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NORTHGATE MASTER DEVELOPMENT DRAINAGE PLAN

(BLACK SQUIRREL CREEK AND MISCELLANEOUS BASINS)

NOVEMBER, 1988
(Revision)
MAY, 1989
AUGUST, 1989

URS
CONSULTANTS
MAKING
TECHNOLOGY
WORK

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URS Consultants Project No. 48239

BLACK SQUIRREL CREEK AND MISCELLANEOUS BASINS DRAINAGE PLAN

TABLE OF CONTENTS **Page**

BLACK SQUIRREL CREEK AND MISCELLANEOUS BASINS DRAINAGE PLAN

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/County 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.

Bryan T. Law, P.E. Colorado No. 25043

COLORADO REGISTERED BRYAN T. LAW 25043 PROFESSIONAL ENGINEER

Developer's Statement:

The Developer has read and will comply with all of the requirements specified in this drainage report and plan.

The Olive Company

BY: ____________

TITLE: Development Manager

Date: 2/28/90

City of Colorado Springs:

Filed in accordance with Section 15-3-906 of the Code of the City of Colorado Springs, 1980, as amended.

City Engineer ____________ Date 4/6/90

*SUBJECT TO ANY ADDITIONAL REQUIREMENTS OF THE U.S. AIRFORCE ACADEMY, THE COLORADO DEPARTMENT OF HIGHWAYS, THE ARMY CORPS OF ENGINEERS AND EL PASO COUNTY.

*SUBJECT TO ALL FINAL DESIGN REQUIREMENTS.

BLACK SQUIRREL CREEK AND MISCELLANEOUS BASINS DRAINAGE PLAN

LIST OF TABLES

LIST OF FIGURES

BLACK SQUIRREL CREEK AND MISCELLANEOUS BASINS DRAINAGE PLAN

I. PURPOSE AND SCOPE

The purpose of this Master Development Drainage Plan (MDDP) is to identify all major drainageways and facilities within the Northgate Master Plan. This plan includes the area lying within the Black Squirrel Creek Drainage Basin and the Miscellaneous Drainage Basin to the south. This report is intended to show location and approximate sizes for major facilities. It also provides a guide to the drainage patterns for initial systems.

The Northgate development is located in the northern outskirts of the City of Colorado Springs and El Paso County. The development generally lies between Interstate 25 on the west, Northgate Road on the north and State Highway 83 on the east and south.

The Northgate development lies within five major drainage basins, Black Squirrel Creek, Middle Tributary, Monument Branch, Smith Creek and Miscellaneous. Except for the Smith Creek Basin, all of the other basins have approved Drainage Basin Planning Studies (DBPS). This report will exclude those areas within Middle Tributary, Monument Branch and Smith Creek Basins. Drainage reports have been approved and submitted for limited roadway construction in the Black Squirrel Creek Basin. A Master Development Drainage Plan has been submitted and approved for the Northgate Development within Middle Tributary and Monument Branch Basins. Smith Creek Basin is not considered since there is no approved Drainage Basin Planning Study. The majority of the basins are not currently developed.

This report evaluates the present conditions of the major channels along with providing recommendations for future fully developed conditions. The overall plan is considered to be the most compatible with projected land use and environmental concerns and conforms to the above mentioned Drainage Basin Planning Studies, as well as the City of Colorado Springs/El Paso County Drainage Criteria Manual (October, 1987).

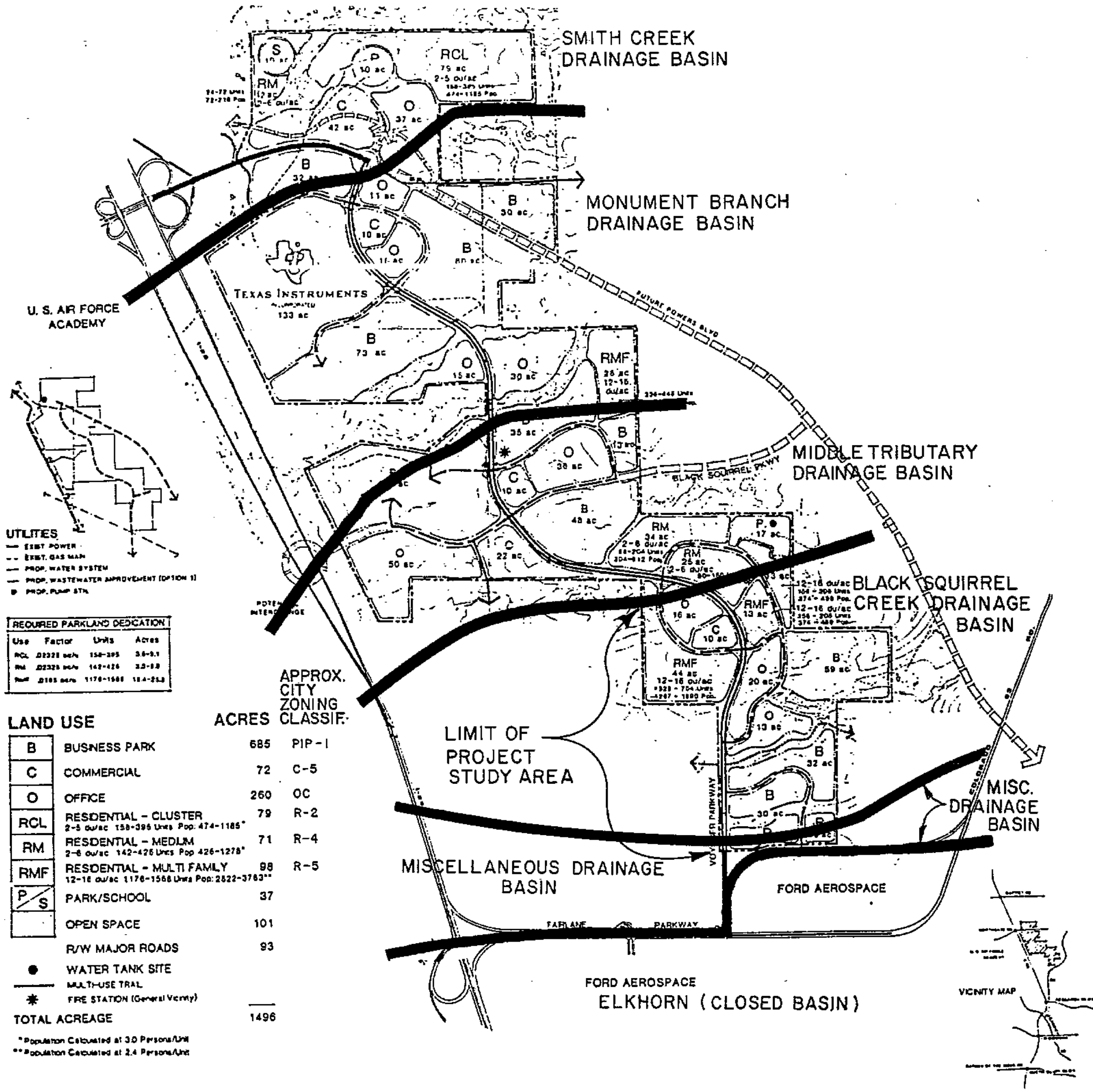
II. PROJECT AREA DESCRIPTION

The Project Study Area encompasses those areas of the Northgate Development within Black Squirrel Creek and Miscellaneous Basins, as shown on Figure 3 (attached). The development generally slopes from east to west and outfalls onto the Air Force Academy property at Interstate 25. The development is located in Township 12 south, Range 66 west, Sections 6, 7, 8, 16, 17, and 18 of the 6th Principal Meridian.

The total development area considered consists of 299 acres and lies within the City of Colorado Springs, in the Black Squirrel Creek (279 acres) and Miscellaneous (20 acres) Drainage Basins. Major road locations planned within the basin were obtained from the approved Northgate Land Use Plan, Figure 1. Presently, Voyager Parkway and Jet Stream Drive exist within the Project Study Area.

The area within the Northgate development was assumed to be developed per the mixed land use presented on the Northgate Land Use Plan.

LAND USE PLAN



NORTHGATE

THE OLIVE COMPANY

THE PLANNING CENTER

FIGURE 1

III. GEOLOGY AND SOILS

Soil and land use characteristics directly affect the relationship between rainfall and runoff within a basin. The U. S. Soil Conservation Service classifies soils into four hydrologic groups (A, B, C and D) according to a soil's runoff potential. Group A soils exhibit high infiltration rates when thoroughly wetted and are considered to have low runoff potential. Group B soils exhibit moderate infiltration rates when thoroughly wetted. Group C soils exhibit slow infiltration rates when thoroughly wetted. Group D soils exhibit very slow infiltration rates when thoroughly wetted and are considered to have high runoff potential.

Soil types within the Northgate Development are listed in Table 1 and delineated in Figure 2. Approximately 95 percent of the Development consists of hydrologic soil group B soils with the remaining five percent consisting of group A soils.

The soil types within the Development also influence the potential site locations for reservoirs. All of the soils within the Development are well drained. In addition, soils types 68, 69 and 93 have potential problems with low strength and many require importation of suitable fill material and/or excavation below the natural ground surface. All of the soils are expected to have moderate potential for frost action.

In addition, a preliminary geological and geotechnical investigation was performed by Geotechnical Consultants, Inc. Their study is included in Appendix B for reference. The recommendations made in the geotechnical report were adhered to in the design recommendations included in this Master Development Drainage Plan.

TABLE 1

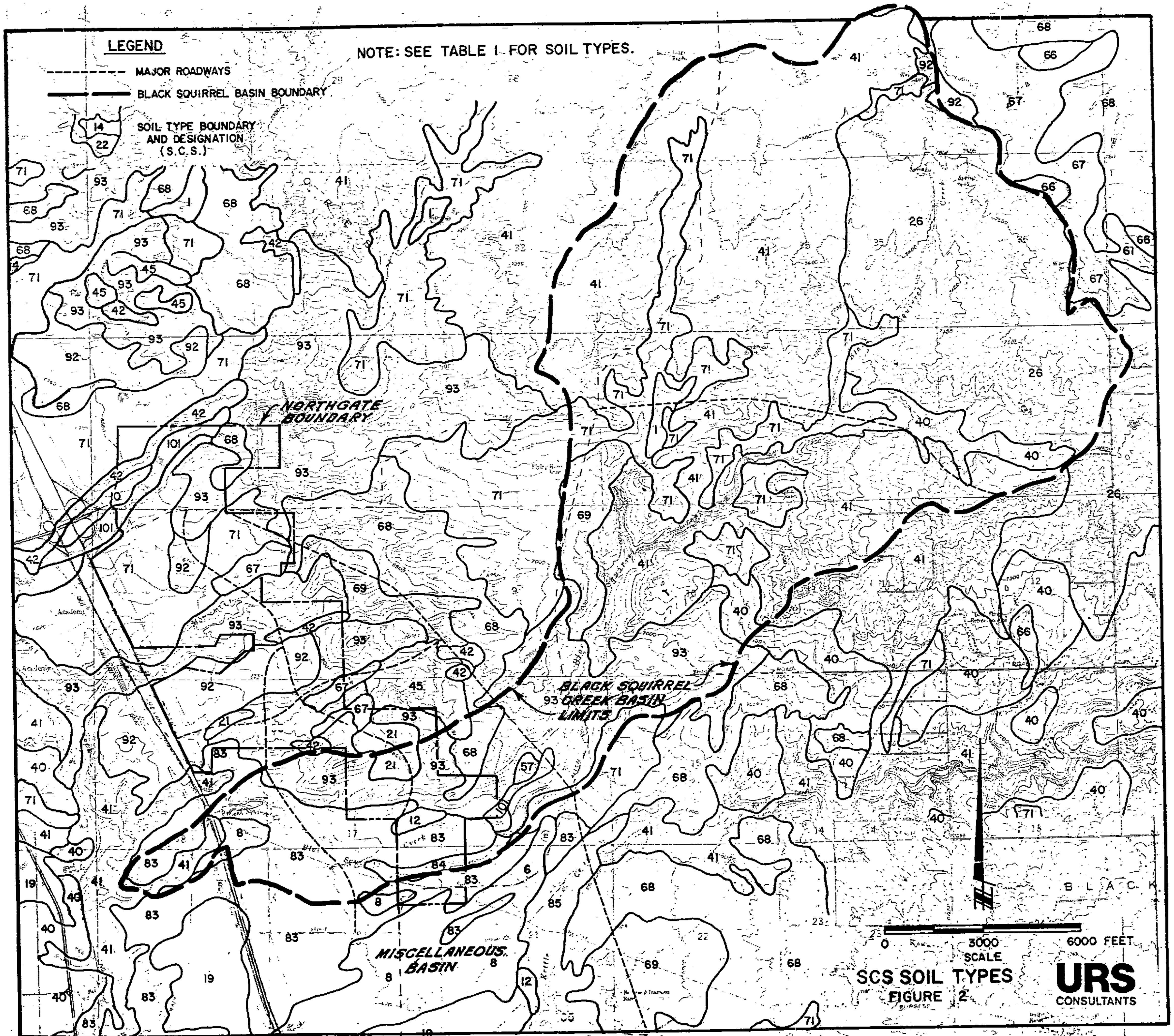
SOIL TYPES

BLACK SQUIRREL CREEK BASIN

Soil Identification Number	Soil Name	Slope %	Hydrologic Soil Group
1	Alamosa Loam	1-3	C
8*	Blakeland Loamy Sand	1-9	A
10	Blendon Sandy Loam	0-3	B
12*	Bresser Sandy Loam	3-5	B
21*	Cruckton Sandy Loam	1-9	B
26	Elbeth Sandy Loam	8-15	B
40	Kettle Gravelly Loamy Sand	3-8	B
41	Kettle Gravelly Loamy Sand	8-40	B
57	Neville Fine Sandy Loam	3-9	B
67	Peyton Sandy Loam	5-9	B
68*	Peyton-Pring Complex	3-8	B
69	Peyton-Pring Complex	8-15	B
71	Pring Coarse Sandy Loam	3-8	B
83*	Stapleton Sandy Loam	3-8	B
84*	Stapleton Sandy Loam	8-15	B
93*	Tomah-Crowfoot Loamy Sands	8-15	B
101*	Ustic Torrifluvents, Loamy	----	B

* Soil types within the Northgate limits and the Black Squirrel Creek/Miscellaneous Basin

Source: Soil Survey of El Paso County Area Colorado
U.S. Soil Conservation Service
June 1981



SCS SOIL TYPES
FIGURE 2

IV. EXISTING DRAINAGE FACILITIES

Currently, major drainage facilities downstream of the development and onsite are constructed at the following locations:

1) Double horseshoe-shaped culverts at old railroad grade (AT&SF)
2) Concrete bridge at Interstate 25
3) Reinforced box culvert at Voyager Parkway

The above mentioned structures are all of adequate size to pass the historic flows.

Field reconnaissance of the "stockpond" reservoirs, downstream of the Development, found that there was no embankment protection or emergency spillways. The "stockpond" reservoirs will have to be removed as required by the Black Squirrel Creek DBPS or evaluated, upgraded and incorporated into a revised Basin Study. For the purpose of this report, all "stockponds" were neglected. However, future site specific studies must incorporate the applicable city, county, state and federal regulations into their design considerations.

The remainder of the existing drainage facilities in the study area consist of storm sewer in Voyager Parkway and Jet Stream Drive. All of the existing drainage channels within the development are natural with no improvements.

Historic conditions for the Northgate Development were taken as present (1988) conditions. Figure 3 (attached) delineates the historic drainage basins and the Federal Emergency Management Agency (FEMA) 100-year floodplain through the Development. (Refer to FEMA map, panel number 080060 0040 B dated December 18, 1986). Tables 3 to 5 show flows locally and regionally for historic and developed conditions. It should be noted that the hydrology does not take into account any "stockponds".

BLACK SQUIRREL CREEK AND MISCELLANEOUS BASINS DRAINAGE PLAN

The following discusses design points and reaches along the major channel(s) for present conditions. All flow data is from the associated Drainage Basin Planning Studies. Refer to the design points and reaches of Figure 3. Cross sections were obtained through field reconnaissance and USGS Quadrangle Maps.

Soils information was obtained from the Soil Survey of El Paso County, Colorado. The historic 100-year 24-hour storm flows are discussed since they are larger than the historic 100-year 2-hour storm.

Design point 8 is located at the west boundary of the Northgate property. Also, a newly constructed (14' x 14') x 10' CBC with an improved inlet is located here (Voyager Parkway). Though this culvert was sized based on data generated from the original Black Squirrel Creek Master Drainage Plan report (Qdev = 4346 cfs), its capacity is more than adequate under the plan recommendations of the report (Qdev = 3779 cfs). The change in developed flow is due to a modification in the detention concept, as flows are now being detained and released at a lower discharge level than previously assumed. The channel for Black Squirrel Creek becomes a broad, shallow channel upstream of this point. The 100-year 24-hour historic flow at this point is 4051 cfs and the 10-year 24-hour flow is 1129 cfs.

The Black Squirrel Creek channel (Reach 1) length through Northgate is approximately 2500 feet. A box culvert has been constructed in the channel at the west property line to convey flows under Voyager Parkway, reducing the net length of channel requiring improvements to approximately 2150 feet. The existing channel is a broad-bottomed stream with a bottom width varying from approximately 100 feet at the east property line to 200 feet just upstream of the box culvert at the west property line. The majority of the reach has an existing width in the 130 to 150-foot range. The overall stream gradient through Northgate is 1.36%. The channel is essentially a bare sandy bottom at the west end with increasing wetlands vegetative cover towards the east property line (upstream). The vegetation is indicative of typical wetlands consisting of grasses, cattails, some small scattered willows in the center portion, and larger willows clustered near the east property line. Figure 4 in Appendix A is the existing plan view indicating the location of the willows and wetlands limits, and the pattern of the channel vegetative cover. The existing channel banks have an average height of 6 to 10 feet with sideslopes varying from nearly vertical in limited areas to typically 2H:1V. The site geology is discussed in detail in the geotechnical report presented in Appendix B, along with the maximum permissible velocities which can occur along the existing channel banks before degradation of channel banks begins.

The normal base flow is minimal and does not flow in a defined channel, but rather through a braided flow pattern. The depth of flow does not normally cover the entire bottom, and varies from a few inches to less than an inch over the various braided flow segments. Currently, base flows are depositing sands and silts along the channel bottom. Under present conditions, the 100-year 24-hour and 10-year 24-hour storm events are estimated to result in flows of 4,051 cfs and 1129 cfs, respectively. The 100-year storm event would result in velocities ranging from approximately 4 to 7 fps. Continued erosion would be expected to occur during these storm events under existing conditions. Additionally, significant erosion is currently taking place as a result of overland flows dropping into the channel. Continued erosion from overland flows can also be expected unless measures are taken to control the entry points of these flows.

The existing 100-year flood plain, as identified by FEMA, scales to be approximately 200 feet wide through the Northgate Development. The flood plain width, with the proposed improvement, will vary from 180 to 240 feet. Due to the additional fill placed in the floodplain, a letter of Map Revisions and a conditional letter will be required based on FEMA Conditions and Criteria for Map Revision. Map Revisions are needed to reflect new information which is supplemental to the original FIS analyses. The approximate FEMA Flood Plain boundary is shown in Figure 4 (Appendix A). Any change in wetland conditions would be subject to the 404 permit requirements per the U.S. Army Corps of Engineers.

V. HYDROLOGY

Determining runoff needs to consider the affects of many different variables. In the absence of a reliable historic record of rainfall, runoff, and other pertinent variables, it is usually necessary to use a synthetic unit hydrograph method to determine the runoff that will occur for a given rainfall event. The SCS method of determining peak flood flows and hydrographs was used to estimate direct runoff for basins in excess of 100 acres. For an explanation of the procedures used, see the "SCS National Engineering Handbook, Section 4". Due to the number of computations necessary to determine the hydrographs and hydrologic routing of the given storm events, the calculations for the main channel were performed with the aid of the TR-20 computer program. Summary sheets for the TR-20 computer runs are included in Appendix C of this report.

For this study the City of Colorado Springs/El Paso County Drainage Criteria Manual was predominately used. For this report, the major facilities were assumed to begin at points where the contributing area is greater than 100 acres. The design peak flow shall be the greater of the peak flows determined for the 100 year 24 hour storm and the 100 year 2 hour storm. In all cases the 24 hour event produced greater peak flows as determined in the corresponding Drainage Basin Planning Studies.

Design of minor facilities (contributing area less than 100 acres) shall be for the 10 year storm in both El Paso County and the City of Colorado Springs. Flows for subbasins shall be calculated using the Rational Method. Minor facilities shall be designed and planned to integrate with the major drainage system to provide overflow capability for major storms. The intent of 100 year overflow provisions are to safely and economically direct 100 year flow from points of concentration and to safely convey runoff without causing property damage or erosion. The onsite drainage basin boundaries were determined from the topographic maps produced by Analytical Surveys, Inc. The subbasin boundaries, design points, and flows for fully developed conditions are shown on Figure 3 (attached).

The hydrologic soil groups were then determined for each subbasin. For historic (present) conditions, a weighted curve number was determined for each subbasin based on soil types, type of cover, and taking into account presently platted areas. For future developed conditions, a weighted curve number was determined based on soil types, type of cover, and taking into account projected development.

As the calculations proceed downstream, the hydrograph was routed through each subsequent reach and combined with local inflow to produce a composite hydrograph at each design point. Hydrologic channel routing was performed by inputting flow vs. area vs. elevation for a representative cross section for each reach. The TR-20 computer program uses the Modified Att-Kin routing method for each reach based on the cross section entered. For detention ponds, the hydrologic reservoir routing was performed by inputting outflow vs. storage vs. elevations, for an assumed reservoir and outlet size. These variables were modified by trial and error until the desired volume of the reservoir and peak outflow were obtained. Peak flows for historic and developed conditions were taken from the Black Squirrel Creek DBPS and summarized in Table 5 and in Table 6 for the detention ponds.

The rainfall depths of 3.0 and 4.6 inches were obtained from isopluvials for the project area for the 10-year 24-hour and 100-year 24-hour storm events, respectively. Table 2 shows the dimensionless precipitation distribution for the SCS Type 11A storm. The rainfall depths of 2.1 and 3.0 inches were obtained from the "Areawide Urban Runoff Control Manual" for the 10-year 2-hour and 100-year 2-hour storm events, respectively. (AMCII was used for the

24-hour storm and AMCIII was used for the 2-hour storm). Intensity curves for the Rational Method were obtained from the City/County drainage criteria manuals.

TABLE 2

BLACK SQUIRREL CREEK
MASTER DEVELOPMENT DRAINAGE PLAN
RAINFALL DISTRIBUTION

24-HOUR STORM – IIA		2-HOUR STORM – IIA		
TIME (hrs)	DISTRIBUTION	TIME (min)	10 YEAR DISTRIBUTION	100 YEAR DISTRIBUTION
0.0	0.000	0	0.000	0.000
1.0	0.005	5	0.017	0.009
2.0	0.012	10	0.049	0.035
3.0	0.021	15	0.120	0.074
4.0	0.032	20	0.250	0.144
5.0	0.060	25	0.466	0.265
6.0	0.700	30	0.570	0.481
7.0	0.780	35	0.618	0.602
8.0	0.820	40	0.655	0.671
9.0	0.840	45	0.688	0.725
10.0	0.860	50	0.716	0.768
11.0	0.875	55	0.743	0.803
12.0	0.890	60	0.771	0.837
13.0	0.905	65	0.799	0.872
14.0	0.918	70	0.826	0.889
15.0	0.930	75	0.854	0.907
16.0	0.940	80	0.876	0.917
17.0	0.950	85	0.892	0.927
18.0	0.960	90	0.908	0.938
19.0	0.970	95	0.925	0.948
20.0	0.980	100	0.941	0.958
21.0	0.985	105	0.958	0.969
22.0	0.990	110	0.974	0.979
23.0	0.995	115	0.989	0.990
24.0	1.000	120	1.000	1.000

TABLE 3

BLACK SQUIRREL CREEK
MASTER DEVELOPMENT DRAINAGE PLAN
HISTORIC SUBBASIN HYDROLOGY

DESIGN POINT	SUBBASIN NO.	AREA (acres)	C-10	C-100	Tc (min)	Q-10 (cfs)	Q-100 (cfs)
BLACK SQUIRREL CREEK BASIN							
	A1	42	0.25	0.35	45	22	47
	A2-1	26	0.25	0.35	27	19	40
	A2-2	14	0.25	0.35	27	10	22
2	A3	14	0.25	0.35	25	11	23
	A4-1	61	0.25	0.35	30	41	87
	A4-2	7	0.25	0.35	15	7	14
	A5	11	0.25	0.35	41	6	13
	A6	40	0.25	0.35	29	28	59
	A7	3	0.25	0.35	48	2	3
	A8	47	0.25	0.35	40	27	58
	A9-1	11	0.25	0.35	32	7	15
	A9-2	3	0.25	0.35	27	2	5
9	A6,A7,A8,C3	98	0.25	0.35	50	49	103
10	A9-1,A9-2	14	0.25	0.35	32	9	20
MISCELLANEOUS BASIN							
	B1-1	12	0.25	0.35	45	6	12
	B1-2	8	0.25	0.35	45	4	9
6	B1-1,B1-2,C1	42	0.25	0.35	45	22	50
OFFSITE							
5	C1	22	0.25	0.35	18	20	42
4	C2	20	0.25	0.35	12	21	46
7	C3	8	0.25	0.35	18	7	15

Note: These runoff calculations are based on the Rational Method. Calculations for Design Points 1, 3, and 8 are not included, as flows were taken from the Black Squirrel Creek DBPS (November, 1988), and were calculated using TR-20 computer model.

TABLE 4

BLACK SQUIRREL CREEK
MASTER DEVELOPMENT DRAINAGE PLAN
DEVELOPED SUBBASIN HYDROLOGY

DESIGN POINT	SUBBASIN NO.	AREA (acres)	C-10	C-100	Tc (min)	Q-10 (cfs)	Q-100 (cfs)
BLACK SQUIRREL CREEK BASIN							
	A1	42	0.72	0.80	17	112	188
	A2-1	26	0.72	0.80	15	73	123
	A2-2	14	0.72	0.80	15	39	66
2	A3	14	0.72	0.80	9	48	81
	A4-1	61	0.72	0.80	14	176	293
	A4-2	7	0.72	0.80	7	26	45
	A5	11	0.72	0.80	7	41	70
	A6	40	0.72	0.80	15	112	189
	A7	3	0.72	0.80	3	13	22
	A8	47	0.72	0.80	12	142	244
	A9-1	11	0.72	0.80	12	33	57
	A9-2	3	0.72	0.80	7	11	19
9	A6,A7,A8,C3	98	0.72	0.80	20	240	400
10	A9-1,A9-2	14	0.72	0.80	12	44	76
MISCELLANEOUS BASIN							
	B1-1	12	0.72	0.80	17	32	54
	B1-2	8	0.72	0.80	13	24	40
6	B1-1,B1-2,C1	42	0.72	0.80	17	112	188
OFFSITE							
5	C1	22	0.72	0.80	18	57	95
4	C2	20	0.72	0.80	9	69	115
7	C3	8	0.72	0.80	8	29	48

Note: These runoff calculations are based on the Rational Method. Calculations for Design Points 1, 3, and 8 are not included, as flows were taken from the Black Squirrel Creek DBPS (November, 1988), and were calculated using TR-20 computer model.

TABLE 5

BLACK SQUIRREL CREEK
MASTER DEVELOPMENT DRAINAGE PLAN
DESIGN PEAK FLOWS FOR
PRESENT AND RECOMMENDED CONDITIONS

	PRESENT CONDITIONS		RECOMMENDED CONDITIONS		
DESIGN POINT	10-YR (cfs)	100-YR (cfs)	10-YR (cfs)	100-YR (cfs)	
1 *	1142	4220	1142	3597	
2 +	11	23	48	81	←(See Note 4)
3 *	164	185	164	183	← (Detained-Peak Flow
4 +	21	46	69	115	Undetained = 410 cfs)
5 +	20	42	20	42	
6 +	22	50	22	50	← (Detained-See Table 4 for
7 +	7	15	29	48	Undetained Flow)
8 *	1129	4051	1129	3779	
9 +	49	103	240	400	←(See Note 4)
10 +	9	20	44	76	←(See Note 4)

Notes: 1) Design points are taken from Figure 3.

2) Present conditions include routed flows without existing "stockponds" or proposed detention facilities. Present conditions are assumed to represent historic conditions.

3) Recommended conditions include routed flows through proposed detention facilities.

4) For runoff leaving the site where recommended flows exceed historic (Design Points 2,6,9,10), temporary onsite detention facilities will be the responsibility of the developers that plat the land.

5) Design flows shown are for the ultimate buildout conditions as represented in the Black Squirrel Creek DBPS. Interim flows may be higher at certain locations along the main channel. (See historic flows, for example). Where facilities are to be constructed along the main channel, the design flow must be analyzed and accepted by the City or County at the preliminary and final drainage report level. All flows leaving the site must be at or below historic levels or downstream detention facilities and drainage easements will be required.

* Flows taken from the Black Squirrel Creek DBPS (November 1988), calculated using TR-20 computer model.

\+ Flows taken from this report (Tables 3 & 4), calculated using the Rational Method.

VI. PLANNING STUDY RECOMMENDATIONS

The overall recommendation of this drainage planning study is the use of sub-regional detention facilities in conjunction with partially lined and fully lined major drainage channels as shown on Figure 3 (attached). The plan should be used as a layout for future drainage facilities and take a natural regime approach to drainage. Channels should be designed to be stable under design flow conditions and still retain as many natural features as possible. This planning study incorporates the City of Colorado Springs/El Paso County Drainage Criteria Manual. Major and initial drainage systems, as described in this study, are reimbursable through the basin drainage fund. These facilities, ultimately, are to be publicly owned and maintained if located in an adequate drainage easement or road right-of-way, and meet all City design and construction standards.

Assumptions incorporated into this report are, 1) sub-regional off stream detention facilities are strategically placed within the study area for the purpose of reducing sub-regional developed runoff, 2) partially lined channels incorporating check structures are provided for the purpose of stabilizing and maintaining the natural character of the channel, and 3) fully lined channels are used where the natural channel is narrow and deep. The design of the channels shall be based on maximum allowable velocities, determined by soil characteristics.

The use of detention for this development is required due to the location of the U. S. Air Force Academy and Interstate 25 downstream of the development. Detention facilities are required to maintain storm runoff at or below historic levels at the Air Force Academy boundary and so that the capacities of existing Colorado Department of Highways structures at Interstate 25 are not exceeded. Sub-regional detention facilities in and around the development are shown on Figure 3 (attached). The facilities should be designed to detain the difference between the historic and developed peak flows for both the 10-year and the 100-year storm events. The bottom of the emergency spillway, in all cases, was assumed to be less than 10 feet high, thus, foregoing State Engineers jurisdiction. Inflow and outflow hydrographs for detention ponds are shown in the Technical Addendums for the Black Squirrel Creek DBPS. A summary of the peak flows for historic and developed conditions are shown on Tables 3 through 6. The sub-regional detention facilities will be publicly owned & maintained upon acceptance by the City and/or County. Any temporary on-site detention facilities which will be required prior to the construction of the permanent regional facilities will be privately owned and maintained.

Drainage facilities are designed and constructed according to the City/County Criteria Manual. Other possible requirements may be imposed through the Corps of Engineers 404 permit process and through the Flood Plain Administrator concerning current FEMA mapping, map revisions, and amendments in conjunction with the planning process. Additional costs associated with these processes have not been included here and are not reimbursable as part of this plan.

BLACK SQUIRREL CREEK BASIN

MAJOR CHANNEL SYSTEM

Reach 1 (Design Point 1 to Design Point 8)

The Black Squirrel Creek 100-year and 10-year peak flows entering Northgate (Design Point 1) under the ultimate developed basin conditions will be approximately equal to the 100-year and 10-year peak flow under present conditions due to planned (future) detention facilities upstream. However, channel improvement will be necessary since the portion of Black Squirrel Creek in Northgate, with a present slope of approximately 1.4%, is not currently in equilibrium. Additionally, these peak flows will be sustained for a longer period of time under developed conditions which, if the channel was left in its natural state, would result in a higher amount of erosion than under present conditions.

A plan view of the proposed improvements described below is shown in Appendix A on Figure 5. The overall design concept of the channel improvements herein is to present a park appearance that will be in harmony with natural features and planned development. This will consist of using natural channel alignment, natural channel bottom, and existing channel widths to the greatest extent possible. Buried channel checks will be utilized to prevent erosion of the bed during the larger storms. The channel sideslopes, for the most part, will be grass-covered with slopes varying from a minimum of 3H:1V to 10H:1V in order to enhance the aesthetics. The grassed slopes will be riprap with a soil/grass cover and will be maintained by the developer. In limited areas it is envisioned that the channel bank will be left in its natural state provided the formation competency and expected velocities are compatible and City drainage criteria is met. This will only be performed in areas that are felt to be visually attractive under their natural state. Overbank erosion will be the responsibility of the developer, and will be controlled by using a combination of landscaped berms, plantings, and swales or minor ditches along the top of the bank to direct runoff to controlled discharge points into the channel. A gravel-surfaced maintenance road is planned along the north bank that will also serve as a recreation trail, future sanitary sewer line access road, and also assist in directing overload flows to controlled discharge points (i.e. access roads to the channel's bottom). An additional access may be required along the south bank for maintenance and wetland conditions. Each aspect of the channel improvements is discussed in detail below.

Channel Alignment and Channel Bottom

The horizontal channel alignment will remain as natural as possible with all major bends and "bays" left intact - no major re-alignment is planned. During the 100-year storm event, and with the channel improvements outlined herein, maximum super elevation of the water surface occurring at any of the bends is expected to be approximately 0.8 feet at the sandstone outcrop near the east property line. The more typical super elevations will be in the 0.2 to 0.5 foot range. Bank protection at the bends will be extended for both freeboard and to account for super elevation, and at the toe to protect against potential scour associated with increased velocities at the outside of bends.

The proposed channel improvements will utilize the existing channel bottom and any construction activities in the channel bottom will be minimized. The existing channel bed slope of approximately 1.4% will be maintained and four buried channel check structures will be utilized to control bed erosion during the 100-year storm. The check structures will vary in height from 6 to 7 feet. Based on an equilibrium analysis of the creek during the 100-year storm (see Appendix A), degradation of the bed slope will occur until the equilibrium slope of approximately 0.25% is reached between check structures. When the final equilibrium state is reached, the check structure is, in effect, a drop structure. The channel will eventually aggrade back to the existing bed slope and the check structures will once again be buried. Channel check structures will be constructed of reinforced concrete, as illustrated in Figure 6. The last 450 feet immediately upstream of the box culvert (to the first check structure) will also use the existing channel bed slope since velocities from the 100-year and 10-year storm event will be reduced to less than 3 fps due to the backwater effects of the box culvert. Water surface profiles and velocities were determined by use of the HEC-2 computer program (see Black Squirrel Creek DBPS). A Mannings coefficient n of .04 was used based on the channel improvements. All channel improvements as described are subject to final design.

In order to minimize wetlands disturbance, this concept calls for leaving existing vegetation and willows in the channel bottom except for the minimal construction area required for the check structures. Massive channel regrading will not be performed. The degradation process which will occur during the 100-year storm (due to increased velocities) will be controlled by the check structures, as described above. Channel lining will be constructed to the 100-year flood level based upon the ultimate channel bed elevation. The depth of toe at these locations will be based on ultimate channel bed elevations. This should greatly reduce the potential of flows undercutting the channel lining. Figure 6 in Appendix A illustrates a typical cross-section of the proposed check structure. This concept would allow the wetlands vegetation to adjust and "rise" with the sedimentation process (following degradation from the 100-year storm). Additionally, the wetlands vegetation is aided by the existing braided flow pattern; therefore, to minimize wetlands disturbance and to promote wetlands vegetative growth, no trickle channel is planned.

Sideslope Protection

The developer intends for the majority of the channel to have buried riprap with a grass cover. Figure 3 in Appendix A shows a cross-section of the typical slope improvement proposed. The materials covering the riprap are not reimbursable and is the responsibility of the developer to provide aesthetic maintenance for this portion of the cross-section. The City would maintain the structural (rip rap, drop) portion of the channel. In limited areas, the existing rock outcrops will be left exposed, as approved by the City. The applicability and adequacy of this type of slope protection is discussed in detail in the geotechnical report found in Appendix B.

BLACK SQUIRREL CREEK AND MISCELLANEOUS BASINS DRAINAGE PLAN

A native seed mixture will be used to re-vegetate the buried portion of the slopes. The native seed mixture shown below are perennial grasses and legumes that will withstand the climatic conditions of the semi-arid upper Arkansas River Valley Basin.

Native Seed Mixture

Native Grasses	Application Rate lbs/acre	% of Mixture
Blue Grama	0.45	15
Little Bluestem	1.05	15
Side Oats Grama	2.70	30
Western Wheatgrass	2.80	20
Smooth Brome	2.60	20

The native grasses require approximately two years for proper establishment. The native grass seed mixture will be drilled and seeded to a depth of one inch. Hay mulch and fertilizer will be used to facilitate initial growth. The channel banks during the initial stages are highly susceptible to loss of seed and topsoil due to flooding events. To assure proper growth and reduce the risk of damage due to flooding, the channel lining will be installed before May 1st or after October 1st. In addition, a temporary watering system shall be installed and maintained by the developer to assure proper growth during establishment.

The median riprap size (D50), based on the expected velocities will be 6 to 9 inches. The City/County criteria does require burial of these sizes of riprap. If topsoil is lost over riprap, we anticipate it will be localized and would require minimal replacement of topsoil and native seed. Replacement would be the responsibility of the developer.

Rock outcrops will only be left in areas that can withstand the expected water velocities and which are visually attractive. Any seepage zones along the rock outcrops that are to be left in their natural state will be buttressed as recommended by the geotechnical engineer. Vertical drop-offs may require safety features for the public (handrail, etc.).

With the improved bank protection, the channel bottom widths will be extended approximately 10 feet. This should decrease mean channel velocities through the channel reach. Therefore, "buffer zones" or "set backs" are not needed and should not be required where acceptable channel lining is provided. An easement will be established to contain the channel and the access roads/trails.

Certain construction procedures will be specified to minimize wetlands disturbance and enhance aesthetics. Construction excavation for placement of the slope protection will begin at the existing toe (approximate limit of wetlands) and "pull back" the slope from that point (refer to Figure 7, Appendix A). This will result in the new toe of slope being set back from the existing toe from 1 to 5 feet. This approach will effectively widen the channel bottom helping to reduce velocities while at the same time greatly reducing excavation and filling in the existing wetlands. Other than this minor widening, the existing channel widths will be utilized throughout this reach.

The channel sideslopes will be varied gradually to create a rolling natural appearance, but the minimum slope used will be 3H:1V. Minor gully and bank alignment variations will be filled in and smoothed while significant "bays" will have erosion protection placed on the existing banks surrounding the bay area. All work shall be subject to COE 404 permit limitations. Any bank seeps encountered will have drains field-fitted as recommended in the geotechnical report (Appendix B). Slope protection will be extended upslope to the depth of the 100-year storm plus freeboard and superelevation requirements. Throughout most of the channel, the depth of flow is expected to be approximately 4.5 feet, resulting in a total slope protection depth of 6 to 7 feet above the ultimate channel bottom. The buried riprap will have a toe down depth of 4 feet below the existing channel bottom, or deeper as required by the scour characteristics. Following the 100-year storm event, the channel bottom will be up to four feet lower than the existing channel bottom at the downstream side of the check structures.

Currently, much of the erosion occurring along the banks is a result of overland flows "spilling" over the top of the banks. This type of erosion will be minimized by construction of landscaping berms and swales along the top of the banks that will direct flows to controlled discharge points. The controlled discharge points will consist of a drop inlet with a lateral pipe discharging onto the downstream end of the check structures. These control points would be installed concurrently with channel improvements. Site specific grading will dictate the number of drop inlets, but it is estimated that there will be 4 inlets per side. Over land flow velocities will additionally be reduced by the planting of trees and shrubs along the top of the banks and on the channel sideslopes above the 100-year floodplain limits. On-site erosion control measures for overland flows will also help in reducing velocities and will be required as development occurs.

Access Road/Recreational Trail

The maintenance road for the channel is proposed to be along the top of the north bank with access to the channel bottom achieved by ramps from the road at locations to be coordinated with the City. The road will be a 12-foot wide compacted gravel surface that will jointly serve as an access to the future sanitary sewer line proposed along the north bank, and as a recreational trail. The Colorado Springs Multi-Use Trails Master Plan Map indicates a minor trail, La Foret Trail, at this location. To enhance the aesthetic quality as a recreational trail, the conceptual design calls for the road to gently meander to and from the top of the bank within the easement set aside for the road. Tree planting along the north bank will be clustered on alternating sides of the trail to enhance the aesthetics. However, these plantings will not impede access to the channel. Maintenance of landscaping will be the responsibility of the developer. To facilitate the use of the road as an access for the future sanitary sewer line, the road will cross over the sewer line at the manhole locations. An additional access may be required along the south bank for maintenance and wetland conditions, but this will be determined at the time of final design.

Channel Maintenance/Acceptance Criteria

As discussed above, the channel banks will be lined with riprap, then buried and seeded through most of the channel reach (see Figure 5, Appendix A). Check structures will be utilized to control water velocities and erosion. A temporary, privately maintained water irrigation system will also be set up to facilitate growth and to reduce the time when the channel banks are highly susceptible to erosion.

Maintenance during the first year would be kept to a minimum by the developer. This will help for proper establishment. Grasses should not be mowed the first year. For the second and remaining years, in general, mowing and debris pick up should be performed a minimum of three times a season. Mowing height should be at least 6-inches. Mowing may be reduced or eliminated once native grasses are well established and potential of weeds crowding out grasses are minimal. Once the channel has met standard City acceptance criteria, the channel will be turned over to the City of Colorado Springs for operation and maintenance of the riprap and channel bottom portions of the reach. Maintenance of the grassed sideslopes and any other landscaping or aesthetic features will remain the responsibility of the developer or his assigns. Maintenance within the wetland areas may be required by the City per the 404 permitting requirements.

Reach 2 (Design Point 3 to Detention Pond 2)
This channel conveys a 100-year developed flow of approximately 285 cfs (Design Point 3) under ultimate conditions with detention facility number 1 in place and operating (see Figure 8). Thus, flows entering the site shall be at or below historic levels. Channel improvements will be necessary since this reach will undergo erosion if left in this natural state.

This report proposes a fully lined grouted riprap channel, 3 to 4 feet deep and an 8 foot bottom with 3 to 1 sideslopes. A maintenance road is also required to one side of the channel. A drainage easement of approximately 50 feet would be required for this type of facility. However, the actual type of facility and its location will depend on future site specific land use constraints. The final facility type shall be addressed at the preliminary and final drainage report level for this area.

Flows also enter the site from design points 4, 5 and 7 located along Northgate's eastern boundary. Flow at theses points are considered minor, due to the tributary area being less than 100 acres.

Developed flow from design point 4 is planned to be conveyed, via future facilities, to existing facilities in Jet Stream Drive. These future facilities shall be described and sized at the time of the preliminary and final drainage reports. Facilities in Jet Stream Drive and Voyager Parkway were sized for the 5 year event and therefore future drainage reports must consider how the 10 and 100-year events will be conveyed. It is anticipated that the existing 42", extending from the existing box culvert, may have to be diverted to Pond 3. This would allow detention of the smaller storms. 100-year flows would have to be diverted to Pond 3 by some overland provision, such as, roads, curb cuts (chase) and on-site grading.

Developed flow from design point 7 is planned to be conveyed to future downstream facilities located in Voyager Parkway. Conveyance facilities from design point 7 to the outfall in Voyager Parkway, shall be addressed at the preliminary and final drainage report level.

BLACK SQUIRREL CREEK AND MISCELLANEOUS BASINS DRAINAGE PLAN

MISCELLANEOUS BASIN

Developed flow from design point 5 is planned to be conveyed to a future facility in a planned future collector road (existing S.H. 83). These facilities shall be designed when State Highway 83 is abandoned and the collector is constructed. For cost estimate purposes conveyance facilities from design point 5 to design point 6 were estimated, as shown on Figure 3 and in Table 8.

All other developed flow within the Miscellaneous Basin in Northgate shall be detained to historic levels using onsite detention. Therefore, developed flow leaving the site at design point 6 shall be at or below historic levels. Design point 6 is anticipated to be an outfall point for the storm sewer in the future collector which ties into Voyager Parkway. Flows south of the Northgate boundary will be conveyed in the proposed storm sewer system within Fairlane Technology Park (see Master Subdivision Drainage Report Fairlane Technology Park, May 1986).

DETENTION FACILITIES (Sub-Regional)

Within the development are two detention facilities (2 and 3). Both are proposed to be offstream of Black Squirrel Creek. Other detention facilities shown (1 and 4) are located just offsite (within the County) and are also offstream of Black Squirrel Creek. See Figure 9 for a typical detention pond sketch.

The offsite detention facilities over-detain for some onsite areas and are required construction for this development. The proposed drainage areas tributary to each pond are listed in Table 6. Sketches are provided in Appendix A showing the areas detained (and undetained) by each pond. It is intended that all these facilities be constructed as proposed in the Black Squirrel Creek Drainage Basin Planning Study to maintain historic flow conditions downstream with the build-out of the Northgate Development. These sub-regional ponds are to be publically maintained upon acceptance by the City of Colorado Springs.

It shall be the responsibility of the developers that plat and develop land tributary (including over detained areas) to the proposed detention facility(s) to either have the permanent detention facility(s) affecting his site constructed or to construct temporary onsite detention facilities to maintain onsite developed flows to historic levels. (See Appendix A for agreement letter regarding the notification of property owners for Detention Pond construction requirements). The permanent facilities must have the ultimate outlet works constructed initially. However, the volume can be increased as development occurs until ultimate conditions are met. The temporary facility will not be accepted by the City or reimbursed, and must be maintained and operated privately. All partially constructed ponds must function to maintain the required historic discharge relative to the developed area. Acceptance will only occur once total ultimate construction of the facility is in place. Once the permanent detention facility(s) is constructed within the tributary area, temporary facility(s) must be abandoned so that the basin drainage system will operate as intended by the Drainage Basin Planning Study. These issues shall be addressed in the preliminary and final drainage reports for each developed site.

INITIAL DRAINAGE SYSTEM

Initial facilities exist within Voyager Parkway and Jet Stream Drive. Their costs are included in this report. Future facilities are designated as proposed facilities (within Voyager Parkway) or by arrows as shown on Figure 3. Figure 10 depicts conceptual minor system types that may be used where arrows are shown. These costs are also included. The initial system, if accepted by the City Engineer and constructed within public easements or rights-of-way, shall be reimbursable per City of Colorado Springs codes and regulations.

BLACK SQUIRREL CREEK AND MISCELLANEOUS BASINS DRAINAGE PLAN

SUMMARY

Tables 7 and 8 include a brief description of proposed improvements for each channel reach and detention pond. Figures in Appendix A represent conceptual details for typical drop structures, dam sections, and channels. Figure 3 shows the approximate right-of-way requirements for major facilities. All drainage improvements in the City that are in a public right-of-way shall be maintained by the City.

The Olive Company, per their annexation agreement, must maintain all public drainage facilities prior to August 13, 1990. After that date, the City of Colorado Springs shall be responsible for maintaining all public drainage facilities once the two year warranty period is met and the facilities are accepted by the City Engineer.

TABLE 6

BLACK SQUIRREL CREEK
MASTER DEVELOPMENT DRAINAGE PLAN
SUMMARY OF DETENTION FACILITIES
(SUB-REGIONAL)

POND NO.	LOCATION*	TYPE	100-YEAR PEAK INFLOW (cfs)	100-YEAR PEAK OUTFLOW (cfs)	100-YEAR PEAK HISTORIC (cfs)	SURFACE AREA (ac)	VOLUME (ac-ft)	DETAINED AREA MDDP Basin	DETAINED AREA Black Squirrel DBPS Basin
1	Des Pt 3	Offstream	410	183	185	1.7	12	Offsite	J1
2	Sub A4	Offstream	358	285	299	1.6	8	A4, Offsite	J1, J2
3	Sub A2	Offstream	333	148	148	1.2	9	A1, C2	J4
4	Des Pt 1	Offstream	233	92	106	1.1	7	A3, Offsite	I1

NOTE:

1) Subbasins A2-1, A2-2, C-3 & A5 through A9, under ultimate conditions, will be maintained to historic flows due to a delayed peak from upstream ponds. For these sub-basins and discharge points with runoff leaving the site where recommended flows exceed historic (Design Points 2,6,9 and 10), temporary onsite detention facilities will be required and will be the responsibility of the developers that plat the land, until permanent detention facilities are constructed.

2) Dual outlet will be required for 10 and 100-year discharge. Peak outflow for 10-year storm are as follows: Pond 1: Q10 = 85 cfs; Pond 2: Q10 = 76 cfs; Pond 3: Q10 = 74 cfs; Pond 4: Q10 = 68 cfs.
Additional 10-year storm design data to be provided at time of final review of ponds.

* Subbasins refered to in the "location" column are taken from the Black Squirrel Creek DBPS.

VII. FINANCIAL SECTION

Shown in Tables 7 and 8 are estimated construction and land costs for all proposed major and initial system drainage improvements (public) affecting the Northgate Development, as reflected in the associated Basin Planning Studies. The facilities are broken out between the Black Squirrel Creek and Miscellaneous Basins for onsite and offsite. Land costs for detention facilities are based on current park land costs of $14,000 per acre. Bridge costs (the box culvert on Voyager Parkway) are subject to reimbursement by the City of Colorado Springs.

These costs only reflect buildout within the Northgate Development. Other cost considerations for development upstream of Northgate which might require additional detention and major channel facilities are not included. Downstream facilities may not be required by this development if developed flows are either detained (or overdetained) to maintain historic flows at the west boundary or if onsite temporary detention is used. Where historic rates are exceeded downstream of the Northgate development, public drainage easements will also be required to convey the flow to a detention or channel facility.

TABLE 7

BLACK SQUIRREL CREEK
MASTER DEVELOPMENT DRAINAGE PLAN
ESTIMATED DRAINAGE IMPROVEMENT COSTS
(PUBLIC, REIMBURSABLE)

DESIGN POINT	REACH	DESIGN FLOW (cfs)	IMPROVEMENT	COMMENT	QTY.	UNIT	UNIT ($)	AREA (ac)	ESTIMATED 1989 CONSTRUCTION COSTS: DRAINAGE CONSTRUCTION COST ($)	DRAINAGE LAND COST ($)	BRIDGE COST ($)
BLACK SQUIRREL CREEK BASIN											
ONSITE FACILITIES -											
-	1	3779	150'-250'x 4'-5' PLC	-	2150	LF	90		193,500		
			CHECKS	-	4	EA	30,000		120,000		
-	2	358	8'x 3' FLC	-	3000	LF	75		225,000		
8	-	3779	(14'x 14') x 10' CBC	VOYAGER PKWY	220	LF	1,345				295,900
			DETENTION POND #2	8 ac-ft	1	LS	72,000	1.6	72,000	22,400	
			DETENTION POND #3	9 ac-ft	1	LS	81,000	1.2	81,000	16,800	
				MAJOR SYSTEM SUBTOTALS					691,500	39,200	295,900
				INITIAL SYSTEM SUBTOTALS					666,050	n/a	n/a
				(SEE TABLE 8) BLACK SQUIRREL CREEK ONSITE TOTALS					1,357,550	39,200	295,900
OFFSITE FACILITIES -											
			DETENTION POND #1	12 ac-ft	1	LS	108,000	1.7	108,000	23,800	
			DETENTION POND #4	7 ac-ft	1	LS	63,000	1.1	63,000	15,400	
				MAJOR SYSTEM SUBTOTALS					171,000	39,200	0
				INITIAL SYSTEM SUBTOTALS					n/a	n/a	n/a
				BLACK SQUIRREL CREEK OFFSITE TOTALS					171,000	39,200	0
				BLACK SQUIRREL CREEK BASIN TOTALS					1,528,550	78,400	295,900
MISCELLANEOUS BASIN											
There are no major system facilities considered in the Miscellaneous basin. All facilities considered are onsite.											
				MAJOR SYSTEM SUBTOTALS					0	0	0
				INITIAL SYSTEM SUBTOTALS					194,450		
				(SEE TABLE 8) MISCELLANEOUS BASIN TOTALS					194,450	0	0
				BSC & MISC SUBTOTALS					1,723,000	78,400	295,900
				CONSTRUCTION CONTINGENCY 5%					86,150		14,795
				ENGINEERING 10%					180,915		31,070
				GRAND TOTAL					$1,990,065	$78,400	$341,765

Notes: 1) Detention Land Area Cost/Acre = $14,000

TABLE 8

BLACK SQUIRREL CREEK
MASTER DEVELOPMENT DRAINAGE PLAN
ESTIMATED INITIAL SYSTEM COSTS
(REIMBURSABLE)

IMPROVEMENT	QUANTITY	UNIT	UNIT ($)	DRAINAGE CONSTRUCTION COST ($)
BLACK SQUIRREL CREEK BASIN				
18" RCP	700	LF	$48	$33,600
24" RCP	850	LF	61	51,850
30" RCP	3,100	LF	76	235,600
36" RCP	2,200	LF	87	191,400
42" RCP	900	LF	104	93,600
INLETS	24	EA	2,500	60,000
	INITIAL SYSTEM SUBTOTAL			$666,050
MISCELLANEOUS BASIN				
18" RCP	50	LF	$48	$2,400
36" RCP	250	LF	87	21,750
Future 36" RCP	1900	LF	87	165,300
INLETS	2	EA	2,500	5,000
	INITIAL SYSTEM SUBTOTAL			$194,450

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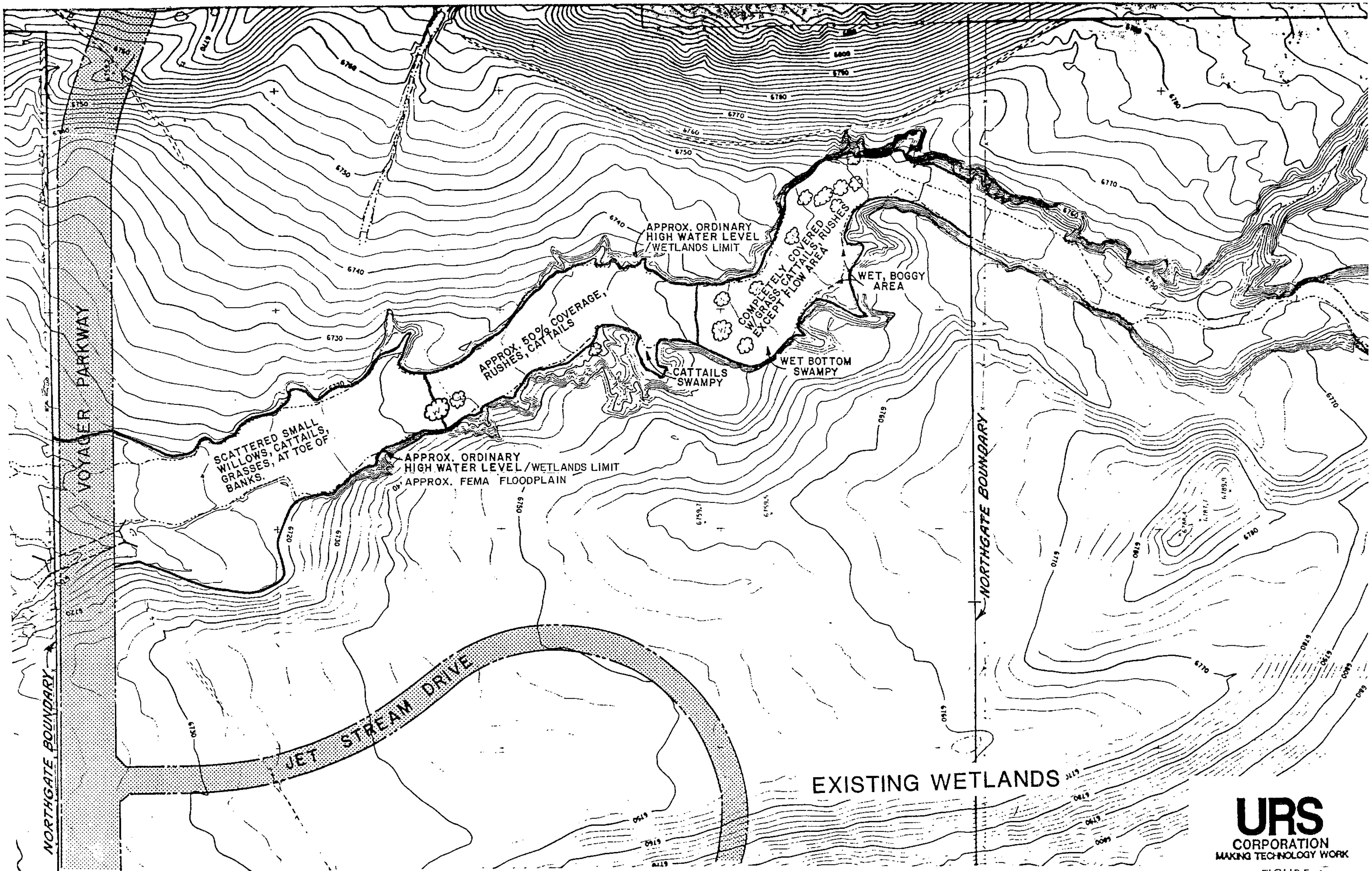
48239dra.rpt

BLACK SQUIRREL CREEK AND MISCELLANEOUS BASINS DRAINAGE PLAN

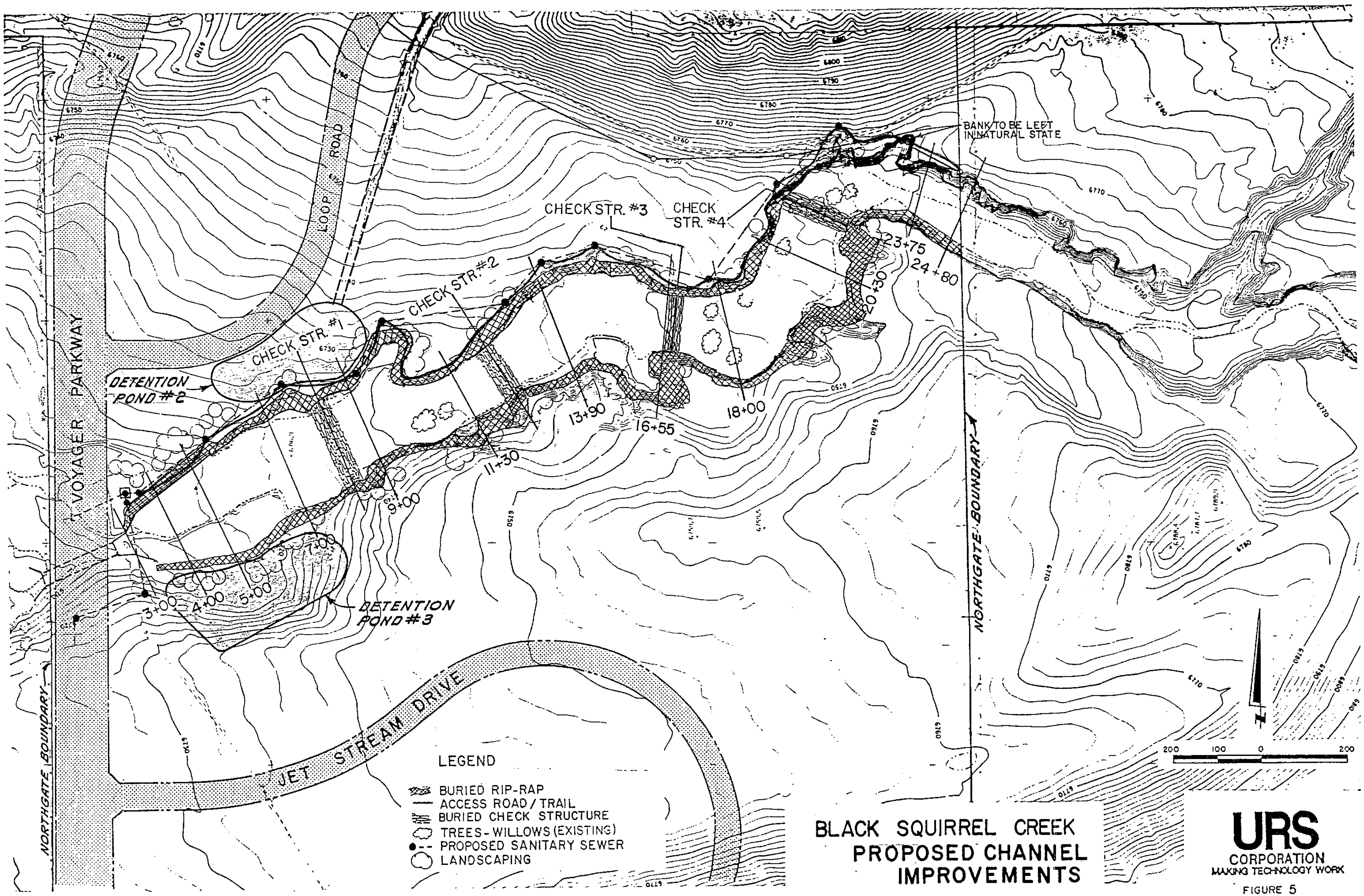
APPENDIX A: REPORT FIGURES, DETAILS AND MISCELLANEOUS CALCULATIONS



EXISTING WETLANDS

URS CORPORATION
MAKING TECHNOLOGY WORK

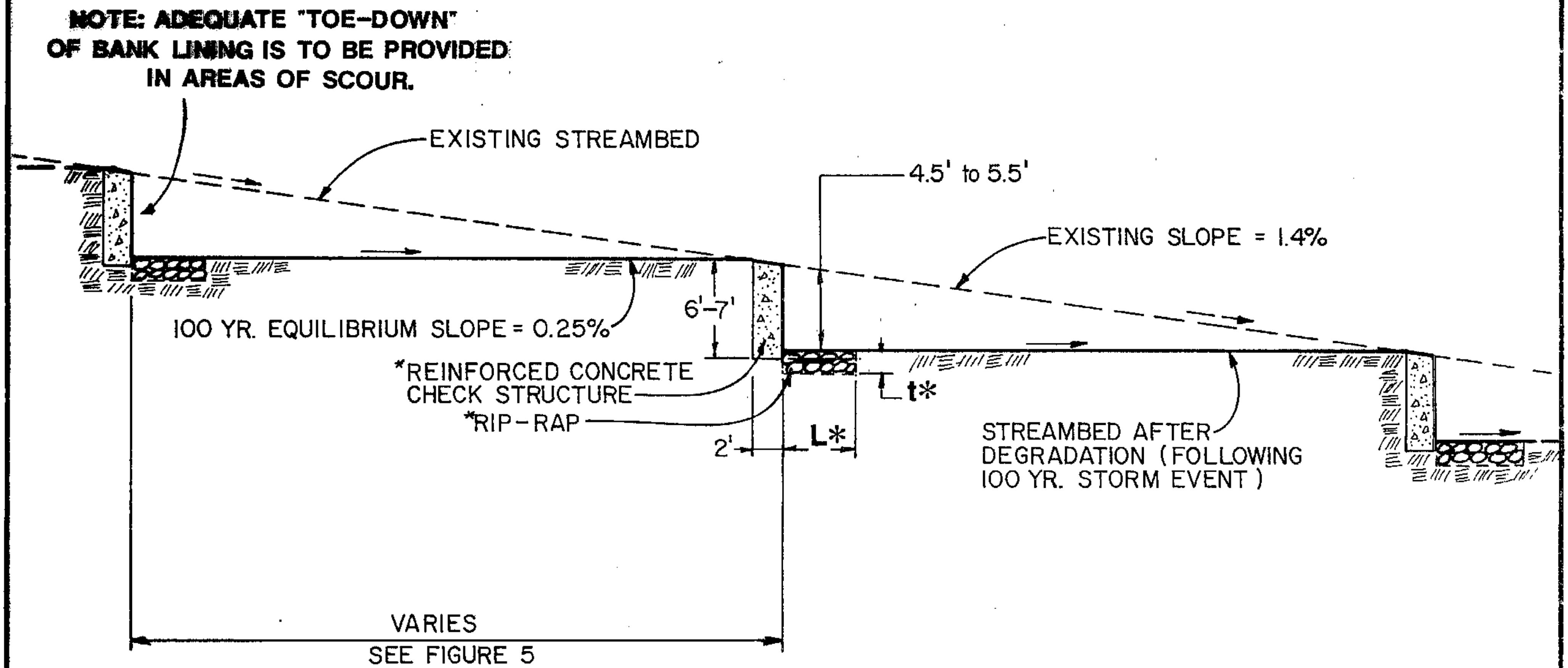
FIGURE 4



BLACK SQUIRREL CREEK
PROPOSED CHANNEL IMPROVEMENTS

URS CORPORATION
MAKING TECHNOLOGY WORK

FIGURE 5



CHECK STRUCTURE

TYPICAL SECTION

*SECTION IS SUBJECT TO FINAL DESIGN

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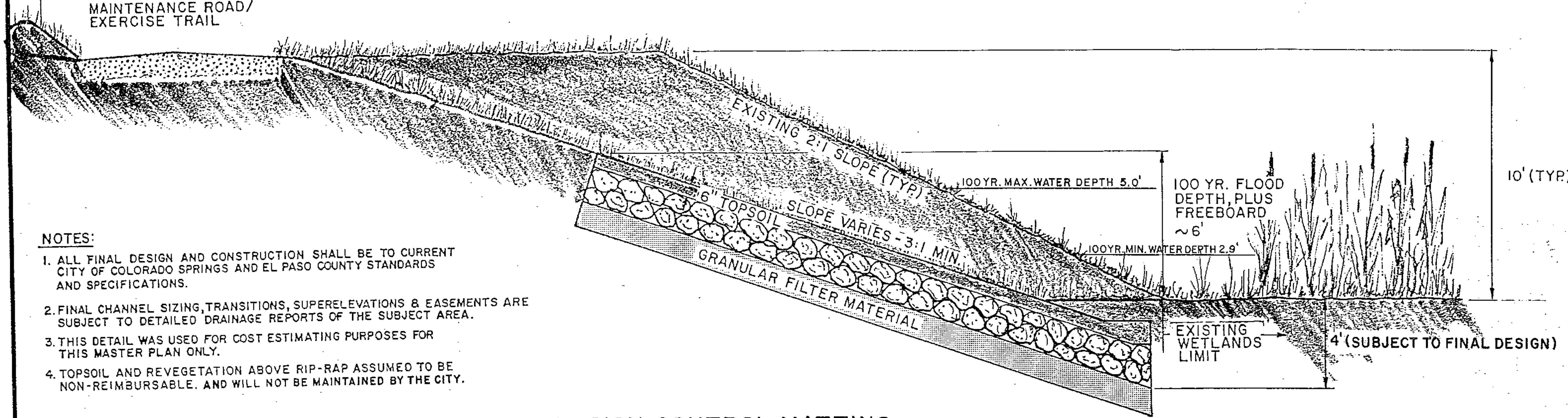
FIGURE 6

BURIED RIPRAP



NOTES:

1. ALL FINAL DESIGN AND CONSTRUCTION SHALL BE TO CURRENT CITY OF COLORADO SPRINGS AND EL PASO COUNTY STANDARDS AND SPECIFICATIONS.
2. FINAL CHANNEL SIZING, TRANSITIONS, SUPERELEVATIONS & EASEMENTS ARE SUBJECT TO DETAILED DRAINAGE REPORTS OF THE SUBJECT AREA.
3. THIS DETAIL WAS USED FOR COST ESTIMATING PURPOSES FOR THIS MASTER PLAN ONLY.
4. TOPSOIL AND REVEGETATION ABOVE RIP-RAP ASSUMED TO BE NON-REIMBURSABLE, AND WILL NOT BE MAINTAINED BY THE CITY.

EROSION CONTROL MATTING

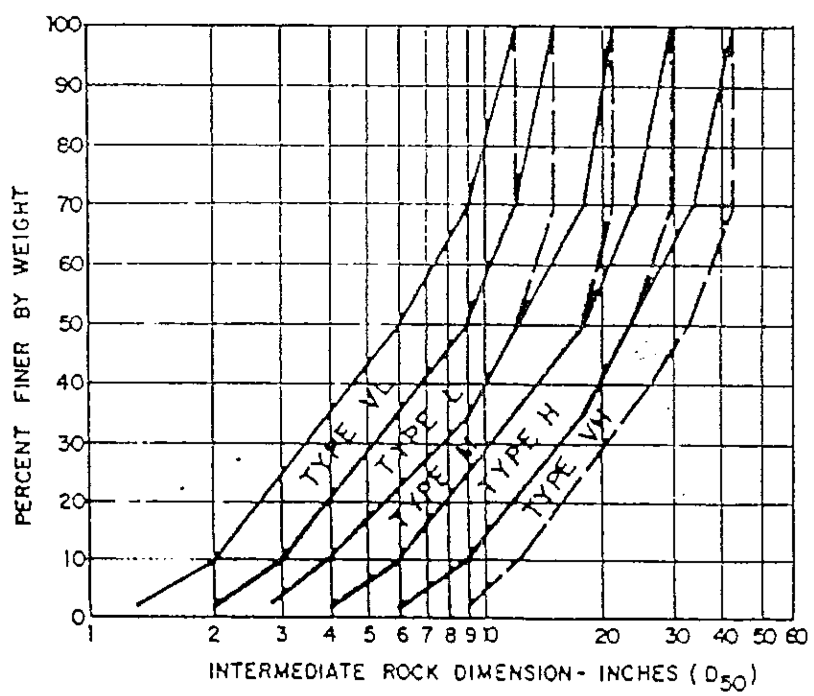
RIPRAP REQUIREMENTS FOR CHANNEL LININGS **

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

* Use S_s = 2.5 unless the source of rock and its densities are known at the time of design.

** Table valid only for Froude number of 0.8 or less and side slopes no steeper than 2h:1v.

*** Type VL and L riprap shall be buried after placement to reduce vandalism.



GRADATION OF ORDINARY RIPRAP

SOURCE: URBAN DRAINAGE & FLOOD CONTROL DISTRICT, DRAINAGE CRITERIA MANUAL

PARTIALLY LINED CHANNEL
FIGURE 7

URS
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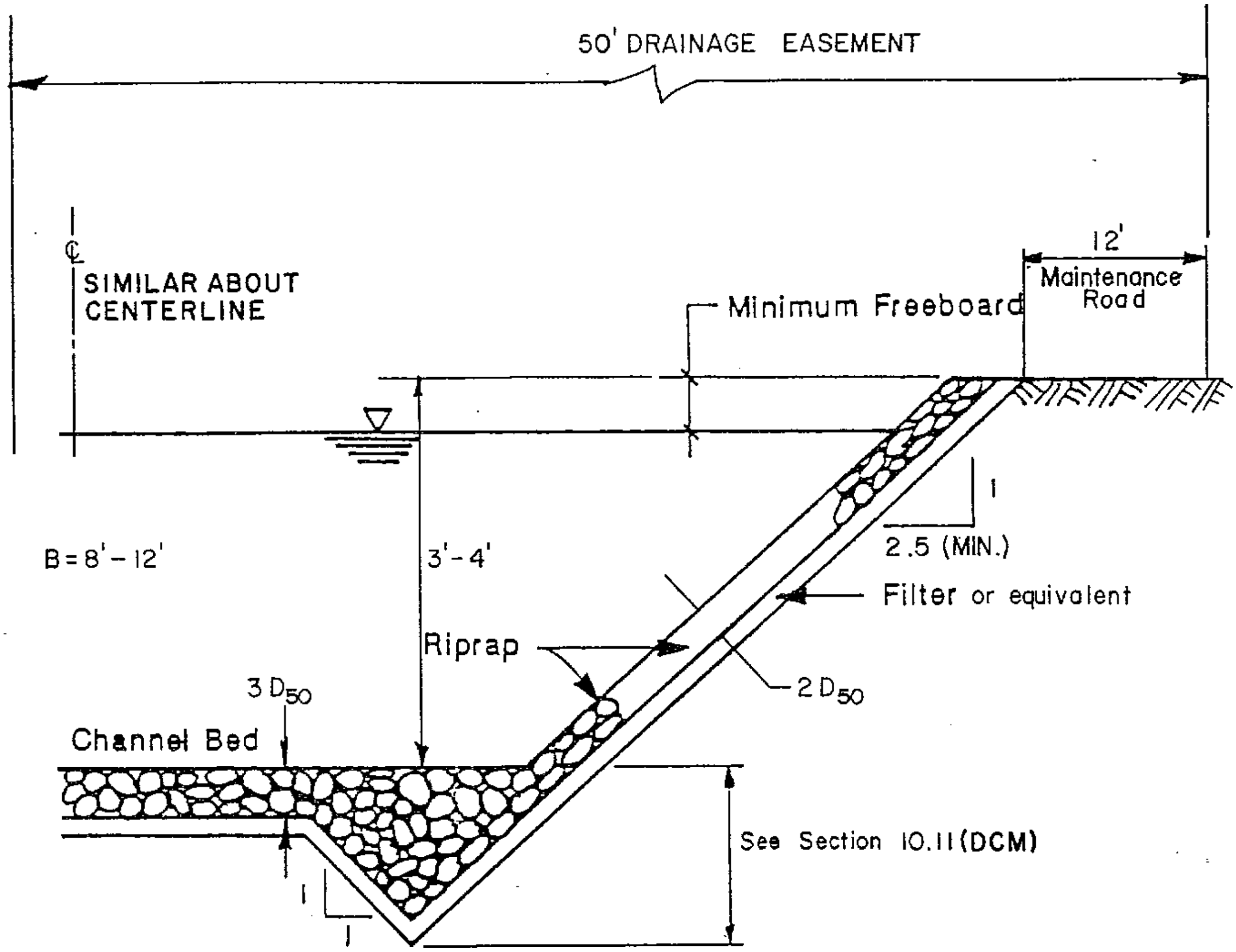
FIGURE 7



Reference : Urban Drainage & Flood Control District, Urban Storm Drainage Criteria Manual, November 15, 1982.

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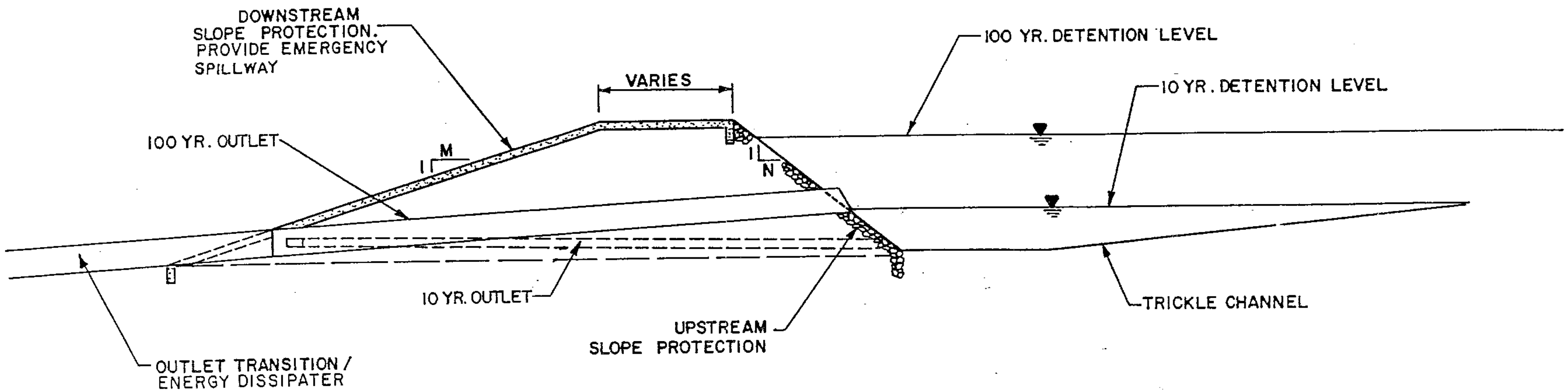
The City of Colorado Springs / El Paso County
Drainage Criteria Manual

Fully Lined — Grouted Ordinary Riprap Channel Section

Date: OCT. 1987

Figure 8



CONCEPTUAL DAM SECTION

NOT TO SCALE

NOTES:

1. THIS SECTION WAS USED FOR COST ESTIMATING PURPOSES (THIS STUDY ONLY).
2. M & N SUBJECT TO GEOTECHNICAL DESIGN.
3. ALL FINAL DESIGN AND CONSTRUCTION SHALL BE TO CURRENT CITY OF COLORADO SPRINGS, EL PASO COUNTY, AND STATE OF COLORADO SPECIFICATIONS WHERE APPLICABLE.
4. DUAL OUTLET REQUIRED FOR 10 & 100 YEAR DISCHARGE.
5. IF DETENTION FACILITY IS AGAINST ROADWAY EMBANKMENT, THEN A SPILLWAY/OVERFLOW STRUCTURE MUST BE PROVIDED BENEATH ROADWAY.

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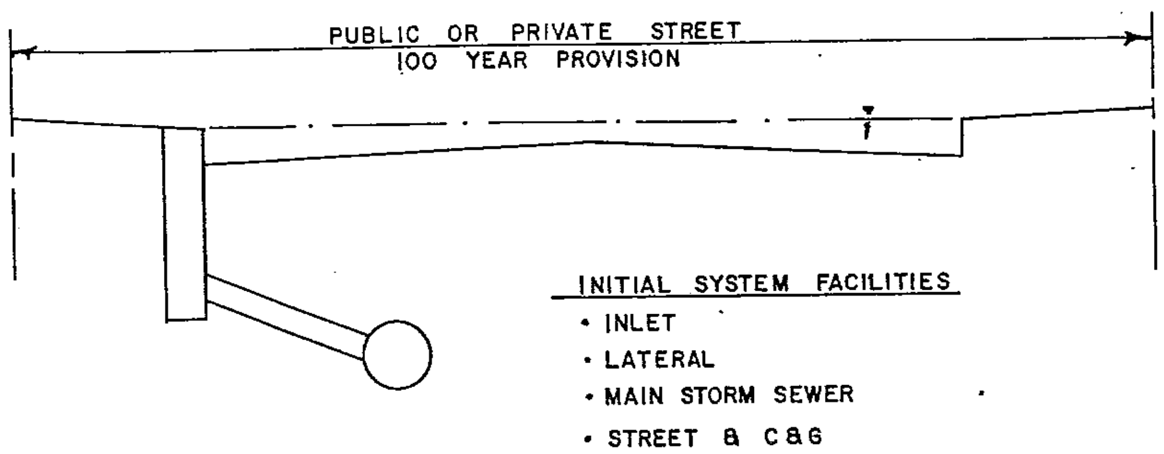
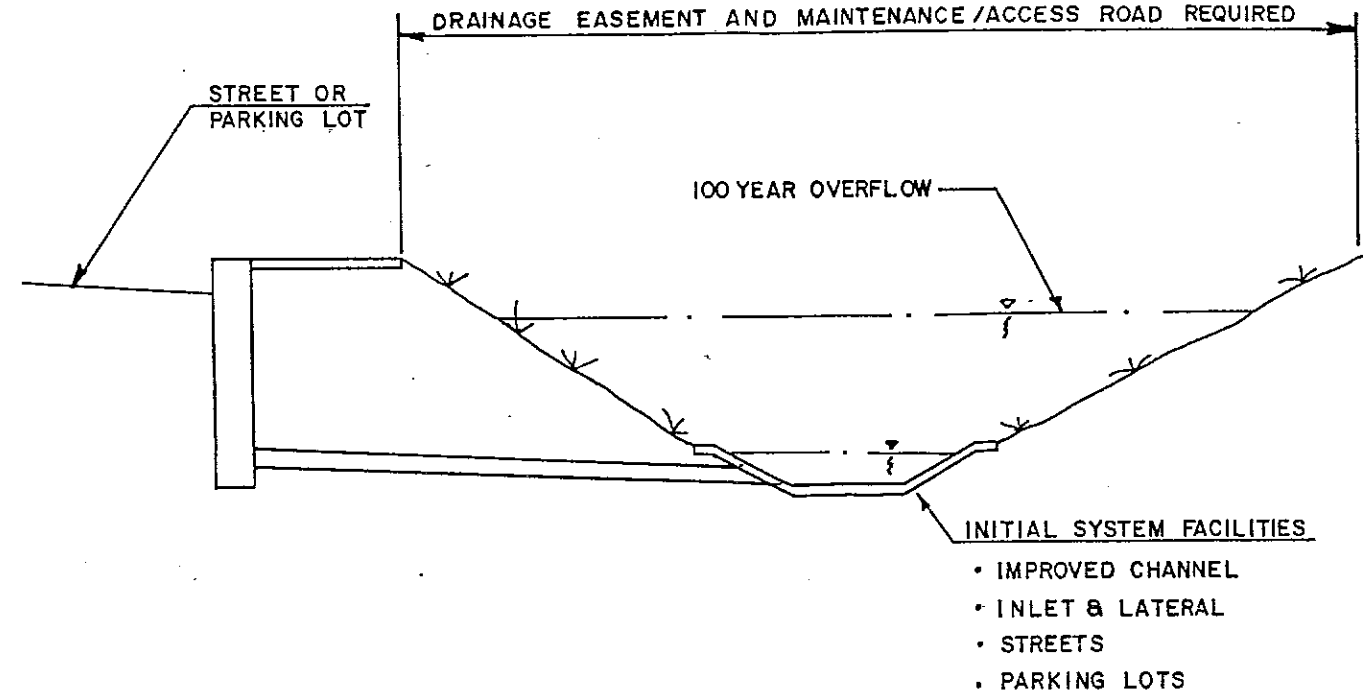
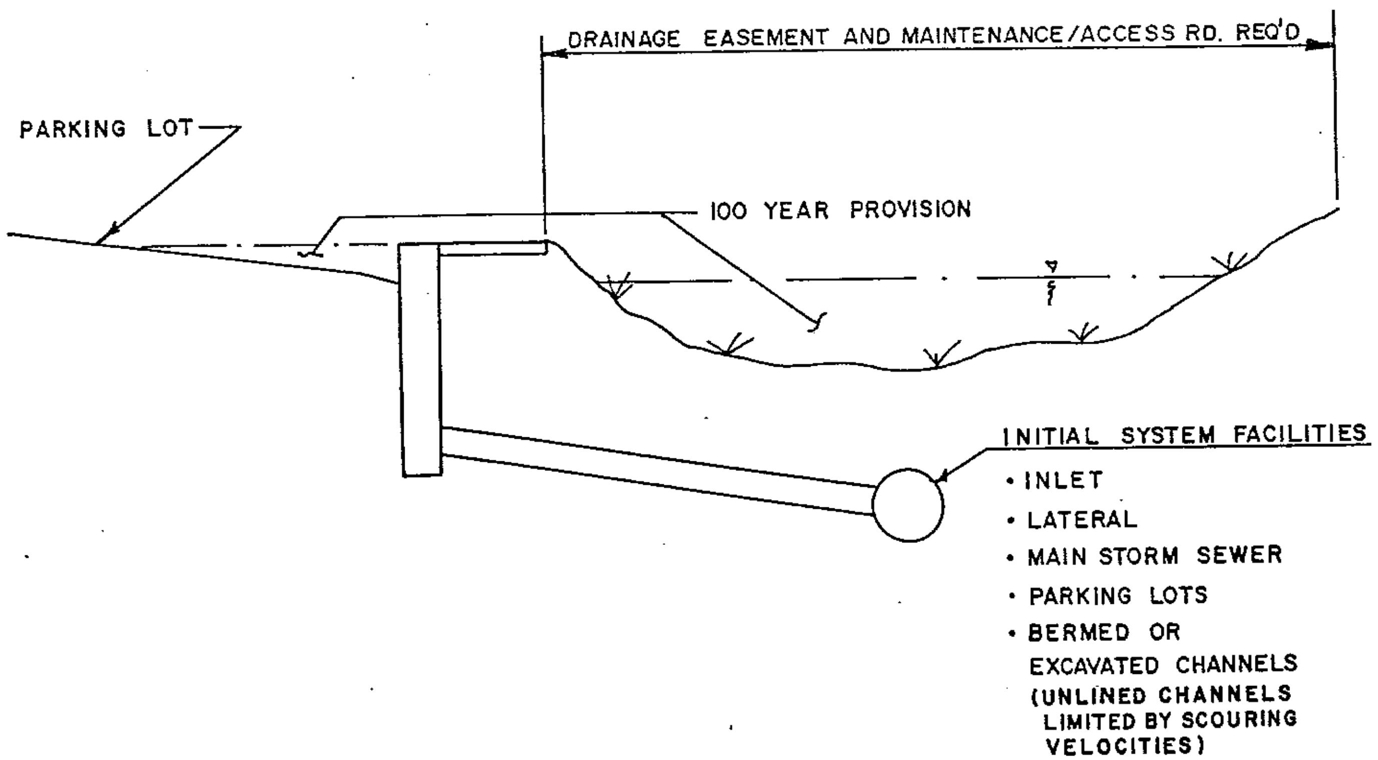
FIGURE 9

CONCEPTUAL
INITIAL SYSTEM DETAILS

NTS







NOTES:

1. ALL FINAL DESIGN AND CONSTRUCTION SHALL BE TO CURRENT CITY OF COLORADO SPRINGS AND EL PASO COUNTY STANDARDS AND SPECIFICATIONS.
2. ALL IMPROVEMENTS ON BASINS GREATER THAN 100 ACRES SHALL BE DESIGNED FOR THE 100-YR., 24-HR. STORM.
3. SUBJECT TO FINAL DESIGN & EASEMENT REQUIREMENTS.

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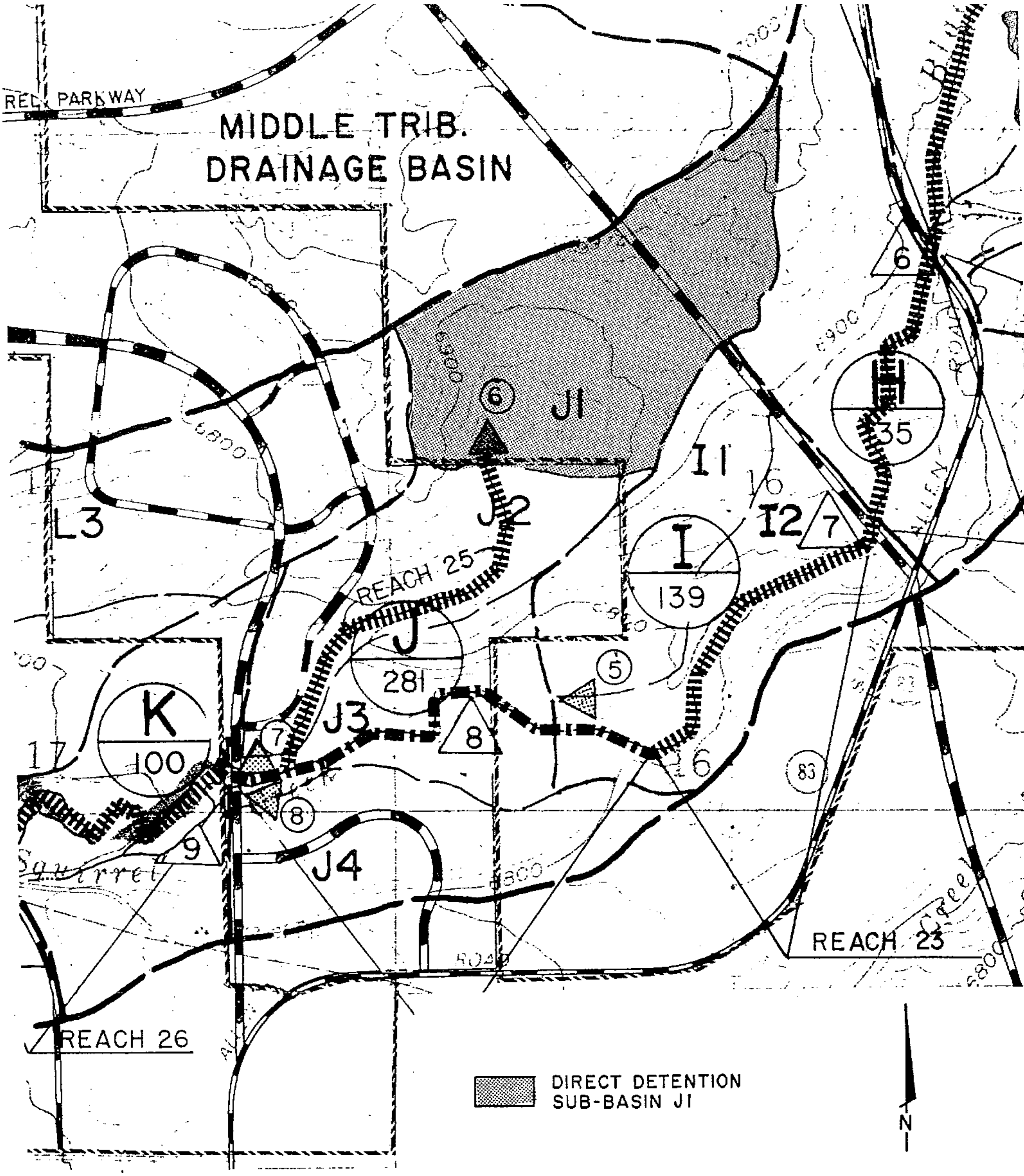
FIGURE 10



DETENTION POND I (MDDP)
DETENTION POND 6 (DBPS)

SCALE: 1" = 1000'

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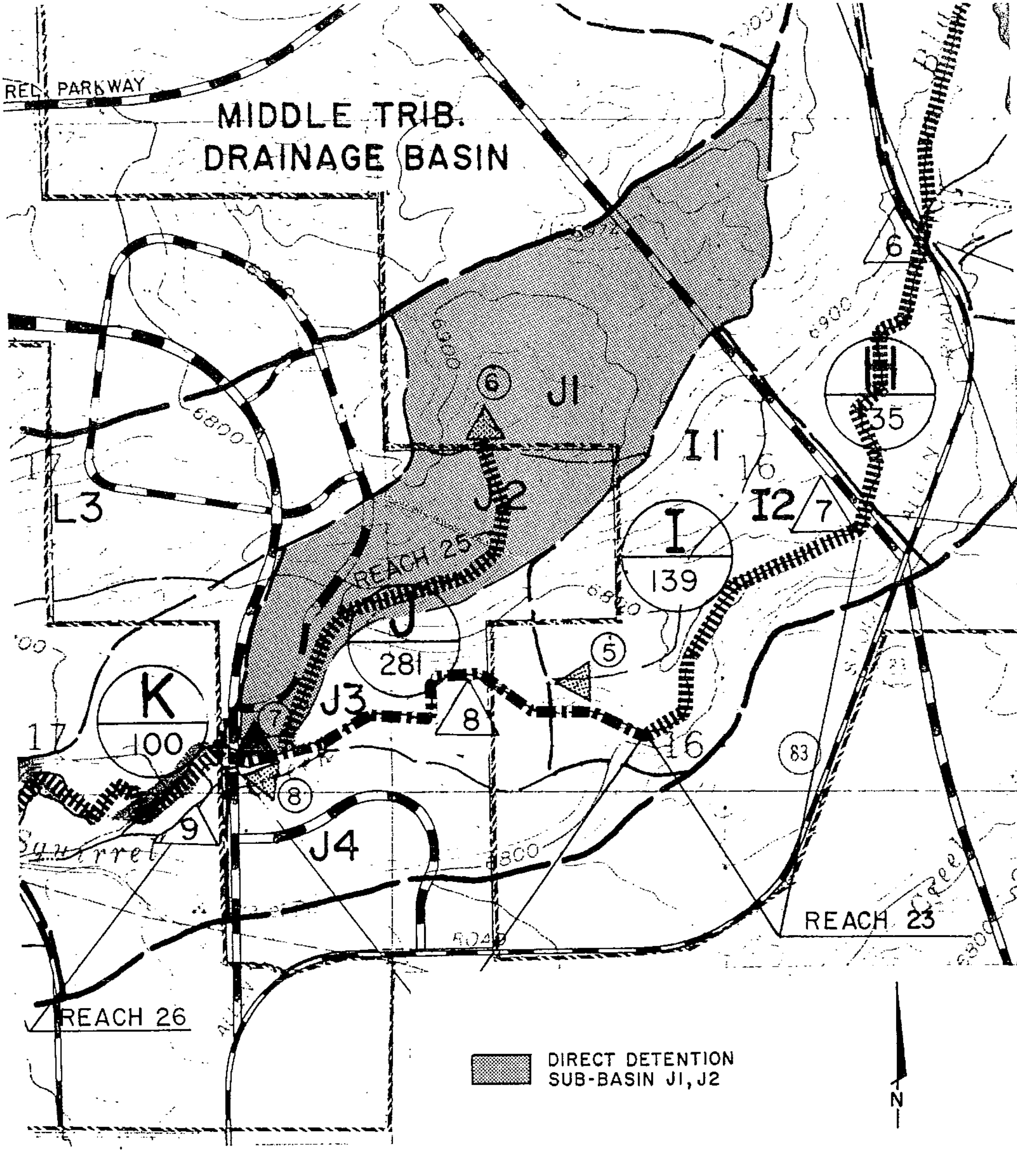
CONCEPTUAL DETENTION POND
TRIBUTARY AREA

FIGURE 11



DETENTION POND 2 (MDDP)
DETENTION POND 7 (DBPS)

SCALE: 1" = 1000'

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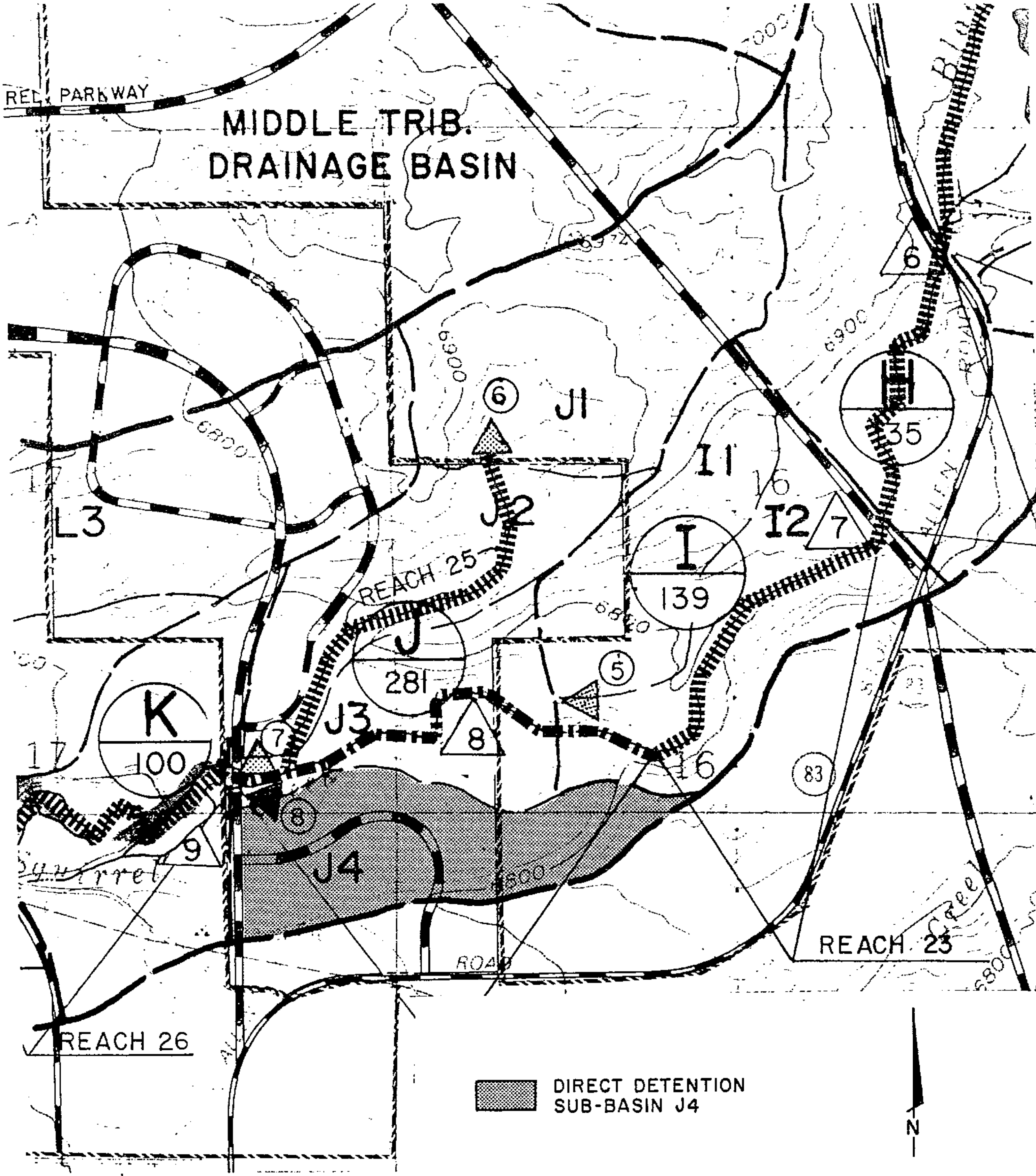
CONCEPTUAL DETENTION POND
TRIBUTARY AREA

FIGURE 12



DETENTION POND 3 (MDDP)
DETENTION POND 8 (DBPS)

SCALE: 1" = 1000'

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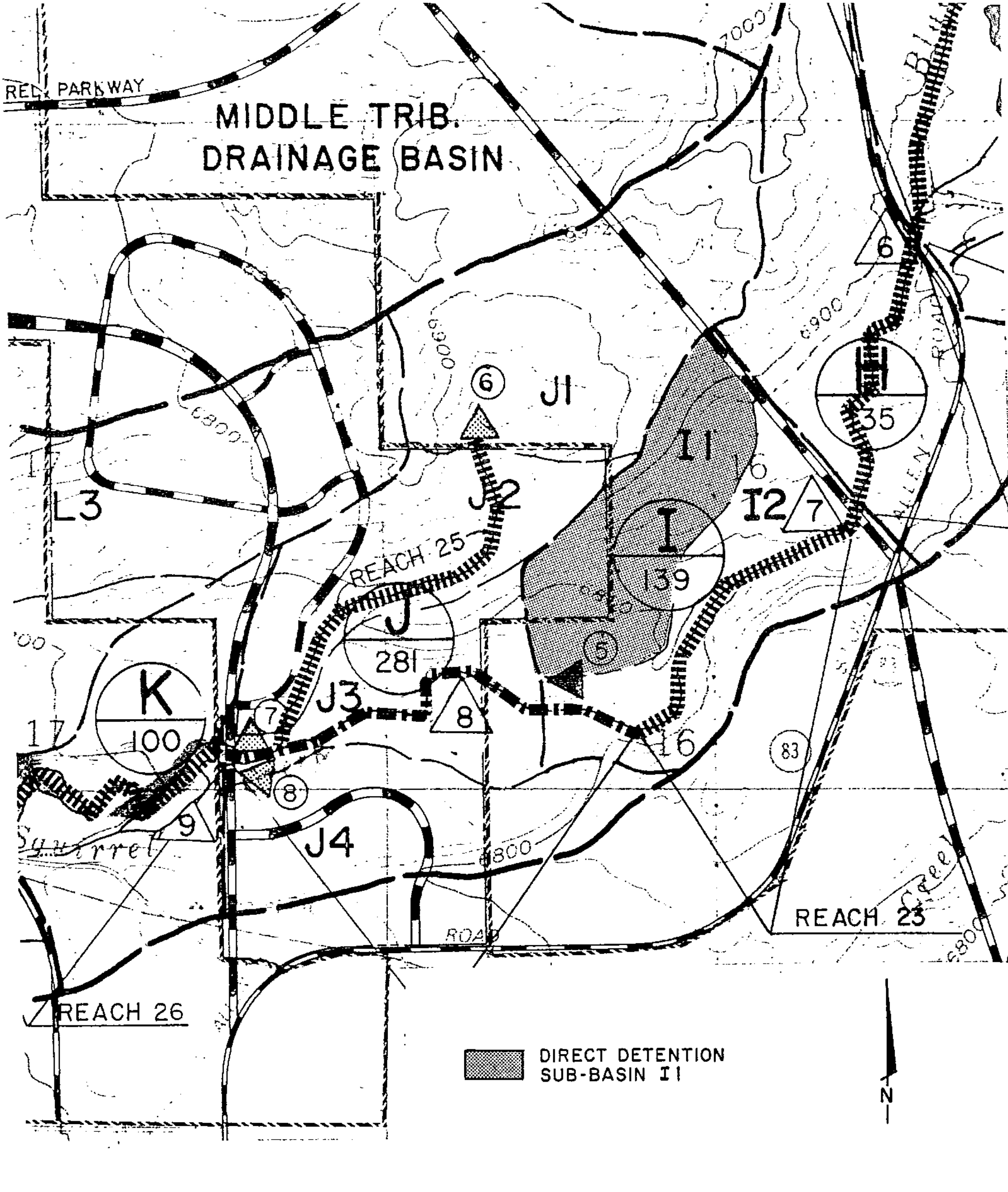
CONCEPTUAL DETENTION POND
TRIBUTARY AREA

FIGURE 13



DETENTION POND 4 (MDDP)
DETENTION POND 5 (DBPS)

SCALE: 1" = 1000'

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CONCEPTUAL DETENTION POND
TRIBUTARY AREA

FIGURE 14

THE OLIVE COMPANY

RECEIVED
PUBLIC WORKS/ENGINEERING
COLORADO SPRINGS, COLO.

NOV 1 1989

October 30, 1989

Mr. Chris Smith, Subdivision Administrator
Public Works Department
City Engineering Division
City of Colorado Springs
P.O. Box 1575
Colorado Springs, CO 80901

RE: Landowner Notification for Detention Pond Construction on Existing or Future Development within the City of Colorado Springs Black Squirrel Creek Drainage Basin

Dear Chris:

It is the understanding of The Olive Company that at the Development Plan-Preliminary Plat Stage of the platting process for all proposed development which occurs within the boundaries of the Black Squirrel Creek drainage basin that a preliminary drainage report will be prepared which definitively states the necessity for and construction of detention ponds as called for in the Black Squirrel Creek drainage basin studies. The preliminary drainage report for each parcel will state whether or not a pond is to be constructed on the property, or as an alternative, whether the property being platted must construct a pond upstream to insure that the over detention referred to in portions of the master drainage basin reports is accomplished. The preliminary drainage report will be submitted to the City Engineering Division concurrently with the plat submittals or developmental plan submittals to the City Planning Department. No parcels within Northgate are exempt from this requirement.

Prior to final plat approval of any parcel within the Northgate ownership, a final drainage report will be submitted to City Engineering for review and approval. The final drainage report will indicate any detention ponds located on the property and define easements required for those ponds. If ponds are constructed upstream of the property which is being platted, the pond will be located accordingly and the appropriate easements will be granted prior to final plat approval of that subdivision.

5450 TECH CENTER DRIVE, SUITE 400, COLORADO SPRINGS, COLORADO 80919
COLORADO SPRINGS (719) 598-3000 FAX: (719) 528-8360 DENVER (303) 893-9555

If this letter correctly sets forth our agreements, would you please sign the enclosed copy of this letter and return it to us while keeping a copy for your own files.

Sincerely,

THE OLIVE COMPANY

Kevin J. Walker
Development Manager

KJW/jb

This letter correctly sets forth the agreement we have reached between the City of Colorado Springs and the Northgate property owners.

Dated this 20th day of November, 1989.

Mr. Chris Smith
Subdivision Administrator

URS
CONSULTANTS, INC.
MAKING TECHNOLOGY WORK™

URS JOB NO. 78239 PAGE Cover OF ____
DATE 3/30/89 BY ZBM CHECKED BY ____ (date)
CLIENT TOC
PROJECT NG MDOP- BSC
SUBJECT Equilibrium Slope Analysis

Using Simons, Li & Assoc - "Design Criteria - Channels & Hyd. Structures on Sandy Soil", 1981

Equilibrium Slope for BSC was determined for several different flows -

Storm	Q	Equilibrium Slope
100-YR	3779 cfs	.25%
10-YR	1129 cfs	1.11%
2-YEAR	200 cfs*	1.41%

* Flow assumed

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URS JOB NO. 4E239 PAGE 1 OF ____
DATE 3/30/89 BY [illegible] CHECKED BY ____ (date)
CLIENT TOC
PROJECT NG MDDP - BLACK SQUIRREL CREEK
SUBJECT SEDIMENT LOAD - BSC

100-YR

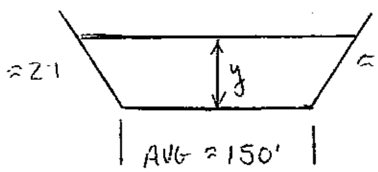
DETERMINE EQUILIBRIUM SLOPE FOR BSC USING SIMONS, LI & ASSOC - "DESIGN CRITERIA - CHANNELS & HYD STRUCTURES ON SANDY SOIL 1981

100-YEAR

EXISTING CHANNEL IS NOT IN EQUILIBRIUM (EXTENSIVE EROSION) - TO DETERMINE INCOMING SEDIMENT SUPPLY UNDER EQUILIBRIUM CONDITIONS, USE USDCM CRITERIA OF $V_{MAX} = 5$ FPS AND $Y_{MAX} = 5'$. (p 75)

SLOPE EXISTING ≈ 1.36%

$n_{ex} = 0.040 = n_{proposed}$



$Q_{100\,YR} = 3779$ CFS (DP8)

$A = 2y^2 + 150y$

FOR STREAM BED GRADATION - USE WOODWARD CLYDE - PH I NG DEVELOPMENT JAN 1986 - TH 6

TYPE	PERCENTAGE = K
VERY FINE SEDIMENT (LESS THAN #100)	11%
FINE SAND (BETWEEN #50 AND #100)	4%
MEDIUM SAND (BETWEEN #16 AND #30)	30%
COURSE SAND (BETWEEN #4 AND #16)	49%
VERY COURSE SAND (BETWEEN 3/8" & #4)	6%

FROM P41, 42 SIMONS LI SEDIMENT TRANSPORT RATE $Q_s = C_1 Y^{C_2} V^{C_3}$

VALUES OF C_1, C_2 + C_3 FOR EACH SOIL TYPE ON PG 43

FOR Y, USE $Y_N = \frac{A}{\text{Wetted Perimeter}}$ (See sample prob p 76)

100-YR

Existing Conditions — @ S = 1.36%
n = .040
Q = 3779 → d = 2.86' V = 8.49 FPS

WITH SAME CROSS SECTION – WOULD NEED TO MODIFY SLOPE TO GET Depth < 5' and V < 5 fps

FLATTEN SLOPE TO BRING Velocity down (and depth up)

@ S = .5% → d = 3.86' (Q = 3784) V = 6.2 FPS
.75% → d = 3.42 (3783) V = 7.05 FPS

@ S = .4% → d = 4.12 (3776) V = 5.79 FPS
(4.13 (3792) V = 5.80)

@ S = .35% → d = 4.29' (3781) V = 5.56 FPS

@ S = .30% → d = 4.49 (3779) V = 5.29

@ S = .25% → d = 4.74 (3779) V = **5.00** FPS ✓

SEDIMENT TRANSPORT RATE: ← For Y_N = 4.42 V = 5.00 FPS

K		
.11	VFS	Q_{s1} = .0473
.04	FS	Q_{s2} = .0240
.30	MS	Q_{s3} = .0097
.49	CS	Q_{s4} = .0046
.06	VCS	Q_{s5} = .0028

Wetted P = $150 + 2\sqrt{(4.74)^2 + [2(4.74)]^2}$
= 171.20

$Y_N = \frac{A}{W_P}$ A = $2y^2 + 150y$ ⇒ for y = 4.74
A = 755.94

$Y_N = \frac{755.94}{171.20} = $ **4.42** ← USE FOR y in Sediment transport eq

$Q_{S,IN}$ = 171.20 [.11(.0473) + .04(.0240) + .30(.0097) + .49(.0046) + .06(.0028)]

= 171.20 (.0115) = **1.97 CFS** ← SEDIMENT TRANSPORT RATE IN @ EQUILIB CONDITION (EXISTING CHANNEL SECTION W/ S = .25%)

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URS JOB NO. ______ PAGE 3 OF ____
DATE ______ BY ______ CHECKED BY ______ (date)
CLIENT ______
PROJECT ______
SUBJECT ______

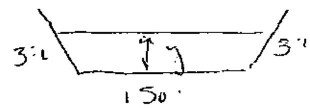
100-YR

DETERMINE $Q_{S\,OUT}$ (AFTER IMPROVEMENTS)

WANT TO FIND VELOCITY SUCH THAT $Q_{S(IN)} = Q_{S(OUT)} = 1.97$ CFS

IMPROVED CONDITION: $n = .040$ $A = 3y^2 + 150y$ $Q_{100} = 3779$ CFS

TRY V = 5 FPS → $A = \frac{Q}{V} = \frac{3779}{5.0} = 755.8$ FT²



y = 4.61 (A = 755.26)

Wetted P = $150 + 2\sqrt{(4.61)^2 + [2(4.61)]^2} = 170.62$

$Y_N = \frac{755.26}{170.62} = \underline{4.43}$

SEDIMENT TRANSPORT RATE - FOR $Y_N = 4.43$, V = 5 FPS

K		
.11	VFS	$Q_{S1} = .0474$
.04	FS	$Q_{S2} = .0240$
.30	MS	$Q_{S3} = .0097$
.49	CS	$Q_{S4} = .0046$
.06	VCS	$Q_{S5} = .0028$

$Q_{S(IN)} = 170.62[.11(.0474) + .04(.0240) + .3(.0097) + .49(.0046) + .06(.0028)]$

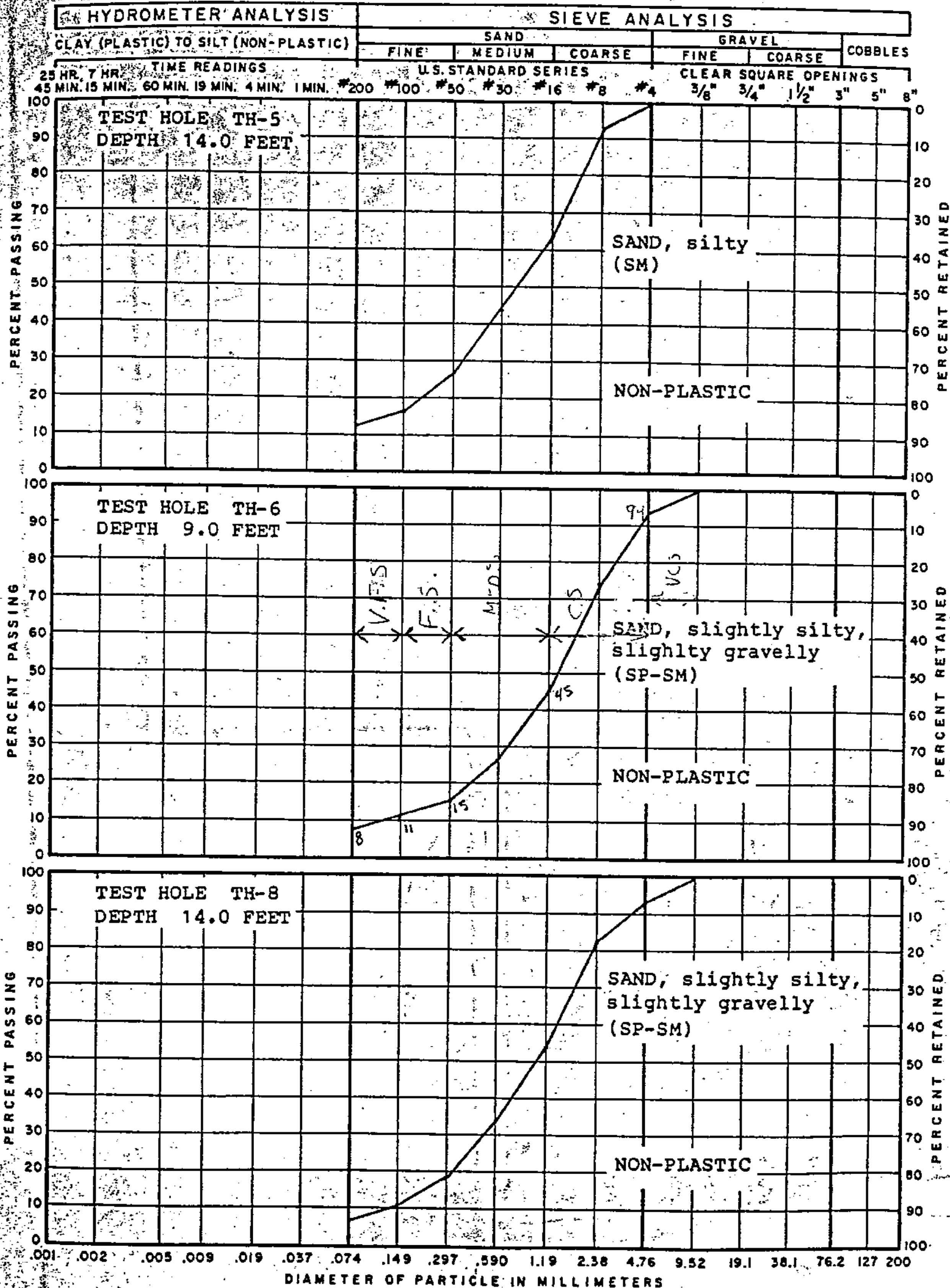
$= 170.62(.0115) = \underline{1.96}$ CFS ≈ 1.97

FOR V = 5 FPS — $V = \frac{1.486}{.040} R^{2/3} S^{1/2}$

R = 4.43 → S = .25% ~~100-YR~~ EQUILIB SLOPE! ←

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS



GRADATION ANALYSIS

JOB NO. 21778

FIG. 7

URS CONSULTANTS, INC.
MAKING TECHNOLOGY WORK™

URS JOB NO. ______ PAGE ____ OF ____
DATE ______ BY ______ CHECKED BY ______ (date)
CLIENT ______
PROJECT ______
SUBJECT ______

10-YR

USING 10-YR FLOW = 1129 CFS

U'STREAM (EXISTING)
2:1 SIDESLOPES

FOR S = 1.36%, n = .040
@ d = 1.4'
Q = 1143 CFS
V = 5.34 FPS > 5

MODIFY SLOPE TO GET V < 5 CFS

@ S = 1.3% @ d = 1.4' Q = 1117.2 CFS V = 5.2
@ S = 1.2% @ d = 1.45 Q = 1138 V = 5.13
@ S = 1.1% @ d = 1.5 Q = 1153 V = 5.0 ←

USE SEDIMENT TRANSPORT RATE EQ FOR d = 1.5'

$$\text{Wetted } P = 150 + 2\sqrt{(1.5)^2 + [2(1.5)]^2} = 156.71$$

$$Y_N = \frac{A}{W_P} \rightarrow A = 2y^2 + 150y = 229.50$$

$$Y_N = 1.46$$

FOR V = 5.0 FPS $Y_N = 1.46$

$Q_{S1} = 0.0150$
$Q_{S2} = .0095$
Q_{S3} .0054
Q_{S4} .0035
Q_{S5} .0030

$$Q_{S\,IN} = 156.71\,[.11(.0150) + .04(.0095) + .30(.0054) + .49(.0035) + .06(.0030)] = 156.71(.0055)$$

$$Q = 0.87$$

SEDIMENT TRANSPORT RATE IN W S = 1.1%
(10-YEAR EQUILIB SLOPE

10-YR

FOR IMPROVED CONDITION

$n = .040 \quad A = 3y^2 + 150y \quad Q = 1129 \text{ CFS}$

TRY V = 5FPS → $A = \frac{Q}{V} = \frac{1129}{5} = 225.80 = 3y^2 + 150y$

$y = 1.46 \quad (A = 225.39)$

Wetted P. $= 150 + 2\sqrt{(1.46)^2 + (2(1.46))^2} = 156.53$

$Y_N = \frac{225.39}{156.53} = 1.44$

Sediment Transport at – For $Y_N = 1.44$, V = 5FPS

$Q_1 = .0147$
$Q_2 \quad .0094$
$Q_3 \quad .0053$
$Q_4 \quad .0035$
$Q_5 \quad .0030$

$Q_{OUT} = 156.53[.11(.0147) + .04(.0094) + .30(.0053) + .49(.0035) + .06(.0030)] =$

$= 156.53(.0055) = .86$ ✓

For $V = 5\text{FPS} = \frac{1.486}{.040}(1.44)^{2/3} S^{1/2}$

$S = 1.11\%$ — 10 YR EQUILIB SLOPE ←

2-YR

2 YR FLOW $Q \approx 200$ cfs (assumed)

UPSTREAM (EXISTING) FOR S = 1.36%
n = 0.04
2:1 SIDESLOPES

@ d = .5'
Q = 205 cfs
V = 2.7 fps
A = 75.9
Wetted P = $150 + 2\sqrt{(.5)^2 + [2(.5)]^2}$
= 152.2

$y_N = \frac{A}{WP} = \frac{75.9}{152.2} = .50$

Assuming Equilibrium (V < 5, d < 5)

SEDIMENT TRANSPORT RATE EQ FOR $y_N = .50$ AND V = 2.7

$Q_1 = .0007$
$Q_2 = .0004$
$Q_3 = .0002$
$Q_4 = .0002$
$Q_5 = .0002$

$Q_{S_{IN}} = 152.2 [.11(.0007) + .04(.0004) + .30(.0002) + .49(.0002) + .06(.0002)]$

$= 152.2 (.0003) = .046$ cfs

FOR IMPROVED CONDITION: 3:1 SIDESLOPES
Q = 200 cfs
$A = 3y^2 + 150y$

TRY V = 2.7 fps − $A = \frac{Q}{V} = \frac{200}{2.7} = 74.1$ → y = .49 (A = 74.2)

WP = ~~150~~ = ~~152.2~~
$= 150 + 2\sqrt{.5^2 + [3(.5)]^2}$
= 153.2

$y_N = \frac{74.2}{153.2} = .48$

SEDIMENT TRANSPORT RATE EQ FOR $y_N = .48$ AND V = 2.7

$Q_1 = .0007$
$Q_2 = .0004$
$Q_3 = .0002$
$Q_4 = .0002$
$Q_5 = .0002$

$Q_{S_{OUT}} = 153.2 (.0003) = .046 \approx .046$ cfs

FOR V = 2.7 fps
R = ~~153.2~~ .48

$V = \frac{1.486}{0.40} R^{2/3} S^{1/2}$

S = 1.41% ← Equilib Slope For 2YR

BLACK SQUIRREL CREEK AND MISCELLANEOUS BASINS DRAINAGE PLAN

APPENDIX B: GEOLOGIC STUDY AND PRELIMINARY GEOTECHNICAL RECOMMENDATIONS BLACK SQUIRREL CREEK CHANNEL.

URS
A PROFESSIONAL SERVICES ORGANIZATION

URS CONSULTANTS
5450 TECH CENTER DRIVE, SUITE 327
COLORADO SPRINGS, COLORADO 80919
TEL: (719) 590-7377

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BOSTON
VIRGINIA BEACH
SAN ANTONIO
PITTSBURGH

October 12, 1988

City of Colorado Springs
Public Works Division
30 South Nevada, Suite 403
Colorado Springs, Colorado 80903

RE: Black Squirrel Creek Master Development Drainage Plan - Clarification to Geotechnical Recommendations
URS Project No. 48329

To Whom It May Concern:

The following geotechnical recommendations, presented by Geotechnical Consultants, Inc., make reference to lining the Black Squirrel Creek Channel with an erosion control netting and then establishing vegetation. This portion of their recommendation is not acceptable by the City of Colorado Springs for this particular channel and therefore should not be considered as a part of the channel construction. All other geotechnical information and recommendations regarding the channel and the proposed riprap side slope lining should be utilized.

Should you have any questions please notify this office.

Sincerely,

URS Consultants

Bryan T. Law, P.E.

BTL/kp

cc: Robert L. Bass, P.E. - G.C.I.

georecom.let

Geotechnical Consultants, Inc.

September 25, 1987

URS Corporation
5450 Tech Center Drive, #327
Colorado Springs, CO 80919

Re: Geologic Study and Preliminary Geotechnical Recommendations
Black Squirrel Creek Channel

Gentlemen:

As requested, personnel of GCI have performed a preliminary geological and geotechnical study for the Black Squirrel Creek Channel between the proposed detention pond area and the proposed Voyager Parkway. This letter is intended to serve as our preliminary report and documentation of discussion and recommendations which we have presented informally on this project.

The channel is a broad-bottomed stream with an approximate bottom width of 150 feet. The average gradient of this stream through this reach is about 1.25%. The normal base flow in the stream is very slight, and consists of a small meandering braided "trickle" which does not cover the entire bottom of the stream bed, and is only a few inches in depth. We understand that the 100 year historic flow for this stream is on the order of 4000 cfs. The banks of the stream are locally very steep and roughly 6 to 10 feet in height. Above the banks the native ground surface consists of gentle to moderately sloping rolling terrain. The total fall of the stream through the reach in question is on the order of 30 feet.

Our geologic research consisted of a review of aerial photography, to provide an indication of local geologic units based upon landforms observed on the stereo photographs. The channel was then inspected on foot, and the materials identified in this field reconnaissance were compared to the units derived from the aerial photography research. Test borings previously drilled in the vicinity of the channel by Woodward, Clyde Consultants were reviewed to determine the type of soil or bedrock encountered at the test boring location.

GEOLOGIC SETTING

Bedrock underlying the Black Squirrel Creek channel area consists of the Dawson Arkose of Tertiary Age. Overlying the bedrock are various surficial deposits which have been deposited in more recent geologic times. The mapped and interpreted geologic units are shown on the enclosed Figure #1.

7750 N. Union Blvd., Suite 105 Colorado Springs, Colorado 80918 (303) 528-1331

The Dawson Arkose is the upper and youngest formation in the Dawson Group. The Dawson Group of formations were deposited in ancient times in the Denver Structural Basin during the uplifting and mountain building along the Front Range. The Dawson Arkose is exposed in several areas along the stream banks of the Black Squirrel Creek channel. These exposures indicate that the Dawson Arkose consists of a variable sequence of sandstone, siltstones and claystones. The layers within the Dawson Arkose are typically lensatic and exhibit a high degree of variability, both horizontally and vertically. This is a consequence of the fact that the Dawson was laid down by rivers and streams, and in small bodies of standing water.

The sandstones are exposed only in the extreme easterly reach of the Black Squirrel Creek on the north bank. They are typically tan to orangish where stained by iron oxide and consist of fine to coarse grain arkosic sand. Observations of the exposures indicate that the sandstones are only slightly cemented, however they are very dense. Some seepage from the sandstone was noted in the exposures.

The majority of the bedrock exposures along Black Squirrel Creek consist of claystone. The claystones are varicolored and range from various shades of grey to orangish to brown. They vary from fine sandy and silty to slightly silty and very fine grained. Desiccation and ravelling of the claystone beds indicate that they contain expansive clay minerals.

A few exposures of siltstone were also recognized along the stream channel. These siltstones typically are tan to brown, sandy and micaceous. They are only slightly cemented to non-cemented but moderately consolidated.

Surficial Deposits:

Bedrock along the stream channel is overlain by alluvial deposits of various ages on several terrace levels. The recent alluvium in the present flood plain is the youngest of these terraces, with the highest terraces being the oldest. These alluvial terraces were deposited by actions of Black Squirrel Creek when it flowed at higher levels. In some cases, it appears that the stream cut terraces, depositing only thin sediments. In other cases the stream deposited significant thicknesses of alluvial soils. During various episodes of stream erosion and deposition, the stream also cut benches within the flood plain of the stream at that time. Younger episodes of stream action (which have also been generally smaller with the passage of time) have served to modify the older terraces. That is, the older, higher terrace surfaces are partially or wholely dissected by younger stream action. These terrace deposits are composed of a stratified sequence of sands, silts and clays.

Along the northern bank of Black Squirrel Creek an alluvial fan deposit can be found. This sizeable deposit has resulted from deposition by a small tributary of Black Squirrel Creek. The geologic mapping and review of the test holes drilled by Woodward, Clyde Consultants indicates that a sizeable portion of this fan appears to be underlain by older alluvial terrace deposits. Remnants of underlying terraces can be found in the easterly portion of the fan area. Exposures along the stream bank also indicate that portions of this alluvial fan directly overlie weathered bedrock. The alluvial fan deposits are similar to the alluvial terraces in that they tend to be highly stratified sands, silts and clays.

Colluvium (slope wash) is unconsolidated surficial deposits which have been deposited as a result of wind, sheetwash, water and gravity. Along the southwest portion of the stream channel some gentle to moderate slopes are underlain by these surficial deposits. In this area the colluvium apparently mantels the underlying bedrock and possibly some older terrace deposits.

EROSION CHARACTERISTICS

A significant portion of the surficial materials in the immediate vicinity of the channel are unconsolidated deposits or weathered materials which will tend to erode rather rapidly. In particular, the alluvial and colluvial materials, the terrace sand and gravel materials, and the alluvial fan deposits will probably begin to experience erosion at the velocities on the order of 2 to 3 feet per second.

The weathered bedrock materials will be somewhat more resistant to erosion. The siltstones will be the most erosive of this group, and significant erosion will probably begin at approximately 4 feet per second in these materials. The weathered claystone materials will be somewhat more resistant to erosion owing to the plasticity imparted by the clay fraction. The claystones should be able to withstand surface velocities of about 6 feet per second before significant erosion occurs. The weathered sandstone materials will be even more resistant to erosion with velocities on the order of 7 to 8 feet per second being permissible. However, we would note that local seepage conditions at the base of the sandstone exposure will result in somewhat unstable conditions in some areas, and localized buttressing with small riprap would be appropriate to ensure the 7 to 8 feet per second allowable velocity.

A map (Figure #2) has been prepared based upon our field reconnaissance, which shows the various geologic units and also indicates the zones of various erosion potential within the stream bank. The locations of small seeps in the stream bank are indicated as well.

CHANNEL IMPROVEMENTS

We understand that a rigid "industrial" type of channel lining, such as concrete or grouted riprap is not desirable aesthetically for the type of development proposed adjacent to the channel. We also understand that a "wild" appearance for the stream bed is not wanted either. A "planned park" appearance with dressed slopes of variable gradient and grasses which are to be periodically mowed and otherwise maintained, in conjunction with planting some trees and shrubs and construction of park trails, is the desired objective.

This concept will involve the use of "drops" to flatten the average gradient of the stream and reduce the velocities to a level which will permit the "soft" channel lining at 100 year historic flows. In order to permit establishment of the grass, we suggest the use of an erosion control material such as Enkamat or Miramat. The combination of the erosion control netting and the establishment of grass roots will permit velocities in the range of 5 to 6 feet per second for the stream banks. This technique would be recommended in the areas of weathered siltstone and unconsolidated alluvial materials. If velocities are reduced to below 6 feet per second, the weathered claystone materials and weathered sandstone materials should be capable of withstanding these velocities without requiring the "soft" channel lining.

At the outside of bends the velocity is higher than the average velocity of the stream, and scour or accelerated erosion is a potential problem. The manufacturer's literature for the erosion mat would seem to indicate that the higher velocities can be tolerated. However, care is required to obtain an acceptable toe depth for the netting to prevent the scour from undermining the material. A more substantial lining such as buried riprap could be used in these locations, but again the critical factor is probably the toe down depth. Another alternative would be the placement of a series of small groins against the bank to deflect water away from the bank and thereby protect against erosion on the outside of the bends.

The crucial consideration in achieving satisfactory performance for the erosion control products described above is the treatment of the top and bottom of the material and proper anchorage of the beginning or end of the material at transitions. The manufacturer will have recommended details for proper treatment of the edges of the mat. The actual construction should meet or exceed the requirements on these details.

Another consideration is that of concentrated flows from outside the channel discharging onto the netting and grass material. These discharges, while relatively small, can result in intense localized erosion. This in turn can result in a weak spot in the channel lining, which may become damaged during higher flows within the channel itself. Therefore, we recommend that drainage from the area adjacent to the channel be controlled in ditches or swales such that it does not enter the channel except at controlled locations. At these locations the flow should be discharged to the channel bed such that erosion does not occur. If stone or gabion drop structures are used, discharge of these flows onto the drop structures could be a good method of eliminating the erosion.

In addition to the requirement of erosional stability, it will be necessary to construct the channel banks in such a manner that the gross stability against slope failure is acceptable. For these low banks, typically 10 feet in height, a slope of three horizontal to 1 vertical will be acceptably stable for the alluvial and terrace materials and other unconsolidated deposits. The weathered bedrock materials can be steeper, with a slope of 1.5 horizontal to 1 vertical being acceptable for the claystone and siltstone materials. The dense, weathered sandstone materials can probably be left at a vertical face, but this should be verified for each outcrop on a case-by-case basis. It also may be possible to leave some claystone outcrops at steeper angles than the 1.5:1 slope, providing the trails, drainage swales, and other features are set back to a location well behind the 1.5:1 slope plane.

The presence of some seepage zones and seeps indicates that groundwater is flowing into the Black Squirrel Creek channel from adjacent surficial (and bedrock) deposits. It will be important from a slope stability standpoint that these seepage areas are not blocked during channel improvements. Small drains may be necessary in areas of proposed fill over these seep areas.

It is believed that this letter covers the erosion and stability characteristics of the channel in brief, as well as stating our interpretation of the existing geologic conditions. While the discussion of the characteristics of various materials is somewhat general, application of our recommendations to the actual design of the channel should not be difficult. We would request the opportunity to review and comment on the ultimate design, as well as the opportunity to inspect during construction to more accurately determine the extent of various soil and rock materials as grading is being performed.

Should you have any questions or should additional discussion be required on any of the points covered in this report, please feel free to contact GCI at your convenience.

Respectfully submitted,

GEOTECHNICAL CONSULTANTS, INC.

By: Robert L. Bass, P.E.

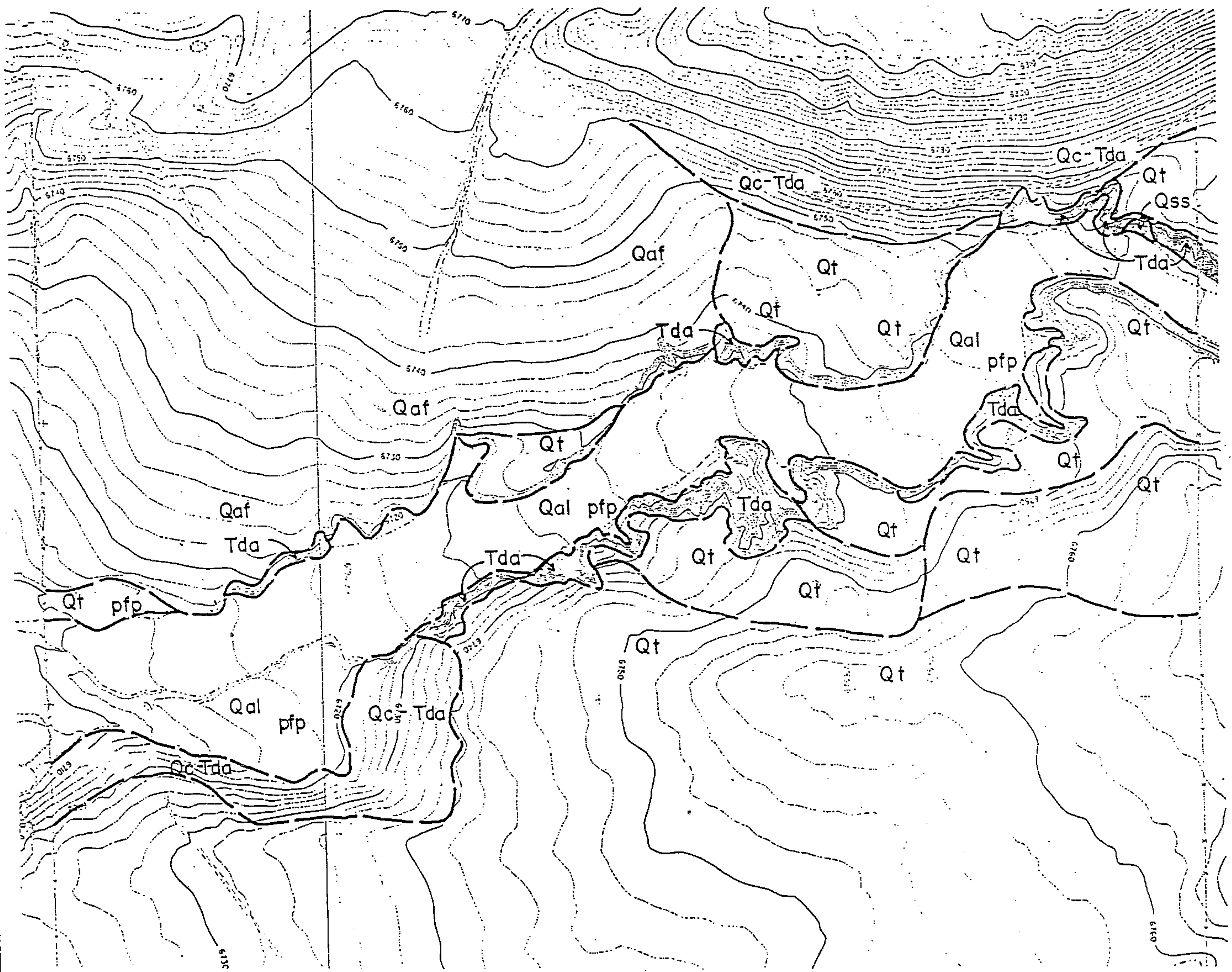
COLORADO REGISTERED
ROBERT L BASS
18669
PROFESSIONAL ENGINEER

By: John W. Himmelreich, Jr.

RLB/JWH/vmw
GCI Job No. 2502-3

NORTH

SCALE: 1" = 200'



LEGEND

Qal... RECENT ALLUVIUM

Qc.... COLLUVIUM (SLOPEWASH)

Qss... SOIL SLUMP

Qaf... ALLUVIAL FAN

Qt.... ALLUVIAL TERRACE (VARIOUS LEVELS NOT DIFFERENTIATED)

Tda... DAWSON ARKOSE

pfp... PHYSIOGRAPHIC FLOODPLAIN

REVISED 10-1-87

GEOLOGIC MAP
BLACK SQUIRREL CREEK CHANNEL AREA

FIGURE No. 1
JOB No. 2502-3

Geotechnical Consultants Incorporated

Geotechnical Consultants, Inc.

April 14, 1988

URS Corporation
5450 Tech Center Drive, Suite 327
Colorado Springs, CO 80919

Re: Supplemental Report
Black Squirrel Creek Channel

Gentlemen:

The purpose of this letter is to summarize and supplement our original report for the site, dated September 25, 1987. Most of the discussion in this letter is comparable to recommendations previously given. However, the discussion herein is perhaps more specific, reflecting concept development subsequent to and partially based on our original report.

Geologically, the vicinity of this site consists of a variety of surficial deposits overlying bedrock of the Dawson Arkose Formation. The Dawson Arkose Formation is the upper and youngest formation in the Dawson group. The Dawson Arkose consists of a variable sequence of sandstone, siltstone and claystone. The layers within the Dawson Arkose are typically lensatic and exhibit a high degree of variability both horizontally and vertically, as a consequence of the fact that the formation was laid down by rivers and streams and in small bodies of standing water.

A reconnaissance of the channel reveals exposures of sandstone, siltstone and claystone in the channel banks. The sandstones are exposed only in the extreme easterly reach of the channel on the north bank. Claystone exposures occur on both banks in the central and western portions of the channel reach. Siltstone was exposed in the eastern portion of the southern bank of this channel reach. We have indicated the approximate locations of the various exposures on the enclosed Geologic Map (Figure 1).

A variety of surficial deposits exist in the vicinity of the channel. Recent alluvium, deposited by the channel as we see it today, is located within the channel banks. At present, deposition rather than erosion is occurring as a result of flows in the channel. Above the channel on both sides, older alluvial terraces can be found. A large alluvial fan deposit exists above the channel on the western half of the northern bank. In addition to these alluvial deposits, a surface colluvium has been mapped in the extreme western portion of the southern channel bank.

With regard to permissible velocities, it is the opinion of GCI that all of the surficial deposits, specifically the alluvial and colluvial soils, will be capable of withstanding flow velocities of 2.5 feet per second. The bedrock materials will be somewhat more resistant to erosion. The siltstone materials are the least resistant of this group, with permissible velocities on the order of four feet per second. The claystones will be capable of withstanding surface velocities of six feet per second before significant erosion occurs. The weathered sandstone materials will be even more resistant to erosion, with velocities on the order of seven to eight feet per second being permissible. However, we have noted localized seepage at the base of the sandstone exposure. We would recommend localized buttressing with riprap at the seep locations to ensure continued stability of these materials (Sta 23+40 to 24+10, see Figure 1).

These permissible velocities are based on our experience. However, they correlate very well with values given in Table 6-7 of the City/County Drainage Criteria Manual. The locations of various materials in the channel banks, with stationing for the transitions, are shown on the enclosed Geologic Map (Figure 1).

Where flow velocities are less than or equal to the permissible values given above, no lining material will be necessary. Where the velocities exceed the values given above, then obviously, some sort of lining will be required. We understand that with the construction of grade control structures (drops), it will be possible to reduce the average velocity for the 100 year discharge to something on the order of five to six feet per second.

The drop structures will be sloped-face gabion structures. The gabions are flexible and permeable, which will be advantageous in this application. The bed will be adequate to support the gabions. We do not anticipate any problems from uplift or seepage, due to the permeable nature of the gabions. We would suggest, however, that a fabric filter be placed between the streambed and the gabions, as a precaution against localized piping.

We understand that a "soft" lining, using seeded grasses and synthetic reinforcing mat will be used in areas where flow velocities exceed the maximum permissible velocities given above. Manufacturer's literature would seem to indicate permissible velocities of 10 to 12 feet per second for Enkamat or Miramat products. We understand that actual velocities for 100-year flow conditions will be substantially less than this.

Typically, failures of channel lining do not occur as a direct result of flow against a continuous properly constructed lining. Rather, failures will occur at boundaries and discontinuities in the lining as the lining becomes outflanked and flows are directed beneath or behind the lining. Additional care is warranted at the critical areas where failures are likely to occur. This would include the toe of the bank in general, and the outsides of bends where velocities tend to be higher.

For this reason, careful attention to the manufacturer's recommended details for installation of their products is important. Additionally, we recommend the mat be "toed down" at least three feet through straight reaches and at the inside of bends. On the outside of bends, we suggest a riprap buttress at the toe, which extends to a depth of at least four feet below the streambed. Alternatively, buried riprap could be used to line the outside of bends. If buried riprap is used, the riprap should extend to four feet below the streambed, and transitions between the riprap and adjacent lining materials should be properly designed and constructed.

Another possibility for protecting the outsides of bends from high velocity is the use of groins. These groins would consist basically of small stone jetties which project from the channel bank a short distance into the stream at an angle from the flow. The groins will deflect the flow from the bank, thereby protecting from erosion, and will facilitate the deposition of silt and sand against the bank between the groins. Properly installed groins have proven to be effective, especially on the outsides of channel bends. If groins are used, no other bank protection is necessary in areas protected by the groins. It will probably be necessary to design the groins for 100-year flow conditions.

In addition to erosion caused from flows within the channel, there typically is erosion that occurs as a result of smaller drainageways discharging into the channel over the channel banks. While these discharges typically are small, they can result in significant erosion due to the high velocities which result from the steep gradients necessary to reach the channel bed. These small erosional occurrences can in turn result in a weak spot in the channel lining which may become damaged during higher flows within the channel itself. Therefore, it is necessary to control these point discharges. This can be done with drainage ditches or swales parallel to the channel to intercept the flows and prevent them from discharging over the bank. These flows can be discharged to the channel at the drop structure locations in order to prevent erosion at the discharge points. A ditch and swale system with discharge onto the drop structures has been incorporated into this design.

In addition to providing for erosional stability of the channel, the channel banks must be constructed in such a manner that the gross stability against slope failure is acceptable. For these low banks which are typically ten feet or lower in height, a slope of three horizontal to one vertical will be acceptably stable for the surficial deposits. For the bedrock claystone and siltstone materials, a somewhat steeper slope, on the order of 1.5 horizontal to 1 vertical will be acceptable. The dense, weathered sandstone materials encountered in the east end of the north bank of the channel can probably be left at their existing nearly vertical face, but this should be verified for each outcrop on a case by case basis.

Also, it will be possible to leave some claystone outcrops at steeper angles than the 1.5:1 slope providing the drainage swales and other features above the outcrop are set back to a location behind the 1.5:1 plane. With exposure to weather, the claystone outcrops may experience surface ravelling to a degree resulting in a gradual flattening of the slope with time. This ravelling process will be very slow and should stabilize before the 1.5:1 plane is reached. The concept plan for the channel indicates several claystone and sandstone outcrops which will be left in an exposed state for aesthetic reasons.

On previous mapping we have noted the presence of some seepage zones adjacent to the channel. Typically these occur within the small drainages which discharge into the channel from the side rather than within the main channel banks. However, in any case, it is important from a slope stability standpoint that these seepage areas not be blocked during construction of channel improvements. If fill is placed over these seeps, small drains made from crushed rock may be necessary to permit drainage. The necessity for these drains can best be determined on a case-by-case basis at the time of construction.

It is believed that the geotechnical aspects of the Black Squirrel Creek channel through Northgate Phase I have been covered above in brief. Should questions arise concerning the discussion contained herein, or should additional information be needed, please feel free to contact GCI at your convenience.

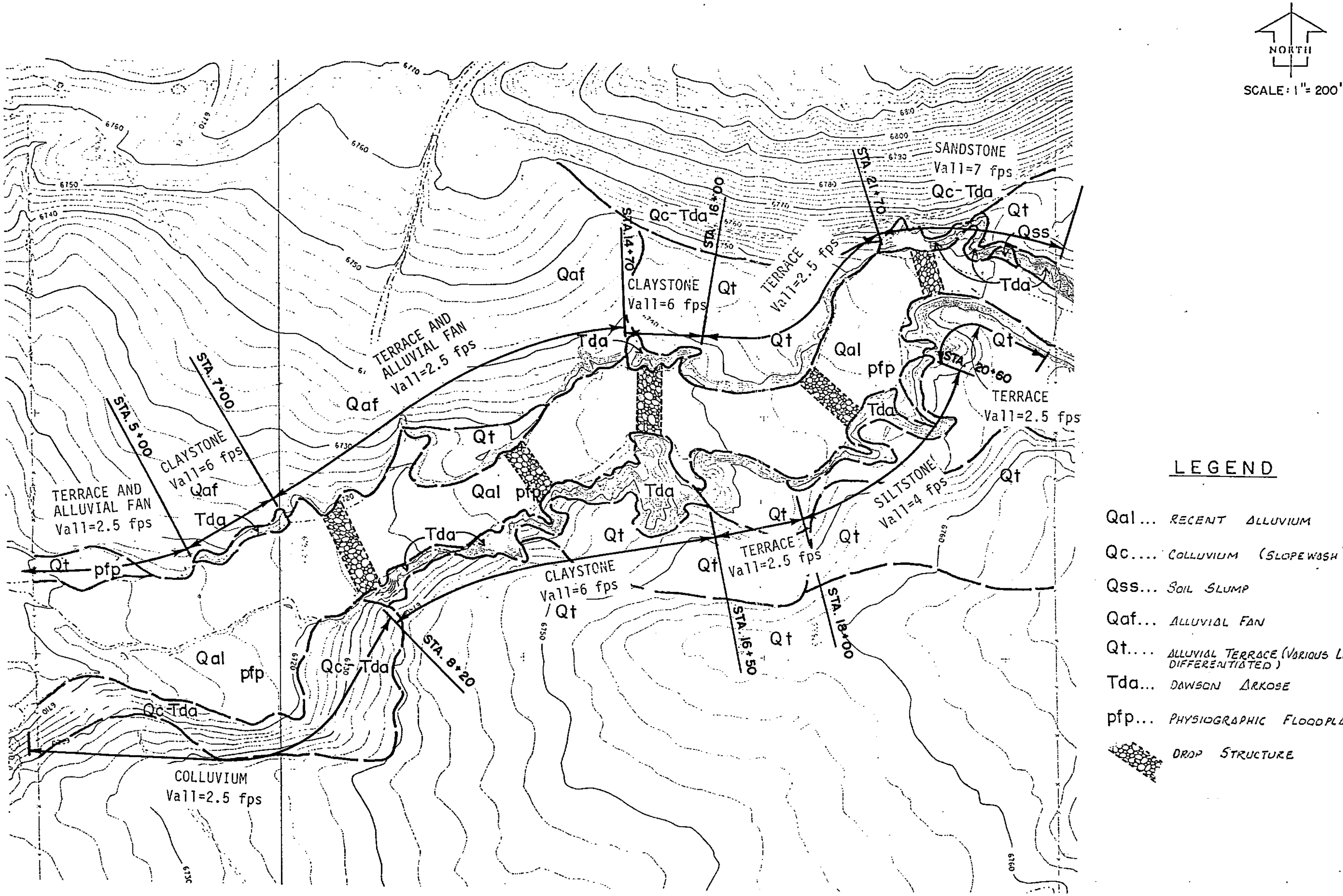
Respectfully submitted,

GEOTECHNICAL CONSULTANTS, INC.

COLORADO REGISTERED
ROBERT L BASS
18663
PROFESSIONAL ENGINEER

By: Robert L. Bass, P. E.

RLB/kk
GCI Job No. 2502-3



LEGEND

Qal... RECENT ALLUVIUM

Qc.... COLLUVIUM (SLOPEWASH)

Qss... SOIL SLUMP

Qaf... ALLUVIAL FAN

Qt.... ALLUVIAL TERRACE (VARIOUS LEVELS NOT DIFFERENTIATED)

Tda... DAWSON ARKOSE

pfp... PHYSIOGRAPHIC FLOODPLAIN

 DROP STRUCTURE

FIGURE No. 1
JOB No. 2502-3

GEOLOGIC MAP
BLACK SQUIRREL CREEK CHANNEL AREA

Geotechnical Consultants Incorporated

BLACK SQUIRREL CREEK AND MISCELLANEOUS BASINS DRAINAGE PLAN

APPENDIX C:TR-20 COMPUTER RUN SUMMARY SHEETS

BLACK SQUIRREL CREEK AND MISCELLANEOUS BASINS DRAINAGE PLAN

APPENDIX C: TR-20 COMPUTER RUN SUMMARY SHEETS

Summary sheets for the TR-20 computer runs (which were computed as part of Black Squirrel Creek Drainage Basin Planning Study) are attached. Copies of the complete input and output files are available in the Black Squirrel Creek DBPS. Structure and detention pond numbers from the Black Squirrel Creek DBPS which correspond to design points or detention ponds from the Northgate Master Development Drainage Plan (this document) are as listed below:

Northgate MDDP Design Point	Black Squirrel Creek DBPS Design Point
1	Structure 8
3	Reach 25
8	Structure 9
Detention Pond 1	Detention Pond 6
Detention Pond 2	Detention Pond 7
Detention Pond 3	Detention Pond 8
Detention Pond 4	Detention Pond 5

Note: Northgate MDDP Design Points not shown do not have corresponding Black Squirrel Creek DBPS Design Points.

BLACK SQUIRREL CREEK DRAINAGE BASIN
TR-20 & HEC-2 CROSS-REFERENCE (DBPS)

FIGURE 3 - PRESENT CONDITIONS TR-20 ID	LOCATION *	FIGURE 4 - DEVELOPED CONDITIONS TR-20 ID	LOCATION *	HEC-2 DATA HEC-2 ID
XSECT 1	REACH 2	-	- -	-
XSECT 2	REACH 3 & 5	XSECT 1	REACH 5	-
XSECT 3	REACH 6 & 7	XSECT 2	REACH 7	-
XSECT 4	REACH 9 & 10	XSECT 3	REACH 9 & 10	-
XSECT 5	REACH 17 & 19	XSECT 4	REACH 17 & 19	-
XSECT 6	REACH 20	XSECT 5	REACH 20	-
-	- -	XSECT 6	REACH 22	-
XSECT 7	REACH 22,23&24	XSECT 7	REACH 23 & 24	-
XSECT 8	REACH 26 & 27	XSECT 8	REACH 26	-
-	- -	XSECT 9	REACH 27	-
XSECT 9	REACH 29	XSECT 10	REACH 29	-
-	- -	XSECT 12	REACH 25	-
STRUC 1	DES PT 1 - Ttl	-	DES PT 1A - Ttl	89
STRUC 2	DES PT 2 - Ttl	-	DES PT 1B - Ttl	85
-	- -	STRUC 1	DES PT 1 - Ttl	-
STRUC 3	DES PT 3 - Ttl	-	- -	108
-	- -	STRUC 2	DES PT 2 - Ttl	-
STRUC 24	DES PT 4 - W	-	- -	-
STRUC 44	DES PT 4 - E	-	- -	-
STRUC 4	DES PT 4 - Ttl	STRUC 3	DES PT 3 - Ttl	72
-	- -	STRUC 24	DES PT 4 - W	-
-	- -	STRUC 44	DES PT 4 - E	-
-	- -	STRUC 4	DES PT 4 - Ttl	-
STRUC 5	DES PT 5 - Ttl	-	- -	45
STRUC 26	DES PT 6 - W	STRUC 25	DES PT 5 - W	-
STRUC 46	DES PT 6 - E	STRUC 45	DES PT 5 - E	-
STRUC 6	DES PT 6 - Ttl	STRUC 5	DES PT 5 - Ttl	38
STRUC 7	DES PT 7 - Ttl	STRUC 6	DES PT 6 - Ttl	33
-	- -	STRUC 7	DES PT 7 - Ttl	-
-	- -	STRUC 8	DES PT 8 - Ttl	-
STRUC 8	DES PT 8 - Ttl	STRUC 9	DES PT 9 - Ttl	24
-	- -	STRUC 10	DES PT 10 - Ttl	-
STRUC 9	DES PT 9 - Ttl	STRUC 11	DES PT 11 - Ttl	16
STRUC 10	DES PT 10 - Ttl	STRUC 12	DES PT 12 - Ttl	10
-	- -	STRUC 51	DET PD 1	-
-	- -	STRUC 52	DET PD 2	-
-	- -	STRUC 53	DET PD 3	-
-	- -	STRUC 54	DET PD 4	-
-	- -	STRUC 55	DET PD 5	-
-	- -	STRUC 56	DET PD 6	-
-	- -	STRUC 57	DET PD 7	-
-	- -	STRUC 58	DET PD 8	-
-	- -	STRUC 59	DET PD 9	-

* - Reach & detention pond location is as shown on Figure 4.
Design point location is as shown on Figure 3 or 4, respectively.

NOTE - The following codes correspond to the TR-20 ID's above:
"10" series codes refer to the total Design Point.
"20" series codes refer to the West side of Design Point.
"40" series codes refer to the East side of Design Point.
"50" series codes refer to the detention pond at that Design Point.

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	AMOUNT (IN)	DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
ALTERNATE 1 STORM 1 (10-YR)													
STRUCTURE 1	RUNOFF	1.44	1	2	.10	.0	3.00	24.00	.66	---	6.30	408.96	283.8
STRUCTURE 51	RESVOR	1.44	1	2	.10	.0	3.00	24.00	.66	7106.81	7.11	98.08	68.1
XSECTION 1	REACH	1.44	1	2	.10	.0	3.00	24.00	.66	7041.78	7.22	98.06	68.1
STRUCTURE 2	RUNOFF	1.40	1	2	.10	.0	3.00	24.00	.69	---	6.43	339.72	242.5
STRUCTURE 52	RESVOR	1.40	1	2	.10	.0	3.00	24.00	.68	7126.50	7.35	95.04	67.8
XSECTION 2	REACH	1.40	1	2	.10	.0	3.00	24.00	.68	7175.87	7.59	94.56	67.5
STRUCTURE 3	ADDHYD	2.84	1	2	.10	.0	3.00	24.00	.67	---	7.43	191.40	67.3
STRUCTURE 3	RUNOFF	.30	1	2	.10	.0	3.00	24.00	.77	---	6.09	180.62	594.2
STRUCTURE 3	ADDHYD	3.15	1	2	.10	.0	3.00	24.00	.68	---	7.36	203.16	64.6
XSECTION 3	REACH	3.15	1	2	.10	.0	3.00	24.00	.68	6974.12	7.48	203.10	64.6
STRUCTURE 5	RUNOFF	.38	1	2	.10	.0	3.00	24.00	.67	---	6.11	178.31	469.2
STRUCTURE 25	ADDHYD	3.53	1	2	.10	.0	3.00	24.00	.68	---	6.16	329.93	93.6
STRUCTURE 24	RUNOFF	1.84	1	2	.10	.0	3.00	24.00	.64	---	6.33	473.09	257.3
STRUCTURE 53	RESVOR	1.84	1	2	.10	.0	3.00	24.00	.63	7206.85	7.33	98.51	53.6
STRUCTURE 44	RUNOFF	1.16	1	2	.10	.0	3.00	24.00	.64	---	6.26	343.06	296.0
STRUCTURE 4	ADDHYD	3.00	1	2	.10	.0	3.00	24.00	.63	---	6.29	378.73	126.3
XSECTION 4	REACH	3.00	1	2	.10	.0	3.00	24.00	.63	7003.64	6.49	334.86	111.7
STRUCTURE 5	RUNOFF	.99	1	2	.10	.0	3.00	24.00	.71	---	6.45	247.14	248.6
STRUCTURE 5	ADDHYD	3.99	1	2	.10	.0	3.00	24.00	.65	---	6.47	580.40	145.4
STRUCTURE 5	RUNOFF	.52	1	2	.10	.0	3.00	24.00	.71	---	6.19	208.50	401.7
STRUCTURE 54	RESVOR	.52	1	2	.10	.0	3.00	24.00	.71	6903.86	6.77	47.85	92.2
XSECTION 4	REACH	.52	1	2	.10	.0	3.00	24.00	.71	7001.14	6.94	47.51	91.5
STRUCTURE 45	ADDHYD	4.51	1	2	.10	.0	3.00	24.00	.66	---	6.49	613.98	136.1
STRUCTURE 5	ADDHYD	8.04	1	2	.10	.0	3.00	24.00	.67	---	6.46	765.48	95.2
XSECTION 5	REACH	8.04	1	2	.10	.0	3.00	24.00	.67	6908.22	6.65	741.22	92.2
STRUCTURE 6	RUNOFF	.55	1	2	.10	.0	3.00	24.00	1.35	---	6.24	399.98	729.9
STRUCTURE 6	ADDHYD	8.59	1	2	.10	.0	3.00	24.00	.71	---	6.44	983.93	114.6
STRUCTURE 6	RUNOFF	.43	1	2	.10	.0	3.00	24.00	.78	---	6.16	201.63	472.2
STRUCTURE 6	ADDHYD	9.01	1	2	.10	.0	3.00	24.00	.71	---	6.37	1081.21	120.0
XSECTION 6	REACH	9.01	1	2	.10	.0	3.00	24.00	.71	6832.63	6.37	1081.21	120.0
STRUCTURE 7	RUNOFF	.21	1	2	.10	.0	3.00	24.00	1.74	---	6.07	287.59	1363.0
STRUCTURE 7	ADDHYD	9.22	1	2	.10	.0	3.00	24.00	.74	---	6.29	1206.40	130.8

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
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SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	AMOUNT (IN)	DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
ALTERNATE 1 STORM 1													
XSECTION 7	REACH	9.22	1	2	.10	.0	3.00	24.00	.74	6720.52	6.58	1091.59	118.4
STRUCTURE 8	RUNOFF	.10	1	2	.10	.0	3.00	24.00	1.74	---	6.01	150.75	1538.3
STRUCTURE 55	RESVOR	.10	1	2	.10	.0	3.00	24.00	1.74	6905.81	6.21	68.06	694.5
STRUCTURE 8	ADDHYD	9.32	1	2	.10	.0	3.00	24.00	.75	---	6.56	1144.30	122.8
STRUCTURE 8	RUNOFF	.12	1	2	.10	.0	3.00	24.00	1.74	---	6.04	175.40	1474.0
STRUCTURE 8	ADDHYD	9.44	1	2	.10	.0	3.00	24.00	.76	---	6.55	1167.26	123.7
XSECTION 7	REACH	9.44	1	2	.10	.0	3.00	24.00	.76	6720.56	6.73	1140.21	120.8
STRUCTURE 9	RUNOFF	.16	1	2	.10	.0	3.00	24.00	1.74	---	6.03	244.81	1492.7
STRUCTURE 56	RESVOR	.16	1	2	.10	.0	3.00	24.00	1.74	6905.66	6.28	84.91	517.8
XSECTION 12	REACH	.16	1	2	.10	.0	3.00	24.00	1.74	6801.72	6.44	82.66	504.1
STRUCTURE 9	RUNOFF	.10	1	2	.10	.0	3.00	24.00	1.74	---	6.01	159.61	1520.1
STRUCTURE 9	ADDHYD	.27	1	2	.10	.0	3.00	24.00	1.74	---	6.06	189.70	705.2
STRUCTURE 57	RESVOR	.27	1	2	.10	.0	3.00	24.00	1.74	6906.04	6.93	75.75	281.6
STRUCTURE 9	ADDHYD	9.71	1	2	.10	.0	3.00	24.00	.79	---	6.74	1209.61	124.6
STRUCTURE 9	RUNOFF	.04	1	2	.10	.0	3.00	24.00	1.74	---	5.99	67.34	1603.3
STRUCTURE 9	ADDHYD	9.75	1	2	.10	.0	3.00	24.00	.79	---	6.74	1213.91	124.5
STRUCTURE 9	RUNOFF	.13	1	2	.10	.0	3.00	24.00	1.74	---	6.06	183.85	1436.3
STRUCTURE 58	RESVOR	.13	1	2	.10	.0	3.00	24.00	1.74	6906.82	6.30	74.11	578.9
STRUCTURE 9	ADDHYD	9.88	1	2	.10	.0	3.00	24.00	.80	---	6.72	1274.13	129.0
XSECTION 8	REACH	9.88	1	2	.10	.0	3.00	24.00	.80	6615.82	6.72	1274.13	129.0
STRUCTURE 10	RUNOFF	.16	1	2	.10	.0	3.00	24.00	1.74	---	6.07	215.22	1379.6
STRUCTURE 10	ADDHYD	10.04	1	2	.10	.0	3.00	24.00	.82	---	6.71	1297.60	129.3
XSECTION 9	REACH	10.04	1	2	.10	.0	3.00	24.00	.82	6565.25	6.86	1282.64	127.8
STRUCTURE 11	RUNOFF	.27	1	2	.10	.0	3.00	24.00	1.74	---	6.11	339.69	1248.9
STRUCTURE 11	ADDHYD	10.31	1	2	.10	.0	3.00	24.00	.84	---	6.83	1324.53	128.5
STRUCTURE 11	RUNOFF	.26	1	2	.10	.0	3.00	24.00	1.74	---	6.08	354.59	1348.2
STRUCTURE 11	ADDHYD	10.57	1	2	.10	.0	3.00	24.00	.86	---	6.82	1357.55	128.4
STRUCTURE 11	RUNOFF	.19	1	2	.10	.0	3.00	24.00	1.19	---	6.15	148.59	762.0
STRUCTURE 59	RESVOR	.19	1	2	.10	.0	3.00	24.00	1.19	6903.71	6.52	54.29	278.4
STRUCTURE 11	ADDHYD	10.77	1	2	.10	.0	3.00	24.00	.87	---	6.81	1405.50	130.6
XSECTION 10	REACH	10.77	1	2	.10	.0	3.00	24.00	.87	6524.51	7.00	1379.33	128.1
STRUCTURE 12	RUNOFF	.14	1	2	.10	.0	3.00	24.00	.64	---	6.15	55.38	384.6
STRUCTURE 12	ADDHYD	10.91	1	2	.10	.0	3.00	24.00	.87	---	7.00	1386.82	127.1
ALTERNATE 1 STORM 2													
STRUCTURE 1	RUNOFF	1.44	1	2	.10	.0	4.60	24.00	1.66	---	6.26	1204.75	836.0
STRUCTURE 51	RESVOR	1.44	1	2	.10	.0	4.60	24.00	1.65	7112.94	6.50	905.81	628.6

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 1 STORM 2 (100-YR)													
XSECTION 1	REACH	1.44	1	2	.10	.0	4.60	24.00	1.65	7047.60	6.62	879.80	610.6
STRUCTURE 2	RUNOFF	1.40	1	2	.10	.0	4.60	24.00	1.70	---	6.39	985.09	703.1
STRUCTURE 52	RESVOR	1.40	1	2	.10	.0	4.60	24.00	1.69	7132.47	6.67	739.72	528.0
XSECTION 2	REACH	1.40	1	2	.10	.0	4.60	24.00	1.69	7177.42	6.81	708.05	505.4
STRUCTURE 3	ADDHYD	2.84	1	2	.10	.0	4.60	24.00	1.67	---	6.72	1430.20	503.2
STRUCTURE 3	RUNOFF	.30	1	2	.10	.0	4.60	24.00	1.84	---	6.07	458.76	1509.1
STRUCTURE 3	ADDHYD	3.15	1	2	.10	.0	4.60	24.00	1.69	---	6.72	1476.47	469.3
XSECTION 3	REACH	3.15	1	2	.10	.0	4.60	24.00	1.69	6980.02	6.86	1402.29	445.7
STRUCTURE 5	RUNOFF	.38	1	2	.10	.0	4.60	24.00	1.68	---	6.09	492.26	1295.4
STRUCTURE 25	ADDHYD	3.53	1	2	.10	.0	4.60	24.00	1.68	---	6.86	1449.65	411.1
STRUCTURE 24	RUNOFF	1.84	1	2	.10	.0	4.60	24.00	1.62	---	6.29	1421.39	772.9
STRUCTURE 53	RESVOR	1.84	1	2	.10	.0	4.60	24.00	1.60	7212.39	6.54	1084.93	590.0
STRUCTURE 44	RUNOFF	1.16	1	2	.10	.0	4.60	24.00	1.62	---	6.22	1029.34	888.1
STRUCTURE 4	ADDHYD	3.00	1	2	.10	.0	4.60	24.00	1.61	---	6.50	1640.67	547.3
XSECTION 4	REACH	3.00	1	2	.10	.0	4.60	24.00	1.61	7008.52	6.69	1345.55	448.8
STRUCTURE 5	RUNOFF	.99	1	2	.10	.0	4.60	24.00	1.74	---	6.41	703.88	708.1
STRUCTURE 5	ADDHYD	3.99	1	2	.10	.0	4.60	24.00	1.64	---	6.63	1909.34	478.3
STRUCTURE 5	RUNOFF	.52	1	2	.10	.0	4.60	24.00	1.74	---	6.16	575.37	1108.6
STRUCTURE 54	RESVOR	.52	1	2	.10	.0	4.60	24.00	1.74	6907.73	6.35	388.59	748.7
XSECTION 4	REACH	.52	1	2	.10	.0	4.60	24.00	1.73	7004.01	6.46	386.66	745.0
STRUCTURE 45	ADDHYD	4.51	1	2	.10	.0	4.60	24.00	1.65	---	6.58	2202.41	488.2
STRUCTURE 5	ADDHYD	8.04	1	2	.10	.0	4.60	24.00	1.67	---	6.76	3327.85	414.1
XSECTION 5	REACH	8.04	1	2	.10	.0	4.60	24.00	1.67	6912.15	6.89	3268.58	406.7
STRUCTURE 6	RUNOFF	.55	1	2	.10	.0	4.60	24.00	2.69	---	6.22	843.76	1539.7
STRUCTURE 6	ADDHYD	8.59	1	2	.10	.0	4.60	24.00	1.73	---	6.87	3467.32	403.9
STRUCTURE 6	RUNOFF	.43	1	2	.10	.0	4.60	24.00	1.85	---	6.13	535.93	1255.1
STRUCTURE 6	ADDHYD	9.01	1	2	.10	.0	4.60	24.00	1.74	---	6.87	3536.11	392.4
XSECTION 6	REACH	9.01	1	2	.10	.0	4.60	24.00	1.74	6834.72	6.87	3536.11	392.4
STRUCTURE 7	RUNOFF	.21	1	2	.10	.0	4.60	24.00	3.19	---	6.06	531.83	2520.5
STRUCTURE 7	ADDHYD	9.22	1	2	.10	.0	4.60	24.00	1.77	---	6.86	3577.29	387.9
XSECTION 7	REACH	9.22	1	2	.10	.0	4.60	24.00	1.77	6722.02	7.00	3507.29	380.3
STRUCTURE 8	RUNOFF	.10	1	2	.10	.0	4.60	24.00	3.20	---	5.99	275.01	2806.2
STRUCTURE 55	RESVOR	.10	1	2	.10	.0	4.60	24.00	3.19	6910.06	6.22	91.89	937.6
STRUCTURE 8	ADDHYD	9.32	1	2	.10	.0	4.60	24.00	1.78	---	7.00	3578.04	383.9
STRUCTURE 8	RUNOFF	.12	1	2	.10	.0	4.60	24.00	3.20	---	6.02	321.44	2701.2
STRUCTURE 8	ADDHYD	9.44	1	2	.10	.0	4.60	24.00	1.80	---	7.00	3597.40	381.1

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
<u>ALTERNATE 1 STORM 2</u>													
XSECTION 7	REACH	9.44	1	2	.10	.0	4.60	24.00	1.80	6722.05	7.12	3575.59	378.8
STRUCTURE 9	RUNOFF	.16	1	2	.10	.0	4.60	24.00	3.20	---	6.01	448.07	2732.1
STRUCTURE 56	RESVOR	.16	1	2	.10	.0	4.60	24.00	3.19	6910.20	6.24	183.03	1116.0
XSECTION 12	REACH	.16	1	2	.10	.0	4.60	24.00	3.19	6802.29	6.37	169.61	1034.2
STRUCTURE 9	RUNOFF	.10	1	2	.10	.0	4.60	24.00	3.20	---	6.00	291.61	2777.3
STRUCTURE 9	ADDHYD	.27	1	2	.10	.0	4.60	24.00	3.19	---	6.04	358.14	1331.4
STRUCTURE 57	RESVOR	.27	1	2	.10	.0	4.60	24.00	3.19	6907.31	6.22	284.81	1058.8
STRUCTURE 9	ADDHYD	9.71	1	2	.10	.0	4.60	24.00	1.84	---	7.12	3696.03	380.7
STRUCTURE 9	RUNOFF	.04	1	2	.10	.0	4.60	24.00	3.20	---	5.98	122.11	2907.4
STRUCTURE 9	ADDHYD	9.75	1	2	.10	.0	4.60	24.00	1.85	---	7.11	3701.98	379.7
STRUCTURE 9	RUNOFF	.13	1	2	.10	.0	4.60	24.00	3.19	---	6.04	332.94	2601.1
STRUCTURE 58	RESVOR	.13	1	2	.10	.0	4.60	24.00	3.18	6911.51	6.29	148.14	1157.3
STRUCTURE 9	ADDHYD	9.88	1	2	.10	.0	4.60	24.00	1.86	---	7.11	3778.76	382.5
XSECTION 8	REACH	9.88	1	2	.10	.0	4.60	24.00	1.86	6617.79	7.11	3778.76	382.5
STRUCTURE 10	RUNOFF	.16	1	2	.10	.0	4.60	24.00	3.19	---	6.06	397.37	2547.2
STRUCTURE 10	ADDHYD	10.04	1	2	.10	.0	4.60	24.00	1.88	---	7.11	3803.30	379.0
XSECTION 9	REACH	10.04	1	2	.10	.0	4.60	24.00	1.88	6568.47	7.23	3788.09	377.5
STRUCTURE 11	RUNOFF	.27	1	2	.10	.0	4.60	24.00	3.19	---	6.10	635.09	2334.9
STRUCTURE 11	ADDHYD	10.31	1	2	.10	.0	4.60	24.00	1.92	---	7.22	3829.45	371.5
STRUCTURE 11	RUNOFF	.26	1	2	.10	.0	4.60	24.00	3.19	---	6.07	656.65	2496.8
STRUCTURE 11	ADDHYD	10.57	1	2	.10	.0	4.60	24.00	1.95	---	7.22	3866.55	365.8
STRUCTURE 11	RUNOFF	.19	1	2	.10	.0	4.60	24.00	2.46	---	6.13	326.81	1676.0
STRUCTURE 59	RESVOR	.19	1	2	.10	.0	4.60	24.00	2.46	6907.60	6.53	106.03	543.7
STRUCTURE 11	ADDHYD	10.77	1	2	.10	.0	4.60	24.00	1.96	---	7.21	3952.51	367.2
XSECTION 10	REACH	10.77	1	2	.10	.0	4.60	24.00	1.96	6527.64	7.35	3919.12	364.1
STRUCTURE 12	RUNOFF	.14	1	2	.10	.0	4.60	24.00	1.62	---	6.12	161.29	1120.1
STRUCTURE 12	ADDHYD	10.91	1	2	.10	.0	4.60	24.00	1.95	---	7.35	3931.01	360.3

SUMMARY TABLE 2 - SELECTED MODIFIED ATT-KIN REACH ROUTINGS IN ORDER OF STANDARD EXECUTIVE CONTROL INSTRUCTIONS
(A STAR(*) AFTER VOLUME ABOVE BASE(IN) INDICATES A HYDROGRAPH TRUNCATED AT A VALUE EXCEEDING BASE + 10% OF PEAK
A QUESTION MARK(?) AFTER COEFF.(C) INDICATES PARAMETERS OUTSIDE ACCEPTABLE LIMITS, SEE PREVIOUS WARNINGS)

		HYDROGRAPH INFORMATION							ROUTING PARAMETERS									PEAK TRAVEL TIME	
		INFLOW		OUTFLOW		OUTFLOW+ INTERV.AREA			VOLUME	MAIN	ITER-	Q AND A EQUATION			PEAK	S/Q	ATT-		
XSEC ID	REACH LENGTH (FT)	PEAK (CFS)	TIME (HR)	PEAK (CFS)	TIME (HR)	PEAK (CFS)	TIME (HR)	BASE-FLOW (CFS)	ABOVE BASE (IN)	TIME INCR (HR)	ATION #	COEFF (X)	POWER (M)	LENGTH FACTOR (K*)	RATIO O/I (Q*)	@PEAK (K) (SEC)	KIN COEFF (C)	STOR-AGE (HR)	KINE-MATIC (HR)
ALTERNATE 1 STORM 1																			
1	2200	98	7.1	98	7.2	---	---	0	.66	.10	1	1.95	1.48	.002	1.000	212	.92?	.10	.06
2	3000	95	7.4	95	7.6	---	---	0	.68	.10	1	2.20	1.24	.012	.995	537	.50	.20	.15
3	3400	203	7.4	203	7.5	---	---	0	.68	.10	1	1.99	1.48	.002	1.000	260	.82?	.10	.07
4	8500	379	6.3	335	6.5	---	---	0	.63	.10	1	2.04	1.47	.019	.883	532	.51	.20	.15
4	3000	48	6.8	47	6.9	---	---	0	.71	.10	1	2.14	1.45	.006	.992	370	.66	.10	.10
5	5000	763	6.5	738	6.7	---	---	0	.67	.10	1	.655	1.50	.009	.967	479	.55	.20	.13
6	2400	1079	6.4	1079	6.4	---	---	0	.71	.10	0	2.30	1.51	.001	1.000	87	1.00?	.00	.00
7	3900	1206	6.3	1091	6.6	---	---	0	.74	.10	1	.081	1.65	.016	.904	652	.43	.30	.18
7	2500	1162	6.5	1138	6.7	---	---	0	.76	.10	1	.081	1.65	.007	.980	424	.60	.20	.12
12	3300	85	6.3	82	6.4	---	---	0	1.74	.10	1	2.82	1.35	.024	.968	362	.66	.10	.10
8	3150	1273	6.7	1273	6.7	---	---	0	.80	.10	0	2.24	1.51	.001	1.000	110	1.00?	.00	.00
9	4700	1297	6.7	1280	6.9	---	---	0	.82	.10	1	1.58	1.38	.009	.987	343	.69?	.20	.10
10	4900	1405	6.8	1379	7.0	---	---	0	.87	.10	1	4.86	1.10	.027	.981	537	.50	.20	.15
ALTERNATE 1 STORM 2																			
1	2200	906	6.5	876	6.6	---	---	0	1.65	.10	1	2.95	1.20	.027	.967	245	.85?	.10	.07
2	3000	734	6.7	707	6.8	---	---	0	1.69	.10	1	1.61	1.33	.020	.962	302	.75?	.10	.08
3	3400	1471	6.7	1393	6.9	---	---	0	1.69	.10	1	2.42	1.24	.023	.947	325	.71?	.20	.09
4	8500	1640	6.5	1345	6.7	---	---	0	1.61	.10	2	2.36	1.25	.089	.820	786	.37	.20	.22
4	3000	379	6.4	379	6.5	---	---	0	1.74	.10	1	2.04	1.47	.012	.999	188	.98?	.10	.05
5	5000	3308	6.8	3268	6.9	---	---	0	1.67	.10	1	.920	1.43	.014	.988	328	.71?	.10	.09
6	2400	3525	6.9	3525	6.9	---	---	0	1.74	.10	0	2.73	1.46	.001	1.000	62	1.00?	.00	.00
7	3900	3565	6.9	3507	7.0	---	---	0	1.77	.10	1	.086	1.64	.012	.984	430	.59	.10	.12
7	2500	3597	7.0	3573	7.1	---	---	0	1.80	.10	1	.086	1.64	.005	.993	275	.79?	.10	.08
12	3300	179	6.2	167	6.4	---	---	0	3.19	.10	1	2.84	1.34	.023	.937	301	.75?	.20	.08
8	3150	3778	7.1	3778	7.1	---	---	0	1.86	.10	0	2.63	1.47	.001	1.000	81	1.00?	.00	.00
9	4700	3803	7.1	3784	7.2	---	---	0	1.88	.10	1	1.57	1.38	.008	.995	254	.83?	.10	.07
10	4900	3952	7.2	3910	7.3	---	---	0	1.96	.10	1	1.50	1.32	.014	.989	375	.65	.10	.10

SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS.......... 1 (10YR)	2 (100-YR)	
STRUCTURE 59	.19			
ALTERNATE 1		54.29	106.03	
STRUCTURE 58	.13			
ALTERNATE 1		74.11	148.14	POND #3
STRUCTURE 57	.27			
ALTERNATE 1		75.75	264.81	POND #2
STRUCTURE 56	.16			
ALTERNATE 1		84.91	183.03	POND #1
STRUCTURE 55	.10			
ALTERNATE 1		68.06	91.89	POND #4
STRUCTURE 54	.52			
ALTERNATE 1		47.85	388.59	
STRUCTURE 53	1.84			
ALTERNATE 1		98.51	1084.93	
STRUCTURE 52	1.40			
ALTERNATE 1		95.04	739.72	
STRUCTURE 51	1.44			
ALTERNATE 1		98.08	905.81	
STRUCTURE 45	4.51			
ALTERNATE 1		613.98	2202.41	
STRUCTURE 44	1.16			
ALTERNATE 1		343.06	1029.34	
STRUCTURE 25	3.53			
ALTERNATE 1		329.93	1449.65	
STRUCTURE 24	1.84			
ALTERNATE 1		473.09	1421.39	
STRUCTURE 12	10.91			
ALTERNATE 1		1386.82	3931.01	

SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS.......... 1 (10-YR)	2 (100-YR)
STRUCTURE 11	10.77		
ALTERNATE 1		1405.50	3952.51
STRUCTURE 10	10.04		
ALTERNATE 1		1297.60	3803.30
STRUCTURE 9	9.88		
ALTERNATE 1		1274.13	3778.76
STRUCTURE 8	9.44		
ALTERNATE 1		1167.26	3597.40
STRUCTURE 7	9.22		
ALTERNATE 1		1206.40	3577.29
STRUCTURE 6	9.01		
ALTERNATE 1		1081.21	3536.11
STRUCTURE 5	8.04		
ALTERNATE 1		765.48	3327.85
STRUCTURE 4	3.00		
ALTERNATE 1		378.73	1640.67
STRUCTURE 3	3.15		
ALTERNATE 1		203.16	1476.47
STRUCTURE 2	1.40		
ALTERNATE 1		339.72	985.09
STRUCTURE 1	1.44		
ALTERNATE 1		408.96	1204.75
XSECTION 1	1.44		
ALTERNATE 1		98.06	879.80
XSECTION 2	1.40		
ALTERNATE 1		94.56	708.05
XSECTION 3	3.15		
ALTERNATE 1		203.10	1402.29

SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS.......... 1 (10-YR)	2 (100-YR)
XSECTION 4	.52		
ALTERNATE 1		47.51	386.66
XSECTION 5	8.04		
ALTERNATE 1		741.22	3268.58
XSECTION 6	9.01		
ALTERNATE 1		1081.21	3536.11
XSECTION 7	9.44		
ALTERNATE 1		1140.21	3575.59
XSECTION 8	9.88		
ALTERNATE 1		1274.13	3778.76
XSECTION 9	10.04		
ALTERNATE 1		1282.64	3788.09
XSECTION 10	10.77		
ALTERNATE 1		1379.33	3919.12
XSECTION 12	.16		
ALTERNATE 1		82.66	169.61

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	AMOUNT (IN)	DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
ALTERNATE 1 STORM 1													
STRUCTURE 1	RUNOFF	.32	9	2	.05	.0	1.97	2.00	.10	---	1.40	17.48	53.8
XSECTION 1	REACH	.32	9	2	.05	.0	1.97	2.00	.10	7379.63	2.05	15.59	48.0
STRUCTURE 2	RUNOFF	.68	9	2	.05	.0	1.97	2.00	.12	---	1.49	39.97	58.8
STRUCTURE 2	ADDHYD	1.00	9	2	.05	.0	1.97	2.00	.11	---	1.54	53.48	53.2
XSECTION 2	REACH	1.00	9	2	.05	.0	1.97	2.00	.11	7240.00	2.13	50.85	50.6
STRUCTURE 4	RUNOFF	.62	9	2	.05	.0	1.97	2.00	.13	---	1.47	39.53	63.9
STRUCTURE 4	ADDHYD	1.62	9	2	.05	.0	1.97	2.00	.12	---	2.01	86.06	53.0
STRUCTURE 3	RUNOFF	.96	9	2	.05	.0	1.97	2.00	.12	---	1.59	56.00	58.2
XSECTION 3	REACH	.96	9	2	.05	.0	1.97	2.00	.12	7175.56	2.21	48.20	50.1
STRUCTURE 4	RUNOFF	.53	9	2	.05	.0	1.97	2.00	.13	---	1.53	33.25	62.6
STRUCTURE 4	ADDHYD	1.49	9	2	.05	.0	1.97	2.00	.12	---	2.06	77.62	52.0
STRUCTURE 4	ADDHYD	3.12	9	2	.05	.0	1.97	2.00	.12	---	2.03	163.57	52.5
XSECTION 4	REACH	3.12	9	2	.05	.0	1.97	2.00	.12	6973.80	2.11	162.52	52.1
STRUCTURE 6	RUNOFF	.38	9	2	.05	.0	1.97	2.00	.14	---	1.50	25.70	67.1
STRUCTURE 6	ADDHYD	3.50	9	2	.05	.0	1.97	2.00	.12	---	2.08	184.89	52.8
STRUCTURE 5	RUNOFF	3.31	9	2	.05	.0	1.97	2.00	.11	---	2.03	167.53	50.7
XSECTION 5	REACH	3.31	9	2	.05	.0	1.97	2.00	.11	7002.42	2.20	165.13	50.0
STRUCTURE 6	RUNOFF	1.23	9	2	.05	.0	1.97	2.00	.13	---	1.55	79.76	64.6
STRUCTURE 6	ADDHYD	4.54	9	2	.05	.0	1.97	2.00	.11	---	2.06	236.61	52.1
STRUCTURE 6	ADDHYD	8.04	9	2	.05	.0	1.97	2.00	.12	---	2.07	421.36	52.4
XSECTION 6	REACH	8.04	9	2	.05	.0	1.97	2.00	.12	6909.34	2.21	410.98	51.1
STRUCTURE 7	RUNOFF	.94	9	2	.05	.0	1.97	2.00	.18	---	1.45	81.94	87.3
STRUCTURE 7	ADDHYD	8.98	9	2	.05	.0	1.97	2.00	.12	---	2.11	470.11	52.4
XSECTION 7	REACH	8.98	9	2	.05	.0	1.97	2.00	.12	6836.02	2.29	453.28	50.5
STRUCTURE 8	RUNOFF	.87	9	2	.05	.0	1.97	2.00	.21	---	1.42	84.45	97.5
STRUCTURE 8	ADDHYD	9.84	9	2	.05	.0	1.97	2.00	.13	---	2.16	499.66	50.8
XSECTION 8	REACH	9.84	9	2	.05	.0	1.97	2.00	.13	6719.91	2.66	422.37	42.9
STRUCTURE 9	RUNOFF	.93	9	2	.05	.0	1.97	2.00	.19	---	1.47	80.96	87.5
STRUCTURE 9	ADDHYD	10.77	9	2	.05	.0	1.97	2.00	.14	---	2.60	429.82	39.9
XSECTION 9	REACH	10.77	9	2	.05	.0	1.97	2.00	.14	6563.65	2.78	423.40	39.3
STRUCTURE 10	RUNOFF	.14	9	2	.05	.0	1.97	2.00	.19	---	1.40	13.33	92.5
STRUCTURE 10	ADDHYD	10.91	9	2	.05	.0	1.97	2.00	.14	---	2.78	423.58	38.8

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 1 STORM 2													
STRUCTURE 1	RUNOFF	.32	8	2	.05	.0	2.89	2.00	.39	---	.92	84.60	260.3
XSECTION 1	REACH	.32	8	2	.05	.0	2.89	2.00	.39	7380.08	1.26	72.42	222.8
STRUCTURE 2	RUNOFF	.68	8	2	.05	.0	2.89	2.00	.44	---	1.07	180.97	266.1
STRUCTURE 2	ADDHYD	1.00	8	2	.05	.0	2.89	2.00	.42	---	1.15	249.02	247.8
XSECTION 2	REACH	1.00	8	2	.05	.0	2.89	2.00	.42	7240.76	1.36	224.23	223.1
STRUCTURE 4	RUNOFF	.62	8	2	.05	.0	2.89	2.00	.46	---	1.02	175.68	283.8
STRUCTURE 4	ADDHYD	1.62	8	2	.05	.0	2.89	2.00	.44	---	1.25	376.32	231.7
STRUCTURE 3	RUNOFF	.96	8	2	.05	.0	2.89	2.00	.45	---	1.17	248.27	258.1
XSECTION 3	REACH	.96	8	2	.05	.0	2.89	2.00	.45	7176.29	1.50	197.25	205.0
STRUCTURE 4	RUNOFF	.53	8	2	.05	.0	2.89	2.00	.46	---	1.11	146.29	275.5
STRUCTURE 4	ADDHYD	1.49	8	2	.05	.0	2.89	2.00	.45	---	1.33	315.08	211.0
STRUCTURE 4	ADDHYD	3.12	8	2	.05	.0	2.89	2.00	.44	---	1.28	687.72	220.6
XSECTION 4	REACH	3.12	8	2	.05	.0	2.89	2.00	.44	6977.58	1.38	679.57	218.0
STRUCTURE 6	RUNOFF	.38	8	2	.05	.0	2.89	2.00	.48	---	1.07	111.02	289.9
STRUCTURE 6	ADDHYD	3.50	8	2	.05	.0	2.89	2.00	.45	---	1.34	771.58	220.5
STRUCTURE 5	RUNOFF	3.31	8	2	.05	.0	2.89	2.00	.41	---	1.30	730.75	221.1
XSECTION 5	REACH	3.31	8	2	.05	.0	2.89	2.00	.41	7006.23	1.48	688.64	208.4
STRUCTURE 6	RUNOFF	1.23	8	2	.05	.0	2.89	2.00	.47	---	1.14	344.14	278.9
STRUCTURE 6	ADDHYD	4.54	8	2	.05	.0	2.89	2.00	.43	---	1.38	968.84	213.4
STRUCTURE 6	ADDHYD	8.04	8	2	.05	.0	2.89	2.00	.44	---	1.36	1738.97	216.3
XSECTION 6	REACH	8.04	8	2	.05	.0	2.89	2.00	.44	6912.76	1.51	1680.43	209.0
STRUCTURE 7	RUNOFF	.94	8	2	.05	.0	2.89	2.00	.57	---	1.00	336.17	358.0
STRUCTURE 7	ADDHYD	8.98	8	2	.05	.0	2.89	2.00	.45	---	1.46	1881.75	209.6
XSECTION 7	REACH	8.98	8	2	.05	.0	2.89	2.00	.45	6841.46	1.73	1691.95	188.5
STRUCTURE 8	RUNOFF	.87	8	2	.05	.0	2.89	2.00	.61	---	.94	347.24	401.0
STRUCTURE 8	ADDHYD	9.84	8	2	.05	.0	2.89	2.00	.47	---	1.71	1813.27	184.2
XSECTION 8	REACH	9.84	8	2	.05	.0	2.89	2.00	.47	6720.64	1.94	1729.18	175.7
STRUCTURE 9	RUNOFF	.93	8	2	.05	.0	2.89	2.00	.57	---	1.01	329.42	356.1
STRUCTURE 9	ADDHYD	10.77	8	2	.05	.0	2.89	2.00	.47	---	1.93	1843.69	171.2
XSECTION 9	REACH	10.77	8	2	.05	.0	2.89	2.00	.47	6566.13	2.04	1830.36	170.0
STRUCTURE 10	RUNOFF	.14	8	2	.05	.0	2.89	2.00	.58	---	.90	56.33	391.2
STRUCTURE 10	ADDHYD	10.91	8	2	.05	.0	2.89	2.00	.48	---	2.04	1846.78	169.2

SUMMARY TABLE 2 - SELECTED MODIFIED ATT-KIN REACH ROUTINGS IN ORDER OF STANDARD EXECUTIVE CONTROL INSTRUCTIONS
(A STAR(*) AFTER VOLUME ABOVE BASE(IN) INDICATES A HYDROGRAPH TRUNCATED AT A VALUE EXCEEDING BASE + 10% OF PEAK
A QUESTION MARK(?) AFTER COEFF.(C) INDICATES PARAMETERS OUTSIDE ACCEPTABLE LIMITS, SEE PREVIOUS WARNINGS)

XSEC ID	REACH LENGTH (FT)	HYDROGRAPH INFORMATION: INFLOW PEAK (CFS)	INFLOW TIME (HR)	OUTFLOW PEAK (CFS)	OUTFLOW TIME (HR)	OUTFLOW+ INTERV.AREA PEAK (CFS)	OUTFLOW+ INTERV.AREA TIME (HR)	BASE-FLOW (CFS)	ROUTING PARAMETERS: VOLUME ABOVE BASE (IN)	MAIN TIME INCR (HR)	ITER-ATION #	Q AND A EQUATION COEFF (X)	Q AND A EQUATION POWER (M)	LENGTH FACTOR (K*)	PEAK RATIO O/I (Q*)	S/Q @PEAK (K) (SEC)	ATT-KIN COEFF (C)	PEAK TRAVEL TIME STOR-AGE (HR)	PEAK TRAVEL TIME KINE-MATIC (HR)
ALTERNATE 1 STORM 1																			
1	4000	17	1.4	16	2.0	---	---	0	.10	.05	1	3.82	1.01	.241	.892	1017	.16	.65	.28
2	5200	53	1.6	51	2.2	---	---	0	.11	.05	1	2.09	1.26	.191	.950	1020	.16	.60	.28
3	8600	56	1.6	48	2.2	---	---	0	.12	.05	1	2.20	1.24	.358	.861	1702	.10	.60	.48
4	3300	163	2.0	162	2.1	---	---	0	.12	.05	1	1.91	1.49	.021	.994	266	.51	.05	.07
5	6700	167	2.0	165	2.2	---	---	0	.11	.05	1	2.06	1.47	.071	.986	546	.28	.10	.15
6	5100	421	2.0	411	2.2	---	---	0	.12	.05	1	4.48	1.13	.098	.976	593	.26	.15	.16
7	8600	470	2.1	453	2.3	---	---	0	.12	.05	1	4.55	1.22	.096	.964	664	.24	.20	.19
8	7900	500	2.2	422	2.7	---	---	0	.13	.05	7	1.19	1.23	.281	.845	1740	.10	.40	.49
9	5000	430	2.6	423	2.8	---	---	0	.14	.05	1	3.69	1.15	.064	.985	630	.25	.20	.18
ALTERNATE 1 STORM 2																			
1	4000	84	.9	72	1.3	---	---	0	.39	.05	2	3.25	1.10	.226	.858	828	.20	.35	.23
2	5200	249	1.1	224	1.4	---	---	0	.42	.05	1	2.05	1.26	.161	.900	738	.22	.20	.21
3	8600	248	1.1	197	1.5	---	---	0	.45	.05	1	2.04	1.26	.300	.795	1225	.14	.35	.35
4	3300	687	1.3	679	1.4	---	---	0	.44	.05	1	2.36	1.33	.031	.988	255	.52	.10	.07
5	6700	731	1.3	688	1.5	---	---	0	.41	.05	3	2.48	1.31	.089	.941	527	.29	.20	.15
6	5100	1738	1.4	1680	1.5	---	---	0	.44	.05	1	3.28	1.21	.069	.967	428	.35	.15	.12
7	8600	1881	1.5	1691	1.8	---	---	0	.45	.05	1	9.58	1.00	.179	.899	898	.18	.30	.25
8	7900	1813	1.7	1729	2.0	---	---	0	.47	.05	1	.169	1.63	.074	.954	728	.22	.25	.20
9	5000	1843	2.0	1830	2.0	---	---	0	.47	.05	1	1.55	1.38	.026	.993	330	.43	.10	.09

SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS.......... 1 10-YR	2 100-YR
STRUCTURE 10	10.91		
ALTERNATE 1		423.58	1846.78
STRUCTURE 9	10.77		
ALTERNATE 1		429.82	1843.69
STRUCTURE 8	9.84		
ALTERNATE 1		499.66	1813.27
STRUCTURE 7	8.98		
ALTERNATE 1		470.11	1881.75
STRUCTURE 6	8.04		
ALTERNATE 1		421.36	1738.97
STRUCTURE 5	3.31		
ALTERNATE 1		167.53	730.75
STRUCTURE 4	3.12		
ALTERNATE 1		163.57	687.72
STRUCTURE 3	.96		
ALTERNATE 1		56.00	248.27
STRUCTURE 2	1.00		
ALTERNATE 1		53.48	249.02
STRUCTURE 1	.32		
ALTERNATE 1		17.48	84.60
XSECTION 1	.32		
ALTERNATE 1		15.59	72.42
XSECTION 2	1.00		
ALTERNATE 1		50.85	224.23
XSECTION 3	.96		
ALTERNATE 1		48.20	197.25
XSECTION 4	3.12		
ALTERNATE 1		162.52	679.57

SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS.......... 1 10-YR	2 100-YR
XSECTION 5	3.31		
ALTERNATE 1		165.13	688.64
XSECTION 6	8.04		
ALTERNATE 1		410.98	1680.43
XSECTION 7	8.98		
ALTERNATE 1		453.28	1691.95
XSECTION 8	9.84		
ALTERNATE 1		422.37	1729.18
XSECTION 9	10.77		
ALTERNATE 1		423.40	1830.36

MAIN - UNEXPECTED RECORD FOUND(IGNORED) >>>BOTTOM <<<

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 1 STORM 1													
STRUCTURE 1	RUNOFF	.32	1	2	.10	.0	3.00	24.00	.44	---	6.13	85.91	264.3
XSECTION 1	REACH	.32	1	2	.10	.0	3.00	24.00	.44	7379.91	6.44	50.94	156.7
STRUCTURE 2	RUNOFF	.68	1	2	.10	.0	3.00	24.00	.48	---	6.21	158.76	233.5
STRUCTURE 2	ADDHYD	1.00	1	2	.10	.0	3.00	24.00	.47	---	6.25	181.51	180.6
XSECTION 2	REACH	1.00	1	2	.10	.0	3.00	24.00	.47	7240.46	6.50	140.08	139.4
STRUCTURE 4	RUNOFF	.62	1	2	.10	.0	3.00	24.00	.51	---	6.20	159.13	257.1
STRUCTURE 24	ADDHYD	1.62	1	2	.10	.0	3.00	24.00	.48	---	6.30	240.43	148.0
STRUCTURE 3	RUNOFF	.96	1	2	.10	.0	3.00	24.00	.49	---	6.28	193.55	201.2
XSECTION 3	REACH	.96	1	2	.10	.0	3.00	24.00	.49	7176.00	6.69	124.30	129.2
STRUCTURE 4	RUNOFF	.53	1	2	.10	.0	3.00	24.00	.51	---	6.23	125.63	236.6
STRUCTURE 44	ADDHYD	1.49	1	2	.10	.0	3.00	24.00	.50	---	6.56	175.41	117.5
STRUCTURE 4	ADDHYD	3.12	1	2	.10	.0	3.00	24.00	.49	---	6.34	404.51	129.8
XSECTION 4	REACH	3.12	1	2	.10	.0	3.00	24.00	.49	6975.60	6.45	400.64	128.5
STRUCTURE 6	RUNOFF	.38	1	2	.10	.0	3.00	24.00	.53	---	6.22	96.63	254.3
STRUCTURE 26	ADDHYD	3.50	1	2	.10	.0	3.00	24.00	.50	---	6.40	466.69	133.5
STRUCTURE 5	RUNOFF	3.31	1	2	.10	.0	3.00	24.00	.46	---	6.39	496.49	150.2
XSECTION 5	REACH	3.31	1	2	.10	.0	3.00	24.00	.46	7004.52	6.55	470.53	142.4
STRUCTURE 6	RUNOFF	1.23	1	2	.10	.0	3.00	24.00	.52	---	6.26	278.04	225.3
STRUCTURE 46	ADDHYD	4.54	1	2	.10	.0	3.00	24.00	.48	---	6.45	651.23	143.5
STRUCTURE 6	ADDHYD	8.04	1	2	.10	.0	3.00	24.00	.49	---	6.43	1117.90	139.1
XSECTION 6	REACH	8.04	1	2	.10	.0	3.00	24.00	.49	6911.50	6.64	1047.86	130.4
STRUCTURE 7	RUNOFF	.94	1	2	.10	.0	3.00	24.00	.63	---	6.20	313.31	333.7
STRUCTURE 7	ADDHYD	8.98	1	2	.10	.0	3.00	24.00	.50	---	6.60	1153.41	128.5
XSECTION 7	REACH	8.98	1	2	.10	.0	3.00	24.00	.50	6839.15	6.84	1066.94	118.9
STRUCTURE 8	RUNOFF	.87	1	2	.10	.0	3.00	24.00	.67	---	6.17	331.69	383.0
STRUCTURE 8	ADDHYD	9.84	1	2	.10	.0	3.00	24.00	.52	---	6.82	1128.33	114.7
XSECTION 8	REACH	9.84	1	2	.10	.0	3.00	24.00	.52	6720.23	7.08	1052.81	107.0
STRUCTURE 9	RUNOFF	.93	1	2	.10	.0	3.00	24.00	.63	---	6.21	301.40	325.8
STRUCTURE 9	ADDHYD	10.77	1	2	.10	.0	3.00	24.00	.52	---	7.06	1104.05	102.5
XSECTION 9	REACH	10.77	1	2	.10	.0	3.00	24.00	.53	6564.95	7.22	1090.97	101.3
STRUCTURE 10	RUNOFF	.14	1	2	.10	.0	3.00	24.00	.64	---	6.15	55.38	384.6
STRUCTURE 10	ADDHYD	10.91	1	2	.10	.0	3.00	24.00	.53	---	7.21	1097.16	100.6

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 1 STORM 2													
STRUCTURE 1	RUNOFF	.32	1	2	.10	.0	4.60	24.00	1.27	---	6.10	307.04	944.7
XSECTION 1	REACH	.32	1	2	.10	.0	4.60	24.00	1.27	7380.79	6.26	236.07	726.4
STRUCTURE 2	RUNOFF	.68	1	2	.10	.0	4.60	24.00	1.35	---	6.17	550.53	809.6
STRUCTURE 2	ADDHYD	1.00	1	2	.10	.0	4.60	24.00	1.33	---	6.20	773.11	769.3
XSECTION 2	REACH	1.00	1	2	.10	.0	4.60	24.00	1.33	7241.71	6.38	656.06	652.8
STRUCTURE 4	RUNOFF	.62	1	2	.10	.0	4.60	24.00	1.39	---	6.16	531.61	858.8
STRUCTURE 24	ADDHYD	1.62	1	2	.10	.0	4.60	24.00	1.35	---	6.28	1039.43	640.0
STRUCTURE 3	RUNOFF	.96	1	2	.10	.0	4.60	24.00	1.37	---	6.23	685.94	713.0
XSECTION 3	REACH	.96	1	2	.10	.0	4.60	24.00	1.37	7177.03	6.48	512.75	533.0
STRUCTURE 4	RUNOFF	.53	1	2	.10	.0	4.60	24.00	1.40	---	6.20	425.81	801.9
STRUCTURE 44	ADDHYD	1.49	1	2	.10	.0	4.60	24.00	1.38	---	6.34	795.02	532.5
STRUCTURE 4	ADDHYD	3.12	1	2	.10	.0	4.60	24.00	1.37	---	6.30	1825.11	585.5
XSECTION 4	REACH	3.12	1	2	.10	.0	4.60	24.00	1.37	6980.60	6.43	1782.72	571.9
STRUCTURE 6	RUNOFF	.38	1	2	.10	.0	4.60	24.00	1.43	---	6.19	318.03	836.9
STRUCTURE 26	ADDHYD	3.50	1	2	.10	.0	4.60	24.00	1.37	---	6.40	1972.55	564.1
STRUCTURE 5	RUNOFF	3.31	1	2	.10	.0	4.60	24.00	1.31	---	6.34	1831.61	554.2
XSECTION 5	REACH	3.31	1	2	.10	.0	4.60	24.00	1.31	7008.98	6.54	1629.77	493.1
STRUCTURE 6	RUNOFF	1.23	1	2	.10	.0	4.60	24.00	1.43	---	6.22	947.26	767.6
STRUCTURE 46	ADDHYD	4.54	1	2	.10	.0	4.60	24.00	1.34	---	6.43	2188.43	482.1
STRUCTURE 6	ADDHYD	8.04	1	2	.10	.0	4.60	24.00	1.36	---	6.42	4156.63	517.3
XSECTION 6	REACH	8.04	1	2	.10	.0	4.60	24.00	1.36	6915.95	6.55	4044.87	503.3
STRUCTURE 7	RUNOFF	.94	1	2	.10	.0	4.60	24.00	1.60	---	6.17	926.42	986.6
STRUCTURE 7	ADDHYD	8.98	1	2	.10	.0	4.60	24.00	1.38	---	6.53	4387.31	488.8
XSECTION 7	REACH	8.98	1	2	.10	.0	4.60	24.00	1.38	6845.18	6.78	3886.92	433.1
STRUCTURE 8	RUNOFF	.87	1	2	.10	.0	4.60	24.00	1.67	---	6.14	957.72	1105.9
STRUCTURE 8	ADDHYD	9.84	1	2	.10	.0	4.60	24.00	1.41	---	6.76	4049.35	411.5
XSECTION 8	REACH	9.84	1	2	.10	.0	4.60	24.00	1.41	6721.53	6.98	3820.52	388.2
STRUCTURE 9	RUNOFF	.93	1	2	.10	.0	4.60	24.00	1.61	---	6.18	892.39	964.7
STRUCTURE 9	ADDHYD	10.77	1	2	.10	.0	4.60	24.00	1.42	---	6.96	3954.81	367.3
XSECTION 9	REACH	10.77	1	2	.10	.0	4.60	24.00	1.42	6568.63	7.09	3932.41	365.3
STRUCTURE 10	RUNOFF	.14	1	2	.10	.0	4.60	24.00	1.62	---	6.12	161.29	1120.1
STRUCTURE 10	ADDHYD	10.91	1	2	.10	.0	4.60	24.00	1.43	---	7.09	3948.24	361.9

SUMMARY TABLE 2 - SELECTED MODIFIED ATT-KIN REACH ROUTINGS IN ORDER OF STANDARD EXECUTIVE CONTROL INSTRUCTIONS
(A STAR(*) AFTER VOLUME ABOVE BASE(IN) INDICATES A HYDROGRAPH TRUNCATED AT A VALUE EXCEEDING BASE + 10% OF PEAK
A QUESTION MARK(?) AFTER COEFF.(C) INDICATES PARAMETERS OUTSIDE ACCEPTABLE LIMITS, SEE PREVIOUS WARNINGS)

		HYDROGRAPH INFORMATION							ROUTING PARAMETERS									PEAK TRAVEL TIME	
		INFLOW		OUTFLOW		OUTFLOW+ INTERV.AREA			VOLUME	MAIN	ITER-	Q AND A EQUATION			PEAK	S/Q	ATT-		
XSEC ID	REACH LENGTH (FT)	PEAK (CFS)	TIME (HR)	PEAK (CFS)	TIME (HR)	PEAK (CFS)	TIME (HR)	BASE-FLOW (CFS)	ABOVE BASE (IN)	TIME INCR (HR)	ATION #	COEFF (X)	POWER (M)	LENGTH FACTOR (K*)	RATIO O/I (Q*)	@PEAK (K) (SEC)	KIN COEFF (C)	STOR-AGE (HR)	KINE-MATIC (HR)
ALTERNATE 1 STORM 1																			
1	4000	84	6.1	50	6.4	---	---	0	.44	.10	4	3.69	1.03	.240	.594	956	.32	.20	.27
2	5200	179	6.3	140	6.5	---	---	0	.47	.10	1	2.12	1.25	.105	.784	806	.37	.20	.23
3	8600	193	6.3	124	6.7	---	---	0	.49	.10	1	2.15	1.24	.213	.645	1327	.24	.30	.38
4	3300	401	6.3	399	6.5	---	---	0	.49	.10	1	1.99	1.48	.007	.994	203	.94?	.20	.06
5	6700	496	6.4	466	6.6	---	---	0	.46	.10	1	2.07	1.47	.024	.938	387	.64	.20	.11
6	5100	1112	6.4	1042	6.6	---	---	0	.49	.10	1	3.78	1.18	.044	.937	485	.54	.20	.14
7	8600	1153	6.6	1062	6.8	---	---	0	.50	.10	2	5.96	1.14	.060	.921	672	.42	.20	.19
8	7900	1127	6.8	1052	7.1	---	---	0	.52	.10	2	.098	1.77	.027	.933	768	.38	.30	.22
9	5000	1102	7.1	1091	7.2	---	---	0	.52	.10	1	1.59	1.38	.014	.990	382	.64	.10	.11
ALTERNATE 1 STORM 2																			
1	4000	307	6.1	232	6.3	---	---	0	1.27	.10	2	2.42	1.22	.160	.757	571	.48	.20	.16
2	5200	773	6.2	653	6.4	---	---	0	1.33	.10	1	1.61	1.33	.096	.845	518	.52	.20	.15
3	8600	677	6.2	512	6.5	---	---	0	1.37	.10	1	1.62	1.33	.168	.756	889	.34	.30	.26
4	3300	1825	6.3	1772	6.4	---	---	0	1.37	.10	1	1.90	1.29	.030	.971	281	.78?	.10	.08
5	6700	1813	6.3	1616	6.5	---	---	0	1.31	.10	1	2.04	1.28	.076	.891	581	.47	.20	.16
6	5100	4151	6.4	4015	6.6	---	---	0	1.36	.10	1	1.99	1.32	.028	.967	309	.74?	.20	.09
7	8600	4377	6.5	3882	6.8	---	---	0	1.38	.10	2	6.64	1.07	.107	.887	768	.38	.30	.21
8	7900	4033	6.8	3816	7.0	---	---	0	1.41	.10	1	.359	1.51	.040	.946	623	.45	.20	.17
9	5000	3945	7.0	3931	7.1	---	---	0	1.42	.10	1	1.57	1.38	.012	.997	268	.80?	.10	.07

SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS.......... 1 (10-YR)	2 (100-YR)
STRUCTURE 46	4.54		
ALTERNATE 1		651.23	2188.43
STRUCTURE 44	1.49		
ALTERNATE 1		175.41	795.02
STRUCTURE 26	3.50		
ALTERNATE 1		466.69	1972.55
STRUCTURE 24	1.62		
ALTERNATE 1		240.43	1039.43
STRUCTURE 10	10.91		
ALTERNATE 1		1097.16	3948.24
STRUCTURE 9	10.77		
ALTERNATE 1		1104.05	3954.81
STRUCTURE 8	9.84		
ALTERNATE 1		1128.33	4049.35
STRUCTURE 7	8.98		
ALTERNATE 1		1153.41	4387.31
STRUCTURE 6	8.04		
ALTERNATE 1		1117.90	4156.63
STRUCTURE 5	3.31		
ALTERNATE 1		496.49	1831.61
STRUCTURE 4	3.12		
ALTERNATE 1		404.51	1825.11
STRUCTURE 3	.96		
ALTERNATE 1		193.55	685.94
STRUCTURE 2	1.00		
ALTERNATE 1		181.51	773.11
STRUCTURE 1	.32		
ALTERNATE 1		85.91	307.04

SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS.......... 1	2
		10-YR	100-YR
XSECTION 1	.32		
ALTERNATE 1		50.94	236.07
XSECTION 2	1.00		
ALTERNATE 1		140.08	656.06
XSECTION 3	.96		
ALTERNATE 1		124.30	512.75
XSECTION 4	3.12		
ALTERNATE 1		400.64	1782.72
XSECTION 5	3.31		
ALTERNATE 1		470.53	1629.77
XSECTION 6	8.04		
ALTERNATE 1		1047.86	4044.87
XSECTION 7	8.98		
ALTERNATE 1		1066.94	3886.92
XSECTION 8	9.84		
ALTERNATE 1		1052.81	3820.52
XSECTION 9	10.77		
ALTERNATE 1		1090.97	3932.41

BLACK SQUIRREL CREEK AND MISCELLANEOUS BASINS DRAINAGE PLAN

APPENDIX D: DRAINAGE BOARD MINUTES