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DESIGN ANALYSIS REPORT
FOR KETTLE CREEK
DETENTION FACILITY "E"

J·R ENGINEERING
A Subsidiary of Westrian

J·R ENGINEERING
A Westrian Company

DESIGN ANALYSIS REPORT FOR KETTLE CREEK DETENTION FACILITY "E"

November 2003

Prepared For:

VINTAGE COMMUNITIES
116 North Nevada Avenue
Colorado Springs, CO 80903
(719) 528-5000

Prepared By:

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DESIGN ANALYSIS REPORT
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DETENTION FACILITY "E"

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DRAINAGE REPORT STATEMENT

ENGINEER'S STATEMENT:
The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the City for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors, or omissions on my part in preparing this report.

John R Bessette 12-29-03

John R. Bessette, Colorado P.E. #32712 Date
For and On Behalf of JR Engineering, LLC

DEVELOPER'S STATEMENT:
I, the developer, have read and will comply with all of the requirements specified in this drainage report and plan.

Business Name: Vintage Communities

By: ~~Dean~~ SHEILA Venezia

Title: Manager

Address: 116 North Nevada Avenue

Colorado Springs, CO 80903

CITY OF COLORADO SPRINGS ONLY:
Filed in accordance with Section 15-3-906 of the Code of the City of Colorado Springs, 1980, as amended.

City Engineer Date: Jan 6, 2004

Conditions:

4310 ArrowsWest Drive, Colorado Springs, CO 80907
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DESIGN ANALYSIS REPORT FOR
KETTLE CREEK DETENTION FACILITY "E"

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FINAL DRAINAGE REPORT FOR
KETTLE CREEK DETENTION FACILITY "E"

PURPOSE

The purpose of this report is to document the basis of design for Kettle Creek Detention Facility "E" in accordance with the "Kettle Creek Drainage Basin Old Ranch Road Tributary Drainage Basin Planning Study and Master Development Drainage Plan," prepared by JR Engineering, dated October 2003.

The construction plans titled "Kettle Creek Detention Facility "E" Storm Water Facilities" are an integral part of this report.

GENERAL DESCRIPTION

The proposed detention facility is located within the southwest quarter of Section 22 and the northwest quarter of Section 27, Township 12 South, Range 66 West of the Sixth Principal Meridian, City of Colorado Springs, El Paso County, Colorado.

The site lies on the northwest corner of the intersection of Old Ranch Road and Chapel Ridge Drive in Bison Ridge Filing No. 1, Tract A.

EXISTING SITE CONDITIONS

The site is located within a parcel of land that has been used for boarding of horses for a number of years. Currently there are plans to develop the majority of the site for residential and commercial uses. The site lies in the natural drainageway of a 531-acre watershed. This drainage was labeled as the South Tributary in the drainage basin planning study for the area. Upstream of the site, the drainageway is shallow and poorly defined. Downstream of the site the channel is well defined and incised. A small pond formed by construction of an elevated ranch

driveway is located immediately downstream of the site. The need for the driveway will be eliminated with the development of the adjacent property.

The site contains jurisdictional wetlands and is just upstream from an area that Prebles Meadow Jumping Mice have been found. The site contains a stand of upland and riparian trees. A good number of the trees are non-native species and many are dead or partially dead. The wetlands are identified in the "Kettle Creek Wetland Delineation Report," by Eric Olgierson PHD, Consulting Ecologist.

Mitigation plans for both the wetlands and the trees that will be disturbed by the project have been prepared by SWCA, Inc., Environmental Consultants. The proposed disturbance of the wetlands has been permitted by the U.S. Army Corps of Engineers. A copy of this permit (U.S. Army Permit No. 2000 00535) is contained in the appendix of this report. Due to the identification of the Prebles Mice nearby, the U.S. Fish and Wildlife Service reviewed and consulted on the permit application. Conditions of the permit includes the requirement to mitigate the disturbed wetlands through the creation of wetlands in the pond bottom and just downstream of the proposed dam. Additionally, approximately 1 acre of upland trees are to be planted in the area surrounding the facility and noxious weed control is to be performed on the site.

To avoid potential impacts to the Prebles Mouse population, the commencement of construction activity on the site must be during the period of November 1 through May 1. Construction fencing must be installed prior to construction to prevent damage to habitat and workers must be instructed about the importance of limiting impacts to the habitat.

PREVIOUS STUDIES

The report titled "Kettle Creek Drainage Basin Old Ranch Road Tributary Drainage Basin Planning Study and Master Development Drainage Plan," prepared by JR Engineering, dated October 2003, defined the criteria and general requirements for Detention Facility "E" as part of the Old Ranch Road Tributary drainage improvements.

The above-referenced D.B.P.S. defined the purpose of proposed Detention Facility "E" as follows:

> "The purpose of Regional Detention Facility "E" is two-fold. It will reduce peak flow rates, and provide a point of diversion where flows from frequent storms will be diverted to a downstream storm drain in Old Ranch Road and large flows will be allowed to flow down the downstream natural channel. In order to minimize the impact to the natural channel, the outflow structure(s) at proposed Detention Facility "E" should be designed to accomplish the following:
>
> - Allow low perennial flow to continue to flow to the downstream natural channel in order to support the wetlands located there.
> - Prevent significant flow rates greater than the perennial flow rates from entering the downstream natural channel in frequent runoff events.
> - Regulate peak flows released to the natural channel in the 2-year and greater design rainfall events to approximate those estimated for the predevelopment condition in the watershed.
> - Divert frequent flows and significant volumes of water from large rainfall events to a proposed storm drain system to be constructed in Old Ranch Road.
> - Lag peak flow released to the proposed Old Ranch Road storm drain."

As part of the analysis presented in the above referenced D.B.P.S., a preliminary grading plan, staged outfalls, and volume/discharge data were generated to accomplish the above-referenced criteria.

In application, a low-flow/tickle flow outfall was provided with a 6" diameter orifice (equivalent) to provide frequent trickle flows to the downstream channel and associated wetlands.

A 42" diameter R.C.P. outfall with a 27" diameter orifice (equivalent) was proposed to convey significant peak flows greater than the perennial flows via a storm drain directly to the proposed Detention Facility "F", now constructed, bypassing the existing downstream channel and wetlands.

For peak flow rates greater than could be handled by the 27" orifice/42" diameter outfall, the design added a 12' x 12' I.D. riser with 96" R.C.P. outfall to the downstream channel to safely discharge the most intense storms. These outfalls were designed in conjunction with the pond storage volume such that the developed condition peak discharges would closely match the historic peak discharge rates for storm frequencies of 2, 5, 10, 25, 50 and 100 years.

The following data for design of Detention Facility "E" was taken directly from the above referenced D.B.P.S.

REGIONAL DETENTION FACILITY "E"
Stage Storage Discharge Data

Water Surface Elevation (Feet)	Cumulative Storage Volume (AC/FT)	Normal Outlet to Storm Drain Discharge (cfs)	Normal Outlet to Natural Channel Discharge (cfs)
22.5	0.0	0	0
23.0	0.1	0	0.7
24.0	0.7	0	1.2
26.0	2.8	18.0	1.8
28.0	5.1	32.5	2.2
30.0	7.8	42.3	2.6
32.0	10.8	50.2	5.4
33.0	12.5	53.7	17
34.0	14.2	57	41
35.0	16.0	60	81
36.0	18.0	63	138
37.0	19.8	66	170
38.0	22.0	69	240
39.0	24.1	71	364
40.0	26.4	74	456
41.0	28.8	76	556
42.0	31.2	79	671
43.0	33.8	81	796
44.0	36.4	83	933

Normal Outlet To Old Ranch Road Storm Drain

Outlet: 2.25' Diameter Vertical Orifice, Invert = 6824.0

Normal Outlet Staged To Natural Channel

Low Stage: 6" Diameter Vertical Orifice, Invert = 6822.25+/-
High Stage: 12' x 12' I.D. Reinforced Concrete Riser with 8' Diameter Outfall to the South Tributary Natural Channel, to Incorporate a 90° V-Notch Weir at Elevation 6831.0, Vertical at 6836.0 Forming a Broad-crested Weir to 6840.7, the Peak 100-year W.S.E.

In the emergency overflow condition the Q_{100} inflow of 1078 cfs is planned to enter the 12' x 12' riser and outfall to the South Tributary through a proposed 8' diameter R.C.P.

In addition to the above criteria, it is undesirable to have overtopping of the narrow portion of the pond embankment in the event that normal outlets are partially clogged or in the event of storms producing flow conditions in excess of the design 100-year frequency storm. For this reason, the 12' x 12' I.D. riser and 96" diameter outfall pipe have been designed to pass the entire DF "E" peak 100-year inflow of 1078 cfs and discharge it to the south tributary. Note this would create an estimated water surface elevation between 6844 and 6845. A further emergency condition HEC-1 routing has been run to establish a peak water surface elevation established by assuming the pond is filled to elevation 6840.00 with a 100-year frequency storm then occurring. This condition is further described later in this report.

As part of this report, the referenced D.B.P.S. data was reviewed and updated in the final design of Detention Facility "E" as presented in the following pages of this report.

OTHER JURISDICTIONAL REQUIREMENTS

As previously stated, there are wetlands on and adjacent to the proposed detention facility site. The construction of the detention facility and roadway fill in Chapel Ridge Drive is covered under Army Corps of Engineers Permit No. 2000 00535 to include mitigation requirements. The final design of the detention facilities grading is kept within the footprint requested in the permit application.

FINAL DESIGN OF DETENTION FACILITY "E"

Final design of Detention Facility "E" includes the review of all design data used in the above referenced D.B.P.S. to include the HEC-1 routings of the various storm frequencies.

The preliminary site grading plan has been revised to facilitate a bench for construction of a proposed 12" gravity sanitary sewer main with a 16' wide maintenance access road and maintenance access road to the pond bottom. This required increasing the slope of the exterior embankment shown on the plans included with this report.

In general, the Detention Facility "E" design criteria is as follows:

1) Stay within the original footprint as permitted by the Corps of Engineers.
2) Provide trickle flow to the natural channel.
3) Provide an intermediate outfall (42" R.C.P.) for the frequent peaks to protect the downstream natural channel.
4) Provide a riser and outfall to the natural channel that can convey the peak flows to include routing of the 100-year storm with pond water surface at elevation 6840 at the beginning of the storm without overtopping the narrow portion embankment.
5) Provide emergency overflow spillways above the routed water surface elevation.
6) Configure the outlet stages and pond volume such that the peak discharges closely match the predevelopment conditions peak flow rates.

GRADING PLAN/POND VOLUME

The grading plan was updated to include a bench in the embankment for the proposed sanitary gravity main and interior access roads to the pond bottom at inlet and outfall locations. In general, this presented a slight increase in pond volume. A spreadsheet comparison follows:

DETENTION FACILITY "E" VOLUME COMPARISON

Detention Pond DF 'E' volume 3/22/01

Detention Pond DF 'E' volume Revised 9/22/03

ELEV	AREA	AREA AVG.	DELTA ELEV.	VOLUME	ACCUM. VOLUME	ACCUM. VOLUME		ELEV	AREA	AREA AVG.	DELTA ELEV.	VOLUME	ACCUM. VOLUME	ACCUM. VOLUME
ft	sf	sf	ft	cu ft	cu ft	ac-ft		ft	sf	sf	ft	cu ft	cu ft	ac-ft
22.50	0							22.50	0					
		7640	0.5	3820						3679	0.5	1840		
23.00	15280				3820	0.09		23.00	7358				1840	0.04
		28455	1	28455						22121	1	22121		
24.00	41630				32275	0.74		24.00	36884				23961	0.55
		44685	2	89370						43004	2	86008		
26.00	47740				121645	2.79		26.00	49124				109969	2.52
		50940	2	101880						52362	2	104724		
28.00	54140				223525	5.13		28.00	55600				214693	4.93
		57700	2	115400						59087	2	118174		
30.00	61260				338925	7.78		30.00	62574				332867	7.64
		64580	1	64580						66222	1	66222		
31.00	64430				403505	9.26		31.00	66221				399088	9.16
		68030	1	68030						70012	1	70012		
32.00	67900				471535	10.82		32.00	69869				469100	10.77
		71585	1	71585						73803	1	73803		
33.00	71630				543120	12.47		33.00	73803				542903	12.46
		75660	1	75660						78022	1	78022		
34.00	75270				618780	14.21		34.00	77737				620925	14.25
		79390	1	79390						82241	1	82241		
35.00	79690				698170	16.03		35.00	82240				703165	16.14
		83770	1	83770						86694	1	86694		
36.00	83510				781940	17.95		36.00	86744				789859	18.13
		85680	1	85680						88946	1	88946		
37.00	87850				867620	19.92		37.00	91148				878805	20.17
		89840	1	89840						93350	1	93350		
38.00	91830				957460	21.98		38.00	95552				972155	22.32
		94020	1	94020						97776	1	97776		
39.00	96210				1051480	24.14		39.00	100000				1069931	24.56
		98278	1	98278						102224	1	102224		
40.00	100346				1149758	26.39		40.00	104448				1172155	26.91
		102553	1	102553						106752	1	106752		
41.00	104760				1252311	28.75		41.00	109056				1278907	29.36
		106915	1	106915						111361	1	111361		
42.00	109070				1359226	31.20		42.00	113665				1390268	31.92
		111370	1	111370						118976	1	118976		
43.00	113670				1470596	33.76		43.00	124286				1509243	34.65
		115905	1	115905						129597	1	129597		
44.00	118140				1586501	36.42		44.00	134907				1638840	37.62
		120515	1	120515						134907	1	134907		
45.00	122890				1707016	39.19		45.00	134907				1773747	40.72

C:\777\EXCEL\DRAINAGE\POND VOL.XLS

OUTFALL DISCHARGE DATA

Data for the staged discharge outlets has been revised slightly from the data presented in the referenced D.B.P.S.

Water surface elevation verses discharge spreadsheets were calculated for the 6" diameter trickle flow orifice were computed using the orifice formula $Q = 0.6A(2gh)^{0.5}$, with the head, h, computed from the center of the orifice to the water surface.

Water surface elevation verses discharge for the 90° V-notch weir and broadcrested weir were computed and tabulated as follows:

Discharge rates for the 90° V-notch were computed using the formula, $Q = 2.48H^{2.48}$ cfs which give slightly lower rates than the formula $Q = 2.5(\tan\phi/2)^{2.5}$. H is computed as the difference between the weir invert 6831.0 and the water surface. As shown on the project plans, the weir changes from the V-notch configuration to a broadcrested weir with vertical sides at elevation 6836.00. To develop the discharge verses elevation rates for the weir above 6836.00, the following approach was used.

First, a spreadsheet was developed for the V-notch weir showing the water surface elevation, head, discharge Q, and increase in Q for each given 1-foot increase in head. Secondly, the same type of spreadsheet was developed for a 10-foot wide broadcrested weir (C = 3.1).

Noting that between water surface elevations 6835 and 6836, the discharge for the V-notch weir increased 57 cfs and 77 cfs between 6836 and 6837, it is logical to transition into the 10' wide weir where the discharge rates are similar. For example, the discharge rate for the 10' wide increased 57 cfs between 1 and 2 feet of head and 73 cfs between 2 and 3 feet of head. Thus, the composite discharge verse head curve was developed using the V-notch data for elevations 6831 to 6836, Q = 134 cfs at 6836, then adding the discharge increases per 1 foot intervals of head for the 10' wide broad-crested weir starting at h = 2', Q = 57 cfs. This equates to 191 cfs at elevation 6837 for the combined weir discharge as shown on the spreadsheet Detention Facility "E" Staged Outfall Capacity comparison included at the end of this section of this report. Note,

this discharge data was used through elevation 6844 to determine peak water surface elevations. Since the riser top is elevation 6840.7, barring any clogging, additional discharge can be expected above 6840.7 as water spills over the other three sides of the riser box. Spreadsheets are included in Appendix "C" of this report for comparison of the outfall rates. This does not affect the peak discharge rates for any of the normal storm routings, only conditions in excess of the design 100-year condition presented in the D.B.P.S. would be slightly different.

DETENTION FACILITY "E" STAGED OUTFALL CAPICITY COMPARISON

DETENTION FACILITY "E" STAGED OUT FALL

6" DIA. ORIFICE AT INVERT 22.25
27" ORIFICE AT INVERT 24.00
90 DEGREE V-NOTCH AT INVERT 31.00 TO 10' WIDE VERT WEIR AT 36.0

DBPS, 3/21/2001

POND WSE	ORIFICE DIA ft	h (ft)	ORIFICE AREA sf	ORIFICE Q cfs	WEIR Q cfs	SUBTOTAL Q cfs	ORIFICE DIA ft	h (ft)	ORIFICE AREA sf	ORIFICE Q cfs	TOTAL Q cfs
22.5	0.5	0	0.196	0.00	0.0	0.0				0.0	0.0
23	0.5	0.5	0.196	0.67	0.0	0.7	2.25	0	3.974	0.0	0.7
24	0.5	1.5	0.196	1.16	0.0	1.2	2.25	0	3.974	0.0	1.2
25	0.5	2.5	0.196	1.49	0.0	1.5	2.25	0	3.974	0.0	1.5
26	0.5	3.5	0.196	1.77	0.0	1.8	2.25	0.88	3.974	18.0	19.7
27	0.5	4.5	0.196	2.00	0.0	2.0	2.25	1.88	3.974	26.2	28.2
28	0.5	5.5	0.196	2.22	0.0	2.2	2.25	2.88	3.974	32.5	34.7
29	0.5	6.5	0.196	2.41	0.0	2.4	2.25	3.88	3.974	37.7	40.1
30	0.5	7.5	0.196	2.59	0.0	2.6	2.25	4.88	3.974	42.3	44.9
31	0.5	8.5	0.196	2.75	0.0	2.8	2.25	5.88	3.974	46.4	49.2
32	0.5	9.5	0.196	2.91	2.5	5.4	2.25	6.88	3.974	50.2	55.6
33	0.5	10.5	0.196	3.06	13.8	16.9	2.25	7.88	3.974	53.7	70.6
34	0.5	11.5	0.196	3.20	37.8	41.0	2.25	8.88	3.974	57	98
35	0.5	12.5	0.196	3.34	77.2	80.5	2.25	9.88	3.974	60	141
36	0.5	13.5	0.196	3.47	134	137.7	2.25	10.88	3.974	63	201
37	0.5	14.5	0.196	3.60	166	169.6	2.25	11.88	3.974	66	236
37.5	0.5	15	0.196	3.66	200	203.7	2.25	12.38	3.974	67	271
38	0.5	15.5	0.196	3.72	237	240.7	2.25	12.88	3.974	69	309
38.5	0.5	16	0.196	3.78	276	279.8	2.25	13.38	3.974	70	350
39	0.5	16.5	0.196	3.84	360	363.8	2.25	13.88	3.974	71	435
40	0.5	17.5	0.196	3.95	452	456.0	2.25	14.88	3.974	74	530
41	0.5	18.5	0.196	4.06	552	556.1	2.25	15.88	3.974	76	632
42	0.5	19.5	0.196	4.17	667	671.2	2.25	16.88	3.974	79	750
43	0.5	20.5	0.196	4.28	792	796.3	2.25	17.88	3.974	81	877
44	0.5	21.5	0.196	4.38	928	932.4	2.25	18.88	3.974	83	1016

DETENTION FACILITY "E" STAGED OUT FALL

6" DIA. ORIFICE AT INVERT 22.25
27" ORIFICE AT INVERT 24.00
90 DEGREE V-NOTCH AT INVERT 31.00 TO 10' WIDE VERT WEIR AT 36.0

REVISED 9/29/2003

POND WSE	ORIFICE DIA ft	h (ft)	ORIFICE AREA sf	ORIFICE Q cfs	WEIR Q cfs	SUBTOTAL Q cfs	ORIFICE DIA ft	h (ft)	ORIFICE AREA sf	ORIFICE Q cfs	TOTAL Q cfs
22.5	0.5	0	0.196	0.00	0.0	0.0				0.0	0.0
23	0.5	0.5	0.196	0.67	0.0	0.7	2.25	0	3.974	0.0	0.7
24	0.5	1.5	0.196	1.16	0.0	1.2	2.25	0	3.974	0.0	1.2
25	0.5	2.5	0.196	1.49	0.0	1.5	2.25	0	3.974	0.0	1.5
26	0.5	3.5	0.196	1.77	0.0	1.8	2.25	0.88	3.974	18.0	19.7
27	0.5	4.5	0.196	2.00	0.0	2.0	2.25	1.88	3.974	26.2	28.2
28	0.5	5.5	0.196	2.22	0.0	2.2	2.25	2.88	3.974	32.5	34.7
29	0.5	6.5	0.196	2.41	0.0	2.4	2.25	3.88	3.974	37.7	40.1
30	0.5	7.5	0.196	2.59	0.0	2.6	2.25	4.88	3.974	42.3	44.9
31	0.5	8.5	0.196	2.75	0.0	2.8	2.25	5.88	3.974	46.4	49.2
32	0.5	9.5	0.196	2.91	2.5	5.4	2.25	6.88	3.974	50.2	55.6
33	0.5	10.5	0.196	3.06	13.8	16.9	2.25	7.88	3.974	53.7	70.6
34	0.5	11.5	0.196	3.20	37.8	41.0	2.25	8.88	3.974	57	98
35	0.5	12.5	0.196	3.34	77.2	80.5	2.25	9.88	3.974	60	141
36	0.5	13.5	0.196	3.47	134	137.7	2.25	10.88	3.974	63	201
37	0.5	14.5	0.196	3.60	191	194.6	2.25	11.88	3.974	66	261
37.5	0.5	15	0.196	3.66	227	230.7	2.25	12.38	3.974	67	298
38	0.5	15.5	0.196	3.72	264	267.7	2.25	12.88	3.974	69	336
38.5	0.5	16	0.196	3.78	307	310.8	2.25	13.38	3.974	70	381
39	0.5	16.5	0.196	3.84	351	354.8	2.25	13.88	3.974	71	426
40	0.5	17.5	0.196	3.95	449	453.0	2.25	14.88	3.974	74	527
41	0.5	18.5	0.196	4.06	558	562.1	2.25	15.88	3.974	76	638
42	0.5	19.5	0.196	4.17	676	680.2	2.25	16.88	3.974	79	759
43	0.5	20.5	0.196	4.28	803	807.3	2.25	17.88	3.974	81	888
44	0.5	21.5	0.196	4.38	938	942.4	2.25	18.88	3.974	83	1026

STORM ROUTINGS

The revised pond volume data and staged outfall data were plugged into the previously referenced D.B.P.S. HEC-1 models to demonstrate that the changes would have an insignificant impact on peak water surface elevations and discharge rates. A comparison follows:

Pond Routing Data

Peak Inflow (cfs)	**Q_2**	**Q_5**	**Q_{10}**	**Q_{25}**	**Q_{50}**	**Q_{100}**
D.B.P.S.	299	470	596	796	935	1079
Current	299	470	595	795	934	1078
Peak Outflow (cfs)	**Q_2**	**Q_5**	**Q_{10}**	**Q_{25}**	**Q_{50}**	**Q_{100}**
D.B.P.S.	60	137	213	366	489	600
Current	60	135	215	359	472	587
Peak Storage (ac-ft)	**V_2**	**V_5**	**V_{10}**	**V_{25}**	**V_{50}**	**V_{100}**
D.B.P.S.	11	16	19	23	25	28
Current	11	16	19	23	26	28
Peak W.S.E.	**E_2**	**E_5**	**E_{10}**	**E_{25}**	**E_{50}**	**E_{100}**
D.B.P.S.	6832.29	6834.90	6836.33	6838.46	6839.58	6840.69
Current	6832.28	6834.86	6836.23	6838.26	6839.45	6840.54

This comparison of D.B.P.S. and current data demonstrates at the final design of Detention Facility "E" is in accordance with the criteria set forth in the referenced D.B.P.S. A copy of the revised HEC-1 Summary Output Data for storm frequencies 2, 5, 10, 25, 50 and 100-year is included in Appendix B of this report.

EMERGENCY ROUTING

As previously discussed, it is undesirable to have overtopping of the narrow portion of the pond embankment. For that reason, an additional HEC-1 routing analysis was done. In this model, it is assumed that the normal outlets are functional; the pond water surface is at elevation 6840.00 with the 100-year frequency storm then occurring. The resulting estimated peak water surface is elevation 6842.76. Based on this information, earthen emergency spillways on the southwest

and northwest corners have been set at elevation 6843.00, and the top of the narrow portion of embankment established at elevation 6845.00 thus allowing a secondary emergency outlet in addition to the 12' x 12' I.D. riser provided. The elevation of the top of the riser walls is 6840.7.

DETENTION FACILITY "E" OUTFALLS

As previously outlined, there are two major storm drain outfalls for proposed Detention Facility "E."

The smaller of the two is completion of the 42" R.C.P. storm drain in Old Ranch Road, which discharges to existing Detention Facility "F." The pipe diameter selection was based on the required capacity (Q_{100} = 75 cfs) and available slope to allow free discharge from the 27" (equivalent) diameter orifice. The Flow Master data sheets are included in Appendix "C" of this report. Pipe class calculations are included in Appendix "D" of this report. A cast-in-place reinforced concrete inlet structure with a steel pipe bargrate is proposed as shown on the accompanying project plans. Design/analysis calculations for the bargrate outlet structure are included in Appendix "H" of this report.

The larger of the two major outfalls is the 96" R.C.P. with 12' x 12' I.D. intake cast-in-place reinforced concrete riser. The trickle flow 12" diameter outlet discharges to the 12' x 12' I.D. cast-in-place reinforced concrete riser as shown on the accompanying project plans.

The 96" R.C.P. outlet pipe selection was based on the pipe's ability to pass the following flow rates:

Normal .....Q_{100} = 600 cfs ±

Pond Full to Elevation 6840 .....Q_{100} = 766 cfs ±

DF "E" Peak Inflow .....Q_{100} = 1080 cfs ±

Flow Master data sheets for these conditions are provided in Appendix "C" of this report. Pipe class calculations are included in Appendix "D" of this report. Note, it is required to radius the 96" R.C.P. inlet as shown on the project plans to prevent inlet losses from increasing the required

depth of the intake riser structure and outfalls. The 96" R.C.P. inlet radius permits the use of an inlet coefficient of 1.3V^2/2g which reduces the possibility of the inlet loss affecting the weir discharge capacity.

The function and capacity of the 90° V-notch and broad-crested weirs has been described previously in this report. Basically the 12' x 12' I.D. riser structure was designed to facilitate maintaining the peak discharge rates at historic levels for storm frequency events as stated in the referenced D.B.P.S., given the available pond volume available. The information outlining the design of the riser structure is included in the Appendix "E" of this report; flotation analysis, structural loading conditions, and free flow analysis for the weirs.

An outlet splash pool for the 96" R.C.P. outfall is required to reduce water velocities of 19 fps ± at the pipe outlet to acceptable levels for discharge to the environmentally sensitive channel. The splash pool analysis did not fit the parameters of and method set forth in Chapter 10 of the Colorado Springs Drainage Criteria Manual. In order to accomplish velocity reduction and change of flow direction as shown on the accompanying project plans, a reinforced concrete outfall structure was incorporated as an integral part of the splash pool. A row of baffles are provided in this structure to break up the flow within the protected reinforced concrete area, prior to reaching the rip-rap splash pool area. The use of Type VH rip-rap is proposed, and the splash pool configured to effect the change of flow direction. Supporting data is provided in Appendix "F" of this report.

It should be noted that removal of the access road across the Old Ranch Road tributary, although not part of this project, is part of the referenced D.B.P.S. improvements and should be done when planned development renders the road unnecessary.

As previously stated, the 6" diameter (equivalent) orifice and 12" diameter outfall are intended to provide frequent trickle flows to the downstream channel to support the wetlands revegetation. Analysis of the 12" diameter outfall structure is provided in Appendix "I" of this report.

ROYAL PINE DRIVE 4' X 12' R.C.B. SPLASH POOL ANALYSIS

The primary concern in the design of the 4' x 12' R.C.B. splash pool is the potential loss of soils and thus structural support at the end of the box culvert. Pond water depth rises quickly in Detention Facility "E" because of the requirement to detain 2- and 5-year frequency storms to historic levels. In order to assess the impact of the pond water depth on outfall water velocities, the outfall was modeled using HEC-RAS. Complete analysis data for the outfall is included in Appendix "G" of this report. Velocities at the outlet are predicted in 21-38 fps range for various depths of ponded water at section #1 (see Appendix "G"). However, at section #5, 25 feet from the end of the R.C.B., velocities are predicted to be 1-4 fps.

In order to secure the rip-rap at the R.C.B. wing and toe walls, it is proposed to construct the entire splash pool with Type VH rip-rap to ensure that the rip-rap adjacent to the wall is "locked" in place.

SEDIMENT FOREBAY

As previously noted, a wetland will be established in the pond bottom as mitigation for wetlands to be disturbed by the project. A rip-rap berm is planned in the upper portion of the pond bottom for the purpose of trapping sediment and facilitating maintenance.

GEOTECHNICAL REPORT

It should be noted that a geotechnical report is being prepared by CTL/Thompson at the time of preparation of this report. Any additional conditions/requirements not addressed in this report and/or on the project plans will be addressed upon completion of that report.

SUMMARY

Construction of Detention Facility "E" facilities in accordance with the concepts presented in this report and the accompanying project plans will result in safe routing of storm water flows and protection of downstream wetlands as outlined in the referenced D.B.P.S. and wetlands permitting.

PREPARED BY:

JR Engineering

John R. Bessette, P.E.
Lead Project Engineer

/cw/8877.15/Design Analysis Rpt.doc

REFERENCES:

1. "City of Colorado Springs/County of El Paso Drainage Criteria Manual," November 1991.

2. "Kettle Creek Drainage Basin, Old Ranch Tributary Drainage Basin Planning Study and Master Development Drainage Plan," prepared by JR Engineering, date of last revision October 2002.

3. "HEC-1 Flood Hydrographic Package Users Manual," U.S. Army Corps of Engineers, September 1990.

4. "HEC-RAS River Analysis System," U.S. Army Corps of Engineers, Hydraulic Engineer Center, September 1998 Version 2.2.

5. Haesteds Methods Inc., Flow Master V5.15 Hydraulic Analysis Software.

6. "Hydraulic Design of Flood Control Channels," EM 1110-2-1601, July 1991, U.S. Army Corps of Engineers.

7. "Standard Handbook for Civil Engineers," Frederick Merritt, Editor, McGraw-Hill Book Company, Copyright 1968.

8. "Hydraulic Design of Highway Culverts," Report No. FHWA-1P-85-15, September 1985.

9. "SCS, Engineering Field Manual," Fourth Printing 1984.

10. Pipe PAC 2000 Version 2.1, Concrete Pipe Software, Copyright 1996-2000. Provide/Developed by Giffels Associates Limited, the Ontario Concrete Pipe Association, the Canadian Concrete Pipe Association, the American Concrete Pipe Association and Tubécon Inc.

APPENDIX "A"

Construction Plans Titled

"Kettle Creek Detention Facility "E" Storm Water Facilities," Sheets 1 through 13, dated October 2003, prepared by JR Engineering.

(Rolled separate from this report)

APPENDIX "B"

The following HEC-1 Model Data Sheets have been updated for the referenced D.B.P.S. HEC-1 model:

Page H-1	Revised DF "E" Input Data
Page H2-1 thru H2-5	2-Year, 24 Hour Developed Condition Model Summary Sheets
Page H5-1 thru H5-5	5-Year, 24 Hour Developed Condition Model Summary Sheets
Page H10-1 thru H10-5	10-Year, 24 Hour Developed Condition Model Summary Sheets
Page H25-1 thru H25-5	25-Year, 24 Hour Developed Condition Model Summary Sheets
Page H50-1 thru H50-5	50-Year, 24 Hour Developed Condition Model Summary Sheets
Page H100-1 thru H100-6	100-Year, 24 Hour Developed Condition Model Summary Sheets

Ultimate Model 100-Year Storm Occurring with Pond Use at 6840.0

Page HU-1	Adjusted Detention Facility "E" Input Data
Page HU-2 thru HU-7	Summary Data Sheets

DE "E" HEC-1 INPUT DATA, 9/29/03

```
KK  RR-DPE
KM   ROUTE FLOW THROUGH THE PROPOSED DETENTION FACILITY "E". STORAGE IS BASED ON
KM   A  GRADING PLAN DATED 9/29/03 WITH THE POND LOCATED AT THE NW
KM   CORNER OF THE INTERSECTION OF OLD RANCH RD. AND CHAPEL RIDGE DRIVE. OUTLET
KM   CAPACITY IS BASED ON A 6" DIA ORIFICE OUTLET WITH INV AT EL 22.25, A 27" DIA
KM   ORIFICE OUTLET AT INVERT ELEV. 24.00.
KM   90 DEGREE V-NOTCH WEIR INVERT ELEV. 31.0,TRIMMED VERT AT 10' WIDTH ELEV. 36.0
KM   6" DIA. OUTLET ALLOWS LOW FLOW TO CONTINUE DOWN THE HISTORIC NATURAL CHANNEL
KM   90 DEGREE V-NOTCH OUTFALLS TO THE HISTORIC NATURAL CHANNEL TO DIRECT  SOME OF
KM   THE PEAK FLOW FROM LARGE STORMS TO THE NATURAL CHANNEL
KM   THE 27" DIA ORIFICE OUTLET OUTFALLS TO A PROPOSED STORM DRAIN IN OLD RANCH RO
KO       1       1
RS       1    STOR       0
SV       0    0.04     .55     2.52     4.93     7.64    10.77    12.46    14.25    16.14
SV   18.13   20.17   22.32   24.56   26.91   29.36   31.92   34.65   37.62
SE    22.5    23.0    24.0    26.0    28.0    30.0    32.0    33.0    34.0    35.0
SE    36.0    37.0    38.0    39.0    40.0    41.0    42.0    43.0    44.0
SQ     0.0     0.7    1.20    19.7    34.7    44.9    55.6    70.6      98     141
SQ     201     261     336     426     527     638     759     888    1026

KK  AP-DPE
KM   DIVERT OUT FLOW THAT PASSES THROUGH THE V-NOTCH AND THE 6" DIA OUTLET TO THE
KM   NATURAL CHANNEL
KO       1       1
DT  AP-D12
DI     0.0     0.7    1.20    19.7    34.7    44.9    55.6    70.6      98     141
DI     201     261     336     426     527     638     759     888    1026
DQ       0     0.7     1.2     1.8     2.2     2.6     5.4    16.9      41    80.5
DQ     138     195     268     355     453     562     680     807     938
```

2-YEAR, 24 HOUR, DEVELOPED CONDITION

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	SB-D1	6.	6.35	1.	1.	1.	0.09		
ROUTED TO	RT-SBD1	6.	6.45	1.	1.	1.	0.09		
HYDROGRAPH AT	SB-D2	8.	6.15	1.	1.	1.	0.06		
2 COMBINED AT	AP-D1	11.	6.25	2.	1.	1.	0.14		
HYDROGRAPH AT	SB-D3	7.	6.20	1.	0.	0.	0.03		
2 COMBINED AT	AP-DDA	17.	6.20	3.	2.	2.	0.17		
ROUTED TO	RR-DFA	17.	6.25	3.	2.	2.	0.17	54.92	6.25
ROUTED TO	RT-APDFA	17.	6.25	3.	2.	2.	0.17		
HYDROGRAPH AT	SB-D6	19.	6.10	2.	1.	1.	0.04		
2 COMBINED AT	AP-D2	30.	6.15	5.	2.	2.	0.21		
ROUTED TO	RT-APD2	29.	6.15	5.	2.	2.	0.21		
HYDROGRAPH AT	SB-D7	36.	6.10	4.	2.	2.	0.07		
HYDROGRAPH AT	SB-D4	5.	6.20	1.	0.	0.	0.05		
HYDROGRAPH AT	SB-D5	8.	6.15	1.	0.	0.	0.03		
2 COMBINED AT	AP-DFB	13.	6.15	2.	1.	1.	0.08		
ROUTED TO	RR-DFB	13.	6.20	2.	1.	1.	0.08	19.35	6.20
ROUTED TO	RT-APDFB	13.	6.20	2.	1.	1.	0.08		
3 COMBINED AT	AP-D3	73.	6.10	11.	5.	5.	0.36		
ROUTED TO	RT-APD3	73.	6.15	11.	5.	5.	0.36		
HYDROGRAPH AT	SB-D8	79.	6.00	8.	3.	3.	0.06		
2 COMBINED AT	AP-DFC	139.	6.05	19.	8.	8.	0.42		
ROUTED TO	RR-DFC	45.	6.40	18.	8.	8.	0.42	55.96	6.40
ROUTED TO	RT-DFC	45.	6.45	18.	8.	8.	0.42		
HYDROGRAPH AT	SB-D9A	5.	6.15	1.	0.	0.	0.02		
2 COMBINED AT	AP-D4	47.	6.30	19.	9.	9.	0.44		
ROUTED TO	RT-APD4	47.	6.30	19.	9.	9.	0.44		
HYDROGRAPH AT	SB-D9	7.	6.15	1.	0.	0.	0.02		
2 COMBINED AT									

	AP-D6	53.	6.20	20.	9.	9.	0.46
HYDROGRAPH AT	SB-D10	2.	6.25	0.	0.	0.	0.03
ROUTED TO	RT-SBD10	2.	6.35	0.	0.	0.	0.03
HYDROGRAPH AT	SB-D11	13.	6.15	2.	1.	1.	0.05
HYDROGRAPH AT	SB-D12	5.	6.20	1.	0.	0.	0.02
ROUTED TO	RT-SBD12	5.	6.25	1.	0.	0.	0.02
3 COMBINED AT	AP-D5	19.	6.20	3.	1.	1.	0.10
ROUTED TO	RT-APD5	18.	6.20	3.	1.	1.	0.10
2 COMBINED AT	AP-D6	71.	6.20	23.	10.	10.	0.56
HYDROGRAPH AT	SB-D13	80.	6.00	8.	3.	3.	0.07
ROUTED TO	RT-SBD13	80.	6.00	8.	3.	3.	0.07
2 COMBINED AT	AP-D6	134.	6.05	31.	14.	14.	0.62
ROUTED TO	RT-APD6	133.	6.05	31.	14.	14.	0.62
HYDROGRAPH AT	SB-D15	13.	6.10	2.	1.	1.	0.04
2 COMBINED AT	AP-D6A	144.	6.05	32.	14.	14.	0.67
ROUTED TO	RT-APD6A	143.	6.10	32.	14.	14.	0.67
HYDROGRAPH AT	SB-D14	10.	6.05	1.	0.	0.	0.02
ROUTED TO	RT-SBD14	10.	6.10	1.	0.	0.	0.02
2 COMBINED AT	AP-D7	153.	6.10	33.	15.	15.	0.69
ROUTED TO	RT-APD7	153.	6.10	33.	15.	15.	0.69
HYDROGRAPH AT	SB-D17	6.	6.05	1.	0.	0.	0.01
2 COMBINED AT	AP-D7A	158.	6.10	34.	15.	15.	0.70
HYDROGRAPH AT	SB-D16A	6.	6.05	1.	0.	0.	0.01
2 COMBINED AT	AP-D7A	164.	6.10	34.	15.	15.	0.71
ROUTED TO	RT-APD8	164.	6.10	34.	15.	15.	0.71
HYDROGRAPH AT	SB-D17A	16.	6.00	2.	1.	1.	0.01
2 COMBINED AT	AP-D8	176.	6.10	36.	16.	16.	0.72
HYDROGRAPH AT	SB-D16	14.	6.10	2.	1.	1.	0.06
ROUTED TO	RT-SBD16	14.	6.15	2.	1.	1.	0.06
2 COMBINED AT	AP-D8	190.	6.10	38.	17.	17.	0.78
ROUTED TO	RT-APD9	190.	6.10	38.	17.	17.	0.78
HYDROGRAPH AT	SB-D36	5.	6.15	1.	0.	0.	0.02

ROUTED TO	RT-SBD36	5.	6.20	1.	0.	0.	0.02	
2 COMBINED AT	AP-D9	194.	6.10	39.	17.	17.	0.81	
HYDROGRAPH AT	SB-D37	18.	6.00	2.	1.	1.	0.01	
ROUTED TO	RT-SBD37	18.	6.00	2.	1.	1.	0.01	
2 COMBINED AT	AP-D9	208.	6.10	40.	18.	18.	0.82	
ROUTED TO	RT-APDFE	208.	6.10	40.	18.	18.	0.82	
HYDROGRAPH AT	SB-D18	19.	6.15	3.	1.	1.	0.06	
ROUTED TO	RR-DFPCH	1.	8.40	1.	0.	0.	0.06	20.13 8.40
ROUTED TO	RT-RRDFP	1.	8.40	1.	0.	0.	0.06	
HYDROGRAPH AT	SB-D19	15.	6.05	1.	1.	1.	0.02	
2 COMBINED AT	AP-D10	15.	6.05	2.	1.	1.	0.09	
ROUTED TO	RT-APD10	15.	6.05	2.	1.	1.	0.09	
HYDROGRAPH AT	SB-D20	46.	6.00	5.	2.	2.	0.03	
2 COMBINED AT	AP-D11	60.	6.00	7.	3.	3.	0.12	
ROUTED TO	RT-APD11	59.	6.05	7.	3.	3.	0.12	
HYDROGRAPH AT	SB-D21	36.	6.05	4.	2.	2.	0.04	
3 COMBINED AT	AP-DFE	299.	6.05	51.	23.	23.	0.98	
ROUTED TO	RR-DFE	60.	7.15	45.	22.	22.	0.98	32.28 7.15
DIVERSION TO	AP-D12	9.	7.15	4.	2.	2.	0.98	
HYDROGRAPH AT	AP-DFE	51.	7.15	41.	20.	20.	0.98	
ROUTED TO	RT-APD13	51.	7.15	41.	20.	20.	0.98	
HYDROGRAPH AT	SB-D22	17.	6.05	2.	1.	1.	0.04	
2 COMBINED AT	AP-D13	56.	6.15	43.	20.	20.	1.02	
ROUTED TO	RT-APD13	55.	6.15	43.	20.	20.	1.02	
HYDROGRAPH AT	SB-D23	5.	6.00	0.	0.	0.	0.00	
2 COMBINED AT	AP-D14	58.	6.15	43.	20.	20.	1.02	
ROUTED TO	AP-DFF	58.	6.15	43.	20.	20.	1.02	
HYDROGRAPH AT	SB-D24	8.	6.10	1.	0.	0.	0.03	
2 COMBINED AT	AP-DFF	66.	6.10	44.	21.	21.	1.05	
ROUTED TO	RR-DFF	48.	8.70	33.	15.	15.	1.05	68.83 8.70
HYDROGRAPH AT	SB-D25	11.	6.05	1.	0.	0.	0.02	

ROUTED TO	RR-SBD25	11.	6.05	1.	0.	0.	0.02	
HYDROGRAPH AT	SB-D26	12.	6.05	1.	1.	1.	0.03	
2 COMBINED AT	AP-D16	23.	6.05	2.	1.	1.	0.05	
ROUTED TO	RT-APD16	23.	6.05	2.	1.	1.	0.05	
2 COMBINED AT	AP-D17	49.	8.70	34.	16.	16.	1.10	
ROUTED TO	RT-APD17	49.	8.70	34.	16.	16.	1.10	
HYDROGRAPH AT	SB-D27	4.	6.05	0.	0.	0.	0.01	
2 COMBINED AT	AP-D18	49.	8.70	34.	17.	17.	1.10	
ROUTED TO	RT-APD18	49.	8.70	34.	17.	17.	1.10	
HYDROGRAPH AT	SB-D29	9.	6.05	1.	0.	0.	0.02	
DIVERSION TO	AP-D19a	0.	6.05	0.	0.	0.	0.02	
HYDROGRAPH AT	AP-D19	9.	6.05	1.	0.	0.	0.02	
ROUTED TO	RT-APD19	9.	6.05	1.	0.	0.	0.02	
HYDROGRAPH AT	SB-D28	3.	6.05	0.	0.	0.	0.00	
3 COMBINED AT	AP-D20	49.	8.70	34.	17.	17.	1.13	
ROUTED TO	RT-APD20	49.	8.70	34.	17.	17.	1.13	
HYDROGRAPH AT	SB-D30	6.	6.10	1.	0.	0.	0.02	
ROUTED TO	RT-SBD30	5.	6.10	1.	0.	0.	0.02	
2 COMBINED AT	AP-D21	49.	8.70	34.	17.	17.	1.14	
HYDROGRAPH AT	SB-D31	3.	6.05	0.	0.	0.	0.01	
2 COMBINED AT	AP-D22	52.	6.10	34.	18.	18.	1.15	
HYDROGRAPH AT	SB-D32	1.	6.05	0.	0.	0.	0.01	
2 COMBINED AT	AP-DFCS	53.	6.10	34.	18.	18.	1.16	
ROUTED TO	RR-DFCS	37.	10.60	34.	17.	17.	1.16	77.82 10.60
HYDROGRAPH AT	DR-APD12	9.	7.15	4.	2.	2.	0.00	
ROUTED TO	RT-APD12	9.	7.45	4.	2.	2.	0.00	
HYDROGRAPH AT	SB-D33	8.	6.10	1.	0.	0.	0.04	
2 COMBINED AT	AP-D23	9.	7.45	5.	2.	2.	0.04	
2 COMBINED AT	AP-D24	40.	10.50	37.	20.	20.	1.19	
HYDROGRAPH AT	SB-D34	16.	6.10	2.	1.	1.	0.04	
ROUTED TO	RT-SBD34	16.	6.10	2.	1.	1.	0.04	

HYDROGRAPH AT	SB-D35	17.	6.10	2.	1.	1.	0.04		
2 COMBINED AT	AP-DFG	33.	6.10	3.	2.	2.	0.08		
ROUTED TO	RR-DFG	2.	7.85	2.	1.	1.	0.08	65.01	8.10

5-YEAR, 24 HOUR, DEVELOPED CONDITION

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	SB-D1	17.	6.30	3.	1.	1.	0.09		
ROUTED TO	RT-SBD1	17.	6.35	3.	1.	1.	0.09		
HYDROGRAPH AT	SB-D2	20.	6.15	2.	1.	1.	0.06		
2 COMBINED AT	AP-D1	31.	6.25	6.	3.	3.	0.14		
HYDROGRAPH AT	SB-D3	13.	6.15	2.	1.	1.	0.03		
2 COMBINED AT	AP-DDA	44.	6.20	7.	3.	3.	0.17		
ROUTED TO	RR-DFA	38.	6.35	7.	3.	3.	0.17	56.38	6.35
ROUTED TO	RT-APDFA	38.	6.35	7.	3.	3.	0.17		
HYDROGRAPH AT	SB-D6	34.	6.05	3.	2.	2.	0.04		
2 COMBINED AT	AP-D2	64.	6.15	11.	5.	5.	0.21		
ROUTED TO	RT-APD2	64.	6.15	11.	5.	5.	0.21		
HYDROGRAPH AT	SB-D7	62.	6.05	7.	3.	3.	0.07		
HYDROGRAPH AT	SB-D4	14.	6.15	2.	1.	1.	0.05		
HYDROGRAPH AT	SB-D5	16.	6.15	2.	1.	1.	0.03		
2 COMBINED AT	AP-DFB	30.	6.15	4.	2.	2.	0.08		
ROUTED TO	RR-DFB	30.	6.15	4.	2.	2.	0.08	19.82	6.15
ROUTED TO	RT-APDFB	30.	6.15	4.	2.	2.	0.08		
3 COMBINED AT	AP-D3	148.	6.10	21.	10.	10.	0.36		
ROUTED TO	RT-APD3	147.	6.15	21.	10.	10.	0.36		
HYDROGRAPH AT	SB-D8	111.	6.00	11.	5.	5.	0.06		
2 COMBINED AT	AP-DFC	237.	6.05	32.	14.	14.	0.42		
ROUTED TO	RR-DFC	60.	6.60	32.	14.	14.	0.42	58.40	6.60
ROUTED TO	RT-DFC	60.	6.60	32.	14.	14.	0.42		
HYDROGRAPH AT	SB-D9A	10.	6.10	1.	1.	1.	0.02		
2 COMBINED AT	AP-D4	64.	6.25	33.	15.	15.	0.44		
ROUTED TO	RT-APD4	63.	6.30	33.	15.	15.	0.44		
HYDROGRAPH AT	SB-D9	14.	6.15	2.	1.	1.	0.02		
2 COMBINED AT									

AP-D6	76.	6.20	35.	16.	16.	0.46
HYDROGRAPH AT SB-D10	7.	6.25	1.	0.	0.	0.03
ROUTED TO RT-SBD10	7.	6.30	1.	0.	0.	0.03
HYDROGRAPH AT SB-D11	27.	6.15	3.	1.	1.	0.05
HYDROGRAPH AT SB-D12	10.	6.20	1.	1.	1.	0.02
ROUTED TO RT-SBD12	10.	6.25	1.	1.	1.	0.02
3 COMBINED AT AP-D5	40.	6.20	6.	3.	3.	0.10
ROUTED TO RT-APD5	40.	6.20	6.	3.	3.	0.10
2 COMBINED AT AP-D6	116.	6.20	41.	18.	18.	0.56
HYDROGRAPH AT SB-D13	115.	6.00	12.	5.	5.	0.07
ROUTED TO RT-SBD13	114.	6.00	12.	5.	5.	0.07
2 COMBINED AT AP-D6	204.	6.05	52.	23.	23.	0.62
ROUTED TO RT-APD6	202.	6.05	52.	23.	23.	0.62
HYDROGRAPH AT SB-D15	26.	6.10	3.	1.	1.	0.04
2 COMBINED AT AP-D6A	226.	6.05	55.	24.	24.	0.67
ROUTED TO RT-APD6A	226.	6.10	55.	24.	24.	0.67
HYDROGRAPH AT SB-D14	19.	6.05	2.	1.	1.	0.02
ROUTED TO RT-SBD14	19.	6.05	2.	1.	1.	0.02
2 COMBINED AT AP-D7	244.	6.10	57.	25.	25.	0.69
ROUTED TO RT-APD7	244.	6.10	57.	25.	25.	0.69
HYDROGRAPH AT SB-D17	10.	6.05	1.	0.	0.	0.01
2 COMBINED AT AP-D7A	252.	6.10	58.	26.	26.	0.70
HYDROGRAPH AT SB-D16A	11.	6.05	1.	0.	0.	0.01
2 COMBINED AT AP-D7A	262.	6.10	59.	26.	26.	0.71
ROUTED TO RT-APD8	262.	6.10	59.	26.	26.	0.71
HYDROGRAPH AT SB-D17A	21.	6.00	2.	1.	1.	0.01
2 COMBINED AT AP-D8	278.	6.10	61.	27.	27.	0.72
HYDROGRAPH AT SB-D16	31.	6.10	4.	2.	2.	0.06
ROUTED TO RT-SBD16	31.	6.10	4.	2.	2.	0.06
2 COMBINED AT AP-D8	309.	6.10	65.	29.	29.	0.78
ROUTED TO RT-APD9	309.	6.10	65.	29.	29.	0.78
HYDROGRAPH AT SB-D36	10.	6.15	1.	1.	1.	0.02

ROUTED TO	RT-SBD36	10.	6.15	1.	1.	1.	0.02	
2 COMBINED AT	AP-D9	318.	6.10	66.	29.	29.	0.81	
HYDROGRAPH AT	SB-D37	23.	6.00	3.	1.	1.	0.01	
ROUTED TO	RT-SBD37	23.	6.00	3.	1.	1.	0.01	
2 COMBINED AT	AP-D9	337.	6.10	69.	31.	31.	0.82	
ROUTED TO	RT-APDFE	336.	6.10	69.	31.	31.	0.82	
HYDROGRAPH AT	SB-D18	38.	6.15	5.	2.	2.	0.06	
ROUTED TO	RR-DFPCH	6.	6.80	3.	1.	1.	0.06	20.80 6.80
ROUTED TO	RT-RRDFP	6.	6.80	3.	1.	1.	0.06	
HYDROGRAPH AT	SB-D19	25.	6.05	2.	1.	1.	0.02	
2 COMBINED AT	AP-D10	25.	6.05	5.	2.	2.	0.09	
ROUTED TO	RT-APD10	25.	6.05	5.	2.	2.	0.09	
HYDROGRAPH AT	SB-D20	62.	6.00	7.	3.	3.	0.03	
2 COMBINED AT	AP-D11	85.	6.00	12.	5.	5.	0.12	
ROUTED TO	RT-APD11	84.	6.00	12.	5.	5.	0.12	
HYDROGRAPH AT	SB-D21	56.	6.05	5.	2.	2.	0.04	
3 COMBINED AT	AP-DFE	470.	6.05	86.	38.	38.	0.98	
ROUTED TO	RR-DFE	135.	6.60	74.	36.	36.	0.98	34.86 6.60
DIVERSION TO	AP-D12	75.	6.60	23.	10.	10.	0.98	
HYDROGRAPH AT	AP-DFE	60.	6.60	51.	26.	26.	0.98	
ROUTED TO	RT-APD13	60.	6.60	51.	26.	26.	0.98	
HYDROGRAPH AT	SB-D22	31.	6.05	3.	1.	1.	0.04	
2 COMBINED AT	AP-D13	79.	6.10	54.	27.	27.	1.02	
ROUTED TO	RT-APD13	79.	6.10	54.	27.	27.	1.02	
HYDROGRAPH AT	SB-D23	8.	6.00	1.	0.	0.	0.00	
2 COMBINED AT	AP-D14	84.	6.10	54.	28.	28.	1.02	
ROUTED TO	AP-DFF	84.	6.10	54.	28.	28.	1.02	
HYDROGRAPH AT	SB-D24	16.	6.05	2.	1.	1.	0.03	
2 COMBINED AT	AP-DFF	100.	6.10	56.	28.	28.	1.05	
ROUTED TO	RR-DFF	57.	8.25	47.	23.	23.	1.05	69.06 8.25
HYDROGRAPH AT	SB-D25	18.	6.05	2.	1.	1.	0.02	

ROUTED TO	RR-SBD25	18.	6.05	2.	1.	1.	0.02	
HYDROGRAPH AT	SB-D26	24.	6.05	2.	1.	1.	0.03	
2 COMBINED AT	AP-D16	41.	6.05	4.	2.	2.	0.05	
ROUTED TO	RT-APD16	41.	6.05	4.	2.	2.	0.05	
2 COMBINED AT	AP-D17	59.	8.10	48.	25.	25.	1.10	
ROUTED TO	RT-APD17	59.	8.10	48.	25.	25.	1.10	
HYDROGRAPH AT	SB-D27	8.	6.05	1.	0.	0.	0.01	
2 COMBINED AT	AP-D18	60.	8.10	48.	25.	25.	1.10	
ROUTED TO	RT-APD18	60.	8.10	48.	25.	25.	1.10	
HYDROGRAPH AT	SB-D29	15.	6.05	2.	1.	1.	0.02	
DIVERSION TO	AP-D19a	0.	6.05	0.	0.	0.	0.02	
HYDROGRAPH AT	AP-D19	15.	6.05	2.	1.	1.	0.02	
ROUTED TO	RT-APD19	15.	6.05	2.	1.	1.	0.02	
HYDROGRAPH AT	SB-D28	5.	6.05	0.	0.	0.	0.00	
3 COMBINED AT	AP-D20	74.	6.05	49.	26.	26.	1.13	
ROUTED TO	RT-APD20	74.	6.05	49.	26.	26.	1.13	
HYDROGRAPH AT	SB-D30	11.	6.05	1.	0.	0.	0.02	
ROUTED TO	RT-SBD30	11.	6.05	1.	0.	0.	0.02	
2 COMBINED AT	AP-D21	84.	6.05	49.	26.	26.	1.14	
HYDROGRAPH AT	SB-D31	6.	6.05	1.	0.	0.	0.01	
2 COMBINED AT	AP-D22	90.	6.05	49.	27.	27.	1.15	
HYDROGRAPH AT	SB-D32	3.	6.05	0.	0.	0.	0.01	
2 COMBINED AT	AP-DFCS	93.	6.05	50.	27.	27.	1.16	
ROUTED TO	RR-DFCS	55.	9.90	45.	25.	25.	1.16	79.38 9.90
HYDROGRAPH AT	DR-APD12	75.	6.60	23.	10.	10.	0.00	
ROUTED TO	RT-APD12	76.	6.70	23.	10.	10.	0.00	
HYDROGRAPH AT	SB-D33	18.	6.05	2.	1.	1.	0.04	
2 COMBINED AT	AP-D23	78.	6.70	25.	11.	11.	0.04	
2 COMBINED AT	AP-D24	109.	6.70	67.	35.	35.	1.19	
HYDROGRAPH AT	SB-D34	30.	6.05	3.	1.	1.	0.04	
ROUTED TO	RT-SBD34	29.	6.10	3.	1.	1.	0.04	

HYDROGRAPH AT	SB-D35	32.	6.05	3.	1.	1.	0.04		
2 COMBINED AT	AP-DFG	60.	6.05	6.	3.	3.	0.08		
ROUTED TO	RR-DFG	11.	6.45	4.	2.	2.	0.08	66.82	6.45

10-YEAR, 24 HR, DEVELOPED CONDITION

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	SB-D1	27.	6.30	5.	2.	2.	0.09		
ROUTED TO	RT-SBD1	27.	6.35	5.	2.	2.	0.09		
HYDROGRAPH AT	SB-D2	30.	6.15	4.	2.	2.	0.06		
2 COMBINED AT	AP-D1	48.	6.20	8.	4.	4.	0.14		
HYDROGRAPH AT	SB-D3	19.	6.15	2.	1.	1.	0.03		
2 COMBINED AT	AP-DDA	66.	6.20	11.	5.	5.	0.17		
ROUTED TO	RR-DFA	45.	6.45	11.	5.	5.	0.17	58.43	6.45
ROUTED TO	RT-APDFA	44.	6.45	11.	5.	5.	0.17		
HYDROGRAPH AT	SB-D6	45.	6.05	5.	2.	2.	0.04		
2 COMBINED AT	AP-D2	81.	6.10	15.	7.	7.	0.21		
ROUTED TO	RT-APD2	80.	6.10	15.	7.	7.	0.21		
HYDROGRAPH AT	SB-D7	82.	6.05	9.	4.	4.	0.07		
HYDROGRAPH AT	SB-D4	22.	6.15	3.	1.	1.	0.05		
HYDROGRAPH AT	SB-D5	22.	6.15	3.	1.	1.	0.03		
2 COMBINED AT	AP-DFB	44.	6.15	6.	3.	3.	0.08		
ROUTED TO	RR-DFB	39.	6.25	6.	3.	3.	0.08	20.69	6.25
ROUTED TO	RT-APDFB	39.	6.25	6.	3.	3.	0.08		
3 COMBINED AT	AP-D3	198.	6.10	29.	13.	13.	0.36		
ROUTED TO	RT-APD3	196.	6.10	29.	13.	13.	0.36		
HYDROGRAPH AT	SB-D8	133.	6.00	13.	6.	6.	0.06		
2 COMBINED AT	AP-DFC	311.	6.05	43.	19.	19.	0.42		
ROUTED TO	RR-DFC	66.	6.80	42.	19.	19.	0.42	60.06	6.80
ROUTED TO	RT-DFC	66.	6.85	42.	19.	19.	0.42		
HYDROGRAPH AT	SB-D9A	14.	6.10	2.	1.	1.	0.02		
2 COMBINED AT	AP-D4	73.	6.20	44.	19.	19.	0.44		
ROUTED TO	RT-APD4	73.	6.20	44.	19.	19.	0.44		
HYDROGRAPH AT	SB-D9	18.	6.15	2.	1.	1.	0.02		
2 COMBINED AT									

	AP-D6	90.	6.15	46.	20.	20.	0.46
HYDROGRAPH AT	SB-D10	11.	6.20	2.	1.	1.	0.03
ROUTED TO	RT-SBD10	10.	6.30	2.	1.	1.	0.03
HYDROGRAPH AT	SB-D11	37.	6.15	4.	2.	2.	0.05
HYDROGRAPH AT	SB-D12	14.	6.15	2.	1.	1.	0.02
ROUTED TO	RT-SBD12	14.	6.20	2.	1.	1.	0.02
3 COMBINED AT	AP-D5	58.	6.15	8.	4.	4.	0.10
ROUTED TO	RT-APD5	58.	6.20	8.	4.	4.	0.10
2 COMBINED AT	AP-D6	148.	6.20	54.	24.	24.	0.56
HYDROGRAPH AT	SB-D13	138.	6.00	14.	6.	6.	0.07
ROUTED TO	RT-SBD13	138.	6.00	14.	6.	6.	0.07
2 COMBINED AT	AP-D6	255.	6.05	68.	30.	30.	0.62
ROUTED TO	RT-APD6	254.	6.05	68.	30.	30.	0.62
HYDROGRAPH AT	SB-D15	36.	6.10	4.	2.	2.	0.04
2 COMBINED AT	AP-D6A	288.	6.05	72.	32.	32.	0.67
ROUTED TO	RT-APD6A	286.	6.10	72.	32.	32.	0.67
HYDROGRAPH AT	SB-D14	25.	6.05	3.	1.	1.	0.02
ROUTED TO	RT-SBD14	25.	6.05	3.	1.	1.	0.02
2 COMBINED AT	AP-D7	310.	6.10	75.	33.	33.	0.69
ROUTED TO	RT-APD7	310.	6.10	75.	33.	33.	0.69
HYDROGRAPH AT	SB-D17	13.	6.05	1.	1.	1.	0.01
2 COMBINED AT	AP-D7A	321.	6.10	76.	34.	34.	0.70
HYDROGRAPH AT	SB-D16A	15.	6.05	1.	1.	1.	0.01
2 COMBINED AT	AP-D7A	335.	6.10	77.	34.	34.	0.71
ROUTED TO	RT-APD8	334.	6.10	77.	34.	34.	0.71
HYDROGRAPH AT	SB-D17A	25.	6.00	3.	1.	1.	0.01
2 COMBINED AT	AP-D8	354.	6.05	80.	35.	35.	0.72
HYDROGRAPH AT	SB-D16	45.	6.10	5.	2.	2.	0.06
ROUTED TO	RT-SBD16	44.	6.10	5.	2.	2.	0.06
2 COMBINED AT	AP-D8	397.	6.10	85.	38.	38.	0.78
ROUTED TO	RT-APD9	397.	6.10	85.	38.	38.	0.78
HYDROGRAPH AT	SB-D36	15.	6.15	2.	1.	1.	0.02

ROUTED TO	RT-SBD36	15.	6.15	2.	1.	1.	0.02	
2 COMBINED AT	AP-D9	411.	6.10	87.	38.	38.	0.81	
HYDROGRAPH AT	SB-D37	27.	6.00	3.	1.	1.	0.01	
ROUTED TO	RT-SBD37	27.	6.00	3.	1.	1.	0.01	
2 COMBINED AT	AP-D9	432.	6.10	90.	40.	40.	0.82	
ROUTED TO	RT-APDFE	432.	6.10	90.	40.	40.	0.82	
HYDROGRAPH AT	SB-D18	51.	6.15	6.	3.	3.	0.06	
ROUTED TO	RR-DFPCH	14.	6.55	4.	2.	2.	0.06	
							21.29	6.55
ROUTED TO	RT-RRDFP	14.	6.55	4.	2.	2.	0.06	
HYDROGRAPH AT	SB-D19	32.	6.05	3.	1.	1.	0.02	
2 COMBINED AT	AP-D10	32.	6.05	7.	3.	3.	0.09	
ROUTED TO	RT-APD10	32.	6.05	7.	3.	3.	0.09	
HYDROGRAPH AT	SB-D20	72.	6.00	8.	3.	3.	0.03	
2 COMBINED AT	AP-D11	103.	6.00	15.	7.	7.	0.12	
ROUTED TO	RT-APD11	101.	6.00	15.	7.	7.	0.12	
HYDROGRAPH AT	SB-D21	69.	6.05	7.	3.	3.	0.04	
3 COMBINED AT	AP-DFE	595.	6.05	111.	50.	50.	0.98	
ROUTED TO	RR-DFE	215.	6.45	96.	47.	47.	0.98	
							36.23	6.45
DIVERSION TO	AP-D12	151.	6.45	42.	17.	17.	0.98	
HYDROGRAPH AT	AP-DFE	64.	6.45	55.	29.	29.	0.98	
ROUTED TO	RT-APD13	64.	6.45	55.	29.	29.	0.98	
HYDROGRAPH AT	SB-D22	42.	6.05	4.	2.	2.	0.04	
2 COMBINED AT	AP-D13	95.	6.10	58.	31.	31.	1.02	
ROUTED TO	RT-APD13	94.	6.10	58.	31.	31.	1.02	
HYDROGRAPH AT	SB-D23	9.	6.00	1.	0.	0.	0.00	
2 COMBINED AT	AP-D14	101.	6.10	59.	31.	31.	1.02	
ROUTED TO	AP-DFF	101.	6.10	59.	31.	31.	1.02	
HYDROGRAPH AT	SB-D24	23.	6.05	2.	1.	1.	0.03	
2 COMBINED AT	AP-DFF	123.	6.10	61.	32.	32.	1.05	
ROUTED TO	RR-DFF	61.	8.10	53.	26.	26.	1.05	
							69.14	8.10
HYDROGRAPH AT	SB-D25	23.	6.05	2.	1.	1.	0.02	

ROUTED TO	RR-SBD25	23.	6.05	2.	1.	1.	0.02	
HYDROGRAPH AT	SB-D26	32.	6.05	3.	1.	1.	0.03	
2 COMBINED AT	AP-D16	55.	6.05	5.	2.	2.	0.05	
ROUTED TO	RT-APD16	55.	6.05	5.	2.	2.	0.05	
2 COMBINED AT	AP-D17	64.	8.05	54.	29.	29.	1.10	
ROUTED TO	RT-APD17	64.	8.05	54.	29.	29.	1.10	
HYDROGRAPH AT	SB-D27	10.	6.05	1.	0.	0.	0.01	
2 COMBINED AT	AP-D18	72.	6.05	54.	29.	29.	1.10	
ROUTED TO	RT-APD18	71.	6.05	54.	29.	29.	1.10	
HYDROGRAPH AT	SB-D29	20.	6.05	2.	1.	1.	0.02	
DIVERSION TO	AP-D19a	0.	6.05	0.	0.	0.	0.02	
HYDROGRAPH AT	AP-D19	20.	6.05	2.	1.	1.	0.02	
ROUTED TO	RT-APD19	20.	6.05	2.	1.	1.	0.02	
HYDROGRAPH AT	SB-D28	6.	6.05	1.	0.	0.	0.00	
3 COMBINED AT	AP-D20	97.	6.05	55.	30.	30.	1.13	
ROUTED TO	RT-APD20	96.	6.05	55.	30.	30.	1.13	
HYDROGRAPH AT	SB-D30	15.	6.05	2.	1.	1.	0.02	
ROUTED TO	RT-SBD30	15.	6.05	2.	1.	1.	0.02	
2 COMBINED AT	AP-D21	111.	6.05	56.	31.	31.	1.14	
HYDROGRAPH AT	SB-D31	8.	6.05	1.	0.	0.	0.01	
2 COMBINED AT	AP-D22	119.	6.05	57.	31.	31.	1.15	
HYDROGRAPH AT	SB-D32	4.	6.05	0.	0.	0.	0.01	
2 COMBINED AT	AP-DFCS	123.	6.05	57.	32.	32.	1.16	
ROUTED TO	RR-DFCS	61.	9.00	53.	29.	29.	1.16	79.54 9.05
HYDROGRAPH AT	DR-APD12	151.	6.45	42.	17.	17.	0.00	
ROUTED TO	RT-APD12	152.	6.50	42.	17.	17.	0.00	
HYDROGRAPH AT	SB-D33	26.	6.05	2.	1.	1.	0.04	
2 COMBINED AT	AP-D23	156.	6.50	44.	18.	18.	0.04	
2 COMBINED AT	AP-D24	191.	6.50	93.	47.	47.	1.19	
HYDROGRAPH AT	SB-D34	40.	6.05	4.	2.	2.	0.04	
ROUTED TO	RT-SBD34	39.	6.05	4.	2.	2.	0.04	

HYDROGRAPH AT	SB-D35	42.	6.05	4.	2.	2.	0.04		
2 COMBINED AT	AP-DFG	81.	6.05	8.	4.	4.	0.08		
ROUTED TO	RR-DFG	23.	6.35	6.	3.	3.	0.08	67.87	6.35

25-YEAR, 24 HOUR, DEVELOPED CONDITION

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	SB-D1	45.	6.30	8.	3.	3.	0.09		
ROUTED TO	RT-SBD1	45.	6.35	8.	3.	3.	0.09		
HYDROGRAPH AT	SB-D2	46.	6.10	6.	2.	2.	0.06		
2 COMBINED AT	AP-D1	79.	6.20	13.	6.	6.	0.14		
HYDROGRAPH AT	SB-D3	27.	6.15	3.	2.	2.	0.03		
2 COMBINED AT	AP-DDA	105.	6.20	16.	7.	7.	0.17		
ROUTED TO	RR-DFA	54.	6.55	16.	7.	7.	0.17	60.75	6.55
ROUTED TO	RT-APDFA	54.	6.55	16.	7.	7.	0.17		
HYDROGRAPH AT	SB-D6	62.	6.05	6.	3.	3.	0.04		
2 COMBINED AT	AP-D2	101.	6.10	23.	10.	10.	0.21		
ROUTED TO	RT-APD2	101.	6.10	23.	10.	10.	0.21		
HYDROGRAPH AT	SB-D7	113.	6.05	12.	5.	5.	0.07		
HYDROGRAPH AT	SB-D4	36.	6.15	4.	2.	2.	0.05		
HYDROGRAPH AT	SB-D5	32.	6.15	4.	2.	2.	0.03		
2 COMBINED AT	AP-DFB	68.	6.15	8.	4.	4.	0.08		
ROUTED TO	RR-DFB	47.	6.30	8.	4.	4.	0.08	23.03	6.30
ROUTED TO	RT-APDFB	47.	6.30	8.	4.	4.	0.08		
3 COMBINED AT	AP-D3	254.	6.10	43.	19.	19.	0.36		
ROUTED TO	RT-APD3	253.	6.10	43.	19.	19.	0.36		
HYDROGRAPH AT	SB-D8	165.	6.00	17.	7.	7.	0.06		
2 COMBINED AT	AP-DFC	405.	6.05	60.	26.	26.	0.42		
ROUTED TO	RR-DFC	75.	7.05	58.	26.	26.	0.42	62.40	7.10
ROUTED TO	RT-DFC	75.	7.10	58.	26.	26.	0.42		
HYDROGRAPH AT	SB-D9A	21.	6.10	2.	1.	1.	0.02		
2 COMBINED AT	AP-D4	85.	6.15	60.	27.	27.	0.44		
ROUTED TO	RT-APD4	85.	6.20	60.	27.	27.	0.44		
HYDROGRAPH AT	SB-D9	26.	6.15	3.	1.	1.	0.02		
2 COMBINED AT									

AP-D6	111.	6.15	64.	29.	29.	0.46
HYDROGRAPH AT SB-D10	17.	6.20	2.	1.	1.	0.03
ROUTED TO RT-SBD10	17.	6.25	2.	1.	1.	0.03
HYDROGRAPH AT SB-D11	55.	6.10	7.	3.	3.	0.05
HYDROGRAPH AT SB-D12	21.	6.15	3.	1.	1.	0.02
ROUTED TO RT-SBD12	21.	6.20	3.	1.	1.	0.02
3 COMBINED AT AP-D5	88.	6.15	12.	5.	5.	0.10
ROUTED TO RT-APD5	87.	6.15	12.	5.	5.	0.10
2 COMBINED AT AP-D6	198.	6.15	75.	34.	34.	0.56
HYDROGRAPH AT SB-D13	173.	6.00	18.	8.	8.	0.07
ROUTED TO RT-SBD13	172.	6.00	18.	8.	8.	0.07
2 COMBINED AT AP-D6	337.	6.05	93.	41.	41.	0.62
ROUTED TO RT-APD6	335.	6.05	93.	41.	41.	0.62
HYDROGRAPH AT SB-D15	52.	6.10	6.	3.	3.	0.04
2 COMBINED AT AP-D6A	385.	6.05	98.	44.	44.	0.67
ROUTED TO RT-APD6A	382.	6.05	98.	44.	44.	0.67
HYDROGRAPH AT SB-D14	35.	6.05	4.	2.	2.	0.02
ROUTED TO RT-SBD14	35.	6.05	4.	2.	2.	0.02
2 COMBINED AT AP-D7	417.	6.05	102.	46.	46.	0.69
ROUTED TO RT-APD7	414.	6.10	102.	46.	46.	0.69
HYDROGRAPH AT SB-D17	18.	6.00	2.	1.	1.	0.01
2 COMBINED AT AP-D7A	429.	6.05	104.	46.	46.	0.70
HYDROGRAPH AT SB-D16A	20.	6.05	2.	1.	1.	0.01
2 COMBINED AT AP-D7A	450.	6.05	106.	47.	47.	0.71
ROUTED TO RT-APD8	448.	6.10	106.	47.	47.	0.71
HYDROGRAPH AT SB-D17A	30.	6.00	3.	1.	1.	0.01
2 COMBINED AT AP-D8	474.	6.05	109.	49.	49.	0.72
HYDROGRAPH AT SB-D16	66.	6.10	7.	3.	3.	0.06
ROUTED TO RT-SBD16	66.	6.10	7.	3.	3.	0.06
2 COMBINED AT AP-D8	537.	6.05	116.	52.	52.	0.78
ROUTED TO RT-APD9	536.	6.10	116.	52.	52.	0.78
HYDROGRAPH AT SB-D36	23.	6.15	3.	1.	1.	0.02

ROUTED TO	RT-SBD36	23.	6.15	3.	1.	1.	0.02	
2 COMBINED AT	AP-D9	558.	6.10	119.	53.	53.	0.81	
HYDROGRAPH AT	SB-D37	33.	6.00	4.	2.	2.	0.01	
ROUTED TO	RT-SBD37	33.	6.00	4.	2.	2.	0.01	
2 COMBINED AT	AP-D9	583.	6.10	122.	55.	55.	0.82	
ROUTED TO	RT-APDFE	583.	6.10	122.	55.	55.	0.82	
HYDROGRAPH AT	SB-D18	74.	6.15	9.	4.	4.	0.06	
ROUTED TO	RR-DFPCK	29.	6.45	7.	3.	3.	0.06	
								21.96 6.45
ROUTED TO	RT-RRDFP	29.	6.45	7.	3.	3.	0.06	
HYDROGRAPH AT	SB-D19	44.	6.05	4.	2.	2.	0.02	
2 COMBINED AT	AP-D10	44.	6.05	11.	5.	5.	0.09	
ROUTED TO	RT-APD10	43.	6.05	11.	5.	5.	0.09	
HYDROGRAPH AT	SB-D20	87.	6.00	9.	4.	4.	0.03	
2 COMBINED AT	AP-D11	129.	6.00	20.	9.	9.	0.12	
ROUTED TO	RT-APD11	128.	6.00	20.	9.	9.	0.12	
HYDROGRAPH AT	SB-D21	89.	6.05	9.	4.	4.	0.04	
3 COMBINED AT	AP-DFE	795.	6.05	152.	68.	68.	0.98	
ROUTED TO	RR-DFE	359.	6.35	132.	63.	63.	0.98	
								38.26 6.35
DIVERSION TO	AP-D12	290.	6.35	74.	30.	30.	0.98	
HYDROGRAPH AT	AP-DFE	69.	6.35	58.	33.	33.	0.98	
ROUTED TO	RT-APD13	69.	6.35	58.	33.	33.	0.98	
HYDROGRAPH AT	SB-D22	58.	6.05	6.	3.	3.	0.04	
2 COMBINED AT	AP-D13	117.	6.10	63.	35.	35.	1.02	
ROUTED TO	RT-APD13	117.	6.10	63.	35.	35.	1.02	
HYDROGRAPH AT	SB-D23	12.	6.00	1.	1.	1.	0.00	
2 COMBINED AT	AP-D14	126.	6.05	64.	36.	36.	1.02	
ROUTED TO	AP-DFF	126.	6.05	64.	36.	36.	1.02	
HYDROGRAPH AT	SB-D24	33.	6.05	3.	1.	1.	0.03	
2 COMBINED AT	AP-DFF	159.	6.05	67.	37.	37.	1.05	
ROUTED TO	RR-DFF	66.	7.65	59.	31.	31.	1.05	
								69.24 7.65
HYDROGRAPH AT	SB-D25	31.	6.05	3.	1.	1.	0.02	

ROUTED TO	RR-SBD25	31.	6.05	3.	1.	1.	0.02	
HYDROGRAPH AT	SB-D26	46.	6.05	5.	2.	2.	0.03	
2 COMBINED AT	AP-D16	77.	6.05	8.	3.	3.	0.05	
ROUTED TO	RT-APD16	77.	6.05	8.	3.	3.	0.05	
2 COMBINED AT	AP-D17	85.	6.05	61.	34.	34.	1.10	
ROUTED TO	RT-APD17	84.	6.05	61.	34.	34.	1.10	
HYDROGRAPH AT	SB-D27	14.	6.05	1.	1.	1.	0.01	
2 COMBINED AT	AP-D18	98.	6.05	61.	35.	35.	1.10	
ROUTED TO	RT-APD18	97.	6.05	61.	35.	35.	1.10	
HYDROGRAPH AT	SB-D29	28.	6.05	3.	1.	1.	0.02	
DIVERSION TO	AP-D19a	8.	5.90	0.	0.	0.	0.02	
HYDROGRAPH AT	AP-D19	20.	5.90	3.	1.	1.	0.02	
ROUTED TO	RT-APD19	20.	5.95	3.	1.	1.	0.02	
HYDROGRAPH AT	SB-D28	8.	6.05	1.	0.	0.	0.00	
3 COMBINED AT	AP-D20	125.	6.05	64.	36.	36.	1.13	
ROUTED TO	RT-APD20	125.	6.05	64.	36.	36.	1.13	
HYDROGRAPH AT	SB-D30	22.	6.05	2.	1.	1.	0.02	
ROUTED TO	RT-SBD30	22.	6.05	2.	1.	1.	0.02	
2 COMBINED AT	AP-D21	146.	6.05	66.	37.	37.	1.14	
HYDROGRAPH AT	SB-D31	11.	6.05	1.	0.	0.	0.01	
2 COMBINED AT	AP-D22	158.	6.05	67.	38.	38.	1.15	
HYDROGRAPH AT	SB-D32	6.	6.05	1.	0.	0.	0.01	
2 COMBINED AT	AP-DFCS	164.	6.05	68.	38.	38.	1.16	
ROUTED TO	RR-DFCS	72.	8.10	63.	35.	35.	1.16	79.85 8.10
HYDROGRAPH AT	DR-APD12	290.	6.35	74.	30.	30.	0.00	
ROUTED TO	RT-APD12	290.	6.45	74.	30.	30.	0.00	
HYDROGRAPH AT	SB-D33	39.	6.05	4.	2.	2.	0.04	
2 COMBINED AT	AP-D23	296.	6.40	77.	32.	32.	0.04	
2 COMBINED AT	AP-D24	337.	6.40	136.	67.	67.	1.19	
HYDROGRAPH AT	SB-D34	57.	6.05	6.	3.	3.	0.04	
ROUTED TO	RT-SBD34	56.	6.05	6.	3.	3.	0.04	

HYDROGRAPH AT	SB-D35	59.	6.05	6.	3.	3.	0.04		
2 COMBINED AT	AP-DFG	115.	6.05	12.	5.	5.	0.08		
ROUTED TO	RR-DFG	31.	6.35	9.	4.	4.	0.08	69.56	6.35

50-YEAR, 24 HOUR, DEVELOPED CONDITION

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	SB-D1	58.	6.25	10.	4.	4.	0.09		
ROUTED TO	RT-SBD1	58.	6.30	10.	4.	4.	0.09		
HYDROGRAPH AT	SB-D2	59.	6.10	7.	3.	3.	0.06		
2 COMBINED AT	AP-D1	102.	6.20	16.	7.	7.	0.14		
HYDROGRAPH AT	SB-D3	33.	6.15	4.	2.	2.	0.03		
2 COMBINED AT	AP-DDA	134.	6.20	21.	9.	9.	0.17		
ROUTED TO	RR-DFA	60.	6.60	21.	9.	9.	0.17	62.11	6.60
ROUTED TO	RT-APDFA	60.	6.60	21.	9.	9.	0.17		
HYDROGRAPH AT	SB-D6	74.	6.05	8.	3.	3.	0.04		
2 COMBINED AT	AP-D2	116.	6.05	28.	12.	12.	0.21		
ROUTED TO	RT-APD2	116.	6.10	28.	12.	12.	0.21		
HYDROGRAPH AT	SB-D7	134.	6.05	14.	6.	6.	0.07		
HYDROGRAPH AT	SB-D4	45.	6.15	6.	2.	2.	0.05		
HYDROGRAPH AT	SB-D5	40.	6.10	5.	2.	2.	0.03		
2 COMBINED AT	AP-DFB	85.	6.15	10.	5.	5.	0.08		
ROUTED TO	RR-DFB	52.	6.30	10.	5.	5.	0.08	24.31	6.30
ROUTED TO	RT-APDFB	52.	6.35	10.	5.	5.	0.08		
3 COMBINED AT	AP-D3	291.	6.10	53.	23.	23.	0.36		
ROUTED TO	RT-APD3	291.	6.10	53.	23.	23.	0.36		
HYDROGRAPH AT	SB-D8	186.	6.00	19.	8.	8.	0.06		
2 COMBINED AT	AP-DFC	465.	6.05	72.	32.	32.	0.42		
ROUTED TO	RR-DFC	81.	7.20	67.	31.	31.	0.42	64.02	7.20
ROUTED TO	RT-DFC	81.	7.20	67.	31.	31.	0.42		
HYDROGRAPH AT	SB-D9A	25.	6.10	3.	1.	1.	0.02		
2 COMBINED AT	AP-D4	93.	6.15	70.	33.	33.	0.44		
ROUTED TO	RT-APD4	93.	6.15	70.	33.	33.	0.44		
HYDROGRAPH AT	SB-D9	32.	6.15	4.	2.	2.	0.02		
2 COMBINED AT									

	AP-D6	125.	6.15	73.	34.	34.	0.46
HYDROGRAPH AT	SB-D10	22.	6.20	3.	1.	1.	0.03
ROUTED TO	RT-SBD10	22.	6.25	3.	1.	1.	0.03
HYDROGRAPH AT	SB-D11	68.	6.10	8.	4.	4.	0.05
HYDROGRAPH AT	SB-D12	26.	6.15	3.	1.	1.	0.02
ROUTED TO	RT-SBD12	26.	6.20	3.	1.	1.	0.02
3 COMBINED AT	AP-D5	110.	6.15	14.	6.	6.	0.10
ROUTED TO	RT-APD5	109.	6.15	14.	6.	6.	0.10
2 COMBINED AT	AP-D6	233.	6.15	88.	41.	41.	0.56
HYDROGRAPH AT	SB-D13	196.	6.00	20.	9.	9.	0.07
ROUTED TO	RT-SBD13	196.	6.00	20.	9.	9.	0.07
2 COMBINED AT	AP-D6	392.	6.05	107.	49.	49.	0.62
ROUTED TO	RT-APD6	390.	6.05	107.	49.	49.	0.62
HYDROGRAPH AT	SB-D15	63.	6.10	7.	3.	3.	0.04
2 COMBINED AT	AP-D6A	452.	6.05	114.	53.	53.	0.67
ROUTED TO	RT-APD6A	449.	6.05	114.	53.	53.	0.67
HYDROGRAPH AT	SB-D14	42.	6.05	4.	2.	2.	0.02
ROUTED TO	RT-SBD14	42.	6.05	4.	2.	2.	0.02
2 COMBINED AT	AP-D7	491.	6.05	119.	54.	54.	0.69
ROUTED TO	RT-APD7	486.	6.10	119.	54.	54.	0.69
HYDROGRAPH AT	SB-D17	21.	6.00	2.	1.	1.	0.01
2 COMBINED AT	AP-D7A	506.	6.05	121.	55.	55.	0.70
HYDROGRAPH AT	SB-D16A	24.	6.05	2.	1.	1.	0.01
2 COMBINED AT	AP-D7A	531.	6.05	123.	56.	56.	0.71
ROUTED TO	RT-APD8	527.	6.05	123.	56.	56.	0.71
HYDROGRAPH AT	SB-D17A	33.	6.00	4.	2.	2.	0.01
2 COMBINED AT	AP-D8	558.	6.05	126.	58.	58.	0.72
HYDROGRAPH AT	SB-D16	82.	6.10	9.	4.	4.	0.06
ROUTED TO	RT-SBD16	82.	6.10	9.	4.	4.	0.06
2 COMBINED AT	AP-D8	636.	6.05	135.	62.	62.	0.78
ROUTED TO	RT-APD9	632.	6.10	135.	62.	62.	0.78
HYDROGRAPH AT	SB-D36	28.	6.15	3.	2.	2.	0.02

ROUTED TO	RT-SBD36	28.	6.15	3.	1.	1.	0.02	
2 COMBINED AT	AP-D9	660.	6.10	139.	63.	63.	0.81	
HYDROGRAPH AT	SB-D37	36.	6.00	4.	2.	2.	0.01	
ROUTED TO	RT-SBD37	36.	6.00	4.	2.	2.	0.01	
2 COMBINED AT	AP-D9	691.	6.05	143.	65.	65.	0.82	
ROUTED TO	RT-APDFE	688.	6.10	143.	65.	65.	0.82	
HYDROGRAPH AT	SB-D18	90.	6.15	11.	5.	5.	0.06	
ROUTED TO	RR-DFPCH	33.	6.45	9.	4.	4.	0.06	
								22.51 6.45
ROUTED TO	RT-RRDFP	33.	6.45	9.	4.	4.	0.06	
HYDROGRAPH AT	SB-D19	51.	6.00	5.	2.	2.	0.02	
2 COMBINED AT	AP-D10	54.	6.05	14.	6.	6.	0.09	
ROUTED TO	RT-APD10	53.	6.05	14.	6.	6.	0.09	
HYDROGRAPH AT	SB-D20	97.	6.00	11.	5.	5.	0.03	
2 COMBINED AT	AP-D11	147.	6.00	24.	11.	11.	0.12	
ROUTED TO	RT-APD11	146.	6.00	24.	11.	11.	0.12	
HYDROGRAPH AT	SB-D21	102.	6.00	11.	5.	5.	0.04	
3 COMBINED AT	AP-DFE	934.	6.05	177.	81.	81.	0.98	
ROUTED TO	RR-DFE	472.	6.30	156.	74.	74.	0.98	
								39.45 6.30
DIVERSION TO	AP-D12	399.	6.30	96.	40.	40.	0.98	
HYDROGRAPH AT	AP-DFE	72.	6.30	60.	34.	34.	0.98	
ROUTED TO	RT-APD13	72.	6.30	60.	34.	34.	0.98	
HYDROGRAPH AT	SB-D22	69.	6.05	7.	3.	3.	0.04	
2 COMBINED AT	AP-D13	132.	6.05	66.	37.	37.	1.02	
ROUTED TO	RT-APD13	131.	6.10	66.	37.	37.	1.02	
HYDROGRAPH AT	SB-D23	14.	6.00	1.	1.	1.	0.00	
2 COMBINED AT	AP-D14	143.	6.05	67.	38.	38.	1.02	
ROUTED TO	AP-DFF	143.	6.05	67.	38.	38.	1.02	
HYDROGRAPH AT	SB-D24	40.	6.05	4.	2.	2.	0.03	
2 COMBINED AT	AP-DFF	183.	6.05	71.	40.	40.	1.05	
ROUTED TO	RR-DFF	70.	7.25	61.	33.	33.	1.05	
								69.35 7.25
HYDROGRAPH AT	SB-D25	36.	6.05	4.	2.	2.	0.02	

ROUTED TO	RR-SBD25	36.	6.05	4.	2.	2.	0.02	
HYDROGRAPH AT	SB-D26	56.	6.05	5.	2.	2.	0.03	
2 COMBINED AT	AP-D16	92.	6.05	9.	4.	4.	0.05	
ROUTED TO	RT-APD16	92.	6.05	9.	4.	4.	0.05	
2 COMBINED AT	AP-D17	101.	6.05	65.	37.	37.	1.10	
ROUTED TO	RT-APD17	100.	6.05	65.	37.	37.	1.10	
HYDROGRAPH AT	SB-D27	16.	6.05	2.	1.	1.	0.01	
2 COMBINED AT	AP-D18	116.	6.05	66.	38.	38.	1.10	
ROUTED TO	RT-APD18	116.	6.05	66.	38.	38.	1.10	
HYDROGRAPH AT	SB-D29	34.	6.05	3.	1.	1.	0.02	
DIVERSION TO	AP-D19a	14.	5.85	0.	0.	0.	0.02	
HYDROGRAPH AT	AP-D19	20.	5.85	3.	1.	1.	0.02	
ROUTED TO	RT-APD19	20.	5.90	3.	1.	1.	0.02	
HYDROGRAPH AT	SB-D28	9.	6.05	1.	0.	0.	0.00	
3 COMBINED AT	AP-D20	145.	6.05	70.	40.	40.	1.13	
ROUTED TO	RT-APD20	144.	6.05	70.	40.	40.	1.13	
HYDROGRAPH AT	SB-D30	27.	6.05	3.	1.	1.	0.02	
ROUTED TO	RT-SBD30	27.	6.05	3.	1.	1.	0.02	
2 COMBINED AT	AP-D21	171.	6.05	72.	41.	41.	1.14	
HYDROGRAPH AT	SB-D31	13.	6.05	1.	1.	1.	0.01	
2 COMBINED AT	AP-D22	184.	6.05	74.	42.	42.	1.15	
HYDROGRAPH AT	SB-D32	8.	6.05	1.	0.	0.	0.01	
2 COMBINED AT	AP-DFCS	192.	6.05	74.	42.	42.	1.16	
ROUTED TO	RR-DFCS	78.	7.50	67.	38.	38.	1.16	80.01 7.50
HYDROGRAPH AT	DR-APD12	399.	6.30	96.	40.	40.	0.00	
ROUTED TO	RT-APD12	398.	6.35	96.	40.	40.	0.00	
HYDROGRAPH AT	SB-D33	49.	6.05	5.	2.	2.	0.04	
2 COMBINED AT	AP-D23	408.	6.35	100.	42.	42.	0.04	
2 COMBINED AT	AP-D24	470.	6.35	166.	80.	80.	1.19	
HYDROGRAPH AT	SB-D34	68.	6.05	7.	3.	3.	0.04	
ROUTED TO	RT-SBD34	67.	6.05	7.	3.	3.	0.04	

HYDROGRAPH AT	SB-D35	71.	6.05	7.	3.	3.	0.04		
2 COMBINED AT	AP-DFG	138.	6.05	14.	6.	6.	0.08		
ROUTED TO	RR-DFG	36.	6.35	11.	5.	5.	0.08	70.85	6.35

100-YEAR, 24HR, DEVELOPED CONDITION

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	SB-D1	72.	6.25	12.	5.	5.	0.09		
ROUTED TO	RT-SBD1	72.	6.30	12.	5.	5.	0.09		
HYDROGRAPH AT	SB-D2	72.	6.10	8.	4.	4.	0.06		
2 COMBINED AT	AP-D1	127.	6.20	20.	9.	9.	0.14		
HYDROGRAPH AT	SB-D3	40.	6.15	5.	2.	2.	0.03		
2 COMBINED AT	AP-DDA	165.	6.15	25.	11.	11.	0.17		
ROUTED TO	RR-DFA	65.	6.60	25.	11.	11.	0.17	63.22	6.60
ROUTED TO	RT-APDFA	65.	6.65	25.	11.	11.	0.17		
HYDROGRAPH AT	SB-D6	86.	6.05	9.	4.	4.	0.04		
2 COMBINED AT	AP-D2	131.	6.05	34.	15.	15.	0.21		
ROUTED TO	RT-APD2	130.	6.10	34.	15.	15.	0.21		
HYDROGRAPH AT	SB-D7	157.	6.05	17.	7.	7.	0.07		
HYDROGRAPH AT	SB-D4	56.	6.15	7.	3.	3.	0.05		
HYDROGRAPH AT	SB-D5	47.	6.10	6.	2.	2.	0.03		
2 COMBINED AT	AP-DFB	103.	6.15	12.	6.	6.	0.08		
ROUTED TO	RR-DFB	57.	6.35	12.	6.	6.	0.08	25.45	6.35
ROUTED TO	RT-APDFB	57.	6.35	12.	6.	6.	0.08		
3 COMBINED AT	AP-D3	330.	6.05	63.	28.	28.	0.36		
ROUTED TO	RT-APD3	329.	6.10	63.	28.	28.	0.36		
HYDROGRAPH AT	SB-D8	208.	6.00	22.	9.	9.	0.06		
2 COMBINED AT	AP-DFC	524.	6.05	84.	37.	37.	0.42		
ROUTED TO	RR-DFC	86.	7.30	74.	37.	37.	0.42	65.48	7.30
ROUTED TO	RT-DFC	86.	7.35	74.	37.	37.	0.42		
HYDROGRAPH AT	SB-D9A	30.	6.10	3.	1.	1.	0.02		
2 COMBINED AT	AP-D4	102.	6.15	78.	38.	38.	0.44		
ROUTED TO	RT-APD4	101.	6.15	78.	38.	38.	0.44		
HYDROGRAPH AT	SB-D9	37.	6.10	5.	2.	2.	0.02		
2 COMBINED AT									

	AP-D6	139.	6.15	82.	40.	40.	0.46
HYDROGRAPH AT	SB-D10	27.	6.20	4.	2.	2.	0.03
ROUTED TO	RT-SBD10	27.	6.25	4.	2.	2.	0.03
HYDROGRAPH AT	SB-D11	81.	6.10	10.	4.	4.	0.05
HYDROGRAPH AT	SB-D12	31.	6.15	4.	2.	2.	0.02
ROUTED TO	RT-SBD12	31.	6.20	4.	2.	2.	0.02
3 COMBINED AT	AP-D5	133.	6.15	17.	8.	8.	0.10
ROUTED TO	RT-APD5	131.	6.15	17.	8.	8.	0.10
2 COMBINED AT	AP-D6	270.	6.15	99.	48.	48.	0.56
HYDROGRAPH AT	SB-D13	219.	6.00	23.	10.	10.	0.07
ROUTED TO	RT-SBD13	219.	6.00	23.	10.	10.	0.07
2 COMBINED AT	AP-D6	449.	6.05	121.	58.	58.	0.62
ROUTED TO	RT-APD6	447.	6.05	121.	58.	58.	0.62
HYDROGRAPH AT	SB-D15	75.	6.10	8.	4.	4.	0.04
2 COMBINED AT	AP-D6A	520.	6.05	129.	61.	61.	0.67
ROUTED TO	RT-APD6A	517.	6.05	129.	61.	61.	0.67
HYDROGRAPH AT	SB-D14	49.	6.05	5.	2.	2.	0.02
ROUTED TO	RT-SBD14	49.	6.05	5.	2.	2.	0.02
2 COMBINED AT	AP-D7	566.	6.05	134.	64.	64.	0.69
ROUTED TO	RT-APD7	560.	6.05	134.	64.	64.	0.69
HYDROGRAPH AT	SB-D17	25.	6.00	2.	1.	1.	0.01
2 COMBINED AT	AP-D7A	585.	6.05	137.	65.	65.	0.70
HYDROGRAPH AT	SB-D16A	28.	6.05	3.	1.	1.	0.01
2 COMBINED AT	AP-D7A	613.	6.05	139.	66.	66.	0.71
ROUTED TO	RT-APD8	609.	6.05	139.	66.	66.	0.71
HYDROGRAPH AT	SB-D17A	36.	6.00	4.	2.	2.	0.01
2 COMBINED AT	AP-D8	643.	6.05	143.	68.	68.	0.72
HYDROGRAPH AT	SB-D16	98.	6.10	11.	5.	5.	0.06
ROUTED TO	RT-SBD16	98.	6.10	11.	5.	5.	0.06
2 COMBINED AT	AP-D8	737.	6.05	154.	72.	72.	0.78
ROUTED TO	RT-APD9	734.	6.05	154.	72.	72.	0.78
HYDROGRAPH AT	SB-D36	34.	6.10	4.	2.	2.	0.02

ROUTED TO	RT-SBD36	34.	6.15	4.	2.	2.	0.02	
2 COMBINED AT	AP-D9	765.	6.10	158.	74.	74.	0.81	
HYDROGRAPH AT	SB-D37	40.	6.00	5.	2.	2.	0.01	
ROUTED TO	RT-SBD37	40.	6.00	5.	2.	2.	0.01	
2 COMBINED AT	AP-D9	802.	6.05	162.	76.	76.	0.82	
ROUTED TO	RT-APDFE	798.	6.05	162.	76.	76.	0.82	
HYDROGRAPH AT	SB-D18	106.	6.15	13.	6.	6.	0.06	
ROUTED TO	RR-DFPCH	36.	6.45	11.	5.	5.	0.06	
							23.15	6.45
ROUTED TO	RT-RRDFP	36.	6.50	11.	5.	5.	0.06	
HYDROGRAPH AT	SB-D19	59.	6.00	6.	3.	3.	0.02	
2 COMBINED AT	AP-D10	65.	6.05	17.	7.	7.	0.09	
ROUTED TO	RT-APD10	65.	6.10	17.	7.	7.	0.09	
HYDROGRAPH AT	SB-D20	107.	6.00	12.	5.	5.	0.03	
2 COMBINED AT	AP-D11	167.	6.00	28.	13.	13.	0.12	
ROUTED TO	RT-APD11	165.	6.05	28.	13.	13.	0.12	
HYDROGRAPH AT	SB-D21	117.	6.00	12.	5.	5.	0.04	
3 COMBINED AT	AP-DFE	1078.	6.05	202.	94.	94.	0.98	
ROUTED TO	RR-DFE	587.	6.30	180.	86.	86.	0.98	
							40.54	6.30
DIVERSION TO	AP-D12	512.	6.30	119.	51.	51.	0.98	
HYDROGRAPH AT	AP-DFE	75.	6.30	61.	36.	36.	0.98	
ROUTED TO	RT-APD13	75.	6.30	61.	36.	36.	0.98	
HYDROGRAPH AT	SB-D22	81.	6.05	8.	4.	4.	0.04	
2 COMBINED AT	AP-D13	147.	6.05	68.	39.	39.	1.02	
ROUTED TO	RT-APD13	145.	6.05	68.	39.	39.	1.02	
HYDROGRAPH AT	SB-D23	15.	6.00	2.	1.	1.	0.00	
2 COMBINED AT	AP-D14	160.	6.05	70.	40.	40.	1.02	
ROUTED TO	AP-DFF	160.	6.05	70.	40.	40.	1.02	
HYDROGRAPH AT	SB-D24	48.	6.05	5.	2.	2.	0.03	
2 COMBINED AT	AP-DFF	207.	6.05	74.	42.	42.	1.05	
ROUTED TO	RR-DFF	75.	7.10	64.	36.	36.	1.05	
							69.47	7.10
HYDROGRAPH AT	SB-D25	42.	6.05	4.	2.	2.	0.02	

ROUTED TO	RR-SBD25	42.	6.05	4.	2.	2.	0.02	
HYDROGRAPH AT	SB-D26	66.	6.05	7.	3.	3.	0.03	
2 COMBINED AT	AP-D16	108.	6.05	11.	5.	5.	0.05	
ROUTED TO	RT-APD16	107.	6.05	11.	5.	5.	0.05	
2 COMBINED AT	AP-D17	117.	6.05	70.	40.	40.	1.10	
ROUTED TO	RT-APD17	116.	6.05	70.	40.	40.	1.10	
HYDROGRAPH AT	SB-D27	19.	6.05	2.	1.	1.	0.01	
2 COMBINED AT	AP-D18	135.	6.05	71.	41.	41.	1.10	
ROUTED TO	RT-APD18	134.	6.05	71.	41.	41.	1.10	
HYDROGRAPH AT	SB-D29	40.	6.05	4.	2.	2.	0.02	
DIVERSION TO	AP-D19a	20.	5.85	1.	0.	0.	0.02	
HYDROGRAPH AT	AP-D19	20.	5.85	3.	1.	1.	0.02	
ROUTED TO	RT-APD19	20.	5.90	3.	1.	1.	0.02	
HYDROGRAPH AT	SB-D28	11.	6.05	1.	0.	0.	0.00	
3 COMBINED AT	AP-D20	165.	6.05	75.	43.	43.	1.13	
ROUTED TO	RT-APD20	164.	6.05	75.	43.	43.	1.13	
HYDROGRAPH AT	SB-D30	32.	6.05	3.	1.	1.	0.02	
ROUTED TO	RT-SBD30	32.	6.05	3.	1.	1.	0.02	
2 COMBINED AT	AP-D21	196.	6.05	78.	44.	44.	1.14	
HYDROGRAPH AT	SB-D31	16.	6.05	2.	1.	1.	0.01	
2 COMBINED AT	AP-D22	211.	6.05	80.	45.	45.	1.15	
HYDROGRAPH AT	SB-D32	9.	6.05	1.	0.	0.	0.01	
2 COMBINED AT	AP-DFCS	221.	6.05	81.	45.	45.	1.16	
ROUTED TO	RR-DFCS	90.	7.10	74.	42.	42.	1.16	80.19 7.10
HYDROGRAPH AT	DR-APD12	512.	6.30	119.	51.	51.	0.00	
ROUTED TO	RT-APD12	513.	6.40	119.	51.	51.	0.00	
HYDROGRAPH AT	SB-D33	59.	6.05	6.	3.	3.	0.04	
2 COMBINED AT	AP-D23	523.	6.35	123.	53.	53.	0.04	
2 COMBINED AT	AP-D24	611.	6.35	196.	95.	95.	1.19	
HYDROGRAPH AT	SB-D34	80.	6.05	8.	4.	4.	0.04	
ROUTED TO	RT-SBD34	79.	6.05	8.	4.	4.	0.04	

HYDROGRAPH AT									
	SB-D35	83.	6.05	8.	4.	4.	0.04		
2 COMBINED AT									
	AP-DFG	162.	6.05	17.	7.	7.	0.08		
ROUTED TO									
	RR-DFG	41.	6.35	14.	6.	6.	0.08	72.16	6.35

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	14.95-HR
(CFS)	(HR)					
		(CFS)				
587.	6.30		180.	86.	86.	86.
		(INCHES)	1.709	2.041	2.041	2.041
		(AC-FT)	89.	107.	107.	107.

PEAK STORAGE	TIME		MAXIMUM AVERAGE STORAGE			
			6-HR	24-HR	72-HR	14.95-HR
(AC-FT)	(HR)					
28.	6.30		17.	9.	9.	9.

PEAK STAGE	TIME		MAXIMUM AVERAGE STAGE			
			6-HR	24-HR	72-HR	14.95-HR
(FEET)	(HR)					
40.54	6.30		35.34	29.92	29.92	29.92

CUMULATIVE AREA = 0.98 SQ MI

H100-6

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KK  AP-DFE
KM   COMBINE THE ROUTED FLOW FROM AP-D11 WITH THE FLOW FROM SB-D21 AND AP-D8A
KM   THIS IS THE TOTAL FLOW TO PROPOSED
KM   DETENTION FACILITY "E"
HC       3

KK  RR-DFE
KM   ROUTE FLOW THROUGH THE PROPOSED DETENTION FACILITY "E". STORAGE IS BASED ON
KM   A CONCEPTUAL GRADING PLAN DATED 11-21-00 WITH THE POND LOCATED AT THE NW
KM   CORNER OF THE INTERSECTION OF OLD RANCH RD. AND CHAPEL HILLS DRIVE. OUTLET
KM   CAPACITY IS BASED ON A 6" DIA ORIFICE OUTLET WITH INV AT EL 22.25, A 27" DIA
KM   ORIFICE OUTLET AT INVERT ELEV. 24.00.
KM   90 DEGREE V-NOTCH WEIR INVERT ELEV. 31.0,TRIMMED VERT AT 10' WIDTH ELEV. 36.0
KM   6" DIA. OUTLET ALLOWS LOW FLOW TO CONTINUE DOWN THE HISTORIC NATURAL CHANNEL
KM   90 DEGREE V-NOTCH OUTFALLS TO THE HISTORIC NATURAL CHANNEL TO DIRECT  SOME OF
KM   THE PEAK FLOW FROM LARGE STORMS TO THE NATURAL CHANNEL
KM   THE 27" DIA ORIFICE OUTLET OUTFALLS TO A PROPOSED STORM DRAIN IN OLD RANCH RO
KO       1       1
RS       1    STOR       0
SV       0    0.00     .00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
SV    0.00   00.00   00.00   00.00   00.00    2.35    4.81    7.37   10.00
SE    22.5    23.0    24.0    26.0    28.0    30.0    32.0    33.0    34.0    35.0
SE      36    37.0    38.0    39.0    40.0    41.0    42.0    43.0    44.0
SQ     0.0     0.7    1.20    19.7    34.7    44.9    55.6    70.6      98     141
SQ     201     236     309     435     530     632     750     877    1016

KK  AP-DFE
KM   DIVERT OUT FLOW THAT PASSES THROUGH THE V-NOTCH AND THE 6" DIA OUTLET TO THE
KM   NATURAL CHANNEL
KO       1       1
DT  AP-D12
DI     0.0     0.7    1.20    19.7    34.7    44.9    55.6    70.6      98     141
DI     201     236     309     435     530     632     750     877    1016
DQ       0     0.7     1.2     1.8     2.2     2.6     5.4    16.9      41    80.5
DQ   137.7   169.6   240.7   363.8     456     556     671     796   932.4
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100-YEAR, WSE at 6840

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	SB-D1	72.	6.25	12.	5.	5.	0.09		
ROUTED TO	RT-SBD1	72.	6.30	12.	5.	5.	0.09		
HYDROGRAPH AT	SB-D2	72.	6.10	8.	4.	4.	0.06		
2 COMBINED AT	AP-D1	127.	6.20	20.	9.	9.	0.14		
HYDROGRAPH AT	SB-D3	40.	6.15	5.	2.	2.	0.03		
2 COMBINED AT	AP-DDA	165.	6.15	25.	11.	11.	0.17		
ROUTED TO	RR-DFA	65.	6.60	25.	11.	11.	0.17	63.22	6.60
ROUTED TO	RT-APDFA	65.	6.65	25.	11.	11.	0.17		
HYDROGRAPH AT	SB-D6	86.	6.05	9.	4.	4.	0.04		
2 COMBINED AT	AP-D2	131.	6.05	34.	15.	15.	0.21		
ROUTED TO	RT-APD2	130.	6.10	34.	15.	15.	0.21		
HYDROGRAPH AT	SB-D7	157.	6.05	17.	7.	7.	0.07		
HYDROGRAPH AT	SB-D4	56.	6.15	7.	3.	3.	0.05		
HYDROGRAPH AT	SB-D5	47.	6.10	6.	2.	2.	0.03		
2 COMBINED AT	AP-DFB	103.	6.15	12.	6.	6.	0.08		
ROUTED TO	RR-DFB	57.	6.35	12.	6.	6.	0.08	25.45	6.35
ROUTED TO	RT-APDFB	57.	6.35	12.	6.	6.	0.08		
3 COMBINED AT	AP-D3	330.	6.05	63.	28.	28.	0.36		
ROUTED TO	RT-APD3	329.	6.10	63.	28.	28.	0.36		
HYDROGRAPH AT	SB-D8	208.	6.00	22.	9.	9.	0.06		
2 COMBINED AT	AP-DFC	524.	6.05	84.	37.	37.	0.42		
ROUTED TO	RR-DFC	86.	7.30	74.	37.	37.	0.42	65.48	7.30
ROUTED TO	RT-DFC	86.	7.35	74.	37.	37.	0.42		
HYDROGRAPH AT	SB-D9A	30.	6.10	3.	1.	1.	0.02		
2 COMBINED AT	AP-D4	102.	6.15	78.	38.	38.	0.44		
ROUTED TO	RT-APD4	101.	6.15	78.	38.	38.	0.44		
HYDROGRAPH AT	SB-D9	37.	6.10	5.	2.	2.	0.02		
2 COMBINED AT									

HU-2

	AP-D6	139.	6.15	82.	40.	40.	0.46
HYDROGRAPH AT	SB-D10	27.	6.20	4.	2.	2.	0.03
ROUTED TO	RT-SBD10	27.	6.25	4.	2.	2.	0.03
HYDROGRAPH AT	SB-D11	81.	6.10	10.	4.	4.	0.05
HYDROGRAPH AT	SB-D12	31.	6.15	4.	2.	2.	0.02
ROUTED TO	RT-SBD12	31.	6.20	4.	2.	2.	0.02
3 COMBINED AT	AP-D5	133.	6.15	17.	8.	8.	0.10
ROUTED TO	RT-APD5	131.	6.15	17.	8.	8.	0.10
2 COMBINED AT	AP-D6	270.	6.15	99.	48.	48.	0.56
HYDROGRAPH AT	SB-D13	219.	6.00	23.	10.	10.	0.07
ROUTED TO	RT-SBD13	219.	6.00	23.	10.	10.	0.07
2 COMBINED AT	AP-D6	449.	6.05	121.	58.	58.	0.62
ROUTED TO	RT-APD6	447.	6.05	121.	58.	58.	0.62
HYDROGRAPH AT	SB-D15	75.	6.10	8.	4.	4.	0.04
2 COMBINED AT	AP-D6A	520.	6.05	129.	61.	61.	0.67
ROUTED TO	RT-APD6A	517.	6.05	129.	61.	61.	0.67
HYDROGRAPH AT	SB-D14	49.	6.05	5.	2.	2.	0.02
ROUTED TO	RT-SBD14	49.	6.05	5.	2.	2.	0.02
2 COMBINED AT	AP-D7	566.	6.05	134.	64.	64.	0.69
ROUTED TO	RT-APD7	560.	6.05	134.	64.	64.	0.69
HYDROGRAPH AT	SB-D17	25.	6.00	2.	1.	1.	0.01
2 COMBINED AT	AP-D7A	585.	6.05	137.	65.	65.	0.70
HYDROGRAPH AT	SB-D16A	28.	6.05	3.	1.	1.	0.01
2 COMBINED AT	AP-D7A	613.	6.05	139.	66.	66.	0.71
ROUTED TO	RT-APD8	609.	6.05	139.	66.	66.	0.71
HYDROGRAPH AT	SB-D17A	36.	6.00	4.	2.	2.	0.01
2 COMBINED AT	AP-D8	643.	6.05	143.	68.	68.	0.72
HYDROGRAPH AT	SB-D16	98.	6.10	11.	5.	5.	0.06
ROUTED TO	RT-SBD16	98.	6.10	11.	5.	5.	0.06
2 COMBINED AT	AP-D8	737.	6.05	154.	72.	72.	0.78
ROUTED TO	RT-APD9	734.	6.05	154.	72.	72.	0.78
HYDROGRAPH AT	SB-D36	34.	6.10	4.	2.	2.	0.02

ROUTED TO	RT-SBD36	34.	6.15	4.	2.	2.	0.02	
2 COMBINED AT	AP-D9	765.	6.10	158.	74.	74.	0.81	
HYDROGRAPH AT	SB-D37	40.	6.00	5.	2.	2.	0.01	
ROUTED TO	RT-SBD37	40.	6.00	5.	2.	2.	0.01	
2 COMBINED AT	AP-D9	802.	6.05	162.	76.	76.	0.82	
ROUTED TO	RT-APDFE	798.	6.05	162.	76.	76.	0.82	
HYDROGRAPH AT	SB-D18	106.	6.15	13.	6.	6.	0.06	
ROUTED TO	RR-DFPCH	36.	6.45	11.	5.	5.	0.06	23.15 6.45
ROUTED TO	RT-RRDFP	36.	6.50	11.	5.	5.	0.06	
HYDROGRAPH AT	SB-D19	59.	6.00	6.	3.	3.	0.02	
2 COMBINED AT	AP-D10	65.	6.05	17.	7.	7.	0.09	
ROUTED TO	RT-APD10	65.	6.10	17.	7.	7.	0.09	
HYDROGRAPH AT	SB-D20	107.	6.00	12.	5.	5.	0.03	
2 COMBINED AT	AP-D11	167.	6.00	28.	13.	13.	0.12	
ROUTED TO	RT-APD11	165.	6.05	28.	13.	13.	0.12	
HYDROGRAPH AT	SB-D21	117.	6.00	12.	5.	5.	0.04	
3 COMBINED AT	AP-DFE	1078.	6.05	202.	94.	94.	0.98	
ROUTED TO	RR-DFE	847.	6.20	202.	94.	94.	0.98	42.76 6.20
DIVERSION TO	AP-D12	766.	6.20	140.	58.	58.	0.98	
HYDROGRAPH AT	AP-DFE	81.	6.20	61.	35.	35.	0.98	
ROUTED TO	RT-APD13	81.	6.20	61.	35.	35.	0.98	
HYDROGRAPH AT	SB-D22	81.	6.05	8.	4.	4.	0.04	
2 COMBINED AT	AP-D13	159.	6.05	69.	39.	39.	1.02	
ROUTED TO	RT-APD13	159.	6.05	69.	39.	39.	1.02	
HYDROGRAPH AT	SB-D23	15.	6.00	2.	1.	1.	0.00	
2 COMBINED AT	AP-D14	173.	6.05	71.	40.	40.	1.02	
ROUTED TO	AP-DFF	173.	6.05	71.	40.	40.	1.02	
HYDROGRAPH AT	SB-D24	48.	6.05	5.	2.	2.	0.03	
2 COMBINED AT	AP-DFF	220.	6.05	76.	42.	42.	1.05	
ROUTED TO	RR-DFF	87.	6.55	65.	36.	36.	1.05	69.73 6.55
HYDROGRAPH AT	SB-D25	42.	6.05	4.	2.	2.	0.02	

ROUTED TO	RR-SBD25	42.	6.05	4.	2.	2.	0.02	
HYDROGRAPH AT	SB-D26	66.	6.05	7.	3.	3.	0.03	
2 COMBINED AT	AP-D16	108.	6.05	11.	5.	5.	0.05	
ROUTED TO	RT-APD16	107.	6.05	11.	5.	5.	0.05	
2 COMBINED AT	AP-D17	118.	6.05	72.	41.	41.	1.10	
ROUTED TO	RT-APD17	118.	6.05	72.	40.	40.	1.10	
HYDROGRAPH AT	SB-D27	19.	6.05	2.	1.	1.	0.01	
2 COMBINED AT	AP-D18	136.	6.05	74.	41.	41.	1.10	
ROUTED TO	RT-APD18	136.	6.05	74.	41.	41.	1.10	
HYDROGRAPH AT	SB-D29	40.	6.05	4.	2.	2.	0.02	
DIVERSION TO	AP-D19a	20.	5.85	1.	0.	0.	0.02	
HYDROGRAPH AT	AP-D19	20.	5.85	3.	1.	1.	0.02	
ROUTED TO	RT-APD19	20.	5.90	3.	1.	1.	0.02	
HYDROGRAPH AT	SB-D28	11.	6.05	1.	0.	0.	0.00	
3 COMBINED AT	AP-D20	166.	6.05	78.	43.	43.	1.13	
ROUTED TO	RT-APD20	166.	6.05	78.	43.	43.	1.13	
HYDROGRAPH AT	SB-D30	32.	6.05	3.	1.	1.	0.02	
ROUTED TO	RT-SBD30	32.	6.05	3.	1.	1.	0.02	
2 COMBINED AT	AP-D21	197.	6.05	81.	45.	45.	1.14	
HYDROGRAPH AT	SB-D31	16.	6.05	2.	1.	1.	0.01	
2 COMBINED AT	AP-D22	213.	6.05	83.	45.	45.	1.15	
HYDROGRAPH AT	SB-D32	9.	6.05	1.	0.	0.	0.01	
2 COMBINED AT	AP-DFCS	222.	6.05	84.	46.	46.	1.16	
ROUTED TO	RR-DFCS	119.	6.45	77.	42.	42.	1.16	80.64 6.45
HYDROGRAPH AT	DR-APD12	766.	6.20	140.	58.	58.	0.00	
ROUTED TO	RT-APD12	765.	6.25	140.	59.	59.	0.00	
HYDROGRAPH AT	SB-D33	59.	6.05	6.	3.	3.	0.04	
2 COMBINED AT	AP-D23	785.	6.25	146.	62.	62.	0.04	
2 COMBINED AT	AP-D24	889.	6.25	221.	104.	104.	1.19	
HYDROGRAPH AT	SB-D34	80.	6.05	8.	4.	4.	0.04	
ROUTED TO	RT-SBD34	79.	6.05	8.	4.	4.	0.04	

HYDROGRAPH AT	SB-D35	83.	6.05	8.	4.	4.	0.04		
2 COMBINED AT	AP-DFG	162.	6.05	17.	7.	7.	0.08		
ROUTED TO	RR-DFG	41.	6.35	14.	6.	6.	0.08	72.16	6.35

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	14.95-HR
(CFS)	(HR)					
		(CFS)				
847.	6.20		202.	94.	94.	94.
		(INCHES)	1.914	2.220	2.220	2.220
		(AC-FT)	100.	116.	116.	116.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	14.95-HR
(AC-FT)	(HR)				
7.	6.20	1.	0.	0.	0.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	14.95-HR
(FEET)	(HR)				
42.76	6.20	38.75	32.71	32.71	32.71

CUMULATIVE AREA = 0.98 SQ MI

HU-7

APPENDIX "C"

Outfall Pipe Hydraulic Analysis Data Sheets, Haested Methods, Inc., Flow Master V5.15

Hydraulic Data Spreadsheets for Discharge Weirs and Orifice

Page 42-1	42" Diameter Outfall, $Q_{100} = 75$ cfs
Page 96-1	96" Diameter Outfall, $Q_{100} = 600$ cfs
Page 96-2	96" Diameter Outfall, Peak Outflow $Q_{100} = 766$ cfs, 100-year Frequency Storm with WSE at 6840 at the beginning of the storm
Page 96-3	96" Diameter Outfall, Peak Outflow = Peak 100-Year Inflow = 1080 cfs ±
Page H1	90° V-notch Weir Capacity 12' x 12' I.D. Riser
Page H2	Broadcrested Weirs Capacity 12' x 12' I.D. Riser
Page H3	42" Diameter R.C.P. Outlet, Estimated Capacity of 27" Diameter Vertical Orifice

Worksheet
Worksheet for Circular Channel

Project Description	
Project File	h:\fmw\project9.fm2
Worksheet	42" RCP OUTFALL
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Slope

Input Data		
Mannings Coefficient	0.013	
Diameter	42.00	in
Discharge	75.00	cfs

Results		
Channel Slope	0.005558	ft/ft
Depth	42.0	in
Flow Area	9.62	ft²
Wetted Perimeter	11.00	ft
Top Width	0.00	ft
Critical Depth	2.71	ft
Percent Full	100.00	
Critical Slope	0.006217	ft/ft
Velocity	7.80	ft/s
Velocity Head	0.94	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	80.68	cfs
Full Flow Capacity	75.00	cfs
Full Flow Slope	0.005558	ft/ft

Worksheet
Worksheet for Circular Channel

Project Description	
Project File	x:\2880000.all\2887715\flowmaster\96 outfa.fm2
Worksheet	96" OUTFALL
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.014000	ft/ft
Diameter	96.00	in
Discharge	600.00	cfs

Results		
Depth	4.26	ft
Flow Area	27.23	ft²
Wetted Perimeter	13.09	ft
Top Width	7.98	ft
Critical Depth	6.23	ft
Percent Full	53.28	
Critical Slope	0.004779	ft/ft
Velocity	22.04	ft/s
Velocity Head	7.55	ft
Specific Energy	11.81	ft
Froude Number	2.10	
Maximum Discharge	1,160.82	cfs
Full Flow Capacity	1,079.13	cfs
Full Flow Slope	0.004328	ft/ft
Flow is supercritical.		

96-1

Worksheet
Worksheet for Circular Channel

Project Description	
Project File	x:\2880000.all\2887715\flowmaster\96 outfa.fm2
Worksheet	96" OUTFALL
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.014000	ft/ft
Diameter	96.00	in
Discharge	766.00	cfs

Results		
Depth	4.98	ft
Flow Area	32.88	ft²
Wetted Perimeter	14.54	ft
Top Width	7.76	ft
Critical Depth	6.93	ft
Percent Full	62.23	
Critical Slope	0.006465	ft/ft
Velocity	23.30	ft/s
Velocity Head	8.43	ft
Specific Energy	13.41	ft
Froude Number	1.99	
Maximum Discharge	1,160.82	cfs
Full Flow Capacity	1,079.13	cfs
Full Flow Slope	0.007054	ft/ft
Flow is supercritical.		

Worksheet
Worksheet for Circular Channel

Project Description	
Project File	x:\2880000.all\2887715\flowmaster\96 outfa.fm2
Worksheet	96" OUTFALL
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.014000	ft/ft
Diameter	96.00	in
Discharge	1,080.00	cfs

Results		
Depth	6.56	ft
Flow Area	44.13	ft^2
Wetted Perimeter	18.13	ft
Top Width	6.14	ft
Critical Depth	7.64	ft
Percent Full	82.04	
Critical Slope	0.012171	ft/ft
Velocity	24.47	ft/s
Velocity Head	9.31	ft
Specific Energy	15.87	ft
Froude Number	1.61	
Maximum Discharge	1,160.82	cfs
Full Flow Capacity	1,079.13	cfs
Full Flow Slope	0.014023	ft/ft
Flow is supercritical.		

96-3

12'X12' I.D. RISER
ESTIMATED CAPICITY OF 90 DEGREE
V-NOTCH WEIR

H ft	Q cfs	WSE	INCREASE
0.5	0.44	31.5	
1	2.48	32	2.04
2	13.84	33	11.36
3	37.82	34	23.98
4	77.19	35	39.37
5	134.24	36	57.05
6	210.99	37	76.75
7	309.24	38	98.25
8	430.64	39	121.40
9	576.73	40	146.09
10	748.95	41	172.22
11	948.65	42	199.70
12	1177.12	43	228.47
13	1435.59	44	258.47
14	1725.24	45	289.65

12'x12' I.D. OUTLET RISER
ESTIMATED CAPICITY OF BROAD CRESTED WEIRS

L ft	H ft	COEFF	Q cfs	INCREASE cfs	WSE
10	1.00	3.10	31.00		36.00
10	2.00	3.10	87.68	56.68	37.00
10	3.00	3.10	161.08	73.40	38.00
10	4.00	3.10	248.00	86.92	39.00
10	5.00	3.10	346.59	98.59	40.00
10	6.00	3.10	455.61	109.01	41.00
10	7.00	3.10	574.13	118.52	42.00
10	8.00	3.10	701.45	127.32	43.00
10	9.00	3.10	837.00	135.55	44.00
10	10.00	3.10	980.31	143.31	45.00
30	0.30	2.64	13.01		40.70
30	1.00	2.75	82.50	69.49	41.00
30	2.00	3.03	257.10	174.60	42.00
30	3.00	3.32	517.54	260.43	43.00
30	4.00	3.32	796.80	279.26	44.00
30	5.00	3.32	1113.56	316.76	45.00
40	0.30	2.64	17.35		40.70
40	1.00	2.75	110.00	92.65	41.00
40	2.00	3.03	342.81	232.81	42.00
40	3.00	3.32	690.05	347.24	43.00
40	4.00	3.32	1062.40	372.35	44.00
40	5.00	3.32	1484.75	422.35	45.00

42" DIA. RCP OUTLET
ESTIMATED CAPICITY OF 27" DIA. VERTICAL ORIFICE

ORIFICE DIA ft	h (ft)	AREA sf	ORIFICE Q cfs	WSE
2.25	0	3.974	0	24
2.25	0	3.974	0	25
2.25	0.88	3.974	17.95	26
2.25	1.88	3.974	26.24	27
2.25	2.88	3.974	32.47	28
2.25	3.88	3.974	37.69	29
2.25	4.88	3.974	42.27	30
2.25	5.88	3.974	46.4	31
2.25	6.88	3.974	50.19	32
2.25	7.88	3.974	53.71	33
2.25	8.88	3.974	57.02	34
2.25	9.88	3.974	60.15	35
2.25	10.88	3.974	63.12	36
2.25	11.88	3.974	65.95	37
2.25	12.38	3.974	67.33	37.5
2.25	12.88	3.974	68.67	38
2.25	13.38	3.974	69.99	38.5
2.25	13.88	3.974	71.29	39
2.25	14.88	3.974	73.81	40
2.25	15.88	3.974	76.25	41
2.25	16.88	3.974	78.62	42
2.25	17.88	3.974	80.91	43
2.25	18.88	3.974	83.14	44
2.25	19.88	3.974	85.32	45

APPENDIX "D"

Reinforced Concrete Pipe Class and Trench Class Calculations

42" R.C.P. Outfall

96" R.C.P. Outfall

Three Edge Bearing Analysis - Results

Project Description

Project Title:	Kettle Creek DF E Outfall	**Consultant:**	
Project Location:	Old Ranch Road	**Contractor:**	
Contract Number:		**Analyzed By:**	
Country:		**Date:**	06-Oct-03
Units:	English	**Comply To:**	ASTM
Alternative:	42" OUTFALL		

D-LOAD REQUIREMENTS FOR A 42 in. DIAMETER CIRCULAR PIPE

PIPE DATA

Inner Diameter (in.)	42
Wall 'B' Thickness (in.)	4.500

INSTALLATION CONDITIONS

Minimum Depth of Fill (ft)	1.00
Maximum Depth of Fill (ft)	22.00
Soil Density (lb/cu. ft)	125.0
Installation Type	Positive Projecting Embankment
Positive Projection Ratio	0.50
Soil Lateral Pressure Ratio	0.33
Soil Lateral Pressure/Friction Term (kμ)	0.1500
Soil Lateral Fraction (m)	0.50
Settlement Ratio	0.70

ADDITIONAL LOADS

No Live or Surcharge Loads

FACTOR OF SAFETY

Factor of Safety on 0.01 Inch Crack D-Load (Earth,Live)	1.00 1.00
Factor of Safety on Ultimate Earth and Live Load (ASTM C 76)	
DL.01 Less Than or Equal To 2000 lbs/ft/ft	1.50
DL.01 Greater Than or Equal To 3000 lbs/ft/ft	1.25
DL.01 Between 2000 and 3000 lbs/ft/ft	Interpolated

D-LOAD REQUIREMENTS FOR A 42 in. DIAMETER CIRCULAR PIPE

Results of Analysis for Bedding Type B

Pipe Depth	Earth Load Arching Factor	Earth Load Load (lb/ft)	Live Load (lb/ft)	Surch Load (lb/ft)	Total Load (lb/ft)	Bedding Factor DL	Required D-Load 0.01 in. (lb/ft/ft)
1.00	**1.04**	**550**	**0**	**0**	**550**	**2.38**	**66 (CL-I)**
2.00	1.07	1141	0	0	1141	2.38	**137 (CL-I)**
3.00	1.11	1775	0	0	1775	2.30	**220 (CL-I)**
4.00	1.16	2455	0	0	2455	2.27	**309 (CL-I)**
5.00	1.20	3185	0	0	3185	2.25	**405 (CL-I)**
6.00	1.25	3969	0	0	3969	2.23	**508 (CL-I)**
7.00	1.29	4810	0	0	4810	2.22	**619 (CL-I)**
8.00	1.34	5689	0	0	5689	2.21	**736 (CL-I)**
9.00	**1.34**	**6427**	**0**	**0**	**6427**	**2.21**	**833 (CL-II)**
10.00	1.35	7167	0	0	7167	2.20	**930 (CL-II)**
11.00	**1.35**	**7901**	**0**	**0**	**7901**	**2.20**	**1026 (CL-III)**
12.00	1.35	8635	0	0	8635	2.20	**1122 (CL-III)**
13.00	1.36	9368	0	0	9368	2.20	**1218 (CL-III)**
14.00	1.36	10101	0	0	10101	2.20	**1314 (CL-III)**
15.00	**1.36**	**10834**	**0**	**0**	**10834**	**2.19**	**1410 (CL-IV)**
16.00	1.36	11566	0	0	11566	2.19	**1506 (CL-IV)**
17.00	1.36	12299	0	0	12299	2.19	**1602 (CL-IV)**
18.00	1.36	13031	0	0	13031	2.19	**1698 (CL-IV)**
19.00	1.36	13764	0	0	13764	2.19	**1794 (CL-IV)**
20.00	1.36	14496	0	0	14496	2.19	**1890 (CL-IV)**
21.00	1.36	15228	0	0	15228	2.19	**1986 (CL-IV)**
22.00	**1.37**	**15960**	**0**	**0**	**15960**	**2.19**	**2082 (CL-V)**

Selected Depth: 20 ft. (closest pipe depth : 20 ft)
Reinforced Pipe Classes for 0.01 in. crack per ASTM C76 (lb/ft/ft):
CL I <= 800; CL II <= 1000; CL III <= 1350; CL IV <= 2000; Class V <= 3000

Three Edge Bearing Analysis - Results

Project Description

Project Title:	Kettle Creek DF E Outfall	**Consultant:**	
Project Location:	Old Ranch Road	**Contractor:**	
Contract Number:		**Analyzed By:**	
Country:		**Date:**	06-Oct-03
Units:	English	**Comply To:**	ASTM
Alternative:	96"		

D-LOAD REQUIREMENTS FOR A 96 in. DIAMETER CIRCULAR PIPE

PIPE DATA

Inner Diameter (in.)	96
Wall 'B' Thickness (in.)	9.000

INSTALLATION CONDITIONS

Minimum Depth of Fill (ft)	2.00
Maximum Depth of Fill (ft)	22.00
Soil Density (lb/cu. ft)	125.0
Installation Type	Positive Projecting Embankment
Positive Projection Ratio	0.50
Soil Lateral Pressure Ratio	0.33
Soil Lateral Pressure/Friction Term (kμ)	0.1500
Soil Lateral Fraction (m)	0.50
Settlement Ratio	0.70

ADDITIONAL LOADS

No Live or Surcharge Loads

FACTOR OF SAFETY

Factor of Safety on 0.01 Inch Crack D-Load (Earth,Live)	1.00 1.00
Factor of Safety on Ultimate Earth and Live Load (ASTM C 76)	
DL.01 Less Than or Equal To 2000 lbs/ft/ft	1.50
DL.01 Greater Than or Equal To 3000 lbs/ft/ft	1.25
DL.01 Between 2000 and 3000 lbs/ft/ft	Interpolated

D-LOAD REQUIREMENTS FOR A 96 in. DIAMETER CIRCULAR PIPE

Results of Analysis for Bedding Type B

Pipe Depth	Earth Load Arching Factor	Earth Load Load (lb/ft)	Live Load (lb/ft)	Surch Load (lb/ft)	Total Load (lb/ft)	Bedding Factor DL	Required D-Load 0.01 in. (lb/ft/ft)
2.00	**1.03**	**2452**	**0**	**0**	**2452**	**2.38**	**129 (CL-I)**
4.00	1.07	5063	0	0	5063	2.38	**266 (CL-I)**
6.00	1.10	7845	0	0	7845	2.31	**424 (CL-I)**
8.00	1.14	10808	0	0	10808	2.28	**592 (CL-I)**
10.00	1.18	13964	0	0	13964	2.26	**773 (CL-I)**
12.00	**1.22**	**17326**	**0**	**0**	**17326**	**2.24**	**966 (CL-II)**
14.00	**1.26**	**20907**	**0**	**0**	**20907**	**2.23**	**1173 (CL-III)**
16.00	**1.30**	**24722**	**0**	**0**	**24722**	**2.22**	**1394 (CL-IV)**
18.00	1.34	28609	0	0	28609	2.21	**1619 (CL-IV)**
20.00	1.34	31921	0	0	31921	2.21	**1809 (CL-IV)**
22.00	1.35	35232	0	0	35232	2.20	**1999 (CL-IV)**

Selected Depth: 22 ft. (closest pipe depth : 22 ft)
Reinforced Pipe Classes for 0.01 in. crack per ASTM C76 (lb/ft/ft):
CL I <= 800; CL II <= 1000; CL III <= 1350; CL IV <= 2000; Class V <= 3000

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APPENDIX "E"

12' x 12' I.D. Riser Analysis
96" R.C.P. Outfall

Client: VINTAGE Job No: 8877.15

Project: DF "E" By: JRB Chk. By: _____ Date: 9/30/03

Subject: RISER 12' X 12' I.D. Sheet No: 1 of 1

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CHECK FLOTATION

COMPUTE WT. OF STRUCT.

FOOTING: $(21^2)\left(\frac{19}{12}\right) 140^{lb}/_{ft^3} = +97,755^{lb}$

SIDE WALLS:

$2 @ (26.7)(1.5)(1.5)(140) = +168,210^{lb}$

INLET / OUTLET WALLS:

$2 @ (26.7)(12)(1.5)(140) = 134,568^{lb}$

$-(1)(4.75)^2(\pi)(1.5)\,140 = -14,878^{lb}$

$-[(4.7)(10)(1.5) + \frac{1}{2}(10)(5)(1.5)]140 = -15,120^{lb}$

FILL CONCRETE:

$(12)(12)(3)\,140 = +60,400^{lb}$

TOTAL WT $431,135^{lb}$

ASSUME: W.S.E. @ 6834.0 WITHOUT MEASURABLE AMOUNT INSIDE

WATER DISPLACED:

$(15)(15)(20)\,62.4 = 280,800$

$(21^2)\left(\frac{19}{12}\right) 62.4 = 53,473$

$334,273 < 431,135$

NOT INCLUDING WT OF SOIL & WATER ON EXTERIOR FOOTING.

F-1

12' X 12' I.D. CONCRETE RISER

Structural Loading Conditions:
Differential Water Pressure

Flow Rate cfs	1.3V^2/2g ft.	Interior W.S.E.	Exterior W.S.E.	Difference ft.
130	pipe 1/2 full	6819.6	6835.0	15.4
512	2.10	6825.7	6840.7	15.0
766	4.70	6828.3	6843.0	14.7

Client: VINTAGE Job No: 8877.15

Project: DF "E" By: JRB Chk. By: _____ Date: 10/29/03

Subject: 12'x 12' I.D. RISER Sheet No: 1 of 2

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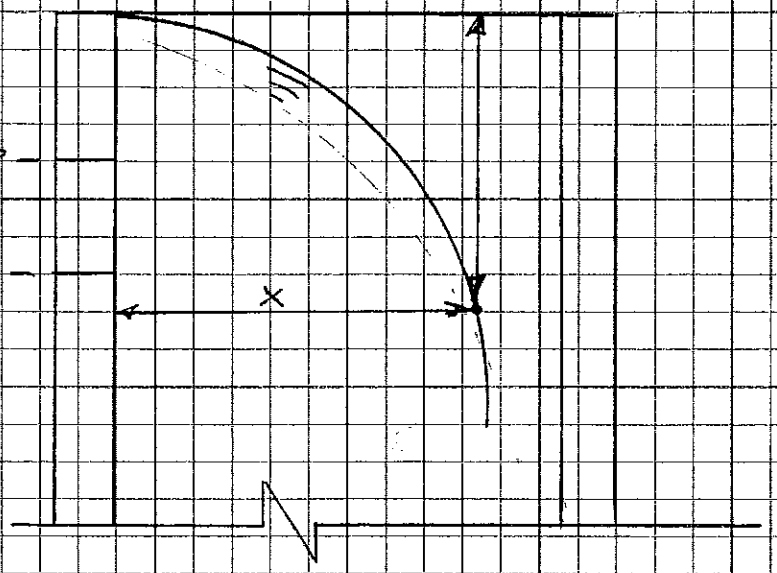
CHECK FOR FREE FALL OF WEIR

FLOW IN 12'x 12' RISER.



$Y = \frac{1}{2} g t^2$

$X = Vt \quad \therefore \quad X/V = t$

$Y = \frac{1}{2} g (X/V)^2$

$X^2 = 2(Y)(V^2/g)$

COMPUTE HORZ VEL. V

ASSUME: Q = 600 cfs +/- WSE 6840.7

$V = Q/A = (600)/(4.7)(10') + (\frac{1}{2})(5)\,10 = 8.3$ fps

H-1

Client: VINTAGE Job No: 8877.15

Project: DF "E" By: JRB Chk. By: Date: 10/29/03

Subject: 12'X 12' I.D. RISER Sheet No: 2 of 2

J·R ENGINEERING
A Subsidiary of Westrian

IF V = 8.3 fps +/- AND

$X = \sqrt{RYV^4/2g}$

COMPUTE CO-ORDINATES POINTS ON THE WATER SURFACE

X ft	Y ft
1.5	1
2.1	2
2.5	3
2.9	4
3.3	5
3.6	6
3.9	7
4.1	8
4.4	9
4.6	10
4.9	11
5.1	12
5.3	13
5.5	14
6.0	17

THUS THERE IS FREE FLOW OVER THE WEIR WITH NO RESTRICTION DUE TO THE OPPOSITE SIDE OF THE RISER

H-2

APPENDIX "F"

96" R.C.P. Outfall Splash Pool

Page 1 of 2	Design Calculations
Page 2 of 2	Design Calculations
Fig. 10-C.2	Drainage Criteria Manual
Fig. 10-C.4	Drainage Criteria Manual
Page B-31	Plate B-29, U.S. Army Corps of Engineers

Client: VINTAGE Job No: 8877.15

Project: DF "E" By: JRB Chk. By: _____ Date: 10-30-03

Subject: 96" RCP SPLASH POOL OUTFALL. Sheet No: 1 of 2

J·R ENGINEERING
A Subsidiary of Westrian

Q_{100} NORMAL = 600 cfs

Q_{100} / POND FULL TO 6840 = 766 cfs

Q_{100} PEAK INFLOW = 1,080 cfs

ESTIMATE SPLASH POOL SIZE

BASED ON DCM EXAMPLE ON PAGE 10-41

1) DETERMINE Y_o AND V_o

$Q/D^{2.5} = 3.31$

$TW/D = 2/8 = 0.25$

FIG. 10-C.1, $Y_o/D = 0.6$

$Y_o = (0.6)\ 8 = 4.8'$

$TW/Y_o = 2/4.8 = 0.42 < 0.75$ OK

BINK AREA $A = 30.95$ sf

$V_o = Q/A = 600/30.95 = 19.4$ fps

2) $Y_e = (A/2)^{1/2} = 3.93$

3) $F = V_o / [(32.2)(Y_e)]^{1/2} = 1.73$

4) VH $d_{50} = 2'$ $d_{50}/Y_e = 2'/3.93 = 0.51$

FIG. 10-C.4 $h_s/Y_e = 0.7$

$h_s = (.7)(3.93) = 2.75'$

$h_s/d_{50} = 2.75/2 = 1.37$

~~OK~~ $2 < h_s/d_{50} = 1.37 < 4$ NOT IN DESIGN LIMITS

Client: VINTAGE Job No: 8872.15

Project: DF "E" By: JRB Chk. By: _____ Date: 10-30-03

Subject: 96" RCP SPLASH POOL Sheet No: 2 of 7

J·R ENGINEERING
A Subsidiary of Westrian

EVEN THOUGH IT FALLS OUTSIDE OF NORMAL DESIGN LIMITS CONTINUE TO ESTIMATE POOL SIZE

5) $L_S = (10) h_c = (10) 2.75 = 27.5'$ (60' PROVIDED)

OR $L_S = 3 W_o = (3) 8' = 24'$

$L_B = (15) h_c = (15)(2.75) = 41'$ (55' PROVIDED)

OR $L_B = (4) W_o = 4(8') = 32'$

SOLUTION:

PROVIDE BAFFLES ON OUTLET STRUCTURE, ENLARGE SPLASH POOL TO FACILITATE CHANGE OF FLOW DIRECTION, AND VELOCITY REDUCTION.

USE TYPE VH RIPRAP TO HANDLE VELOCITIES FROM 12 TO 17 fps

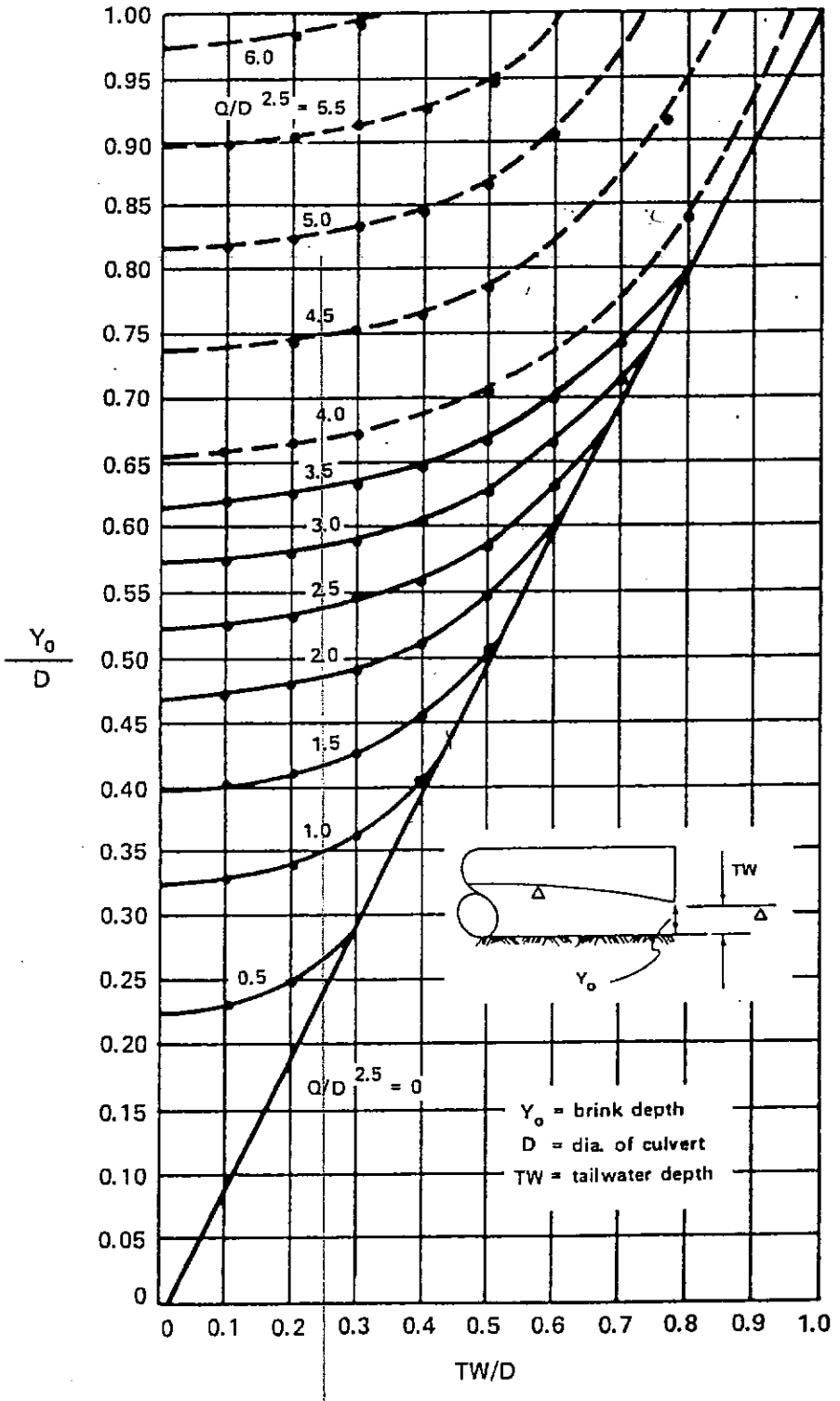


Figure 10-C.2 Dimensionless Rating Curve for the Outlets of Circular Culverts on Horizontal and Mild Slopes .

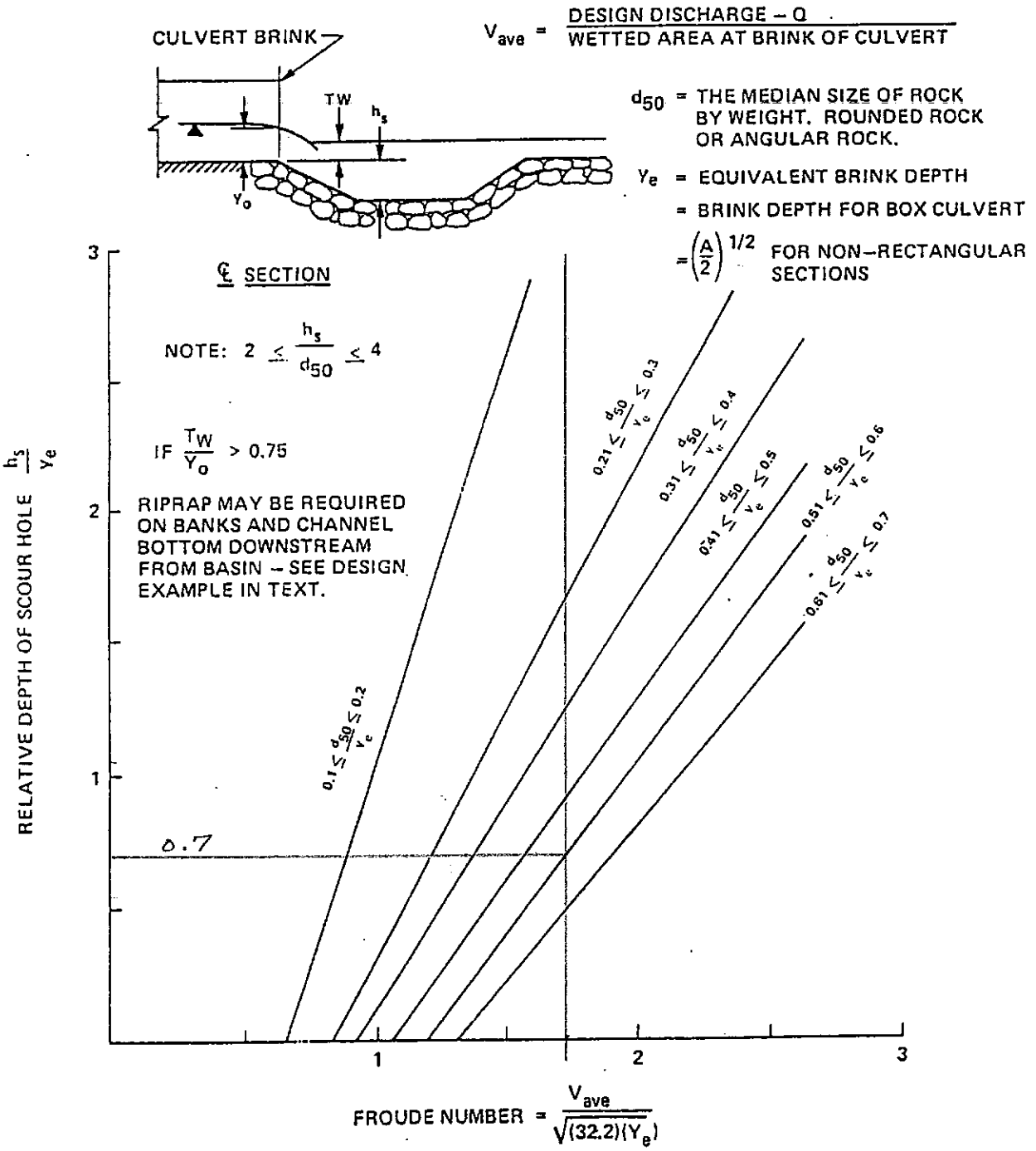


FIGURE 10-C.4 RELATIVE DEPTH OF SCOUR HOLE VERSUS FROUDE NUMBER AT BRINK OF CULVERT WITH RELATIVE SIZE OF RIPRAP AS A THIRD VARIABLE

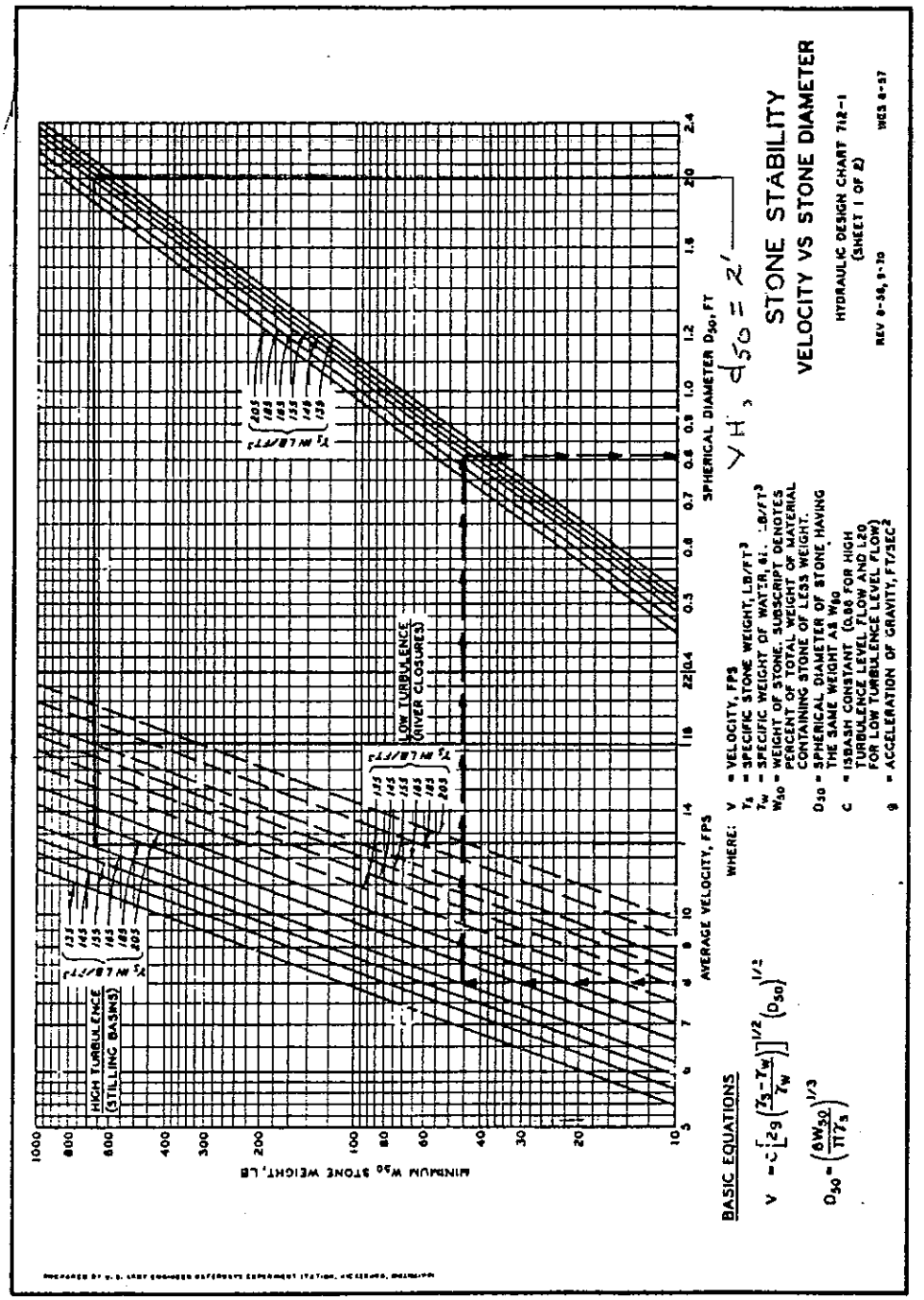

STONE STABILITY
VELOCITY VS STONE DIAMETER
HYDRAULIC DESIGN CHART 712-1
(SHEET 1 OF 2)
REV 8-58, 8-70
WES 6-57
HIGH TURBULENCE
(STILLING BASINS)
LOW TURBULENCE
(RIVER CLOSURES)
MINIMUM W50 STONE WEIGHT, LB
AVERAGE VELOCITY, FPS
SPHERICAL DIAMETER D50, FT
BASIC EQUATIONS
WHERE:
V = VELOCITY, FPS
γs = SPECIFIC STONE WEIGHT, LB/FT3
γw = SPECIFIC WEIGHT OF WATER, 64 LB/FT3
W50 = WEIGHT OF STONE, SUBSCRIPT DENOTES PERCENT OF TOTAL WEIGHT OF MATERIAL CONTAINING STONE OF LESS WEIGHT.
D50 = SPHERICAL DIAMETER OF STONE HAVING THE SAME WEIGHT AS W50
C = ISBASH CONSTANT (0.86 FOR HIGH TURBULENCE LEVEL FLOW AND 1.20 FOR LOW TURBULENCE LEVEL FLOW)
g = ACCELERATION OF GRAVITY, FT/SEC2

PLATE B-29

APPENDIX "G"

4' x 12' RCB Outlet
Splash Pool Analysis

Page A1	Splash Pool Analysis Data
Page 1-9	HEC-RAS Analysis Report
Map	HEC-RAS Selection Map Detention Facility "E"
Page B-13	Plate B-29, U.S. Army Corps of Engineers Rip-rap Selection Chart
Page 16-20	SCS Rip-rap Selection Chart

4' X 12' R.C.B. OUTLET SPLASH POOL

Analysis Data

Storm Frequency (yr)	2	5	25	100
Peak Flow Rate (cfs)	208	337	559	799
DF "E" W.S.E.	6832.29	6834.86	6838.46	6840.7

REC-RAS analysis was modeled with the above flow rates and water surface elevations of 6823.2, 6824.2, 6825.2, and 6826.2 at Section #1. Note that these water surface elevations are less than those predicted by the HEC-1 models for the above storm frequencies.

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: DF-E RCB OUTFALL
Project File : dfe.prj
Run Date and Time: 9/17/2003 1:59:36 PM

Project in English units

Project Description:
DF-E SPLASH POOL DESIGN

PLAN DATA

Plan Title: Plan 01
Plan File : x:\2880000.all\2887715\HEC-RAS\dfe.p01

Geometry Title: DF-E RCB SPLASH POOL
Geometry File : x:\2880000.all\2887715\HEC-RAS\dfe.g01

Flow Title : DF E RCB SPLASH POOL
Flow File : W:\dfe.f01

Plan Summary Information:
Number of: Cross Sections = 11 Mulitple Openings = 0
Culverts = 0 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: DF E RCB SPLASH POOL
Flow File : x:\dfe.f01

Flow Data (cfs)

River	Reach	RS	PF 1,5,9,12	PF 2,6,10,13	PF 3,7,11,14	PF 4,8,12,16
royal pine	one	10	208	337	559	799

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
royal pine	one	PF 1	Normal S = .0895	Known WS = 23.2
royal pine	one	PF 2	Normal S = .0895	Known WS = 23.2
royal pine	one	PF 3	Normal S = .0895	Known WS = 23.2
royal pine	one	PF 4	Normal S = .0895	Known WS = 23.2
royal pine	one	PF 5	Normal S = .0895	Known WS = 24.2
royal pine	one	PF 6	Normal S = .0895	Known WS = 24.2
royal pine	one	PF 7	Normal S = .0895	Known WS = 24.2
royal pine	one	PF 8	Normal S = .0895	Known WS = 24.2
royal pine	one	PF 9	Normal S = .0895	Known WS = 25.2
royal pine	one	PF 10	Normal S = .0895	Known WS = 25.2
royal pine	one	PF 11	Normal S = .0895	Known WS = 25.2
royal pine	one	PF 12	Normal S = .0895	Known WS = 25.2
royal pine	one	PF 13	Normal S = .0895	Known WS = 26.2
royal pine	one	PF 14	Normal S = .0895	Known WS = 26.2
royal pine	one	PF 15	Normal S = .0895	Known WS = 26.2
royal pine	one	PF 16	Normal S = .0895	Known WS = 26.2

GEOMETRY DATA

Geometry Title: DF-E RCB SPLASH POOL
Geometry File : x:\2880000.all\2887715\HEC-RAS\dfe.g01

CROSS SECTION RIVER: royal pine
REACH: one RS: 10

INPUT
Description: RCB STA. 3+14

Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
10	45.29	10.01	41.29	22	41.29	22.01	45.29

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
10	.013	10	.013	22.01	.013

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
10	22.01	190	190	190	.1	.3

CROSS SECTION RIVER: royal pine
REACH: one RS: 9

INPUT
Description: RCB STA. 1+24
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
10	28.28	10.01	24.28	22	24.28	22.01	28.28

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
10	.013	10	.013	22.01	.013

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
10	22.01	10	10	10	.1	.3

CROSS SECTION RIVER: royal pine
REACH: one RS: 8

INPUT
Description: RCB STA. 1+14
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
10	28.18	10.01	24.18	22	24.18	22.01	28.18

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
10	.045	10	.045	22.01	.045

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
10	22.01	.1	.1	.1	.1	.3

CROSS SECTION RIVER: royal pine
REACH: one RS: 7.9

INPUT
Description: At Outlet
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
12	28.18	20	24.18	32	24.18	40	28.18

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
12	.045	12	.045	40	.045

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
12	40	6	6	6	.1	.3

CROSS SECTION RIVER: royal pine
REACH: one RS: 7

INPUT
Description: Splash Pool
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	30	15	22	25	22	40	30

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	0	.045	40	.045

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
0	40	10	10	.1	.3

CROSS SECTION RIVER: royal pine
REACH: one RS: 6

INPUT
Description: Splash Pool
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	30	18	22	52	22	82	30

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	0	.045	82	.045

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
0	82	10	10	.1	.3

CROSS SECTION RIVER: royal pine
REACH: one RS: 5

INPUT
Description: Splash Pool
Station Elevation Data num= 6

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	30	23	24	28	22	65	22	69	24
95	30								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	0	.045	95	.045

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
0	95	10	10	.1	.3

CROSS SECTION RIVER: royal pine
REACH: one RS: 4

INPUT
Description: Splash Pool
Station Elevation Data num= 6

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	30	23	24	28	22	76	22	81	24
106	30								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	0	.045	106	.045

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
0	106	10	10	.1	.3

CROSS SECTION RIVER: royal pine
REACH: one RS: 3

INPUT
Description: Splash Pool
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	30	32	23.8	92	23.8	118	30

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	0	.045	118	.045

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
0	118	10	10	.1	.3

CROSS SECTION RIVER: royal pine
REACH: one RS: 2

INPUT
Description: Splash Pool
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	30	23	23.75	104	23.75	129	30

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	0	.045	129	.045

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
0	129	50	50	.1	.3

CROSS SECTION RIVER: royal pine
REACH: one RS: 1

INPUT
Description: Splash Pool
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	30	23	23.75	162	23.75	188	30

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	0	.045	188	.045

Bank Sta: Left	Right	Coeff Contr.	Expan.
0	188	.1	.3

SUMMARY OF MANNING'S N VALUES

River:royal pine

Reach	River Sta.	n1	n2	n3
one	10	.013	.013	.013
one	9	.013	.013	.013
one	8	.045	.045	.045
one	7.9	.045	.045	.045
one	7	.045	.045	.045
one	6	.045	.045	.045
one	5	.045	.045	.045
one	4	.045	.045	.045
one	3	.045	.045	.045
one	2	.045	.045	.045
one	1	.045	.045	.045

SUMMARY OF REACH LENGTHS

River: royal pine

Reach	River Sta.	Left	Channel	Right
one	10	190	190	190
one	9	10	10	10
one	8	.1	.1	.1
one	7.9	6	6	6
one	7	10	10	10
one	6	10	10	10
one	5	10	10	10
one	4	10	10	10
one	3	10	10	10
one	2	50	50	50
one	1			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: royal pine

Reach	River Sta.	Contr.	Expan.
one	10	.1	.3
one	9	.1	.3
one	8	.1	.3
one	7.9	.1	.3
one	7	.1	.3
one	6	.1	.3
one	5	.1	.3
one	4	.1	.3
one	3	.1	.3
one	2	.1	.3
one	1	.1	.3

HEC-RAS Plan: Plan 01 River: royal pine Reach: one

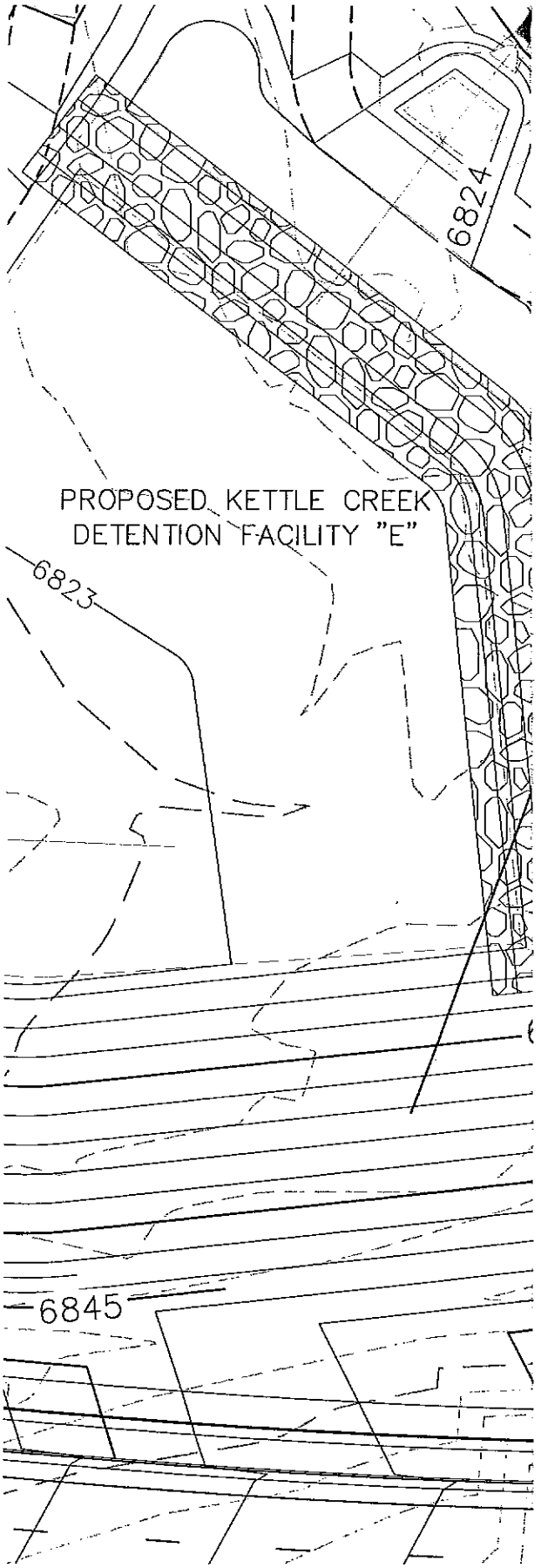
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
one	10	208.00	41.29	41.99	43.39	51.66	0.089619	24.96	8.33	11.99	5.28
one	10	337.00	41.29	42.23	44.19	56.05	0.089605	29.83	11.30	11.99	5.42
one	10	559.00	41.29	42.59	45.36	62.48	0.089582	35.79	15.62	12.00	5.53
one	10	799.00	41.29	42.93	46.45	68.45	0.089566	40.54	19.71	12.00	5.57
one	10	208.00	41.29	41.99	43.39	51.66	0.089619	24.96	8.33	11.99	5.28
one	10	337.00	41.29	42.23	44.19	56.05	0.089605	29.83	11.30	11.99	5.42
one	10	559.00	41.29	42.59	45.36	62.48	0.089582	35.79	15.62	12.00	5.53
one	10	799.00	41.29	42.93	46.45	68.45	0.089566	40.54	19.71	12.00	5.57
one	10	208.00	41.29	41.99	43.39	51.66	0.089619	24.96	8.33	11.99	5.28
one	10	337.00	41.29	42.23	44.19	56.05	0.089605	29.83	11.30	11.99	5.42
one	10	559.00	41.29	42.59	45.36	62.48	0.089582	35.79	15.62	12.00	5.53
one	10	799.00	41.29	42.93	46.45	68.45	0.089566	40.54	19.71	12.00	5.57
one	10	208.00	41.29	41.99	43.39	51.66	0.089619	24.96	8.33	11.99	5.28
one	10	337.00	41.29	42.23	44.19	56.05	0.089605	29.83	11.30	11.99	5.42
one	10	559.00	41.29	42.59	45.36	62.48	0.089582	35.79	15.62	12.00	5.53
one	10	779.00	41.29	42.91	46.37	67.98	0.089562	40.19	19.38	12.00	5.57
one	9	208.00	24.28	24.97	26.38	34.72	0.090750	25.06	8.30	11.99	5.31
one	9	337.00	24.28	25.22	27.18	39.12	0.090433	29.92	11.26	11.99	5.44
one	9	559.00	24.28	25.58	28.35	45.53	0.090013	35.85	15.59	12.00	5.54
one	9	799.00	24.28	25.92	29.44	51.67	0.090828	40.73	19.62	12.00	5.61
one	9	208.00	24.28	24.97	26.38	34.72	0.090750	25.06	8.30	11.99	5.31
one	9	337.00	24.28	25.22	27.18	39.12	0.090433	29.92	11.26	11.99	5.44
one	9	559.00	24.28	25.58	28.35	45.53	0.090013	35.85	15.59	12.00	5.54
one	9	799.00	24.28	25.92	29.44	51.67	0.090828	40.73	19.62	12.00	5.61
one	9	208.00	24.28	24.97	26.38	34.72	0.090750	25.06	8.30	11.99	5.31
one	9	337.00	24.28	25.22	27.18	39.12	0.090433	29.92	11.26	11.99	5.44
one	9	559.00	24.28	25.58	28.35	45.53	0.090013	35.85	15.59	12.00	5.54
one	9	799.00	24.28	25.92	29.44	51.67	0.090828	40.73	19.62	12.00	5.61
one	9	208.00	24.28	24.97	26.38	34.72	0.090750	25.06	8.30	11.99	5.31
one	9	337.00	24.28	25.22	27.18	39.12	0.090433	29.92	11.26	11.99	5.44
one	9	559.00	24.28	25.58	28.35	45.53	0.090013	35.85	15.59	12.00	5.54
one	9	779.00	24.28	25.89	29.36	51.18	0.090720	40.36	19.30	12.00	5.61
one	8	208.00	24.18	25.00	26.28	31.98	0.639207	21.21	9.81	11.99	4.13
one	8	337.00	24.18	25.23	27.08	36.30	0.756792	26.69	12.63	12.00	4.58
one	8	559.00	24.18	25.59	28.25	42.63	0.845817	33.13	16.87	12.00	4.92
one	8	799.00	24.18	25.92	29.34	48.68	0.902097	38.29	20.87	12.00	5.12
one	8	208.00	24.18	25.00	26.28	31.98	0.639207	21.21	9.81	11.99	4.13
one	8	337.00	24.18	25.23	27.08	36.30	0.756792	26.69	12.63	12.00	4.58
one	8	559.00	24.18	25.59	28.25	42.63	0.845817	33.13	16.87	12.00	4.92
one	8	799.00	24.18	25.92	29.34	48.68	0.902097	38.29	20.87	12.00	5.12
one	8	208.00	24.18	25.00	26.28	31.98	0.639207	21.21	9.81	11.99	4.13
one	8	337.00	24.18	25.23	27.08	36.30	0.756792	26.69	12.63	12.00	4.58
one	8	559.00	24.18	25.59	28.25	42.63	0.845817	33.13	16.87	12.00	4.92
one	8	799.00	24.18	25.92	29.34	48.68	0.902097	38.29	20.87	12.00	5.12
one	8	208.00	24.18	25.00	26.28	31.98	0.639207	21.21	9.81	11.99	4.13
one	8	337.00	24.18	25.23	27.08	36.30	0.756792	26.69	12.63	12.00	4.58
one	8	559.00	24.18	25.59	28.25	42.63	0.845817	33.13	16.87	12.00	4.92
one	8	779.00	24.18	25.89	29.26	48.21	0.898653	37.91	20.55	12.00	5.11
one	7.9	208.00	24.18	24.91	26.06	31.89	0.744024	21.21	9.81	14.91	4.61
one	7.9	337.00	24.18	25.09	26.68	36.21	0.908653	26.75	12.60	15.65	5.25
one	7.9	559.00	24.18	25.35	27.52	42.51	1.047443	33.24	16.82	16.69	5.83
one	7.9	799.00	24.18	25.58	28.26	48.56	1.143830	38.46	20.77	17.61	6.24
one	7.9	208.00	24.18	24.91	26.06	31.89	0.744024	21.21	9.81	14.91	4.61
one	7.9	337.00	24.18	25.09	26.68	36.21	0.908653	26.75	12.60	15.65	5.25
one	7.9	559.00	24.18	25.35	27.52	42.51	1.047443	33.24	16.82	16.69	5.83
one	7.9	799.00	24.18	25.58	28.26	48.56	1.143830	38.46	20.77	17.61	6.24
one	7.9	208.00	24.18	24.91	26.06	31.89	0.744024	21.21	9.81	14.91	4.61
one	7.9	337.00	24.18	25.09	26.68	36.21	0.908653	26.75	12.60	15.65	5.25
one	7.9	559.00	24.18	25.35	27.52	42.51	1.047443	33.24	16.82	16.69	5.83
one	7.9	799.00	24.18	25.58	28.26	48.56	1.143830	38.46	20.77	17.61	6.24
one	7.9	208.00	24.18	24.91	26.06	31.89	0.744024	21.21	9.81	14.91	4.61
one	7.9	337.00	24.18	25.09	26.68	36.21	0.908653	26.75	12.60	15.65	5.25
one	7.9	559.00	24.18	25.35	27.52	42.51	1.047443	33.24	16.82	16.69	5.83
one	7.9	779.00	24.18	25.56	28.21	48.08	1.137665	38.08	20.46	17.54	6.21
one	7	208.00	22.00	22.96	24.07	28.15	0.407441	18.28	11.38	13.61	3.52
one	7	337.00	22.00	23.20	24.73	31.41	0.503962	22.99	14.66	14.49	4.03
one	7	559.00	22.00	23.50	25.63	36.57	0.622029	29.01	19.27	15.64	4.61
one	7	799.00	22.00	23.76	26.42	41.75	0.717690	34.03	23.48	16.62	5.05
one	7	208.00	22.00	22.96	24.07	28.15	0.407441	18.28	11.38	13.61	3.52
one	7	337.00	22.00	23.20	24.73	31.41	0.503962	22.99	14.66	14.49	4.03

HEC-RAS Plan: Plan 01 River: royal pine Reach: one (Continued)

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)	
one	7	559.00	22.00	23.50	25.63	36.57	0.622029	29.01	19.27	15.64	4.61
one	7	799.00	22.00	23.76	26.42	41.75	0.717690	34.03	23.48	16.62	5.05
one	7	208.00	22.00	22.98	24.07	28.15	0.407441	18.28	11.38	13.61	3.52
one	7	337.00	22.00	23.20	24.73	31.41	0.503962	22.99	14.66	14.49	4.03
one	7	559.00	22.00	23.50	25.63	36.57	0.622029	29.01	19.27	15.64	4.61
one	7	799.00	22.00	23.76	26.42	41.75	0.717690	34.03	23.48	16.62	5.05
one	7	208.00	22.00	26.14	24.07	26.27	0.001978	2.82	73.64	25.54	0.29
one	7	337.00	22.00	23.20	24.73	31.41	0.503962	22.99	14.66	14.49	4.03
one	7	559.00	22.00	23.50	25.63	36.57	0.622029	29.01	19.27	15.64	4.61
one	7	779.00	22.00	23.74	26.36	41.33	0.710885	33.66	23.15	16.54	5.01
one	6	208.00	22.00	24.98	23.02	25.02	0.000745	1.62	128.07	51.89	0.18
one	6	337.00	22.00	25.32	23.39	25.40	0.001338	2.31	145.77	53.90	0.25
one	6	559.00	22.00	25.77	23.91	25.93	0.002332	3.28	170.57	56.59	0.33
one	6	799.00	22.00	22.90	24.39	32.02	0.690732	24.24	32.96	39.39	4.67
one	6	208.00	22.00	24.97	23.02	25.01	0.000756	1.63	127.43	51.82	0.18
one	6	337.00	22.00	25.32	23.39	25.40	0.001338	2.31	145.77	53.90	0.25
one	6	559.00	22.00	25.77	23.91	25.93	0.002332	3.28	170.57	56.59	0.33
one	6	799.00	22.00	22.90	24.39	32.02	0.690732	24.24	32.96	39.39	4.67
one	6	208.00	22.00	25.29	23.02	25.32	0.000523	1.44	144.48	53.76	0.15
one	6	337.00	22.00	25.43	23.39	25.51	0.001184	2.22	152.00	54.59	0.23
one	6	559.00	22.00	25.76	23.91	25.93	0.002342	3.28	170.32	56.57	0.33
one	6	799.00	22.00	22.90	24.39	32.02	0.690732	24.24	32.96	39.39	4.67
one	6	208.00	22.00	26.21		26.23	0.000215	1.06	196.54	59.26	0.10
one	6	337.00	22.00	26.24	23.39	26.28	0.000552	1.70	197.91	59.42	0.16
one	6	559.00	22.00	26.30	23.91	26.42	0.001435	2.77	201.89	59.82	0.27
one	6	779.00	22.00	22.89	24.35	31.74	0.678172	23.88	32.62	39.34	4.62
one	5	208.00	22.00	24.98		25.02	0.000713	1.58	131.81	53.97	0.18
one	5	337.00	22.00	25.31		25.39	0.001296	2.25	150.11	56.68	0.24
one	5	559.00	22.00	25.75		25.91	0.002281	3.18	176.00	60.29	0.33
one	5	799.00	22.00	26.15	24.33	26.40	0.003216	3.98	200.97	63.58	0.39
one	5	208.00	22.00	24.96		25.00	0.000724	1.59	131.14	53.87	0.18
one	5	337.00	22.00	25.31		25.39	0.001296	2.25	150.11	56.68	0.24
one	5	559.00	22.00	25.75		25.91	0.002281	3.18	176.00	60.29	0.33
one	5	799.00	22.00	26.15	24.33	26.40	0.003216	3.98	200.97	63.58	0.39
one	5	208.00	22.00	25.29		25.32	0.000503	1.40	149.08	56.53	0.15
one	5	337.00	22.00	25.42		25.50	0.001148	2.15	156.75	57.62	0.23
one	5	559.00	22.00	25.75		25.90	0.002290	3.18	175.73	60.25	0.33
one	5	799.00	22.00	26.16	24.33	26.40	0.003208	3.97	201.16	63.61	0.39
one	5	208.00	22.00	26.21		26.23	0.000207	1.02	204.78	64.07	0.10
one	5	337.00	22.00	26.23		26.28	0.000533	1.63	206.14	64.24	0.16
one	5	559.00	22.00	26.30		26.41	0.001390	2.66	210.16	64.75	0.26
one	5	779.00	22.00	26.40	24.29	26.60	0.002480	3.60	216.65	65.57	0.35
one	4	208.00	22.00	24.98		25.01	0.000422	1.25	166.76	65.85	0.14
one	4	337.00	22.00	25.32		25.37	0.000765	1.78	189.37	68.54	0.19
one	4	559.00	22.00	25.77		25.87	0.001342	2.53	221.38	72.18	0.25
one	4	799.00	22.00	26.19		26.35	0.001884	3.17	252.33	75.53	0.31
one	4	208.00	22.00	24.97		24.99	0.000428	1.25	165.94	65.75	0.14
one	4	337.00	22.00	25.32		25.37	0.000765	1.78	189.37	68.54	0.19
one	4	559.00	22.00	25.77		25.87	0.001342	2.53	221.38	72.18	0.25
one	4	799.00	22.00	26.19		26.35	0.001884	3.17	252.33	75.53	0.31
one	4	208.00	22.00	25.29		25.31	0.000299	1.11	187.68	68.34	0.12
one	4	337.00	22.00	25.43		25.48	0.000679	1.71	197.32	69.46	0.18
one	4	559.00	22.00	25.77		25.87	0.001347	2.53	221.06	72.15	0.25
one	4	799.00	22.00	26.19		26.35	0.001879	3.16	252.55	75.56	0.30
one	4	208.00	22.00	26.22		26.23	0.000125	0.82	254.10	75.72	0.08
one	4	337.00	22.00	26.24		26.27	0.000322	1.32	255.99	75.92	0.13
one	4	559.00	22.00	26.31		26.38	0.000833	2.14	261.53	76.50	0.20
one	4	779.00	22.00	26.43		26.56	0.001471	2.88	270.35	77.42	0.27
one	3	208.00	23.80	24.83		24.98	0.009435	3.11	66.81	69.64	0.56
one	3	337.00	23.80	25.08		25.33	0.011832	3.99	84.52	71.98	0.65
one	3	559.00	23.80	25.38		25.81	0.016035	5.27	106.13	74.74	0.78
one	3	799.00	23.80	25.59		26.25	0.020931	6.51	122.75	76.79	0.91
one	3	208.00	23.80	24.81		24.97	0.010060	3.18	65.47	69.46	0.58
one	3	337.00	23.80	25.08		25.33	0.011832	3.99	84.52	71.98	0.65
one	3	559.00	23.80	25.38		25.81	0.016035	5.27	106.13	74.74	0.78
one	3	799.00	23.80	25.59		26.25	0.020931	6.51	122.75	76.79	0.91
one	3	208.00	23.80	25.23		25.30	0.003130	2.19	95.00	73.33	0.34
one	3	337.00	23.80	25.26		25.45	0.007489	3.44	97.88	73.70	0.53
one	3	559.00	23.80	25.36		25.80	0.016518	5.32	105.12	74.61	0.79
one	3	799.00	23.80	25.48	25.48	26.24	0.026228	7.00	114.06	75.72	1.01

HEC-RAS Plan: Plan 01 River: royal pine Reach: one (Continued)

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)	
one	3	208.00	23.80	26.20		26.22	0.000519	1.22	170.86	82.44	0.15
one	3	337.00	23.80	26.20		26.26	0.001365	1.97	170.70	82.42	0.24
one	3	559.00	23.80	26.19		26.36	0.003790	3.28	170.21	82.37	0.40
one	3	779.00	23.80	26.18		26.51	0.007491	4.60	169.21	82.25	0.57
one	2	208.00	23.75	24.81	24.33	24.90	0.004773	2.30	90.48	89.17	0.40
one	2	337.00	23.75	25.08	24.55	25.21	0.005926	2.95	114.32	91.20	0.46
one	2	559.00	23.75	25.41	24.86	25.64	0.007707	3.86	144.76	93.73	0.55
one	2	799.00	23.75	25.68	25.16	26.02	0.009369	4.68	170.70	95.83	0.62
one	2	208.00	23.75	24.79		24.88	0.005123	2.35	88.51	89.00	0.42
one	2	337.00	23.75	25.08	24.55	25.21	0.005926	2.95	114.32	91.20	0.46
one	2	559.00	23.75	25.41	24.86	25.64	0.007707	3.86	144.76	93.73	0.55
one	2	799.00	23.75	25.68	25.16	26.02	0.009369	4.68	170.70	95.83	0.62
one	2	208.00	23.75	25.23		25.27	0.001575	1.62	128.01	92.34	0.24
one	2	337.00	23.75	25.27		25.37	0.003745	2.55	132.07	92.68	0.38
one	2	559.00	23.75	25.39		25.63	0.007930	3.90	143.46	93.62	0.55
one	2	799.00	23.75	25.58	25.16	25.95	0.011285	4.97	160.89	95.04	0.67
one	2	208.00	23.75	26.20		26.22	0.000281	0.94	221.68	99.83	0.11
one	2	337.00	23.75	26.20		26.24	0.000735	1.52	221.96	99.85	0.18
one	2	559.00	23.75	26.21		26.31	0.001998	2.51	222.81	99.92	0.30
one	2	779.00	23.75	26.23		26.41	0.003812	3.48	224.09	100.02	0.41
one	1	208.00	23.75	24.16	24.16	24.36	0.040005	3.61	57.57	142.21	1.00
one	1	337.00	23.75	24.31	24.31	24.59	0.036419	4.25	79.38	143.41	1.01
one	1	559.00	23.75	24.54	24.54	24.93	0.032473	5.00	111.87	145.17	1.00
one	1	799.00	23.75	24.75	24.75	25.24	0.030253	5.62	142.24	146.80	1.01
one	1	208.00	23.75	24.20	24.16	24.37	0.029188	3.28	63.34	142.53	0.87
one	1	337.00	23.75	24.31	24.31	24.59	0.036419	4.25	79.38	143.41	1.01
one	1	559.00	23.75	24.54	24.54	24.93	0.032473	5.00	111.87	145.17	1.00
one	1	799.00	23.75	24.75	24.75	25.24	0.030253	5.62	142.24	146.80	1.01
one	1	208.00	23.75	25.20	24.16	25.22	0.000580	0.99	209.79	150.37	0.15
one	1	337.00	23.75	25.20	24.31	25.24	0.001523	1.61	209.79	150.37	0.24
one	1	559.00	23.75	25.20	24.54	25.31	0.004190	2.66	209.79	150.37	0.40
one	1	799.00	23.75	25.20	24.75	25.43	0.008561	3.81	209.79	150.37	0.57
one	1	208.00	23.75	26.20	24.16	26.21	0.000099	0.57	364.08	158.21	0.07
one	1	337.00	23.75	26.20	24.31	26.21	0.000260	0.93	364.08	158.21	0.11
one	1	559.00	23.75	26.20	24.54	26.24	0.000715	1.54	364.08	158.21	0.18
one	1	779.00	23.75	26.20	24.73	26.27	0.001389	2.14	364.08	158.21	0.25

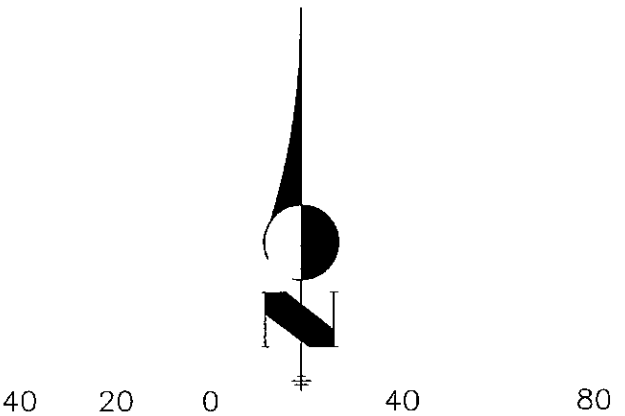


HEC-RAS ANALYSIS
OUTFALL VELOCITIES

SECTION NO.	VELOCITY RANGE fps
1	1 TO 6
2	1 TO 5
3	1 TO 7
4	1 TO 3
5	1 TO 4
6	1 TO 24
7	18 TO 34
7.9	21 TO 38
8	21 TO 38
9	25 TO 40
10	25 TO 40

LEGEND

SECTION LOCATION AND NO. 1



SCALE: 1" = 40'

HEC-RES SECTION MAP
KETTLE CREEK DET. FAC. "E"
JOB NO. 28877.15
4' X 12' RCB SPLASH POOL
OCTOBER 2003

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A Subsidiary of Westrian

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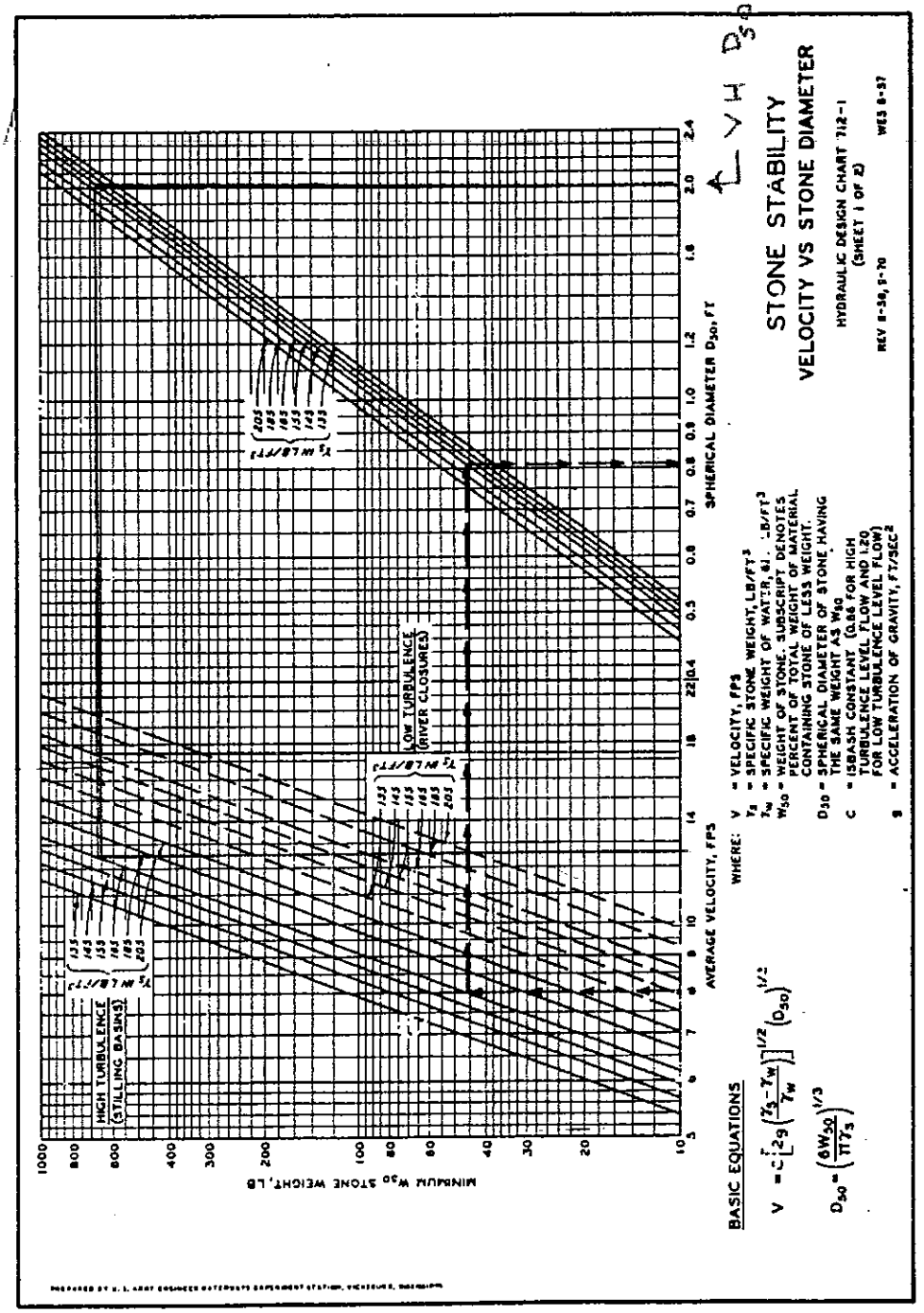

PLATE B-29

FROM U.S. ARMY CORPS OF ENG. "HYDRAULIC DESIGN OF FLOOD CONTROL CHANNELS"

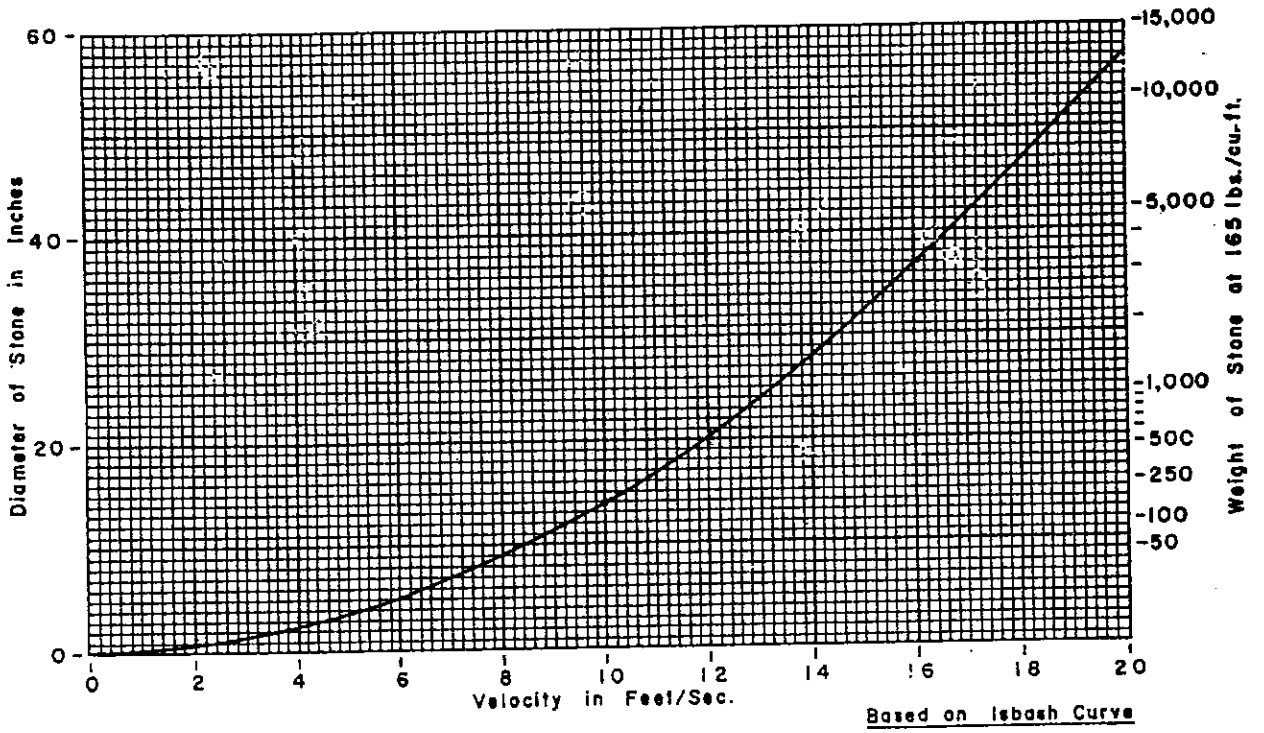

Exhibit 16-1 Maximum stone size for riprap

FROM SCS ENGINEERING FIELD MANUAL

APPENDIX "H"

42" R.C.P. Outfall
Bargrate Outlet Structure

Client: VINTAGE Job No: 8877.15

Project: DF "E" By: JRB Chk. By: _____ Date: 9/30/03

Subject: 42" OUTFALL Sheet No: 1 of 2

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CHECK VELOCITY THROUGH BARGRATE

COMPUTE NET OPEN AREA:

16 SPACES @ 4" WIDE

LENGTH = 107" − 3" − 3" = 101"

AREA = (101)(16)(4) = 6464 SQ.IN. = 44.9 SF

Q max = 80 cfs

V = 80 cfs / 44.9 = 1.8 FPS OK

NOT INCLUDING LOW FLOW PORTION.

COMPUTE WT. OF GRATE

6 PIPE SECTION

(117"/12)(6)(227 lb/FT) = 133 lb

4 BARS, 1, (4)(33×3/144) 16.37 lb/SF = 45 lb

178 lb/SECTION OK

42-1

Client: VINTAGE Job No: 8877.15

Project: DF "E" By: JRB Chk. By: Date: 9/30/03

Subject: 42" OUTFALL Sheet No: 2 of 2

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CHECK CAPACITY OF LOW FLOW
PORTION OF OUTLET
STRUCTURE TO PROVIDE
18.0 cfs @ 6826.0 TO 27" DIA ORIFICE

OPENING PROVED
8' X 1' + 11 x 1" = 7sf > 3.96sf
AREA OF 27" DIA ORIFICE

INVERT OF OPENING 6824.08
TOP OF OPENING 6825.08 +/-
INVERT OF 27" DIA ORIFICE 6824.0

SAFTY FACTOR: 7/3.96 = 1.77 Good!

42-2

Client: VINTAGE Job No: 8877.15

Project: DF "E" By: JRB Chk. By: _____ Date: 10/1/03

Subject: 42" DIA. OUTLET Sheet No: 1 of 4

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BARGRATE

CHECK STRENGTH OF 11¼" DIA.
STANDARD WT. PIPE

ASSUME LOADING OF 300 PSF
NORMAL TO PIPE

FROM STEEL HAND BOOK
3 CONTINUOUS SPANS

MAX MOMENT = $-0.12wl^2$

$= (-0.12)(300)(4.5)^2$

$= 729$ FT-lb

$Sf = M$

$S = 0.235\ in^3$ 17 PIPES OVER 8 ft WIDTH

$f = (0.47)(35{,}000\ psi) = 23{,}450\ psi$

$SA = (729)\ 12"/ft$

$\frac{17}{8}(0.235)\ f = 8748$ in-lb

$f = \left(\frac{8}{17}\right)\left(\frac{1}{0.235}\right) 8748 = 17{,}520\ psi$

$17{,}520 < 23{,}450\ psi$ OK !

42 - 3

Client: VINTAGE Job No: 8877.15

Project: DF "E" By: JRB Chk. By: _____ Date: 10-1-03

Subject: 42" DIA OUTLET Sheet No: 3 of 4

J·R ENGINEERING
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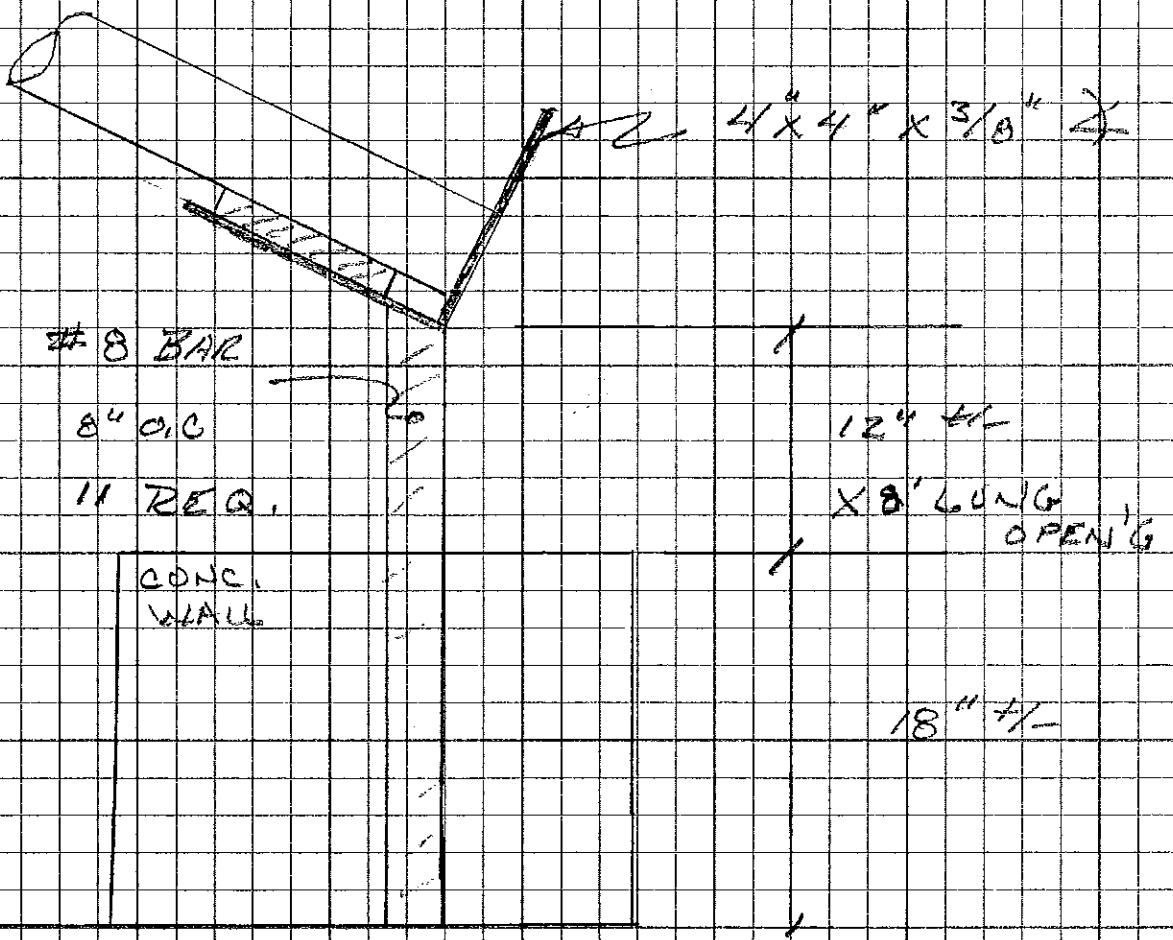
BARGRATE

CHECK SUPPORT AT LOW FLOW INLET END OF BARGRATE



$w = (4.5/2)(300) = 675$ lb/LF

OR (8) 675/LF = 490 lbs/BAR ASSUME

CHECK d_4 FOR BOND

$f_c = (3.4)\sqrt{4,000}/D = 215$ PSI

$d_4 = 490/215 = 2.3" < 18"$ OK

42-5

Client: VINTAGE Job No: 8877.15

Project: DF "E" By: JRB Chk. By: Date: 10-1-03

Subject: 42" DIA OUTLET Sheet No: 4 of 4

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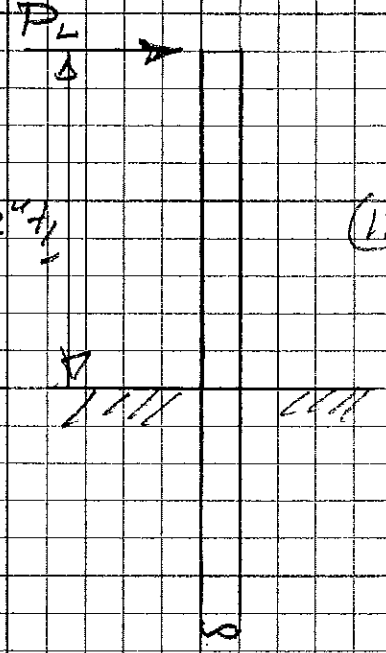
BAR GRATE

CHECK LATERAL LOAD CAPACITY OF #8 BAR SUPPORTS



$$BM = P_L(12)$$

$$(12)P_L = S_{\#8} f$$

$$S_{\#8} = \left(\frac{\pi d^3}{32}\right) = 0.098$$

$$f = (.67)(60{,}000) =$$

$$= 40{,}200 \text{ psi}$$

$$P_L = (0.098)(40{,}200)/12$$

$$= 328 \text{ lb} \rightarrow / \text{BAR}$$

OR $(4)\ 328/8 = 450$ lb/LF OF SUPPORT

OK !

42-6

APPENDIX "I"

12" Diameter Outfall Bargrate Structure

Page 1 of 2 Bargrate Structural Calculation

Page 2 of 2 Check Adequacy of Low Flow Portion of the Structure

Client: VINTAGE Job No: 8877.15

Project: DF "E" By: JRB Chk. By: _____ Date: 10-30-03

Subject: 12" DIA OUTFALL Sheet No: 1 of 2

BARGRATE STRUCTURE

J·R ENGINEERING
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CHECK STRUCT. CAPICITY

1 1/4" Φ STAND WT PIPE 3" CLEAR BETWEEN PIPES

UNIFORM LOAD PER PIPE

O.D. = 1.66 LOAD: 300 psf
CLR = 3.00
4.66"

$W = \left(\frac{4.66}{12}\right)(300) = 117$ #/L.F.

SIMPLE BEAM

$WL^2/2 = \frac{(117)(4.85')^2}{8} = 344$ FT-#

$S = 0.235$ IN^3

$Sf = (344)(12)/0.235 = 17,566$ psi

17,566 psi < 0.67(35000) = 23,450 ok

Client: VINTAGE Job No: 8877.15

Project: DF "E" By: JRB Chk. By: _____ Date: 10-30-03

Subject: 12" DIA OUTFALL Sheet No: 2 of 2
BAR GRATE STRUCTURE

J·R ENGINEERING
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CHECK AREA OF LOW FLOW PORTION
OF OUTLET STRUCTURE (VERTICAL)

NET OPEN AREA

(48" - 5") 3 = 129 SQ.IN = 0.9 SF.

6" Ø ORIFICE = $(3^2)\pi$ = 28.3 SQ.IN = 0.2 SF

0.9/0.2 = 4.5 GOOD.

APPENDIX "J"

Copy of Army Corps of Engineer Permit No. 2000-00535 for DF "E" and Roadway Fill

DEPARTMENT OF THE ARMY
ALBUQUERQUE DISTRICT, CORPS OF ENGINEERS
SOUTHERN COLORADO REGULATORY OFFICE
720 NORTH MAIN STREET, SUITE 205
PUEBLO, COLORADO 81003-3046
FAX (719) 543-9475

March 20, 2001

REPLY TO
ATTENTION OF:

Operations Division
Regulatory Branch

Mr. Dean Venezia
Vintage Companies
c/o Mr. Larry Semo
SWCA, Incorporated
8461 Turnpike Drive
Westminster, CO 80031

Dear Mr. Venezia:

Your final Department of the Army Permit No. 2000 00535, for your proposed regional stormwater detention basin and roadway fill in a tributary of Kettle Creek, El Paso County, Colorado is enclosed. Please notify us when you propose to start construction. Note special conditions No. 2 and 3, which require submittal and approval of a riparian woodland mitigation plan and a noxious weed control plan within 60 days of issuance of this permit (May 19, 2001).

I draw your attention to the general conditions of this permit, which specifically address requests for extension, modification and revocation, authorized maintenance, abandonment, permit transfer, and archeological discoveries. Also, the permit contains disclaimers regarding the need for other permits, property rights and limits of the Government's liability for this work. Please also note the special conditions.

Enclosed is a self-certification letter. Upon completion of the project, please sign and date the letter and return it to this office. To help us improve our service, please complete and return the attached Customer Service Survey.

If you have any questions, please contact Ms. Anita Culp at (719) 543-6914 or by e-mail at anita.e.culp@usace.army.mil.

Sincerely,

Van A. Truan
Chief, Southern Colorado
Regulatory Office

3 Enclosures
1. Permit No. 2000 00535
2. Self-certification letter
3. Customer Service Survey

DEPARTMENT OF THE ARMY PERMIT

Permittee Vintage Companies

Permit No. 2000 00535

Issuing Office Albuquerque District Corps of Engineers

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below.

Project Description:

The regional detention pond bottom will be excavated. An earthen dam will be constructed to a height approximately 18 feet above the land surface. The side slopes of the pond and dam will be at a 4H:1V ratio. The outfall from the pond to the natural channel will be an 84-inch storm drain constructed of reinforced concrete pipe. A riprap-lined energy dissipating basin will be constructed at the end of the outfall.

On the upstream side of the detention pond, fill up to 16 feet in depth will be placed to allow future construction of the Chapel Hills Drive extension (4 lanes wide and with a minimum 85-foot right-of-way). Only basic roadfill to cross the drainageway will be constructed at this time.

The remaining short section of the stream located above the detention pond and roadway fill will be filled to allow future development of commercial sites.

Materials used in construction will include non-toxic, earthen fill, Portland cement and concrete, and rock riprap.

The project will be constructed in accordance with the attached drawings, entitled, "Kettle Creek Ranch Detention Pond and Road Construction in Kettle Creek, Colorado Springs, El Paso County, Colorado," sheets 1 through 6, dated August 30, 2000.

Project Location: In a tributary of Kettle Creek and adjacent wetlands in Colorado Springs, El Paso County, Colorado in the NW1/4 of Section 27, Township 12S, Range 66W.

Permit Conditions:

General Conditions:

1. The time limit for completing the work authorized ends on December 31, 2004. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and state coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

6. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of your permit.

Special Conditions:

After a detailed and careful review of all of the conditions contained in this permit, the permittee acknowledges that, although said conditions were required by the Corps of Engineers, nonetheless the permittee agreed to those conditions voluntarily to facilitate issuance of the permit; the permittee will comply fully with all the terms of all the permit conditions.

1. The mitigation described in the "Mitigation Plan for Waters of the United States on a Portion of the Kettle Creek Ranch Property, Colorado Springs, Colorado," prepared by SWCA. Inc., dated July 2000, will be implemented within 1 year following construction. The Plan includes success criteria, a 3-year monitoring period, and submittal of a final monitoring report.

2. The loss of approximately 1 acre of riparian woodland will be mitigated with planting of approximately 1 acre of upland trees surrounding the detention basin. A plan describing planting locations, species, planting densities, and success criteria will be provided to the Corps of Engineers for review and approval within 60 days of permit issuance.

3. Noxious weed control will be performed on the project site. A plan will be provided to the Corps of Engineers for review and approval within 60 days of permit issuance.

4. To avoid impacts to Preble's meadow jumping mouse populations during the season when they are active above ground, the following is required: (a) Construction activities for the proposed work will begin during the period of November 1 through May 1, (b) temporary orange construction fencing will be used to prevent inadvertent impacts to downstream PMJM habitat, and (c) on-site workers will be informed as to the reason for and importance of limiting impacts to vegetated habitat outside the fenced area.

Further Information:

1. Congressional Authorities: You have been authorized to undertake the activity described above pursuant to:

( ) Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403).

(XX) Section 404 of the Clean Water Act (33 U.S.C. 1344).

( ) Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. 1413).

2. Limits of this authorization.

a. This permit does not obviate the need to obtain other Federal, state, or local authorizations required by law.

b. This permit does not grant any property rights or exclusive privileges.

c. This permit does not authorize any injury to the property or rights of others.

d. This permit does not authorize interference with any existing or proposed Federal project.

3. Limits of Federal Liability. In issuing this permit, the Federal Government does not assume any liability for the following:

a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.

b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the United States in the public interest.

c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.

d. Design or construction deficiencies associated with the permitted work.

e. Damage claims associated with any future modification, suspension, or revocation of this permit.

4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.

5. Reevaluation of Permit Decision. This office may reevaluate its decision on this permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:

a. You fail to comply with the terms and conditions of this permit.

b. The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate (See 4 above).

c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 325.7 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you to comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. Extensions. General condition 1 establishes a time limit for the completion of the activity authorized by this permit. Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

Vicki M. Venezia — (PERMITTEE)

March 13 01 — (DATE)

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

Van A. Truan
Chief, Southern Colorado Regulatory Branch
(for the DISTRICT ENGINEER)

20 MARCH 2001 — (DATE)

When the structures or work authorized by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

(TRANSFEREE)

(DATE)

STATE OF COLORADO

Bill Owens, Governor
Jane E. Norton, Executive Director

Dedicated to protecting and improving the health and environment of the people of Colorado

4300 Cherry Creek Dr. S.
Denver, Colorado 80246-1530
Phone (303) 692-2000
TDD Line (303) 691-7700
Located in Glendale, Colorado

Laboratory and Radiation Services Division
8100 Lowry Blvd.
Denver CO 80230-6928
(303) 692-3090

http://www.cdphe.state.co.us

Colorado Department
of Public Health
and Environment

November 20, 2000

Vintage Companies
7710 North Union Boulevard
Colorado Springs, CO 80920

Re: Section 401 Water Quality Certification
Permit No. COE 200000535
Colo. Cert. No. 2888

Dear Sir or Madam:

The Water Quality Control Division has reviewed the federal license or permit application, public notice, or other information submitted related to certification for the activity described below. Provided the plans of operation included in the submitted information are followed and the attached General Conditions (where applicable) are complied with, the Division is reasonably assured that Sections 301, 302, 303, 306 and 307 of the Clean Water Act and applicable sections of the Colorado Water Quality Control Act will not be violated by this activity.

Description: To place dredged and fill material as a regional stormwater detention basin and roadway fill for the future Chapel Hills Drive crossing.

Location: NW 1/4 of Section 27, Township 12S, Range 66W, El Paso County, Colorado.

Watercourse: Tributary to Kettle Creek.

This certification does not constitute a relinquishment of the Water Quality Control Division's authority as delineated in the "Colorado Water Quality Control Act," or any subsequent alterations thereto, nor does it fulfill or waive any other local, state or federal regulations.

Sincerely,

Phil Hegeman
Water Quality Assessor
WATER QUALITY CONTROL DIVISION

Attachment

cc: Applicant's Agent, Mr. Larry Semo, SWCA, Inc.
U. S. Army Corps of Engineers, Albuquerque District, NM
U. S. Army Corps of Engineers, Southern Colorado Project Office, CO
District Engineer, Dave Knope, WQCD
File

BEST MANAGEMENT PRACTICES

1. At least fifteen days before a federal licensee or permittee commences any project in a watercourse, which project may adversely affect water quality, it shall notify the following:

   A. Applicable local health department;

   B. Owners or operators of municipal and domestic water supply intakes which are located within twenty miles downstream from the site of the project; and

   C. Owners or operators of other intakes or diversions which are located within five miles downstream from the site of the project.

2. Construction operations in watercourses and water bodies shall be restricted to areas specified in the federal license or permit.

3. Permanent erosion and sediment control measures shall be installed at the earliest practicable time consistent with good construction practices and shall be maintained as necessary throughout the operation of the project. One of the first construction activities shall be the placement of permanent and temporary erosion and sediment control measures around the perimeter of the project or the initial work areas to protect the project water resources.

4. Temporary erosion and sediment control measures shall be coordinated with permanent measures to assure economical, effective, and continuous control throughout the construction phase and during the operation of the project.

5. Work should be carried out diligently and completed as soon as possible.

6. The use of chemicals such as soil stabilizers, dust palliatives, sterilants, growth inhibitors, fertilizers, deicing salts, etc., during construction and operation should be limited to the best estimate of optimum application rates. All reasonable measures shall be taken to avoid excess application and introduction of chemicals into the waters.

7. Measures shall be taken to prevent spilled fuels, lubricants, or other toxic materials from entering the watercourse.

8. Whenever practicable, discharges of dredged or fill materials shall be conducted during lowflow periods, during periods when spawning is not occurring and during periods when recreational use is relatively low. If such discharges will occur when water temperatures are near freezing and where a domestic water supply diversion is located within twenty miles downstream, the permittee shall coordinate with the water purveyor in order to minimize impacts on treated water quality.

9. Solids, sludges, dredged, stockpiled or other materials which are potential sources of toxic pollutants, shall be controlled in a manner so as to prevent such materials

(over)

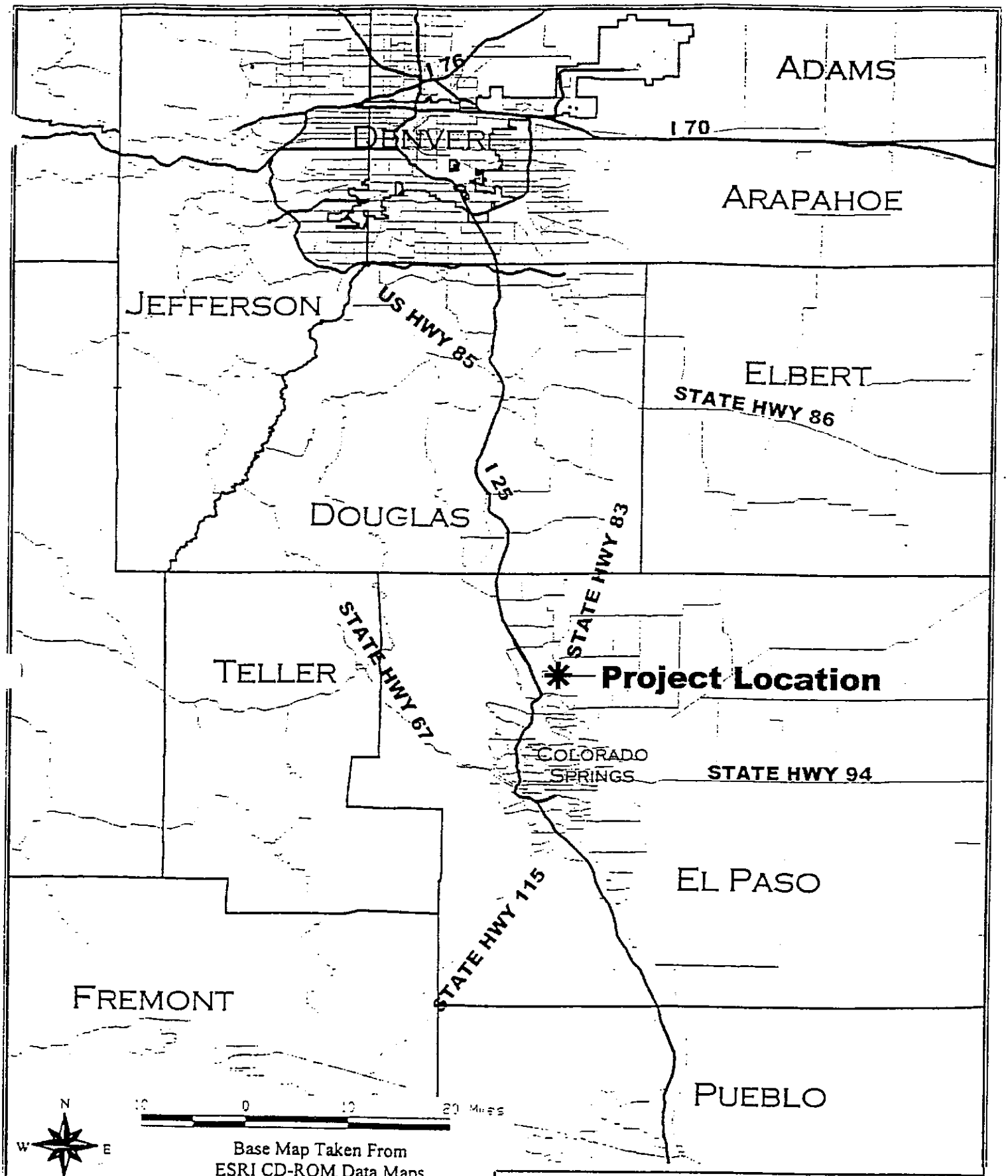


Figure 1. Vicinity map for Kettle Creek Detention Pond Project

Kettle Creek Ranch Detention Pond and Road Construction in Kettle Creek, Colorado Springs, El Paso County, Colorado

Application by Vintage Companies

Application No. 2000 00535

Sheet 1 of 6

August 30, 2000

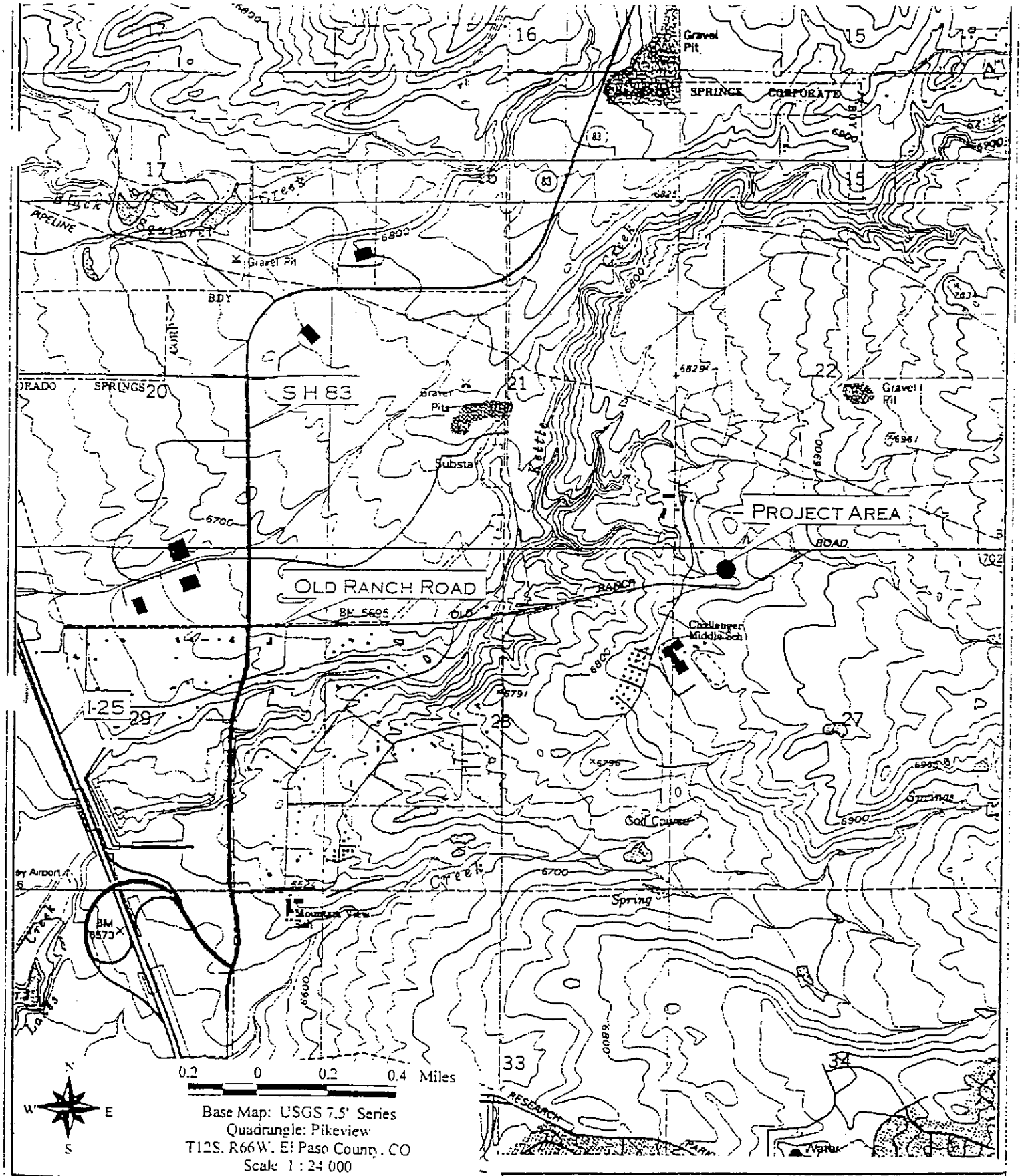
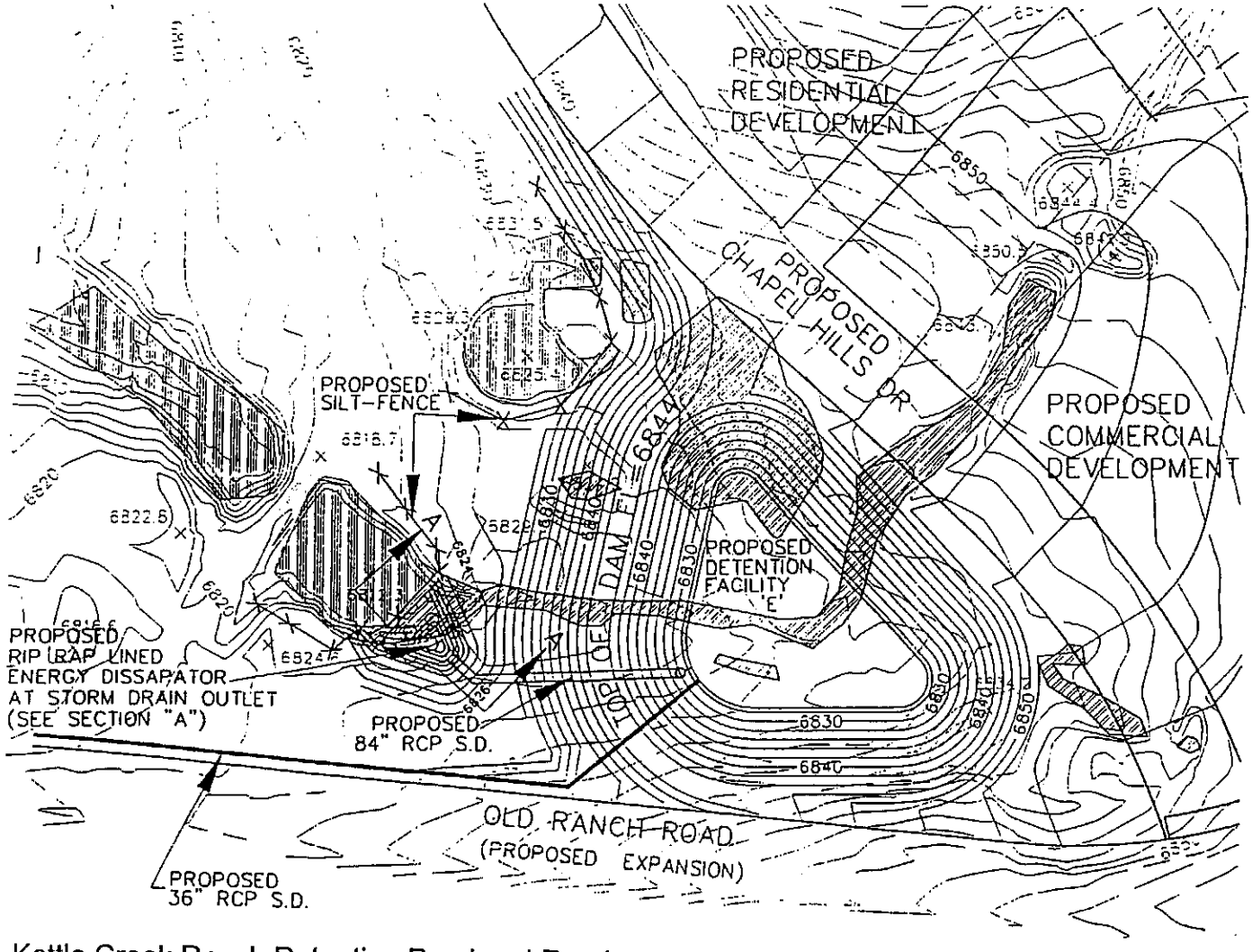


Figure 2. Project Area Map for Kettle Creek Detention Pond Project

Kettle Creek Ranch Detention Pond and Road Construction in Kettle Creek, Colorado Springs, El Paso County, Colorado
Application by Vintage Companies
Application No. 2000 00535
Sheet 2 of 6
August 30, 2000



LEGEND

EXISTING CONTOUR 2'
EXISTING CONTOUR 10'
PROPOSED CONTOUR 2'
PROPOSED CONTOUR 10'

EXISTING WETLANDS TO REMAIN

EXISTING WETLANDS TO BE DISTRUBED

100 50 0 100 200

ORIG.
SCALE: 1" = 100'

JOB #: 8906.00
EXHIBIT
6/21/00

J·R ENGINEERING
A Subsidiary of Wastrian

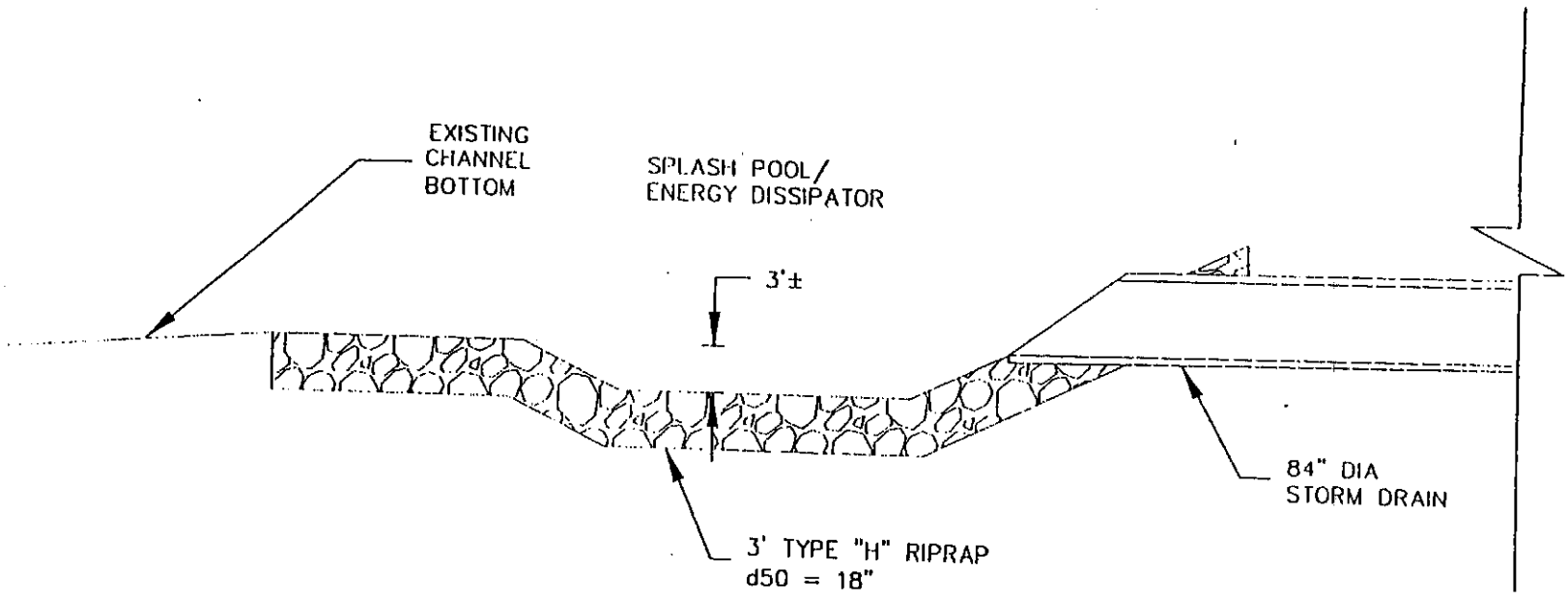
430 ArrowsWest Drive • Colorado Springs, CO 80907
719-593-2593 • Fax 719-528-6601 • www.jrengineering.com

Kettle Creek Ranch Detention Pond and Road Construction in Kettle Creek, Colorado Springs, El Paso County, Colorado

Application by Vintage Companies
Application No. 2000 00535
Sheet 3 of 6

August 30, 2000

X:\870000 / 71610\EXHIBITS\TROWE-SD-OUTFALL1.DWG



A-A 84" DIA. STORM DRAIN OUTFALL
SECTION

Kettle Creek Ranch Detention Pond and Road Construction in Kettle Creek, Colorado Springs, El Paso County, Colorado

Application by Vintage Companies
Application No. 2000 00535
Sheet 4 of 6

August 30, 2000

J·R ENGINEERING
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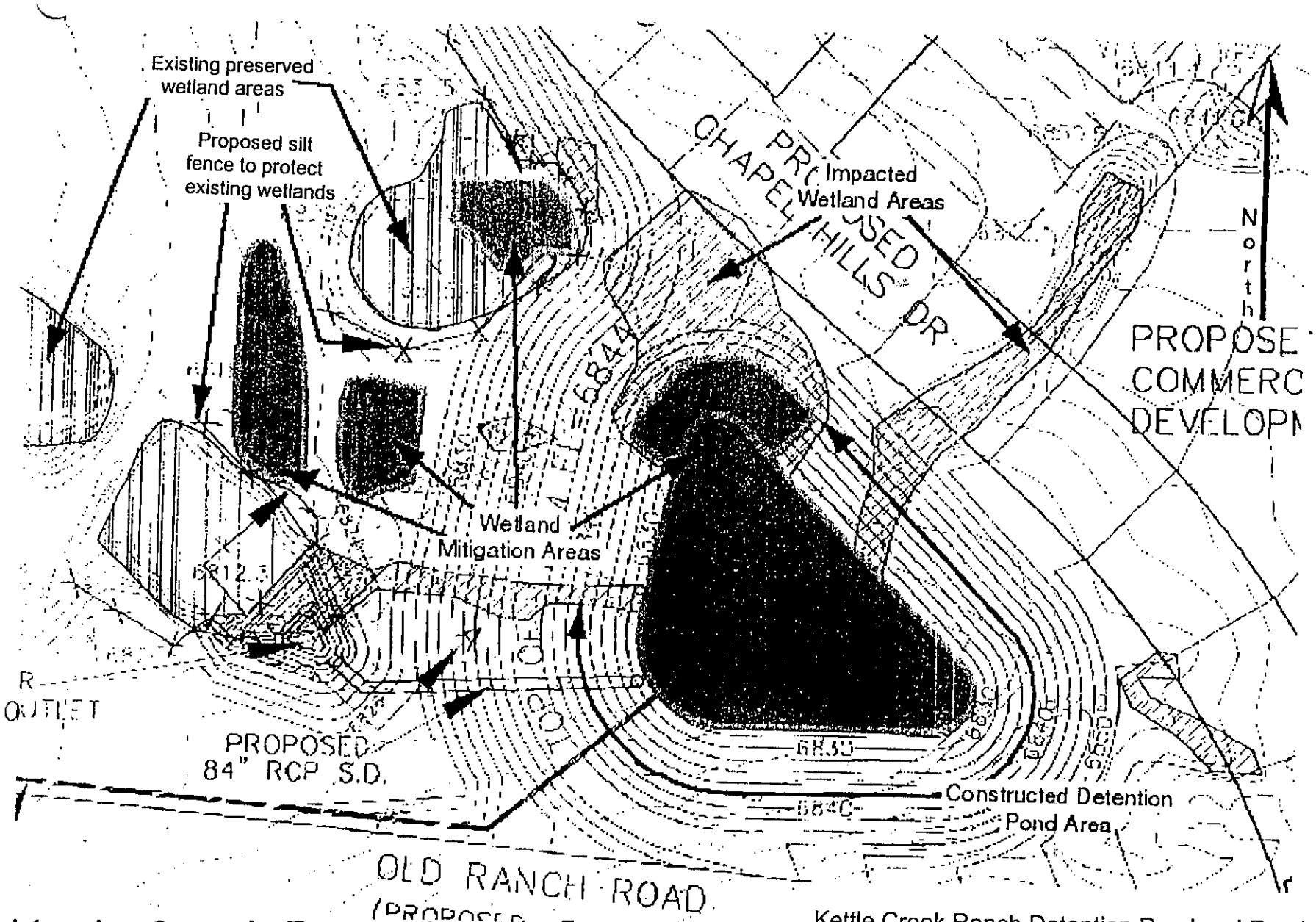
4310 ArrowsWest Drive • Colorado Springs, CO 80907
719-593-2593 • Fax 719-528-6610 • www.jrengineering.com



Kettle Creek Detention Pond Wetland Mitigation Area

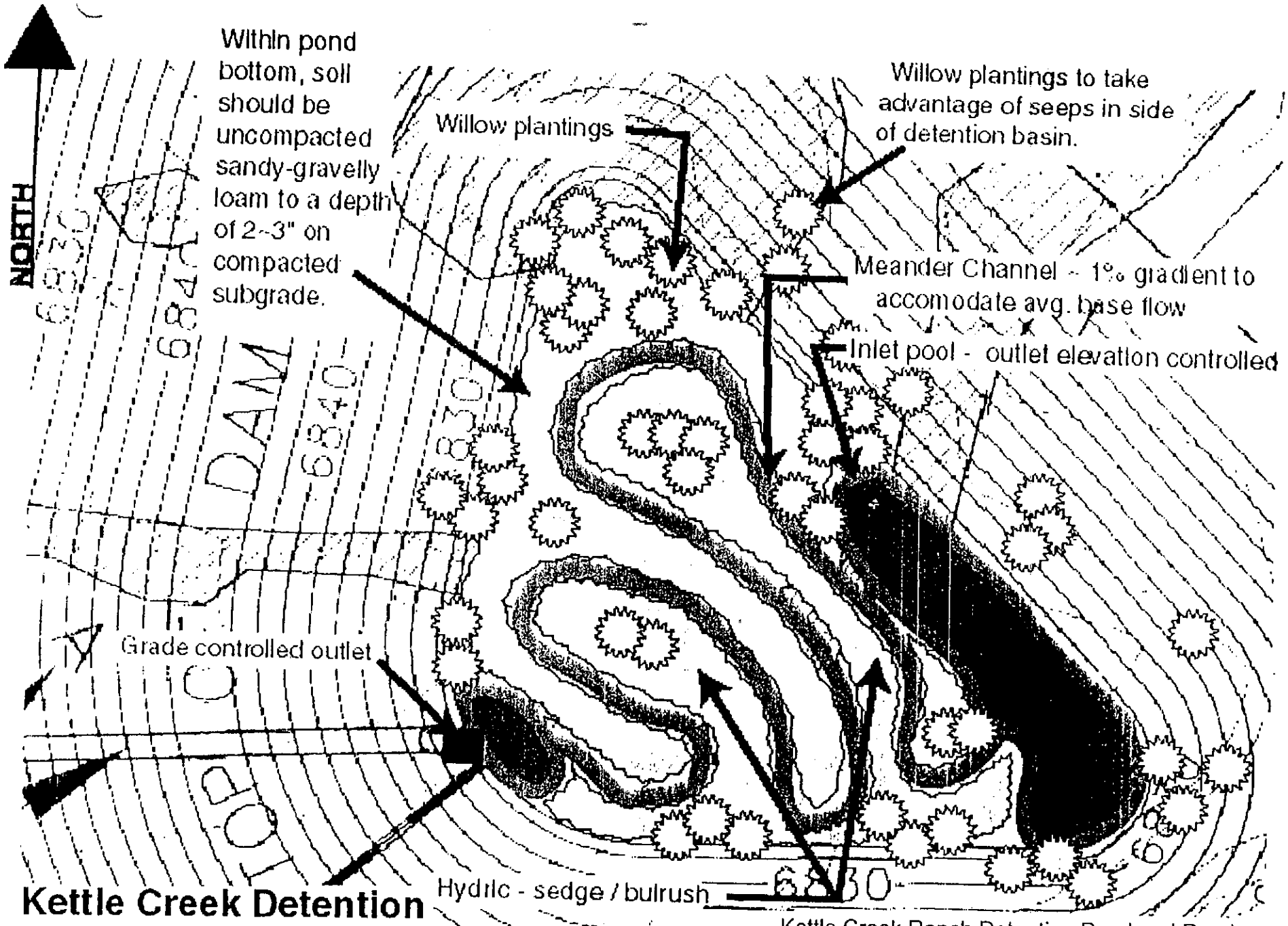
July 25, 2000 Scale 1 in. ~ 88 ft.

(ORIG.)

Kettle Creek Ranch Detention Pond and Road Construction in Kettle Creek, Colorado Springs, El Paso County, Colorado

Application by Vintage Companies
Application No. 2000 00535
Sheet 5 of 6

August 30, 2000



Kettle Creek Detention Pond Wetland Mitigation

July 13,2000 Scale 1"= 50ft

Kettle Creek Ranch Detention Pond and Road Construction in Kettle Creek, Colorado Springs, El Paso County, Colorado
Application by Vintage Companies
Application No. 2000 00535

Certification of Compliance with Department of the Army Permit

Permit Number: 2000 00535

Name of Permittee: **Vintage Companies**

Date of Issuance: **March 20, 2001**

Upon completion of the activity authorized by this permit, sign this certification and return it to the following address:

Anita Culp
Albuquerque District, Corps of Engineers
Southern Colorado Regulatory Office
720 North Main Street, Suite 205
Pueblo, Colorado 81003-3046

Please note that your permitted activity is subject to a compliance inspection by an Army Corps of Engineers representative. If you fail to comply with this permit you are subject to permit suspension, modification, or revocation.

Please enclose photographs showing the completed project (if available).

I hereby certify that the work authorized by the above referenced permit has been completed in accordance with the terms and conditions of the said permit.

_____
Signature of Permittee

Date Work Started _____

Date Work Completed _____