OUTFALL SYSTEMS PLANNING

LOWER DAD CLARK GULCH AND DFA 0068

URBAN DRAINAGE & FLOOD CONTROL DISTRICT

CITY OF LITTLETON

FEBRUARY 1991

CENTENNIAL ENGINEERING INC

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February 14, 1991

Mr. Scott Tucker, Executive Director
Urban Drainage & Flood Control District
2480 West 26th Avenue, Suite 156B
Denver, CO 80211

Re: Lower Dad Clark Gulch & DFA 0068
Outfall Systems Planning Report
CEI - 906.00

Dear Mr. Tucker:

Presented with this letter is the report entitled "Outfall Systems Planning, Lower Dad Clark Gulch and DFA 0068." This document represents the completion of a contract between the District and our firm which began in June, 1989. The contract also resulted in the publication of two other reports: 1) "Alternative Evaluation Report," dated April, 1990, which resulted in the selection of the outfall plan shown in this report and 2) the report entitled "Flood Hazard Area Delineation, Lower Dad Clark Gulch and DFA 0068", dated September, 1990, which should be referred to for floodplain regulation.

The purpose of the Outfall Systems Planning is to present a drainage system which addresses costs, flood control, erosion control, water quality enhancements and environmental protection. The outfall plan was developed through an alternative selection process which evaluated the three drainageways in the area: Rangeview Gulch, Jackass Gulch and Lower Dad Clark Gulch. Three alternatives were presented to the sponsors for each of the three drainageways, and a selected outfall plan was chosen.

This report will assist the sponsoring agencies in implementing the outfall systems plan so as to provide a uniform level of flood protection for the present and future property owners. It will also help insure an integrated drainage system as development occurs. Maintenance of this outfall system will be an important element in successful operation.

A technical addendum, which contains all of the hydrologic, hydraulic, and cost estimating support data, is submitted under separate cover. This related document includes the original computer files on floppy disk and the computer printouts.

We would like to express our appreciation to Ben Urbonas and Barb Benik of the District and Bob Deeds of the City of Littleton for their direction and assistance during the development of this project. We would also like to thank Diane Schade of the South Suburban Park and Recreation District and Michael Woika of the City of Englewood for their assistance. Thank you for the opportunity to be of service to the District and City of Littleton.

Very truly yours,

CENTENNIAL ENGINEERING, INC.

David L. Mallory, P.E.
Project Manager

Douglas C. Weber, P.E.
Chief Civil Engineer

Enclosures

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SECTION 1
INTRODUCTION

1.1 Authorization

The Urban Drainage and Flood Control District (District) authorized this outfall planning study under Agreement No. 89-02.06 and the Notice to Proceed became effective on July 19, 1989 (the date which pencil manuscripts were received). The City of Littleton is also a project sponsor. The principle project goals are:

1. Formulate an outfall system plan for basins drained by Rangeview Gulch, Jackass Gulch, and Lower Dad Clark Gulch.

2. Interface the outfall system with the South Platte Park.

The study area is located almost entirely within the corporate limits of Littleton and covers approximately 2.6 square miles. It is located just north of County Line Road and is bounded on the east by South Broadway and on the west by the South Platte River. The Lee Gulch Basin is adjacent to the north. Figure 1-1 shows the general location of the study area in the metropolitan region.

1.2 Scope of Work

The alternative evaluation phase of the outfall system planning includes the following tasks:

- Field reconnaissance.
- Compilation of existing data.
- Hydrologic analysis including flood routing.
- Development and evaluation of alternatives.
- Development of the selected plan.

In evaluating each alternative, consideration was given to costs, existing and proposed land use, existing and proposed drainage systems, constructibility, maintenance needs, right-of-way needs, flood control, water quality impacts, and open space benefits.

1.3 Modifications to Scope

Modifications were made to the original scope of work due to complications which arose in the hydrologic analysis of McLellan Reservoir. The initial review of the background hydrology for Upper Dad Clark Gulch revealed that a 100-year composite inflow hydrograph for McLellan Reservoir was not available. Because of this, further evaluation and flood routing had to be done in order to obtain a composite hydrograph. In addition, inflow hydrographs were also computed for the 2-, 5-, 10-, and 50-year storm frequencies.

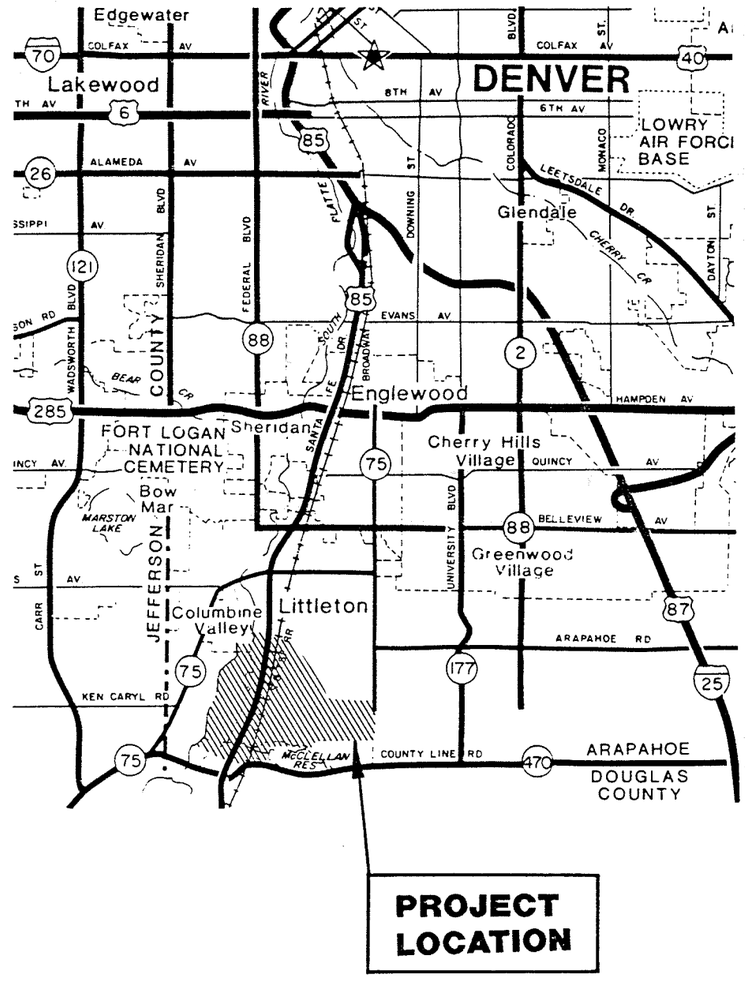


FIGURE 1-1
LOWER DAD CLARK GULCH & DFA 0068

1.4 Basin Descriptions

Some important features of the overall study area include:

1. Santa Fe Drive, the Denver & Rio Grande Western Railroad (D&RGW), and the Atchison, Topeka and Santa Fe Railroad (AT&SF): These features are located adjacent to each other and run north and south through the study area. These features greatly influence the natural westerly drainage patterns.

2. City Ditch: The ditch (owned by Englewood) flows to the north and is located in the lower basin areas, mostly on the west side of Santa Fe Drive. In the future, the ditch is planned to be enclosed in a 60 inch concrete pipe.

3. Highline Canal: This feature is owned and operated by the Denver Water Department and crosses the upper basins of Rangeview, Jackass, and Dad Clark Gulches. Rangeview basin drainage upstream of the Highline Canal would normally be intercepted by the canal. However, the development in the area directs storm runoff up to and including the 100-year flow through a storm sewer system to the Jackass Gulch basin. Flow from the Upper Jackass basin crosses under the canal in a storm sewer system. Storm runoff from the SouthPark commercial area just south of the Upper Jackass basin is discharged into the Highline Canal through several onsite detention facilities. During the 100-year event, the total discharge from these facilities is approximately 550 cfs. In this way, the canal is utilized for a trans-basin diversion.

   Routine Highline Canal releases during rainfall events have caused local flooding in the Lee Gulch drainageway. From the Highline Canal Master Plan (Reference 22, Appendix A), the capacity of the canal between Lee Gulch and Little Dry Creek was found to be approximately 600 cfs. The portion of the Highline Canal which crosses the study area was assumed to have a similar capacity.

4. McLellan Reservoir: The reservoir is owned and operated by Englewood as a water supply facility and is located in the Dad Clark Gulch basin just north of County Line Road. Currently, it is not used as a flood control facility but could be if an Adequate Assurances Agreement were signed between the City of Englewood, the City of Littleton, and the District.

The study area drains to the west toward the South Platte River, and each of the three major drainage basins (Rangeview, Jackass, and Lower Dad Clark) are served by existing drainage systems. The six direct flow areas do not have a significant drainage system. Records of previous flooding in the area are nonexistent.

The Rangeview Gulch basin is approximately 430 acres in size and is almost entirely residential. The drainage system in the upper basin (east of the railroad lines) is mostly open channel with numerous irrigation ponds. Both Ridgeview Park, and Turtle Lake (also known as Lynhardt Reservoir No. 2), could be used for flood control facilities if agreements were made with the property owners. Ridgeview Park is located in the center of the basin and is owned by South Suburban Park and Recreation District. Turtle Lake is located just upstream of the railroad lines and is private property. An existing 36" RCP storm sewer system is located under Curtice Street in the residential area between Ridgeview Park and Turtle Lake. However, flows in excess of the 2-year storm event will exceed the storm sewer capacities and will flood the street. At Turtle Lake, low flows are intercepted by the City Ditch before they reach the lake. Flows which are discharged from Turtle Lake would historically drain directly to the South Platte River. However, due to the construction of the AT&SF Railroad embankment, these flows drain north along the east side of the railroad and discharge into Lee Gulch. Refer to the "Flood Hazard Area Delineation" report for Lower Dad Clark Gulch and DFA 0068, dated September 1990.

The Jackass Gulch basin is just south of Rangeview Gulch and is approximately 500 acres in size. It is an elongated basin extending from South Broadway to the South Platte River and is zoned almost entirely as a Planned Development (PD, PD-R, PD-C & PD-I). The upper basin (east of the Highline Canal) is mostly commercial with some residential. All of the existing developments in the upper basin have been designed to detain storm runoff for the 100-year event via private onsite detention facilities. The area between the Highline Canal and the railroad lines is zoned residential. The storm runoff system in this area consists of a natural channel with a municipal detention facility located on the east side of the railroad spur line. The lower basin (west of Santa Fe Drive) is a future commercial area and has a 60" RCP storm outfall system which discharges into an open channel in South Platte Park just upstream of the South Platte River. Currently, over half of the Jackass Gulch basin is undeveloped.

The Lower Dad Clark Gulch basin extends from McLellan Reservoir to the South Platte River. The basin is approximately 290 acres in size and contains residential, commercial and industrial areas. Most of the basin is undeveloped at the present time. A portion of the South Park residential area is included in this basin. The drainage system is an open channel with bridge structures at the railroad and Santa Fe Drive (State Highway No. 85) crossings.

1.5 Background Information

A compilation of development drainage reports, utility information, construction plans, and other reference sources is listed in Appendix A. The availability of information for a specific area varied depending on the development. Two areas have minimal background information -- Rangeview Basin, which is an older development, and the Santa Fe Park area (between Santa Fe Drive and the South Platte River) which is still in the conceptual planning phase.

1.6 Key Issues

The initial coordination meeting with the District, City of Littleton, City of Englewood, and South Suburban Park and Recreation District identified a number of key issues. These are listed below:

1. Water quality issues should be addressed.

2. Recreation and aesthetic concerns should be addressed.

3. Irrigation ditches will be considered full, thereby accepting no storm runoff.

4. Existing flood control detention facilities should be included in the existing conditions hydrologic analysis. However, they should not be recognized in the developed conditions analysis unless they are publicly owned and maintained. Non-flood control facilities, such as McLellan Reservoir, should be ignored in the drainage analysis unless an Adequate Assurances Agreement is in place. Irrigation ponds should also be considered as non-flood control facilities and therefore ignored. Inadvertent detention, such as behind railroad embankments, should also be ignored.

5. The City Ditch flows are planned to be piped in a 60 inch concrete conduit with construction being done in three phases.

6. Diversion of storm flows from the Highline Canal into the Jackass Gulch basin should to be considered to reduce the periodic discharge at Lee Gulch.

7. The wetlands area on Jackass Gulch at the upstream side of the railroad spur line should be protected.

8. Detention facilities should be considered for Jackass Gulch in order to reduce 100-year discharge rates to the capacity of the existing 48 and 60 inch outfall system.

9. Storm flows should not be discharged into McLellan Reservoir except as provided by separate agreement.

10. McLellan Reservoir should be analyzed with and without dedicated flood storage for the Master Plan alternatives.

11. Negative impacts to the South Platte Park area should be minimized, including disturbance to the wildlife and harm to the vegetation.

1.7 Acknowledgements

This report was prepared by Centennial Engineering, Inc., consulting engineers of Arvada, Colorado, at the request of the Urban Drainage and Flood Control District.

All surveying and topographic data for this study was collected and compiled by Landmark, Ltd., Denver, Colorado, under a separate contract with the Urban Drainage and Flood Control District.

Various agencies, including the City of Littleton and the South Suburban Park and Recreation District, provided information pertaining to the analysis of these basins. Also, coordination was done with J.F. Sato and Associates, who is a subconsultant to DeLeuw Cather on the improvements to Santa Fe Drive (see the bibliography for a list of references). Technical data developed in this study is on file with the Urban Drainage and Flood Control District.

SECTION 2
PROJECT HYDROLOGY

2.1 Introduction

The hydrologic analysis was done for the 2-, 5-, 10-, 50-, and 100-year frequencies for both the existing and developed basin conditions.

Each basin was divided into subbasins which had a maximum size of 130 acres and an average size of 100 acres. In delineating subbasins, consideration was given to major drainage features, type of zoning, and land topography.

Imperviousness was determined with the aid of the Littleton zoning map and zoning regulations. The Urban Drainage and Flood Control Design Criteria and the City of Littleton Storm Drainage & Technical Criteria were used as a basis for all hydrologic analysis.

2.2 Design Rainfall

The 1-hour rainfall depths for the 2-, 5-, 10-, 50-, and 100-year events were determined from the Littleton Drainage Criteria and are shown in Table 2-1.

TABLE 2-1
1-Hour Rainfall Depths

FREQUENCY	RAINFALL Inches
2-yr	0.97
5-yr	1.38
10-yr	1.65
50-yr	2.32
100-yr	2.67

2.3 Computer Modeling

Runoff hydrographs were developed for each subbasin using the Colorado Urban Hydrograph Procedure (CUHP) and were then routed using the UD&FCD modified Environmental Protection Agency Storm Water Management Model (UDSWM2PC, referred to in this report as SWMM). Figure 2-1 shows the CUHP and SWMM networks and Figure 2-2 shows the projected future imperviousness.

2.3.1 CUHP Analysis

Subbasin areas, lengths, centroids, and slopes were determined from 1"=200' topographic mapping with a 2 foot contour interval. Time of concentration and percent imperviousness were determined for the existing and developed conditions of each subbasin. Detention storage depths were taken as the same for all basins, 0.35 inches and 0.05 inches for pervious and impervious areas, respectively. Infiltration rates, which are based on soil type, varied depending on location. Most soils in the area belong to hydrologic soil group C with initial and final infiltration rates of 3.0 in/hr and 0.50 in/hr., respectively. An infiltration decay coefficient of 0.0018 was used for all soils. The CUHP parameters are listed in Table 2-2.

For basins under 90 acres, a modified time to peak was used in accordance with District policy. Since all basins were under 160 acres, an estimated peak flow was calculated using the Rational Method.

The only basins not analyzed by the CUHP method were those upstream of McLellan Reservoir. The hydrographs from these basins were determined from previous studies.

2.3.2 SWMM Analysis

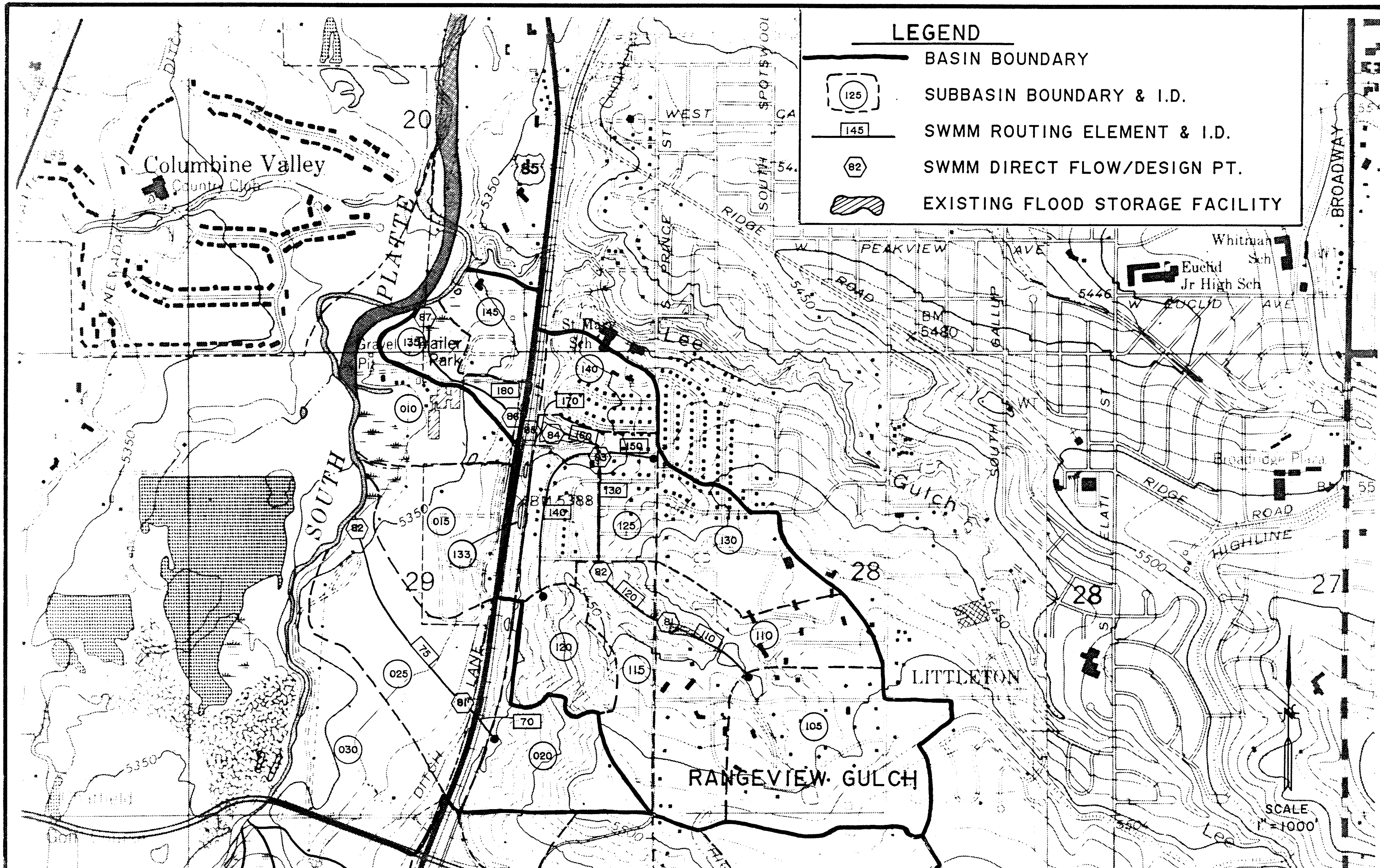
Two storm routing networks were developed for each of the three major basins and also for the direct flow areas. One network was prepared for existing conditions and one for developed conditions. The existing conditions network recognized all existing detention facilities. This excluded available detention in Rangeview Park, Turtle Lake, and McLellan Reservoir since these facilities were not being used formally or were not designated for flood control purposes. Also, no detention was assumed behind railroad embankments or in the irrigation ponds along Rangeview Gulch. The developed conditions network was the same as the existing except fully developed runoff conditions were used and only publicly owned detention facilities were recognized. The only detention facility in the study area which is publicly owned is on Jackass Gulch at Mineral Avenue upstream of the AT&SF Railroad spurline embankment. Table 2-4 summarizes the SWMM network parameters. The peak flows based on developed conditions were used in creating the flood discharge profiles.

For the alternative analysis, the networks were modified, as necessary, to reflect proposed detention facilities, storm sewer improvements, and flow diversions. These new networks were then run with developed runoff flows.

2.4 Hydrology Results

The hydrologic analysis was reviewed by Urban Drainage and approved in a letter dated November 28, 1989.

The results of the hydrologic analysis are summarized in the flood discharge profiles for the 2-, 10- and 100-year events and are shown in Figures 2-3, 2-4 and 2-5. These profiles represent the fully developed basin conditions with public detention facilities recognized. Tables 2-3a and 2-3b list the peak storm discharges for the existing and proposed conditions, respectively.



BASE MAP UNITED STATES GEOLOGICAL SURVEY MAP LITTLETON QUAD — HIGHLANDS RANCH QUAD	CENTENNIAL ENGINEERING INC	DESIGNED DJN DATE 10/89 DRAWN G.G.H. DATE 10/89 CHECKED DLM DATE 10/89 REVISED DATE	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	RANGEVIEW BASIN CUHP AND SWMM NETWORK	FIGURE 2-1a CEI JN 906.00

JACKASS GULCH

SOUTH PARK (RESIDENTIAL)

SOUTH PARK (COMMERCIAL)

LOWER DAD CLARK GULCH

UPPER DAD CLARK GULCH

ARAPAHOE CO

DOUGLAS CO

SOUTH PLATTE

DITCH

CITY

MINERAL AVE

HIGHLINE CANAL

BROADWAY

SPILLWAY ELEV 5489

PIPELINE

Wolhurst

Trailer Park

Wolhurst Lake

Pumping Station

Roadside

Blakeland

BM 5444

Water Tank

Sub Sta

SCALE 1" = 1000'

BASE MAP UNITED STATES GEOLOGICAL SURVEY MAP LITTLETON QUAD HIGHLANDS RANCH QUAD	CENTENNIAL ENGINEERING INC	DESIGNED DJN DATE 10/89 DRAWN G.G.H DATE 10/89 CHECKED DLM DATE 10/89 REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	JACKASS & LOWER DAD CLARK BASINS CUHP AND SWMM NETWORK	FIGURE 2-1b CEI JN 906.00

LEGEND

SYMBOL	PROBABLE FUTURE LAND USE	% IMPERV.
	OPEN SPACE AND AGRICULTURAL	2-10%
	RESIDENTIAL, LIGHT	20-35%
	RESIDENTIAL, NORMAL	40-50%
	RESIDENTIAL, DENSE	60-75%
	COMMERCIAL AND INDUSTRIAL AND PAVED AREAS	75-95%

Columbine Valley Country Club
Euclid Jr High Sch
Broadridge Plaza
LITTLETON
MATCH LINE
SCALE 1" = 1000'

BASE MAP
UNITED STATES GEOLOGICAL SURVEY MAP
LITTLETON QUAD HIGHLANDS RANCH QUAD

CENTENNIAL ENGINEERING INC

DESIGNED DJN DATE 10/89
DRAWN G.G.H. DATE 10/89
CHECKED DLM DATE 10/89
REVISED ____ DATE ____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

RANGEVIEW BASIN
PROJECTED FUTURE BASIN IMPERVIOUSNESS

FIGURE 2-2a
CEI JN 906.00

MATCH LINE

DITCH

HIGHLINE

MINERAL AVE

Chatfield

Golf Course

Water Tank

SOUTH PLATTE

Waterton

Trailer Park

Waterton Lake

Roadside Park

ARAPAHOE CO

DOUGLAS CO

Me Latten

Reservoir

CANAL

Sub Sta

BROADWAY

HIGHLINE CANAL

Blakeland

BM 5444

PIPELINE

85

470

5350

5360

5450

5500

5550

5600

32

33

34

5

4

3

1

SCALE 1" = 1000'

BASE MAP UNITED STATES GEOLOGICAL SURVEY MAP LITTLETON QUAD HIGHLANDS RANCH QUAD	CENTENNIAL ENGINEERING INC	DESIGNED DSN DATE 10/89 DRAWN G.G.H. DATE 10/89 CHECKED DLM DATE 10/89 REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	JACKASS & LOWER DAD CLARK BASINS PROJECTED FUTURE BASIN IMPERVIOUSNESS	FIGURE 2-2b CEI JN 906.00

TABLE 2-2 CUHP PARAMETERS

SUB BASIN I.D.	TRIBUTARY AREA (ac)	TRIBUTARY AREA (mi^2)	BASIN LENGTH (mi)	CENTROID LENGTH (mi)	BASIN SLOPE (ft/ft)	TIME OF CONCENTRATION EXISTING (min)	TIME OF CONCENTRATION DEVELOPED (min)	PERCENT IMPERVIOUSNESS EXISTING (%)	PERCENT IMPERVIOUSNESS DEVELOPED (%)	DEPRESSION STORAGE AND INFILTRATION RATE (See Note)
010	44	.0688	.5530	.2936	.0094	50	26	3	4	(1)
015	51	.0797	.4564	.2576	.0162	22	22	49	51	(1)
020	48	.0750	.3977	.1326	.0493	49	23	5	7	(1)
025	98	.1531	.8902	.5208	.0118	93	31	6	64	(1)
030	64	.1067	.3788	.2178	.0227	50	16	8	48	(1)
040	48	.0750	.4830	.2652	.0097	45	24	6	76	(1)
050	56	.0875	.5966	.3693	.0063	99	28	2	42	(1)
060	27	.0422	.4072	.1799	.0074	58	22	2	18	(1)
105	90	.1406	.5114	.2462	.0274	25	25	9	9	(1)
110	84	.1313	.5019	.1894	.0328	25	25	14	14	(1)
115	35	.0547	.5777	.2462	.0294	27	25	27	27	(1)
120	31	.0484	.3314	.1610	.0355	18	18	43	43	(2)
125	57	.0891	.5208	.1989	.0189	24	24	43	43	(3)
130	45	.0703	.5587	.2178	.0180	26	26	28	28	(1)
133	10	.0156	.3977	.2178	.0070	29	22	4	25	(4)
135	24	.0375	.3600	.1420	.0232	26	20	20	39	(3)
140	28	.0438	.3220	.1705	.0267	19	19	46	46	(2)
145	28	.0438	.2652	.1326	.0210	21	18	24	77	(2)
203	53	.0833	.4450	.2180	.0212	17	17	64	87	(1)
205	83	.1297	.6250	.3880	.0076	28	28	41	80	(1)
210	52	.0808	.6250	.2936	.0053	32	28	23	83	(1)
215	45	.0703	.5019	.2936	.0113	25	25	95	95	(1)
220	16	.0250	.2652	.0947	.0164	17	17	50	50	(1)

TABLE 2-2
CUHP PARAMETERS
(Continued)

SUB BASIN I.D.	TRIBUTARY AREA (ac)	TRIBUTARY AREA (mi^2)	BASIN LENGTH (mi)	CENTROID LENGTH (mi)	BASIN SLOPE (ft/ft)	TIME OF CONCENTRATION EXISTING (min)	TIME OF CONCENTRATION DEVELOPED (min)	PERCENT IMPERVIOUSNESS EXISTING (%)	PERCENT IMPERVIOUSNESS DEVELOPED (%)	DEPRESSION STORAGE AND INFILTRATION RATE (See Note)
225	54	.0844	.3598	.1799	.0179	21	21	43	43	(1)
230	25	.0391	.2746	.0947	.0297	18	18	20	20	(1)
235	11	.0172	.2936	.1515	.0303	19	19	19	23	(1)
240	40	.0625	.5966	.2178	.0286	28	28	56	58	(1)
245	60	.0938	.5492	.2462	.0307	28	26	4	43	(1)
250	17	.0266	.2273	.0947	.0607	17	17	2	54	(1)
255	23	.0359	.3030	.0852	.0450	19	19	22	79	(1)
260	18	.0281	.4072	.2273	.0223	36	21	23	69	(1)
360	42	.0656	.5227	.2273	.0206	25	25	45	45	(1)
365	51	.0797	.6061	.3409	.0326	28	28	64	64	(1)
370	41	.0641	.5303	.2652	.0332	20	20	11	13	(1)
375	34	.0531	.4830	.2557	.0439	38	24	2	80	(1)
380	8	.0125	.3125	.1515	.0150	33	19	21	36	(1)
385	16	.0250	.4545	.2178	.0140	40	23	21	32	(1)
390	98	.1531	.6345	.3598	.0100	55	23	9	66	(1)

NOTE: Depression storage was taken as the same for all basins: Impervious Areas = 0.05 inches
Pervious Areas = 0.35 inches

Infiltration rates were one of four types:

	Initial Rate	Final Rate	Decay Coeff.
(1)	3.0	0.5	0.0018
(2)	3.4	0.52	0.0018
(3)	3.7	0.55	0.0018
(4)	4.5	0.6	0.0018

TABLE 2-3a
PEAK DISCHARGES - EXISTING CONDITION

SUB BASIN I.D.	TRIBUTARY AREA (acres)	Q2 (cfs)	Q5 (cfs)	Q10 (cfs)	Q50 (cfs)	Q100 (cfs)
Direct Flow Areas						
010	44	2	15	24	54	70
015	51	38	68	90	154	185
020	48	3	18	27	60	77
025	98	4	24	36	81	104
030	68	5	28	41	89	113
040	48	3	20	29	64	82
050	56	1	11	18	42	55
060	27	1	8	12	27	35
Rangeview Gulch						
105	90	10	46	67	144	183
110	84	17	69	100	199	252
115	35	12	29	40	76	94
120	31	22	41	55	97	119
125	57	35	64	83	152	184
130	45	16	40	55	104	128
133	10	1	3	5	13	18
135	24	6	16	24	48	61
140	28	20	38	50	87	105
145	28	10	26	36	69	87
Jackass Gulch						
203	53	62	102	128	206	246
205	83	45	91	118	210	258
210	52	14	39	53	104	130
215	45	70	100	119	173	199

TABLE 2-3a
PEAK DISCHARGES - EXISTING CONDITION
(continued)

SUB BASIN I.D.	TRIBUTARY AREA (acres)	Q2 (cfs)	Q5 (cfs)	Q10 (cfs)	Q50 (cfs)	Q100 (cfs)
220	16	13	24	31	53	64
225	54	36	70	93	164	198
230	25	8	26	36	68	86
235	11	3	10	14	26	33
240	40	31	53	66	110	133
245	60	4	36	54	119	152
250	17	1.0	13	19	41	53
255	23	7	23	32	60	76
260	18	4	11	14	29	36
Lower Dad Clark Gulch						
360	42	25	49	62	108	133
365	51	46	75	93	151	181
370	41	7	34	50	100	128
375	34	1.0	15	22	50	65
380	8	2	4	6	12	15
385	16	3	8	11	23	28
390	98	7	33	48	106	135

TABLE 2-3b
PEAK DISCHARGES - DEVELOPED CONDITIONS

SUB BASIN I.D.	TRIBUTARY AREA (acres)	Q2 (cfs)	Q5 (cfs)	Q10 (cfs)	Q50 (cfs)	Q100 (cfs)
Direct Flow Areas						
010	44	3	27	40	88	112
015	51	40	70	92	157	187
020	48	6	34	51	106	136
025	98	93	154	190	307	369
030	68	58	111	144	243	296
040	48	57	87	107	166	194
050	56	30	61	78	139	170
060	27	7	23	33	63	80
Rangeview Gulch						
105	90	10	46	67	144	183
110	84	17	69	100	199	252
115	35	12	31	43	81	100
120	31	22	41	55	97	119
125	57	35	64	83	152	184
130	45	16	40	55	104	128
133	10	3	7	10	20	25
135	24	14	27	36	66	81
140	28	20	38	50	87	105
145	28	39	59	73	112	132
Jackass Gulch						
203	53	87	128	153	225	266
205	83	103	155	186	284	338
210	52	65	96	115	174	207
215	45	70	100	119	173	199

TABLE 2-3b
PEAK DISCHARGES - DEVELOPED CONDITIONS
(Continued)

SUB BASIN I.D.	TRIBUTARY AREA (acres)	Q2 (cfs)	Q5 (cfs)	Q10 (cfs)	Q50 (cfs)	Q100 (cfs)
220	16	15	29	36	60	74
225	54	36	70	93	164	198
230	25	8	26	36	68	86
235	11	3	10	14	27	33
240	40	31	53	66	110	133
245	60	34	68	87	154	189
250	17	15	27	35	58	70
255	23	32	49	60	91	107
260	18	20	31	38	61	72
Lower Dad Clark Gulch						
360	42	25	49	62	108	133
365	51	46	75	93	151	181
370	41	8	36	52	103	131
375	34	42	63	77	118	137
380	8	4	8	11	20	25
385	16	6	15	20	36	45
390	98	114	182	230	369	433

TABLE 2-4
SWMM NETWORK PARAMETERS

CONVEYANCE ELEMENT NUMBER	NEXT D/S CONVEYANCE ELEMENT	TYPE OF CONVEYANCE ELEMENT	LENGTH (ft)	SLOPE (ft/ft)	PIPE DIAMETER (ft)	CHANNEL BOTTOM WIDTH (ft)	CHANNEL SIDE SLOPES LEFT (ft/ft)	CHANNEL SIDE SLOPES RIGHT (ft/ft)	MANNING'S COEFF.	OVERFLOW DEPTH (ft)
DIRECT FLOW AREAS - EXISTING CONDITION										
70	75	Pipe with overflow across R.R.	300	0.025	2.5				0.016	2.5
				0.025		5.0	20	20	0.020	
75	--	Channel to South Platte R.	3750	0.009		3.0	50	50	0.040	
DIRECT FLOW AREAS - DEVELOPED CONDITION										
		(SAME AS EXISTING)								
RANGEVIEW GULCH - EXISTING CONDITION										
110	120	Channel	1300	0.0208		25	10	10	0.060	
120	130	Channel	950	0.0179		10	6	6	0.055	
130	160	Pipe with overflow	1300	0.020	2				0.024	2
				0.020		1	20	20	0.020	
140	160	Flow down Costilla Street	2000	0.015		1	20	20	0.020	
150	160	Flow down Costilla Avenue	800	0.033		1	20	20	0.020	
160	170	Channel	800	0.0233		5	25	25	0.030	
170	175	Overflow across AT&SF R.R.	100	0.020		4	25	25	0.030	
175	180	Channel to west side of Santa Fe	200	0.020		4	25	25	0.030	
180	--	Channel to South Platte R.	1550	0.018		50	20	20	0.030	
RANGEVIEW GULCH - DEVELOPED CONDITION										
		(SAME AS EXISTING)								
JACKASS GULCH - EXISTING CONDITION										
205	81/91	Pipe with overflow	2000	0.0085	3				0.016	3
				0.0060		4	5	5	0.040	

TABLE 2-4
SWMM NETWORK PARAMETERS
(Continued)

CONVEYANCE ELEMENT NUMBER	NEXT D/S CONVEYANCE ELEMENT	TYPE OF CONVEYANCE ELEMENT	LENGTH (ft)	SLOPE (ft/ft)	PIPE DIAMETER (ft)	CHANNEL BOTTOM WIDTH (ft)	CHANNEL SIDE SLOPES LEFT (ft/ft)	CHANNEL SIDE SLOPES RIGHT (ft/ft)	MANNING'S COEFF.	OVERFLOW DEPTH (ft)
81/91	210	Pipe - detention simulation	1.0	0.0068	4.5	--	--	--	0.016	4.5
210	215	Pipe with overflow	2700	0.008	4.5				0.016	4.5
				0.017		1	20	20	0.020	
215	250	Channel with overflow	1550	0.020		0.5	12	12	0.016	0.5
				0.030		4	4	4	0.040	
220	82/92	Channel	1800	0.014		1	4	4	0.040	5
82/92	225	Pipe - detention simulation	1.0	0.0265	3	--	--	--	0.016	3
225	230	Pipe with overflow	1300	0.0285	3				0.016	3
				0.0285		1	20	20	0.020	
230	235	Pipe with overflow	750	0.0125	3.5				0.016	3.5
				0.0125		1	20	20	0.020	
235	250	Channel to Gulch	500	0.030		4	4	4	0.040	
240	83/93	Pipe - out of sump area	1650	0.0093	4.5				0.016	4.5
83/93	245	Pipe - detention simulation	300	0.080	2.25				0.016	2.25
245	250	Channel to Gulch	350	0.040		4	4	4	0.040	
250	85/95	Channel	2500	0.023		4	4	4	0.040	
85/95	255	Pipe with overflow - detention behind Jackass Hill Road.	150	0.0250	5.5				0.016	4
				0.0250		1	20	20	0.020	
255	86/96	Channel	500	0.0220		4	4	4	0.040	
86/96	260	Detention release VOLUME = OUTFLOW =	0 ac-ft 0 cfs	12 ac-ft 170 cfs	15 ac-ft 700 cfs	19 ac-ft 1400 cfs				
260	265	Pipe with overflow	700	0.0190	4				0.016	4

TABLE 2-4
SWMM NETWORK PARAMETERS
(Continued)

CONVEYANCE ELEMENT NUMBER	NEXT D/S CONVEYANCE ELEMENT	TYPE OF CONVEYANCE ELEMENT	LENGTH (ft)	SLOPE (ft/ft)	PIPE DIAMETER (ft)	CHANNEL BOTTOM WIDTH (ft)	CHANNEL SIDE SLOPES LEFT (ft/ft)	CHANNEL SIDE SLOPES RIGHT (ft/ft)	MANNING'S COEFF.	OVERFLOW DEPTH (ft)
				0.040		1	20	20	0.020	
265	270	Pipe with overflow	1300	0.015	5				0.016	5
				0.015		1	20	20	0.020	
270	--	Channel	600	0.010		10	4	4	0.040	
JACKASS GULCH - DEVELOPED CONDITION										
		SAME AS EXISTING EXCEPT DELETE DETENTION AT 91, 92, 93, AND 95.								
LOWER DAD CLARK GULCH - EXISTING CONDITION										
81/91	210	Pipe with overflow - detention simulation	1.0	0.0265	1.5				0.016	1.5
				0.0265		1	20	20	0.020	1.95
210	220	Channel	1000	0.028		4	5	5	0.030	
220	82/92	Pipe with overflow	300	0.020	3				0.016	3
				0.020		10	25	25	0.040	
82/92	230	Pipe with overflow - detention simulation	1.0	0.0165	3				0.016	3
				0.0165		1	20	20	0.020	3.65
230	250	Channel	1200	0.017		5	10	10	0.040	
301 [2/]	240	Inflow hydrograph [1/] TIME = / INFLOW =	1.0 hr / 0 cfs	1.33 hr / 324 cfs	1.67 hr / 800 cfs	2.0 hr / 1052 cfs	2.33 hr / 1168 cfs	3.0 hr / 1260 cfs		
		TIME = / INFLOW =	4.0 hr / 1260 cfs	5.33 hr / 1080 cfs	8.0 hr / 360 cfs	8.67 hr / 230 cfs	10.0 hr / 90 cfs	12.0 hr / 60 cfs		
302	240	Inflow hydrograph [1/] TIME = / INFLOW =	0 hr / 0 cfs	1.0 hr / 352 cfs	4.13 hr / 0 cfs					

TABLE 2-4
SWMM NETWORK PARAMETERS
(Continued)

CONVEYANCE ELEMENT NUMBER	NEXT D/S CONVEYANCE ELEMENT	TYPE OF CONVEYANCE ELEMENT	LENGTH (ft)	SLOPE (ft/ft)	PIPE DIAMETER (ft)	CHANNEL BOTTOM WIDTH (ft)	CHANNEL SIDE SLOPES LEFT (ft/ft)	CHANNEL SIDE SLOPES RIGHT (ft/ft)	MANNING'S COEFF.	OVERFLOW DEPTH (ft)
303	240	Inflow hydrograph [1/] TIME = / INFLOW =	0 hr / 0 cfs	0.33 hr / 114 cfs	2.0 hr / 0 cfs					
240	242	Channel	4200	0.003		10	4	4	.040	
304	242	Inflow hydrograph [1/] TIME = / INFLOW =	0 hr / 0 cfs	1.0 hr / 635 cfs	2.0 hr / 0 cfs					
305	242	Inflow hydrograph [1/] TIME = / INFLOW =	0 hr / 0 cfs	0.83 hr / 315 cfs	1.98 hr / 0 cfs					
306	242	Inflow hydrograph [1/] TIME = / INFLOW=	0 hr / 0 cfs	1.0 hr / 285 cfs	2.2 hr / 0 cfs					
242	245	Channel	4200	0.003		10	4	4	0.040	
307	245	Inflow hydrograph [1/] TIME = / INFLOW =	0 hr / 0 cfs	0.62 hr / 62 cfs	1.62 hr / 0 cfs					
308	245	Inflow hydrograph [1/] TIME = / INFLOW =	0 hr / 0 cfs	0.38 hr / 30.2 cfs	1.37 hr / 0 cfs					
245	250	Channel	2200	0.010		20	5	5	0.040	
250	260	Channel	250	0.010		50	3	3	0.040	
260	270	Channel with overflow	2400	0.005		3	3	3	0.040	2
				0.005		15	20	20	0.070	
270	--	Channel to South Platte R.	1100	0.008		3	50	50	0.070	
LOWER DAD CLARK GULCH - DEVELOPED CONDITION										
260	270	SAME AS EXISTING EXCEPT DELETE DETENTION AT 91 & 92 AND REPLACE 260 WITH THE FOLLOWING: Channel	2400	0.005		20	4	4	.040	

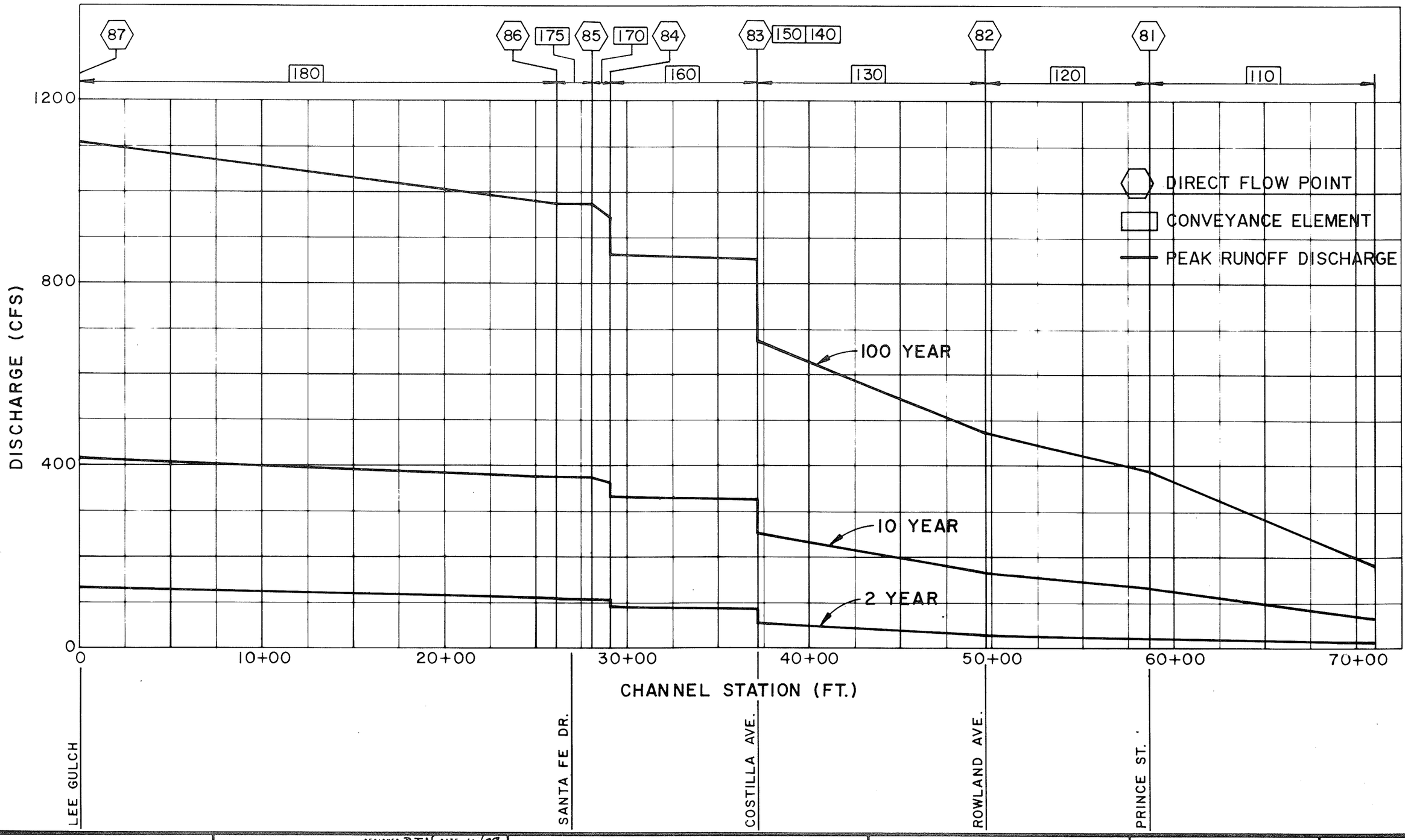
TABLE 2-4
SWMM NETWORK PARAMETERS
(Continued)

CONVEYANCE ELEMENT NUMBER	NEXT D/S CONVEYANCE ELEMENT	TYPE OF CONVEYANCE ELEMENT	LENGTH (ft)	SLOPE (ft/ft)	PIPE DIAMETER (ft)	CHANNEL BOTTOM WIDTH (ft)	CHANNEL SIDE SLOPES LEFT (ft/ft)	CHANNEL SIDE SLOPES RIGHT (ft/ft)	MANNING'S COEFF.	OVERFLOW DEPTH (ft)
LOWER DAD CLARK GULCH - DEVELOPED CONDITION Assuming McLellan Reservoir has adequate assurances agreement										
		SAME AS DEVELOPED CONDITION ABOVE EXCEPT ALL INFLOW HYDROGRAPHS PLUS ELEMENTS 240 & 242 ARE REPLACED WITH THE FOLLOWING:								
311	72/73	Inflow hydrograph [1/] TIME =	0 hr	0.67 hr	1.0 hr	1.17 hr	1.67 hr	2.0 hr		
		INFLOW =	0 cfs	1300 cfs	1686 cfs	1530 cfs	1530 cfs	1340 cfs		
		TIME =	3.67 hr	5.33 hr	8.0 hr	8.67 hr	10.0 hr	12.0 hr		
		INFLOW =	1340 cfs	1080 cfs	360 cfs	230 cfs	90 cfs	60 cfs		
72/73	245	Detention release VOLUME =	0	100 ac-ft	200 ac-ft	325 ac-ft	450 ac-ft	550 ac-ft	650 ac-ft	
		OUTFLOW =	0	200 cfs	400 cfs	720 cfs	1100 cfs	1490 cfs	2000 cfs	

[1/] NOTE: These parameters are for the 100-year frequency storm. For the other frequencies, the inflow hydrograph discharge values are taken as a percentage of the 100-year: 50-year = 80%, 10-yr = 50%, 5-yr = 40%, 2-yr = 20%.

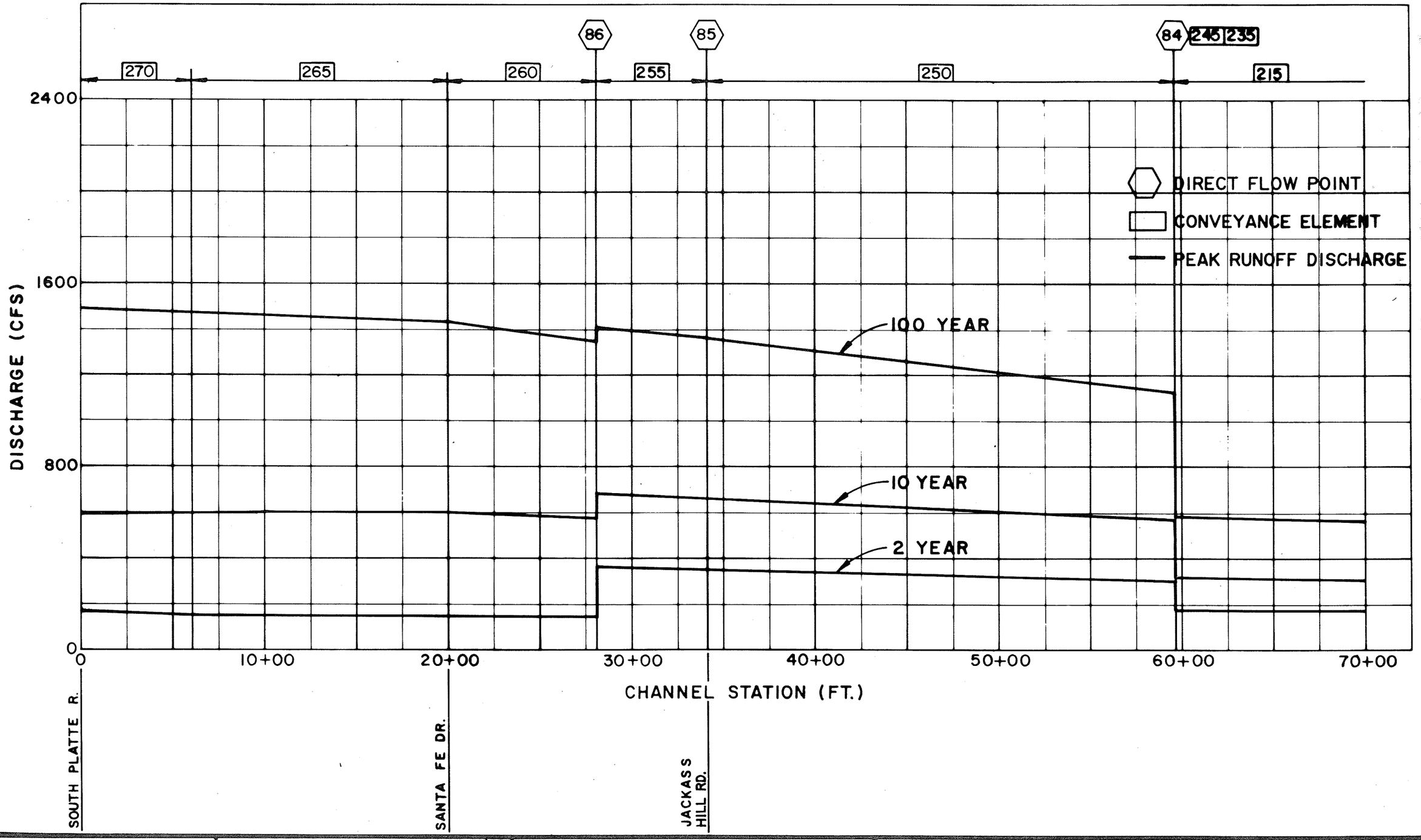
[2/] This hydrograph includes the effects of upper basin regional detention.

RANGEVIEW GULCH
DEVELOPED CONDITION



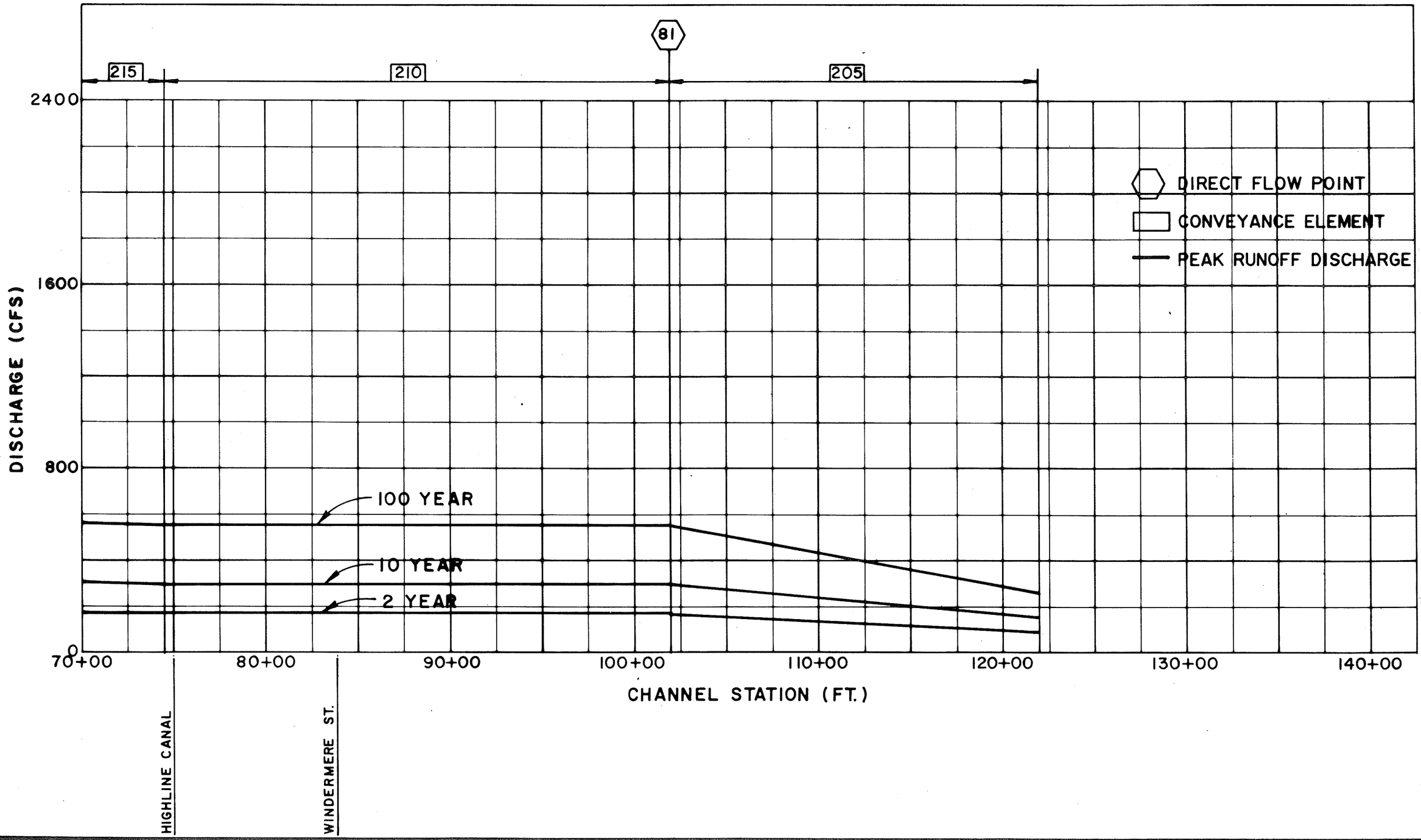
CENTENNIAL ENGINEERING INC.	DESIGNED DJN DATE 10/89 DRAWN C.J.H. DATE 10/89 CHECKED DLM DATE 10/89 REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	RANGEVIEW GULCH DISCHARGE PROFILE DEVELOPED CONDITION	FIGURE 2-3 CEI JN 906.00

JACKASS GULCH
DEVELOPED CONDITION



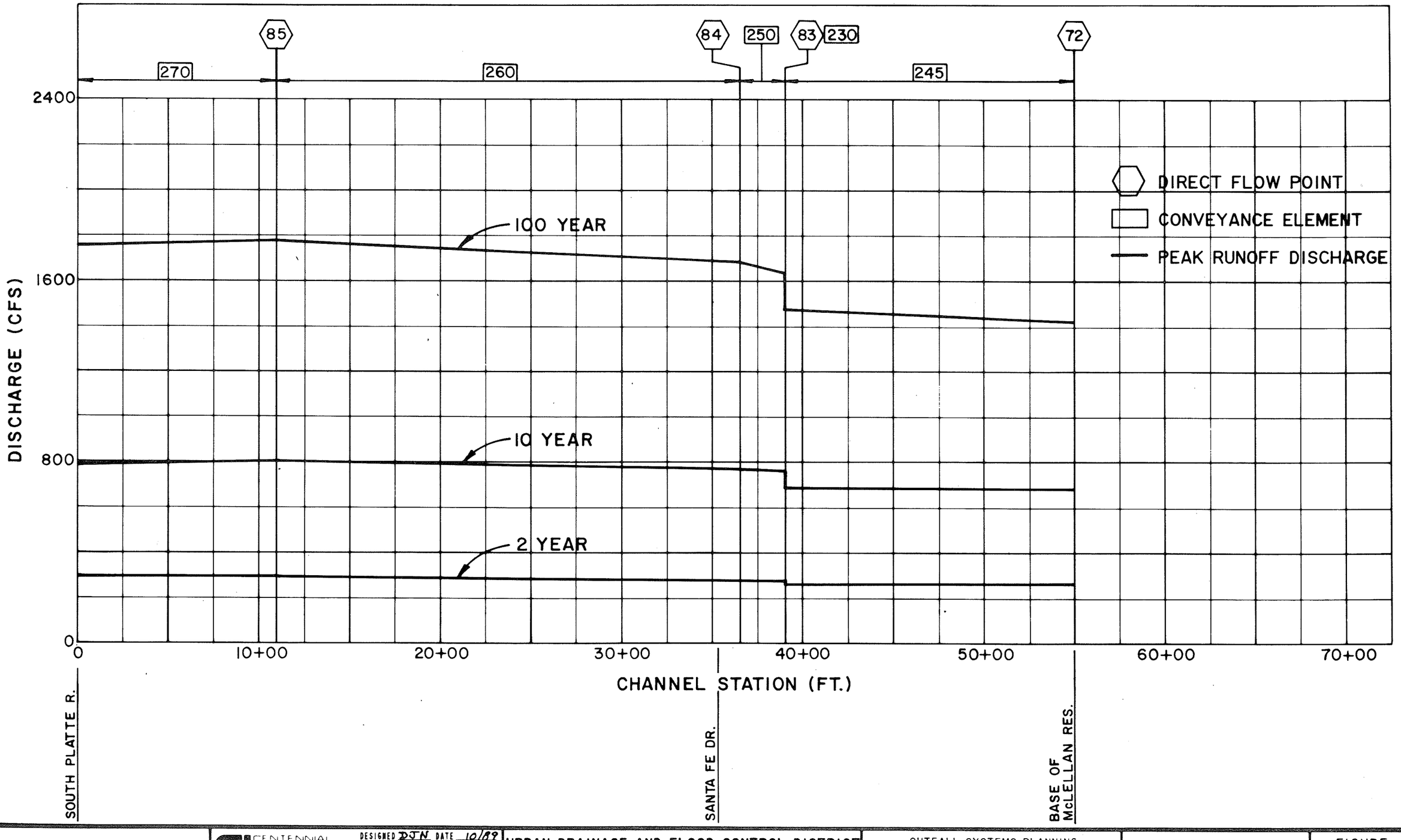
	CENTENNIAL ENGINEERING INC	DESIGNED DJN DATE 10/89 DRAWN C.J.A DATE 10/89 CHECKED DLM DATE 10/89 REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	JACKASS GULCH STA. 0+00 TO STA. 70+00 DISCHARGE PROFILE DEVELOPED CONDITION	FIGURE 2-4a CEI JN 906.00

JACKASS GULCH
DEVELOPED CONDITION



	CENTENNIAL ENGINEERING INC	DESIGNED DJN DATE 10/89 DRAWN C.L.H. DATE 10/89 CHECKED DLM DATE 10/89 REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	JACKASS GULCH STA. 70+00 TO STA. 122+00 DISCHARGE PROFILE DEVELOPED CONDITION	FIGURE 2-4b CEI JN 906.00

LOWER DAD CLARK GULCH
DEVELOPED CONDITION



	CENTENNIAL ENGINEERING INC DESIGNED DJN DATE 10/89 DRAWN C.L.H. DATE 10/89 CHECKED DLM DATE 10/89 REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	LOWER DAD CLARK GULCH DISCHARGE PROFILE DEVELOPED CONDITION	FIGURE 2—5 CEI JN 906.00

SECTION 3
ALTERNATIVE DEVELOPMENT AND EVALUATION

3.1 Introduction

There are three basins under consideration, Rangeview, Jackass, and Lower Dad Clark. The direct flow areas, which cover about 440 acres of land, were not analyzed since these areas will discharge directly into the South Platte River through onsite drainage systems as development progresses. Storm discharges developed in Direct Flow Basin 020 (east of the railroad lines) should be restricted to historic rates (see Table 2-3a) and released through the existing culverts under the railways and Santa Fe Drive.

Three outfall alternatives were developed and evaluated for each basin. As described earlier, additional hydrologic routing was done, if necessary. An estimated construction cost was projected for each of the three alternatives and an evaluation matrix was developed. The drainage basins are independent of each other, and therefore, different alternatives can be selected for each.

3.2 Design Criteria

Unless specific criteria was stipulated by the Project Sponsors, the Urban Storm Drainage Criteria Manual (USDCM) and the City of Littleton Drainage Criteria Manual were used as a basis of the design.

3.2.1. Basis for Outfall Service to 100 Acre Basins.

Outfall systems were developed to serve all basins of approximately 100 acres or more in area. This area criterion is a "rule of thumb" and is based on the observation that, during a 100-year runoff event, a typical urban watershed with a two-year storm sewer capacity will generally convey the flow in a combination of pipe and street gutter drainage systems for tributary areas of 100 acres or smaller.

In watersheds larger than 100 acres, the local storm sewer collection system and allowable street capacity become inadequate to handle major runoff events, and a major outfall system becomes necessary. Because Littleton requires a two-year storm sewer capacity for new developments, a basin size of 100 acres was selected as the smallest area to which an outfall system would extend.

3.2.2 Open Channels

Open channels were designed specifically for District maintenance eligibility. All open channels were designed as trapezoidal sections with side slopes of 4:1 and flow depths less than or equal to 5 feet. Channel slopes generally ranged from 0.2 to 0.4 percent except where it was desired to minimize the number of drop structures. The Froude Number was limited to 0.8 and velocities were limited to 7 fps (5 fps in sandy soils).

There are two types of channels referred to in this study: 1) "grass-lined channels" which are designed with a concrete trickle channel, and 2) "wetlands bottom channels" which have grass-lined side slopes, a wetlands bottom and no trickle channel. (In this report, all channel improvement reaches are grass-lined channels unless specified otherwise.)

Most channels are grass-lined channels and were assigned an n-value of 0.035. Wetlands bottom channels were assigned n-values of 0.045 for a major storm event and 0.07 for low flows.

Three foot vertical concrete wall drop structures were used for grade control. Maintenance roads were proposed for all channels except in areas where access exists from adjacent public streets.

3.2.3 Crossing Structures

Three types of crossing structures were examined for this study: bridges, culverts, and low flow crossings. The only existing bridge structures along the project reaches are located on Lower Dad Clark Gulch for the railroad and State Highway crossings. Since these structures are adequate for the flow, no improvements were proposed except as required for highway improvements associated with Santa Fe Drive. Culvert crossings were designed for both inlet and outlet control conditions and for a maximum HW/D of 1.5. Where pipe outlet velocities exceed 12 fps an energy dissipator will be recommended. The only existing culvert crossing designed specifically for overtopping is located at Jackass Hill Road. (The development plan utilizes the area behind the roadway as a private detention facility.) The one low flow crossing was proposed in the Alternative Evaulation Phase for Rangeview Gulch across the river access road. In the Outfall Systems Plan, a culvert crossing was used instead.

3.2.4 Storm Water Detention Facilities

Detention facilities were designed to be non-jurisdictional facilities, which means, the facility is not under the State Engineer's control or inspection. There are three basic requirements for non-jurisdictional facilities as specified in the State of Colorado "Rules and Regulations for Dam Safety and Dam Construction":

1. The distance from the elevation of the original thalweg at the center of the embankment to the elevation of the emergency spillway flowline must be 10 feet or less.

2. And the available storage is limited to a maximum of 100 ac-ft. as measured at the emergency spillway flowline.

3. And the maximum water surface area is limited to 20 acres as measured at the emergency spillway flowline.

Embankments which are primarily designed as roadways or railways which are normally dry and which are not designed or operated for the purpose of impounding water are considered exempt even if they do not meet any of the above listed requirements for non-jurisdictional structures.

All detention facilities must be designed for both the 10-year and 100-year storm frequencies as per Littleton's Drainage Criteria. The public detention facilities must have a minimum freeboard of 3 feet to meet FEMA criteria. Like open channels, detention facilities were also designed for District maintenance eligibility. Side slopes on the embankment were limited to 3:1 and side slopes for the rest of the pond were limited to 4:1. Detention facilities were one of three types: 1. ponds with a permanent water surface, 2. wetland bottom facilities, and 3. normally-dry facilities. The normally-dry detention ponds were designed with a minimum cross slope of 2% and with a concrete trickle channel at a minimum slope of 1%. Maintenance access was required for all detention facilities.

3.2.5 Water Quality Facilities

Water quality and sedimentation ponds are required for all new developments that are tributary to the South Platte River Park, and the outlet works should be designed for easy access and maintenance. The entire study area is within the designated impact area. The planning of these facilities is the responsibility of each individual developer and was not considered in the cost evaluations except for Lower Dad Clark Gulch. On Dad Clark, the most practical design would be for the Santa Fe Park development to drain directly into Lower Dad Clark Gulch and to construct a water quality pond on the gulch just upstream of the South Platte Park. This design was included in the cost evaluation for each of the three alternatives.

3.2.6 Storm Sewer Facilities

All storm sewers were designed using the Manning's equation under full flowing conditions. Reinforced concrete pipe (RCP) was used for all storm sewer design, assuming an n=0.013. Outlet velocities in excess of 12 fps will require energy dissipation and/or riprap.

3.2.7 Irrigation Facilities

There are three irrigation facilities which are considered in the alternative analysis. The first is the flume structure for the City Ditch across Lower Dad Clark Gulch. This is assumed to remain in service and has no effect on the alternative evaluation process. The second facility is the Highline Canal crossing through the Jackass Gulch basin. The possibility of storm flows being discharged into Jackass Gulch was an option of the alternative development. The third facility is the City Ditch around Turtle Lake in the Rangeview basin. This will be relocated in a 60" RCP in the Turtle Lake dam embankment. (Englewood plans to relocate the ditch into a 60" pipe in three phases). The interception of storm flows by any of the irrigation facilities was not considered in this study.

3.3 Unit Cost Evaluation

The unit costs used for the alternative evaluation have been separated into three categories: grass-lined channel costs, detention storage costs, and storm sewer costs. These costs are shown in Tables 3-1, 3-2 and 3-3, respectively.

Unit costs for construction, property acquisition, and maintenance are listed in these tables. Engineering, legal and administrative, and utility relocation costs are added to each alternative as a percent contingency. All appurtenances of a specific item were included in the unit cost for that item. Some examples are riprap for drop structures, headwall and wingwalls for culverts, and manholes and inlets for storm sewer systems. Riprap for channel areas other than around drop structures was listed as a separate item.

TABLE 3-1

GRASS-LINED CHANNEL UNIT COSTS

Item Description	*Unit*	*Cost*
CAPITAL COSTS:		
EARTHWORK		
Excavation	Cubic Yard	$ 5.00
Embankment	Cubic Yard	4.00
SITE PREPARATION AND RESTORATION:		
Clearing and Stripping	Acre	3,000.00
Restoration (top soil, grading, and revegetation)	Acre	2,500.00
Westlands Restoration		
General Channel Areas	Acre	5,000.00
South Platte Park Area	Acre	25,000.00
Maintenance Road	Linear Foot	25.00
HYDRAULIC STRUCTURES:		
Trickle Channel	Linear Foot	20.00
Riprap and Bedding	Cubic Yard	50.00
Concrete Drop Structure - 3 feet (excavation, concrete wall, footing, backfill, & riprap)	Linear Foot	225.00
Low Water Crossing Structure (excavation, concrete, riprap, and backfill)	Each	5,000.00

(Table 3-1 continued)

Reinforced Concrete Culvert (excavation, bedding, backfill, headwall, and wingwalls)		
Span (feet) x Rise (Feet)		
4 x 4	Linear Foot	$200.00
6 x 4	Linear Foot	250.00
6 x 6	Linear Foot	290.00
7 x 4	Linear Foot	300.00
8 x 6	Linear Foot	430.00
8 x 8	Linear Foot	470.00
10 x 6	Linear Foot	600.00
10 x 8	Linear Foot	660.00
10 x 10	Linear Foot	720.00
12 x 8	Linear Foot	780.00
12 x 10	Linear Foot	840.00
12 x 12	Linear Foot	900.00
Energy Dissipation and End Treatment	Lump Sum	25,000.00
ENGINEERING, LEGAL AND ADMINISTRATIVE, UTILITY RELOCATION:		35%
CONTINGENCY:		15%
LAND VALUE COSTS:		
Floodway Property	Acre	$4,500.00
Residential Property	Acre	40,000.00
Industrial Property	Acre	85,000.00
Retail Commercial Property	Acre	130,000.00
ANNUAL ROUTINE MAINTENANCE COSTS:		
Mowing (3 times/year)	Acre	$1,000.00
Debris and Trash Removal (3 times/year)	Acre	250.00

TABLE 3-2

DETENTION STORAGE UNIT COSTS

Item Description	*Unit*	*Cost*
CAPITAL COSTS:		
EARTHWORK		
Excavation	Cubic Yard	$ 5.00
Embankment	Cubic Yard	4.00
SITE PREPARATION AND RESTORATION:		
Clearing and Stripping	Acre	3,000.00
Restoration (top soil, grading, and revegetation)	Acre	2,500.00
Westlands Restoration	Acre	5,000.00
HYDRAULIC STRUCTURES:		
Trickle Channel	Linear Foot	20.00
Riprap and Bedding	Cubic Yard	50.00
Concrete Drop Structure - 3 feet (excavation, concrete wall, footing, backfill, and riprap)	Linear Foot	225.00
Outlet Works (concrete outlet structure, trash rack, outlet pipe, energy dissipator, and emergency spillway)	Each	30,000.00 to 45,000.00
Highline Canal Overflow Spillway (excavation, concrete, riprap, and backfill)	Each	30,000.00

(Table 3-2 continued)

ENGINEERING, LEGAL AND ADMINISTRATIVE, UTILITY RELOCATION:		35%
CONTINGENCY:		15%
LAND VALUE COSTS:		
Residential Property	Acre	40,000.00
Industrial Property	Acre	85,000.00
Retail Commercial Property	Acre	130,000.00
ANNUAL ROUTINE MAINTENANCE COSTS:		
Mowing (3 times/year)	Acre	$1,000.00
Debris and Trash Removal (3 times/year)	Acre	250.00
Detention Area Sediment Removal (once/year)	Lump Sum	1,000.00

TABLE 3-3

STORM SEWER UNIT COSTS

Item Description	*Unit*	*Cost*
CAPITAL COSTS:		
Reinforced Concrete Pipe (excavation, bedding, backfill, manholes and inlets)		
18 inch	Linear Foot	$ 50.00
24 inch	Linear Foot	60.00
30 inch	Linear Foot	75.00
36 inch	Linear Foot	90.00
42 inch	Linear Foot	110.00
48 inch	Linear Foot	130.00
54 inch	Linear Foot	150.00
60 inch	Linear Foot	175.00
66 inch	Linear Foot	190.00
72 inch	Linear Foot	210.00
78 inch	Linear Foot	250.00
Jacking Cost	Linear Foot	4 times basic pipe cost
Energy Dissipation	Lump Sum	10,000.00
ENGINEERING, LEGAL AND ADMINISTRATIVE, UTILITY RELOCATION:		35%
CONTINGENCY:		15%
ANNUAL ROUTINE MAINTENANCE COSTS:		
Cleaning and Debris Removal (once a year)	Linear Foot	$0.30

3.4 Study Reaches

Each of the three major basins were divided into two or three study reaches. These reaches are used to help define the alternatives and are described below.

RANGEVIEW GULCH

Reach 1.1 - From the South Platte River to the east side of the railroad lines.

Reach 1.2 - From the railroad lines to the upper basin limit at the Highline Canal.

JACKASS GULCH

Reach 2.1 - From the South Platte River to the east side of the railroad lines at the existing regional detention pond.

Reach 2.2 - From the regional detention pond to Highline Canal.

Reach 2.3 - Upstream of Highline Canal to Broadway.

LOWER DAD CLARK GULCH

Reach 3.1 - From the South Platte River to the east side of the railroad lines.

Reach 3.2 - Upstream of the railroad lines to McLellan Reservoir embankment/spillway.

3.5 Drainage Problems and Maintenance Needs

In developing the alternatives, consideration was given to known flood prone areas and maintenance needs. There are two areas on Rangeview Gulch which are flood prone: 1. The residential area just upstream of Turtle Lake, which does not have an adequate drainage system to convey storm flows, and 2. the area downstream of Santa Fe Drive which has no defined channel. Turtle Lake is currently only accessible by the irrigation ditch rider path coming from the north along the City Ditch.

Flooding will occur on Jackass Gulch downstream of the lower detention pond due to the inadequate outfall system. Water will pond at Mineral Avenue and Santa Fe Drive and will then flood to the areas adjacent to West Mineral Avenue as it flows to the South Platte River. Currently, there are only a few areas which are accessible for maintenance.

Flooding does occur on Lower Dad Clark Gulch downstream of Santa Fe Drive, however this area is used for agricultural purposes and is not a major problem. Most of the existing channel is accessible for maintenance if the proper right-of-way is obtained.

3.6 Alternative Descriptions

Three alternatives were developed for each major basin (see Figures 3-1 and 3-2). The main difference between alternatives is the amount of detention and the size of outfall facilities. However, the alignment and type of the proposed facilities also differ in some cases. All of the alternative components were sized to convey up to and including the 100-year event, unless otherwise stated for a specific component.

3.6.1 Rangeview Gulch

There are four major factors which distinguish the Rangeview Gulch alternatives:

1. Detention at Turtle Lake (also known as Lynhardt Reservoir No. 2).

2. A new alignment for the outfall for Turtle Lake. This would entail a channel north from Turtle Lake along the east side of the AT&SF railroad embankment to a new culvert crossing under the railroads and Santa Fe Drive. Storm runoff from subbasin 140, north of Turtle Lake, would utilize the same culvert.

   The alternative alignment would be to pipe an outfall directly west from Turtle Lake and upgrade the existing culvert crossing for the railroad and Santa Fe Drive. With this alternate, a new culvert would still need to be constructed for storm runoff from subbasin 140.

3. A lateral storm sewer system from Turtle Lake to South Costilla Street. The capacity of this system would be approximately 95 cfs for the 100-year storm event.

4. Detention at Ridgeview Park.

The following items are the same for all alternatives:

1. A new open channel from the outlet of the culvert at Santa Fe Drive to the old South Platte River channel.

2. Embankment, outlet and spillway improvements for Turtle Lake.

3. City Ditch relocation in 60" pipe under Turtle Lake embankment.

4. Storm sewer improvements from Turtle Lake to Ridgeview Park. This system was designed assuming flow in a swale just upstream of Turtle Lake and flow in Curtice Street which would be contained within the existing 50' ROW.

5. Outlet improvements at Ridgeview Park.

6. Culvert improvements at Prince Street.

ALTERNATIVE 1 (Refer to Figure 3-1a)

Reach 1.1 - Open channel downstream of Santa Fe Drive with low water crossing structure.
- Culvert improvements under the railroads and Santa Fe Drive directly west of Turtle Lake (at existing culvert location).
- Additional culvert improvements under the railroads and Santa Fe Drive for subbasin north of Turtle Lake.

Reach 1.2 - Embankment, outlet, and spillway improvements for Turtle Lake to direct discharges west to culvert.
- City Ditch relocation.
- Storm sewer improvements in Curtice Street from Turtle Lake to Ridgeview Park.
- Outlet improvements at Ridgeview Park.
- Culvert improvements at Prince Street.

ALTERNATIVE 2 (Refer to Figure 3-1b)

Reach 1.1 - Open channel downstream of Santa Fe Drive with low water crossing structure.
- Culvert improvements under the railroads and Santa Fe Drive directly west of Turtle Lake.
- Additional culvert improvements under the railroads and Santa Fe Drive for subbasin north of Turtle Lake.

Reach 1.2 - Embankment, outlet, and spillway improvements for Turtle Lake to direct discharge west to culvert.
- Detention at Turtle Lake.
- City Ditch relocation.
- Lateral storm sewer improvements from Turtle Lake to South Costilla Street.
- Storm sewer improvements in Curtice Street from Turtle Lake to Ridgeview Park.
- Outlet improvements for Ridgeview Park.
- Culvert improvements at Prince Street.

ALTERNATIVE 3 (Refer to Figure 3-1c)

Reach 1.1 - Open channel downstream of Santa Fe Drive with low crossing structure.
- Culvert improvements under the railroads and Santa Fe Drive at a location north of Turtle Lake (subbasin north of Turtle Lake will utilize this culvert).

Reach 1.2 - Channel improvements from Turtle Lake north to the new culvert.
- Embankment, outlet, and spillway improvements for Turtle Lake to direct discharge north in new channel.
- Detention at Turtle Lake.
- City Ditch relocation.
- Lateral storm sewer improvements for Turtle Lake to South Costilla Street.
- Storm sewer improvements in Curtice Street from Turtle Lake to Ridgeview Park.
- Embankment, outlet, and spillway improvements for Ridgeview Park.
- Detention at Ridgeview Park.
- Culvert improvements at Prince Street.

LITTLETON

Columbine Valley Country Club

PLATTE

SANTA FE DR

RAILROAD LINES

SOUTH PRINCE GULCH

WEST CALEY AVE

SOUTH RIDGE ROAD

W PEAKVIEW AVE

SOUTH GALLUP ST

BROADWAY

W EUCLID AVE

South Sch

Euclid Jr High Sch

Wyman Sch

Gravel Trailer Park

Broadridge Plaza

RIDGE ROAD

HIGHLINE

CULVERT
Q_{100} = 100 cfs
48" RCP

TURTLE LAKE EMBANKMENT, OUTLET & SPILLWAY IMPROVEMENTS
* RELOCATE CITY DITCH IN 60" RCP

CHANNEL
Q_{100} = 1109 cfs
V = 5.8 fps
B = 20 ft.
D = 4.9 ft.
S = 0.4%

LOW WATER CROSSING STRUCTURE

CHANNEL
Q_{100} = 1000 cfs
V = 5.7 fps
B = 18 ft.
D = 4.8 ft.
S = 0.4%

CULVERT
Q_{100} = 977 cfs
EXIST. 6'x 6' RCB
PLUS ONE NEW
8'x 6' RCB

CULVERT
Q_{100} = 947
10'x 6' RCB

7'x 4' RCB PLUS SWALE
Q_{PIPE} = 664 cfs
Q_{SWALE} = 193 cfs

66" RCP
Q_{PIPE} = 532 cfs
Q_{STREET} = 92 cfs

60" RCP
Q_{PIPE} = 405 cfs
Q_{STREET} = 69 cfs

CULVERT
Q_{100} = 388 cfs
6'x 6' RCB

BM 5388

BM 5480

ROWLAND

CURTICE

COSTILLA

CITY DITCH

LANE

DITCH

RIDGEVIEW PARK

RANGEVIEW GULCH

HIGHLINE CANAL

Chatfield

Golf Course

C-470

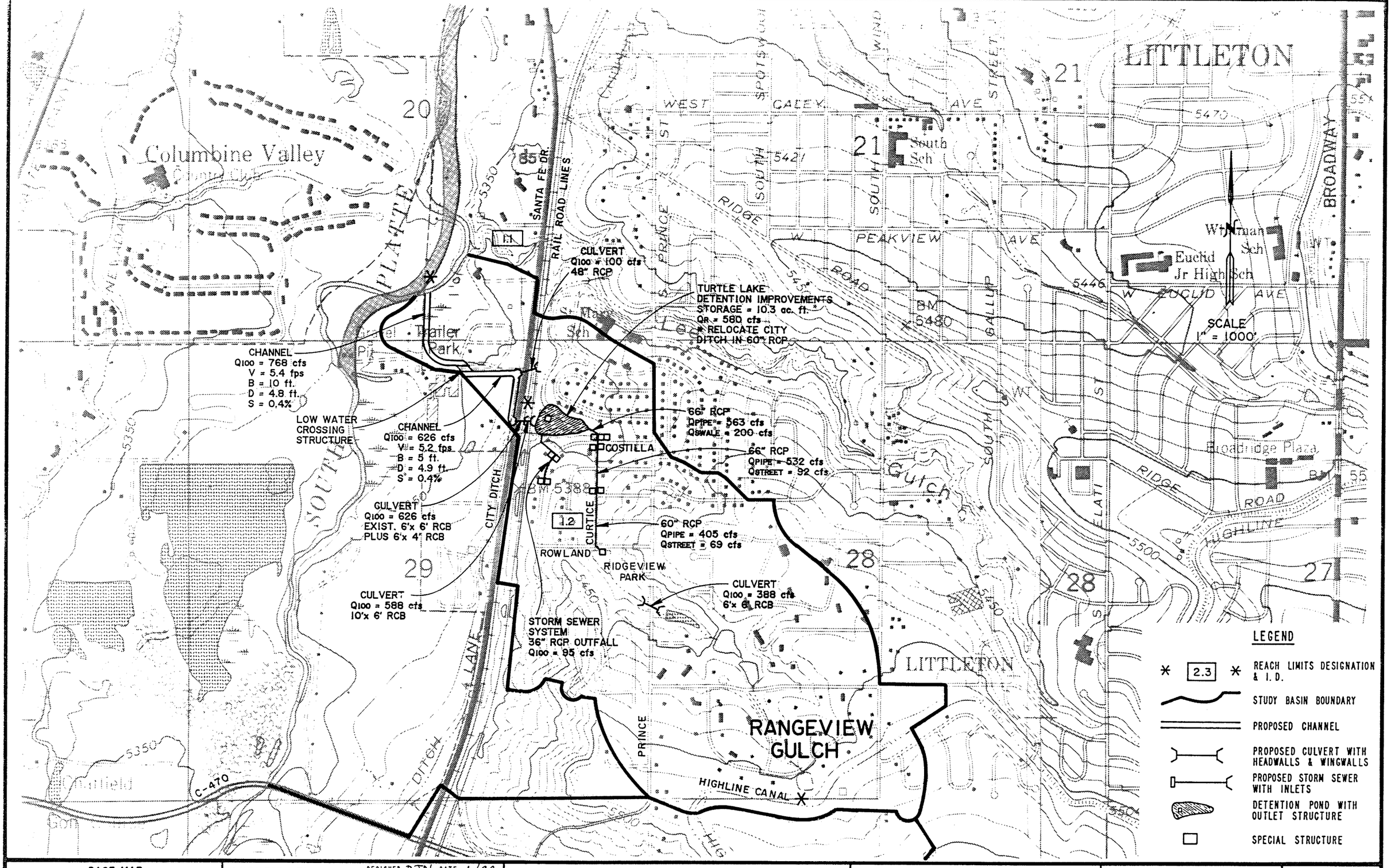
SCALE
1" = 1000'

LEGEND

- 2.3 — REACH LIMITS DESIGNATION & I. D.
- STUDY BASIN BOUNDARY
- PROPOSED CHANNEL
- PROPOSED CULVERT WITH HEADWALLS & WINGWALLS
- PROPOSED STORM SEWER WITH INLETS
- DETENTION POND WITH OUTLET STRUCTURE
- SPECIAL STRUCTURE

BASE MAP UNITED STATES GEOLOGICAL SURVEY MAP LITTLETON QUAD, HIGHLANDS RANCH QUAD	CENTENNIAL ENGINEERING INC	DESIGNED DJN DATE 1/90 DRAWN GDF DATE 1/90 CHECKED BLM DATE 3/90 REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	RANGEVIEW BASIN OUTFALL SYSTEM SCHEMATIC ALTERNATIVE 1	FIGURE 3-1a CEI JN 906.00

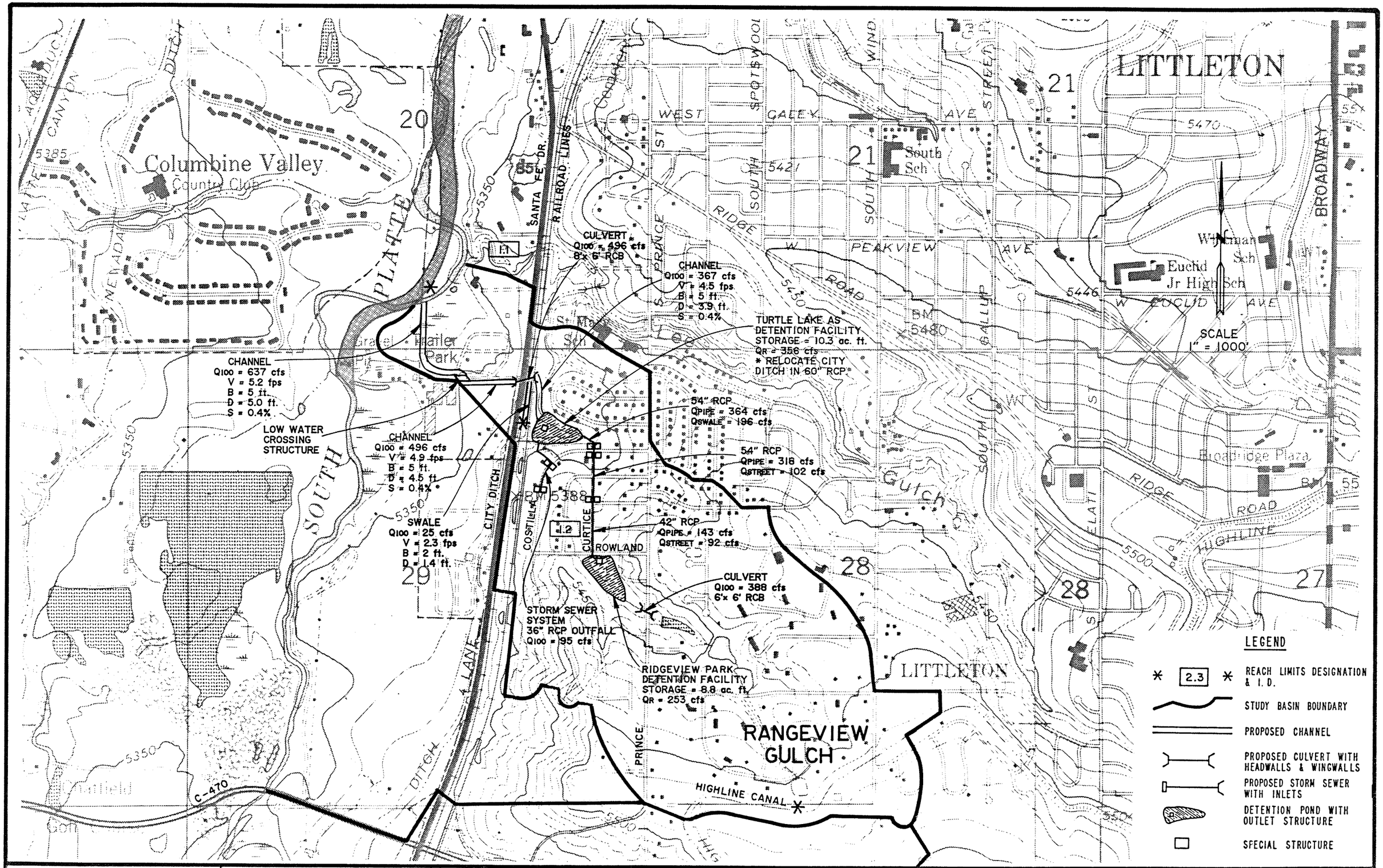


LEGEND

- 2.3 — REACH LIMITS DESIGNATION & I.D.
- STUDY BASIN BOUNDARY
- PROPOSED CHANNEL
- PROPOSED CULVERT WITH HEADWALLS & WINGWALLS
- PROPOSED STORM SEWER WITH INLETS
- DETENTION POND WITH OUTLET STRUCTURE
- SPECIAL STRUCTURE

BASE MAP UNITED STATES GEOLOGICAL SURVEY MAP LITTLETON QUAD HIGHLANDS RANCH QUAD	CENTENNIAL ENGINEERING INC	DESIGNED DJN DATE 1/90 DRAWN G.D.F. DATE 11/90 CHECKED DLM DATE 3/90 REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	RANGEVIEW BASIN OUTFALL SYSTEM SCHEMATIC ALTERNATIVE 2	FIGURE 3-1b CEI JN 906.00



BASE MAP
UNITED STATES GEOLOGICAL SURVEY MAP
LITTLETON QUAD
HIGHLANDS RANCH QUAD

CENTENNIAL ENGINEERING INC

DESIGNED DJN DATE 1/90
DRAWN G.D.F. DATE 1/90
CHECKED DLM DATE 3/90
REVISED ____ DATE ____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

RANGEVIEW BASIN
OUTFALL SYSTEM SCHEMATIC
ALTERNATIVE 3

FIGURE
3-Ic
CEI JN 906.00

3.6.2 Jackass Gulch

There are three major factors which distinguish the Jackass Gulch alternatives:

1. An additional outfall system designed for 260 cfs. This outfall would go from Mineral Avenue south along the east side of the AT&SF railroad embankment to Lower Dad Clark Gulch. This outfall would increase the discharge for Lower Dad Clark Gulch. However, since the effect is minimal, it was not considered in the analysis for Lower Dad Clark Gulch.

   An optimal alignment for this outfall would be to stay on the north side of Mineral Avenue by crossing the railroad lines and Santa Fe Drive and discharging directly into the South Platte River.

2. Acquisition of existing private detention ponds in the upper basin east of the Highline Canal.

3. The acceptance of storm flows from the Highline Canal. This would be done by constructing an overflow spillway on the Highline Canal just north of Mineral Avenue to discharge storm flows into the existing City open space area (future Equestrian Park).

The following items are the same for all alternatives:

1. Existing outfall system to the South Platte River will be utilized (Capacity = 260 cfs).

2. Expansion of existing detention pond at Mineral Avenue and the railroad spur line.

3. New detention pond at Mineral Avenue and the railroad lines just below the existing detention pond. The ponds 100-year release rate is designed for the outfall system capacity. (Note: the existing system's capacity is 260 cfs, but with the additional system the capacity would be 520 cfs.)

4. Existing inadvertent detention behind Jackass Hill Road will be formalized.

5. Channel improvements upstream of Jackass Hill Road. These improvements were limited to certain reaches in order to minimize wetlands disturbance.

6. Detention in channel area just downstream of the Highline Canal. All of the alternatives require three detention ponds in order to reduce the flow as needed downstream.

7. Water quality and sedimentation control will be required of all future development in the basin.

ALTERNATIVE 1 (Refer to Figure 3-2a)

Reach 2.1 - Utilization of existing outfall system to the South Platte River.
- Additional outfall system.

Reach 2.2 - Expansion of existing detention pond at Mineral Avenue and the railroad lines.
- New detention pond at Mineral Avenue and the railroad lines.
- Recognition of existing inadvertent detention behind Jackass Hill Road.
- Channel improvements upstream of Jackass Hill Road.
- Detention in channel area just downstream of the Highline Canal.
- No additional flows from Highline Canal.

Reach 2.3 - No acquisition of existing ponds in the upper basin.

ALTERNATIVE 2 (Refer to Figure 3-2b)

Reach 2.1 - Utilization of existing outfall system to the South Platte River.
- No additional outfall system.

Reach 2.2 - Expansion of existing detention pond at Mineral Avenue and the railroad lines.
- New detention pond at Mineral Avenue and the railroad lines.
- Recognition of existing inadvertent detention behind Jackass Hill Road.
- Channel improvements upstream of Jackass Hill Road.
- Detention in channel area just downstream of Highline Canal.
- No additional flows from Highline Canal.

Reach 2.3 - Acquisition of existing private detention ponds in the upper basin east of the Highline Canal.

ALTERNATIVE 3 (Refer to Figure 3-2c)

Reach 2.1 - Utilization of existing outfall system to the South Platte River.
- Additional outfall system.

Reach 2.2 - Expansion of existing detention pond at Mineral Avenue and the railroad spur line.
- New detention pond at Mineral Avenue and the railroad lines.
- Recognition of existing inadvertent detention behind Jackass Hill Road.
- Channel improvements upstream of Jackass Hill Road.
- Detention in channel area just downstream of the Highline Canal.
- Acceptance of storm flows from the Highline Canal.

Reach 2.3 - Acquisition of existing private detention ponds in the upper basin east of the Highline Canal.

SEE NOTE #2

DETENTION POND
STORAGE = 7.2 ac. ft.
Q_R = 480 cfs

EXPAND EXIST. DETENTION POND
STORAGE = 17.5 ac. ft.
Q_R = 525 cfs

DETENTION AREA
STORAGE = 10± ac. ft.
Q_R = 800 cfs
CULVERT
Q_C = 460 cfs

DITCH

JACKASS HILLS RD.

2.1

2.2

THREE TYPICAL
DETENTION PONDS
STORAGE = 10.2 ac. ft.
Q_R ① = 495 cfs
Q_R ② = 590 cfs
Q_R ③ = 720 cfs

EXIST. 60" RCP
& CHANNEL
Q_{100} = 260 cfs

LOW FLOWS
Q_{DESIGN} = 100 cfs
48" RCP PLUS
EXIST. DITCH

SEE NOTE #2

CITY

SOUTH PLATTE

85

WATER QUALITY POND
(APPROX. VOL. = 5 ac. ft.)

CHANNEL
Q_{100} = 800 cfs
V = 7.1 fps
B = 5 ft.
D = 4.7 ft.
S = 0.8%

FUTURE
EQUESTRIAN
PARK

JACKASS
GULCH

2.3

MINERAL AVE.

SCALE
1" = 1000'

NOTE:
ASSUMES NO UPPER
BASIN DETENTION FOR
JACKASS GULCH.

3.1

3.2

CHANNEL
Q_{100} = 1800 cfs
V = 7.0 fps
B = 36 ft.
D = 4.7 ft.
S = 0.52%

LOWER DAD
CLARK GULCH

SEE NOTE #1

SPILLWAY
ELEV 5489

McLellan Reservoir

CANAL

ARAPAHOE CO
DOUGLAS CO

SANTA FE DR.

RAILROAD LINES

BROADWAY

470

BM 5444

NOTE #1
SUBALTERNATIVE "A" DOES NOT INCLUDE ANY IMPROVEMENTS UPSTREAM OF THE RAILROAD LINES FOR DAD CLARK GULCH. SUBALTERNATIVE "B" IS AS SHOWN.

NOTE #2
THIS OUTFALL IS A 60" RCP AND CHANNEL TO DISCHARGE 260 cfs TO DAD CLARK GULCH. AN OPTIONAL ALIGNMENT WOULD BE TO GO DIRECTLY TO THE SOUTH PLATTE RIVER ALONG THE NORTH SIDE OF MINERAL AVE. THIS OPTION WOULD CONSIST OF A 60" RCP AND CHANNEL, ALSO.

LEGEND

- * 2.3 * — REACH LIMITS DESIGNATION & I. D.
- STUDY BASIN BOUNDARY
- PROPOSED CHANNEL
- PROPOSED CULVERT WITH HEADWALLS & WINGWALLS
- PROPOSED STORM SEWER WITH INLETS
- DETENTION POND WITH OUTLET STRUCTURE
- SPECIAL STRUCTURE

BASE MAP UNITED STATES GEOLOGICAL SURVEY MAP LITTLETON QUAD — HIGHLANDS RANCH QUAD	CENTENNIAL ENGINEERING INC	DESIGNED DJN DATE 1/90 DRAWN G.R.E. DATE 1/90 CHECKED DLM DATE 3/90 REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	JACKASS & LOWER DAD CLARK BASINS OUTFALL SYSTEM SCHEMATIC ALTERNATIVE 1	FIGURE 3-2a CEI JN 906.00

DETENTION POND
STORAGE = 7.2 ac. ft.
Q_R = 239 cfs

EXPAND EXIST. DETENTION POND
STORAGE = 17.5 ac. ft.
Q_R = 270 cfs

DETENTION POND
STORAGE = 4.4 ac. ft.
Q_R = 400 cfs
CULVERT
Q_C = 460 cfs

DETENTION POND
STORAGE = 7.0 ac. ft.
Q_R ① = 200 cfs

TWO TYPICAL
DETENTION PONDS
STORAGE = 11.4 ac. ft.
Q_R ② = 225 cfs
Q_R ③ = 275 cfs

EXIST. 60" RCP
& CHANNEL
Q_{100} = 260 cfs

LOW FLOW CHANNEL
Q_{DESIGN} = 100 cfs
V = 3.3 fps
B = 2 ft.
D = 2.5 ft.

WATER QUALITY POND
(APPROX. VOL. = 5 ac. ft.)

CHANNEL
Q_{100} = 400 cfs
V = 6.2 fps
B = 5 ft.
D = 3.4 ft.
S = 0.9%

CHANNEL & DROP
Q_{100} = 850 cfs.
V = 4.9 fps
B = 15 ft.
D = 5.0 ft.
S = 0.3%

SEE NOTE #1

ADEQUATE ASSURANCES AGREEMENT ON McLELLAN

SPILLWAY ELEV 5489

SCALE
1" = 1000'

NOTE:
ASSUMES UPPER BASIN DETENTION FOR JACKASS GULCH.

FUTURE EQUESTRIAN PARK

JACKASS GULCH

LOWER DAD CLARK GULCH

JACKASS HILL RD.

MINERAL AVE.

BROADWAY

SOUTH PLATTE

HIGHLINE CANAL

SANTA FE DR.

RAILROAD LINES

PIPELINE

ARAPAHOE CO

DOUGLAS CO

Littleton

Englewood

Wolhurst

Trailer Park

Willowood Lake

Lee

Water Tank

Sub Sta

Blakeland

2.1 2.2 2.3 3.1 3.2

32 33 34 4 5

470

5350 5400 5450 5500 5550 5600

RM 5444

RM 5662

NOTE #1
SUBALTERNATIVE "A" DOES NOT INCLUDE ANY IMPROVEMENTS UPSTREAM OF THE RAILROAD LINES FOR DAD CLARK GULCH. SUBALTERNATIVE "B" IS AS SHOWN.

LEGEND

- * 2.3 * — REACH LIMITS DESIGNATION & I.D.
- STUDY BASIN BOUNDARY
- PROPOSED CHANNEL
- PROPOSED CULVERT WITH HEADWALLS & WINGWALLS
- PROPOSED STORM SEWER WITH INLETS
- DETENTION POND WITH OUTLET STRUCTURE
- SPECIAL STRUCTURE

BASE MAP UNITED STATES GEOLOGICAL SURVEY MAP LITTLETON QUAD HIGHLANDS RANCH QUAD	CENTENNIAL ENGINEERING INC	DESIGNED DJN DATE 1/90 DRAWN G.D.F. DATE 1/90 CHECKED DLM DATE 3/90 REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	JACKASS & LOWER DAD CLARK BASINS OUTFALL SYSTEM SCHEMATIC ALTERNATIVE 2	FIGURE 3-2b CEI JN 906.00

SEE NOTE #2

DETENTION POND
STORAGE = 7.2 ac. ft.
QR = 530 cfs

EXPAND EXIST. DETENTION POND
STORAGE = 17.5 ac. ft.
QR = 570 cfs

DETENTION AREA
STORAGE = 10± ac. ft.
QR = 800 cfs
CULVERT
Qc = 460 cfs

JACKASS HILL RD.

2.1

2.2

THREE TYPICAL DETENTION PONDS
STORAGE = 11.4 ac. ft.
QR ① = 485 cfs
QR ② = 525 cfs
QR ③ = 575 cfs

EXIST. 60" RCP & CHANNEL
Q100 = 260 cfs

LOW FLOWS w/WETLANDS
QDESIGN = 100 cfs
V = 2.1 fps
B = 5 ft.
D = 3.2 ft.

WATER QUALITY POND (APPROX. VOL. = 5 ac. ft.)

SEE NOTE #2

CHANNEL
Q100 = 850 cfs
V = 14.9 fps
B = 15 ft.
D = 5.0 ft.
S = 0.3%

CHANNEL
Q100 = 800 cfs
V = 7.1 fps
B = 5 ft.
D = 4.7 ft.
S = 0.8%

JACKASS GULCH

SCALE
1" = 1000'

NOTE:
ASSUMES UPPER BASIN DETENTION FOR JACKASS GULCH.

MINERAL AVE.

2.3

3.1

3.2

CHANNEL w/WETLANDS
Q100 = 850 cfs
V = 4.5 fps
B = 20 ft.
D = 4.8 ft.
S = 0.52%

LOWER DAD CLARK GULCH

SEE NOTE #1

FUTURE EQUESTRIAN PARK

ADEQUATE ASSURANCES AGREEMENT ON McLELLAN

HIGHLAND CANAL OVERFLOW SPILLWAY (DESIGNED FOR A SUSTAINED PEAK DISCHARGE OF 300 cfs)

SPILLWAY ELEV 5489

ARAPAHOE CO
DOUGLAS CO

SANTA FE DR.

RAILROAD LINES

BM 5444

470

NOTE #1
SUBALTERNATIVE "A" DOES NOT INCLUDE ANY IMPROVEMENTS UPSTREAM OF THE RAILROAD LINES FOR DAD CLARK GULCH. SUBALTERNATIVE "B" IS AS SHOWN.

NOTE #2
THIS OUTFALL IS A 60" RCP AND CHANNEL TO DISCHARGE 260 cfs TO DAD CLARK GULCH. AN OPTIONAL ALIGNMENT WOULD BE TO GO DIRECTLY TO THE SOUTH PLATTE RIVER ALONG THE NORTH SIDE OF MINERAL AVE. THIS OPTION WOULD CONSIST OF A 60" RCP AND CHANNEL, ALSO.

LEGEND

- 2.3 — REACH LIMITS DESIGNATION & I. D.
- STUDY BASIN BOUNDARY
- PROPOSED CHANNEL
- PROPOSED CULVERT WITH HEADWALLS & WINGWALLS
- PROPOSED STORM SEWER WITH INLETS
- DETENTION POND WITH OUTLET STRUCTURE
- SPECIAL STRUCTURE

BASE MAP
UNITED STATES GEOLOGICAL SURVEY MAP
LITTLETON QUAD — HIGHLANDS RANCH QUAD

CENTENNIAL ENGINEERING INC

DESIGNED DJN DATE 1/90
DRAWN G.D.E. DATE 1/90
CHECKED DLM DATE 3/90
REVISED ____ DATE ____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

JACKASS & LOWER DAD CLARK BASINS
OUTFALL SYSTEM SCHEMATIC
ALTERNATIVE 3

FIGURE 3-2c
CEI JN 906.00

3.6.3 Lower Dad Clark Gulch

There are four major factors which distinguish the Lower Dad Clark Gulch alternatives:

1. Execution of an Adequate Assurances Agreement for McLellan Reservoir for dedicated flood storage. This agreement would have to be signed by the City of Englewood (who own McLellan Reservoir), the City of Littleton, and the District.

2. The type of improvements across South Platte Park. These improvements were designed for water quality pond releases of 100 cfs. Larger storm flows were designed to spread out as shallow flooding across the park.

3. The type of channel improvements across the Santa Fe Development (from Santa Fe Drive to South Platte Park).

4. Channel improvements upstream of Santa Fe Drive. This is an environmental concern since there are a lot of wetlands in the area. Subalternatives "A" do not consider channel improvements in the area whereas Subalternatives "B" do consider channel improvements.

The following items are the same for all alternatives:

1. A water quality and sedimentation pond located just upstream of the South Platte Park Boundary. This pond is designed for the Santa Fe Park Development area and should be designed in accordance with Chapter 15 of the Littleton Storm Drainage Criteria Manual.

2. The existing City Ditch flume structure will remain to separate the ditch flows from Dad Clark Gulch flows.

ALTERNATIVE 1A (Refer to Figure 3-2a)

Reach 3.1 - No flood attenuation in McLellan Reservoir due to no Adequate Assurances Agreement.
- New storm sewer with existing low flow ditch across South Platte Park.
- Water quality and sedimentation pond.
- Grass-lined channel from the water quality pond to Santa Fe Drive designed for the 100-year McLellan Reservoir release of 1800 cfs.
- Perpetuate existing flow separation at City Ditch.

Reach 3.2 - No improvements upstream of Santa Fe Drive.

ALTERNATIVE 1B (Refer to Figure 3-2a)

Reach 3.1 - (Same as Alternative 1A)

Reach 3.2 - Grass-lined channel upstream of Santa Fe Drive designed for the 100-year flow of 1800 cfs.

ALTERNATIVE 2A (Refer to Figure 3-2b)

Reach 3.1 - Flood attenuation in McLellan Reservoir with the Adequate Assurances Agreement recorded.
- New grass-lined low flow channel across South Platte Park.
- Water quality and Sedimentation Pond.
- Grass-lined channel from the water quality pond to Santa Fe Drive designed for the 100-year McLellan Reservoir release of 850 cfs.
- Perpetuate existing flow separation at the City Ditch.

Reach 3.2 - No improvements upstream of Santa Fe Drive. Plans for any changes to the gulch by future developers would have to be approved by the District and City.

ALTERNATIVE 2B (Refer to Figure 3-2b)

Reach 3.1 - (Same as Alternative 2A)

Reach 3.2 - Grass-lined channel design for the 100-year flow of 850 cfs.

ALTERNATIVE 3A (Refer to Figure 3-3a)

Reach 3.1 - Flood attenuation in McLellan Reservoir with the Adequate Assurances Agreement recorded.
- New wetlands bottom low flow channel across South Platte Park.
- Water quality and sedimentation pond.
- Wetlands bottom channel from the water quality pond to Santa Fe Drive designed for the 100-year McLellan Reservoir release of 850 cfs.
- Perpetuate existing flow separation at the City Ditch.

Reach 3.2 - Same as Alternative 2A, above.

ALTERNATIVE 3B (Refer to Figure 3-2c)

Reach 3.1 - (Same as Alternative 3A)

Reach 3.2 - Grass-lined channel designed for the 100-year flow of 850 cfs.

3.7 Alternative Costs

The components of each alternative were sized based on the previously stated design criteria, and quantity take-offs were determined for the items listed in the unit cost tables. Right-of-way acquisition areas were costed out either based on zoning or as floodway areas. The land acquisition areas for each basin are listed as follows:

Rangeview Gulch

- Turtle Lake, if used for detention, was considered floodway property.
- The swale just upstream of Turtle Lake and channels downstream of Turtle Lake were costed out as property is presently zoned.

- No acquisition upstream of Costilla Avenue.

Jackass Gulch

- Existing detention ponds on private property were assumed to be floodway property.

- A 60' wide channel area from the existing City open space (which is located in the NW corner of Mineral Avenue and the Highline Canal) to Jackass Hill Road was assumed to be floodway property.

- Improvements in the existing City open space just downstream of the Highline Canal were assumed to be on public property.

- The existing detention area downstream of Jackass Hill Road is currently on public easement.

- All other channel and detention areas were costed out as property is presently zoned, (no acquisition in South Platte Park).

Lower Dad Clark Gulch

- The entire channel area from the spillway of McLellan Reservoir to the South Platte Park was considered floodway property, (no acquisition necessary in South Platte Park).

Estimated costs were calculated for each basin for each of the three alternatives. The results are listed in Tables 3-4, 3-5, and 3-6.

3.8 Alternative Evaluation Matrix

Each alternative was evaluated on four criteria: cost, constructibility, flood control, and environmental issues. Maintenance accessibility was included in the design of all facilities by considering needed right-of-way and maintenance road.

Cost -- The cost of an alternative is a combination of three components - construction, right-of-way, and maintenance. Construction and right-of-way are associated with the initial alternative cost and are listed as a combined item in the table separate from the maintenance cost.

Constructibility -- Constructibility was evaluated on a comparison basis of each of the three alternatives. This item includes possible problems with right-of-way acquisition, accessibility of the construction area, and the complexity of construction.

Flood Control -- Flood control was evaluated on an adequate/ inadequate basis depending on if the improvements eliminate flooding for the 100-year event. Flood control was considered adequate if flows were confined in a channel or street right-of-way.

Environmental Issues -- Environmental issues include aesthetic, recreational and water quality aspects. This item, like constructibility, was evaluated on a comparison basis between the alternatives. William Wenk Associates have conducted a site review of the study area. Their recommendations are contained in a memorandum (dated December 19, 1989).

A summary of the evaluation is shown in Table 3-7 and a brief discussion of each basin follows. Flood control was considered adequate for all alternatives. The only minor flooding was street flooding down Curtice Street on Rangeview Gulch (less than a half foot above the street crown and contained within the 50 foot R.O.W.) and weir overflow across Jackass Hill Road (less than one foot above road).

Rangeview Gulch -- All of the alternatives for Rangeview Gulch are much the same. However, Alternative 3 is more cost effective. Constructibility is not considered "GOOD" since Turtle Lake is not easily accessible. Access to the lake would improve when the City Ditch is piped in the future.

Jackass Gulch -- For Jackass Gulch, Alternative 2 is good for both constructibility and environmental issues, whereas Alternatives 1 and 3 do not rate as high in either of these categories due to the additional outfall system. Alternative 2 is also the most cost effective. When comparing these alternatives, it is important to keep in mind that Alternative 3 is the only alternative which takes storm flows out of Highline Canal in order to reduce flooding of Lee Gulch.

Lower Dad Clark Gulch -- Lower Dad Clark Gulch alternatives are all about the same on constructibility. Subalternatives "A" are more cost effective and have less environmental impacts than Subalternatives "B" since Subalternatives "A" propose no channel improvements upstream of the railroad tracks. Alternatives "3" are comparatively better due to the wetlands which are proposed.

TABLE 3-4
PRELIMINARY COST ESTIMATE

PROJECT: DAD CLARK GULCH - UD&FCD
BASIN: RANGEVIEW GULCH

ITEM	UNITS	UNIT COST	ALTERNATIVE 1 QUANTITY	ALTERNATIVE 1 EXTENSION	ALTERNATIVE 2 QUANTITY	ALTERNATIVE 2 EXTENSION	ALTERNATIVE 3 QUANTITY	ALTERNATIVE 3 EXTENSION
Excavation	CY	5	21,583.0	107,915.00	16,169.0	80,845.00	13,782.0	68,910.00
Embankment	CY	4	511.0	2,044.00	4,090.0	16,360.00	7,413.0	29,652.00
Clearing & Grubbing	AC	2,000	6.1	12,200.00	5.5	11,000.00	6.6	13,200.00
Restoration (top soil, grading and revegetation)	AC	2,500	6.1	15,250.00	5.5	13,750.00	6.6	16,500.00
Wetlands Restoration								
General Channel Areas	AC	5,000	-	0.00	-	0.00	-	0.00
South Platte Park Area	AC	25,000	-	0.00	-	0.00	-	0.00
Maintenance Road	LF	25	-	0.00	-	0.00	-	0.00
Trickle Channel	LF	20	2,050.0	41,000.00	2,050.0	41,000.00	2,100.0	42,000.00
Riprap and Bedding	CY	50	1,759.0	87,950.00	1,594.0	79,700.00	1,080.0	54,000.00
Concrete Drop Structure - 3 feet (excavation, concrete wall, footing, backfill & riprap)	LF	225	718.0	161,550.00	607.0	136,575.00	467.0	105,075.00
Outlet Works (emergency spillway, concrete outlet structure, trash rack, outlet pipe, energy dissipator)								
Small Pond (6 ac-ft)	EA	30,000	1.0	30,000.00	1.0	30,000.00	1.0	30,000.00
Medium Pond (10 ac-ft)	EA	40,000	1.0	40,000.00	1.0	40,000.00	1.0	40,000.00
Large Pond (20 ac-ft)	EA	45,000	-	0.00	-	0.00	-	0.00
Low Water Crossing Structure	EA	5,000	1.0	5,000.00	1.0	5,000.00	1.0	5,000.00
Reinforced Concrete Pipe (excavation, bedding, backfill manholes, and inlets)								
30 inch	LF	75	-	0.00	500.0	37,500.00	500.0	37,500.00
36 inch	LF	90	-	0.00	400.0	36,000.00	400.0	36,000.00
42 inch	LF	110	-	0.00	-	0.00	600.0	66,000.00
48 inch	LF	130	300.0	39,000.00	300.0	39,000.00	-	0.00
54 inch	LF	150	-	0.00	-	0.00	950.0	142,500.00
60 inch	LF	175	1,000.0	175,000.00	1,000.0	175,000.00	400.0	70,000.00
66 inch	LF	190	650.0	123,500.00	950.0	180,500.00	-	0.00
72 inch	LF	210	-	0.00	-	0.00	-	0.00
78 inch	LF	250	-	0.00	-	0.00	-	0.00
Reinforced Concrete Culverts (excavation, bedding, backfill headwall, and wingwalls)								
4' x 4' RCB	LF	200	-	0.00	-	0.00	-	0.00
6' x 4' RCB	LF	250	-	0.00	200.0	50,000.00	-	0.00
6' x 6' RCB	LF	290	200.0	58,000.00	200.0	58,000.00	200.0	58,000.00
7' x 4' RCB	LF	300	300.0	90,000.00	-	0.00	-	0.00
8' x 6' RCB	LF	430	200.0	86,000.00	-	0.00	300.0	129,000.00
8' x 8' RCB	LF	470	-	0.00	-	0.00	-	0.00

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TABLE 3-4
PRELIMINARY COST ESTIMATE

PROJECT: DAD CLARK GULCH - UD&FCD
BASIN: RANGEVIEW GULCH

ITEM	UNITS	UNIT COST	ALTERNATIVE 1 QUANTITY	ALTERNATIVE 1 EXTENSION	ALTERNATIVE 2 QUANTITY	ALTERNATIVE 2 EXTENSION	ALTERNATIVE 3 QUANTITY	ALTERNATIVE 3 EXTENSION
10' x 6' RCB	LF	600	-	0.00	80.0	48,000.00	-	0.00
10' x 8' RCB	LF	660	80.0	52,800.00	-	0.00	-	0.00
10' x 10' RCB	LF	720	-	0.00	-	0.00	-	0.00
12' x 8' RCB	LF	780	-	0.00	-	0.00	-	0.00
12' x 10' RCB	LF	840	-	0.00	-	0.00	-	0.00
12' x 12' RCB	LF	900	-	0.00	-	0.00	-	0.00
Jacking Cost								
48" RCP	LF	520	100.0	52,000.00	100.0	52,000.00	-	0.00
60" RCP	LF	700	-	0.00	-	0.00	-	0.00
8' x 6' RCB	LF	1,720	-	0.00	-	0.00	100.0	172,000.00
10' x 6' RCB	LF	2,400	-	0.00	80.0	192,000.00	-	0.00
10' x 8' RCB	LF	2,640	80.0	211,200.00	-	0.00	-	0.00
SUBTOTAL				1,390,409.00		1,322,230.00		1,115,337.00
Engineering, Legal and Administrative, Utility Relocation (35%)				486,643.15		462,780.50		390,367.95
Contingency (15%)				208,561.35		198,334.50		167,300.55
TOTAL CONSTRUCTION COST				2,085,613.50		1,983,345.00		1,673,005.50
Land Value								
Floodway Property	AC	4,500	-	0.00	2.7	12,150.00	2.7	12,150.00
Residential	AC	40,000	1.7	68,000.00	1.4	56,000.00	1.4	56,000.00
Industrial	AC	85,000	-	0.00	-	0.00	-	0.00
Retail Commercial	AC	130,000	1.7	221,000.00	1.5	195,000.00	1.3	169,000.00
LAND ACQUISITION COST				289,000.00		263,150.00		237,150.00
TOTAL PROJECT COST				2,374,613.50		2,246,495.00		1,910,155.50
ANNUAL ROUTINE MAINTENANCE COSTS:								
Mowing (3 times/year)	AC	1,000	7.4	7,400.00	9.6	9,600.00	9.4	9,400.00
Debris and Trash Removal (3 times/year)	AC	250	7.4	1,850.00	9.6	2,400.00	9.4	2,350.00
Detention Area Sediment Removal (once/year)	LS	1,000	2.0	2,000.00	2.0	2,000.00	2.0	2,000.00
Storm Sewer Cleaning and Debris Removal (once/year)	LF	0.3	2,930.0	879.00	3,430.0	1,029.00	3,750.0	1,125.00
TOTAL MAINTENANCE COST				12,129.00		15,029.00		14,875.00

TABLE 3-5
PRELIMINARY COST ESTIMATE

PROJECT: DAD CLARK GULCH - UD&FCD
BASIN: JACKASS GULCH

ITEM	UNITS	UNIT COST	ALTERNATIVE 1 * QUANTITY	ALTERNATIVE 1 * EXTENSION	ALTERNATIVE 2 QUANTITY	ALTERNATIVE 2 EXTENSION	ALTERNATIVE 3 * QUANTITY	ALTERNATIVE 3 * EXTENSION
Excavation	CY	5	82,300.0	411,500.00	62,900.0	314,500.00	82,300.0	411,500.00
Embankment	CY	4	39,640.0	158,560.00	17,600.0	70,400.00	39,640.0	158,560.00
Clearing & Grubbing	AC	2,000	23.0	46,000.00	18.3	36,600.00	23.0	46,000.00
Restoration (top soil, grading and revegetation)	AC	2,500	20.9	52,250.00	16.2	40,500.00	20.9	52,250.00
Wetlands Restoration								
General Channel Areas	AC	5,000	2.1	10,500.00	2.1	10,500.00	2.1	10,500.00
South Platte Park Area	AC	25,000	-	0.00	-	0.00	-	0.00
Maintenance Road	LF	25	5,350.0	133,750.00	3,750.0	93,750.00	5,350.0	133,750.00
Trickle Channel	LF	20	4,450.0	89,000.00	2,900.0	58,000.00	4,450.0	89,000.00
Riprap and Bedding	CY	50	717.0	35,850.00	422.0	21,100.00	717.0	35,850.00
Concrete Drop Structure - 3 feet (excavation, concrete wall, footing, backfill & riprap)	LF	225	1,059.0	238,275.00	788.0	177,300.00	1,059.0	238,275.00
Outlet Works (emergency spillway, concrete outlet structure, trash rack, outlet pipe, energy dissipator)								
Small Pond (6 ac-ft)	EA	30,000	-	0.00	2.0	60,000.00	-	0.00
Medium Pond (10 ac-ft)	EA	40,000	3.0	120,000.00	2.0	80,000.00	3.0	120,000.00
Large Pond (20 ac-ft)	EA	45,000	1.0	45,000.00	-	0.00	1.0	45,000.00
Highline Canal Overflow Spillway	LS	30,000	-	0.00	-	0.00	1.0	30,000.00
Reinforced Concrete Pipe (excavation, bedding, backfill manholes, and inlets)								
30 inch	LF	75	-	0.00	-	0.00	-	0.00
36 inch	LF	90	-	0.00	-	0.00	-	0.00
42 inch	LF	110	-	0.00	-	0.00	-	0.00
48 inch	LF	130	-	0.00	-	0.00	-	0.00
54 inch	LF	150	-	0.00	-	0.00	-	0.00
60 inch	LF	175	880.0	154,000.00	-	0.00	880.0	154,000.00
66 inch	LF	190	-	0.00	-	0.00	-	0.00
72 inch	LF	210	-	0.00	-	0.00	-	0.00
78 inch	LF	250	-	0.00	-	0.00	-	0.00
Reinforced Concrete Culverts (excavation, bedding, backfill headwall, and wingwalls)								
4' x 4' RCB	LF	200	-	0.00	-	0.00	-	0.00
6' x 4' RCB	LF	250	-	0.00	-	0.00	-	0.00
6' x 6' RCB	LF	290	-	0.00	-	0.00	-	0.00
7' x 4' RCB	LF	300	-	0.00	-	0.00	-	0.00
8' x 6' RCB	LF	430	-	0.00	-	0.00	-	0.00
8' x 8' RCB	LF	470	-	0.00	-	0.00	-	0.00
10' x 6' RCB	LF	600	-	0.00	-	0.00	-	0.00

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TABLE 3-5
PRELIMINARY COST ESTIMATE

PROJECT: DAD CLARK GULCH - UD&FCD
BASIN: JACKASS GULCH

ITEM	UNITS	UNIT COST	ALTERNATIVE 1 * QUANTITY	ALTERNATIVE 1 * EXTENSION	ALTERNATIVE 2 QUANTITY	ALTERNATIVE 2 EXTENSION	ALTERNATIVE 3 * QUANTITY	ALTERNATIVE 3 * EXTENSION
10' x 8' RCB	LF	660	-	0.00	-	0.00	-	0.00
10' x 10' RCB	LF	720	-	0.00	-	0.00	-	0.00
12' x 8' RCB	LF	780	-	0.00	-	0.00	-	0.00
12' x 10' RCB	LF	840	-	0.00	-	0.00	-	0.00
12' x 12' RCB	LF	900	-	0.00	-	0.00	-	0.00
Jacking Cost								
48" RCP	LF	520	-	0.00	-	0.00	-	0.00
60" RCP	LF	700	-	0.00	-	0.00	-	0.00
8' x 6' RCB	LF	1,720	-	0.00	-	0.00	-	0.00
10' x 6' RCB	LF	2,400	-	0.00	-	0.00	-	0.00
10' x 8' RCB	LF	2,640	-	0.00	-	0.00	-	0.00
SUBTOTAL				1,494,685.00		962,650.00		1,524,685.00
Engineering, Legal and Administrative, Utility Relocation (35%)				523,139.75		336,927.50		533,639.75
Contingency (15%)				224,202.75		144,397.50		228,702.75
TOTAL CONSTRUCTION COST				2,242,027.50		1,443,975.00		2,287,027.50
Land Value								
Floodway Property	AC	4,500	3.4	15,300.00	38.9	175,050.00	39.3	176,850.00
Residential	AC	40,000	10.6	424,000.00	6.9	276,000.00	10.6	424,000.00
Industrial	AC	85,000	-	0.00	-	0.00	-	0.00
Retail Commercial	AC	130,000	-	0.00	-	0.00	-	0.00
LAND ACQUISITION COST				439,300.00		451,050.00		600,850.00
TOTAL PROJECT COST				2,681,327.50		1,895,025.00		2,887,877.50
ANNUAL ROUTINE MAINTENANCE COSTS:								
Mowing (3 times/year)	AC	1,000	21.4	21,400.00	17.8	17,800.00	21.4	21,400.00
Debris and Trash Removal (3 times/year)	AC	250	21.4	5,350.00	17.8	4,450.00	21.4	5,350.00
Detention Area Sediment Removal (once/year)	LS	1,000	5.0	5,000.00	5.0	5,000.00	5.0	5,000.00
Storm Sewer Cleaning and Debris Removal (once/year)	LF	0.3	2,790.0	837.00	1,910.0	573.00	2,790.0	837.00
TOTAL MAINTENANCE COST				32,587.00		27,823.00		32,587.00

* Alternatives 1 & 3 are based on an outfall system to Dad Clark Gulch. The option of going directly to the South Platte River would be similar in cost.

TABLE 3-6
PRELIMINARY COST ESTIMATE

PROJECT: DAD CLARK GULCH - UD&FCD
BASIN: LOWER DAD CLARK

ITEM	UNITS	UNIT COST	ALTERNATIVE 1A QUANTITY	ALTERNATIVE 1A EXTENSION	ALTERNATIVE 2A QUANTITY	ALTERNATIVE 2A EXTENSION	ALTERNATIVE 3A QUANTITY	ALTERNATIVE 3A EXTENSION
Excavation	CY	5	30,760.0	153,800.00	21,134.0	105,670.00	21,643.0	108,215.00
Embankment	CY	4	17.0	68.00	17.0	68.00	17.0	68.00
Clearing & Grubbing	AC	2,000	7.7	15,400.00	7.1	14,200.00	7.5	15,000.00
Restoration (top soil, grading and revegetation)	AC	2,500	6.7	16,750.00	6.1	15,250.00	4.2	10,500.00
Wetlands Restoration								
General Channel Areas	AC	5,000	-	0.00	-	0.00	2.3	11,500.00
South Platte Park Area	AC	25,000	1.0	25,000.00	1.0	25,000.00	1.0	25,000.00
Maintenance Road	LF	25	3,350.0	83,750.00	3,350.0	83,750.00	3,350.0	83,750.00
Trickle Channel	LF	20	2,300.0	46,000.00	3,350.0	67,000.00	-	0.00
Riprap and Bedding	CY	50	4,511.0	225,550.00	4,541.0	227,050.00	4,541.0	227,050.00
Concrete Drop Structure - 3 feet (excavation, concrete wall, footing, backfill & riprap)	LF	225	-	0.00	126.0	28,350.00	-	0.00
Outlet Works (emergency spillway, concrete outlet structure, trash rack, outlet pipe, energy dissipator)								
Small Pond (6 ac-ft)	EA	30,000	1.0	30,000.00	1.0	30,000.00	1.0	30,000.00
Medium Pond (10 ac-ft)	EA	40,000	-	0.00	-	0.00	-	0.00
Large Pond (20 ac-ft)	EA	45,000	-	0.00	-	0.00	-	0.00
Reinforced Concrete Pipe (excavation, bedding, backfill manholes, and inlets)								
30 inch	LF	75	-	0.00	-	0.00	-	0.00
36 inch	LF	90	1,050.0	94,500.00	-	0.00	-	0.00
42 inch	LF	110	-	0.00	-	0.00	-	0.00
48 inch	LF	130	-	0.00	-	0.00	-	0.00
54 inch	LF	150	-	0.00	-	0.00	-	0.00
60 inch	LF	175	-	0.00	-	0.00	-	0.00
66 inch	LF	190	-	0.00	-	0.00	-	0.00
72 inch	LF	210	-	0.00	-	0.00	-	0.00
78 inch	LF	250	-	0.00	-	0.00	-	0.00
Reinforced Concrete Culverts (excavation, bedding, backfill headwall, and wingwalls)								
4'x 4' RCB	LF	200	-	0.00	-	0.00	-	0.00
6'x 4' RCB	LF	250	-	0.00	-	0.00	-	0.00
6'x 6' RCB	LF	290	-	0.00	-	0.00	-	0.00
7'x 4' RCB	LF	300	-	0.00	-	0.00	-	0.00
8'x 6' RCB	LF	430	-	0.00	-	0.00	-	0.00
8'x 8' RCB	LF	470	-	0.00	-	0.00	-	0.00
10'x 6' RCB	LF	600	-	0.00	-	0.00	-	0.00

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TABLE 3-6
PRELIMINARY COST ESTIMATE

PROJECT: DAD CLARK GULCH - UD&FCD
BASIN: LOWER DAD CLARK

ITEM	UNITS	UNIT COST	ALTERNATIVE 1A QUANTITY	ALTERNATIVE 1A EXTENSION	ALTERNATIVE 2A QUANTITY	ALTERNATIVE 2A EXTENSION	ALTERNATIVE 3A QUANTITY	ALTERNATIVE 3A EXTENSION
10'x 8' RCB	LF	660	-	0.00	-	0.00	-	0.00
10'x10' RCB	LF	720	-	0.00	-	0.00	-	0.00
12'x 8' RCB	LF	780	-	0.00	-	0.00	-	0.00
12'x10' RCB	LF	840	-	0.00	-	0.00	-	0.00
12'x12' RCB	LF	900	-	0.00	-	0.00	-	0.00
Jacking Cost								
48" RCP	LF	520	-	0.00	-	0.00	-	0.00
60" RCP	LF	700	-	0.00	-	0.00	-	0.00
8'x 6' RCB	LF	1,720	-	0.00	-	0.00	-	0.00
10'x 6' RCB	LF	2,400	-	0.00	-	0.00	-	0.00
10'x 8' RCB	LF	2,640	-	0.00	-	0.00	-	0.00
SUBTOTAL				690,818.00		596,338.00		511,083.00
Engineering, Legal and Administrative, Utility Relocation (35%)				241,786.30		208,718.30		178,879.05
Contingency (15%)				103,622.70		89,450.70		76,662.45
TOTAL CONSTRUCTION COST				1,036,227.00		894,507.00		766,624.50
Land Value								
Floodway Property	AC	4,500	5.0	22,500.00	3.9	17,550.00	3.9	17,550.00
Residential	AC	40,000	-	0.00	-	0.00	-	0.00
Industrial	AC	85,000	-	0.00	-	0.00	-	0.00
Retail Commercial	AC	130,000	-	0.00	-	0.00	-	0.00
LAND ACQUISITION COST				22,500.00		17,550.00		17,550.00
TOTAL PROJECT COST				1,058,727.00		912,057.00		784,174.50
ANNUAL ROUTINE MAINTENANCE COSTS:								
Mowing (3 times/year)	AC	1,000	4.9	4,900.00	3.8	3,800.00	3.3	3,300.00
Debris and Trash Removal (3 times/year)	AC	250	4.9	1,225.00	3.8	950.00	3.3	825.00
Detention Area Sediment Removal (once/year)	LS	1,000	1.0	1,000.00	1.0	1,000.00	1.0	1,000.00
Storm Sewer Cleaning and Debris Removal (once/year)	LF	0.3	1,050.0	315.00	-	0.00	-	0.00
TOTAL MAINTENANCE COST				7,440.00		5,750.00		5,125.00

TABLE 3-6
PRELIMINARY COST ESTIMATE

PROJECT: DAD CLARK GULCH - UD&FCD
BASIN: LOWER DAD CLARK

ITEM	UNITS	UNIT COST	ALTERNATIVE 1B QUANTITY	ALTERNATIVE 1B EXTENSION	ALTERNATIVE 2B QUANTITY	ALTERNATIVE 2B EXTENSION	ALTERNATIVE 3B QUANTITY	ALTERNATIVE 3B EXTENSION
Excavation	CY	5	52,804.0	264,020.00	35,000.0	175,000.00	35,509.0	177,545.00
Embankment	CY	4	17.0	68.00	17.0	68.00	17.0	68.00
Clearing & Grubbing	AC	2,000	12.3	24,600.00	11.0	22,000.00	11.4	22,800.00
Restoration (top soil, grading and revegetation)	AC	2,500	11.3	28,250.00	10.0	25,000.00	8.1	20,250.00
Wetlands Restoration								
General Channel Areas	AC	5,000	-	0.00	-	0.00	2.3	11,500.00
South Platte Park Area	AC	25,000	1.0	25,000.00	1.0	25,000.00	1.0	25,000.00
Maintenance Road	LF	25	4,950.0	123,750.00	4,950.0	123,750.00	4,950.0	123,750.00
Trickle Channel	LF	20	3,900.0	78,000.00	4,950.0	99,000.00	1,600.0	32,000.00
Riprap and Bedding	CY	50	4,511.0	225,550.00	4,541.0	227,050.00	4,541.0	227,050.00
Concrete Drop Structure - 3 feet (excavation, concrete wall, footing, backfill & riprap)	LF	225	168.0	37,800.00	315.0	70,875.00	189.0	42,525.00
Outlet Works (emergency spillway, concrete outlet structure, trash rack, outlet pipe, energy dissipator)								
Small Pond (6 ac-ft)	EA	30,000	1.0	30,000.00	1.0	30,000.00	1.0	30,000.00
Medium Pond (10 ac-ft)	EA	40,000	-	0.00	-	0.00	-	0.00
Large Pond (20 ac-ft)	EA	45,000	-	0.00	-	0.00	-	0.00
Reinforced Concrete Pipe (excavation, bedding, backfill manholes, and inlets)								
30 inch	LF	75	-	0.00	-	0.00	-	0.00
36 inch	LF	90	1,050.0	94,500.00	-	0.00	-	0.00
42 inch	LF	110	-	0.00	-	0.00	-	0.00
48 inch	LF	130	-	0.00	-	0.00	-	0.00
54 inch	LF	150	-	0.00	-	0.00	-	0.00
60 inch	LF	175	-	0.00	-	0.00	-	0.00
66 inch	LF	190	-	0.00	-	0.00	-	0.00
72 inch	LF	210	-	0.00	-	0.00	-	0.00
78 inch	LF	250	-	0.00	-	0.00	-	0.00
Reinforced Concrete Culverts (excavation, bedding, backfill headwall, and wingwalls)								
4'x 4' RCB	LF	200	-	0.00	-	0.00	-	0.00
6'x 4' RCB	LF	250	-	0.00	-	0.00	-	0.00
6'x 6' RCB	LF	290	-	0.00	-	0.00	-	0.00
7'x 4' RCB	LF	300	-	0.00	-	0.00	-	0.00
8'x 6' RCB	LF	430	-	0.00	-	0.00	-	0.00
8'x 8' RCB	LF	470	-	0.00	-	0.00	-	0.00
10'x 6' RCB	LF	600	-	0.00	-	0.00	-	0.00

REVISED March 27, 1990

TABLE 3-6
PRELIMINARY COST ESTIMATE

PROJECT: DAD CLARK GULCH - UD&FCD
BASIN: LOWER DAD CLARK

ITEM	UNITS	UNIT COST	ALTERNATIVE 1B QUANTITY	ALTERNATIVE 1B EXTENSION	ALTERNATIVE 2B QUANTITY	ALTERNATIVE 2B EXTENSION	ALTERNATIVE 3B QUANTITY	ALTERNATIVE 3B EXTENSION
10'x 8' RCB	LF	660	-	0.00	-	0.00	-	0.00
10'x10' RCB	LF	720	-	0.00	-	0.00	-	0.00
12'x 8' RCB	LF	780	-	0.00	-	0.00	-	0.00
12'x10' RCB	LF	840	-	0.00	-	0.00	-	0.00
12'x12' RCB	LF	900	-	0.00	-	0.00	-	0.00
Jacking Cost								
48" RCP	LF	520	-	0.00	-	0.00	-	0.00
60" RCP	LF	700	-	0.00	-	0.00	-	0.00
8'x 6' RCB	LF	1,720	-	0.00	-	0.00	-	0.00
10'x 6' RCB	LF	2,400	-	0.00	-	0.00	-	0.00
10'x 8' RCB	LF	2,640	-	0.00	-	0.00	-	0.00
SUBTOTAL				931,538.00		797,743.00		712,488.00
Engineering, Legal and Administrative, Utility Relocation (35%)				326,038.30		279,210.05		249,370.80
Contingency (15%)				139,730.70		119,661.45		106,873.20
TOTAL CONSTRUCTION COST				1,397,307.00		1,196,614.50		1,068,732.00
Land Value								
Floodway Property	AC	4,500	6.9	31,050.00	5.4	24,300.00	5.4	24,300.00
Residential	AC	40,000	-	0.00	-	0.00	-	0.00
Industrial	AC	85,000	-	0.00	-	0.00	-	0.00
Retail Commercial	AC	130,000	-	0.00	-	0.00	-	0.00
LAND ACQUISITION COST				31,050.00		24,300.00		24,300.00
TOTAL PROJECT COST				1,428,357.00		1,220,914.50		1,093,032.00
ANNUAL ROUTINE MAINTENANCE COSTS:								
Mowing (3 times/year)	AC	1,000	8.0	8,000.00	6.1	6,100.00	5.6	5,600.00
Debris and Trash Removal (3 times/year)	AC	250	8.0	2,000.00	6.1	1,525.00	5.6	1,400.00
Detention Area Sediment Removal (once/year)	LS	1,000	1.0	1,000.00	1.0	1,000.00	1.0	1,000.00
Storm Sewer Cleaning and Debris Removal (once/year)	LF	0.3	1,050.0	315.00	-	0.00	-	0.00
TOTAL MAINTENANCE COST				11,315.00		8,625.00		8,000.00

TABLE 3-7
ALTERNATIVE EVALUATION MATRIX

	EVALUATION CRITERIA			
	COST Project Cost (Main. Cost)	CONSTRUCTIBILITY	100-YR FLOOD CONTROL	ENVIRONMENTAL ISSUES
RANGEVIEW GULCH				
Alternative 1	2,400,000 (12,000)	FAIR	ADEQUATE	FAIR
Alternative 2	2,200,000 (15,000)	FAIR	ADEQUATE	FAIR
Alternative 3	1,900,000 (15,000)	FAIR	ADEQUATE	FAIR
JACKASS GULCH				
Alternative 1	2,700,000 (32,500)	FAIR	ADEQUATE	POOR 2/
Alternative 2	1,900,000 (28,000)	GOOD	ADEQUATE	FAIR
Alternative 3	2,900,000 (32,500)	FAIR	ADEQUATE 1/	POOR 2/
LOWER DAD CLARK 3/				
Alternative 1A	1,100,000 (7,500)	GOOD	ADEQUATE	GOOD
Alternative 2A 4/	900,000 (6,000)	GOOD	ADEQUATE	GOOD
Alternative 3A 4/	800,000 (5,000)	GOOD	ADEQUATE	EXCELLENT
Alternative 1B	1,400,000 (11,500)	GOOD	ADEQUATE	FAIR
Alternative 2B 4/	1,200,000 (8,500)	GOOD	ADEQUATE	FAIR
Alternative 3B 4/	1,100,000 (8,000)	GOOD	ADEQUATE	GOOD

1/ 300 cfs of the Highline Canal storm flows is discharged into Jackass Gulch. This will have a positive effect on Lee Gulch.
2/ If the second outfall is directed east to the South Platte River, then a new discharge point will be established.
3/ Subalternatives "A" do not propose any improvements upstream of the railroad lines, whereas subalternatives "B" include channel improvements for that area.
4/ Assumes an Adequate Assurances Agreement has been executed for McLellan Reservoir.

SECTION 4
THE SELECTED PLAN

4.1 Introduction

The Project Sponsors, the South Suburban Park and Recreation District, other agencies, and interested parties were provided copies of the Alternative Evaluation Report (Reference 21, Appendix A) which included Sections 1, 2 and 3 of this report and other supporting data. The report was reviewed and a consensus was reached on a selected plan for each drainageway. This selected plan was then restated in writing, and the Consultant was directed to proceed with the preliminary design which is documented in this section and depicted in Sheets 1 through 13.

The Project Sponsors based their evaluation primarily on environmental issues. The selected alternatives were those which least impacted, and in some cases enhanced, the existing environment. The selected alternatives also happened to be the least in project cost and the best in constructibility and flood control. The only disadvantage was that the Jackass Gulch selected plan did not include the acceptance of Highline Canal flows into the drainageway. Therefore, the frequent flooding of Lee Gulch, which is north of the study area, will continue to be a problem and will need to be managed between the City and the Denver Water Department.

The selected alternatives are listed as follows:

Rangeview Gulch:	Alternative 3
Jackass Gulch:	Alternative 2
Lower Dad Clark Gulch:	Alternative 3A

In five cases, the selected alternative was modified slightly: 1) The existing private detention facilities in the upper Jackass Gulch basin will not be acquired by Littleton, but they will still be recognized for master planning purposes. However, for floodplain regulation purposes, these facilities will not be recognized until they are under public ownership and maintenance. This was agreed upon by UD&FCD because the City of Littleton has a well-managed inventory, owner accountability, and maintenance program for these private facilities, 2) The developer in the Santa Fe Park area of Lower Dad Clark Gulch is to be given the option to use a grass-lined channel instead of a wetlands bottom channel pending agency approval, 3) The regional water quality pond proposed for Dad Clark Gulch was taken out so that the developers could design these improvements as part of their development plans, 4) Water quality on Jackass Gulch will be addressed by each property owner as property develops, and 5) The low flow crossing for the lower Rangeview Gulch outfall was replaced with a culvert.

The preliminary design presented in this section is based upon the alternative evaluation of Section 3. However, in some cases the plans and costs differ significantly. These differences should be viewed as representative of the

refinements in concepts which are inevitably made between conceptual and preliminary design stages. They are not contradictions of the original ideas.

All of the technical support data for this study is contained in a technical addendum which is a separate document on file with the Urban Drainage and Flood Control District.

4.2 The Outfall Plan

Each of the outfall plans is described below. The reader is referred to the plan and profile drawings, as necessary, to supplement the following discussion.

4.2.1 Rangeview Gulch

Two existing ponds, Turtle Lake and Ridgeview Park, will be utilized for detention with embankment and outlet works improvements. Both of the ponds will have a permanent wet pond which will be at the existing water surface elevations. The storage volumes are as follows:

Turtle Lake Pond (existing) = 10.0 acre-feet
Ridgeview Park Pond (existing) = 8.8 acre-feet

The outfall from Turtle Lake will be directed to the north, and a new culvert will be constructed under the railroad tracks and Santa Fe Drive discharging into an open channel along the south side of the proposed public access road to the river. The basin north of Turtle Lake will utilize this same culvert. Also, the area between the railroad tracks will be drained by inlets discharging into the culvert. The channel will extend to the outfall location of the old South Platte River channel.

Between Turtle Lake and Ridgeview Park, the existing 36" RCP storm sewer will be replaced by a larger capacity system which will carry the 100-year discharges. (The possibility of utilizing the existing 36" system by installing a parallel system should be addressed in the final design.) A special inlet structure is proposed at Curtice Street and Costilla Avenue in order to pick up the entire 100-year surface flow of approximately 175 cfs. (The swale proposed in the alternative evaluation was eliminated due to R.O.W. concerns.) A separate lateral storm sewer system from Turtle Lake to Costilla Street will be used to help pick up storm flows.

Upstream of Ridgeview Park a new culvert will be provided under Prince Street to convey the 100-year flow.

4.2.2 Jackass Gulch

The selected plan for Jackass Gulch is mainly a storm runoff detention outfall plan. The first location for detention storage is the existing private detention facilities in the upper basin. In the alternative evaluation, acquisition of these facilities was assumed to be necessary. However, through discussions in the selection process, UD&FCD will recognize these private detention facilities for only master planning purposes because of the City of Littleton's maintenance program. The City of Littleton ensures maintenance of all private drainage facilities by sending out an annual survey to all private facilities owners. About 80% respond to this survey. For those owners that do not respond, the City does whatever maintenance is necessary and the owner is billed for the work. This program is well managed and has ensured adequate maintenance.

The second location for detention storage is in the area just downstream of the Highline Canal. Two detention facilities will be located in the open space area and one in the channel just downstream of the open space area. The placement of these ponds was chosen so as to have the least impact to the wetlands in the area, especially the large cottonwood trees (Reference 60, Appendix A). The third location for detention storage is behind Jackass Hill Road. Due to the two 48" CMP's, detention occurs behind the roadway embankment. With the upstream detention proposed in this plan, no flow will overtop the roadway. The fourth location for detention storage is at the northeast corner of Mineral Boulevard and the railroad tracks. The existing detention pond will be expanded and a new pond will be constructed just below the existing. Both of these ponds will be revegetated with wetlands and the existing wetlands just downstream of Jackass Hill Road will not be disturbed. It is proposed to use the abandoned railroad spur embankment for the upper pond embankment. Further investigation will need to be done in the final design to determine if this embankment can be used as such. The excavation and embankment quantities reflect the possibility of having to replace this entire embankment. Below is a summary of the detention improvements.

Upper Open Space Pond (proposed)	= 11.1 acre-feet
Lower Open Space Pond (proposed)	= 11.2 acre-feet
Jackass Channel Pond (proposed)	= 7.0 acre-feet
Jackass Hill Road Detention (existing)	= 4.4 acre-feet
Upper Railroad Pond (existing)	= 17.6 acre-feet
Lower Railroad Pond (proposed)	= 7.2 acre-feet

With the proposed detention storage facilities, the existing outfall system under West Mineral Avenue will have sufficient capacity. The only other improvement which is proposed is some channelization upstream of Jackass Hill road. Due to the wetlands in this area, the structural channel improvements were limited as much as possible.

4.2.3 Lower Dad Clark Gulch

The selected plan for Lower Dad Clark Gulch was based on the assumption that flood storage exists in McLellan Reservoir. In order for this to be assumed, an Adequate Assurances Agreement must be signed by the City of Englewood, the City of Littleton and the District. The 100-year discharge from McLellan Reservoir, assuming flood storage, is 850 cfs. If an agreement cannot be signed, the downstream improvements must be designed assuming a 100-year discharge of 1800 cfs.

The only improvements in South Platte Park will be the regrading of the existing ditch. The entire ditch will be grass-lined with 4:1 side slopes and a depth of three feet. The ditch will be used for storm flows up to and including the 2-year event and for routine discharges from the 30" McLellan Reservoir outlet pipe system. From the South Platte Park boundary to the City Ditch flume structure, an open channel with wetlands bottom will be constructed. Other options for this channel are possible pending agency approval. An important aspect of Santa Fe Park is the fact that the existing ground level adjacent to Lower Dad Clark Gulch is too low to contruct the channel improvements. Because of this, the developer needs to fill in the area up to the channel banks in order for these improvements to be constructed. The proposed improvements would be subject to the zoning regulations at the time of construction. No improvements are proposed upstream of the City Ditch since the existing channel is full of wetlands and because the flows are within a defined channel. Improvements to the Santa Fe Drive bridge and D&RGW bridge are currently being designed as part of another State Highway Department project.

4.3 Outfall System Costs

Costs for the outfall plan were itemized for the following categories: drainage improvements, street crossings, utility relocations, and property acquisition. Drainage costs include all culverts, pipes, manholes, inlets, open channels and detention ponds. Street costs are limited to street rehabilitation--asphalt patching, curb and gutter, sidewalks, and concrete pavement. The cost figures listed with the sheet commentaries are rounded to the nearest hundred dollars. A detailed cost estimate is included in the technical addendum.

The cost analysis was basically the same as that used for the Alternative Evaluation phase, but with some changes. Some of the cost items were broken down more specifically, namely street rehabilitation costs and utility relocation costs. Because the drainage improvements for Jackass Gulch and Lower Dad Clark Gulch are in undeveloped areas, minimal street rehabilitation is necessary. Rangeview Gulch, however, will need extensive street rehabilitation. For utility relocations, none are foreseen for Jackass Gulch whereas Lower Dad Clark Gulch will require protection of the 33" sanitary line and the removal of approximately 2,000 feet of 30" concrete pipe. Rangeview Gulch will definitely need some utility relocations, but since the extent of the work is unknown, 15 percent of the drainage cost was used. A contingency of 35%, which includes engineering, legal and administrative expenses, was added as a percent of the total construction cost.

4.4 Phasing and Priority of Improvements

The phasing of a drainage outfall project should insure that no properties or residents would be adversely affected during the scheduled construction of facilities. In general, construction of improvements should begin at the downstream end of a drainageway and proceed upstream. The detention facilities should be constructed before or concurrently with the downstream facilities. For this study, there are two main instances where the sequence of construction would cause adverse effects. These are listed as follows:

1. On Rangeview Gulch, the channel downstream of Santa Fe Drive must be constructed from the downstream end up to Santa Fe Drive. Also, it must be constructed before constructing the culvert under the railroad tracks and Santa Fe Drive.

2. On Lower Dad Clark Gulch, filling of the low lying area in Santa Fe Park should be done concurrently with the construction of the channel improvements.

Besides the previously mentioned items, the priority of improvements is mainly dependent on development. It is important to be aware of the right-of-way requirements for each component since possible delays in obtaining right-of-way would be a problem in scheduling. The following is a prioritized list of construction based on the worst flood areas.

1. Rangeview Gulch - Ridgeview Park detention; storm sewer discharging into Turtle Lake.

2. Rangeview Gulch - Turtle Lake detention and outfall channel.

3. Jackass Gulch - Detention upstream of Jackass Hill Road.

4. Jackass Gulch - Detention at Mineral Avenue and the railroad lines.

5. Rangeview Gulch - Channel improvements downstream of Santa Fe Drive; culvert under Santa Fe Drive and railroad tracks.

6. Rangeview Gulch - Culvert improvements under Prince Street.

7. Lower Dad Clark Gulch - Execution of Adequate Assurances Agreement for McLellan Reservoir.

8. Lower Dad Clark Gulch - Channel improvements for Santa Fe Park.

9. Jackass Gulch - Channelization upstream of Jackass Hill Road.

10. Lower Dad Clark Gulch - Ditch improvements across South Platte Park.

4.5 Final Design Recommendations

Since this Outfall System Planning document is conceptual only, much of the detailed research and analysis must be done during final design. Below is a list of key issues which should be addressed during final design:

1. A complete survey of the existing wetlands in the area must be done. The final design must demonstrate that avoidance, minimization and mitigation measures were taken.

2. A complete research of utilities in the area must be done.

3. Right-of-way must be obtained.

4. Erosion protection and sediment control must be analyzed in more detail.

5. Detention pond sizes must be verified and embankment, spillway, and outlet works need to be designed. Emergency overflows must be carefully addressed, including spillway requirements, erosion protection and surface relief routes at the time of implementation.

6. Water quality and sedimentation ponds, public and private, shall be designed in accordance with Littleton Drainage Criteria Manual, Chapter 15.

7. Irrigation design must be coordinated with the irrigation ditch owners.

8. Maintenance access must be designed in more detail.

9. An Adequate Assurances Agreement will need to be executed by the City of Englewood, with the City of Littleton and the Urban Drainage and Flood Control District to utilize McLellan Reservoir for flood attenuation.

10. The construction of facilities near and under Santa Fe Drive must be coordinated with the proposed improvements planned for that corridor.

11. Coordination needs to be done with the Army Corps of Engineers and the Colorado Department of Health for needed permits.

OUTFALL SYSTEMS PLANNING

LOWER DAD CLARK GULCH AND DFA0068

The Urban Drainage and Flood Control District
City of Littleton

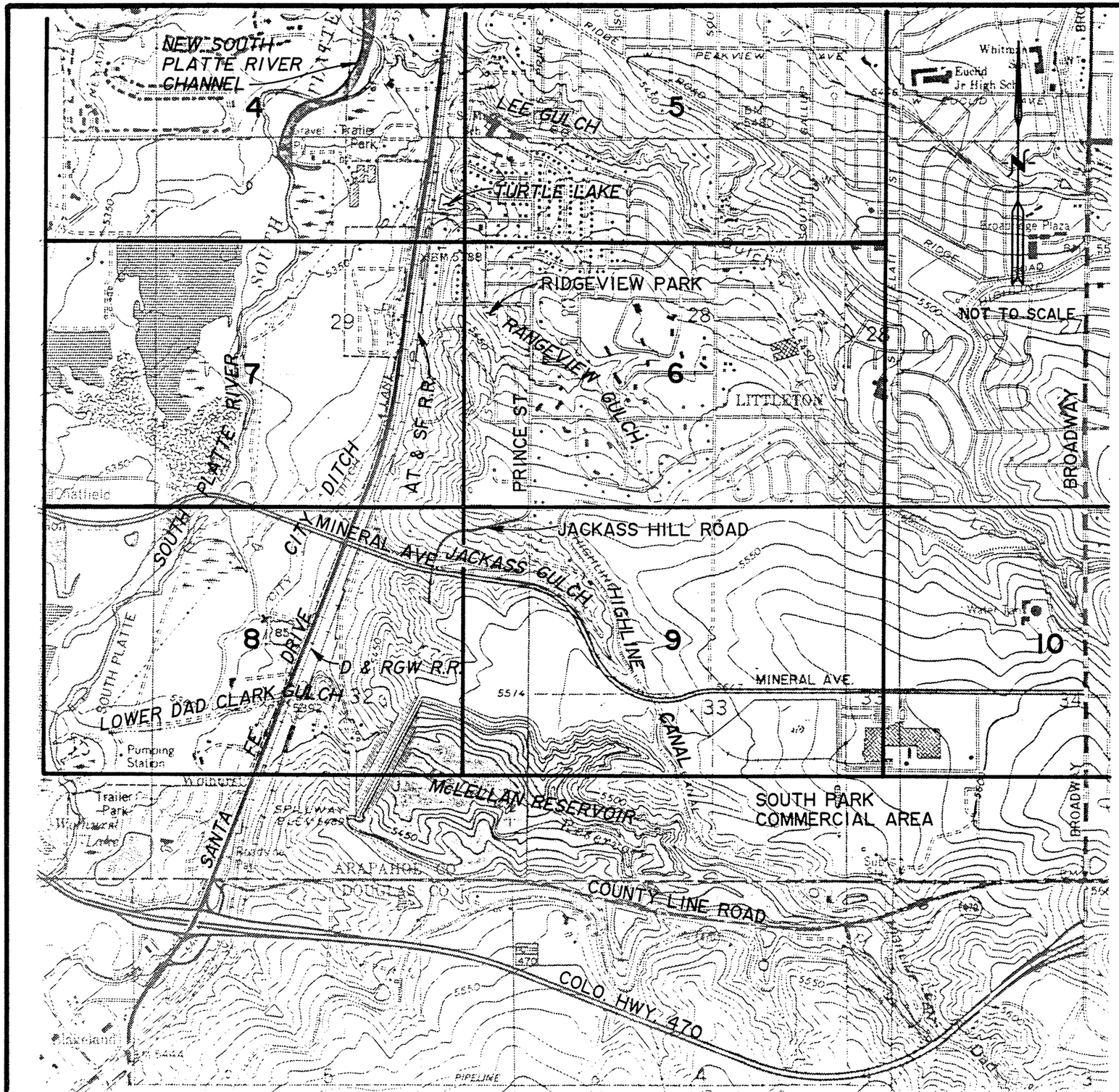
LEGEND

PLAN

- EXISTING RIGHT-OF-WAY LINE
- 50 — STATIONING LINE
- PROPOSED DETENTION POND W/OUTLET WORKS AND SPILLWAY
- EXISTING CULVERT OR STORM SEWER SYSTEM
- 30" — EXISTING UTILITY
- PROPOSED CULVERT
- PROPOSED STORM SEWER SYSTEM
- PROPOSED ENERGY DISSIPATOR
- PROPOSED RIPRAP PROTECTION
- PROPOSED CHANNEL (R.O.W. LIMITS)
- PROPOSED DROP STRUCTURE
- EXISTING DETENTION
- EMBANKMENT FILL
- EXISTING 100-YR. FLOOD PLAIN

PROFILE

- PROPOSED TOP OF BANK ELEVATION
- EXISTING GROUND AT CHANNEL STATION LINE
- PROPOSED GROUND ELEVATION WITH DROP STRUCTURE
- PROPOSED STORM SEWER AND MANHOLE
- EXISTING CULVERT
- PROPOSED CULVERT AND HEADWALLS
- PROPOSED ENERGY DISSIPATOR
- PROPOSED RIPRAP PROTECTION
- EXISTING POND AND NORMAL WATER SURFACE ELEVATION
- PROPOSED POND WITH OUTLET WORKS AND 100-YEAR WATER SURFACE ELEVATION
- EXISTING BRIDGE



SHEET INDEX

SHEET NO.	TITLE
1	TITLE SHEET
2	GENERAL NOTES
3	SHEET INDEX
*4	RANGEVIEW GULCH - PLAN
*5	RANGEVIEW GULCH - PLAN
*6	RANGEVIEW GULCH - PLAN
*7	RANGEVIEW GULCH - PLAN
*8	JACKASS & LOWER DAD CLARK GULCHES - PLAN
*9	JACKASS GULCH - PLAN
*10	JACKASS GULCH - PLAN
11	RANGEVIEW GULCH - PROFILE
12	JACKASS GULCH - PROFILE
13	LOWER DAD CLARK GULCH - PROFILE

* REFER TO PLAN SHEET LAYOUT ON THE MAP TO THE LEFT

BASE MAP
UNITED STATES GEOLOGICAL SURVEY MAP
LITTLETON QUAD HIGHLANDS RANCH QUAD

CENTENNIAL ENGINEERING INC

DESIGNED DJN DATE 8/90
DRAWN G.D.F. DATE 8/90
CHECKED DLM DATE 10/90
REVISED ____ DATE ____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

SHEET INDEX

SHEET 3 OF 13
CEI JN 906.00

SHEET 4 COMMENTARY

Rangeview Gulch

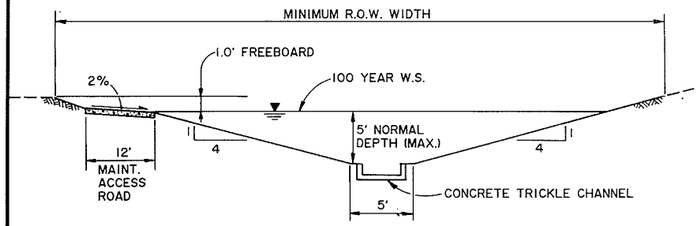
Due to the AT&SF railroad embankment, storm flows continue north from Turtle Lake along the east side of the embankment with the majority of the flow discharging into Lee Gulch. Some of the flow crosses the railroad tracks and Santa Fe Drive into the mobile home area. In order to control these flows, a channel will be constructed north from Turtle Lake to a new culvert crossing under the railroad lines and Santa Fe Drive. An open channel will then continue from the culvert outlet to the old South Platte River channel. The culvert construction will require jacking of an 8' x 6' RCB under the railroad embankments. Also, design of the culvert should be coordinated with the Santa Fe Drive/RTD improvements project of CDOH. A double 8' x 5' RCB culvert will be constructed under the river access road. The only critical utility in the area which needs to be worked around is the 33-inch sanitary sewer line. It will need to be protected due to minimum cover. The location of the outfall into the old South Platte River channel was chosen to minimize wetland disturbance.

Two modifications are proposed for Turtle Lake. First, the embankment will be raised in order to utilize the lake as a detention pond. (No regrading of the lake is proposed.) The second improvement is to relocate the City Ditch into a pipe under the new proposed embankment. An inverted siphon will be needed for the relocated pipe to cross the detention outlet works pipe. Wetlands in the area should be protected.

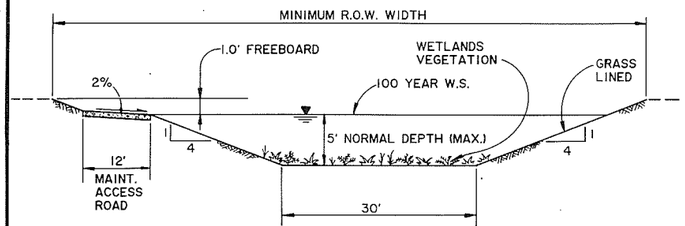
A lateral storm sewer system is proposed on the south side of Turtle Lake to pick up street flows along Costilla Street. Any excess street flows will then continue to the low point at Costilla Avenue and Curtice Street. An easement agreement will be needed for the portion of the proposed system which crosses private property to Turtle Lake.

COST ESTIMATE

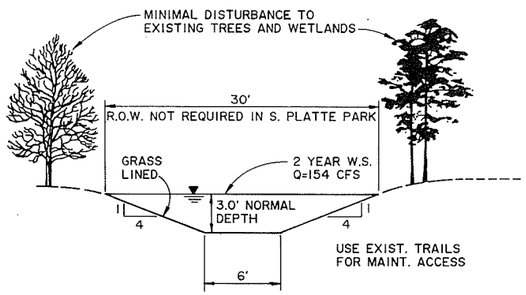
CONSTRUCTION	
Drainage Improvements	$ 1,298,700
Street Crossings	29,800
Utility Relocations	194,800
Total Construction Cost	$ 1,523,300
ENGINEERING AND CONTINGENCIES (35% of Total Construction Cost)	$ 533,200
PROPERTY ACQUISITION	$ 274,400
TOTAL COST OF IMPROVEMENTS	$ 2,330,900
OPERATION AND MAINTENANCE (per year)	$ 6,500



DETAIL A
GRASS-LINED CHANNEL
TYPICAL SECTION
N.T.S.



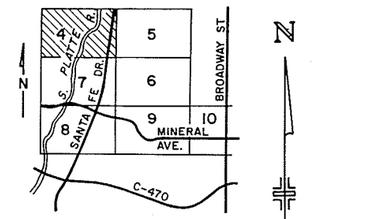
DETAIL B
WETLANDS BOTTOM CHANNEL
TYPICAL SECTION
N.T.S.

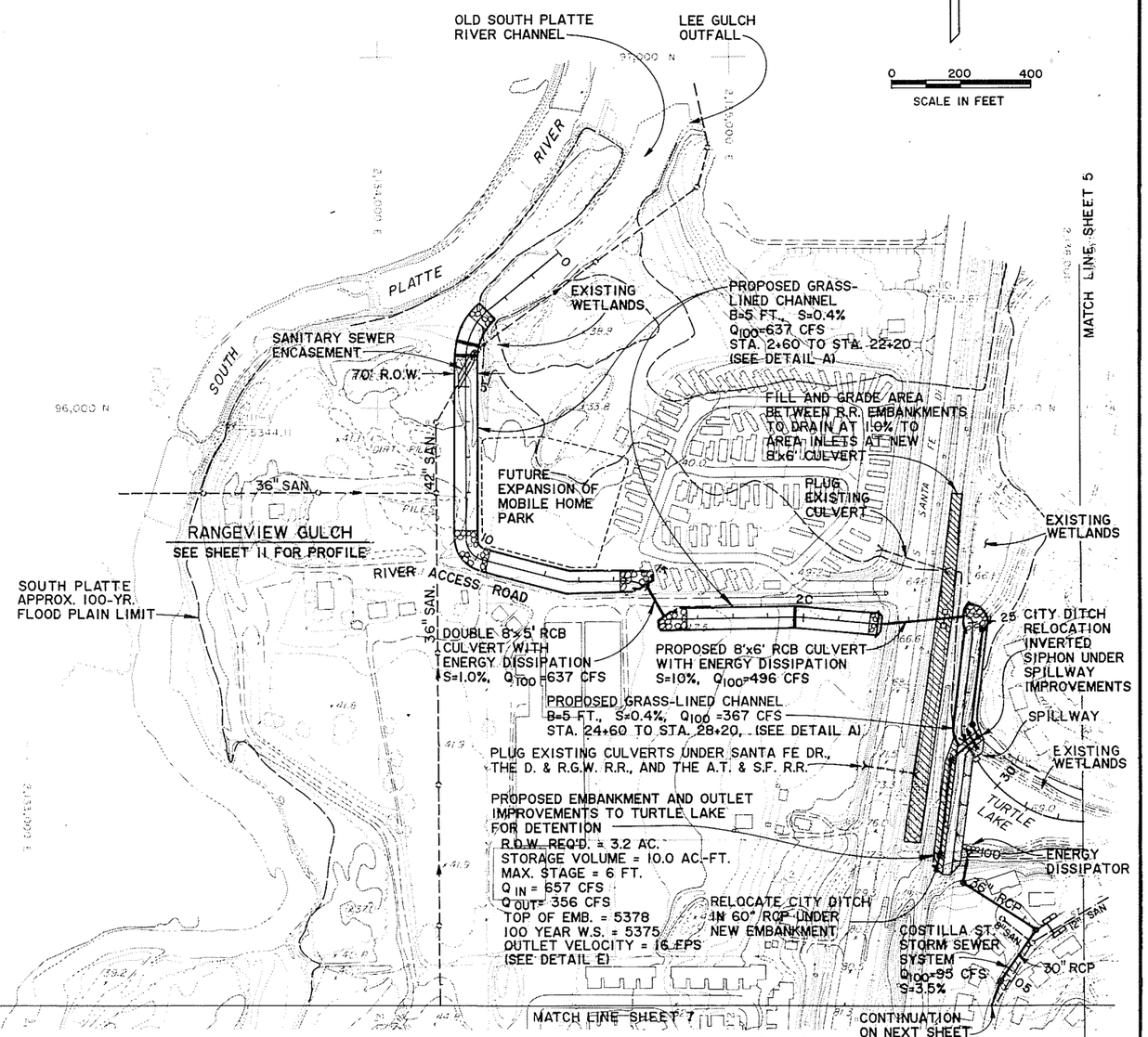


DETAIL C
LOW FLOW CHANNEL
ACROSS SOUTH PLATTE PARK
TYPICAL SECTION
N.T.S.

NOTES

1. THIS DRAWING REPRESENTS MASTER PLANNING AND CONCEPTUAL ENGINEERING. IT SHALL NOT BE USED FOR CONSTRUCTION PURPOSES. IT IS SUBJECT TO CHANGE.
2. REFER TO THE FLOOD HAZARD AREA DELINEATION REPORT "LOWER DAD CLARK GULCH & DFA 0068", NOVEMBER 1990, FOR REGULATORY 100-YEAR FLOODPLAINS, WHERE APPLICABLE.
3. WETLANDS VEGETATION IS LOCATED ALONG THE ENTIRE OUTFALL SYSTEM. PROMINENT WETLANDS AREAS ARE NOTED ON THE PLANS. FINAL DESIGN MUST DEMONSTRATE AVOIDANCE, MINIMIZED DISTURBANCE, AND MITIGATION MEASURES FOR ALL WETLANDS ENCOUNTERED. AVOIDANCE IS THE PRIMARY GOAL AND MITIGATION IS A LAST MEASURE.
4. THE DRAINAGE WAYS FOR THIS OUTFALL SYSTEMS PLAN ARE WITHIN THE DESIGNATED WATER QUALITY IMPACT AREA. DEVELOPERS IN THE AREA MUST DESIGN WATER QUALITY AND SEDIMENTATION PONDS IN ACCORDANCE WITH LITTLETON DRAINAGE CRITERIA MANUAL, CHAPTER 15.
5. UTILITIES ARE SHOWN FOR INFORMATION PURPOSES ONLY. CONTACT UTILITY NOTIFICATION CENTER OF COLORADO AT 534-6700 FOR UP-TO-DATE LOCATION INFORMATION.
6. TYPICAL SECTIONS AND DETAILS ARE SHOWN ON SHEETS 4 AND 5.





ALL ELEVATIONS ARE MEAN SEA LEVEL DATUM

GROUND CONTROL SURVEY BY LANDMARK, LTD.
AERIAL PHOTOGRAPHY BY SCHARF & ASSOC.
TOPOGRAPHIC MAPPING BY LANDMARK, LTD.
CONTOUR INTERVAL 2 FT DATE FLOWN 4-13-89

CENTENNIAL ENGINEERING INC
ARVADA CO. 80001 420-0221
CEI JN. 906.00

DESIGNED DJN DATE 8/90
DRAWN CJH DATE 11/90
CHECKED DLM DATE 2/91
REVISED ____ DATE ____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

PLAN
RANGEVIEW GULCH

SHEET 4
OF 13

SHEET 5 COMMENTARY

Rangeview Gulch

The existing swale and 36" storm sewer which was constructed from the low point at Costilla Avenue to Turtle Lake is not sufficient to convey the 100-year flows. The swale will be kept to carry surface flow. However, the 36" storm sewer will be replaced with a 66", designed for the entire 100-year flow. A drainage R.O.W. currently exists for this reach of pipe. A special inlet structure will need to be constructed at Costilla Avenue and Curtice Street to pick up approximately 175 cfs.

It is proposed to remove the 36" storm sewer system up Curtice Street and replace it with a larger capacity system designed for the 100-year flows. (The possibility of utilizing the existing 36" system by installing a parallel pipe system should be addressed in the final design.) Inlets will be placed at the intersections to pick up street flows.

See Sheet 6 for the continuation of the proposed improvements.

COST ESTIMATE

CONSTRUCTION	
Drainage Improvements	$ 121,200
Street Crossings	26,000
Utility Relocations	18,200
Total Construction Cost	$ 165,400
ENGINEERING AND CONTINGENCIES (35% of Total Construction Cost)	$ 57,900
PROPERTY ACQUISITION	$ ---
TOTAL COST OF IMPROVEMENTS	$ 223,300
OPERATION AND MAINTENANCE (per year)	$ 200

NOTES

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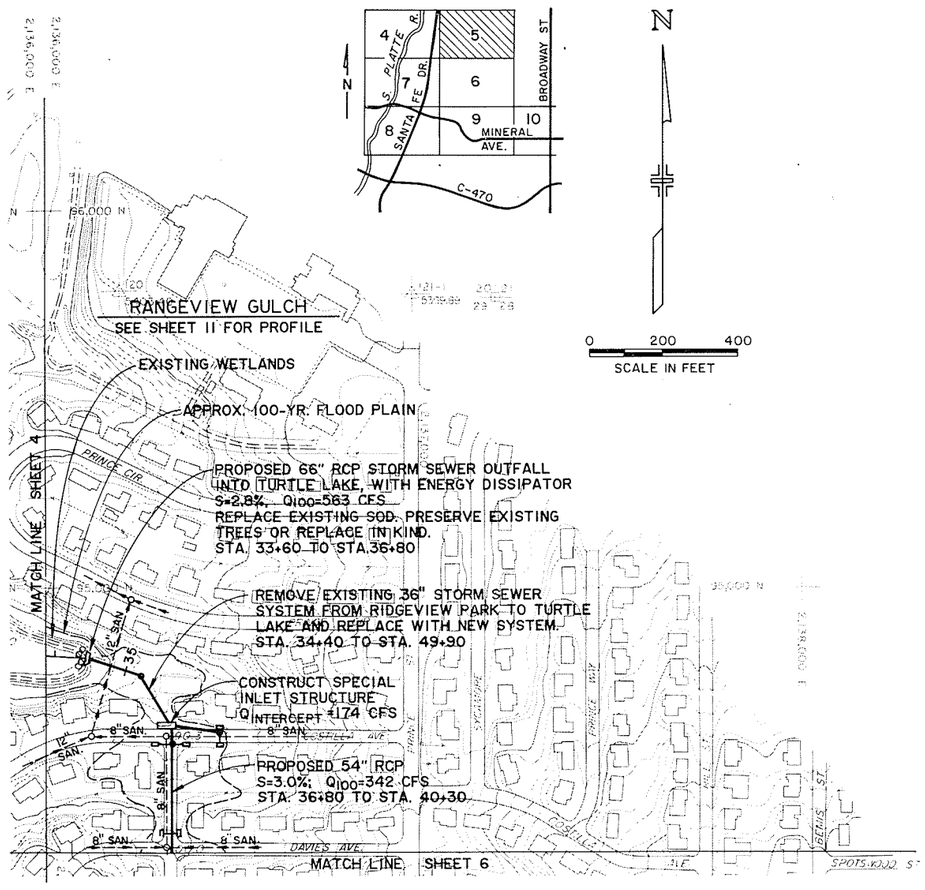
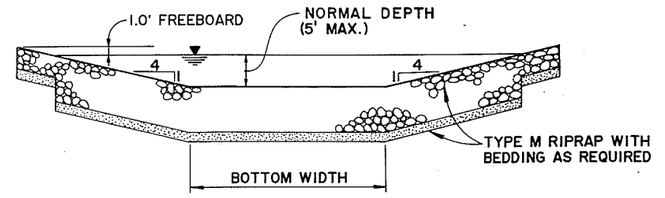
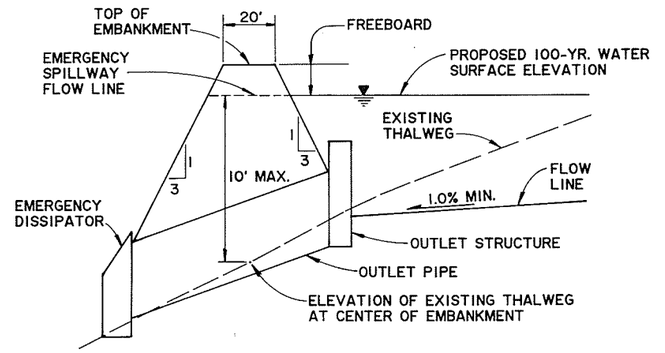
3. WETLANDS VEGETATION IS LOCATED ALONG THE ENTIRE OUTFALL SYSTEM. PROMINENT WETLANDS AREAS ARE NOTED ON THE PLANS. FINAL DESIGN MUST DEMONSTRATE AVOIDANCE, MINIMIZED DISTURBANCE, AND MITIGATION MEASURES FOR ALL WETLANDS ENCOUNTERED. AVOIDANCE IS THE PRIMARY GOAL AND MITIGATION IS A LAST MEASURE.
4. THE DRAINAGE WAYS FOR THIS OUTFALL SYSTEMS PLAN ARE WITHIN THE DESIGNATED WATER QUALITY IMPACT AREA. DEVELOPERS IN THE AREA MUST DESIGN WATER QUALITY AND SEDIMENTATION PONDS IN ACCORDANCE WITH LITTLETON DRAINAGE CRITERIA MANUAL, CHAPTER 15.
5. UTILITIES ARE SHOWN FOR INFORMATION PURPOSES ONLY. CONTACT UTILITY NOTIFICATION CENTER OF COLORADO AT 534-6700 FOR UP-TO-DATE LOCATION INFORMATION.
6. TYPICAL SECTIONS AND DETAILS ARE SHOWN ON SHEETS 4 AND 5.

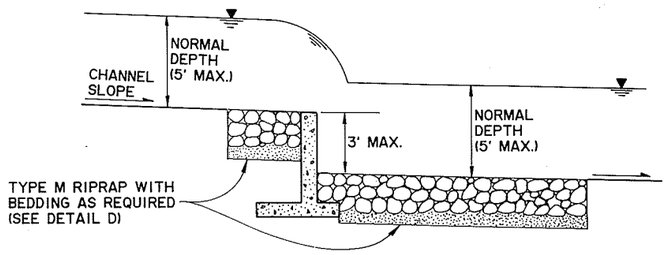




DETAIL D
RIPRAP-LINED CHANNEL
TYPICAL SECTION
N.T.S.



DETAIL E
PROPOSED STORMWATER DETENTION FACILITY
N.T.S.



DETAIL F
DROP STRUCTURE DETAIL
N.T.S.

ALL ELEVATIONS ARE MEAN SEA LEVEL DATUM

SEE SHEET 11 FOR PROFILE

GROUND CONTROL SURVEY BY LANDMARK, LTD.
AERIAL PHOTOGRAPHY BY SCHARF & ASSOC.
TOPOGRAPHIC MAPPING BY LANDMARK, LTD.
CONTOUR INTERVAL 2 FT DATE FLOWN 4-13-89

CENTENNIAL ENGINEERING INC
ARVADA CO. 80001 420-0221
CEI JN. 906.00

DESIGNED	DJN	DATE 8/90
DRAWN	CJH	DATE 11/90
CHECKED	DLM	DATE 2/91
REVISED		DATE

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

PLAN
RANGEVIEW GULCH

SHEET 5 OF 13

SHEET 6 COMMENTARY

Rangeview Gulch

It is proposed to remove the 36" storm sewer system up Curtice Street and replace it with a larger capacity system designed for the 100-year flows. (The possibility of utilizing the existing 36" system by installing a parallel pipe system should be addressed in the final design.) Inlets will be placed at the intersections to pick up street flows. A sanitary sewer line needs to be relocated on Curtice Street from Rowland Avenue to Quinn Avenue.

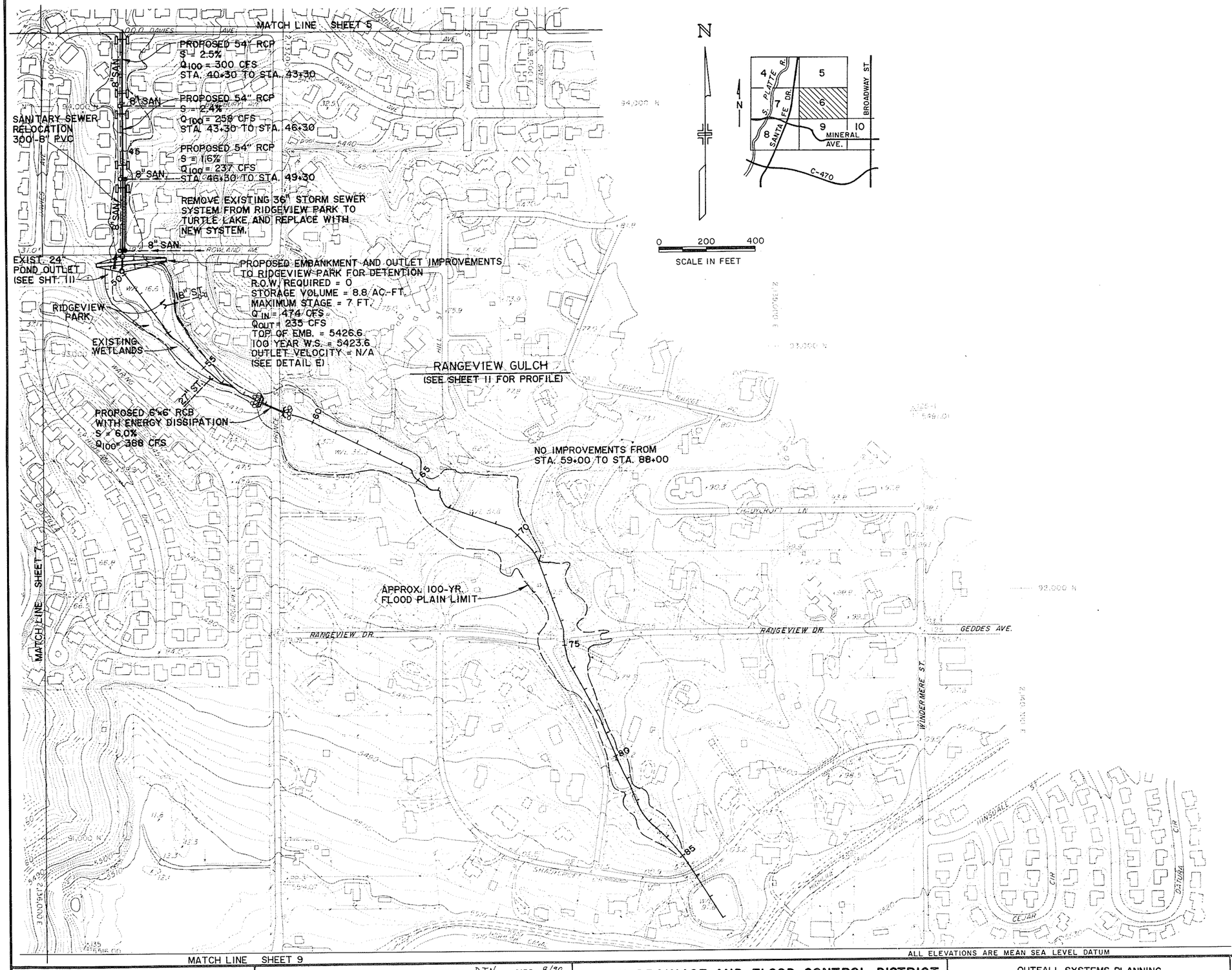
Ridgeview Park will be utilized as a detention pond and will require construction of a berm and outlet works. Since the improvements are limited to the north side of the park, there will be minimal disturbance to the ducks and wetland vegetation in the park. Also the existing water level will be kept the same during and after construction.

The proposed culvert under Prince Street is designed for the 100-year storm event and will prevent flows from overtopping the roadway in the future.

Upstream of Prince Street, storm flooding is minimal since the area is less urbanized. The natural channel is basically undisturbed except for various irrigation ponds or minor road crossings. No improvements are proposed.

COST ESTIMATE

CONSTRUCTION	
Drainage Improvements	$ 240,900
Street Crossings	57,300
Utility Relocations	36,100
Total Construction Cost	$ 334,300
ENGINEERING AND CONTINGENCIES (35% of Total Construction Cost)	$ 117,000
PROPERTY ACQUISITION	$ ---
TOTAL COST OF IMPROVEMENTS	$ 451,300
OPERATION AND MAINTENANCE (per year)	$ 6,300



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3. WETLANDS VEGETATION IS LOCATED ALONG THE ENTIRE OUTFALL SYSTEM. PROMINENT WETLANDS AREAS ARE NOTED ON THE PLANS. FINAL DESIGN MUST DEMONSTRATE AVOIDANCE, MINIMIZED DISTURBANCE, AND MITIGATION MEASURES FOR ALL WETLANDS ENCOUNTERED. AVOIDANCE IS THE PRIMARY GOAL AND MITIGATION IS A LAST MEASURE.
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6. TYPICAL SECTIONS AND DETAILS ARE SHOWN ON SHEETS 4 AND 5.

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AERIAL PHOTOGRAPHY BY SCHARF & ASSOC.
TOPOGRAPHIC MAPPING BY LANDMARK, LTD.
CONTOUR INTERVAL 2 FT DATE FLOWN 4-13-89

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CEI JN. 906.00

DESIGNED DJN DATE 8/90
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REVISED DATE

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

PLAN
RANGEVIEW GULCH

SHEET 6 OF 13

SHEET 7 COMMENTARY

Rangeview Gulch

See Sheet 4 Commentary and Costs.

NOTES

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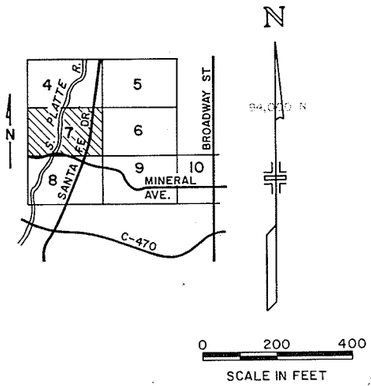

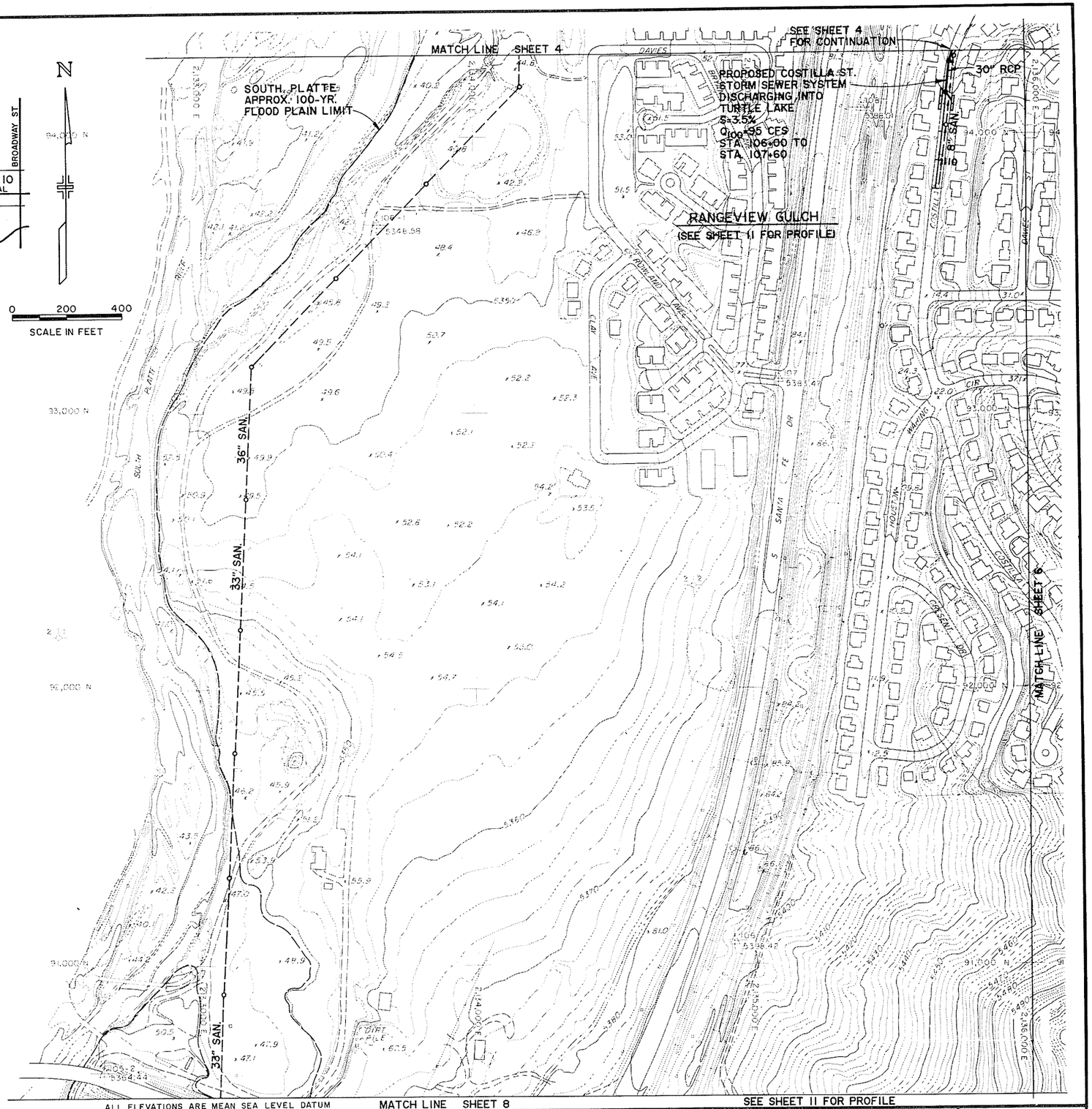

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URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

PLAN
RANGEVIEW GULCH

SHEET 7 OF 13

SHEET 8 COMMENTARY

Jackass Gulch

The existing outfall system to the South Platte River (which consists of an open channel and a 48" CMP and 60" RCP) is utilized in the design to carry 260 cfs. No additional outfall pipe system will be necessary due to the proposed detention facilities upstream of Santa Fe Drive.

Detention at Mineral Avenue and the AT&SF R.R. involves two detention facilities. The existing Upper Railroad Pond will be enlarged with a higher berm and larger pond area. The new Lower Railroad Pond will receive the upper pond releases and will discharge into the 60" outfall system. Only 240 cfs will be released into the 60" in order to allow for other flows entering the outfall system. Both of these ponds will be revegetated with wetlands. Also, the existing wetlands just downstream of Jackass Hill Road will not be disturbed.

Jackass Hill Road currently acts as a detention facility with some of the 100-year flow overtopping the roadway. This detention will be utilized but the roadway overtopping will be eliminated due to the proposed detention facilities further upstream.

Improvements in the natural channel upstream of Jackass Hill Road should be minimized due to the existing wetlands vegetation and the large cottonwood trees. However, the channel is steep and some sort of erosion control is necessary. The proposed improvements (which include drop structures, channelization and riprap protection) have been localized to reaches where minimal disturbance will result. Water quality and sedimentation control will be required of all future development in the basin.

See Sheet 9 for the continuation of the proposed improvements.

COST ESTIMATE

CONSTRUCTION	
Drainage Improvements	$ 453,200
Street Crossings	900
Utility Relocations	---
Total Construction Cost	$ 454,100
ENGINEERING AND CONTINGENCIES (35% of Total Construction Cost)	$ 158,900
PROPERTY ACQUISITION	$ 33,800
TOTAL COST OF IMPROVEMENTS	$ 646,800
OPERATION AND MAINTENANCE (per year)	$ 9,170

Lower Dad Clark Gulch

The lowest portion of the gulch crosses the South Platte Park. Environmental concerns, were addressed in a number of ways. First of all, storm flows entering the park will be allowed to spread out as shallow flooding at the park boundary. Secondly, for low flows, the existing ditch will be utilized with only minor regrading. Thirdly, existing trails will be utilized for maintenance access, if possible.

The channel improvements upstream of the park boundary were designed for the 100-year storm event assuming flood storage in McLellan Reservoir. In order for McLellan Reservoir to be used for flood storage, an Adequate Assurances Agreement needs to be signed between the City of Littleton, the City of Englewood, and the District. With the agreement, the 100-year storm releases from McLellan would be 850 cfs. If an Adequate Assurances Agreement cannot be signed, the downstream improvements must be designed assuming a 100-year discharge of 1800 cfs.

A 100-year channel with wetlands bottom will be constructed from the flume structure to the South Platte Park boundary. Other options for the channel across Santa Fe Park are possible pending agency approval. The flume structure will be left in place but will need to be protected with riprap. Flows from the existing 30" pipe system for McLellan Reservoir will be discharged into the proposed channel and a portion of the existing pipe will be removed downstream of the outfall location, as necessary. The shallow land adjacent to the improvements must be filled up to the channel banks by the developer. Any future development in the basin will be required to implement water quality and sedimentation control measures.

No improvements are planned for the channel upstream of the flume structure since the 100-year flows do not inundate any houses and since the natural channel is full of vegetation and large trees. Improvements to the Santa Fe Drive bridge and D&RGW bridge are currently being designed as part of another State Highway Department project.

COST ESTIMATE

CONSTRUCTION	
Drainage Improvements	$ 221,200
Street Crossings	---
Utility Relocations	18,500
Total Construction Cost	$ 239,700
ENGINEERING AND CONTINGENCIES (35% of Total Construction Cost)	$ 83,900
PROPERTY ACQUISITION	$ 22,100
TOTAL COST OF IMPROVEMENTS	$ 345,700
OPERATION AND MAINTENANCE (per year)	$ 7,130

NOTES

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N

0 200 400
SCALE IN FEET

MATCH LINE SHEET 7

EXISTING WETLANDS

EXISTING WETLANDS BOTTOM CHANNEL
Q_{100} = 260 CFS

EXISTING CHANNEL AND STORM SEWER SYSTEM (SEE FEDERAL AID PROJECT NO. M1030 (3), CONSTRUCTION PLANS, 1982) STA. 0+50 TO STA. 23+00

EXISTING 60" RCP AT 1.0%
Q_{100} = 260 CFS

CONNECT DETENTION OUTLET PIPE TO EXISTING 60" RCP STA. 23+00

UPPER RAILROAD POND (SEE DETAIL E)
R.O.W. REQUIRED = 0
STORAGE VOLUME = 17.6 AC.-FT.
MAXIMUM STAGE = 10 FT.
Q_{IN} = 433 CFS
Q_{OUT} = 270 CFS
TOP OF EMB. = 5418
100-YR. W.S = 5415
OUTLET VELOCITY = 28 FPS

EXISTING WETLAND CHANNEL

WETLANDS

EXISTING TWO 48" CMP CULVERTS INSTALL INLETS

EXISTING 48" CMP (PLUG & ABANDON)

JACKASS GULCH
(SEE SHEET 12 FOR PROFILE)

LOWER RAILROAD POND
R.O.W. REQUIRED = 0
STORAGE VOLUME = 7.2 AC.-FT.
MAXIMUM STAGE = 10 FT.
Q_{IN} = 270 CFS
Q_{OUT} = 240 CFS
TOP OF EMB. = 5404
100-YR. W.S. = 5401
OUTLET VELOCITY = N/A
(SEE DETAIL E)

EXISTING JACKASS HILL ROAD DETENTION
R.O.W. REQUIRED = 0
STORAGE VOLUME = 4.4 AC.-FT.
MAXIMUM STAGE = 13 FT.
Q_{IN} = 515 CFS
Q_{OUT} = 400 CFS
TOP OF ROAD = 5334.8
100-YR. W.S. = 5432.0

EXISTING WETLANDS
PROPOSED GRASS-LINED CHANNEL
B = 5 FT.
S = 0.9%
Q_{100} = 400 CFS
STA. 35+00 TO STA. 37+00
(SEE DETAIL A)

APPROX. 100-YR. FLOOD PLAIN LIMITS

**NOTE: TEMPORARY SEDEMENTATION TRAP FOR THE LOWER RAILROAD POND MUST BE INSTALLED AND MAINTAINED DURING UPSTREAM CONSTRUCTION UNTIL DISTURBED AREAS ARE STABILIZED.

LOWER DAD CLARK GULCH
(SEE SHEET 13 FOR PROFILE)

**NOTE: THE LAND ADJACENT TO LOWER DAD CLARK GULCH MUST BE FILLED PRIOR TO DEVELOPMENT. STA. 12+00 TO STA. 24+50, MINIMUM FILL ELEVATIONS ARE SHOWN.

SOUTH PLATTE PARK BOUNDARY
NO R.O.W. ACQUISITION NECESSARY FOR DRAINAGE FACILITIES IN THE PUBLIC PARK AREA.

GRADE CHANNEL TO MATCH EXISTING AT UPSTREAM SIDE OF FLUME. (MINIMIZE DISTURBANCE TO WETLANDS)

FLUME STRUCTURE LEAVE IN PLACE PROTECT W/RIPRAP

EXISTING WETLANDS

NO CHANNEL IMPROVEMENTS STA. 33+00 TO STA. 56+50 NO R.O.W. ACQUISITION REQUIRED.

PROPOSED WETLANDS BOTTOM CHANNEL
B = 30 FT.
S = 0.2%
Q = 870 CFS
STA. 12+10 TO STA. 33+00
(SEE DETAIL B)

PROTECT SAN.

REGRADE EXISTING DITCH. EXACT ALIGNENT OF EXISTING DITCH WILL BE DETERMINED DURING FINAL DESIGN.
S = 0.2%
Q = 154 CFS
(SEE DETAIL C)

EXISTING 30" PIPE (FOR McCLELLAN)

OUTLET 30" PIPE INTO PROPOSED CHANNEL W/ENERGY DISSIPATOR. REMOVE 30" AS NEEDED D/S.

PUMP STATION

EXISTING WETLANDS

FUTURE IMPROVEMENTS TO SANTA FE DRIVE AND D. & R.G.W. BRIDGES. (PRELIMINARY PLANNING DONE BY C.D.O.H.)

GRADE CHANNEL TO MATCH EXISTING AT THE SOUTH PLATTE PARK BOUNDARY

EXISTING WETLANDS

EXISTING 30" PIPE (FOR McCLELLAN)

EXISTING 24" PIPE

EXISTING OUTFALL STRUCTURE

ABANDONED PUMP STATION

McLELLAN RESERVOIR
(OWNED BY ENGLEWOOD)

TOP OF DAM

FLOOD STORAGE ASSUMED IN McLELLAN RESERVOIR (ADEQUATE ASSURANCES AGREEMENT NECESSARY)

MATCH LINE SHEET 9

SEE SHEETS 12 & 13 FOR PROFILES

ALL ELEVATIONS ARE MEAN SEA LEVEL DATUM

GROUND CONTROL SURVEY BY LANDMARK, LTD.
AERIAL PHOTOGRAPHY BY SCHARF & ASSOC.
TOPOGRAPHIC MAPPING BY LANDMARK, LTD.
CONTOUR INTERVAL 2 FT DATE FLOWN 4-13-89

CENTENNIAL ENGINEERING INC
ARVADA CO. 80001 420-0221
CEI JN. 906.00

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URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

PLAN
JACKASS GULCH AND LOWER DAD CLARK GULCH

SHEET 8 OF 13

SHEET 9 COMMENTARY

Jackass Gulch

Improvements in the natural channel upstream of Jackass Hill Road should be minimized due to the existing wetlands vegetation and the large cottonwood trees. However, the channel is steep and some sort of erosion control is necessary. The proposed improvements (which include drop structures, channelization and riprap protection) have been localized to reaches where minimal disturbance will result. Water quality and sedimentation control will be required of all future development in the basin.

Also, detention ponds were located so as to avoid major wetland reaches. Three detention ponds will be constructed. The smallest pond and furthest downstream will be constructed separate from the other ponds. The other two ponds are approximately the same size and will be located in the open space area just downstream of the Highline Canal. Due to the topography, the shapes of the ponds will be quite different.

In the upper basin east of the Highline Canal, most of the private developments have constructed private on-site detention facilities. Due to Littleton's storm maintenance program, these facilities are recognized but only for master planning purposes.

COST ESTIMATE

CONSTRUCTION	
Drainage Improvements	$ 968,600
Street Crossings	---
Utility Relocations	---
Total Construction Cost	$ 968,600
ENGINEERING AND CONTINGENCIES (35% of Total Construction Cost)	$ 339,000
PROPERTY ACQUISITION	$ 69,500
TOTAL COST OF IMPROVEMENTS	$ 1,377,100
OPERATION AND MAINTENANCE (per year)	$ 17,000

MATCH LINE SHEET 6

JACKASS HILL ROAD

EXISTING 24" RCP STORM SEWER OUTFALL W/EXIST. ENERGY DISSIPATOR

COTTONWOOD TREES TO BE PROTECTED

DROP STRUCTURES

70' R.O.W.

8" SAN

18" SAN

24" SAN

PROPOSED GRASS-LINED CHANNEL
B = 5'
S = 0.9%
Q_{100} = 400 CFS
STA. 40+30 TO STA. 45+00
(SEE DETAIL 'A')

PROPOSED GRASS-LINED CHANNEL
B = 5'
S = 0.9%
Q_{100} = 200 CFS
STA. 47+65 TO STA. 48+65
(SEE DETAIL A)

PROPOSED GRASS-LINED CHANNEL
B = 5'
S = 0.9%
Q_{100} = 225 CFS
STA. 52+10 TO STA. 52+80

LIMITS OF CITY'S OPEN SPACE AREA (NO R.O.W. ACQUISITION NECESSARY FOR DRAINAGE FACILITIES IN THE PARK) (FUTURE EQUESTRIAN PARK)

JACKASS CHANNEL POND
R.O.W. REQUIRED = 1.7 AC.
STORAGE VOLUME = 7.0 AC.-FT.
MAXIMUM STAGE = 10.0 FT.
Q_{IN} = 225 CFS
Q_{OUT} = 200 CFS
TOP OF EMB. = 5467
100 YEAR W.S. = 5464
OUTLET VELOCITY = 13 FPS
(SEE DETAIL E)

EXISTING WETLANDS

LOWER OPEN SPACE POND
R.O.W. REQUIRED = 0
STORAGE VOLUME = 11.2 AC.-FT.
MAXIMUM STAGE = 10 FT.
Q_{IN} = 275 CFS
Q_{OUT} = 225 CFS
TOP OF EMB. = 5492
100 YEAR W.S. = 5489
OUTLET VELOCITY = 15 FPS
(SEE DETAIL E)

EXISTING 27" RCP DETENTION OUTFALL
Q_{100} = 78 CFS, REQ'D. ENERGY DISSIPATOR

EXISTING 42" RCP STORM SEWER OUTFALL
Q_{100} = 162 CFS, REQ'D. ENERGY DISSIPATOR

UPPER OPEN SPACE POND
R.O.W. REQUIRED = 0
STORAGE VOLUME = 11.1 AC.-FT.
MAXIMUM STAGE = 10 FT.
Q_{IN} = 406 CFS
Q_{OUT} = 275 CFS
TOP OF EMB. = 5505
100 YEAR W.S. = 5502
OUTLET VELOCITY = 15 FPS
(SEE DETAIL E)

JACKASS GULCH
(SEE SHEET 12 FOR PROFILE)

EXISTING 54" RCP STORM SEWER OUTFALL
Q_{100} = 146 CFS
CONSTRUCT NEW OUTFALL WITH ENERGY DISSIPATION

NO IMPROVEMENTS STA. 69+00 TO STA. 85+00

APPROX. 100-YR. FLOOD PLAIN LIMIT

ON-SITE DETENTION

NOTE: UPPER BASIN PRIVATE DETENTION FACILITIES RECOGNIZED THROUGH CITY OF LITTLETON'S MAINTENANCE PROGRAM. (NO R.O.W. ACQUISITION NECESSARY)

DRY CREEK RD

KETTLE AVE

MINERAL AVE

BROADWAY

WINDERMERE

TAMPA DR

SOUTHPARK

MCLELLAN RESERVOIR

54" ST

MATCH LINE SHEET 8

MATCH LINE SHEET 10

SEE SHEET 12 FOR PROFILE

87,000 N

2,136,000 E

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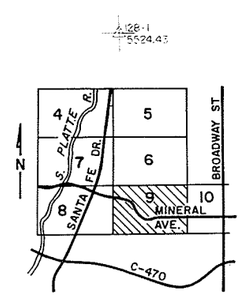

NOTES

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6. TYPICAL SECTIONS AND DETAILS ARE SHOWN ON SHEETS 4 AND 5.

ALL ELEVATIONS ARE MEAN SEA LEVEL DATUM

GROUND CONTROL SURVEY BY LANDMARK, LTD.
AERIAL PHOTOGRAPHY BY SCHARF & ASSOC.
TOPOGRAPHIC MAPPING BY LANDMARK, LTD.
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URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

PLAN
JACKASS GULCH

SHEET 9 OF 13

SHEET 10 COMMENTARY

Jackass Gulch

See Sheet 9 Commentary.

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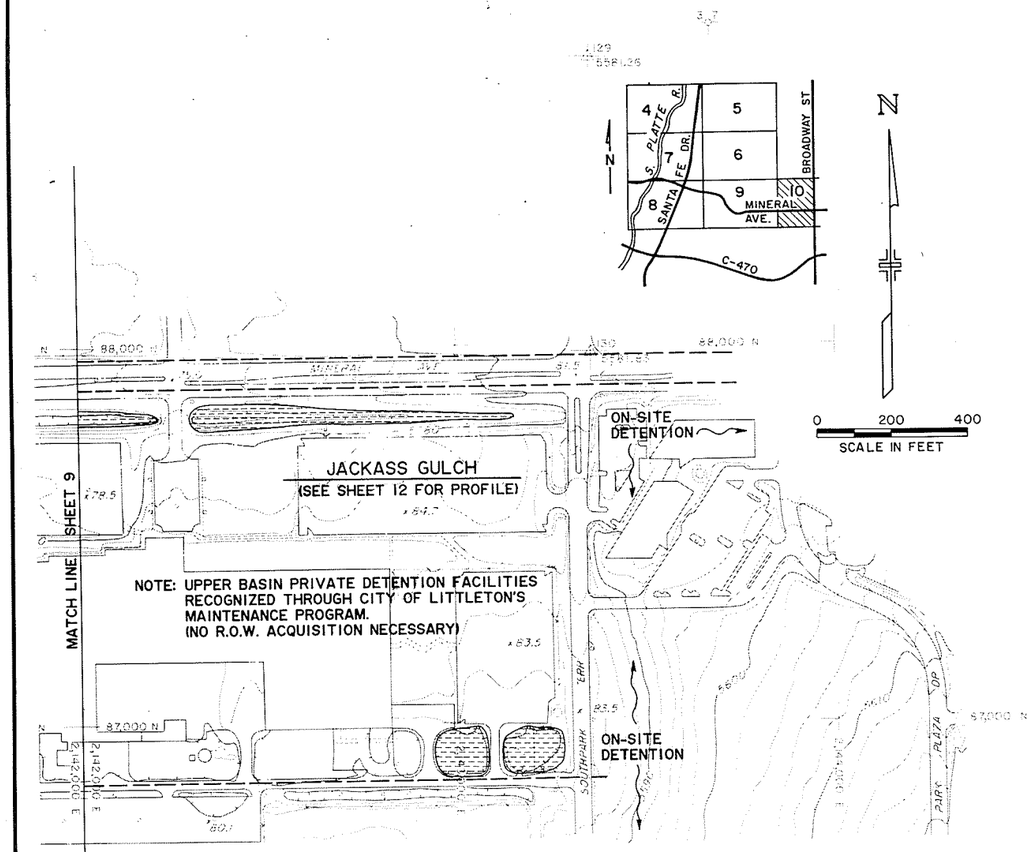

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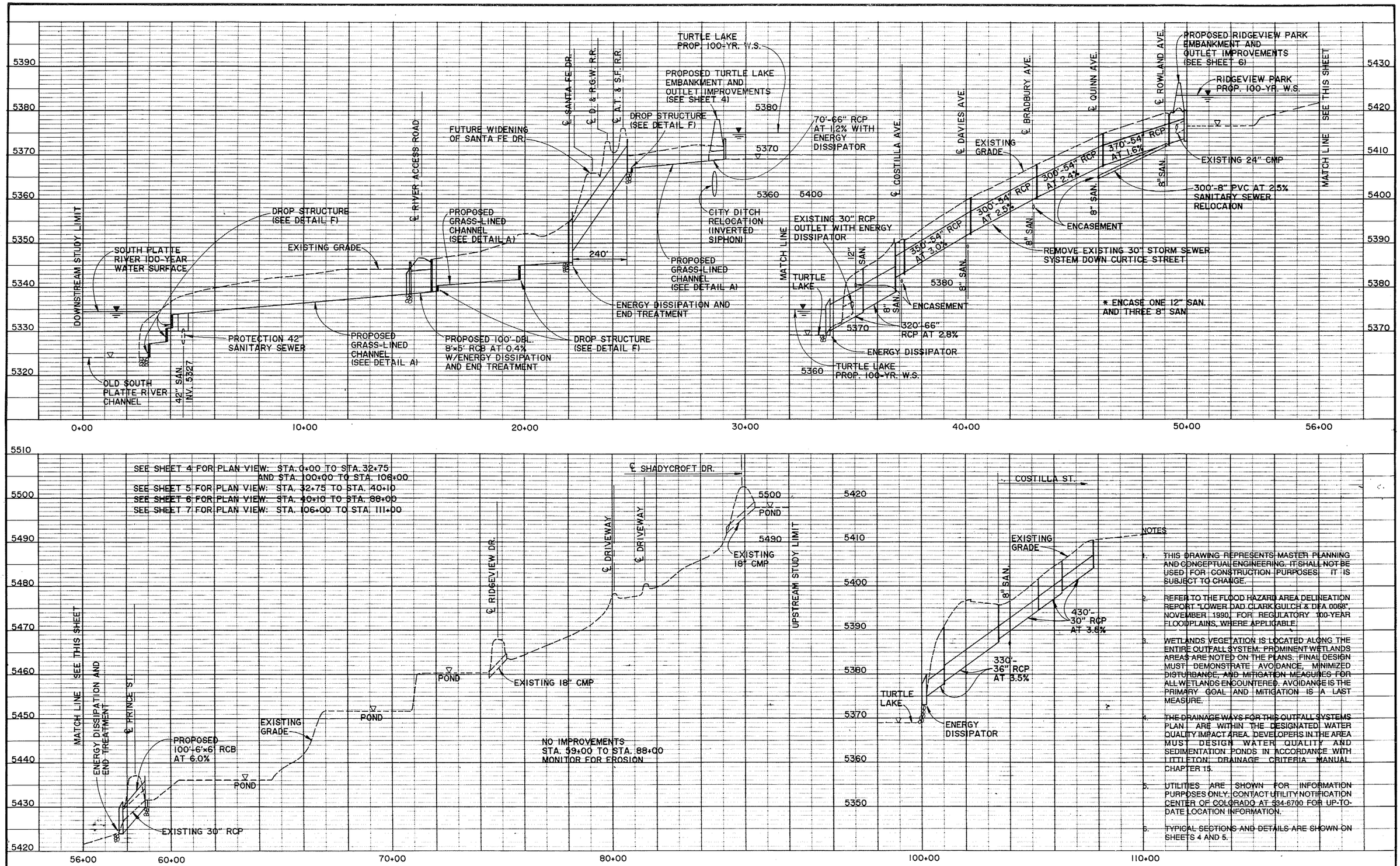
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

PLAN
JACKASS GULCH

SHEET 10
OF 13



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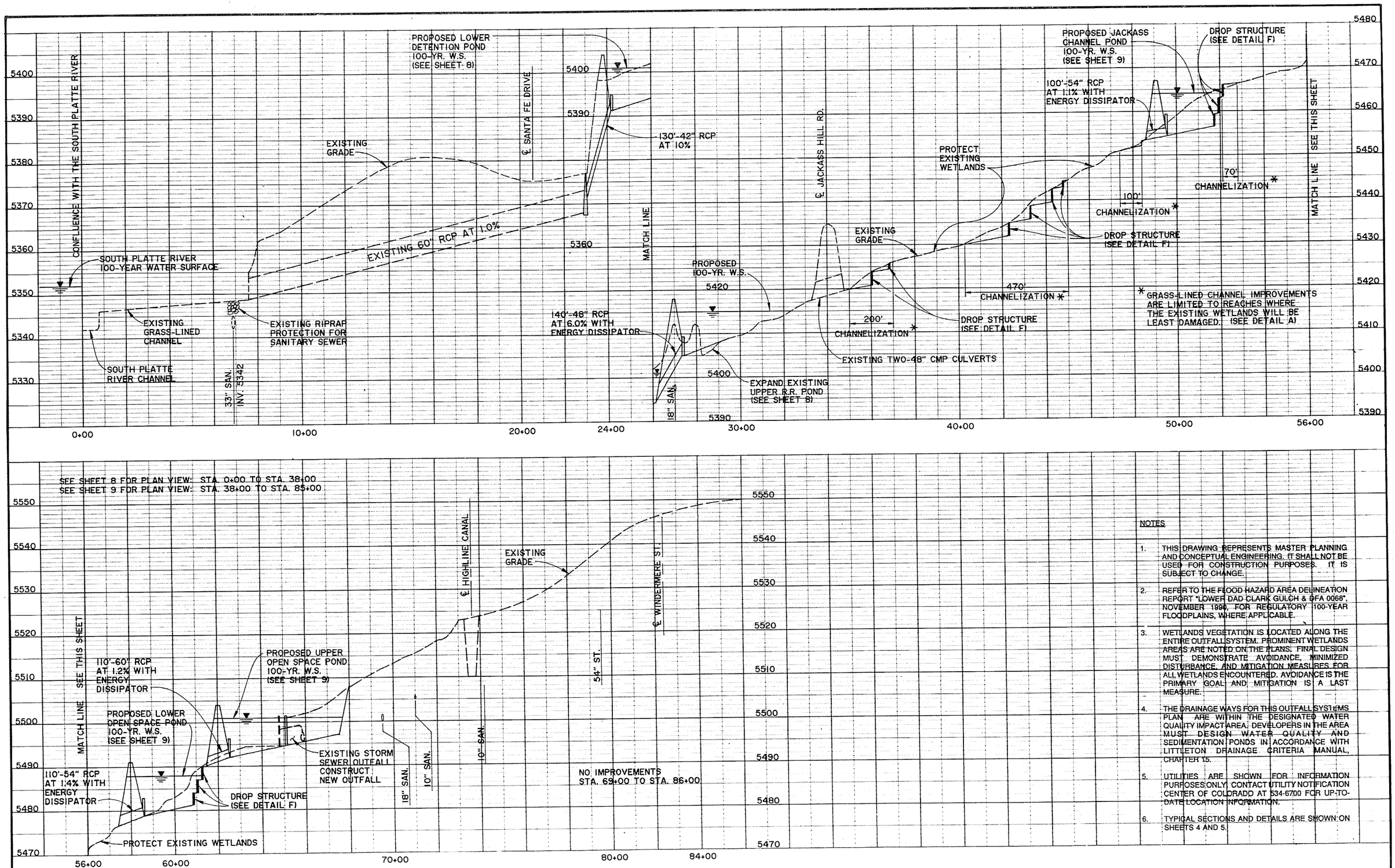
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

PROFILE
RANGEVIEW GULCH

SHEET 11 OF 13



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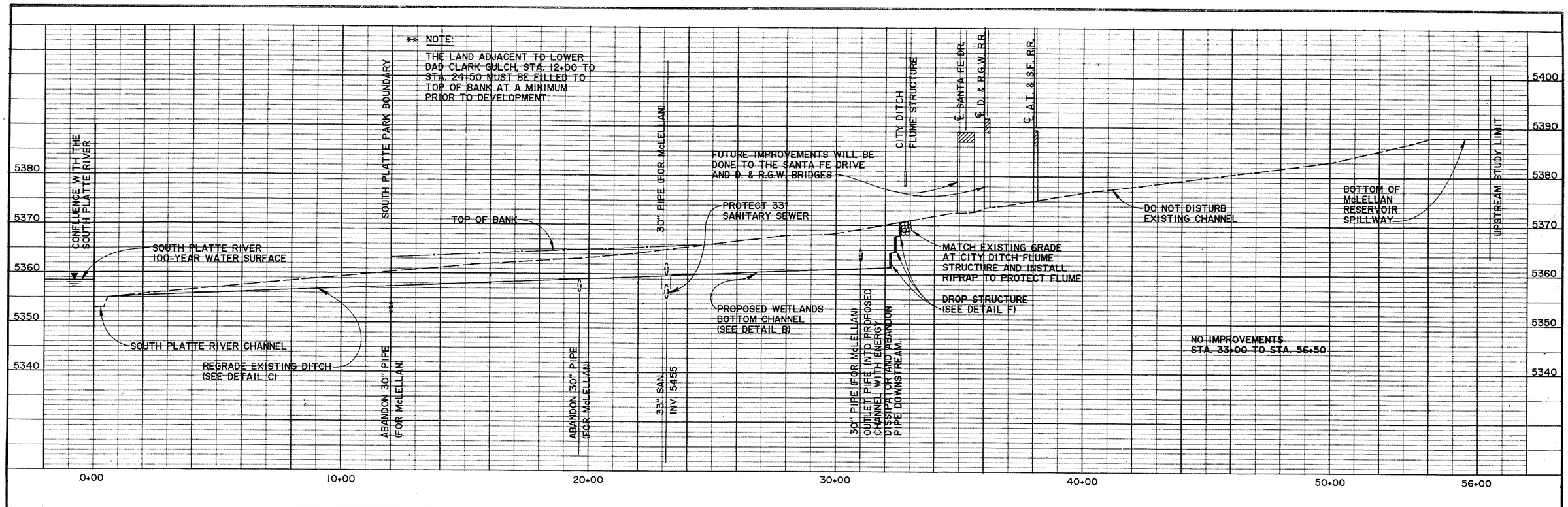
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

PROFILE
JACKASS GULCH

SHEET 12 OF 13



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SEE SHEET 8 FOR PLAN VIEW

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URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

PROFILE
LOWER DAD CLARK GULCH

APPENDIX A

REFERENCES &

BACKGROUND INFORMATION

SUMMARY

REFERENCES AND BACKGROUND INFORMATION SUMMARY

	Item	Source
REPORTS:		
1	"Final Drainage Report for Martin Marietta, Littleton Systems Center," prepared for Martin Marietta Aerospace, (Merrick & Company, Sept. 1983).	Littleton
2	"Final Drainage Report for Southpark Subdivision Filing No. 1," prepared for Southpark, A Joint Venture, (Merrick & Company, April 30, 1981).	Littleton
3	"Addendum to Final Drainage Report for Southpark Subdivision Filing No. 1," prepared for Southpark, A Joint Venture, (Merrick & Company, Oct. 4, 1983).	Littleton
4	Southpark Pond routing calculations for ponds "C", "E" and "F" for 2, 10, 100 year storms, (Merrick & Company, March 3, 1982).	Littleton
5	"Drainage Study for Southpark Subdivision, City of Littleton, CO," (Tri-Consultants, Feb. 1981, Revised June 1981).	Littleton
6	"Final Drainage Study for Southpark Subdivision Filing No. 11, City of Littleton, CO," prepared for the Writer Corporation, (Carroll & Lange, Inc., Feb. 13, 1987).	Littleton
7	"Final Drainage Report for Southpark Subdivision Filing, No. 5," prepared for Southpark, A Joint Venture, (Merrick & Company, Sept. 30, 1981).	Littleton
8	Southbridge I and II Office Buildings, Drainage Study, (KKBNA, April 3, 1981).	Littleton
9	Final Drainage Report for Southbridge Retail Center/ Southbridge Plaza, prepared for C.W. Fentress and Associates, (KKBNA, March 11, 1983, revised March 18, 1983).	Littleton

	Item	Source
REPORTS:		
10	"Southbridge, Planned Unit Development," prepared for U.S. Home, (THK Associates, Inc., July 23, 1978).	Littleton
11	"Southbridge Filing No. 1, Littleton, CO, Final Drainage Study," prepared for US Home, (Gingery Associates, Feb. 9, 1979).	Littleton
12	"Southbridge Filing No. 4, Final Drainage Study, Littleton, CO," prepared for US Home, Inc., (Gingery Associates, Inc., June 29, 1981).	Littleton
13	"Drainage Report for Jackass Hill Road SID No. 84-1, Littleton, CO," prepared for City of Littleton, (KKBNA, Inc., August 1985, revised Oct. 1985).	Littleton
14	"Major Drainageway Planning, South Platte River, Chatfield Dam to Baseline Road," Phase A and Phase B, prepared for UD&FCD, (Wright Water Engineers, Inc., Aug. 1984 and Nov. 1985, respectively).	CEI Library
15	"Flood Hazard Area Delineation, Dad Clark Gulch," prepared for UD&FCD, Douglas County and Mission Viejo Company, (Jack G. Raub Company, Feb. 1980, revised Nov. 1980).	CEI Library
16	"Master Plan of Drainage, Dad Clark Gulch," prepared for Mission Viejo Company, (Jack G. Raub Company, the Nov. 1980 revised report and the July 1982 revised report).	Littleton
17	"Final Report on the Investigation of the 100-year Flood Plain on Dad Clark Gulch across the Santa Fe Park Development," prepared for Hardin & Company, (Sellards & Grigg, Inc., March 1985) including UD&FCD letters to Littleton re: District review for maintenance assistance.	Littleton
18	"State Engineers Report on McLellan Dam, ID #80225," dated Oct. 28, 1983.	Littleton

	Item	Source
REPORTS:		
19	"Phase I Inspection Report of McLellan Dam, Arapahoe County, CO," City of Englewood, ID #CO 01153, (U.S. Army Corps of Engineers, July 1978).	UD&FCD
20	"Highline Canal Master Plan, Lee Gulch to Little Dry Creek, Final Report," prepared for UD&FCD and Denver Board of Water Commissioners, (Leonard Rice Consultants, Nov. 1975).	UD&FCD
21	"Alternative Evaluation Report for Outfall Systems Planning for Lower Dad Clark Gulch and DFA 0068," prepared for UD&FCD, (Centennial Engineering, Inc., April 1990).	CEI Library
UTILITIES:		
22	License Agreements for Storm Sewer Utilities crossing the High Line Canal, Denver Water Department.	DWD
23	Culvert and bridge survey information.	Landmark Ltd.
CONSTRUCTION PLANS:		
24	"Mineral Avenue R.R. Separation," plan and profile of proposed Federal Aid Project No. M-1030-(3), State Highway #85, (Centennial Engineering, Inc., March 30, 1982), includes special revisions.	DeLeuw Cather & Company
25	Plan and Profile of Proposed Federal Aid Project No. CXFRU (GF) 10-0085-12, State Highway #85, (DeLeuw Cather & Company, Draft).	UD&FCD
26	Southbridge Filing No. 1 Storm Sewer Construction Drawings, prepared for US Home, (Gingery Associates, Inc., February 16, 1979, five sheets).	UD&FCD
27	Drainage Plan Lots 2 & 3, Block 2, Southbridge Filing No. 1, Littleton, CO, prepared for US Home, (Futura Engineering, Inc., Aug. 22, 1982, two sheets).	UD&FCD

	Item	Source
CONSTRUCTION PLANS:		
28	North Highlands Ranch Parkway Culverts, Phase I, prepared for Highlands Ranch Metropolitan District No. 1, (Jack G. Raub Company, January 6, 1982, sheets 9, 10 and 11 of 11).	Littleton
29	Construction Plans for Highlands Ranch Filing No. 1, South Broadway Culvert and Plaza Drive (Canal Road) Culvert (Jack G. Raub Company, As built, (March 17, 1982, seven sheets).	UD&FCD
30	The New Town of Highlands Ranch, Culvert 22, prepared for Highlands Ranch Metropolitan District No. 1, (Jack G. Raub Company, March 1985, five sheets).	UD&FCD
31	Highlands Ranch Culvert 23, prepared for Highlands Ranch Metropolitan District No. 1, (Jack G. Raub Company, Dec. 1985, four sheets).	UD&FCD
32	The New Town of Highlands Ranch Culvert 12, prepared for Highlands Ranch Metropolitan District No. 1, (Jack G. Raub Company, Jan. 1986, sheets 12 and 13 of 13).	UD&FCD
33	Highlands Ranch Culvert No. 14, prepared for Highlands Ranch Metropolitan District No. 1, (Jack G. Raub Company, April 1987, sheets 14, 15 and 16 of 19).	UD&FCD
OTHER:		
34	Littleton City Limits map.	
35	City of Littleton Storm Drainage Basin Map, Figure 301, enlarged from Drainage Manual.	Littleton
36	City of Littleton Generalized Zoning Map, (Sept. 1987).	Littleton
37	City of Littleton Zoning Regulations, (1989).	Littleton
38	Copy of current FEMA Flood Insurance Study, Introductory pages, Discharge Table, and Flood Profiles for South Platte River, (Arapahoe County, CO) - obtained from UD&FCD, August 19, 1989.	UD&FCD
39	Landis Aerial Photo, Sept. 17, 1988.	CEI Library

	Item	Source
OTHER:		
40	Flood Insurance Rate Map, Community Panel Number 080017-0003C and 080017-0006C, (Feb. 3, 1981).	CEI Library
41	Flood Insurance Rate Map, Map Number 08005C-0065F and 08005C-0070F, (April 17, 1989).	CEI Library
42	USGS Quad Map, Highlands Ranch Quadrangle, (photo revised 1980).	CEI Library
43	USGS Quad Map, Littleton Quadrangle, (photo revised 1971).	CEI Library
44	City of Littleton Storm Drainage Design and Technical Criteria, (WRC Engineering, Inc., Oct. 1986).	CEI Library
45	Arapahoe County Storm Drainage Design and Technical Criteria, (WRC Engineering, Inc., Sept. 1985).	CEI Library
46	Urban Storm Drainage Criteria Manual, (Wright-McLaughlin Engineers, 1969).	CEI Library
47	Soil Survey of Arapahoe County, Colorado, Sheet No. 48, (USDA-SCS, March 1971).	UD&FCD
48	CUHP EPC.EXE - Colorado Urban Hydrograph Procedure computer program - PC version, (Boyle Engineering Corp., Jan. 1985).	UD&FCD
49	UDSWM 2PC.EXE - Environmental Protection Agency - Storm Water Management Model - Version PC.1, (METCALF + EDDY, Inc., Sept. 1970).	Littleton
50	Rules and Regulations for Dam Safety and Dam Construction, (Division of Water Resources, State of Colorado, Aug. 26, 1988).	Littleton
51	"Chapter 10 - Evaluation of Storm Water Treatment Alternatives for McLellan Reservoir," City of Englewood, (preliminary).	Littleton
52	1/4 Section map of Equestrian Park Site at Mineral Ave. and the Highline Canal.	Littleton

	Item	Source
OTHER:		
53	South Platte River Park Boundary Map, (Sutherland Engineers, Inc., July 7, 1980, two sheets) - not including latest land swap with Newton Trust.	Littleton
54	Southpark PD General Plan by Emkay Development, Development plan and standards, (sheets 1 and 2 of 6, 1980).	Littleton
55	Sante Fe Park PD, prepared for KC Ensor Realty Co., Conceptual Master Plan and development standards, (Rahenkamp/Oldham, Inc., sheets 1 and 6 of 7, Feb. 25, 1985).	CEI Library
56	Santa Fe/South Platte Joint Use Corridor Plan prepared by DHM, Inc. & Urban Edges, Inc. - not dated.	Littleton
57	"Santa Fe Corridor Study Policies", (revised 1988, four pages).	Littleton
58	Santa Fe Drive Corridor Study Zoning Plan", (Dec. 10, 1984).	Littleton
59	Cross-sectional information for bridges on Dad Clark Gulch, (J.F. Sato & Associates, Aug. 14 & 15, 1989).	J.F. Sato
60	Memorandum on environmental concerns of Rangeview, Jackass and Lower Dad Clark Drainageways, (William Wenk Associates, December 19, 1989) - This memorandum is included in Appendix B of the Alternative Evaluation Report (Reference 21).	CEI Library