num=      17
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      56  956.66      98  954.83     186  954.17     300   954.6     303  953.52
     321  953.58     335  952.97     339     949     342  947.81     367  947.39
     370  949.38     372  951.15     382  952.31     403  952.14     433  953.16
     459  954.27     491  956.57

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      56     .04     335     .04     382     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          335     382                57      57      57             .1      .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 1934

INPUT
Description:
Station Elevation Data    num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      56  956.66      98  954.83     143  953.73     186  953.02     300  952.77
     320  952.45     341  951.83     344  950.96     346  949.09     353  947.55
     361  947.45     373  948.73     376  949.43     380  952.09     396  952.19
     419  952.47     471  954.95     543  955.33     588  956.58     634  958.58

Manning's n Values        num=       3
```

```
     Sta   n Val     Sta   n Val     Sta   n Val
      56     .04     341     .04     380     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          341     380                50      50      50             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
      56     347  952.85     363     634   952.9

CULVERT                RIVER: Hog Creek
REACH: R1                 RS: 1909

INPUT
Description:
Distance from Upstream XS =      13
Deck/Roadway Width        =      19
Weir Coefficient          =     2.6
Bridge Deck/Roadway Skew  =
Upstream  Deck/Roadway Coordinates
    num=       5
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
     200  953.02             320  952.69             356  953.01
     396  952.69             471  954.05

Upstream Bridge Cross Section Data
Station Elevation Data     num=      20
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
      56  956.66       98  954.83     143  953.73     186  953.02     300  952.77
     320  952.45     341  951.83     344  950.96     346  949.09     353  947.55
     361  947.45     373  948.73     376  949.43     380  952.09     396  952.19
     419  952.47     471  954.05     543  955.33     588  956.58     634  958.58

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      56     .04     341     .04     380     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          341     380             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
      56     347  952.85     363     634   952.9

Downstream  Deck/Roadway Coordinates
    num=       7
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
     192  953.02             300  952.45             338  952.13
     386  953.01             427  952.69             483   953.5
     573  955.33

Downstream Bridge Cross Section Data
Station Elevation Data     num=      22
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
      62  956.66     104  954.83     149  953.73     192  953.02     300  951.19
     322  950.86     338  949.45     351  950.43     361  949.16     373  947.62
     375  946.67     378  946.12     383  945.71     386  945.83     389  947.35
     398  947.87     407  950.55     427   950.8     454  951.38     483  951.78
     573  955.33     618  956.58

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      62     .04     351     .04     407     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          351     407             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
      62     373   952.8     393     618   952.9

Upstream Embankment side slope              =       3 horiz. to 1.0 vertical
Downstream Embankment side slope            =       3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Culverts =  2

Culvert Name      Shape      Rise    Span
Culvert #2       Circular     2.5
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length     n Value   Entrance Loss Coef   Exit Loss Coef
                  3      41        .024                  .5                1
Upstream   Elevation =  949.04
           Centerline Station =  349
Downstream Elevation =  948.68
           Centerline Station =  375

Culvert Name      Shape      Rise    Span
Culvert #1       Circular       1
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length     n Value   Entrance Loss Coef   Exit Loss Coef
                  3      51        .024                  .5                1
Number of Barrels =  4
Upstream   Elevation =  949.62
Centerline Stations
    Sta.     Sta.     Sta.     Sta.
     351      353      355      360
Downstream Elevation =  949.41
Centerline Stations
    Sta.     Sta.     Sta.     Sta.
     379      382      385      390

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 1884

INPUT
Description:
Station Elevation Data     num=      22
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
```

```
      62  956.66     104  954.83     149  953.73     192  953.02     300  951.19
     322  950.86     338  949.45     351  950.43     361  949.16     373  947.62
     375  946.67     378  946.12     383  945.71     386  945.83     389  947.35
     398  947.87     407  950.55     427   950.8     454  951.38     483  951.78
     573  955.33     618  956.58

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
      62     .04      351     .04      407     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           351     407                 65      65      65             .1      .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
      62     373   952.8     393     618   952.9

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 1819

INPUT
Description:
Station Elevation Data    num=      12
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      75   953.84      100   949.78      136   948.61      150   947.41      154   946.62
     162   945.69      166   945.83      170   947.53      185   949.78      215   950.07
     250   950.95      322   954.05

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
      75     .04      100     .04      215     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           100     215                700     700     700             .1      .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 1119

INPUT
Description:
Station Elevation Data    num=      16
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      50      947      100   945.25      135   944.04      162   944.37      198   944.31
     234   944.54      251   944.02      270   943.64      295   943.34      323   943.31
     350   943.33      376   943.19      401   943.52      412   945.16      415   945.27
     445      947

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
      50     .04      100     .04      412     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           100     412                  1       1       1             .1      .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 1118

INPUT
Description:
Station Elevation Data    num=      20
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     100   945.25      135   944.04      162   944.37      198   944.31      234   944.54
     255   943.81      272   942.74      278   941.07      285   941.51      297   942.45
     298    943.2      334   943.31      359   942.97      367   941.75      376   941.21
     380   940.58      388   941.19      391   941.81      415   945.09      421   945.24

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      100     .04      415     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           100     415                 51      51      51             .1      .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 1067

INPUT
Description:
Station Elevation Data    num=      15
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     100   947.13      189      942      214    942.1      233   941.57      249   940.62
     272   941.85      296   942.92      321   943.08      338   942.34      358   942.57
     369   941.38      377    941.3      383   941.47      410   944.61      420   945.21

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      100     .04      410     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           100     410                 67      67      67             .1      .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 1000

INPUT
Description:
Station Elevation Data    num=      22
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      65   945.25      100   943.27      124   942.01      148   940.45      179   938.86
     184   939.55      189   938.82      200      939      202   937.17      212   937.73
     213   939.53      249   942.96      264   943.07      285   943.43      308    942.8
     345   941.53      362   942.16      376   942.23      386   942.28      420   942.25
     459   942.78      470   945.21

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
      65     .04      100     .04      285     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           100     285                  0       0       0             .1      .3

Profile Output Table - Standard Table 1

  Reach         River Sta         Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev  E.G. Slope   Vel Chnl  Flow Area  Top Width  Froude # Chl
                                    (cfs)       (ft)       (ft)       (ft)       (ft)     (ft/ft)     (ft/s)    (sq ft)       (ft)
```

R1	5827	3458.00	995.35	1007.32	1002.85	1007.40	0.000359	2.64	1591.47	329.38	0.17
R1	5827	2708.00	995.35	1006.49	1002.36	1006.57	0.000363	2.45	1328.75	309.47	0.17
R1	5827	2401.00	995.35	1006.23	1002.14	1006.30	0.000339	2.31	1248.51	302.70	0.16
R1	5827	1635.00	995.35	1006.02	1001.55	1006.06	0.000181	1.65	1186.35	296.89	0.12
R1	5798	4198.00	994.32	1007.26	1003.75	1007.38	0.000476	3.18	1612.37	328.02	0.20
R1	5798	3274.00	994.32	1006.45	1002.65	1006.55	0.000461	2.91	1359.84	308.32	0.19
R1	5798	2898.00	994.32	1006.19	1002.22	1006.28	0.000423	2.72	1283.47	301.54	0.18
R1	5798	1964.00	994.32	1005.51	1000.90	1006.00	0.001382	5.61	349.91	282.54	0.33
R1	5768	Culvert									
R1	5737	4198.00	994.30	1003.14	1003.14	1006.64	0.013412	15.01	279.68	194.80	1.00
R1	5737	3274.00	994.30	1002.08	1002.08	1005.04	0.014106	13.80	237.31	143.17	1.00
R1	5737	2898.00	994.30	1001.61	1001.61	1004.34	0.014396	13.27	218.33	123.99	1.00
R1	5737	1964.00	994.30	1000.25	1000.25	1002.44	0.015669	11.88	165.34	50.17	1.01
R1	4048	4198.00	971.47	979.19	979.91	981.85	0.015798	13.65	355.79	127.69	1.06
R1	4048	3274.00	971.47	978.71	979.19	980.88	0.014219	12.15	299.93	109.25	0.99
R1	4048	2898.00	971.47	978.48	978.80	980.45	0.013640	11.50	275.32	100.05	0.96
R1	4048	1964.00	971.47	977.76	977.59	979.18	0.011791	9.64	211.92	78.79	0.87
R1	4020	4198.00	972.02	978.59	979.28	981.29	0.025868	13.19	320.15	107.01	1.28
R1	4020	3274.00	972.02	978.12	978.60	980.36	0.025975	12.03	272.14	94.95	1.25
R1	4020	2898.00	972.02	977.92	978.30	979.94	0.024331	11.42	253.73	90.77	1.20
R1	4020	1964.00	972.02	977.43	977.43	978.76	0.017162	9.25	212.31	80.13	1.00
R1	3741	4198.00	969.62	976.47	975.51	977.35	0.005688	7.70	597.30	194.16	0.63
R1	3741	3274.00	969.62	976.06	974.90	976.74	0.004932	6.74	520.60	177.16	0.58
R1	3741	2898.00	969.62	975.85	974.63	976.46	0.004650	6.33	485.15	168.73	0.56
R1	3741	1964.00	969.62	975.24	973.91	975.65	0.003879	5.17	389.46	143.52	0.50
R1	3711	4198.00	968.72	976.43	975.46	977.13	0.005096	6.97	680.10	256.62	0.59
R1	3711	3274.00	968.72	975.98	974.90	976.57	0.004761	6.26	571.79	227.37	0.56
R1	3711	2898.00	968.72	975.76	974.64	976.30	0.004655	5.96	523.59	213.06	0.55
R1	3711	1964.00	968.72	975.13	973.96	975.52	0.004270	5.02	402.09	171.78	0.51
R1	3696	Culvert									
R1	3681	4198.00	968.26	975.39	975.39	976.84	0.014074	9.72	445.86	170.60	0.94
R1	3681	3274.00	968.26	974.83	974.83	976.15	0.016251	9.22	357.46	144.18	0.98
R1	3681	2898.00	968.26	974.58	974.58	975.84	0.017191	8.98	323.19	133.46	0.99
R1	3681	1964.00	968.26	973.90	973.90	974.95	0.018902	8.22	239.03	115.83	1.01
R1	3505	4198.00	966.15	973.02	972.12	973.74	0.004986	7.25	677.04	231.50	0.59
R1	3505	3274.00	966.15	972.51	971.59	973.13	0.004832	6.60	565.81	210.31	0.57
R1	3505	2898.00	966.15	972.28	971.35	972.85	0.004750	6.30	518.74	200.67	0.56
R1	3505	1964.00	966.15	971.62	970.65	972.05	0.004502	5.41	394.32	172.61	0.53
R1	3495	Culvert									
R1	3484	4198.00	965.73	972.05	972.05	973.33	0.011364	9.48	505.07	214.19	0.87
R1	3484	3274.00	965.73	971.53	971.53	972.72	0.012530	9.00	400.09	185.99	0.89
R1	3484	2898.00	965.73	971.29	971.29	972.43	0.013125	8.75	357.70	173.30	0.90
R1	3484	1964.00	965.73	970.58	970.58	971.59	0.016232	8.10	248.00	135.06	0.95
R1	3444	4198.00	961.89	970.22	970.85	972.76	0.020468	13.10	346.73	118.63	1.15
R1	3444	3274.00	961.89	969.55	970.21	972.00	0.024521	12.71	270.83	107.29	1.22
R1	3444	2898.00	961.89	970.62	969.89	971.56	0.006800	8.04	395.56	125.39	0.67
R1	3444	1964.00	961.89	970.17	969.05	970.74	0.004734	6.24	339.83	117.65	0.55
R1	3372	4198.00	963.24	971.48	970.15	971.85	0.003079	5.36	913.61	310.24	0.46
R1	3372	3274.00	963.24	970.95	969.69	971.29	0.003189	4.99	757.33	287.72	0.46
R1	3372	2898.00	963.24	970.75	969.45	971.05	0.003105	4.79	698.38	278.75	0.45
R1	3372	1964.00	963.24	970.15	968.80	970.39	0.002752	4.16	538.87	248.64	0.41
R1	3343	Culvert									
R1	3335	4198.00	963.37	970.70	969.96	971.46	0.005102	7.51	682.01	262.69	0.60
R1	3335	3274.00	963.37	970.15	969.34	970.84	0.005233	7.01	546.77	227.16	0.60
R1	3335	2898.00	963.37	969.87	969.06	970.54	0.005415	6.82	486.26	209.31	0.60
R1	3335	1964.00	963.37	969.03	968.22	969.62	0.006237	6.25	332.94	155.18	0.62
R1	3312	4198.00	963.05	969.96	969.92	971.25	0.009171	9.82	529.61	221.20	0.81
R1	3312	3274.00	963.05	969.35	969.35	970.61	0.010347	9.48	405.45	181.44	0.83
R1	3312	2898.00	963.05	969.04	969.04	970.31	0.011203	9.36	353.08	161.76	0.86
R1	3312	1964.00	963.05	968.19	968.19	969.36	0.013875	8.75	236.17	117.51	0.91
R1	2226	4444.00	945.74	956.80	956.80	959.57	0.012337	13.39	343.01	85.62	0.92
R1	2226	3463.00	945.74	956.33	955.30	958.31	0.009701	11.30	308.62	61.37	0.80
R1	2226	3063.00	945.74	956.14	954.71	957.79	0.008333	10.32	297.64	55.73	0.74
R1	2226	2074.00	945.74	955.38	952.89	956.37	0.005387	7.97	260.30	45.95	0.59
R1	2102	4444.00	949.79	955.68	956.46	957.74	0.013782	11.95	426.43	176.14	0.98
R1	2102	3463.00	949.79	955.38	955.38	956.89	0.010966	10.18	378.48	146.78	0.87
R1	2102	3063.00	949.79	955.06	955.06	956.53	0.011601	9.94	334.71	128.59	0.88
R1	2102	2074.00	949.79	954.56		955.52	0.008763	7.91	275.58	111.49	0.75
R1	2092	4444.00	947.18	953.62	955.02	957.38	0.027814	15.55	286.33	77.45	1.36
R1	2092	3463.00	947.18	955.55	953.90	956.36	0.004725	7.41	511.62	160.01	0.58
R1	2092	3063.00	947.18	955.49	953.39	956.14	0.003876	6.65	501.64	155.23	0.53
R1	2092	2074.00	947.18	954.90		955.31	0.002718	5.25	419.72	125.46	0.43
R1	1991	4444.00	947.39	955.38	955.38	956.29	0.005613	9.18	762.42	389.16	0.64
R1	1991	3463.00	947.39	955.00	955.00	955.85	0.005260	8.54	618.12	375.24	0.61
R1	1991	3063.00	947.39	954.71		955.64	0.005762	8.64	511.05	351.63	0.64
R1	1991	2074.00	947.39	954.49		955.00	0.003251	6.32	438.17	289.82	0.47
R1	1934	4444.00	947.45	955.43	954.66	955.81	0.002794	6.76	1111.94	462.50	0.46
R1	1934	3463.00	947.45	955.11	954.32	955.43	0.002430	6.10	965.26	438.84	0.43
R1	1934	3063.00	947.45	954.96	954.13	955.26	0.002241	5.77	903.34	427.52	0.41
R1	1934	2074.00	947.45	954.57	953.65	954.78	0.001635	4.72	743.12	392.01	0.34
R1	1909	Culvert									
R1	1884	4444.00	945.71	953.53	953.05	954.17	0.004854	7.94	844.13	366.41	0.60
R1	1884	3463.00	945.71	952.90	952.90	953.61	0.005874	8.05	629.77	312.32	0.64
R1	1884	3063.00	945.71	952.90	952.90	953.46	0.004596	7.12	629.77	312.32	0.57
R1	1884	2074.00	945.71	952.90	952.90	953.15	0.002107	4.82	629.83	312.33	0.39
R1	1819	4444.00	945.69	953.02	952.20	953.80	0.005899	7.56	668.36	217.88	0.64
R1	1819	3463.00	945.69	952.57	951.73	953.21	0.005457	6.76	574.18	204.79	0.60
R1	1819	3063.00	945.69	952.36	951.50	952.95	0.005261	6.40	532.66	198.74	0.59

R1	1819	2074.00	945.69	951.77	950.90	952.19	0.004724	5.39	418.96	181.15	0.54
R1	1119	4938.00	943.19	945.91	945.91	946.88	0.018158	7.91	632.16	344.95	0.99
R1	1119	3840.00	943.19	945.60	945.60	946.43	0.019623	7.34	526.28	330.55	1.00
R1	1119	3394.00	943.19	945.46	945.46	946.23	0.020363	7.06	481.84	324.32	1.00
R1	1119	2293.00	943.19	945.09	945.09	945.70	0.022635	6.28	365.40	306.96	1.01
R1	1118	4938.00	940.58	944.96	945.49	946.79	0.050395	10.85	455.09	305.58	1.57
R1	1118	3840.00	940.58	944.68	945.17	946.34	0.057438	10.34	371.27	295.47	1.63
R1	1118	3394.00	940.58	944.56	945.03	946.14	0.061009	10.08	336.61	291.19	1.65
R1	1118	2293.00	940.58	944.12	944.62	945.59	0.044967	9.74	235.51	170.41	1.46
R1	1067	4938.00	940.62	944.56	944.56	945.68	0.018371	8.49	581.35	264.89	1.01
R1	1067	3840.00	940.62	944.22	944.20	945.16	0.018191	7.76	494.80	256.27	0.98
R1	1067	3394.00	940.62	944.07	944.04	944.93	0.018277	7.44	455.97	252.31	0.98
R1	1067	2293.00	940.62	943.69	943.58	944.31	0.017052	6.33	362.12	242.46	0.91
R1	1000	4938.00	937.17	943.50	943.55	944.49	0.016066	8.56	658.34	366.41	0.96
R1	1000	3840.00	937.17	943.28	943.28	944.07	0.013566	7.63	576.53	346.75	0.87
R1	1000	3394.00	937.17	943.12	943.12	943.89	0.012781	7.42	525.26	328.78	0.85
R1	1000	2293.00	937.17	942.47	942.47	943.30	0.013140	7.40	338.13	247.60	0.85

```
                    HEC-RAS September 1998 Version 2.2
                      U.S. Army Corp of Engineers
                     Hydrologic Engineering Center
                       609 Second Street, Suite D
                      Davis, California 95616-4687
                            (916) 756-1104

          X     X  XXXXXX    XXXX        XXXX       XX      XXXX
          X     X  X        X    X       X   X     X  X    X
          X     X  X        X            X   X    X    X   X
          XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
          X     X  X        X            X  X     X    X        X
          X     X  X        X    X       X   X    X    X        X
          X     X  XXXXXX    XXXX        X    X   X    X   XXXXX


PROJECT DATA
Project Title: Fully developed /Existing Hog Creek
Project File : HCdeveloped.prj
Run Date and Time: 8/8/01 5:17:56 PM

Project in English units

Project Description:
Hog Creek Drainage Study



PLAN DATA

Plan Title: Plan 02
Plan File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Develop\HCdeveloped.p02

          Geometry Title: Hog Creek
          Geometry File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Develop\HCdeveloped.g01

          Flow Title    : Developed Flow Data
          Flow File     : p:\active\2000-33 Woodcreek MP\HEC-RAS\Develop\HCdeveloped.f02

Plan Summary Information:
Number of:  Cross Sections =   25    Mulitple Openings =    0
            Culverts       =    5    Inline Weirs      =    0
            Bridges        =    0

Computational Information
    Water surface calculation tolerance =  0.01
    Critical depth calculaton tolerance =  0.01
    Maximum number of interations       =  20
    Maximum difference tolerance        =  0.3
    Flow tolerance factor               =  0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Subcritical Flow



FLOW DATA

Flow Title: Developed Flow Data
Flow File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Develop\HCdeveloped.f02

Flow Data (cfs)

  River          Reach          RS             PF 1          PF 2          PF 3          PF 4
  Hog Creek      R1             5827           3819          3072          2777          2004
  Hog Creek      R1             4084           4643          3724          3362          2415
  Hog Creek      R1             2226           4917          3941          3557          2552
  Hog Creek      R1             1119           5466          4376          3947          2826


Boundary Conditions

  River          Reach          Profile                 Upstream              Downstream

  Hog Creek      R1             PF 1                      Critical              Critical



GEOMETRY DATA

Geometry Title: Hog Creek
Geometry File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Develop\HCdeveloped.g01

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 5827

INPUT
Description:
Station Elevation Data    num=      18
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
     100 1015.89      122 1014.43      139 1009.46      150 1004.71      159  998.37
     163  995.35      175  996.26      187  998.87      207 1000.93      241 1000.85
     270 1001.42      303 1002.26      343 1003.08      378 1003.69      416 1004.94
     452 1006.34      496 1008.35      531 1009.41

Manning's n Values        num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      150     .04      270     .04

Bank Sta: Left   Right     Lengths: Left Channel   Right     Coeff Contr.   Expan.
          150     270                29      29      29             .1       .3

CROSS SECTION          RIVER: Hog Creek
```

```
REACH: R1                RS: 5798

INPUT
Description:
Station Elevation Data    num=      18
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100 1015.89     122 1014.43     139 1009.46     150 1004.71     159  996.92
     163  996.55     175  997.45     187  994.32     207 1000.93     241 1000.85
     270 1001.42     303 1002.26     343 1003.08     378 1003.69     416 1004.94
     452 1006.34     496 1008.35     531 1009.41

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     150     .04     270     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          150     270                61      61      61              .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     153  1010.4     193     531    1006

CULVERT                RIVER: Hog Creek
REACH: R1              RS: 5768

INPUT
Description:
Distance from Upstream XS =      10
Deck/Roadway Width        =      45
Weir Coefficient          =     2.6
Bridge Deck/Roadway Skew  =
Upstream  Deck/Roadway Coordinates
    num=       6
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
     122 1014.43             175 1007.64             207 1004.96
     241 1004.92             303 1004.92             416 1004.94

Upstream Bridge Cross Section Data
Station Elevation Data    num=      18
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100 1015.89     122 1014.43     139 1009.46     150 1004.71     159  996.92
     163  996.55     175  997.45     187  994.32     207 1000.93     241 1000.85
     270 1001.42     303 1002.26     343 1003.08     378 1003.69     416 1004.94
     452 1006.34     496 1008.35     531 1009.41

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     150     .04     270     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          150     270              .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     153  1010.4     193     531    1006

Downstream  Deck/Roadway Coordinates
    num=       6
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
     122 1014.43             175 1007.64             207 1004.96
     241 1004.92             303 1004.92             416 1004.94

Downstream Bridge Cross Section Data
Station Elevation Data    num=      18
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100 1015.89     122 1014.43     139 1009.46     150 1004.71     159  996.28
     163  995.35     175  996.54     187   994.3     207 1000.93     241 1000.85
     270 1001.42     303 1002.26     343 1003.08     378 1003.69     416 1004.94
     452 1006.34     496 1008.35     531 1009.41

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     150     .04     270     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          150     270              .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     153  1010.4     193     531    1006

Upstream Embankment side slope             =       3 horiz. to 1.0 vertical
Downstream Embankment side slope           =       3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins        =
Energy head used in spillway design        =
Spillway height used in design             =
Weir crest shape                           = Broad Crested

Number of Culverts =  3

Culvert Name      Shape      Rise    Span
Culvert #1       Circular      10
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    n Value   Entrance Loss Coef   Exit Loss Coef
                 5      60       .024                  .5                1
Upstream   Elevation =  996.92
           Centerline Station =  159
Downstream Elevation =  996.28
           Centerline Station =  159

Culvert Name      Shape      Rise    Span
Culvert #2       Circular      10
FHWA Chart # 1 - Concrete Pipe Culvert
FHWA Scale # 1 - Square edge entrance with headwall
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    n Value   Entrance Loss Coef   Exit Loss Coef
                 5      60       .024                  .5                1
Upstream   Elevation =  997.45
           Centerline Station =  175
Downstream Elevation =  996.54
           Centerline Station =  175

Culvert Name      Shape      Rise    Span
Culvert #3       Circular      10
```

```
FHWA Chart # 1 - Concrete Pipe Culvert
FHWA Scale # 1 - Square edge entrance with headwall
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length     n Value   Entrance Loss Coef   Exit Loss Coef
                  5      60        .024                  .5                1
Upstream   Elevation =  994.32
           Centerline Station =  187
Downstream Elevation =  994.3
           Centerline Station =  187

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 5737

INPUT
Description:
Station Elevation Data    num=      18
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     100 1015.89      122 1014.43      139 1009.46      150 1004.71      159  996.28
     163  995.35      175  996.54      187   994.3      207 1000.93      241 1000.85
     270 1001.42      303 1002.26      343 1003.08      378 1003.69      416 1004.94
     452 1006.34      496 1008.35      531 1009.41

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     150     .04     270     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           150     270              1689    1689    1689             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     153  1010.4     193     531    1006

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 4048

INPUT
Description:
Station Elevation Data    num=      13
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      90      980      135  977.42      155  977.13      166  973.67      170  972.76
     172  971.92      176  971.47      180  971.78      184  972.59      199   974.7
     209  978.13      248  979.93      290  980.47

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      90     .04     155     .04     209     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           155     209                28      28      28             .1       .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 4020

INPUT
Description:
Station Elevation Data    num=      10
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     100      981      129  978.08      153  976.4       175  973.06      179  972.06
     186  972.02      195  973.29      212  976.6       225  978.3       267  980.4

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     129     .04     225     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           129     225              279     279     279             .1       .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3741

INPUT
Description:
Station Elevation Data    num=      15
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     100      980      145  974.75      157  971.82      163  971.04      191  971.18
     197  969.69      200  969.62      203  969.87      207  971.13      219  971.52
     226  972.31      242  973.04      257   974.4      342  977.01      590      980

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     145     .04     257     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           145     257                30      30      30             .1       .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3711

INPUT
Description:
Station Elevation Data    num=      10
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     100      980      176  974.75      206  971.42      225  971.69      235  968.72
     238  968.72      248  971.58      290  973.04      305   974.4      590      980

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     176     .04     305     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           176     305                30      30      30             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     232   971.6     241     590   971.6

CULVERT                RIVER: Hog Creek
REACH: R1                 RS: 3696

INPUT
Description:
Distance from Upstream XS =       4
Deck/Roadway Width        =      14
Weir Coefficient          =     2.6
Bridge Deck/Roadway Skew  =
```

```
Upstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     225  971.69              248  971.58

Upstream Bridge Cross Section Data
Station Elevation Data     num=      10
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     100      980      176  974.75       206  971.42       225  971.69       235  968.72
     238  968.72       248  971.58       290  973.04       305   974.4       590      980

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      176     .04      305     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
           176     305              .1       .3
Ineffective Flow      num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     232   971.6     241     590   971.6

Downstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     225  971.69              248  971.58

Downstream Bridge Cross Section Data
Station Elevation Data     num=      10
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     100      980      176  974.75       206  971.42       225  971.69       235  968.26
     238  968.27       248  971.58       290  973.04       305   974.4       390  977.01

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      176     .04      305     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
           176     305              .1       .3
Ineffective Flow      num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     232   971.6     241     390   971.6

Upstream Embankment side slope              =       3 horiz. to 1.0 vertical
Downstream Embankment side slope            =       3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Culverts =  1

Culvert Name      Shape      Rise    Span
Culvert #1      Circular        2
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    n Value   Entrance Loss Coef   Exit Loss Coef
                  4      30       .024                  .5                1
Number of Barrels =  2
Upstream   Elevation =  968.72
Centerline Stations
    Sta.    Sta.
     235     238
Downstream Elevation =  968.26
Centerline Stations
    Sta.    Sta.
     235     238

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3681

INPUT
Description:
Station Elevation Data     num=      10
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     100      980      176  974.75       206  971.42       225  971.69       235  968.26
     238  968.27       248  971.58       290  973.04       305   974.4       390  977.01

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      176     .04      305     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           176     305              176     176     176              .1       .3
Ineffective Flow      num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     232   971.6     241     390   971.6

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3505

INPUT
Description:
Station Elevation Data     num=       9
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     100      980      232  970.05       236  969.87       261  968.32       275  968.09
     288  966.15       315  968.68       339  970.06       539     977

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      232     .04      339     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           232     339               21      21      21              .1       .3
Ineffective Flow      num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     284   967.7     292     539     968

CULVERT                RIVER: Hog Creek
REACH: R1                 RS: 3495

INPUT
Description:
```

```
Distance from Upstream XS =       5
Deck/Roadway Width        =      14
Weir Coefficient          =     2.6
Bridge Deck/Roadway Skew  =
Upstream  Deck/Roadway Coordinates
    num=       3
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     275  968.09              288  967.61              315  968.68

Upstream Bridge Cross Section Data
Station Elevation Data    num=       9
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
     100     980      232  970.05      236  969.87      261  968.32      275  968.09
     288  966.15      315  968.68      339  970.06      539     977

Manning's n Values        num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100    .04       232    .04       339    .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          232     339             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     284   967.7     292     539     968

Downstream  Deck/Roadway Coordinates
    num=       3
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     275  968.09              288  967.61              315  968.68

Downstream Bridge Cross Section Data
Station Elevation Data    num=       9
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
     100     980      232  970.05      236  969.87      261  968.32      275  968.09
     288  965.73      315  968.68      339  970.06      539     975

Manning's n Values        num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100    .04       232    .04       339    .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          232     339             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     284   967.7     292     539     968

Upstream Embankment side slope              =       3 horiz. to 1.0 vertical
Downstream Embankment side slope            =       3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Culverts =  1

Culvert Name      Shape      Rise    Span
Culvert #1       Circular     .67
FHWA Chart # 1 - Concrete Pipe Culvert
FHWA Scale # 3 - Groove end entrance; pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length     n Value   Entrance Loss Coef   Exit Loss Coef
                  5      21        .013                  .5                1
Number of Barrels =  2
Upstream   Elevation =  966.15
Centerline Stations
    Sta.     Sta.
     287      289
Downstream Elevation =  965.73
Centerline Stations
    Sta.     Sta.
     287      289

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3484

INPUT
Description:
Station Elevation Data    num=       9
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
     100     980      232  970.05      236  969.87      261  968.32      275  968.09
     288  965.73      315  968.68      339  970.06      539     975

Manning's n Values        num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100    .04       232    .04       339    .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          232     339                  40      40      40             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     284   967.7     292     539     968

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3444

INPUT
Description:
Station Elevation Data    num=      13
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
     100     980      232  968.93      252  967.01      271  965.85      278  961.89
     286  962.08      287  964.83      298  966.68      300  967.99      306  968.67
     329  968.97      340  971.19      540     973

Manning's n Values        num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100    .04       232    .04       306    .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          232     306                  72      72      72             .1       .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3372
```

```
INPUT
Description:
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100  980.02     124  977.45     158  972.83     184  970.89     244  966.41
     273   965.6     278  963.56     281  963.24     287  966.15     322   967.9
     452  970.32     490   971.6     590     976

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     184     .04     322     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           184     322                37      37      37              .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     275  966.91     284     590  966.91

CULVERT                RIVER: Hog Creek
REACH: R1                 RS: 3343

INPUT
Description:
Distance from Upstream XS =       5
Deck/Roadway Width        =      16
Weir Coefficient          =     2.6
Bridge Deck/Roadway Skew  =
Upstream  Deck/Roadway Coordinates
    num=       6
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
     184  970.89             250  966.93             296  966.91
     317  967.79             337  967.85             490   971.8

Upstream Bridge Cross Section Data
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100  980.02     124  977.45     158  972.83     184  970.89     244  966.41
     273   965.6     278  963.56     281  963.24     287  966.15     322   967.9
     452  970.32     490   971.6     590     976

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     184     .04     322     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
           184     322             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     275  966.91     284     590  966.91

Downstream  Deck/Roadway Coordinates
    num=       6
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
     184  970.89             250  966.93             296  966.91
     317  967.79             337  967.85             490   971.8

Downstream Bridge Cross Section Data
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100  980.02     124  977.45     158  972.83     184  970.89     239  968.24
     250  966.42     274  965.97     290  963.37     303  963.37     317  967.35
     337  968.09     490   971.6     590     976

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     239     .04     337     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
           239     337             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     291  966.91     301     590  966.91

Upstream Embankment side slope             =       3 horiz. to 1.0 vertical
Downstream Embankment side slope           =       3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins        =
Energy head used in spillway design        =
Spillway height used in design             =
Weir crest shape                           = Broad Crested

Number of Culverts =  1

Culvert Name      Shape      Rise    Span
Culvert #1      Circular       2
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    n Value   Entrance Loss Coef   Exit Loss Coef
                  5      37       .024                  .5                1
Number of Barrels =  2
Upstream   Elevation =  963.24
Centerline Stations
    Sta.    Sta.
     278     281
Downstream Elevation =  963.37
Centerline Stations
    Sta.    Sta.
     293     298

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3335

INPUT
Description:
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100  980.02     124  977.45     158  972.83     184  970.89     239  968.24
     250  966.42     274  965.97     290  963.37     303  963.37     317  967.35
     337  968.09     490   971.6     590     976

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     239     .04     337     .04
```

```
Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          239     337              23      23      23             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     291  966.91     301     590  966.91

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 3312

INPUT
Description:
Station Elevation Data    num=      13
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      40      971      100  968.72       112  966.86       127  965.42       145  964.93
     151  963.66       157  963.05       161  963.68       171  965.61       183  967.06
     189  967.64       206   967.8       351   971.6

Manning's n Values        num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
      40     .04      112     .04      189     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          112     189             1086    1086    1086             .1       .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 2226

INPUT
Description:
Station Elevation Data    num=      20
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     100  957.52       156  957.86       185  959.14       218  959.14       251  958.17
     297  956.58       312  955.83       319  952.24       325  947.21       332  945.83
     338  945.74       342  946.06       344   947.1       347  949.85       348  952.32
     362  956.28       392  957.38       425  958.03       459  959.24       559  965.13

Manning's n Values        num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      312     .04      362     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          312     362              124     124     124             .1       .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 2102

INPUT
Description:
Station Elevation Data    num=      20
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      20      958      100  955.76       130   955.9       161  956.02       191  955.76
     219  955.64       244  955.13       257  954.49       273  951.39       279  950.88
     286  949.79       298  949.81       311   949.9       316  950.06       331  953.82
     361  954.15       380  955.47       415   956.8       449  957.65       484  958.83

Manning's n Values        num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
      20     .04      257     .04      331     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          257     331               10      10      10             .1       .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 2092

INPUT
Description:
Station Elevation Data    num=      21
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      20      958      100  955.76       130   955.9       161  956.02       191  955.76
     219  955.64       244  955.13       259  954.06       272  951.02       274  949.55
     280  948.74       286  947.63       297  947.33       306  947.18       314  949.38
     331  953.46       362  954.15       381  955.47       416   956.8       450  957.65
     485  958.83

Manning's n Values        num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
      20     .04      244     .04      331     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          244     331              101     101     101             .1       .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 1991

INPUT
Description:
Station Elevation Data    num=      17
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      56  956.66        98  954.83       186  954.17       300   954.6       303  953.52
     321  953.58       335  952.97       339     949       342  947.81       367  947.39
     370  949.38       372  951.15       382  952.31       403  952.14       433  953.16
     459  954.27       491  956.57

Manning's n Values        num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
      56     .04      335     .04      382     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          335     382               57      57      57             .1       .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 1934

INPUT
Description:
Station Elevation Data    num=      20
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      56  956.66        98  954.83       143  953.73       186  953.02       300  952.77
     320  952.45       341  951.83       344  950.96       346  949.09       353  947.55
     361  947.45       373  948.73       376  949.43       380  952.09       396  952.19
     419  952.47       471  954.05       543  955.33       588  956.58       634  958.58
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Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      56     .04     341     .04     380     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           341     380                  50        50        50              .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
      56     347  952.85     363     634   952.9

CULVERT                 RIVER: Hog Creek
REACH: R1               RS: 1909

INPUT
Description:
Distance from Upstream XS =       13
Deck/Roadway Width        =       19
Weir Coefficient          =      2.6
Bridge Deck/Roadway Skew  =
Upstream  Deck/Roadway Coordinates
    num=       5
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     200  953.02              320  952.69              356  953.01
     396  952.69              471  954.05

Upstream Bridge Cross Section Data
Station Elevation Data    num=       20
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
      56  956.66       98  954.83      143  953.73      186  953.02      300  952.77
     320  952.45      341  951.83      344  950.96      346  949.09      353  947.55
     361  947.45      373  948.73      376  949.43      380  952.09      396  952.19
     419  952.47      471  954.05      543  955.33      588  956.58      634  958.58

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      56     .04     341     .04     380     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
           341     380              .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
      56     347  952.85     363     634   952.9

Downstream  Deck/Roadway Coordinates
    num=       7
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     192  953.02              300  952.45              338  952.13
     386  953.01              427  952.69              483   953.5
     573  955.33

Downstream Bridge Cross Section Data
Station Elevation Data    num=       22
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
      62  956.66      104  954.83      149  953.73      192  953.02      300  951.19
     322  950.86      338  949.45      351  950.43      361  949.16      373  947.62
     375  946.67      378  946.12      383  945.71      386  945.83      389  947.35
     398  947.87      407  950.55      427   950.8      454  951.38      483  951.78
     573  955.33      618  956.58

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      62     .04     351     .04     407     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
           351     407              .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
      62     373   952.8     393     618   952.9

Upstream Embankment side slope                =       3 horiz. to 1.0 vertical
Downstream Embankment side slope              =       3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins           =
Energy head used in spillway design           =
Spillway height used in design                =
Weir crest shape                              = Broad Crested

Number of Culverts =  2

Culvert Name      Shape      Rise     Span
Culvert #2      Circular      2.5
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    n Value   Entrance Loss Coef   Exit Loss Coef
                  3      41       .024                  .5                1
Upstream   Elevation =  949.04
           Centerline Station =  349
Downstream Elevation =  948.68
           Centerline Station =  375

Culvert Name      Shape      Rise     Span
Culvert #1      Circular         1
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    n Value   Entrance Loss Coef   Exit Loss Coef
                  3      51       .024                  .5                1
Number of Barrels =  4
Upstream   Elevation =  949.62
Centerline Stations
    Sta.     Sta.     Sta.     Sta.
     351      353      355      360
Downstream Elevation =  949.41
Centerline Stations
    Sta.     Sta.     Sta.     Sta.
     379      382      385      390

CROSS SECTION           RIVER: Hog Creek
REACH: R1               RS: 1884

INPUT
Description:
Station Elevation Data    num=       22
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     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      62   956.66      104   954.83      149   953.73      192   953.02      300   951.19
     322   950.86      338   949.45      351   950.43      361   949.16      373   947.62
     375   946.67      378   946.12      383   945.71      386   945.83      389   947.35
     398   947.87      407   950.55      427    950.8      454   951.38      483   951.78
     573   955.33      618   956.58

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
      62     .04      351     .04      407     .04

Bank Sta: Left   Right     Lengths: Left Channel   Right     Coeff Contr.   Expan.
           351     407                 65      65      65             .1      .3
Ineffective Flow      num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
      62     373   952.8     393     618   952.9

CROSS SECTION           RIVER: Hog Creek
REACH: R1               RS: 1819

INPUT
Description:
Station Elevation Data      num=      12
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      75   953.84      100   949.78      136   948.61      150   947.41      154   946.62
     162   945.69      166   945.83      170   947.53      185   949.78      215   950.07
     250   950.95      322   954.05

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
      75     .04      100     .04      215     .04

Bank Sta: Left   Right     Lengths: Left Channel   Right     Coeff Contr.   Expan.
           100     215                700     700     700             .1      .3

CROSS SECTION           RIVER: Hog Creek
REACH: R1               RS: 1119

INPUT
Description:
Station Elevation Data      num=      16
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      50      947      100   945.25      135   944.04      162   944.37      198   944.31
     234   944.54      251   944.02      270   943.64      295   943.34      323   943.31
     350   943.33      376   943.19      401   943.52      412   945.16      415   945.27
     445      947

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
      50     .04      100     .04      412     .04

Bank Sta: Left   Right     Lengths: Left Channel   Right     Coeff Contr.   Expan.
           100     412                  1       1       1             .1      .3

CROSS SECTION           RIVER: Hog Creek
REACH: R1               RS: 1118

INPUT
Description:
Station Elevation Data      num=      20
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     100   945.25      135   944.04      162   944.37      198   944.31      234   944.54
     255   943.81      272   942.74      278   941.07      285   941.51      297   942.45
     298    943.2      334   943.31      359   942.97      367   941.75      376   941.21
     380   940.58      388   941.19      391   941.81      415   945.09      421   945.24

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      100     .04      415     .04

Bank Sta: Left   Right     Lengths: Left Channel   Right     Coeff Contr.   Expan.
           100     415                 51      51      51             .1      .3

CROSS SECTION           RIVER: Hog Creek
REACH: R1               RS: 1067

INPUT
Description:
Station Elevation Data      num=      15
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     100   947.13      189      942      214    942.1      233   941.57      249   940.62
     272   941.85      296   942.92      321   943.08      338   942.34      358   942.57
     369   941.38      377    941.3      383   941.47      410   944.61      420   945.21

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
     100     .04      100     .04      410     .04

Bank Sta: Left   Right     Lengths: Left Channel   Right     Coeff Contr.   Expan.
           100     410                 67      67      67             .1      .3

CROSS SECTION           RIVER: Hog Creek
REACH: R1               RS: 1000

INPUT
Description:
Station Elevation Data      num=      22
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      65   945.25      100   943.27      124   942.01      148   940.45      179   938.86
     184   939.55      189   938.92      200      939      202   937.17      212   937.73
     213   939.53      249   942.96      264   943.07      285   943.43      308    942.8
     345   941.53      362   942.16      376   942.23      386   942.28      420   942.25
     459   942.78      470   945.21

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
      65     .04      100     .04      285     .04

Bank Sta: Left   Right     Lengths: Left Channel   Right     Coeff Contr.   Expan.
           100     285                  0       0       0             .1      .3

Profile Output Table - Standard Table 1

  Reach         River Sta         Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev  E.G. Slope   Vel Chnl  Flow Area  Top Width  Froude # Chl
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		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
R1	5827	3819.00	995.35	1008.31		1008.38	0.000256	2.42	1930.02	353.38	0.15
R1	5827	3072.00	995.35	1006.87		1006.96	0.000368	2.56	1448.73	318.71	0.17
R1	5827	2777.00	995.35	1006.57		1006.64	0.000364	2.47	1351.57	311.25	0.17
R1	5827	2004.00	995.35	1006.04		1006.09	0.000268	2.01	1191.50	297.38	0.14
R1	5798	4643.00	994.32	1004.23	1004.23	1007.98	0.013109	15.55	298.57	243.78	1.00
R1	5798	3724.00	994.32	1006.82	1003.20	1006.94	0.000478	3.07	1474.95	317.44	0.20
R1	5798	3362.00	994.32	1006.52	1002.76	1006.63	0.000466	2.95	1381.67	310.07	0.19
R1	5798	2415.00	994.32	1005.20	1001.55	1006.00	0.002353	7.15	337.66	273.96	0.43
R1	5768	Culvert									
R1	5737	4643.00	994.30	1003.63	1003.63	1007.37	0.013092	15.51	299.27	223.43	1.00
R1	5737	3724.00	994.30	1002.60	1002.60	1005.83	0.013786	14.43	258.14	167.44	1.00
R1	5737	3362.00	994.30	1002.18	1002.18	1005.20	0.014078	13.94	241.26	147.16	1.00
R1	5737	2415.00	994.30	1000.94	1000.94	1003.39	0.014832	12.57	192.18	91.60	1.00
R1	4048	4643.00	971.47	980.43	980.43	981.95	0.007355	10.76	550.36	196.93	0.75
R1	4048	3724.00	971.47	979.59	979.59	981.22	0.009010	10.84	410.41	143.45	0.81
R1	4048	3362.00	971.47	979.28	979.28	980.89	0.009404	10.66	367.72	131.30	0.82
R1	4048	2415.00	971.47	978.21	978.21	979.83	0.012079	10.37	249.36	89.33	0.89
R1	4020	4643.00	972.02	979.60	979.60	981.44	0.012644	10.99	442.14	136.95	0.93
R1	4020	3724.00	972.02	978.93	978.93	980.66	0.014612	10.58	358.08	117.14	0.98
R1	4020	3362.00	972.02	978.67	978.67	980.32	0.015361	10.32	328.40	109.30	0.99
R1	4020	2415.00	972.02	977.92	977.92	979.32	0.016823	9.50	254.19	90.88	1.00
R1	3741	4643.00	969.62	976.68		977.63	0.005844	8.05	639.62	202.93	0.65
R1	3741	3724.00	969.62	976.23		977.03	0.005461	7.29	552.80	184.49	0.62
R1	3741	3362.00	969.62	976.11		976.81	0.004970	6.82	529.78	179.28	0.58
R1	3741	2415.00	969.62	975.56		976.07	0.004250	5.75	437.76	156.75	0.53
R1	3711	4643.00	968.72	976.67	975.73	977.41	0.004993	7.16	744.64	272.57	0.59
R1	3711	3724.00	968.72	976.17	975.16	976.83	0.005121	6.71	615.86	239.70	0.59
R1	3711	3362.00	968.72	976.04	974.95	976.63	0.004747	6.32	584.79	231.07	0.56
R1	3711	2415.00	968.72	975.46	974.27	975.92	0.004457	5.50	462.04	193.25	0.53
R1	3696	Culvert									
R1	3681	4643.00	968.26	975.64	975.64	977.14	0.013263	9.91	490.32	182.45	0.93
R1	3681	3724.00	968.26	975.11	975.11	976.50	0.015107	9.49	399.59	157.32	0.96
R1	3681	3362.00	968.26	974.88	974.88	976.22	0.016153	9.30	364.49	146.45	0.98
R1	3681	2415.00	968.26	974.25	974.25	975.40	0.018118	8.61	280.49	122.79	1.00
R1	3505	4643.00	966.15	973.23	972.34	974.00	0.005040	7.51	728.91	240.74	0.60
R1	3505	3724.00	966.15	972.76	971.83	973.43	0.004923	6.94	620.25	220.93	0.59
R1	3505	3362.00	966.15	972.56	971.61	973.19	0.004847	6.67	576.79	212.49	0.58
R1	3505	2415.00	966.15	971.96	970.99	972.46	0.004624	5.87	456.15	187.08	0.55
R1	3495	Culvert									
R1	3484	4643.00	965.73	972.27	972.27	973.59	0.011065	9.72	552.77	225.84	0.86
R1	3484	3724.00	965.73	971.80	971.80	973.03	0.011801	9.22	452.86	200.66	0.87
R1	3484	3362.00	965.73	971.59	971.59	972.78	0.012296	9.03	411.42	189.23	0.88
R1	3484	2415.00	965.73	970.94	970.94	972.03	0.014452	8.45	300.53	154.56	0.92
R1	3444	4643.00	961.89	971.02	971.02	972.93	0.012569	11.56	446.10	132.02	0.92
R1	3444	3724.00	961.89	970.88		972.21	0.009059	9.63	427.90	129.67	0.78
R1	3444	3362.00	961.89	970.79		971.93	0.007969	8.91	416.10	128.12	0.73
R1	3444	2415.00	961.89	970.41		971.15	0.005723	7.13	368.72	121.72	0.61
R1	3372	4643.00	963.24	971.60	970.35	972.02	0.003360	5.70	951.40	315.45	0.48
R1	3372	3724.00	963.24	971.20	969.90	971.55	0.003200	5.22	827.93	298.10	0.46
R1	3372	3362.00	963.24	971.01	969.71	971.34	0.003181	5.03	772.16	289.93	0.46
R1	3372	2415.00	963.24	970.44	969.16	970.72	0.002978	4.51	616.20	265.75	0.43
R1	3343	Culvert									
R1	3335	4643.00	963.37	970.93	970.20	971.72	0.005056	7.72	745.27	277.44	0.61
R1	3335	3724.00	963.37	970.43	969.67	971.16	0.005124	7.25	615.17	245.77	0.60
R1	3335	3362.00	963.37	970.21	969.40	970.91	0.005206	7.06	560.41	230.98	0.60
R1	3335	2415.00	963.37	969.46	968.64	970.10	0.005760	6.55	406.87	183.29	0.61
R1	3312	4643.00	963.05	970.17	970.17	971.52	0.009177	10.12	577.71	234.80	0.81
R1	3312	3724.00	963.05	969.65	969.65	970.94	0.009837	9.70	463.13	200.89	0.82
R1	3312	3362.00	963.05	969.41	969.41	970.68	0.010213	9.52	417.14	185.54	0.83
R1	3312	2415.00	963.05	968.60	968.60	969.85	0.012783	9.18	287.30	135.54	0.90
R1	2226	4917.00	945.74	958.39	958.39	959.98	0.005886	10.68	603.95	259.92	0.66
R1	2226	3941.00	945.74	956.50	955.93	958.92	0.011410	12.49	320.05	69.61	0.88
R1	2226	3557.00	945.74	956.36	955.42	958.43	0.010042	11.54	310.76	62.99	0.82
R1	2226	2552.00	945.74	955.78	953.83	957.08	0.006845	9.14	279.25	48.16	0.67
R1	2102	4917.00	949.79	956.68	956.68	957.79	0.006522	9.37	718.51	344.46	0.70
R1	2102	3941.00	949.79	955.66	955.66	957.30	0.011012	10.65	423.13	171.20	0.88
R1	2102	3557.00	949.79	955.45	955.45	956.97	0.010823	10.23	389.27	151.37	0.86
R1	2102	2552.00	949.79	954.77	954.60	956.02	0.010745	9.10	298.89	118.53	0.84
R1	2092	4917.00	947.18	955.91	955.31	957.26	0.007324	9.65	580.80	255.56	0.73
R1	2092	3941.00	947.18	955.68		956.66	0.005560	8.17	533.12	177.76	0.63
R1	2092	3557.00	947.18	955.58		956.42	0.004877	7.55	516.35	162.22	0.59
R1	2092	2552.00	947.18	955.22		955.74	0.003336	5.94	461.37	137.53	0.48
R1	1991	4917.00	947.39	955.50	955.50	956.47	0.006034	9.64	808.23	393.47	0.67
R1	1991	3941.00	947.39	955.18	955.18	956.08	0.005575	8.95	683.32	381.59	0.63
R1	1991	3557.00	947.39	955.03	955.03	955.90	0.005415	8.68	625.96	376.01	0.62
R1	1991	2552.00	947.39	954.60		955.33	0.004531	7.56	472.64	335.15	0.56
R1	1934	4917.00	947.45	955.58	954.78	955.98	0.002915	7.01	1182.02	471.35	0.47
R1	1934	3941.00	947.45	955.27	954.46	955.62	0.002636	6.46	1035.93	451.41	0.44
R1	1934	3557.00	947.45	955.14	954.32	955.47	0.002468	6.17	980.07	441.50	0.43
R1	1934	2552.00	947.45	954.77	953.91	955.02	0.001958	5.28	821.61	411.01	0.38
R1	1909	Culvert									
R1	1884	4917.00	945.71	953.83	953.23	954.43	0.004373	7.81	957.55	390.14	0.57
R1	1884	3941.00	945.71	953.19	952.91	953.88	0.005493	8.09	723.99	337.07	0.63
R1	1884	3557.00	945.71	952.94	952.91	953.66	0.005897	8.12	643.40	315.98	0.65
R1	1884	2552.00	945.71	952.90	952.90	953.29	0.003190	5.93	629.79	312.32	0.47
R1	1819	4917.00	945.69	953.20	952.43	954.06	0.006128	7.92	709.35	223.34	0.66
R1	1819	3941.00	945.69	952.80	951.99	953.51	0.005668	7.16	621.71	211.50	0.62

R1	1819	3557.00	945.69	952.61	951.79	953.27	0.005512	6.85	583.26	206.09	0.61
R1	1819	2552.00	945.69	952.07	951.21	952.58	0.004991	5.91	476.31	190.23	0.56
R1	1119	5466.00	943.19	946.05	946.05	947.08	0.017557	8.15	681.94	351.51	0.98
R1	1119	4376.00	943.19	945.76	945.76	946.65	0.018774	7.62	579.32	337.84	0.99
R1	1119	3947.00	943.19	945.63	945.63	946.48	0.019387	7.39	537.45	332.10	1.00
R1	1119	2826.00	943.19	945.28	945.28	945.97	0.021638	6.69	422.78	315.85	1.01
R1	1118	5466.00	940.58	945.86	945.64	946.71	0.012812	7.39	742.04	321.00	0.85
R1	1118	4376.00	940.58	945.51	945.35	946.26	0.014033	6.96	630.62	321.00	0.87
R1	1118	3947.00	940.58	945.36	945.20	946.08	0.014945	6.80	581.00	321.00	0.88
R1	1118	2826.00	940.58	944.97	944.83	945.56	0.016213	6.17	457.72	305.89	0.89
R1	1067	5466.00	940.62	944.73	944.73	945.91	0.017757	8.71	627.58	270.33	1.00
R1	1067	4376.00	940.62	944.39	944.39	945.42	0.018395	8.15	536.87	260.49	1.00
R1	1067	3947.00	940.62	944.26	944.23	945.21	0.018251	7.84	503.19	257.12	0.99
R1	1067	2826.00	940.62	943.82	943.82	944.62	0.020008	7.18	393.43	245.79	1.00
R1	1000	5466.00	937.17	943.70	943.70	944.67	0.014406	8.52	730.06	370.73	0.92
R1	1000	4376.00	937.17	943.42	943.42	944.28	0.014434	7.94	628.92	364.00	0.90
R1	1000	3947.00	937.17	943.31	943.31	944.11	0.013701	7.68	588.09	350.63	0.88
R1	1000	2826.00	937.17	942.88	942.88	943.62	0.011144	7.19	450.97	295.45	0.80

HEC-RAS September 1998 Version 2.2
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street, Suite D
Davis, California 95616-4687
(916) 756-1104

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

PROJECT DATA
Project Title: Hog Creek Proposed
Project File : HCproposed.prj
Run Date and Time: 8/9/01 3:29:32 PM

Project in English units

Project Description:
Hog Creek Drainage Study

PLAN DATA

Plan Title: Plan 24
Plan File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Proposed\HCproposed.p24

Geometry Title: CI 1000-1934 & BH Bridge
Geometry File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Proposed\HCproposed.g02

Flow Title : Developed Flow Data
Flow File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Proposed\HCproposed.f04

Plan Summary Information:
Number of: Cross Sections = 25 Mulitple Openings = 0
Culverts = 4 Inline Weirs = 0
Bridges = 1

Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculaton tolerance = 0.01
Maximum number of interations = 20
Maximum difference tolerance = 0.3
Flow tolerance factor = 0.001

Computation Options
Critical depth computed only where necessary
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Subcritical Flow

FLOW DATA

Flow Title: Developed Flow Data
Flow File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Proposed\HCproposed.f04

Flow Data (cfs)

River	Reach	RS	PF 1	PF 2	PF 3	PF 4
Hog Creek	R1	5827	3819	3072	2777	2004
Hog Creek	R1	4084	4643	3724	3362	2415
Hog Creek	R1	2226	4917	3941	3557	2552
Hog Creek	R1	1119	5466	4376	3947	2826

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Hog Creek	R1	PF 1	Critical	Critical

GEOMETRY DATA

Geometry Title: CI 1000-1934 & BH Bridge
Geometry File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Proposed\HCproposed.g02

CROSS SECTION RIVER: Hog Creek
REACH: R1 RS: 5827

INPUT
Description:
Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	1015.89	122	1014.43	139	1009.46	150	1004.71	159	998.37
163	995.35	175	996.26	187	998.87	207	1000.93	241	1000.85
270	1001.42	303	1002.26	343	1003.08	378	1003.69	416	1004.94
452	1006.34	496	1008.35	531	1009.41				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	150	.04	270	.04

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
150	270	29	29	.1	.3

CROSS SECTION RIVER: Hog Creek
REACH: R1 RS: 5798

```
INPUT
Description:
Station Elevation Data    num=      18
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
     100 1015.89      122 1014.43      139 1009.46      150 1004.71      159  996.92
     163  996.55      175  997.45      187  994.32      207 1000.93      241 1000.85
     270 1001.42      303 1002.26      343 1003.08      378 1003.69      416 1004.94
     452 1006.34      496 1008.35      531 1009.41

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     150     .04     270     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          150     270                61      61      61              .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     153  1010.4     193     531    1006

CULVERT                RIVER: Hog Creek
REACH: R1              RS: 5768

INPUT
Description:
Distance from Upstream XS =       10
Deck/Roadway Width        =       45
Weir Coefficient          =      2.6
Bridge Deck/Roadway Skew  =
Upstream  Deck/Roadway Coordinates
    num=       6
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     122 1014.43              175 1007.64              207 1004.96
     241 1004.92              303 1004.92              416 1004.94

Upstream Bridge Cross Section Data
Station Elevation Data    num=      18
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
     100 1015.89      122 1014.43      139 1009.46      150 1004.71      159  996.92
     163  996.55      175  997.45      187  994.32      207 1000.93      241 1000.85
     270 1001.42      303 1002.26      343 1003.08      378 1003.69      416 1004.94
     452 1006.34      496 1008.35      531 1009.41

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     150     .04     270     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          150     270             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     153  1010.4     193     531    1006

Downstream  Deck/Roadway Coordinates
    num=       6
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     122 1014.43              175 1007.64              207 1004.96
     241 1004.92              303 1004.92              416 1004.94

Downstream Bridge Cross Section Data
Station Elevation Data    num=      18
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
     100 1015.89      122 1014.43      139 1009.46      150 1004.71      159  996.28
     163  995.35      175  996.54      187   994.3      207 1000.93      241 1000.85
     270 1001.42      303 1002.26      343 1003.08      378 1003.69      416 1004.94
     452 1006.34      496 1008.35      531 1009.41

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     150     .04     270     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          150     270             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     153  1010.4     193     531    1006

Upstream Embankment side slope              =       3 horiz. to 1.0 vertical
Downstream Embankment side slope            =       3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Culverts =  3

Culvert Name      Shape      Rise    Span
Culvert #1       Circular      10
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length     n Value   Entrance Loss Coef   Exit Loss Coef
              5      60          .024                  .5                 1
Upstream   Elevation =  996.92
           Centerline Station =  159
Downstream Elevation =  996.28
           Centerline Station =  159

Culvert Name      Shape      Rise    Span
Culvert #2       Circular      10
FHWA Chart # 1 - Concrete Pipe Culvert
FHWA Scale # 1 - Square edge entrance with headwall
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length     n Value   Entrance Loss Coef   Exit Loss Coef
              5      60          .024                  .5                 1
Upstream   Elevation =  997.45
           Centerline Station =  175
Downstream Elevation =  996.54
           Centerline Station =  175

Culvert Name      Shape      Rise    Span
Culvert #3       Circular      10
FHWA Chart # 1 - Concrete Pipe Culvert
```

```
FHWA Scale # 1 - Square edge entrance with headwall
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length     n Value   Entrance Loss Coef   Exit Loss Coef
                  5      60        .024                  .5                1
Upstream   Elevation =  994.32
           Centerline Station =  187
Downstream Elevation =  994.3
           Centerline Station =  187

CROSS SECTION           RIVER: Hog Creek
REACH: R1                  RS: 5737

INPUT
Description:
Station Elevation Data    num=      18
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100 1015.89     122 1014.43     139 1009.46     150 1004.71     159  996.28
     163  995.35     175  996.54     187   994.3     207 1000.93     241 1000.85
     270 1001.42     303 1002.26     343 1003.08     378 1003.69     416 1004.94
     452 1006.34     496 1008.35     531 1009.41

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     150     .04     270     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           150     270             1689    1689    1689             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     153  1010.4     193     531    1006

CROSS SECTION           RIVER: Hog Creek
REACH: R1                  RS: 4048

INPUT
Description:
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      90     980     135  977.42     155  977.13     166  973.67     170  972.76
     172  971.92     176  971.47     180  971.78     184  972.59     199   974.7
     209  978.13     248  979.93     290  980.47

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      90     .04     155     .04     209     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           155     209               28      28      28             .1       .3

CROSS SECTION           RIVER: Hog Creek
REACH: R1                  RS: 4020

INPUT
Description:
Station Elevation Data    num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100     981     129  978.08     153   976.4     175  973.06     179  972.06
     186  972.02     195  973.29     212   976.6     225   978.3     267   980.4

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     129     .04     225     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           129     225               279     279     279             .1       .3

CROSS SECTION           RIVER: Hog Creek
REACH: R1                  RS: 3741

INPUT
Description:
Station Elevation Data    num=      15
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100     980     145  974.75     157  971.82     163  971.04     191  971.18
     197  969.69     200  969.62     203  969.87     207  971.13     219  971.52
     226  972.31     242  973.04     257   974.4     342  977.01     590     980

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     145     .04     257     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           145     257               30      30      30             .1       .3

CROSS SECTION           RIVER: Hog Creek
REACH: R1                  RS: 3711

INPUT
Description:
Station Elevation Data    num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100     980     176  974.75     206  971.42     225  971.69     235  968.72
     238  968.72     248  971.58     290  973.04     305   974.4     590     980

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     176     .04     305     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           176     305               30      30      30             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     232   971.6     241     590   971.6

CULVERT                 RIVER: Hog Creek
REACH: R1                  RS: 3696

INPUT
Description:
Distance from Upstream XS =       4
Deck/Roadway Width        =      14
Weir Coefficient          =     2.6
Bridge Deck/Roadway Skew  =
Upstream  Deck/Roadway Coordinates
```

```
    num=       2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     225  971.69              248  971.58

Upstream Bridge Cross Section Data
Station Elevation Data    num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100     980     176  974.75     206  971.42     225  971.69     235  968.72
     238  968.72     248  971.58     290  973.04     305   974.4     590     980

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     176     .04     305     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          176     305            .1        .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     232   971.6     241     590   971.6

Downstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     225  971.69              248  971.58

Downstream Bridge Cross Section Data
Station Elevation Data    num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100     980     176  974.75     206  971.42     225  971.69     235  968.26
     238  968.27     248  971.58     290  973.04     305   974.4     390  977.01

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     176     .04     305     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          176     305            .1        .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     232   971.6     241     390   971.6

Upstream Embankment side slope              =       3 horiz. to 1.0 vertical
Downstream Embankment side slope            =       3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Culverts =  1

Culvert Name      Shape      Rise    Span
Culvert #1       Circular       2
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    n Value   Entrance Loss Coef   Exit Loss Coef
                  4      30       .024                  .5                1
Number of Barrels =  2
Upstream   Elevation =  968.72
Centerline Stations
    Sta.    Sta.
     235     238
Downstream Elevation =  968.26
Centerline Stations
    Sta.    Sta.
     235     238

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3681

INPUT
Description:
Station Elevation Data    num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100     980     176  974.75     206  971.42     225  971.69     235  968.26
     238  968.27     248  971.58     290  973.04     305   974.4     390  977.01

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     176     .04     305     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          176     305               176     176     176             .1        .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     232   971.6     241     390   971.6

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3505

INPUT
Description:
Station Elevation Data    num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100     980     232  970.05     236  969.87     261  968.32     275  968.09
     288  966.15     315  968.68     339  970.06     539     977

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     232     .04     339     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          232     339                21      21      21             .1        .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     284   967.7     292     539     968

CULVERT                RIVER: Hog Creek
REACH: R1                 RS: 3495

INPUT
Description:
Distance from Upstream XS =       5
```

```
Deck/Roadway Width        =      14
Weir Coefficient          =     2.6
Bridge Deck/Roadway Skew  =
Upstream  Deck/Roadway Coordinates
    num=       3
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     275  968.09              288  967.61              315  968.68

Upstream Bridge Cross Section Data
Station Elevation Data     num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100     980     232  970.05     236  969.87     261  968.32     275  968.09
     288  966.15     315  968.68     339  970.06     539     977

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     232     .04     339     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          232     339              .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     284   967.7     292     539     968

Downstream  Deck/Roadway Coordinates
    num=       3
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
     275  968.09              288  967.61              315  968.68

Downstream Bridge Cross Section Data
Station Elevation Data     num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100     980     232  970.05     236  969.87     261  968.32     275  968.09
     288  965.73     315  968.68     339  970.06     539     975

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     232     .04     339     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          232     339              .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     284   967.7     292     539     968

Upstream Embankment side slope             =       3 horiz. to 1.0 vertical
Downstream Embankment side slope           =       3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins        =
Energy head used in spillway design        =
Spillway height used in design             =
Weir crest shape                           = Broad Crested

Number of Culverts =  1

Culvert Name      Shape      Rise    Span
Culvert #1      Circular      .67
FHWA Chart # 1 - Concrete Pipe Culvert
FHWA Scale # 3 - Groove end entrance; pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    n Value   Entrance Loss Coef   Exit Loss Coef
                  5      21       .013                   .5                1
Number of Barrels =  2
Upstream   Elevation =  966.15
Centerline Stations
    Sta.    Sta.
     287     289
Downstream Elevation =  965.73
Centerline Stations
    Sta.    Sta.
     287     289

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3484

INPUT
Description:
Station Elevation Data     num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100     980     232  970.05     236  969.87     261  968.32     275  968.09
     288  965.73     315  968.68     339  970.06     539     975

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     232     .04     339     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          232     339               40      40      40              .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     284   967.7     292     539     968

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3444

INPUT
Description:
Station Elevation Data     num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100     980     232  968.93     252  967.01     271  965.85     278  961.89
     286  962.08     287  964.83     298  966.68     300  967.99     306  968.67
     329  968.97     340  971.19     540     973

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     232     .04     306     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          232     306               72      72      72              .1       .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3372

INPUT
```

```
Description:
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100  980.02     124  977.45     158  972.83     184  970.89     244  966.41
     273   965.6     278  963.56     281  963.24     287  966.15     322   967.9
     452  970.32     490   971.6     590     976

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     184     .04     322     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           184     322                37      37      37             .1      .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     275  966.91     284     590  966.91

CULVERT                RIVER: Hog Creek
REACH: R1                 RS: 3343

INPUT
Description:
Distance from Upstream XS =       5
Deck/Roadway Width        =      16
Weir Coefficient          =     2.6
Bridge Deck/Roadway Skew  =
Upstream  Deck/Roadway Coordinates
    num=       6
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
     184  970.89             250  966.93             296  966.91
     317  967.79             337  967.85             490   971.8

Upstream Bridge Cross Section Data
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100  980.02     124  977.45     158  972.83     184  970.89     244  966.41
     273   965.6     278  963.56     281  963.24     287  966.15     322   967.9
     452  970.32     490   971.6     590     976

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     184     .04     322     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
           184     322             .1      .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     275  966.91     284     590  966.91

Downstream  Deck/Roadway Coordinates
    num=       6
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
     184  970.89             250  966.93             296  966.91
     317  967.79             337  967.85             490   971.8

Downstream Bridge Cross Section Data
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100  980.02     124  977.45     158  972.83     184  970.89     239  968.24
     250  966.42     274  965.97     290  963.37     303  963.37     317  967.35
     337  968.09     490   971.6     590     976

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     239     .04     337     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
           239     337             .1      .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     291  966.91     301     590  966.91

Upstream Embankment side slope             =       3 horiz. to 1.0 vertical
Downstream Embankment side slope           =       3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins        =
Energy head used in spillway design        =
Spillway height used in design             =
Weir crest shape                           = Broad Crested

Number of Culverts =  1

Culvert Name      Shape      Rise    Span
Culvert #1       Circular       2
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    n Value   Entrance Loss Coef   Exit Loss Coef
                  5      37       .024                  .5                1
Number of Barrels =  2
Upstream   Elevation =  963.24
Centerline Stations
    Sta.    Sta.
     278     281
Downstream Elevation =  963.37
Centerline Stations
    Sta.    Sta.
     293     298

CROSS SECTION          RIVER: Hog Creek
REACH: R1                 RS: 3335

INPUT
Description:
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100  980.02     124  977.45     158  972.83     184  970.89     239  968.24
     250  966.42     274  965.97     290  963.37     303  963.37     317  967.35
     337  968.09     490   971.6     590     976

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     239     .04     337     .04
```

```
Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          239     337               23      23      23             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
     100     291  966.91     301     590  966.91

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 3312

INPUT
Description:
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      40     971     100  968.72     112  966.86     127  965.42     145  964.93
     151  963.66     157  963.05     161  963.68     171  965.61     183  967.06
     189  967.64     206   967.8     351   971.6

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      40     .04     112     .04     189     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          112     189              1086    1086    1086             .1       .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 2226

INPUT
Description:
Station Elevation Data    num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100  957.52     156  957.86     185  959.14     216  959.14     251  958.17
     297  956.58     312  955.83     319  952.24     325  947.21     332  945.83
     338  945.74     342  946.06     344   947.1     347  949.85     348  952.32
     362  956.28     392  957.38     425  958.03     459  959.24     559  965.13

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
     100     .04     312     .04     362     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          312     362               124     124     124             .1       .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 2102

INPUT
Description:
Station Elevation Data    num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      20     958     100  955.76     130   955.9     161  956.02     191  955.76
     219  955.64     244  955.13     257  954.49     273  951.39     279  950.88
     286  949.79     298  949.81     311   949.9     316  950.06     331  953.62
     361  954.15     380  955.47     415   956.8     449  957.65     484  958.83

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      20     .04     257     .04     331     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          257     331                10      10      10             .1       .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 2092

INPUT
Description:
Station Elevation Data    num=      21
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      20     958     100  955.76     130   955.9     161  956.02     191  955.76
     219  955.64     244  955.13     259  954.06     272  951.02     274  949.55
     280  948.74     286  947.63     297  947.33     306  947.18     314  949.38
     331  953.46     362  954.15     381  955.47     416   956.8     450  957.65
     485  958.83

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      20     .04     244     .04     331     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          244     331               101     101     101             .1       .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 1991

INPUT
Description:
Station Elevation Data    num=      17
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      56  956.66      98  954.83     186  954.17     300   954.6     303  953.52
     321  953.58     335  952.97     339    .949     342  947.81     367  947.39
     370  949.38     372  951.15     382  952.31     403  952.14     433  953.16
     459  954.27     491  956.57

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      56     .04     335     .04     382     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          335     382                57      57      57             .1       .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 1934

INPUT
Description:
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      56  956.66      98  954.83     143  953.73     186  953.02     295  952.77
     315  946.34     385  946.34     403  952.21     419  952.47     471  954.05
     543  955.33     588  956.58     634  958.58

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
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```
      56     .04     295     .035     403     .04

Bank Sta: Left   Right     Lengths: Left Channel   Right     Coeff Contr.   Expan.
          295    403                 50      50      50          .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
      56     300     954     400     634     954

BRIDGE                  RIVER: Hog Creek
REACH: R1               RS: 1909

INPUT
Description:
Distance from Upstream XS =       13
Deck/Roadway Width        =       19
Weir Coefficient          =      2.6
Bridge Deck/Roadway Skew  =
Upstream  Deck/Roadway Coordinates
    num=       7
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
      98  954.83     951     143     954     951     200     954     951
     320     954     951     356     954     951     396     954     951
     471  954.05     951

Upstream Bridge Cross Section Data
Station Elevation Data    num=      13
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
      56  956.66      98  954.83     143  953.73     186  953.02     295  952.77
     315  946.34     385  946.34     403  952.21     419  952.47     471  954.05
     543  955.33     588  956.58     634  958.58

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      56     .04     295    .035     403     .04

Bank Sta: Left   Right     Coeff Contr.   Expan.
          295    403           .1          .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
      56     300     954     400     634     954

Downstream  Deck/Roadway Coordinates
    num=       9
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
     104  954.83     951     149     954     951     192     954     951
     300     954     951     338     954     951     386     954     951
     427     954     951     483     954     951     573  955.33     951

Downstream Bridge Cross Section Data
Station Elevation Data    num=      14
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
      62  956.66     104  954.83     149  953.73     192  953.02     300  951.19
     322  950.86     333  949.45     344  945.84     414  945.84     429  950.76
     454  951.38     483  951.78     573  955.33     618  956.58

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      62     .04     322    .035     429     .04

Bank Sta: Left   Right     Coeff Contr.   Expan.
          322    429           .1          .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
      62     333     954     429     618     954

Upstream Embankment side slope               =       3 horiz. to 1.0 vertical
Downstream Embankment side slope             =       3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins          =
Energy head used in spillway design          =
Spillway height used in design               =
Weir crest shape                             = Broad Crested

Number of Piers =  2

Pier Data
Pier Station     Upstream=     320    Downstream=     350
Upstream     num=       2
    Width   Elev    Width   Elev
        1     945        1     952
Downstream     num=       2
    Width   Elev    Width   Elev
        1     945        1     952

Pier Data
Pier Station     Upstream=     380    Downstream=     410
Upstream     num=       2
    Width   Elev    Width   Elev
        1     945        1     952
Downstream     num=       2
    Width   Elev    Width   Elev
        1     945        1     952

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
       Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
       Energy Only

Additional Bridge Parameters
       Add Friction component to Momentum
       Do not add Weight component to Momentum
       Class B flow critical depth computations use critical depth
           inside the bridge at the upstream end
       Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION           RIVER: Hog Creek
REACH: R1               RS: 1884

INPUT
Description:
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```
Station Elevation Data    num=      14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      62  956.66     104  954.83     149  953.73     192  953.02     300  951.19
     322  950.86     333  949.45     344  945.84     414  945.84     429  950.76
     454  951.38     483  951.78     573  955.33     618  956.58

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
      62    .04     322    .035     429    .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           322     429                 65      65      65             .1      .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
      62     333     954     429     618     954

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 1619

INPUT
Description:
Station Elevation Data    num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      75  953.84     100  949.78  126.29  948.93   137.5  945.19   177.5  945.19
  191.46  949.84     215  950.07     250  950.95     322  954.05

Manning's n Values        num=       5
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
      75    .04     100    .04  126.29    .035  191.46    .04     215    .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           100     215                700     700     700             .1      .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 1119

INPUT
Description:
Station Elevation Data    num=      17
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      50     947     100  945.25     135  944.04     162  944.37     198  944.31
  217.27  944.43     236  938.19     276  938.19  291.57  943.38     295  943.34
     323  943.31     350  943.33     376  943.19     401  943.52     412  945.16
     415  945.27     445     947

Manning's n Values        num=       5
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
      50    .04     100    .04  217.27    .035  291.57    .04     412    .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           100     412                   1       1       1             .1      .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 1118

INPUT
Description:
Station Elevation Data    num=      18
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100  945.25     135  944.04     162  944.37     198  944.31     234  944.54
  236.14  944.47     255  938.18     295  938.18  310.17  943.24     334  943.31
     359  942.97     367  941.75     376  941.21     380  940.58     388  941.19
     391  941.81     415  945.09     421  945.24

Manning's n Values        num=       5
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
     100    .04     100    .04  236.14    .035  310.17    .04     415    .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           100     415                  51      51      51             .1      .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 1067

INPUT
Description:
Station Elevation Data    num=      16
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
     100  947.13     189     942     214   942.1  216.96  942.02     230  937.67
     270  937.67  284.17  942.39     296  942.92     321  943.08     338  942.34
     358  942.57     369  941.38     377   941.3     383  941.47     410  944.61
     420  945.21

Manning's n Values        num=       5
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
     100    .04     100    .04  216.96    .035  284.17    .04     410    .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           100     410                  67      67      67             .1      .3

CROSS SECTION          RIVER: Hog Creek
REACH: R1              RS: 1000

INPUT
Description:
Station Elevation Data    num=      19
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      65  945.25     100  943.27     124  942.01     148  940.45  173.59  939.14
     180     937     220     937  233.43  941.48     249  942.96     264  943.07
     285  943.43     308   942.8     345  941.53     362  942.16     376  942.23
     386  942.28     420  942.25     459  942.78     470  945.21

Manning's n Values        num=       5
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
      65    .04     100    .04  173.59    .035  233.43    .04     470    .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           100     470                   0       0       0             .1      .3

Profile Output Table - Standard Table 1

  Reach         River Sta         Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev  E.G. Slope   Vel Chnl  Flow Area  Top Width  Froude # Chl
                                    (cfs)       (ft)       (ft)       (ft)       (ft)     (ft/ft)     (ft/s)    (sq ft)       (ft)
```

R1	5827	3819.00	995.35	1008.31		1008.38	0.000256	2.42	1930.02	353.38	0.15
R1	5827	3072.00	995.35	1006.87		1006.96	0.000368	2.56	1448.73	318.71	0.17
R1	5827	2777.00	995.35	1006.57		1006.64	0.000364	2.47	1351.57	311.25	0.17
R1	5827	2004.00	995.35	1006.04		1006.09	0.000268	2.01	1191.50	297.38	0.14
R1	5798	4643.00	994.32	1004.23	1004.23	1007.98	0.013109	15.55	298.57	243.78	1.00
R1	5798	3724.00	994.32	1006.82	1003.20	1006.94	0.000478	3.07	1474.95	317.44	0.20
R1	5798	3362.00	994.32	1006.52	1002.76	1006.63	0.000466	2.95	1381.67	310.07	0.19
R1	5798	2415.00	994.32	1005.20	1001.55	1006.00	0.002353	7.15	337.66	273.96	0.43
R1	5768	Culvert									
R1	5737	4643.00	994.30	1003.63	1003.63	1007.37	0.013092	15.51	299.27	223.43	1.00
R1	5737	3724.00	994.30	1002.60	1002.60	1005.83	0.013786	14.43	258.14	167.44	1.00
R1	5737	3362.00	994.30	1002.18	1002.18	1005.20	0.014078	13.94	241.26	147.16	1.00
R1	5737	2415.00	994.30	1000.94	1000.94	1003.39	0.014832	12.57	192.18	91.60	1.00
R1	4048	4643.00	971.47	980.43	980.43	981.95	0.007355	10.76	550.36	196.93	0.75
R1	4048	3724.00	971.47	979.59	979.59	981.22	0.009010	10.84	410.41	143.45	0.81
R1	4048	3362.00	971.47	979.28	979.28	980.89	0.009404	10.66	367.72	131.30	0.82
R1	4048	2415.00	971.47	978.21	978.21	979.83	0.012079	10.37	249.36	89.33	0.89
R1	4020	4643.00	972.02	979.60	979.60	981.44	0.012644	10.99	442.14	136.95	0.93
R1	4020	3724.00	972.02	978.93	978.93	980.66	0.014612	10.58	358.08	117.14	0.98
R1	4020	3362.00	972.02	978.67	978.67	980.32	0.015361	10.32	328.40	109.30	0.99
R1	4020	2415.00	972.02	977.92	977.92	979.32	0.016823	9.50	254.19	90.88	1.00
R1	3741	4643.00	969.62	976.68		977.63	0.005844	8.05	639.62	202.93	0.65
R1	3741	3724.00	969.62	976.23		977.03	0.005461	7.29	552.80	184.49	0.62
R1	3741	3362.00	969.62	976.11		976.81	0.004970	6.82	529.78	179.28	0.58
R1	3741	2415.00	969.62	975.56		976.07	0.004250	5.75	437.76	156.75	0.53
R1	3711	4643.00	968.72	976.67	975.73	977.41	0.004993	7.16	744.64	272.57	0.59
R1	3711	3724.00	968.72	976.17	975.16	976.83	0.005121	6.71	615.86	239.70	0.59
R1	3711	3362.00	968.72	976.04	974.95	976.63	0.004747	6.32	584.79	231.07	0.56
R1	3711	2415.00	968.72	975.46	974.27	975.92	0.004457	5.50	462.04	193.25	0.53
R1	3696	Culvert									
R1	3681	4643.00	968.26	975.64	975.64	977.14	0.013263	9.91	490.32	182.45	0.93
R1	3681	3724.00	968.26	975.11	975.11	976.50	0.015107	9.49	399.59	157.32	0.96
R1	3681	3362.00	968.26	974.88	974.88	976.22	0.016153	9.30	364.49	146.45	0.98
R1	3681	2415.00	968.26	974.25	974.25	975.40	0.018118	8.61	280.49	122.79	1.00
R1	3505	4643.00	966.15	973.23	972.34	974.00	0.005040	7.51	728.91	240.74	0.60
R1	3505	3724.00	966.15	972.76	971.83	973.43	0.004923	6.94	620.25	220.93	0.59
R1	3505	3362.00	966.15	972.56	971.61	973.19	0.004847	6.67	576.79	212.49	0.58
R1	3505	2415.00	966.15	971.96	970.99	972.46	0.004624	5.87	456.15	187.08	0.55
R1	3495	Culvert									
R1	3484	4643.00	965.73	972.27	972.27	973.59	0.011065	9.72	552.77	225.84	0.86
R1	3484	3724.00	965.73	971.80	971.80	973.03	0.011801	9.22	452.86	200.66	0.87
R1	3484	3362.00	965.73	971.59	971.59	972.78	0.012296	9.03	411.42	189.23	0.88
R1	3484	2415.00	965.73	970.94	970.94	972.03	0.014452	8.45	300.53	154.56	0.92
R1	3444	4643.00	961.89	971.02	971.02	972.93	0.012569	11.56	446.10	132.02	0.92
R1	3444	3724.00	961.89	970.88		972.21	0.009059	9.63	427.90	129.67	0.78
R1	3444	3362.00	961.89	970.79		971.93	0.007969	8.91	416.10	128.12	0.73
R1	3444	2415.00	961.89	970.41		971.15	0.005723	7.13	368.72	121.72	0.61
R1	3372	4643.00	963.24	971.60	970.35	972.02	0.003360	5.70	951.40	315.45	0.48
R1	3372	3724.00	963.24	971.20	969.90	971.55	0.003200	5.22	827.93	298.10	0.46
R1	3372	3362.00	963.24	971.01	969.71	971.34	0.003181	5.03	772.16	289.93	0.46
R1	3372	2415.00	963.24	970.44	969.16	970.72	0.002978	4.51	616.20	265.75	0.43
R1	3343	Culvert									
R1	3335	4643.00	963.37	970.93	970.20	971.72	0.005056	7.72	745.27	277.44	0.61
R1	3335	3724.00	963.37	970.43	969.67	971.16	0.005124	7.25	615.17	245.77	0.60
R1	3335	3362.00	963.37	970.21	969.40	970.91	0.005206	7.06	560.41	230.98	0.60
R1	3335	2415.00	963.37	969.46	968.64	970.10	0.005760	6.55	406.87	183.29	0.61
R1	3312	4643.00	963.05	970.17	970.17	971.52	0.009177	10.12	577.71	234.80	0.81
R1	3312	3724.00	963.05	969.65	969.65	970.94	0.009837	9.70	463.13	200.89	0.82
R1	3312	3362.00	963.05	969.41	969.41	970.68	0.010213	9.52	417.14	185.54	0.83
R1	3312	2415.00	963.05	968.60	968.60	969.85	0.012783	9.18	287.30	135.54	0.90
R1	2226	4917.00	945.74	958.39	958.39	959.98	0.005886	10.68	603.95	259.92	0.66
R1	2226	3941.00	945.74	956.50	955.93	958.92	0.011410	12.49	320.05	69.61	0.88
R1	2226	3557.00	945.74	956.36	955.42	958.43	0.010042	11.54	310.76	62.99	0.82
R1	2226	2552.00	945.74	955.78	953.86	957.08	0.006852	9.14	279.14	48.15	0.67
R1	2102	4917.00	949.79	956.68	956.68	957.79	0.006522	9.37	718.51	344.46	0.70
R1	2102	3941.00	949.79	955.66	955.66	957.30	0.011012	10.65	423.13	171.20	0.88
R1	2102	3557.00	949.79	955.45	955.45	956.97	0.010823	10.23	389.27	151.37	0.86
R1	2102	2552.00	949.79	954.80		956.02	0.010443	9.01	302.23	119.50	0.83
R1	2092	4917.00	947.18	955.90	955.31	957.26	0.007354	9.66	579.45	253.24	0.73
R1	2092	3941.00	947.18	955.68		956.66	0.005560	8.17	533.12	177.76	0.63
R1	2092	3557.00	947.18	955.57		956.42	0.004924	7.58	514.24	161.23	0.59
R1	2092	2552.00	947.18	955.23		955.75	0.003295	5.92	463.51	138.51	0.48
R1	1991	4917.00	947.39	955.53	955.53	956.47	0.005810	9.49	821.83	394.75	0.65
R1	1991	3941.00	947.39	955.18	955.18	956.08	0.005577	8.96	683.21	381.58	0.63
R1	1991	3557.00	947.39	955.05	955.05	955.90	0.005265	8.58	635.01	376.90	0.61
R1	1991	2552.00	947.39	953.91	953.91	955.17	0.008632	9.56	326.92	148.64	0.76
R1	1934	4917.00	946.34	955.58	951.28	955.82	0.000675	4.42	1569.48	471.03	0.27
R1	1934	3941.00	946.34	953.16	950.65	953.81	0.002126	6.47	609.55	264.57	0.46
R1	1934	3557.00	946.34	952.71	950.38	953.32	0.002247	6.31	563.74	131.57	0.47
R1	1934	2552.00	946.34	951.50	949.62	952.01	0.002580	5.76	443.12	101.87	0.48
R1	1909	Bridge									
R1	1884	4917.00	945.84	952.48	950.75	953.59	0.003682	8.47	580.51	276.73	0.61
R1	1884	3941.00	945.84	952.05	950.13	952.88	0.003016	7.30	539.67	240.83	0.54
R1	1884	3557.00	945.84	951.84	949.88	952.57	0.002794	6.85	519.27	222.91	0.52
R1	1884	2552.00	945.84	951.14	949.12	951.64	0.002281	5.64	452.16	141.11	0.46
R1	1819	4917.00	945.19	951.56	951.56	953.20	0.008081	10.42	507.99	175.08	0.92
R1	1819	3941.00	945.19	951.00	951.00	952.51	0.008222	9.91	414.88	158.68	0.94
R1	1819	3557.00	945.19	950.75	950.75	952.20	0.008304	9.71	376.42	148.02	0.96
R1	1819	2552.00	945.19	950.04	950.04	951.31	0.008092	9.03	282.72	113.34	1.00

R1	1119	5466.00	938.19	944.93	944.93	946.03	0.007643	8.42	649.07	301.30	1.01
R1	1119	4376.00	938.19	944.62	944.62	945.58	0.006608	7.85	557.47	290.26	1.00
R1	1119	3947.00	938.19	944.45	944.45	945.39	0.006351	7.76	508.36	284.17	1.02
R1	1119	2826.00	938.19	943.71	943.71	944.69	0.006325	7.94	355.90	182.88	1.00
R1	1118	5466.00	938.18	944.74	944.74	945.85	0.007688	8.47	645.07	297.53	1.01
R1	1118	4376.00	938.18	944.33	944.33	945.38	0.007107	8.22	532.41	222.72	0.94
R1	1118	3947.00	938.18	943.78	943.78	945.07	0.009452	9.11	433.43	167.21	1.00
R1	1118	2826.00	938.18	943.06		944.25	0.009041	8.75	323.13	117.00	0.93
R1	1067	5466.00	937.67	943.90	943.90	945.15	0.009140	8.97	609.10	247.93	1.01
R1	1067	4376.00	937.67	943.52	943.52	944.64	0.008491	8.46	517.04	236.10	1.01
R1	1067	3947.00	937.67	943.37	943.37	944.42	0.008120	8.23	479.68	233.99	1.01
R1	1067	2826.00	937.67	942.80	942.80	943.77	0.007351	7.89	358.06	185.41	1.00
R1	1000	5466.00	937.00	943.30	943.30	944.30	0.008001	8.03	680.76	349.30	1.01
R1	1000	4376.00	937.00	942.92	942.92	943.88	0.007399	7.86	556.65	297.60	1.01
R1	1000	3947.00	937.00	942.77	942.77	943.69	0.006959	7.69	513.58	286.62	1.01
R1	1000	2826.00	937.00	941.72	941.72	943.02	0.009317	9.15	308.94	118.47	1.00

APPENDIX D – TWDB COMMENTS

TWDB Comments
Response to TWDB Comments

TEXAS WATER DEVELOPMENT BOARD

September 21, 2001

The Honorable Ken Jacobs
Mayor, City of Woodcreek
P.O. box 1570
Wimberley, TX 78776

Re: Flood Protection Planning Grant Contract Between and the City of Woodcreek (City) and Texas Water Development Board (Board), TWDB Contract No. 2000-483-360, Draft Final Report

Dear Mayor Jacobs:

Staff members of the Texas Water Development Board have completed a review of the draft report under TWDB Contract No. 2000-483-360. As stated in the above referenced contract, the City will consider incorporating comments from the EXECUTIVE ADMINISTRATOR shown in Attachment 1, and other commentors on the draft final report into a final report. The City must include a copy of the EXECUTIVE ADMINISTRATOR's comments in the final report.

The Board looks forward to receiving one (1) electronic copy of the report with all appendices, one (1) unbound single-sided camera-ready original, and nine (9) bound double-sided copies of the final report on this planning project. Please contact Mr. Gilbert Ward at (512) 463-6418 if you have any questions about the Board's comments.

Sincerely,

Tommy Knowles, Ph.D., P.E.
Deputy Executive Administrator
Office of Planning

Cc: Gilbert R. Ward

ATTACHMENT 1
TEXAS WATER DEVELOPMENT BOARD
Contract No. 2000-483-360
Draft Woodcreek Master Drainage Plan,
Improvements to Hog Creek, City of Woodcreek, Texas"

1. In general, the study follows standard practice. However, the method used is dependent on the assumptions made by the evaluator. I did not see any indication that the study was calibrated with a known event to confirm the assumed basin and storm attributes used in the study or to develop any correlation with statistical expectation.

   For example, a 100-yr frequency rainfall applied to a drainage basin does not necessarily correlate to a 100-year runoff event. Runoff is a function of precipitation depth minus losses. Losses can include consideration of soil moisture conditions that can vary regionally; dry, average, or saturated.

2. Loss models, such as the NRCS curve number (CN) procedure generally consider methods that typically yield "average" procedural conditions that do not necessary reflect actual climatic or regional conditions. Runoff can vary considerably as to where basin soil conditions statistically fall within the dry to saturated range. A 100-yr precipitation applied to a saturated basin could yield a 500-yr flood/ runoff event.

   If a historical event were unavailable for calibration, at least some sensitivity analyses might have proven useful as a planning tool. Again, as an example, does the community wish to plan on a "statistical," or average, or do they wish to go conservative? Conservative may be "safe," but it also has serious political implication (land value/ tax base, etc.).

3. Basin response is also be a function of storm duration. The storm used for this project was a 24-hour event while the basin itself was quite small (under 2 square miles). A 24-hour event might (or might not) be overly conservative. I have seen studies where the use of the 24-hr duration, without calibration, yielded discharges two to three time greater than a statistical approach. If the study intended to target a statistical expectation, but without calibration who can tell what the this study actually tells? Again, however, we can return to the question as to what is the planning intention of the community.

4. An Application for Approval of Reclamation Project need not be filed with the Texas Natural Resource Conservation Commission for the referenced proposal. It was determined from our review that the proposed project, since it is in the City of Woodcreek, needs to be permitted by the City. The City of Woodcreek by virtue of its participation in the National Flood Insurance Program, and in accordance with Section 16.236 (d) (3&4) of the Texas Water Code, has approval authority for the project. If the City has not already done so, they should insure that the proposed construction is documented and permitted in accordance with their Flood Hazard Prevention Ordinance. This documentation should also be submitted by the City to the Federal Emergency Management Agency to obtain a Letter of Map Revision (LOMR) of **Woodcreek**'s Flood Insurance Rate Map.

5. The technical content of the referenced report is based on acceptable hydrological and hydraulic methods and is complete. Therefore, the merits of the proposed project can be evaluated from the report.

6. The report describes the results of hydrologic and hydraulic analyzes completed in an effort to identify and quantify current flood conditions along Hog Creek. Preliminary construction cost estimates and a recommended implementation plan are also included in the report.

7. It appears that current, acceptable methodologies have been employed in the accumulation and presentation of data in this report. The recommended construction of main channel improvements and modification of bridges for flood control purposes are eligible for Board financing. The implementation plan and proposed construction phasing appear to be sound, The report would be appropriate for use in support of an application to the Board for financing the proposed improvements, however estimations of project costs should be refined before application submittal. All additional information required by Board rules, 31 TAC 363.401-404, and required to make legal findings required by Texas Water Code Chapter 17.771-776 would be required at the time of application. Flood control work is not eligible for the Board's pre-design funding option.

8. Water surface elevations are estimated in the report for the 10-year, 50-year, 100-year, and 500-year floods, however it is not apparent from the narrative what level of flood protection is provided by the recommended projects.

Espey Consultants, Inc.
Environmental & Engineering Services

November 30, 2001

Mr. Tommy Knowles, Ph.D., P.E.
Texas Water Development Board
1700 North Congress Avenue
Austin, Texas
78711-3231

Re: Response to TWDB Comments
Woodcreek Masterplan
EC Job#: 2000-33

Dear Dr. Knowles:

Please accept the following response to your comment letter dated September 21, 2001.

1. Complete rainfall (depth and distribution) and peak flow rate information was not available for calibration in this study. However, the results of the analysis were reviewed by representatives of the Guadalupe-Blanco River Authority (GBRA), and compared with the values computed using the USGS regional regression equations published in WRIR 96-4307. The upper and lower confidence limits (67%) of the equations were computed to estimate a correlation and/or statistical expectation. The results are as follows for the 100 year design storm:

HEC-HMS 100-yr Design Storm:	**4376 cfs**
100-yr regression equation upper limit:	5529 cfs
100-yr regression equation:	2731 cfs
100-yr regression equation lower limit:	1349 cfs

2. Refer to comments and calculations presented in 1.

3. The 24-hour storm is used to conform to design criteria of the National Flood Insurance Program (NFIP) and is adequate for planning purposes and the purposes of updating FEMA's flood insurance rate maps (FIRM). In light of the comparison reported in 1, the estimate of the 100-year peak flow using the 24-hour design storm appears to lie within acceptable limits. Without statistical information for the watershed (recorded annual peak flow rates), a statistical approach is not available for use in this study.

4. Understood.

5. No action required.

6. No action required.

7. Understood.

8. The intended level of service of the recommended channel improvements lies between a 50-year and 100-year design storm for the existing flooding areas adjacent to lower Hog Creek. These areas have historically been flooded due to their proximity to the creek and the undersized road crossings that serve them. Therefore, due to the existing constraints (low slab elevations, shallow creek depth, limited creek right-of-way, etc.) this level of service is all that can be expected.

If you have any questions or require any additional information please do not hesitate to call Keith A. Moody, P.E. or myself at 512-326-5659.

Sincerely,

Brian K. Reis

Brian K. Reis, P.E.
Managing Engineer

P:\active\2000-33 Woodcreek MP\letters\TWDB response.doc