APPENDIX A EXISTING BASINS

Located Existing Outfalls
Basin Information Summary
Existing Basin Runoff Calculations
Existing Basin Weir/Flooding Calculations

Located Existing Outfalls
Physical Properties

Number on Map	Project Significance	Name	CDOT Outfall ID	Additional Location and Land Use Description	Highway	Milepost	City	Receiving	Size	Material	Type	Longitude	Latitude	Elevation (feet)	Watershed Land Uses	Date(s) Flow Observed
1		South platte R 37, spr85 209.37	85A209.37	SE of intersection between Santa Fe Dr. and Mississipi on the westside of the South Platte River (across from Carpet Exchange) along bike path. Drains S/B SH 85.	85	209	Denver	South Platte	12"	Concrete	Circular Pipe	-104.992981405	39.696037866	5179.38	Industrial, Commercial	8/1/2002
2		spr85 a209.35	8A209.35	Drains N/B SH85. South of Mississippi and SH 85 in retaining wall on east side of river. Difficult to access.	85	209	Denver	South Platte	15"	brick	circular pipe	-104.992377695	39.695940212	5177.60	highway	
3		spr85 a209.27	85A209.27	N/B SH 85, across from Denver floor and South of Mississippi. On East side of River, visible from bike trail on west side, appears to be new.	85	209	Denver	South Platte	15"	Green PVC	circular pipe	-104.992839783	39.694761435	5175.01	highway	
4		South platte R 38	85A209.26	South of intersection between Santa Fe Dr. and Mississippi on west side of South Platte River along bike path. Across from Investors Realty. Drains S/B SH 85.	85	209	Denver	South Platte	12"	Concrete	Circular Pipe	-104.9935337	39.69443204	5183.31	Industrial, Commercial	
5		spr85 a209.16	85A209.16	Along trail following S/B SH 85 and South Platte. Just north of where S/B SH 85 crosses the South Platte.	85	209	Denver	South Platte				-104.994156954	39.693052187	5177.53	highway	
6		southplatteriver08	85A209.95	I-25 and S/B Santa Fe (SH 85), Under S/B lanes of SH 85, East side of SPR, directly under bridge, toward West side of bridge. 15" Concrete pipe is inside 21"x21" opening in bridge support wall. Seems to drain highway only.	85	210	Denver	South Platte	15"	Concrete	Circular Pipe	-104.9957928	39.70374007	5170.32	Highway	
7	CCD - 42" Outfall	southplatteriver07	85A209.91	I-25 and S/B Santa Fe (SH 85), Under S/B lanes of SH 85, East side of SPR, directly under bridge, along East side of SPR and toward East side of bridge	85	210	Denver	South Platte	42"	Concrete	Circular Pipe	-104.9954385	39.70338035	5164.44	Highway, Commercial	10/21/2002
8		South platte R 33	85A209.80	Rock marked green. Outfall is south of S/B Santa Fe bridge (Hwy 85) on west side of South Platte River along bike path, across from Habitat Park. Drains S/B SH 85.	85	210	Denver	South Platte	15"	Concrete	Circular Pipe	-104.9948875	39.70210156	5173.70	Industrial	
9		spr85 a209.78	85A209.78	S/B SH 85 and South Platte, just South of SB 85 bridge over South Platte River. Outfall hidden in brush, could be difficult to locate without GPS.	85	210	Denver	South Platte	18"	Concrete	Circular Pipe	-104.994582695	39.701696857	5177.76	highway	
10		South platte R 34	85A209.76	North of intersection between Santa Fe Dr. and Mississippi on west side of South Platte River along bike path, south of Sante Fe bridge over river. Drains S/B SH 85.	85	210	Denver	South Platte	30"	Concrete	Circular Pipe	-104.9937658	39.70072421	5175.91	Industrial, Commercial	
11		spr85 a209.62	85A209.62	On west side of South Platte in retaining wall. Drains N/B SH 85, east side of South Platte. Not very accessible.	85	210	Denver	South Platte				-104.992448297	39.699754905	5175.13	highway	
12		34B, spr85 a209.55 estimated	85A209.56	North of intersection between Santa Fe Dr. and Mississippi on west side of South Platte River along bike path. Giant rip rap wash out area. Drains S/B SH 85	85	210	Denver	South Platte	15"	Concrete	Circular Pipe	-104.9926469	39.69886607	5181.61	Industrial, Commercial	
13		southplatteriver12	25A207.42	North of SH 85 interchange with I-25, east side of South Platte River. Drains S/B and N/B I-25.	25	207	Denver	South Platte	24"	Concrete	Circular Pipe	-104.9982257	39.70767239	5166.74	Highway, Industrial, Commercial	
14		southplatteriver11	25A207.36	North of SH 85 interchange with I-25, east side of South Platte River. Drains S/B and N/B I-25.	25	207	Denver	South Platte	24"	Concrete	Circular Pipe	-104.9977523	39.70669099	5171.87	Highway	6/28/2002
15	Next to CCD - Virginia Outfall	southplatteriver10	25A207.29	~0.5 mi South of Alameda along East bank of SPR. Appears to drain S/B SH 85, but may be draining other areas as well (i.e. other side of freeway)	25	207	Denver	South Platte	54"	Concrete	Circular Pipe	-104.9972653	39.70574844	5172.31	Highway, Commercial	6/28/2002, 10/21/2002
16		southplatteriver09	25A207.18	0.1 mi North of S/B SH85 Bridge over SPR, along East side of SPR, outfall is marked green	25	207	Denver	South Platte	15"	Concrete	Circular Pipe	-104.9963305	39.70430796	5172.11	Highway	
17		SPR22 eastbank 18inFES	25A208.35	North of Alameda along bike trail, after trail crosses river just under the freeway sign.	25	208	Denver	South Platte	18"	concrete	circular pipe w/ FES	-105.006608755	39.718951776	5157.30	highway	
18		westbank spr15in1240 Bayaud	25A207.97	I-25 and South Platte, north of Alameda, West bank of River, just below bike trail. Not sure if this is CDOT owned during visit.Marked green.	25	208	Denver	South Platte	15"	CMP	circular pipe	-105.001835633	39.714225523	5162.01	commercial/ park	
19	I-25 - Alameda Pump Station Outfall	southplatteriver15	25A207.66	CDOT marked green and CDOT sign in front of outfall. Drains S/B and N/B I-25.	25	208	Denver	South Platte	24"	Concrete	Circular Pipe	-104.9995648	39.7107339	5172.11	Highway	6/28/2002
20	CCD - Alameda Outfall	southplatteriver14	25A207.59	CDOT marked green and CDOT sign in front of outfall. Drains S/B and N/B I-25.	25	208	Denver	South Platte	30"	Concrete	Circular Pipe	-104.9992875	39.70989537	5165.01	Highway	
21		southplatteriver13	25A207.51	East side of South Platte River and just south of Alameda Ave. Bridge. Drain S/B and N/B I-25. No pipe observed on 10/21/02.	25	208	Denver	South Platte	24"	Concrete	Circular Pipe	-104.9987569	39.70891695	5173.69	Highway	
22	CDOT flow only	spr north of 8th and zuni	25A209.38	South Platte River and I-225. Walk along bike path North from 8th and Zuni. Overflow is on East bank of bike trail follows west back.	25	209	Denver	South Platte	36"?	concrete	circular pipe	-105.016763152	39.731313908	5142.30	highway	
23	CDOT flow only	SPR31	25A209.13	South along bike trail (East bank of South Platte) from 6th Ave. crossing.	25	209	Denver	South Platte	18"	conrete	circular pipe w/ lid	-105.015514107	39.727893280	5143.98	highway	
24	CDOT flow only	SPR29	25A209.08	South of W/B 6th Ave. lanes just below bike trail on E. Bank of SPR.	25	209	Denver	South Platte	18"	concrete	circular pipe	-105.015416414	39.727068369	5145.33	highway	
25	I-25 - 6th Avenue Outfall	SPR27.5	25A208.91	South Platte River and 6th Ave., just north of 6th Ave. E/B lanes, on East bank of SPR.	25	209	Denver	South Platte	24"	concrete	circular pipe w/ lid	-105.015521669	39.725086822	5140.56	highway	6/28/2002
26		SPR27.4	25A208.90	Between 6th Ave W/B and 6th to N/B I-25 off ramp from 6th Ave (elevated). On East bank of SPR.	25	209	Denver	South Platte	24"	concrete	Circular pipe	-105.015515804	39.724876262	5142.57	highway	

Located Existing Outfalls
Physical Properties

Number on Map	Project Significance	Name	CDOT Outfall ID	Additional Location and Land Use Description	Highway	Milepost	City	Receiving	Size	Material	Type	Longitude	Latitude	Elevation (feet)	Watershed Land Uses	Date(s) Flow Observed
27	CDOT flow only	SPR26 eastbank retwall	25A208.62	I-25 and South Platte, north of Alameda along bike trail. North of fancy bridge and in retaining wall. Not accessible for sampling.	25	209	Denver	South Platte	12"	concrete	circular pipe	-105.009776974	39.721819151	5169.68	industrial/ highway	
28	Next to CCD - 3rd Avenue Outfall	SPR23 24InFES eastbank	25A208.56	I-25 and South Platte, north of Alameda along bike trail. South of fancy bridge along bike trail.	25	209	Denver	South Platte	24"	concrete	circular pipe w/ FES	-105.008312251	39.720643161	5168.60	Industrial/ Highway	10/21/2002
29	CDOT flow only	SPR25 eastbank retwall	25A208.50	I-25 and South Platte, north of Alameda along bike trail. North of fancy bridge and in retaining wall. Not accessible for sampling.	25	209	Denver	South Platte	12"	concrete	circular pipe	-105.009072348	39.721305360	5164.72	highway	
30		South platte R 41	23RDVIA	SE corner of S/B SH 85 and Mississippi. Across from Carpet Exchange and west side of South Platte River.			Denver	S. Platte	66"	Concrete	Circular Pipe w/Headwall&Wingwalls	-104.9910474 *	39.76546888 *	5101.69	Industrial, Commercial	8/1/2002
31	CCD - Bayaud Outfall	DenverFastening EastBank RetWall		I-25 and South Platte, north of Alameda on east bank of river, across from 1240 W. Bayaud in retaining wall.			Denver	SPR	36"	concrete	circular pipe	-105.001471357	39.714586360	5157.45	highway/ industrial/ commercial	
32	Major US 6 and CCD Outfall	SPR27.6		South Platte River and 6th Ave., on North side of 6th Ave, E/B lanes bridge. West bank of South Platte, between 6th and I-25 off-ramp. No access from bike trail, cross 6th Ave. bridge to get to outfall.			Denver	SPR	42"	concrete	circular pipe with lid	-105.016022797	39.725108305	5144.69	highway	6/28/2002, 10/10/2002
33		SPR28		6th Ave. and I-25 at south Platte Riv. (under E/B lanes of 6th ave.)				SPR	18"W x 24"H	concrete	box culvert	-105.015505630	39.725722152	5143.38	highway	
34		SPR31.5		South Platte River located between 6th and 8th Ave., West of N/B I-25 lanes below grassy area left of bike trail. Outfall has circular access lid cover.				SPR	24"	concrete	circular pipe with lid	-105.015772573	39.728308037	5142.64	highway	

* PROVIDED DATA APPEARS TO BE INCORRECT

BASIN INFORMATION SUMMARY

			Existing Conditions					Future Conditions							
Basin ID	Sub-basin ID	Soil Type	Basin Area (acre)	100-yr Q (cfs)	CFS/ Acre	I %	WQDV	Basin Area (acre)	100-yr Q (cfs)	CFS/ Acre	5-yr Q (cfs)	2-yr Q (cfs)	I %	WQDV	
US 6 - West		C	26	81	3.12	64	0.65	* Incorporated into US - 6 Decatur Basin							
US 6 - East		C	17	55	3.24	50	0.35	* Incorporated into US - 6 Decatur Basin							
US 6 - Decatur		C						43.0	127.00	2.95	49.00	21.00	64	1.08	
US 6 - South Platte River		B	7.8	47	6.03	90	0.31	7.8	50.00	6.41	23.00	16.00	92	0.33	
I-25 - 6th Avenue Interchange		B	36	100	2.78	43	0.68	37.0	103.00	2.78	33.00	19.00	43	0.69	
I-25 - 3rd Avenue		B	13	59	4.54	100	0.65	17.0	71.00	4.18	35.00	24.00	100	0.85	
I-25 - Alameda		B	25	126	5.04	94	1.09	25.0	90.00	3.60	37.00	24.00	70	0.69	
	SB-21	B						5.3	20.00	3.77	8.40	5.50	70	0.15	
	SB-22	B						9.6	39.00	4.06	16.00	11.00	70	0.26	
	SB-23	B						9.6	36.00	3.75	15.00	10.00	70	0.26	
SH 85 - SYS 1		B	13	51	3.92	90	0.52	9.6	38.00	3.96	17.00	12.00	87	0.36	
SH 85 - SYS 2		B						9.6	39.50	4.11	18.80	13.00	93	0.41	3
SH 85 - SYS 3		B						11.0	42.00	3.82	20.00	14.00	89	0.43	
I-25 - Low Point		B	2.6	18	6.92	100	0.13	* Incorporated into other basin							
I-25 - Broadway		B	14	57	4.07	82	0.48	20.0	70.00	3.50	31.00	21.00	81	0.67	
	SB-31	B						5.9	42.00	7.12	21.00	14.00	100	0.30	
	SB-32	B						9.3	58.00	6.24	28.00	20.00	100	0.47	
	SB-33	B						5.4	17.00	3.15	4.70	2.40	30	0.08	
I-25 - TREX		B	5.4	22	4.07	100	0.27	6.3	25.64	4.07			100	0.32	1
CCD - 7th Ave West		C	47		0.00	75	1.41	No Change in Basin							
CCD - 5th Ave West		C	39		0.00	75	1.17	No Change in Basin							
CCD - 6th Avenue East		B	263	840	3.19	80	8.63	No Change in Basin							
CCD - 3rd Avenue		C	187	570	3.05	62	4.54	No Change in Basin							
CCD - Ellsworth (combined with Bayaud in future)		C	9.3	70	7.53	65	0.24	265.0	810.9	3.06			55.0	5.84	
CCD - Bayaud (combined with Ellsworth in future)		C	310	950	3.06	55	6.83								
	CCD - SB-1	B						265.0	810.90	3.06			55	5.84	1
	CCD - SB-2	B						11.7	43.00	3.68	19.00	13.00	80	0.38	
	CCD - SB-3	B						5.1	24.00	4.71	12.00	8.80	90	0.20	
	CCD - SB-4	B						6.2	29.00	4.68	13.00	9.30	90	0.25	
	CCD - SB-5	B						15.0	45.97	3.06			55	0.33	1
	CCD - SB-6	B						3.8	19.00	5.00	9.00	6.20	90	0.15	
	CCD - SYS 1 - SB-7	B						11.9	38.01	3.19			90	0.48	1
	CCD - SYS 1 - SF SUMP	B						0.9	7.50	8.33	3.90	2.80	100	0.05	
	CCD - SYS 1 - K SUMP	B						0.5	4.30	9.35	2.10	1.50	100	0.02	
	CCD - SYS 2 - SB-7	B						5.1	13.00	2.55	3.00	2.20	20	0.06	
	CCD - SYS 2 - SB-8	B						4.2	18.00	4.29	9.10	6.30	90	0.17	
	CCD - SYS 2 - SB 9	B						1.2	6.10	5.08	2.80	2.00	90	0.05	3
	CCD - SYS 2 - SF SUMP	B						1.8	12.10	6.72	5.90	4.10	100	0.09	3
	CCD - SYS 2 - K SUMP	B						1.7	11.60	6.82	5.70	4.00	100	0.09	3
	CCD - SYS 3 - SB-2	B						25.0	92.00	3.06	42.00	29.00	85	0.91	
	CCD - SYS 3 - SB-3	B						2.3	6.60		2.10	1.20	40	0.04	
	CCD - SYS 3 - SB-4	B						2.6	15.00		7.10	4.90	90	0.10	
	CCD - SYS 3 - SB-6	B						8.5	29.00		12.00	8.10	73	0.25	
	CCD - SYS 3 - SF SUMP	B						7.0	37.00		16.00	13.00	100	0.35	
	CCD - SYS 1 - TOTAL	B						585.1	1832.6		59.0	41.6		13.5	
	CCD - SYS 2 - TOTAL	B						584.1	1832.0		73.8	51.9		13.4	
	CCD - SYS 3 - TOTAL	B						590.4	1847.4		79.2	56.2		13.7	
CCD - Virginia		C	726	2560	3.53	48	14.58	No Change in Basin							
CCD - Alameda (System Alternative 1)		C	99	400	4.04	80	3.25	No Change in Basin							
	CCD-SB-11	C						59.0	238.36	4.04			80	1.94	1
	CCD-SB-12	C						12.0	48.48	4.04			80	0.39	1
	CCD-SB-13	C						3.9	23.63	6.06			80	0.13	2
	CCD - SYS 2 - SB-15	C						4.5	27.27	6.06			100	0.23	2, 3
	CCD - SYS 3 - SB-14	C						17.0	68.68	4.04			65	0.43	1
CCD - 42" Outfall		B	49	200	4.08	86	1.81	30.7					86	1.13	

1) Future Conditions calculated using existing cfs/acre

2) Future Conditions calculated using existing cfs/acre * 1.5 because of small basin

3) Revised 02/02/04

Existing Basin Runoff Calculations

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: Existing US6 West Basin

I. Catchment Hydrologic Data

Catchment ID = E US6 WEST
Area = 26.00 Acres
Percent Imperviousness = 64.00 %
NRCS Soil Type = C A, B, C, or D

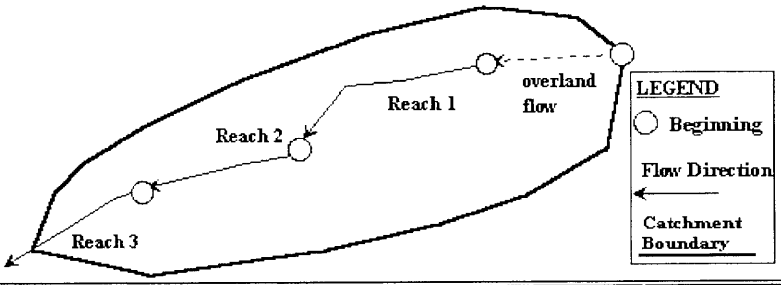
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.65
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.48
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.48		0.13	6.25
1	0.0030	200		20.00	1.10	3.04
2	0.0400	3,000		20.00	4.00	12.50
3						
4						
5						
Sum		3,250				

Computed Tc = 21.80
Regional Tc = 28.06

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 4.83 inch/hr	Rainfall Intensity at Tc, I = 4.19 inch/hr
Peak Flowrate, Qp = 81.46 cfs	Peak Flowrate, Qp = 70.73 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: Existing US6 East Basin

I. Catchment Hydrologic Data

Catchment ID = E US6 EAST
Area = 17.00 Acres
Percent Imperviousness = 50.00 %
NRCS Soil Type = C A, B, C, or D

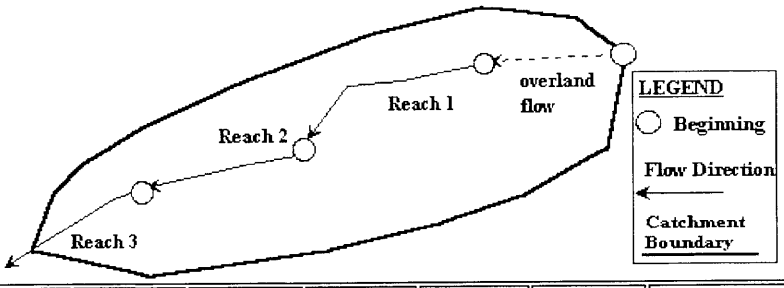
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.60
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.40
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.40		0.12	7.13
1	0.0100	1,300		20.00	2.00	10.83
2						
3						
4						
5						
Sum		1,350				

Computed Tc = 17.97
Regional Tc = 17.50

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 5.34 inch/hr	Rainfall Intensity at Tc, I = 5.41 inch/hr
Peak Flowrate, Qp = 54.74 cfs	Peak Flowrate, Qp = 55.47 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: Existing US6-South Platte River Basin

I. Catchment Hydrologic Data

Catchment ID = E US6-SPR
Area = 7.80 Acres
Percent Imperviousness = 90.00 %
NRCS Soil Type = B A, B, C, or D

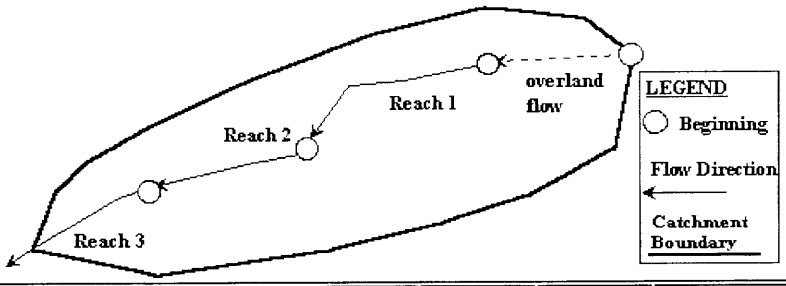
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100 years	(input return period for design storm)
C1 =	28.50	(input the value of C1)
C2=	10.00	(input the value of C2)
C3=	0.786	(input the value of C3)
P1=	2.57 inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.81
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.73
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft	C-5		fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.73		0.22	3.79
1	0.0300	900		20.00	3.46	4.33
2						
3						
4						
5						
Sum		950				

Computed Tc = 8.12
Regional Tc = 15.28

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 7.51 inch/hr	Rainfall Intensity at Tc, I = 5.78 inch/hr
Peak Flowrate, Qp = 47.46 cfs	Peak Flowrate, Qp = 36.53 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: Existing I-25 - 6th Avenue Interchange Basin

I. Catchment Hydrologic Data

Catchment ID = E I-25 - 6th Avenue
Area = 36.00 Acres
Percent Imperviousness = 43.00 %
NRCS Soil Type = B A, B, C, or D

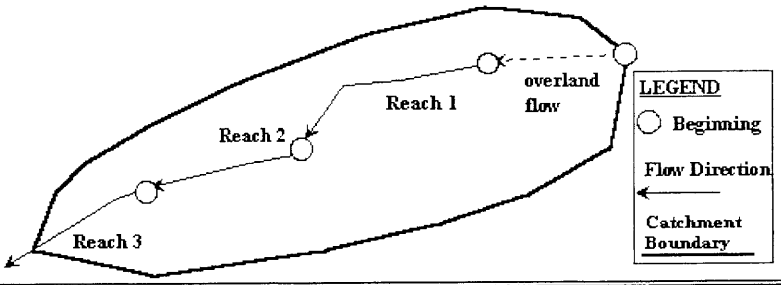
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.50
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.31
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.31		0.10	8.00
1	0.0222	1,580		20.00	2.98	8.85
2						
3						
4						
5						
Sum		1,630				

Computed Tc = 16.85
Regional Tc = 19.06

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 5.52 inch/hr	Rainfall Intensity at Tc, I = 5.18 inch/hr
Peak Flowrate, Qp = 99.93 cfs	Peak Flowrate, Qp = 93.92 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: Existing I-25 - 3rd Avenue Basin

I. Catchment Hydrologic Data

Catchment ID = E I-25 - 3rd Avenue
Area = 13.00 Acres
Percent Imperviousness = 100.00 %
NRCS Soil Type = B A, B, C, or D

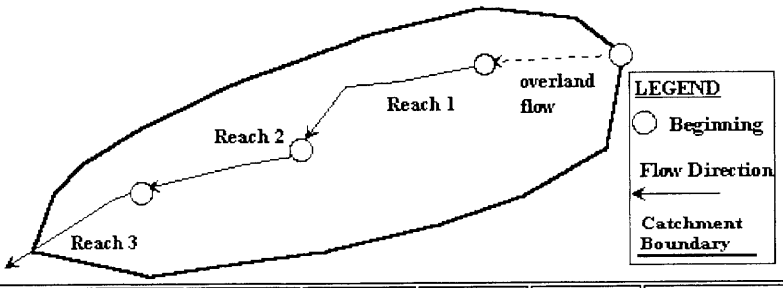
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.96
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.90
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft	C-5		fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.90		0.40	2.08
1	0.0044	2,250		20.00	1.33	28.13
2						
3						
4						
5						
Sum		2,300				

Computed Tc = 30.20
Regional Tc = 22.78

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 4.02 inch/hr	Rainfall Intensity at Tc, I = 4.72 inch/hr
Peak Flowrate, Qp = 49.89 cfs	Peak Flowrate, Qp = 58.57 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: Existing SH 85

I. Catchment Hydrologic Data

Catchment ID = E SH 85
Area = 13.00 Acres
Percent Imperviousness = 90.00 %
NRCS Soil Type = B A, B, C, or D

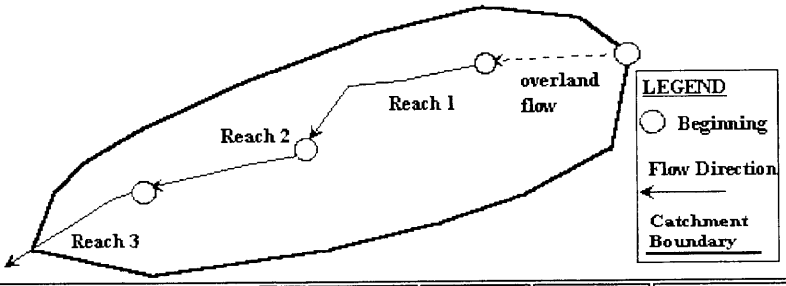
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.81
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.73
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.73		0.22	3.79
1	0.0040	2,100		20.00	1.26	27.67
2						
3						
4						
5						
Sum		2,150				

Computed Tc = 31.46
Regional Tc = 21.94

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 3.92 inch/hr	Rainfall Intensity at Tc, I = 4.81 inch/hr
Peak Flowrate, Qp = 41.27 cfs	Peak Flowrate, Qp = 50.65 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: Existing - I-25 - Low Point Basin

I. Catchment Hydrologic Data

Catchment ID = E I-25 Low Poing
Area = 2.60 Acres
Percent Imperviousness = 100.00 %
NRCS Soil Type = B A, B, C, or D

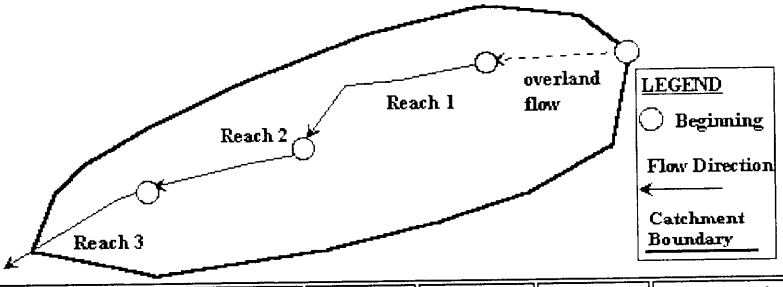
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.96
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.90
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.90		0.40	2.08
1	0.0150	1,060		20.00	2.45	7.21
2						
3						
4						
5						
Sum		1,110				

Computed Tc = 9.29
Regional Tc = 16.17

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 7.15 inch/hr	Rainfall Intensity at Tc, I = 5.63 inch/hr
Peak Flowrate, Qp = 17.77 cfs	Peak Flowrate, Qp = 13.98 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: Existing I-25 - Alameda Avenue Basin

I. Catchment Hydrologic Data

Catchment ID = E I-25 - Alameda
Area = 25.00 Acres
Percent Imperviousness = 90.00 %
NRCS Soil Type = B A, B, C, or D

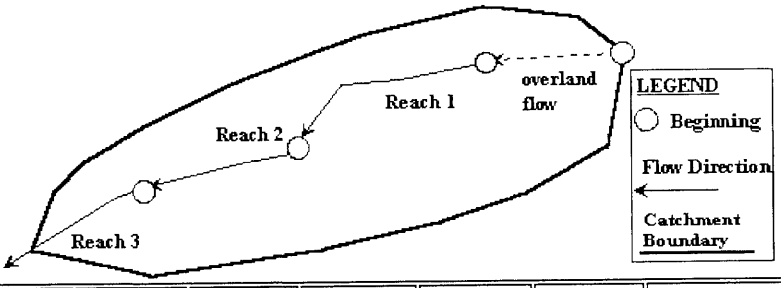
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.81
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.73
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.73		0.22	3.79
1	0.0350	2,053		20.00	3.74	9.14
2						
3						
4						
5						
Sum		2,103				

Computed Tc = 12.94
Regional Tc = 21.68

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 6.24 inch/hr	Rainfall Intensity at Tc, I = 4.84 inch/hr
Peak Flowrate, Qp = 126.39 cfs	Peak Flowrate, Qp = 98.04 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: Existing I-25 - TREX Basin

I. Catchment Hydrologic Data

Catchment ID = E I-25 - TREX
Area = 5.40 Acres
Percent Imperviousness = 100.00 %
NRCS Soil Type = B A, B, C, or D

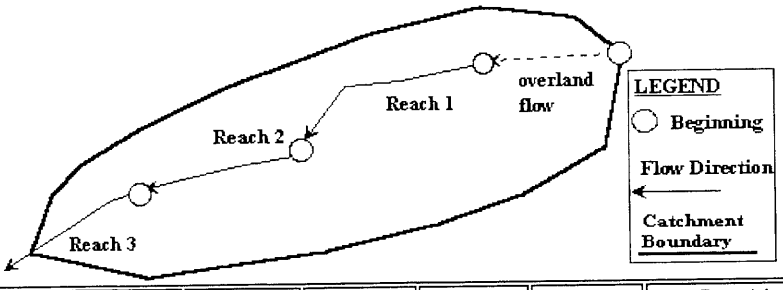
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100 years	(input return period for design storm)
C1 =	28.50	(input the value of C1)
C2=	10.00	(input the value of C2)
C3=	0.786	(input the value of C3)
P1=	2.57 inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.96
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.90
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft	C-5		fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.90		0.40	2.08
1	0.0050	3,000		20.00	1.41	35.36
2						
3						
4						
5						
Sum		3,050				

Computed Tc = 37.43
Regional Tc = 26.94

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 3.53 inch/hr	Rainfall Intensity at Tc, I = 4.29 inch/hr
Peak Flowrate, Qp = 18.20 cfs	Peak Flowrate, Qp = 22.15 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: Existing I-25 - Broadway Basin

I. Catchment Hydrologic Data

Catchment ID = E I-25 - Broadway
Area = 14.00 Acres
Percent Imperviousness = 82.00 %
NRCS Soil Type = B A, B, C, or D

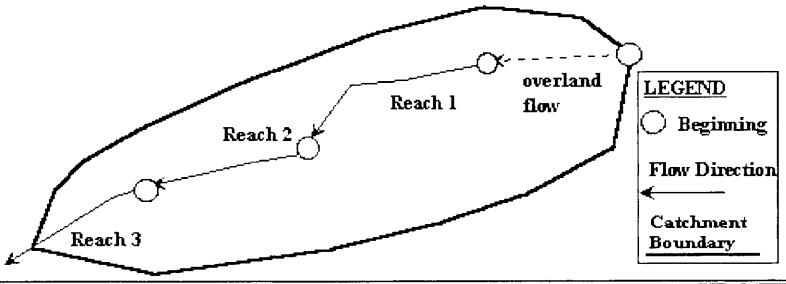
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.72
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.62
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.62		0.17	4.89
1	0.0240	2,116		20.00	3.10	11.38
2						
3						
4						
5						
Sum		2,166				

Computed Tc = 16.28
Regional Tc = 22.03

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 5.61 inch/hr	Rainfall Intensity at Tc, I = 4.80 inch/hr
Peak Flowrate, Qp = 56.52 cfs	Peak Flowrate, Qp = 48.37 cfs

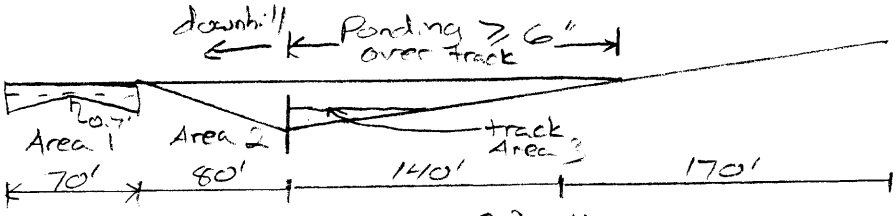
Existing Basin Weir/Flooding Calculations

Subject: Flow Depths Sheet No. _____ Of _____

Prepared By: SAW/JJE Checked By: _____ Date: Calc 6-18-03 Project No.: 99041.06

Third Avenue

XS - 2



@ 2/3 H

$Q = CLH^{3/2}$ $Q = 392$ @ tracks

Estimate Q in 1st 1/2 foot

$Q = (2.8)(20)(.5)^{3/2} = 20$ cfs (flow down tracks)

Estimate Q in next 1/2 foot

$Q = (2.8)(147)(0.5)^{3/2} = 145$ cfs

$Q = (2.8)(70)(0.5)^{3/2} = 69$ cfs > 214 cfs

Recalculate @ 1.1 feet deep:

Area 1 = $Q = (2.8)(70)(0.6-0.2)^{3/2} = 50$ cfs → down road

Area 2 = $Q = (2.8)(2/3 \cdot 80)(1.1)^{3/2} = 172$ cfs → down tracks

Area 3 = $Q = (2.8)(2/3 \cdot (1.1)(140))(0.6)^{3/2} = 134$ cfs → over tracks

356 cfs

⇒ Proportional 51 cfs on Road
177 cfs along tracks
125 cfs over tracks

Recalculate @ 1.2 feet deep:

Area 1 = $Q = (2.8)(70)(0.7-0.2)^{3/2} = 70$

Area 2 = $Q = (2.8)(53.3)(1.2)^{3/2} = 196$

Area 3 = $Q = (2.8)(1/2)(0.7)^{3/2} = 183$

449

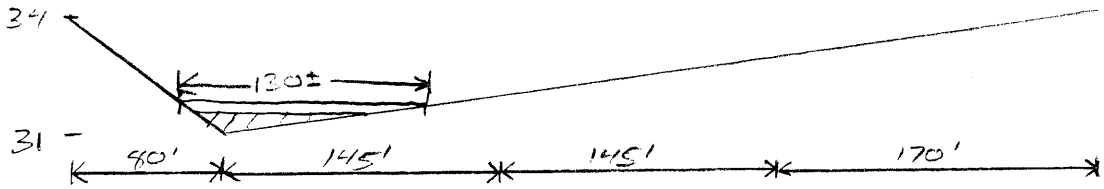
Muller Engineering Company, Inc.
DESIGN NOTES AND COMPUTATIONS

Subject: Flow Depths Sheet No. ____ Of ____

Prepared By: JAW/JE Checked By: ____ Date: 6/18/03 Project No.: 9904.06

Ellsworth

XS #7 - @ track



$Q = 175 = CLH^{3/2}$

L (@2/3 H)	H	Q	
39	0.8	78	
48	0.5	47.5	→ trapped on east side of tracks; everything else to go over I-25.
108	0.75	197	
115	1.0	322	
92	0.8	183	
86	0.75	156	

Q = 48 cfs, down tracks

Q = 175 - 48 = 127

127 cfs, over tracks

☆ Q = 127 cfs w/ w = 130± & d = 0.3'± sheet flow over I-25.

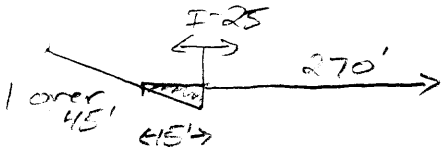
Muller Engineering Company, Inc.
DESIGN NOTES AND COMPUTATIONS

Subject: Flow Depths Sheet No. _____ Of _____

Prepared By: JAW/JIE Checked By: _____ Date: Calc 6-18-03 Project No.: 9704.06

Ellsworth

XS #8



$Q = CLH^{3/2}$ L @ 2/3 H

$Q = (2.8)(10)(0.5)^{3/2}$

$Q = 10$ cfs ← Includes 10 cfs →

D = H - 0.5
H_{wy} = 270'

	H	L tracks	Q tracks	Q H_{wy}
8"	0.67	23	35 cfs +	53 cfs = 88 cfs
7"	0.58	17.4	22 cfs +	17 cfs = 39 cfs
7½"	0.63	20.9	29 cfs	35 cfs = 64 cfs
	0.59	19	24 cfs +	20.41 cfs = 44 cfs

10 cfs will join Third Ave Flows

Muller Engineering Company, Inc.
DESIGN NOTES AND COMPUTATIONS

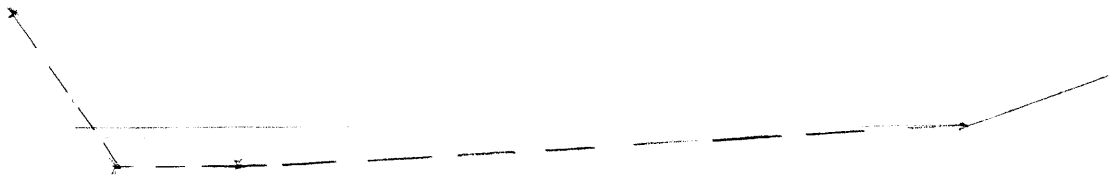
Subject: I-25 @ Bayard

Sheet No. _____ Of _____

Prepared By: BJB Checked By: _____ Date: 5/19/05 Project No.: [illegible]

XS-#4

I-25
@ Bayard
X-section



$Q = 2.8(340)(1.0)^{1.5} = 952$ cfs

$D = 1.0'$

$Q = 2.8(300)(.8)^{1.5} = 600$ cfs

USE THIS CROSS SECTION TO DET. DEPTH OF I-25 OVERTOPPING.

$\boxed{\text{USE } 10'' \text{ DEPTH}} \rightarrow 650$ cfs

$9'' \rightarrow 528$ cfs

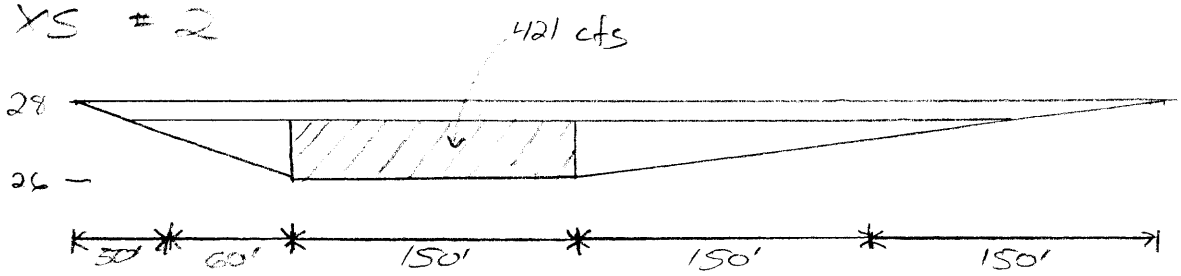
Muller Engineering Company, Inc.
DESIGN NOTES AND COMPUTATIONS

Subject: Flow Depths Sheet No. _____ Of _____

Prepared By: JAW/JJE Checked By: _____ Date: _____ Project No.: 9904.06

Alameda

XS # 2



Alameda, across Kalamath & into grassy area prior to I-25

$$Q = CLH^{3/2}$$

Q	H	L = 150 + (2/3 H(150)) + 2/3 H(50)
3358	2.0	424
2091	1.6	369
2228	1.65	375.5
2370	1.7	382
2528	1.75	390
2459	1.73	386

Q = 2465

1.73' of Ponding
12/5/03

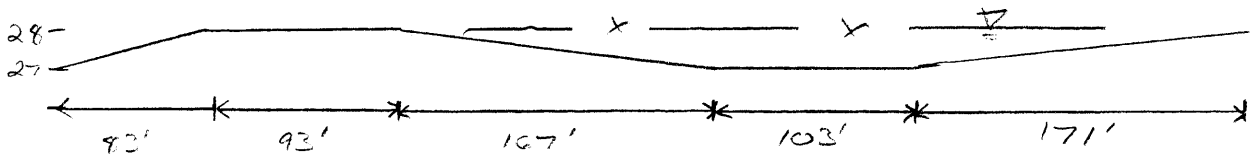
Muller Engineering Company, Inc.
DESIGN NOTES AND COMPUTATIONS

Subject: Flow Depths Sheet No. _____ Of _____

Prepared By: JAW/JJE Checked By: _____ Date: _____ Project No.: 9904.06

Santa Fe

XS #1



What Q ponds before flowing over 28?

$h = 1$ $L = 328$ @ 2/3 H $C = 2.8$

$Q = CLH^{3/2}$

$Q = (2.8)(328)(1)^{3/2}$

$Q = 918 >$ Future Q_{100}

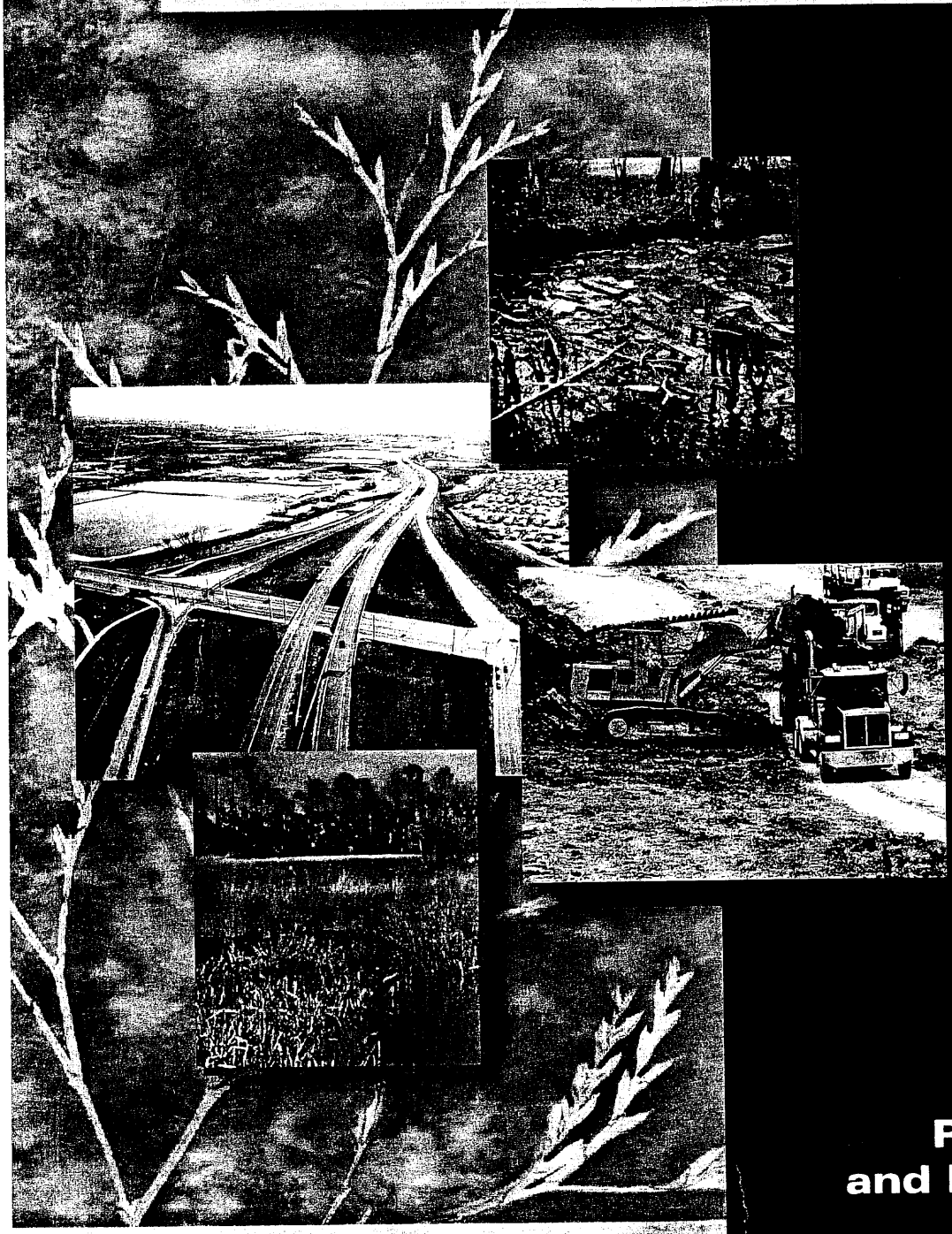
APPENDIX B BMP FACT SHEETS

BMP Fact Sheets (from CDOT MS4 Permit New Development and Redevelopment Program)

[illegible] Development and Redevelopment Program

9704.06

Rec'd 2/18/03



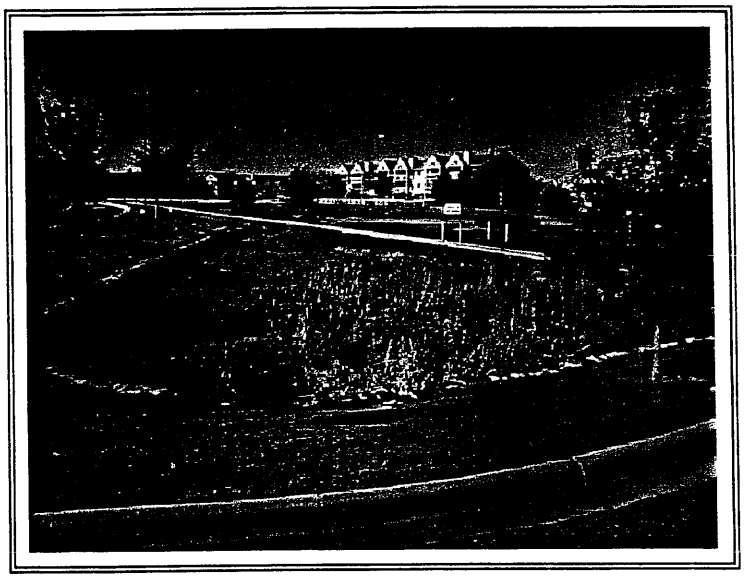
DOT

DEPARTMENT OF TRANSPORTATION

Submittal to the
Colorado Department of Public Health and Environment

Jan 2003

Extended Detention Pond with Micropool



Description

A structural BMP used to capture and treat a specific volume of stormwater runoff. Because of a smaller outlet, the pond releases stored flows over a period of a few days and drains totally dry sometime after the storm ends. The pond is considered dry, although the formation of small wetland marshes or shallow pools in the bottom can enhance the effectiveness of the pond.

Application Guidelines

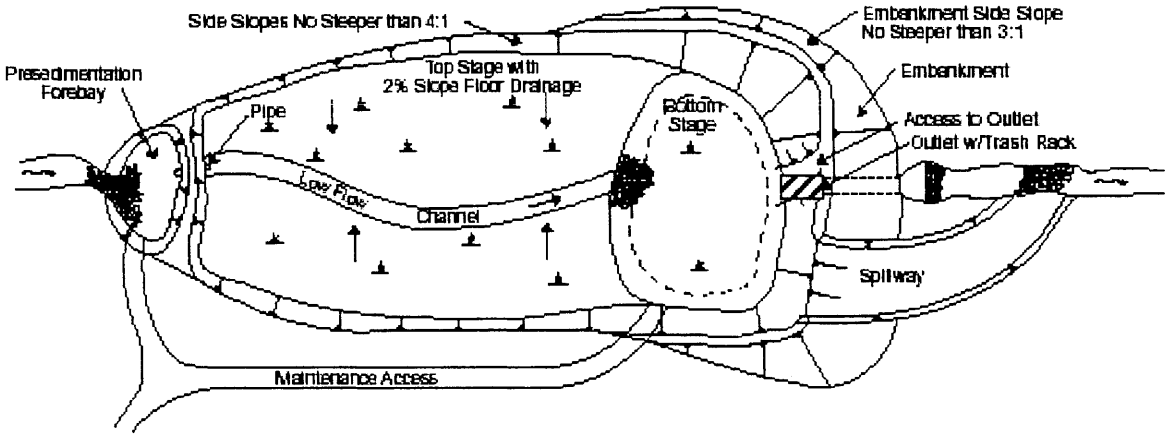
- Pond can be used to enhance stormwater quality and reduce peak discharges,
- Most applicable in residential, commercial, and industrial areas,
- If constructed early in development of a particular site, the pond becomes an effective means of trapping sediment from construction activities,
- Ponds can be retrofitted into existing flood control facilities,
- Ponds are used to improve quality of urban runoff,
- Used for regional and/or follow-up water quality treatment but are also effective as an "on-site" BMP,
- Pond also works well in conjunction with other BMP's used to control upstream and downstream sediments,
- Ponds can be effective if they are combined with BMP's that attenuate peak stormwater discharges or reduce runoff volumes. If needed, flood routing detention volume can be designed and captured by the pond, above volume used for water quality treatment,
- Pond size can be reduced if effectively combined with other BMP's,
- Pond can also be used for recreation and open space and in some cases, wildlife habitat if wetlands or shallow pools are incorporated into the design.

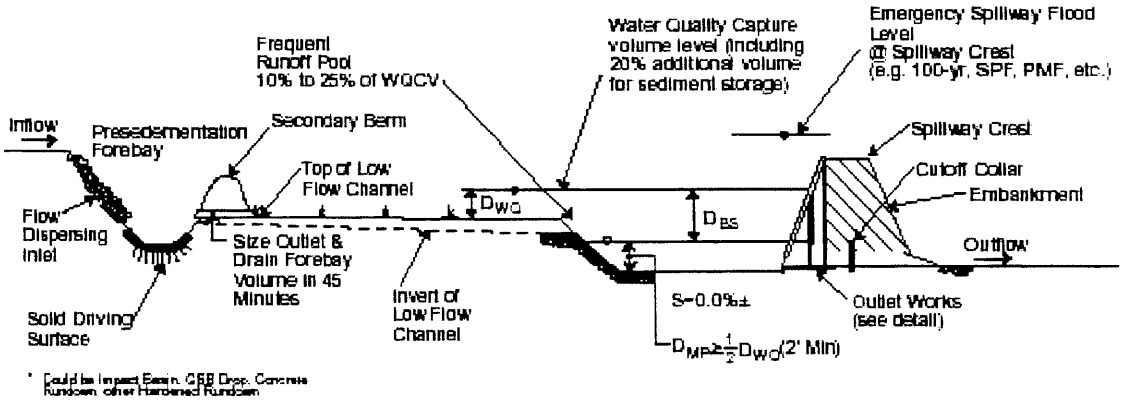
Basic Design Criteria

- If possible, pond should be incorporated into existing facility or flood control basin,
- Consider other urban uses such as recreation, open space, and/or wildlife habitat,
- Generally, minimum drain time of 40 hours is recommended to allow finer particulates found in urban stormwater runoff to settle,
- Generally, land required is approximately 0.5 to 2.0% of tributary development area,
- Account for groundwater elevations in the design and construction of the basin,
- Review State Engineer's regulatory requirements for dam embankments and storage volumes if minimum dam heights and volumes are exceeded.

Extended Detention Pond with Micropool

Reference: Denver Urban Drainage and Flood Control District, Volume 3 Criteria Manual.





SECTION
NOT TO SCALE

6TH AVE INFIELD, DECATUR

Extended Detention Shallow Wetland

Description

A structural BMP used to capture and treat a specific volume of stormwater runoff. This structure is a shallow wetland with additional detention storage provided for water quality treatment. Wetland species are added to the bottom of the pond to enhance the pollutant removal capability and a perennial base flow is required to maintain and promote wetland vegetation.

Application Guidelines

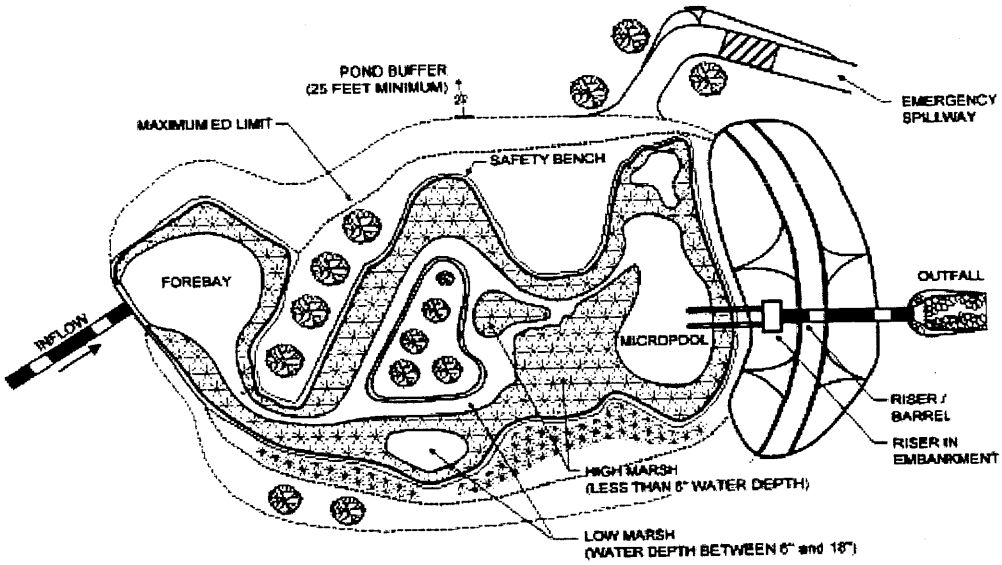
- Wetland can be used to reduce peak discharges,
- Can be used as a follow-up structural BMP or as a stand-alone facility,
- Small existing wetlands can be enlarged and incorporated into constructed wetland (requires state and federal permits),
- Requires an area sufficiently large for impounding stormwater in shallow basins,
- Wetland cells can be arranged in a series of terraces,
- If needed, flood storage can be provided above volume used for water quality treatment,
- Wetlands can provide effective follow-up treatment to on-site and other basin BMP's,
- State and Federal regulations protecting natural wetlands recognize classification of wetlands constructed for water quality treatment,
- Constructed wetlands generally not allowed on receiving waters and cannot be used to mitigate loss of natural wetlands,
- Advantage is in aesthetics and creation of wildlife habitat, disadvantage is need for continuous base flow to maintain wetland growth.

Basic Design Criteria

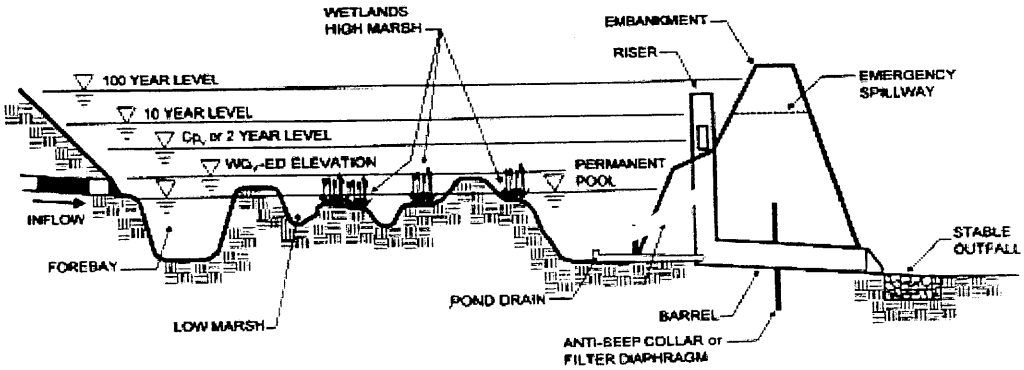
- Generally, minimum drain time of 24 hours is recommended,
- Wetlands constructed outside of the Waters of the U.S. and explicitly designed for stormwater management, are not subject to the provisions of the Clean Water Act (Sections 401 and 404). When abandoned, they may be regulated as natural wetlands,
- Perennial base flow is needed and is determined through a water budget analysis,
- Consider other urban uses such as recreation, open space, and/or wildlife habitat,
- Loamy soils are required in the wetland bottom to sustain plant growth,
- Exfiltration through pond bottom is not reliable because of low permeability soils and/or high ground water elevations,
- Review State Engineer's regulatory requirements for dam embankments and storage volumes if minimum dam heights and volumes are exceeded.

Extended Detention Shallow Wetland

Reference: Maryland Stormwater Design Manual.



PLAN VIEW



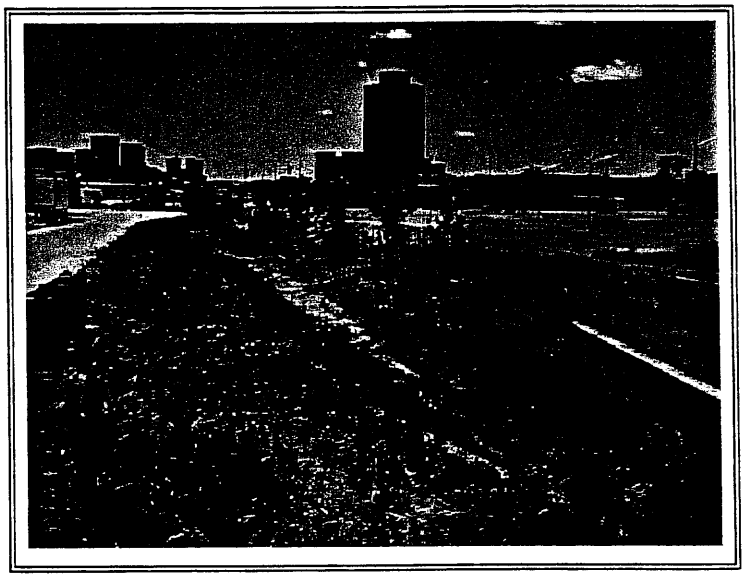
PROFILE

ALAMEDA

Dry Swale

Description

A structural BMP used to filter pollutants as stormwater runoff moves through the swale. This BMP is constructed as an open-channel drainageway with grass or other vegetation to provide conveyance and to filter pollutants. Other features such as check dams, pre-treatment forebays, gravel pads, and riprap can be used to temporarily inhibit stormwater runoff and enhance treatment.



Application Guidelines

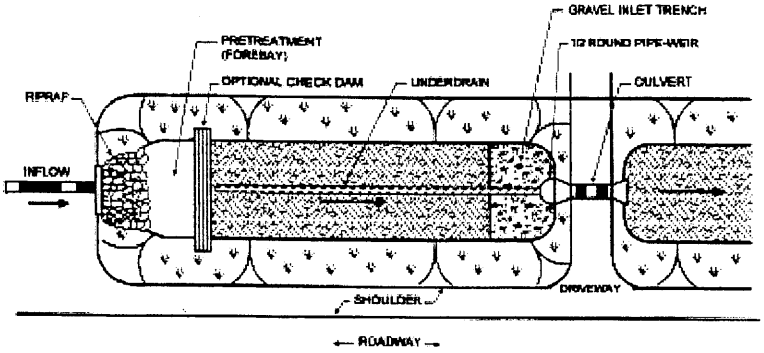
- Structure can be used to enhance stormwater quality and reduce peak runoff,
- Efficient for removing a wide variety of pollutants including suspended solids and nutrients.
- Swales work best in conjunction with other BMP's and can be used as an alternative to or enhancement of a conventional storm sewer,
- Excavated area is lined with layers of filter fabric around the permeable soil,
- Flows that infiltrate into the channel soil are conveyed by an underdrain system,
- Swales are used in low density residential areas or for very small impervious areas, generally less than 10 acres,
- Runoff sources can be overland flow from impervious areas or discharges from drainage pipes,
- Swales can be used in early post-construction when stabilizing vegetation is not established and principal consideration is preventing erosion in unvegetated channels,
- Well suited for flat or rolling terrain,
- Swale depressions can be used in place of above-ground islands in large parking lots.

Basic Design Criteria

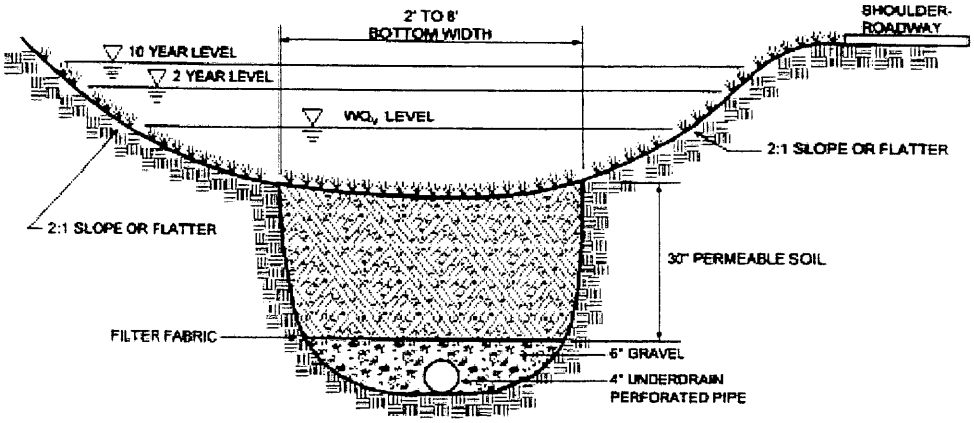
- Generally, swales are designed to temporarily store the water quality volume for a maximum of 48 hours,
- Regular inspection and maintenance is necessary to remove surface sediment, trash, debris, and leaf litter, and dead or diseased plant material. Routine mowing is required,
- A vegetative cover needs to be established as soon as possible to prevent erosion and scour. They should also be constructed early in the construction schedule before grading and paving increase runoff rates,
- The maximum ponding depth is generally no greater than 1.5 feet at the outlet,
- Longitudinal slope should be as flat as possible, to minimize velocities and enhance pollutant filtering.

Dry Swale

Reference: Denver Urban Drainage and Flood Control District, Volume 3 Criteria Manual.



PLAN VIEW



SECTION

APPENDIX C BASIN AND INLET INFORMATION

Basin Information Summary
Future Basin Runoff Calculations
Inlet Spacing Spreadsheet

BASIN INFORMATION SUMMARY

			Existing Conditions					Future Conditions							
Basin ID	Sub-basin ID	Soil Type	Basin Area (acre)	100-yr Q (cfs)	CFS/ Acre	I %	WQDV	Basin Area (acre)	100-yr Q (cfs)	CFS/ Acre	5-yr Q (cfs)	2-yr Q (cfs)	I %	WQDV	
US 6 - West		C	26	81	3.12	64	0.65	* Incorporated into US - 6 Decatur Basin							
US 6 - East		C	17	55	3.24	50	0.35	* Incorporated into US - 6 Decatur Basin							
US 6 - Decatur		C						43.0	127.00	2.95	49.00	21.00	64	1.08	
US 6 - South Platte River		B	7.8	47	6.03	90	0.31	7.8	50.00	6.41	23.00	16.00	92	0.33	
I-25 - 6th Avenue interchange		B	36	100	2.78	43	0.68	37.0	103.00	2.78	33.00	19.00	43	0.69	
I-25 - 3rd Avenue		B	13	59	4.54	100	0.65	17.0	71.00	4.18	35.00	24.00	100	0.85	
I-25 - Alameda		B	25	126	5.04	94	1.09	25.0	90.00	3.60	37.00	24.00	70	0.69	
	SB-21	B						5.3	20.00	3.77	8.40	5.50	70	0.15	
	SB-22	B						9.6	39.00	4.06	16.00	11.00	70	0.26	
	SB-23	B						9.6	36.00	3.75	15.00	10.00	70	0.26	
SH 85 - SYS 1		B	13	51	3.92	90	0.52	9.6	38.00	3.96	17.00	12.00	87	0.36	
SH 85 - SYS 2		B						9.6	39.50	4.11	18.80	13.00	93	0.41	3
SH 85 - SYS 3		B						11.0	42.00	3.82	20.00	14.00	89	0.43	
I-25 - Low Point		B	2.6	18	6.92	100	0.13	* Incorporated into other basin							
I-25 - Broadway		B	14	57	4.07	82	0.48	20.0	70.00	3.50	31.00	21.00	81	0.67	
	SB-31	B						5.9	42.00	7.12	21.00	14.00	100	0.30	
	SB-32	B						9.3	58.00	6.24	28.00	20.00	100	0.47	
	SB-33	B						5.4	17.00	3.15	4.70	2.40	30	0.08	
I-25 - TREX		B	5.4	22	4.07	100	0.27	6.3	25.64	4.07			100	0.32	1
CCD - 7th Ave West		C	47		0.00	75	1.41	No Change in Basin							
CCD - 5th Ave West		C	39		0.00	75	1.17	No Change in Basin							
CCD - 6th Avenue East		B	263	840	3.19	80	8.63	No Change in Basin							
CCD - 3rd Avenue		C	187	570	3.05	62	4.54	No Change in Basin							
CCD - Ellsworth (combined with Bayaud in future)		C	9.3	70	7.53	65	0.24	265.0	810.9	3.06			55.0	5.84	
CCD - Bayaud (combined with Ellsworth in future)		C	310	950	3.06	55	6.83								
	CCD - SB-1	B						265.0	810.90	3.06			55	5.84	1
	CCD - SB-2	B						11.7	43.00	3.68	19.00	13.00	80	0.38	
	CCD - SB-3	B						5.1	24.00	4.71	12.00	8.80	90	0.20	
	CCD - SB-4	B						6.2	29.00	4.68	13.00	9.30	90	0.25	
	CCD - SB-5	B						15.0	45.97	3.06			55	0.33	1
	CCD - SB-6	B						3.8	19.00	5.00	9.00	6.20	90	0.15	
	CCD - SYS 1 - SB-7	B						11.9	38.01	3.19			90	0.48	1
	CCD - SYS 1 - SF SUMP	B						0.9	7.50	8.33	3.90	2.80	100	0.05	
	CCD - SYS 1 - K SUMP	B						0.5	4.30	9.35	2.10	1.50	100	0.02	
	CCD - SYS 2 - SB-7	B						5.1	13.00	2.55	3.00	2.20	20	0.06	
	CCD - SYS 2 - SB-8	B						4.2	18.00	4.29	9.10	6.30	90	0.17	
	CCD - SYS 2 - SB 9	B						1.2	6.10	5.08	2.80	2.00	90	0.05	3
	CCD - SYS 2 - SF SUMP	B						1.8	12.10	6.72	5.90	4.10	100	0.09	3
	CCD - SYS 2 - K SUMP	B						1.7	11.60	6.82	5.70	4.00	100	0.09	3
	CCD - SYS 3 - SB-2	B						25.0	92.00	3.06	42.00	29.00	85	0.91	
	CCD - SYS 3 - SB-3	B						2.3	6.60		2.10	1.20	40	0.04	
	CCD - SYS 3 - SB-4	B						2.6	15.00		7.10	4.90	90	0.10	
	CCD - SYS 3 - SB-6	B						8.5	29.00		12.00	8.10	73	0.25	
	CCD - SYS 3 - SF SUMP	B						7.0	37.00		16.00	13.00	100	0.35	
	CCD - SYS 1 - TOTAL	B						585.1	1832.6		59.0	41.6		13.5	
	CCD - SYS 2 - TOTAL	B						584.1	1832.0		73.8	51.9		13.4	
	CCD - SYS 3 - TOTAL	B						590.4	1847.4		79.2	56.2		13.7	
CCD - Virginia		C	726	2560	3.53	48	14.58	No Change in Basin							
CCD - Alameda (System Alternative 1)		C	99	400	4.04	80	3.25	No Change in Basin							
	CCD-SB-11	C						59.0	238.36	4.04			80	1.94	1
	CCD-SB-12	C						12.0	48.48	4.04			80	0.39	1
	CCD-SB-13	C						3.9	23.63	6.06			80	0.13	2
	CCD - SYS 2 - SB-15	C						4.5	27.27	6.06			100	0.23	2, 3
	CCD - SYS 3 - SB-14	C						17.0	68.68	4.04			65	0.43	1
CCD - 42" Outfall		B	49	200	4.08	86	1.81	30.7					86	1.13	

1) Future Conditions calculated using existing cfs/acre

2) Future Conditions calculated using existing cfs/acre * 1.5 because of small basin

3) Revised 02/02/04

Future Basin Runoff Calculations

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: US6 Decatur Basin

I. Catchment Hydrologic Data

Catchment ID = US6 DECATUR
Area = 43.00 Acres
Percent Imperviousness = 64.00 %
NRCS Soil Type = C A, B, C, or D

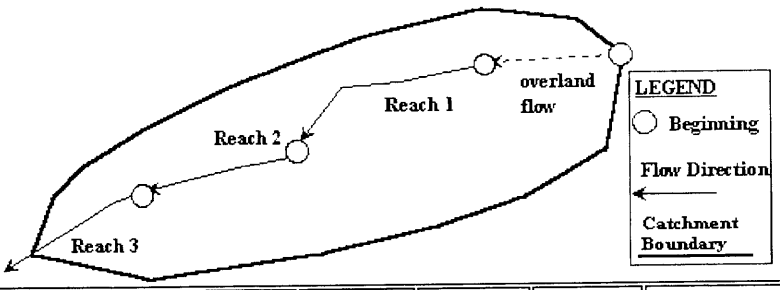
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.65
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.48
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft	C-5		fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.48		0.13	6.25
1	0.0030	200		20.00	1.10	3.04
2	0.0400	3,000		20.00	4.00	12.50
3	0.0100	300		20.00	2.00	2.50
4						
5						
Sum		3,550				

Computed Tc = 24.30
Regional Tc = 29.72

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 4.55 inch/hr	Rainfall Intensity at Tc, I = 4.05 inch/hr
Peak Flowrate, Qp = 126.94 cfs	Peak Flowrate, Qp = 113.10 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: US6-South Platte River Basin

I. Catchment Hydrologic Data

Catchment ID = US6-SPR
Area = 7.80 Acres
Percent Imperviousness = 92.00 %
NRCS Soil Type = B A, B, C, or D

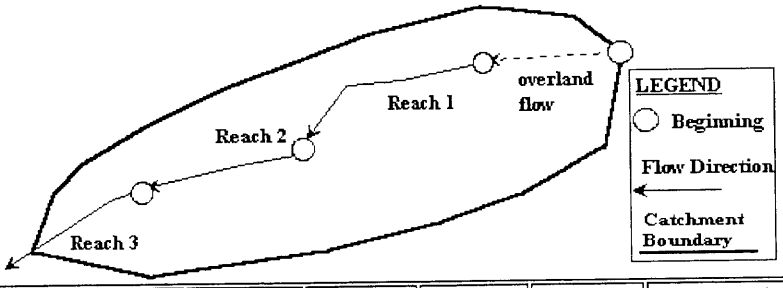
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.84
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.76
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft	C-5		fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.76		0.24	3.48
1	0.0300	900		20.00	3.46	4.33
2						
3						
4						
5						
Sum		950				

Computed Tc = 7.81
Regional Tc = 15.28

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 7.62 inch/hr	Rainfall Intensity at Tc, I = 5.78 inch/hr
Peak Flowrate, Qp = 49.65 cfs	Peak Flowrate, Qp = 37.71 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: I-25 - 6th Avenue Interchange Basin

I. Catchment Hydrologic Data

Catchment ID = I-25 - 6th Avenue
Area = 37.00 Acres
Percent Imperviousness = 43.00 %
NRCS Soil Type = B A, B, C, or D

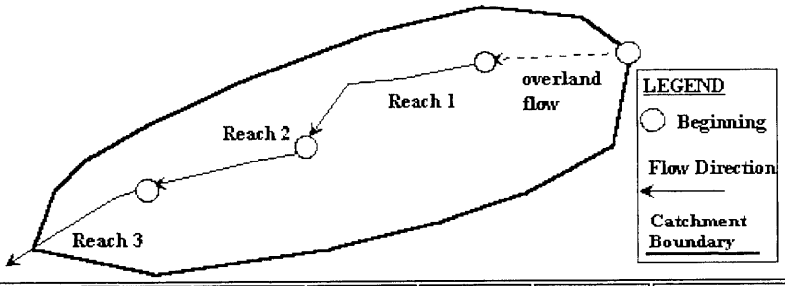
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.50
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.31
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft	C-5		fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.31		0.10	8.00
1	0.0222	1,580		20.00	2.98	8.85
2						
3						
4						
5						
Sum		1,630				

Computed Tc = 16.85
Regional Tc = 19.06

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 5.52 inch/hr	Rainfall Intensity at Tc, I = 5.18 inch/hr
Peak Flowrate, Qp = 102.71 cfs	Peak Flowrate, Qp = 96.53 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: I-25 - 3rd Avenue Basin

I. Catchment Hydrologic Data

Catchment ID = I-25 - 3rd Avenue
Area = 17.00 Acres
Percent Imperviousness = 100.00 %
NRCS Soil Type = B A, B, C, or D

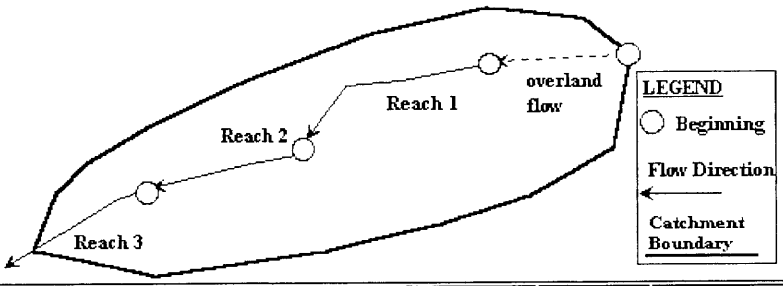
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.96
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.90
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	88	0.90		0.53	2.76
1	0.0050	2,800		20.00	1.41	33.00
2						
3						
4						
5						
Sum		2,888				

Computed Tc = 35.75
Regional Tc = 26.04

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 3.63 inch/hr	Rainfall Intensity at Tc, I = 4.38 inch/hr
Peak Flowrate, Qp = 58.93 cfs	Peak Flowrate, Qp = 71.09 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: CCD - Bayaud Basin - System Alternatives 1 and 2 - Sub-Basin 2

I. Catchment Hydrologic Data

Catchment ID = SB-2 (SA 1, 2)
Area = 11.70 Acres
Percent Imperviousness = 80.00 %
NRCS Soil Type = B A, B, C, or D

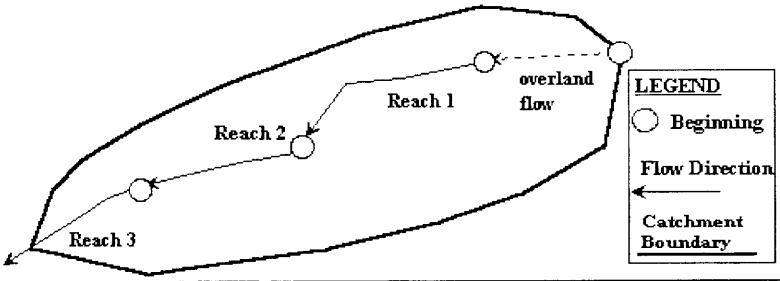
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.70
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.59
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft	C-5		fps	minutes
	input	input	output	input	output	output
Overland	0.0133	300	0.59		0.35	14.38
1	0.0075	600		20.00	1.73	5.77
2	0.0033	300		20.00	1.15	4.33
3	0.0067	300		20.00	1.63	3.06
4						
5						
Sum		1,500				

Computed Tc = 27.55
Regional Tc = 18.33

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 4.24 inch/hr	Rainfall Intensity at Tc, I = 5.29 inch/hr
Peak Flowrate, Qp = 34.72 cfs	Peak Flowrate, Qp = 43.32 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: CCD - Bayaud Basin - System Alternatives 1 and 2 - Sub-Basin 3

I. Catchment Hydrologic Data

Catchment ID = SB-3 (SA 1,2)
Area = 5.10 Acres
Percent Imperviousness = 90.00 %
NRCS Soil Type = B A, B, C, or D

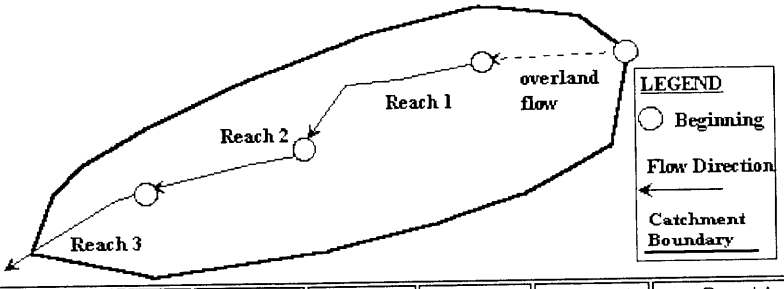
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.81
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.73
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0150	300	0.73		0.49	10.21
1	0.0150	100		20.00	2.45	0.68
2	0.0033	600		20.00	1.15	8.66
3						
4						
5						
Sum		1,000				

Computed Tc = 19.55
Regional Tc = 15.56

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 5.12 inch/hr	Rainfall Intensity at Tc, I = 5.73 inch/hr
Peak Flowrate, Qp = 21.13 cfs	Peak Flowrate, Qp = 23.68 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: CCD - Bayaud Basin - System Alternatives 1 and 2 - Sub-Basin 4

I. Catchment Hydrologic Data

Catchment ID = SB-4 (SA 1,2)
Area = 6.20 Acres
Percent Imperviousness = 90.00 %
NRCS Soil Type = B A, B, C, or D

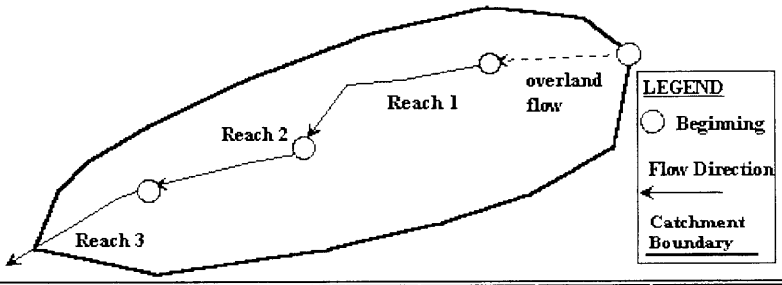
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.81
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.73
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft	C-5		fps	minutes
	input	input	output	input	output	output
Overland	0.0068	300	0.73		0.38	13.24
1	0.0068	250		20.00	1.65	2.52
2	0.0044	450		20.00	1.33	5.63
3						
4						
5						
Sum		1,000				

Computed Tc = 21.39
Regional Tc = 15.56

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 4.88 inch/hr	Rainfall Intensity at Tc, I = 5.73 inch/hr
Peak Flowrate, Qp = 24.49 cfs	Peak Flowrate, Qp = 28.79 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: CCD - Bayaud Basin - System Alternative 1 and 2 - Sub-Basin 6

I. Catchment Hydrologic Data

Catchment ID = SB-6 (SA 1,2)
Area = 3.80 Acres
Percent Imperviousness = 90.00 %
NRCS Soil Type = B A, B, C, or D

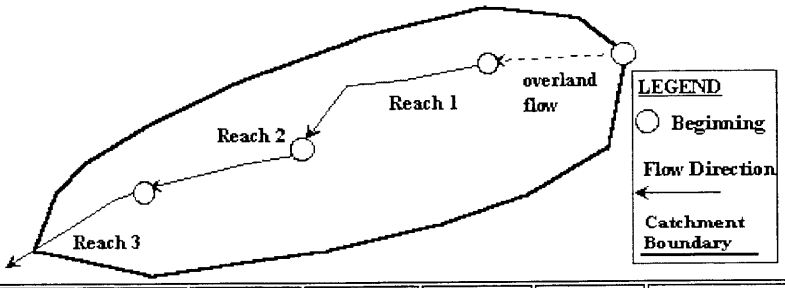
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.81
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.73
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft	C-5		fps	minutes
	input	input	output	input	output	output
Overland	0.0060	300	0.73		0.36	13.82
1	0.0060	200		20.00	1.55	2.15
2						
3						
4						
5						
Sum		500				

Computed Tc = 15.97
Regional Tc = 12.78

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 5.66 inch/hr	Rainfall Intensity at Tc, I = 6.28 inch/hr
Peak Flowrate, Qp = 17.43 cfs	Peak Flowrate, Qp = 19.32 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: CCD - Bayaud Basin - System Alternative 1 - Santa Fe Sump Sub-Basin

I. Catchment Hydrologic Data

Catchment ID = SA-1 - SF Sump
Area = 0.90 Acres
Percent Imperviousness = 100.00 %
NRCS Soil Type = B A, B, C, or D

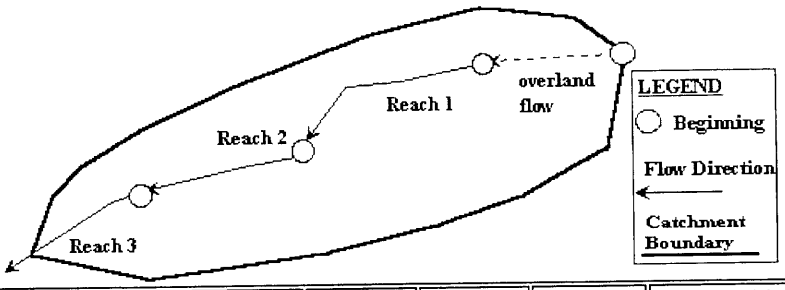
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.90
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.90
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	25	0.90		0.28	1.47
1	0.0340	500		20.00	3.69	2.26
2						
3						
4						
5						
Sum		525				

Computed Tc = 3.73
Regional Tc = 12.92

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 9.35 inch/hr	Rainfall Intensity at Tc, I = 6.25 inch/hr
Peak Flowrate, Qp = 7.53 cfs	Peak Flowrate, Qp = 5.04 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: CCD - Bayaud Basin - System Alternative 1 - Kalamath Sump Sub-Basin

I. Catchment Hydrologic Data

Catchment ID = SA-1 - K Sump
Area = 0.46 Acres
Percent Imperviousness = 100.00 %
NRCS Soil Type = B A, B, C, or D

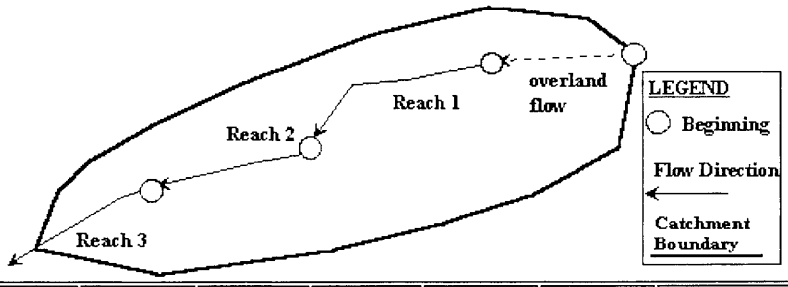
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.96
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.90
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	25	0.90		0.28	1.47
1	0.0429	350		20.00	4.14	1.41
2						
3						
4						
5						
Sum		375				

Computed Tc = 2.88
Regional Tc = 12.08

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 9.83 inch/hr	Rainfall Intensity at Tc, I = 6.43 inch/hr
Peak Flowrate, Qp = 4.32 cfs	Peak Flowrate, Qp = 2.83 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: CCD - Bayaud Basin - System Alternative 2 - Sub-Basin 7

I. Catchment Hydrologic Data

Catchment ID = SA-2 - SB-7
Area = 5.10 Acres
Percent Imperviousness = 20.00 %
NRCS Soil Type = B A, B, C, or D

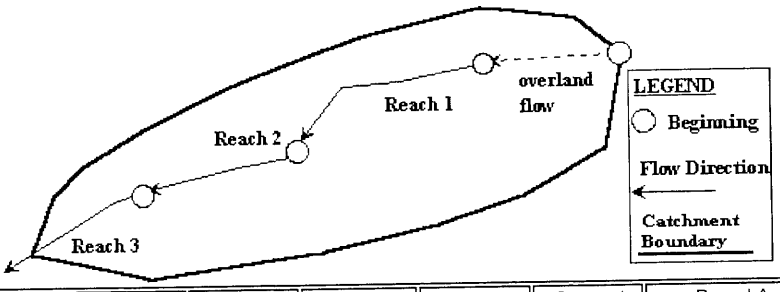
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.44
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.20
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft	C-5		fps	minutes
	input	input	output	input	output	output
Overland	0.0067	300	0.20		0.15	32.28
1	0.0067	600		20.00	1.63	6.12
2				20.00		
3				20.00		
4						
5						
Sum		900				

Computed Tc = 38.40
Regional Tc = 15.00

IV.

Peak Runoff Prediction using Computed Tc
Rainfall Intensity at Tc, I = 3.47 inch/hr
Peak Flowrate, Qp = 7.81 cfs

ediction using Regional Tc
Rainfall Intensity at Tc, I = 5.83 inch/hr
Peak Flowrate, Qp = 13.12 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: CCD - Bayaud Basin - System Alternative 2 - Sub-Basin 8

I. Catchment Hydrologic Data

Catchment ID = SA-2 - SB-8
Area = 4.20 Acres
Percent Imperviousness = 90.00 %
NRCS Soil Type = B A, B, C, or D

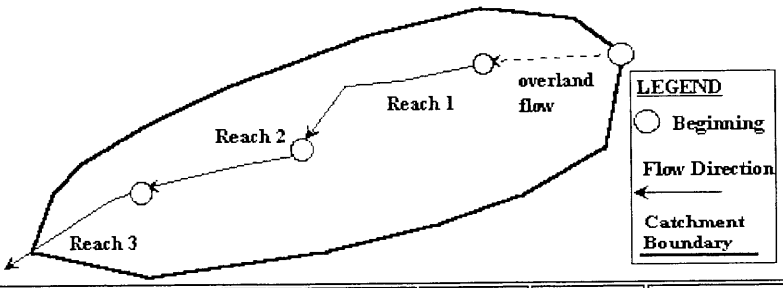
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.73
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.73
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0060	300	0.73		0.36	13.82
1	0.0060	700		20.00	1.55	7.53
2				20.00		
3				20.00		
4						
5						
Sum		1,000				

Computed Tc = 21.35
Regional Tc = 15.56

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 4.88 inch/hr	Rainfall Intensity at Tc, I = 5.73 inch/hr
Peak Flowrate, Qp = 14.91 cfs	Peak Flowrate, Qp = 17.50 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: CCD - Bayaud Basin - System Alternatives 2 - Sub-Basin 9

I. Catchment Hydrologic Data

Catchment ID = SB-9 (SA 2)
Area = 1.20 Acres
Percent Imperviousness = 90.00 %
NRCS Soil Type = B A, B, C, or D

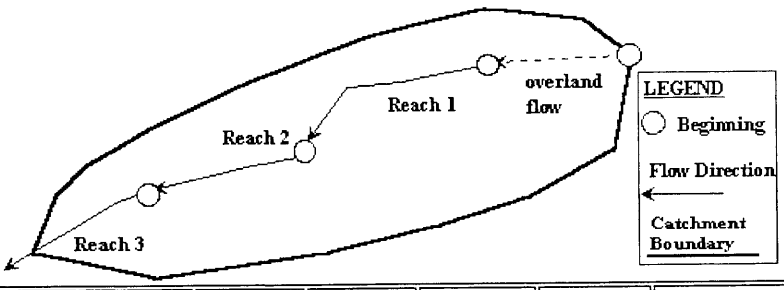
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.81
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.73
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0133	300	0.73		0.47	10.62
1	0.0075	240		20.00	1.73	2.31
2						
3						
4						
5						
Sum		540				

Computed Tc = 12.92
Regional Tc = 13.00

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 6.25 inch/hr	Rainfall Intensity at Tc, I = 6.23 inch/hr
Peak Flowrate, Qp = 6.07 cfs	Peak Flowrate, Qp = 6.05 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: CCD - Bayaud/Alameda Basin - System Alternative 2 - Santa Fe Sump Sub-Basi

I. Catchment Hydrologic Data

Catchment ID = SA-2 - SF Sump
Area = 1.80 Acres
Percent Imperviousness = 100.00 %
NRCS Soil Type = B A, B, C, or D

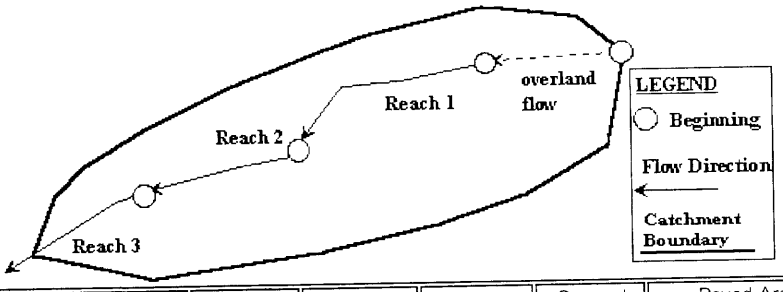
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.96
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.90
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft	C-5		fps	minutes
	input	input	output	input	output	output
Overland	0.0200	25	0.90		0.28	1.47
1	0.0125	400		20.00	2.24	2.98
2	0.0350	300		20.00	3.74	1.34
3	0.0400	600		20.00	4.00	2.50
4	0.0125	200		20.00	2.24	1.49
5						
Sum		1,525				

Computed Tc = 9.78
Regional Tc = 18.47

IV.

Peak Runoff Prediction using Computed Tc
Rainfall Intensity at Tc, I = 7.01 inch/hr
Peak Flowrate, Qp = 12.06 cfs

ediction using Regional Tc
Rainfall Intensity at Tc, I = 5.27 inch/hr
Peak Flowrate, Qp = 9.06 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: CCD - Bayaud Basin - System Alternative 2 - Kalamath Sump Sub-Basin

I. Catchment Hydrologic Data

Catchment ID = SA-2 - K Sump
Area = 1.70 Acres
Percent Imperviousness = 100.00 %
NRCS Soil Type = B A, B, C, or D

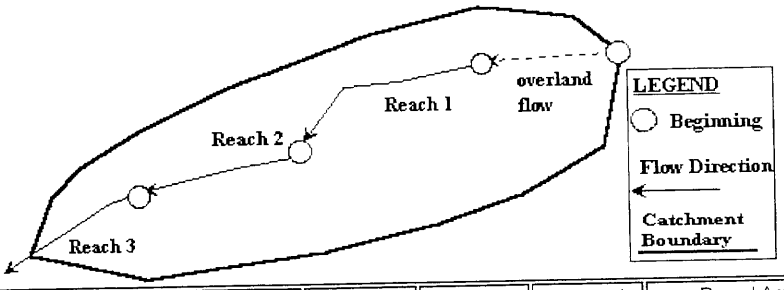
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.96
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.90
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft	C-5		fps	minutes
	input	input	output	input	output	output
Overland	0.0200	25	0.90		0.28	1.47
1	0.0100	500		20.00	2.00	4.17
2	0.0428	900		20.00	4.14	3.63
3						
4						
5						
Sum		1,425				

Computed Tc = 9.26
Regional Tc = 17.92

IV.

Peak Runoff Prediction using Computed Tc
Rainfall Intensity at Tc, I = 7.16 inch/hr
Peak Flowrate, Qp = 11.63 cfs

ediction using Regional Tc
Rainfall Intensity at Tc, I = 5.35 inch/hr
Peak Flowrate, Qp = 8.69 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: CCD - Bayaud Basin - System Alternatives 3 - Sub-Basin 2

I. Catchment Hydrologic Data

Catchment ID = SB-2 (SA 3)
Area = 25.40 Acres
Percent Imperviousness = 85.00 %
NRCS Soil Type = B A, B, C, or D

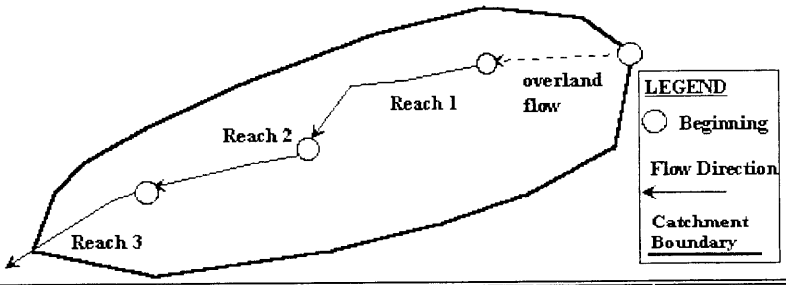
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.75
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.66
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0133	300	0.66		0.40	12.62
1	0.0075	600		20.00	1.73	5.77
2	0.0050	600		20.00	1.41	7.07
3	0.0033	600		20.00	1.15	8.66
4						
5						
Sum		2,100				

Computed Tc = 34.12
Regional Tc = 21.67

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 3.73 inch/hr	Rainfall Intensity at Tc, I = 4.85 inch/hr
Peak Flowrate, Qp = 71.20 cfs	Peak Flowrate, Qp = 92.41 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: CCD - Bayaud Basin - System Alternative 3 - Sub-Basin 3

I. Catchment Hydrologic Data

Catchment ID = SB-3 (SA 3)
Area = 2.30 Acres
Percent Imperviousness = 40.00 %
NRCS Soil Type = B A, B, C, or D

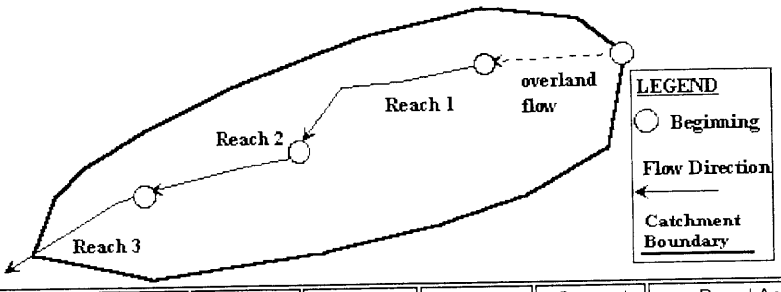
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.50
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.30
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft	C-5		fps	minutes
	input	input	output	input	output	output
Overland	0.0056	100	0.30		0.09	17.55
1	0.0056	800		20.00	1.50	8.91
2						
3						
4						
5						
Sum		900				

Computed Tc = 26.46
Regional Tc = 15.00

IV.

Peak Runoff Prediction using Computed Tc
Rainfall Intensity at Tc, I = 4.34 inch/hr
Peak Flowrate, Qp = 4.94 cfs

ediction using Regional Tc
Rainfall Intensity at Tc, I = 5.83 inch/hr
Peak Flowrate, Qp = 6.64 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: CCD - Bayaud Basin - System Alternative 3 - Sub-Basin 4

I. Catchment Hydrologic Data

Catchment ID = SB-4 (SA 3)
Area = 2.60 Acres
Percent Imperviousness = 90.00 %
NRCS Soil Type = B A, B, C, or D

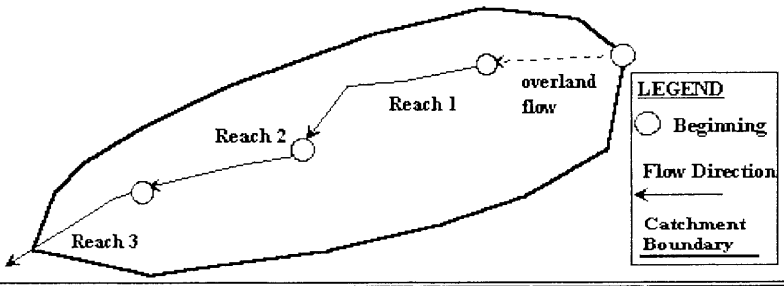
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.81
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.73
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0091	50	0.73		0.17	4.92
1	0.0091	500		20.00	1.91	4.37
2						
3						
4						
5						
Sum		550				

Computed Tc = 9.28
Regional Tc = 13.06

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 7.16 inch/hr	Rainfall Intensity at Tc, I = 6.22 inch/hr
Peak Flowrate, Qp = 15.06 cfs	Peak Flowrate, Qp = 13.09 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: CCD - Bayaud Basin - System Alternative 3 - Sub-Basin 6

I. Catchment Hydrologic Data

Catchment ID = SB-6 (SA 3)
Area = 8.50 Acres
Percent Imperviousness = 73.00 %
NRCS Soil Type = B A, B, C, or D

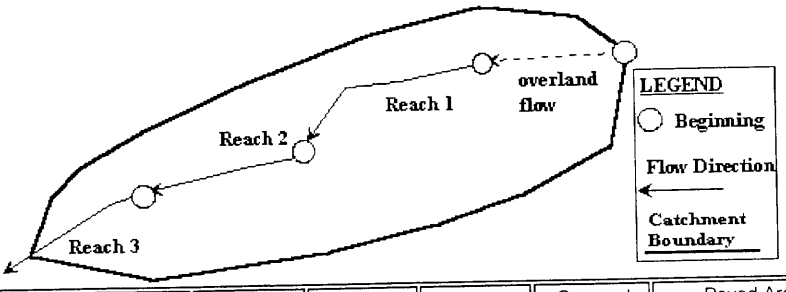
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.64
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.52
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft	C-5		fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.52		0.14	5.89
1	0.0021	1,400		20.00	0.93	25.20
2						
3						
4						
5						
Sum		1,450				

Computed Tc = 31.10
Regional Tc = 18.06

IV.

Peak Runoff Prediction using Computed Tc
Rainfall Intensity at Tc, I = 3.95 inch/hr
Peak Flowrate, Qp = 21.53 cfs

ediction using Regional Tc
Rainfall Intensity at Tc, I = 5.33 inch/hr
Peak Flowrate, Qp = 29.07 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: CCD - Bayaud/Alameda Basin - Sys Alt 3 - Santa Fe Sump Sub-Basin

I. Catchment Hydrologic Data

Catchment ID = SA-3 - SF Sump
Area = 7.00 Acres
Percent Imperviousness = 100.00 %
NRCS Soil Type = B A, B, C, or D

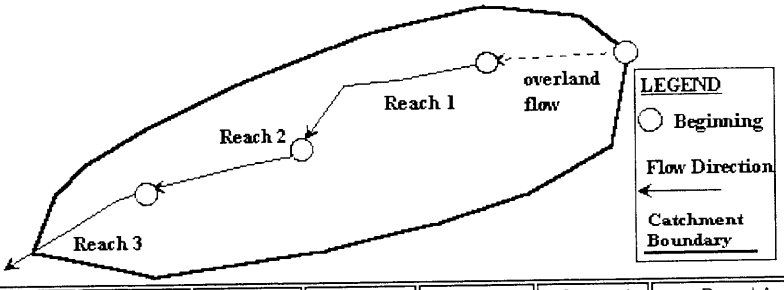
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.96
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.90
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.90		0.40	2.08
1	0.0111	1,800		20.00	2.11	14.23
2						
3						
4						
5						
Sum		1,850				

Computed Tc = 16.31
Regional Tc = 20.28

IV.

Peak Runoff Prediction using Computed Tc
Rainfall Intensity at Tc, I = 5.61 inch/hr
Peak Flowrate, Qp = 37.49 cfs

ediction using Regional Tc
Rainfall Intensity at Tc, I = 5.02 inch/hr
Peak Flowrate, Qp = 33.57 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: I-25 - Alameda Avenue Basin

I. Catchment Hydrologic Data

Catchment ID = I-25 - Alameda
Area = 25.00 Acres
Percent Imperviousness = 70.00 %
NRCS Soil Type = B A, B, C, or D

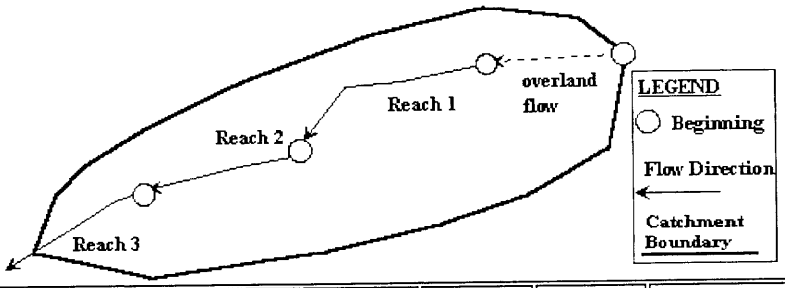
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.62
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.49
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.49		0.13	6.18
1	0.0350	2,000		20.00	3.74	8.91
2						
3						
4						
5						
Sum		2,050				

Computed Tc = 15.09
Regional Tc = 21.39

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 5.82 inch/hr	Rainfall Intensity at Tc, I = 4.88 inch/hr
Peak Flowrate, Qp = 90.27 cfs	Peak Flowrate, Qp = 75.69 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: I-25 - Alameda Avenue Sub-Basin 21

I. Catchment Hydrologic Data

Catchment ID = I-25 - Alameda - SB 21
Area = 5.30 Acres
Percent Imperviousness = 70.00 %
NRCS Soil Type = B A, B, C, or D

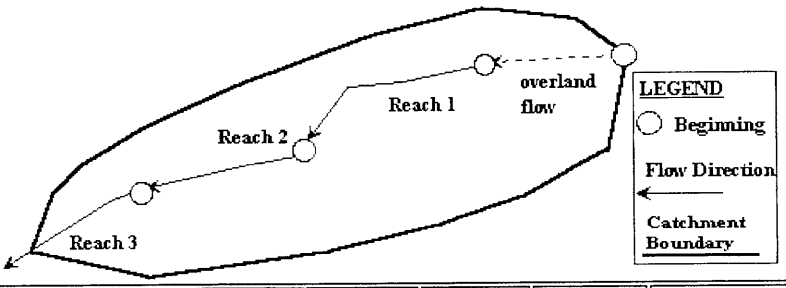
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.62
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.49
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	88	0.49		0.18	8.20
1	0.0139	718		20.00	2.36	5.07
2						
3						
4						
5						
Sum		806				

Computed Tc = 13.27
Regional Tc = 14.48

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 6.17 inch/hr	Rainfall Intensity at Tc, I = 5.93 inch/hr
Peak Flowrate, Qp = 20.30 cfs	Peak Flowrate, Qp = 19.51 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: I-25 - Alameda Avenue Sub-Basin 22

I. Catchment Hydrologic Data

Catchment ID = I-25 - Alameda - SB 22
Area = 9.60 Acres
Percent Imperviousness = 70.00 %
NRCS Soil Type = B A, B, C, or D

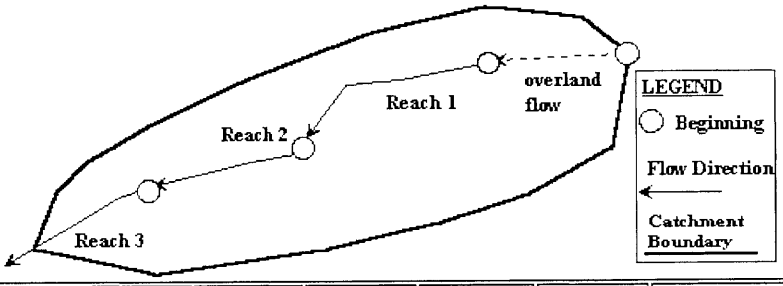
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.62
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.49
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft	C-5		fps	minutes
	input	input	output	input	output	output
Overland	0.0200	88	0.49		0.18	8.20
1	0.0350	700		20.00	3.74	3.12
2						
3						
4						
5						
Sum		788				

Computed Tc = 11.32
Regional Tc = 14.38

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 6.61 inch/hr	Rainfall Intensity at Tc, I = 5.95 inch/hr
Peak Flowrate, Qp = 39.40 cfs	Peak Flowrate, Qp = 35.46 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: I-25 - Alameda Avenue Sub-Basin 23

I. Catchment Hydrologic Data

Catchment ID = I-25 - Alameda - SB 23
Area = 9.60 Acres
Percent Imperviousness = 70.00 %
NRCS Soil Type = B A, B, C, or D

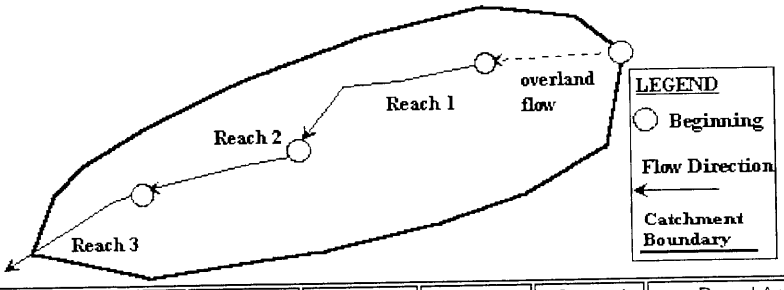
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.62
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.49
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft	C-5		fps	minutes
	input	input	output	input	output	output
Overland	0.0200	88	0.49		0.18	8.20
1	0.0350	1,350		20.00	3.74	6.01
2						
3						
4						
5						
Sum		1,438				

Computed Tc = 14.21
Regional Tc = 17.99

IV.

Peak Runoff Prediction using Computed Tc
Rainfall Intensity at Tc, I = 5.98 inch/hr
Peak Flowrate, Qp = 35.65 cfs

ediction using Regional Tc
Rainfall Intensity at Tc, I = 5.34 inch/hr
Peak Flowrate, Qp = 31.81 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: SH 85 - System Alternative 1

I. Catchment Hydrologic Data

Catchment ID = SH 85
Area = 9.60 Acres
Percent Imperviousness = 87.00 %
NRCS Soil Type = B A, B, C, or D

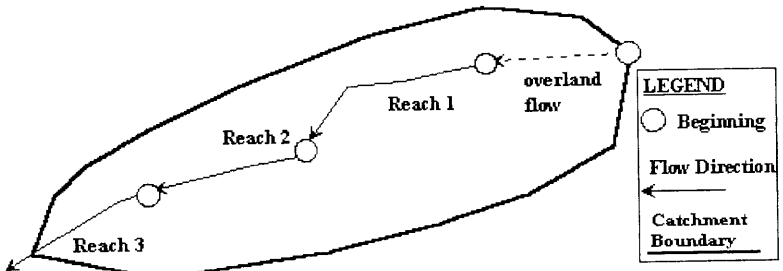
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.77
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.68
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft	C-5		fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.68		0.20	4.23
1	0.0057	1,750		20.00	1.51	19.29
2						
3						
4						
5						
Sum		1,800				

Computed Tc = 23.52
Regional Tc = 20.00

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 4.63 inch/hr	Rainfall Intensity at Tc, I = 5.06 inch/hr
Peak Flowrate, Qp = 34.40 cfs	Peak Flowrate, Qp = 37.54 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: SH 85 - System Alternative 2

I. Catchment Hydrologic Data

Catchment ID = SH 85
Area = 9.60 Acres
Percent Imperviousness = 93.00 %
NRCS Soil Type = B A, B, C, or D

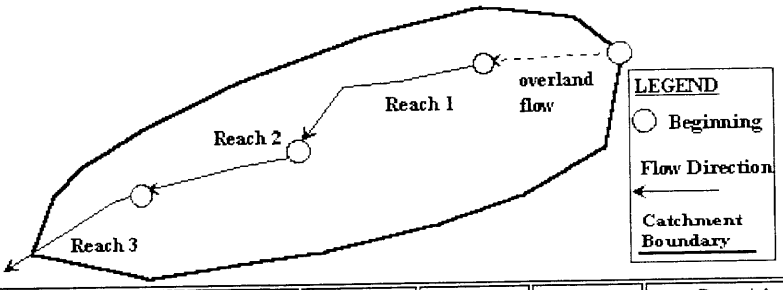
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.85
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.77
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.77		0.25	3.32
1	0.0049	2,050		20.00	1.40	24.46
2						
3						
4						
5						
Sum		2,100				

Computed Tc = 27.78
Regional Tc = 21.67

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 4.22 inch/hr	Rainfall Intensity at Tc, I = 4.85 inch/hr
Peak Flowrate, Qp = 34.39 cfs	Peak Flowrate, Qp = 39.51 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: SH 85 - System Alternative 3

I. Catchment Hydrologic Data

Catchment ID = SH 85
Area = 11.00 Acres
Percent Imperviousness = 89.00 %
NRCS Soil Type = B A, B, C, or D

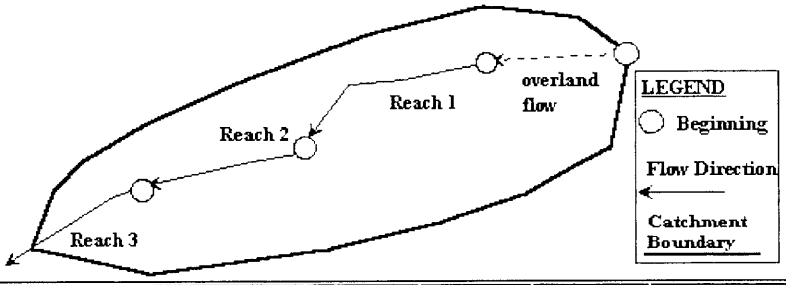
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.80
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.71
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.71		0.21	3.94
1	0.0049	2,050		20.00	1.40	24.46
2						
3						
4						
5						
Sum		2,100				

Computed Tc = 28.40
Regional Tc = 21.67

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 4.16 inch/hr	Rainfall Intensity at Tc, I = 4.85 inch/hr
Peak Flowrate, Qp = 36.52 cfs	Peak Flowrate, Qp = 42.49 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: I-25 - Broadway Basin

I. Catchment Hydrologic Data

Catchment ID = I-25 - Broadway
Area = 20.00 Acres
Percent Imperviousness = 81.00 %
NRCS Soil Type = B A, B, C, or D

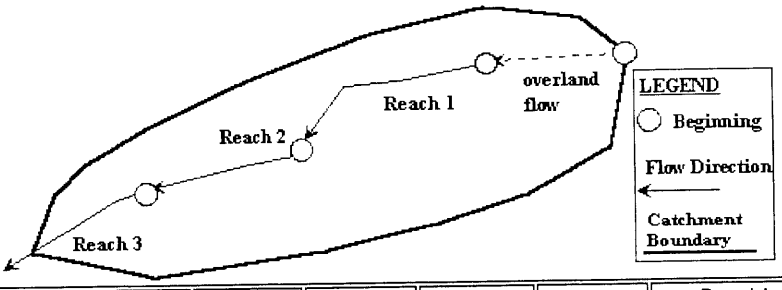
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.71
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.61
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	96	0.61		0.23	6.95
1	0.0300	2,900		20.00	3.46	13.95
2						
3						
4						
5						
Sum		2,996				

Computed Tc = 20.90
Regional Tc = 26.64

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 4.94 inch/hr	Rainfall Intensity at Tc, I = 4.32 inch/hr
Peak Flowrate, Qp = 70.11 cfs	Peak Flowrate, Qp = 61.32 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: I-25 - Broadway Sub-Basin 31

I. Catchment Hydrologic Data

Catchment ID = I-25 - Broadway SB-31
Area = 5.90 Acres
Percent Imperviousness = 100.00 %
NRCS Soil Type = B A, B, C, or D

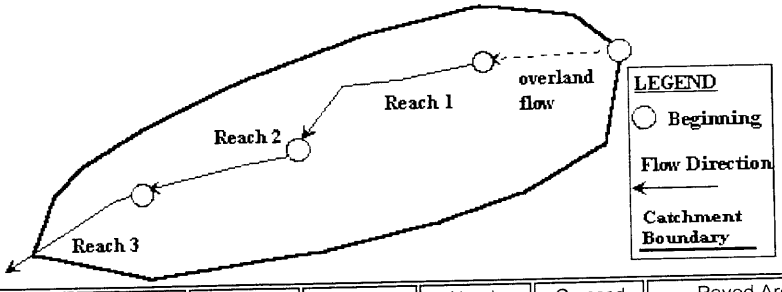
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100 years	(input return period for design storm)
C1 =	28.50	(input the value of C1)
C2=	10.00	(input the value of C2)
C3=	0.786	(input the value of C3)
P1=	2.57 inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.96
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.90
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	96	0.90		0.56	2.88
1	0.0300	1,100		20.00	3.46	5.29
2						
3						
4						
5						
Sum		1,196				

Computed Tc = 8.17
Regional Tc = 16.64

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 7.50 inch/hr	Rainfall Intensity at Tc, I = 5.55 inch/hr
Peak Flowrate, Qp = 42.27 cfs	Peak Flowrate, Qp = 31.28 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: I-25 - Broadway Sub-Basin 32

I. Catchment Hydrologic Data

Catchment ID = I-25 - Broadway SB-32
Area = 9.30 Acres
Percent Imperviousness = 100.00 %
NRCS Soil Type = B A, B, C, or D

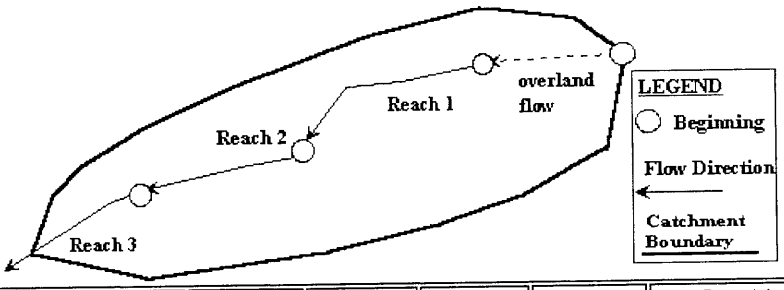
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.96
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.90
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	96	0.90		0.56	2.88
1	0.0300	1,800		20.00	3.46	8.66
2						
3						
4						
5						
Sum		1,896				

Computed Tc = 11.54
Regional Tc = 20.53

IV.

Peak Runoff Prediction using Computed Tc
Rainfall Intensity at Tc, I = 6.56 inch/hr
Peak Flowrate, Qp = 58.29 cfs

ediction using Regional Tc
Rainfall Intensity at Tc, I = 4.99 inch/hr
Peak Flowrate, Qp = 44.31 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: I-25 - Broadway Sub-Basin 33

I. Catchment Hydrologic Data

Catchment ID = I-25 - Broadway SB-33
Area = 5.40 Acres
Percent Imperviousness = 30.00 %
NRCS Soil Type = B A, B, C, or D

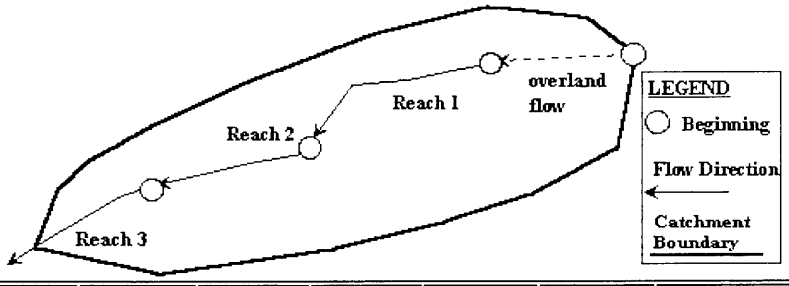
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.47
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.25
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.25		0.10	8.65
1	0.0300	400		20.00	3.46	1.92
2	0.3300	150		20.00	11.49	0.22
3						
4						
5						
Sum		600				

Computed Tc = 10.79
Regional Tc = 13.33

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 6.74 inch/hr	Rainfall Intensity at Tc, I = 6.16 inch/hr
Peak Flowrate, Qp = 17.10 cfs	Peak Flowrate, Qp = 15.61 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Valley Highway EIS
Catchment ID: I-25 - Broadway Tunnel Basin

I. Catchment Hydrologic Data

Catchment ID = I-25 Broadway Tunnel
Area = 1.30 Acres
Percent Imperviousness = 100.00 %
NRCS Soil Type = B A, B, C, or D

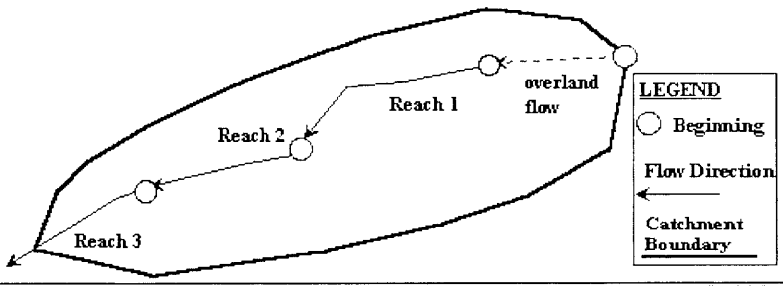
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.96
Overide Runoff Coefficient, C = _____ (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.90
Overide 5-yr. Runoff Coefficient, C = _____ (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S	Length L	5-yr Runoff Coeff C-5	NRCS Convey-ance	Flow Velocity V	Flow Time Tf
	ft/ft	ft			fps	minutes
	input	input	output	input	output	output
Overland	0.0200	50	0.90		0.40	2.08
1	0.0400	300		20.00	4.00	1.25
2	0.0200	200		20.00	2.83	1.18
3	0.0040	1,300		20.00	1.26	17.13
4						
5						
Sum		1,850				

Computed Tc = 21.63
Regional Tc = 20.28

IV.

Peak Runoff Prediction using Computed Tc	ediction using Regional Tc
Rainfall Intensity at Tc, I = 4.85 inch/hr	Rainfall Intensity at Tc, I = 5.02 inch/hr
Peak Flowrate, Qp = 6.02 cfs	Peak Flowrate, Qp = 6.23 cfs

Inlet Spacing Spreadsheet

Valley Highway EIS

Gutter Flow Rates and Approximate Inlet Spacing

9/24/2003

Design Frequency =	Minor	
Inlet Type	C	
Allowable Spread =	**12 ft**	(Shoulder Width)
Cross Slope, S_x	0.02 (ft/ft)	
Grate Width =	2 ft	
Grate Length =	3 ft	

		One Vane Grate			Two Vane Grates			Three Vane Grates			Four Vane Grates			Five Vane Grates		
Long. Slope, S_L (ft/ft)	Allowable Flow, $Q_{(allow)}$ (cfs)	Qin (cfs)	Qb (cfs)	Capture %	Qin (cfs)	Qb (cfs)	Capture %	Qin (cfs)	Qb (cfs)	Capture %	Qin (cfs)	Qb (cfs)	Capture %	Qin (cfs)	Qb (cfs)	Capture %
0.001	1.52	0.80	0.72	52.80	1.30	0.22	85.80	1.40	0.12	92.40	1.50	0.02	99.00	1.50	0.02	99.00
0.002	2.14	1.20	0.94	56.00	1.60	0.54	74.67	1.90	0.24	88.67	2.00	0.14	93.34	2.10	0.04	98.01
0.003	2.62	1.20	1.42	45.73	1.80	0.82	68.59	2.20	0.42	83.83	2.40	0.22	91.45	2.50	0.12	95.27
0.004	3.03	1.70	1.33	56.10	1.80	1.23	59.40	2.10	0.93	69.30	2.40	0.63	79.20	2.60	0.43	85.80
0.005	3.39	1.40	1.99	41.32	2.10	1.29	61.99	2.70	0.69	79.70	3.00	0.39	88.55	3.20	0.19	94.45
0.006	3.71	1.60	2.11	43.11	2.20	1.51	59.28	2.90	0.81	78.14	3.30	0.41	88.92	3.40	0.31	91.61
0.008	4.29	1.80	2.49	42.00	2.40	1.89	56.00	3.20	1.09	74.67	3.60	0.69	84.01	3.90	0.39	91.01
0.010	4.79	2.00	2.79	41.74	2.60	2.19	54.27	3.40	1.39	70.96	4.00	0.79	83.49	4.30	0.49	89.75
0.015	5.87	2.40	3.47	40.90	2.90	2.97	49.42	3.80	2.07	64.76	4.60	1.27	78.39	5.00	0.87	85.21
0.020	6.78	2.70	4.08	39.85	3.20	3.58	47.23	4.10	2.68	60.51	5.00	1.78	73.79	5.60	1.18	82.65
0.025	7.58	3.00	4.58	39.60	3.50	4.08	46.20	4.40	3.18	58.08	5.40	2.18	71.28	6.10	1.48	80.52
0.030	8.30	3.10	5.20	37.36	3.70	4.60	44.59	4.70	3.60	56.64	5.70	2.60	68.69	6.50	1.80	78.33
0.035	8.96	3.20	5.76	35.70	4.00	4.96	44.63	4.90	4.06	54.67	5.90	3.06	65.82	6.80	2.16	75.86
0.040	9.58	3.20	6.38	33.39	4.20	5.38	43.83	5.10	4.48	53.22	6.20	3.38	64.70	7.10	2.48	74.09
0.045	10.16	3.30	6.86	32.47	4.40	5.76	43.29	5.30	4.86	52.15	6.40	3.76	62.97	7.30	2.86	71.82
0.050	10.71	3.30	7.41	30.80	4.60	6.11	42.94	5.50	5.21	51.34	6.60	4.11	61.60	7.60	3.11	70.94
0.055	11.24	3.30	7.94	29.37	4.80	6.44	42.72	5.60	5.64	49.84	6.80	4.44	60.52	7.80	3.44	69.42
0.060	11.74	3.40	8.34	28.97	4.90	6.84	41.75	5.80	5.94	49.42	6.90	4.84	58.79	8.00	3.74	68.17

Design Frequency =	Major	
Inlet Type	C	
Allowable Spread =	**16 ft**	(Shoulder Width+4 feet)
Cross Slope, S_x	0.02 (ft/ft)	
Grate Width =	2 ft	
Grate Length =	3 ft	

		One Vane Grate			Two Vane Grates			Three Vane Grates			Four Vane Grates			Five Vane Grates		
Long. Slope, S_L (ft/ft)	Flow Rate, $Q_{(allow)}$ (cfs)	Qin (cfs)	Qb (cfs)	Capture %	Qin (cfs)	Qb (cfs)	Capture %	Qin (cfs)	Qb (cfs)	Capture %	Qin (cfs)	Qb (cfs)	Capture %	Qin (cfs)	Qb (cfs)	Capture %
0.001	3.26	1.4	1.86	42.91	2.40	0.86	73.55	2.90	0.36	88.88	3.20	0.06	98.07	3.20	0.06	98.07
0.002	4.61	1.70	2.91	36.84	3.00	1.61	65.01	3.90	0.71	84.52	4.20	0.41	91.02	4.40	0.21	95.35
0.003	5.65	2.00	3.65	35.39	3.30	2.35	58.39	4.40	1.25	77.85	5.00	0.65	88.47	5.30	0.35	93.78
0.004	6.53	2.70	3.83	41.37	3.20	3.33	49.03	3.80	2.73	58.23	4.50	2.03	68.96	5.10	1.43	78.15
0.005	7.30	2.40	4.90	32.89	3.70	3.60	50.71	5.20	2.10	71.27	6.10	1.20	83.60	6.60	0.70	90.46
0.006	7.99	2.60	5.39	32.53	3.90	4.09	48.79	5.50	2.49	68.81	6.50	1.49	81.32	7.10	0.89	88.83
0.008	9.23	3.00	6.23	32.51	4.20	5.03	45.51	5.90	3.33	63.93	7.20	2.03	78.01	8.00	1.23	86.68
0.010	10.32	3.30	7.02	31.98	4.40	5.92	42.64	6.20	4.12	60.09	7.70	2.62	74.62	8.70	1.62	84.31
0.015	12.64	4.00	8.64	31.65	5.00	7.64	39.56	6.90	5.74	54.60	8.70	3.94	68.84	10.00	2.64	79.13
0.020	14.59	4.30	10.29	29.47	5.50	9.09	37.69	7.40	7.19	50.71	9.40	5.19	64.42	10.90	3.69	74.70
0.025	16.31	4.50	11.81	27.58	5.90	10.41	36.16	7.80	8.51	47.81	9.90	6.41	60.68	11.70	4.61	71.71
0.030	17.87	4.60	13.27	25.74	6.30	11.57	35.25	8.10	9.77	45.32	10.30	7.57	57.63	12.30	5.57	68.82
0.035	19.30	4.60	14.70	23.83	6.70	12.60	34.71	8.50	10.80	44.03	10.70	8.60	55.43	12.80	6.50	66.31
0.040	20.64	4.70	15.94	22.77	7.00	13.64	33.92	8.80	11.84	42.64	11.10	9.54	53.79	13.30	7.34	64.45
0.045	21.89	4.60	17.29	21.02	7.10	14.79	32.44	9.10	12.79	41.57	11.40	10.49	52.08	13.70	8.19	62.59
0.050	23.07	4.60	18.47	19.94	7.10	15.97	30.77	9.40	13.67	40.74	11.70	11.37	50.71	14.00	9.07	60.68
0.055	24.20	4.50	19.70	18.60	7.10	17.10	29.34	9.70	14.50	40.08	11.90	12.30	49.18	14.40	9.80	59.51
0.060	25.27	4.50	20.77	17.80	7.10	18.17	28.09	10.00	15.27	39.56	13.30	11.97	52.62	14.90	10.37	58.95

APPENDIX D DENVER STORM DRAINAGE MASTER PLAN

City and County of Denver Storm Drainage Master Plan – Phase I Final (selected sheets)

CITY & COUNTY OF DENVER
STORM DRAINAGE MASTER PLAN

PHASE I FINAL

December 2, 2003

Basin 0063-01 (Central Platte Valley)

Existing System Description:
This basin consists of a majority of the Central Platte Valley area of downtown Denver. This basin consists of 1,342 acres (2.10 square miles) and includes older neighborhood residential in the upper reaches east of the railroad tracks and Sante Fe, and commercial in the lower reaches. All drainage from this basin will outfall into the South Platte River. Intercepted stormwater is discharged via at least 32 storm drainage outfalls, which are comprised mainly of local storm drains from I-25 and adjacent properties. Some of the existing larger outfalls include:

- Bayaud Avenue outfall is 36-inch (54-inch upstream) with 351 tributary acres
- 3rd Avenue outfall is 54-inch with 104 tributary acres
- 6th Avenue outfall is 72-inch with 273 tributary acres
- 13th Avenue outfall is 42-inch with 119 tributary acres
- Colfax Avenue outfall is 36-inch with 53 tributary acres
- Elitch outfall is 48-inch with 44 tributary acres

The storm drain infrastructure consists of a random network of drains and laterals. Drainage from the basin is constrained by the elevation of the South Platte River and I-25, which generally reduces capacity and creates sump or surcharge conditions during major storm events. The reach adjacent to the South Platte River between 6th Avenue and Cherry Creek is in the 100-year floodplain, but Phase II South Platte channel improvements may remove these properties from riverine flooding.

Drainage Deficiencies:
The existing drainage systems have capacities varying from a 1-year storm event to a 5-year storm event. Rainfall runoff in excess of the storm drain capacity has a history of ponding within the commercial and industrial areas against the railroad and I-25. Drainage problems have been experienced at Bayaud and Galapago where the railroad creates a sump and localized ponding (see "Potential Ponding" delineation). Flooding has occurred within Broadway, exacerbated by the roadway cross-section, which has steep side slopes and reduced conveyance capacity due to construction over an old trolley bed.

The basin delineation is based upon the storm drain network. The only split flow situation in this basin where the pipe flow contravenes the site topography is at the Elitches site. Runoff in excess of the 16'x4' box culvert capacity at the Pepsi Center will flow from the Auraria Campus and the Pepsi Center area northwest into Six Flags Elitch Gardens.

Proposed Capital Improvements:
Difficulties in constructing additional or replacement storm drains are the crossing of the railroad and I-25. ***Blueprint Denver*** shows the majority of the basin (commercial areas) subject to change. Only the residential neighborhood east of the railroad tracks between Alameda and 8th Avenue is shown as an "Areas of Stability", a relatively small area of the overall basin.

Project A: West 13th Avenue Outfall includes replacing the existing 42-inch outfall with a new 66-inch pipe to provide a 5-year level of service. The enlargement of the existing system is carried up the storm drains along 13th Avenue. The 13th Avenue outfall is shown with a lateral extension of a 54-inch storm drain further into the sub-basin for connection by future redevelopment.

Project B: West 7th Avenue Outfall The relatively new 72-inch storm drain in 6th Avenue must be upsized to an 90-inch pipe to provide a minimum 5-year level of service. An existing constriction occurs where a 60-inch pipe with 0.61% slope connects downstream to a 42-inch and 48-inch pipe at 0.61%. This intermediate reach of pipe between Quivas and Tejon should be replaced with a larger pipe (78-inch for 5-year capacity).

Project C: West Bayaud Avenue The existing system has less than a 1-year event capacity (Design Point 1516 with 351 tributary acres). The Bayaud Avenue outfall consisting of a 54-inch pipe is proposed for replacement with an 84-inch pipe for a 5-year system. (Alternatively, a 100-year system to serve the sump at Galapago & Bayaud would require a 120-inch pipe outfall.) At Galapago, the proposed pipe jogs over to Ellsworth Avenue to preserve the existing trunk system upstream. Since flooding is known to occur in Broadway, the proposed storm system extends to Lincoln to provide additional storm conveyance in this area.

Project D: West Ellsworth Avenue A short 24-inch storm drain outfall in Ellsworth under I-25 should be replaced with a 54-inch pipe to provide 5-year capacity.

Project E: West Mulberry Place A new 48"x72" box culvert outfall is proposed in Mulberry Place. This 60 acre area is currently served by 15 and 18-inch outfalls. Redevelopment of the area will prompt the construction of a new outfall.

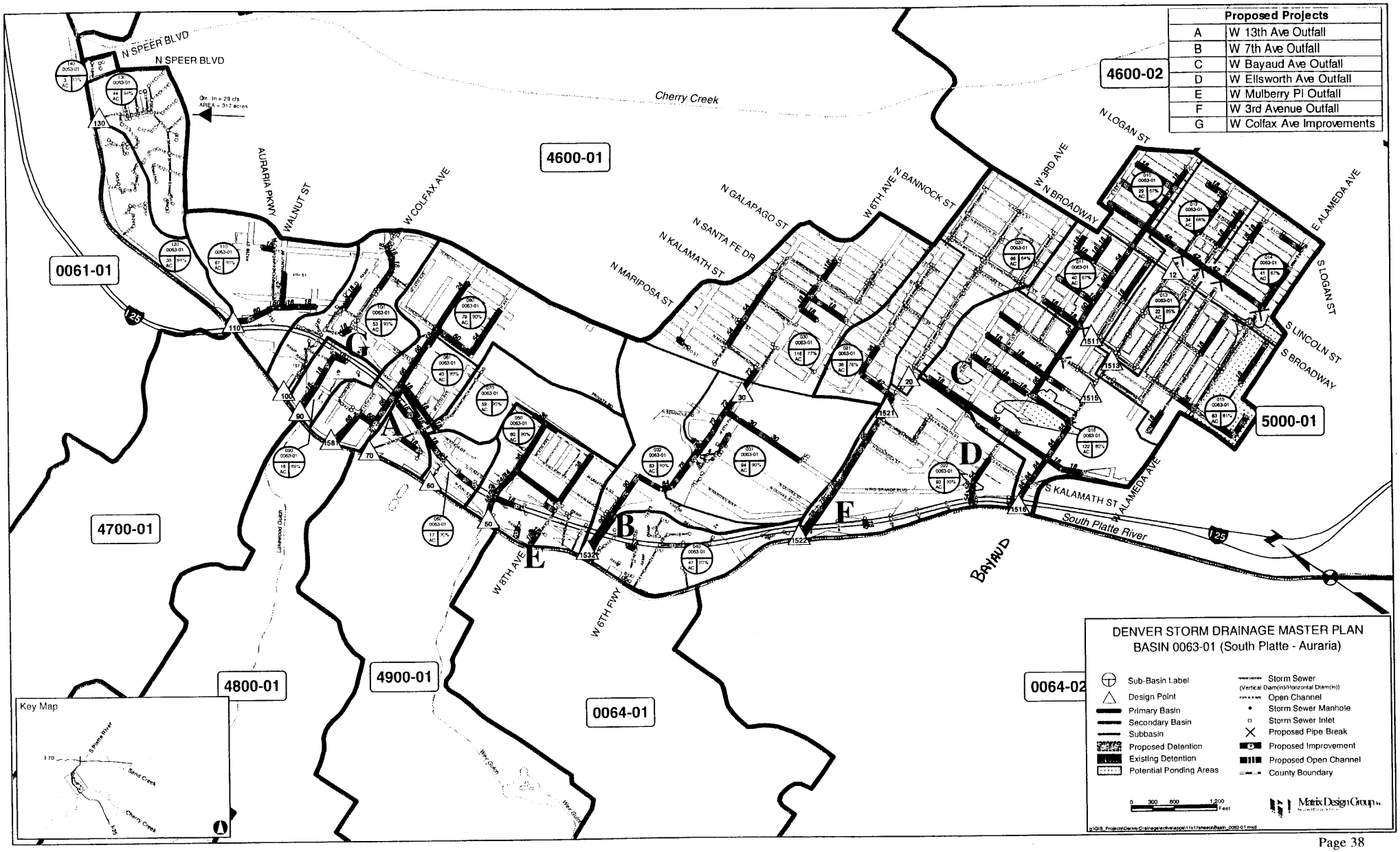
Project F: West 3rd Avenue Outfall A new 78-inch outfall will replace the existing 60-inch outfall in 3rd Avenue to achieve a 5-year level of service.

Project G: West Colfax Avenue Improvements 18-inch upgrades and replacement of an existing 36-inch pipe with a new 60-inch pipe is proposed in this general area.

Hydrology:
BASIN 0063-01

Design Point	Design Point	Contributing Basins	Tributary Area	Peak Discharge*		
Minor Event Model	Overland Flow Model	Minor Event Model	Minor Event Model (acres)	2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
12		12	34	38	62	148
20		20	66	47	78	192
30		30	116	160	246	546
50		50	60	98	142	292
60		60	17	27	39	81
70		70	59	75	109	229
90		90	16	24	35	74
100		100	53	70	102	214
110		110	67	106	154	317
130	1070	130	44	74	106	**176**
1511		10,11	69	66	106	263
1513		10-13	125	115	190	477
1515		10-15	229	207	333	820
1516		10-16	351	276	431	1111
1521		20,21	104	89	143	338
1522		20-22	197	192	276	581
1532		30-32	273	299	391	922
1581		80,81	119	122	179	411

* 100-year discharge in **bold** represents analysis based on "overland" drainage paths determined from topography. Other events (2-year, 5-year, and remaining 100-year) are analyzed based on existing pipe network flow paths.


Proposed Projects
A W 13th Ave Outfall
B W 7th Ave Outfall
C W Bayaud Ave Outfall
D W Ellsworth Ave Outfall
E W Mulberry Pl Outfall
F W 3rd Avenue Outfall
G W Colfax Ave Improvements
DENVER STORM DRAINAGE MASTER PLAN
BASIN 0063-01 (South Platte - Auraria)
Sub-Basin Label
Design Point
Primary Basin
Secondary Basin
Subbasin
Proposed Detention
Existing Detention
Potential Ponding Areas
Storm Sewer
(Vertical Diam(in)/Horizontal Diam(in))
Open Channel
Storm Sewer Manhole
Storm Sewer Inlet
Proposed Pipe Break
Proposed Improvement
Proposed Open Channel
County Boundary
0 300 600 1,200 Feet
Matrix Design Group
Key Map
Cherry Creek
South Platte River
Sand Creek
4600-01
4600-02
0061-01
4700-01
4800-01
4900-01
0064-01
0064-02
5000-01
N SPEER BLVD
AURARIA PKWY
WALNUT ST
W COLFAX AVE
N GALAPAGO ST
N SANTA FE DR
N KALAMATH ST
N MARIPOSA ST
W 6TH AVE
N BANNOCK ST
W 3RD AVE
N BROADWAY
N LOGAN ST
E ALAMEDA AVE
S LOGAN ST
S LINCOLN ST
S BROADWAY
S KALAMATH ST
BALAMEDA AVE
W 8TH AVE
W 6TH FWY
BAYAUD
A
B
C
D
E
F
G

Basin 0064-01 (1st & Federal)

Existing System Description:
This basin is tributary to Weir Gulch and the South Platte River by topography and pipe network. In general, this basin is located south of Weir Gulch. This basin consists of 610 acres (0.95 square miles) and includes residential in the upper reaches, and industrial/commercial in the lower reaches. Much of the industrial land is within the current South Platte River floodplain.

Intercepted stormwater is discharged in 8 storm drainage outfalls, which is comprised of two to Weir Gulch and 6 directly to the South Platte River. The outfalls include:

Weir Gulch
- Irving Street outfall is 38"x60" with 208 tributary acres
- Grove Street outfall is 42-inch with 78 tributary acres

South Platte River
- Yuma Street outfall is 24-inch for local drainage
- 5th Avenue outfall is 42-inch with 177 tributary acres
- 6th Avenue 42-inch outfall for 72 tributary acres
- 6th Avenue 15-inch outfall for local drainage
- 7th Avenue 36-inch outfall
- 8th Avenue 24-inch outfall

The storm drain infrastructure consists of a random network of drains and laterals in the low reaches and collectors in the residential reaches. The condition of the existing inlets is unknown at this time.

Blueprint Denver shows the Federal Boulevard subject to change along with some of the commercial/industrial area adjacent to the South Platte River. The residential neighborhoods are shown as "Areas of Stability" in ***Blueprint Denver***.

Drainage Deficiencies:
Significant portions of Basin 0064-01 are within the South Platte River regulatory floodplain, including sub-basins 10, 20, and 32.

The areas in the South Platte River floodplain have capacity for the 2-year storm event, although this area should have a 5-year level of service by land use criteria.

Proposed Capital Improvements:
Proposed South Platte River channel improvements will remove much of the development in this basin from the regulatory floodplain. The lower reaches of Weir Gulch have been improved to convey drainage from the 100-year event and even includes 500-year capacity culverts.

No major drainage complaints have been reported in these basins outside the regulatory floodplains due to the relatively steep gradient toward the receiving drainageways and lack of sumps or flat areas. This basin generally meets Denver drainage criteria. The roads and drainage pipe convey the 2-year storm event in residential areas and 5-year storm event in the commercial/industrial areas.

Most of the capital improvements proposed in the 1989 Master Plan have been constructed. This area has been improved by construction of diversion facilities to Weir Gulch implemented since the 1989 plan.

A difficulty in constructing additional or replacement storm drain outfalls is presence of the Metro Sanitary Sewer along the west bank of the South Platte River. Otherwise, railroad tracks and the interstate are located on the opposite bank of the South Platte, and there are relatively few obstructions for new storm pipe in this basin. Proposed projects include:

Project A: West Bayaud Avenue A 24-inch lateral in Bayaud previously identified in the 1989 Master Plan is shown again in this master plan for construction.

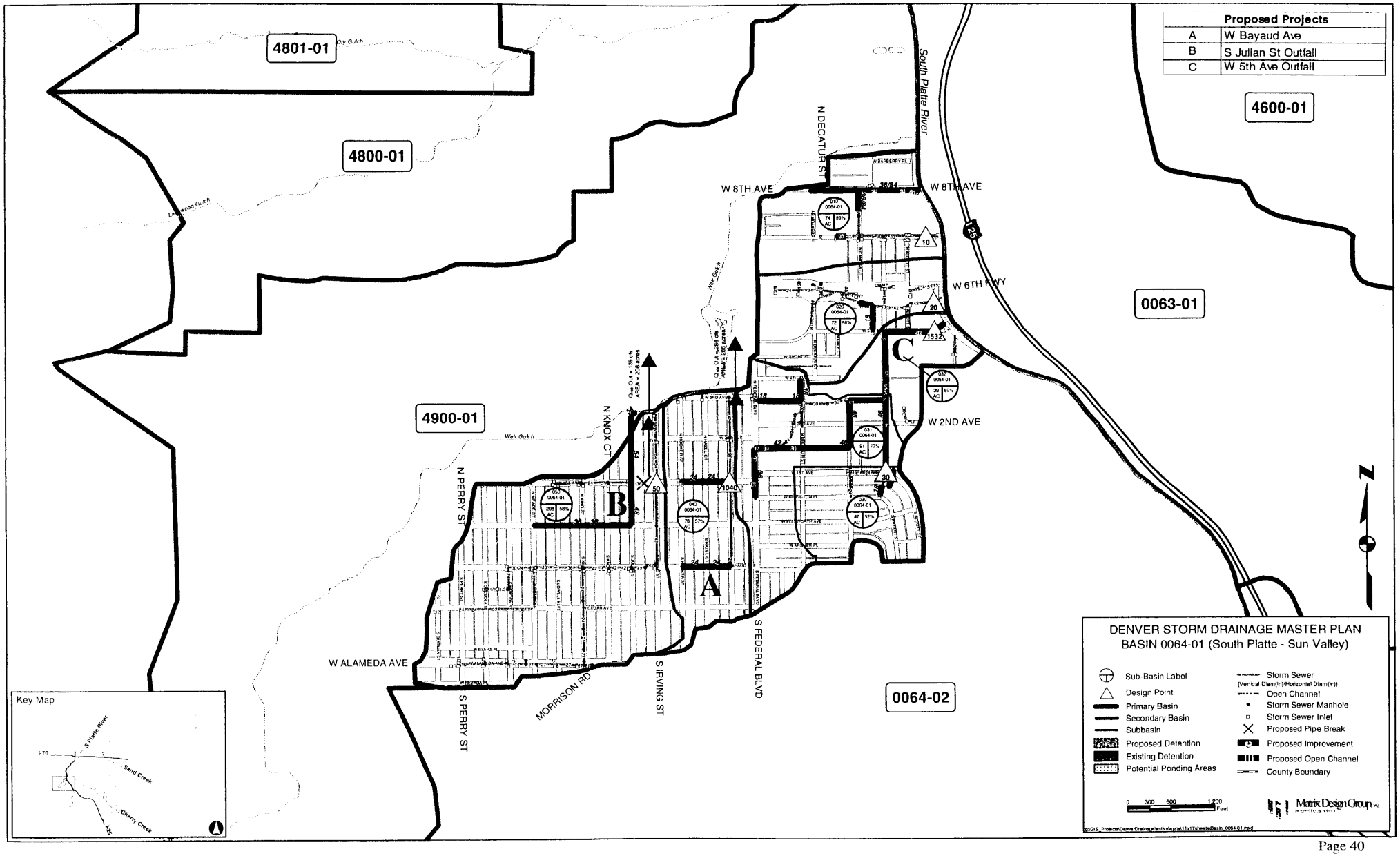
Project B: South Julian Street Outfall A new 54-inch outfall is proposed in Julian Street to meet current criteria. This proposed pipe will also remove some flow to a currently undersized outfall in Irving Street.

Project C: West 5th Avenue Outfall A new 72-inch outfall is proposed in 5th Avenue to better serve properties in the current South Platte River floodplain. A new 48-inch outfall is also proposed in 8th Avenue. All 12-inch and 15-inch collector storm drains do not meet current drainage criteria and have been proposed for replacement with 18-inch pipes.

Hydrology:

BASIN 0064-01

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge 2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10	10	74	102	149	311
20	20	72	69	112	265
30	30	47	41	75	195
50	50	208	209	361	915
1032	30,31,32,40,50	463	162	373	1403
1040	40,50	286	121	327	1048


Proposed Projects
A W Bayaud Ave
B S Julian St Outfall
C W 5th Ave Outfall
4801-01
4800-01
4600-01
0063-01
4900-01
0064-02
Dry Gulch
Lakewood Gulch
Weir Gulch
South Platte River
N DECATUR ST
W 8TH AVE
W 6TH FWY
W 2ND AVE
N KNOX CT
N PERRY ST
S PERRY ST
W ALAMEDA AVE
MORRISON RD
S IRVING ST
S FEDERAL BLVD
A
B
C
DENVER STORM DRAINAGE MASTER PLAN
BASIN 0064-01 (South Platte - Sun Valley)
Sub-Basin Label
Design Point
Primary Basin
Secondary Basin
Subbasin
Proposed Detention
Existing Detention
Potential Ponding Areas
Storm Sewer
(Vertical Diam(in)/Horizontal Diam(in))
Open Channel
Storm Sewer Manhole
Storm Sewer Inlet
Proposed Pipe Break
Proposed Improvement
Proposed Open Channel
County Boundary
0 300 600 1,200 Feet
Matrix Design Group
Key Map
S Platte River
I-70
Sand Creek
Cherry Creek

Basin 5000-01 (I-25 Basin)

Existing System Description:
This basin consists of 802.55 acres (1.25 square miles) and is fully built-out with older neighborhood residential in the upper reaches and commercial in the lower reaches. ***Blueprint Denver*** shows the commercial areas west of Broadway subject to change. The residential neighborhood is shown as an "Areas of Stability". All drainage from this basin outfalls to the South Platte River. Intercepted stormwater is discharged in at least 13 storm drainage outfalls, which are comprised of the following:

- 54-inch with 602 tributary acres, or 75% of basin 5000-01
- 36-inch for the I-25 & Sante Fe intersection
- 30-inch for the Sante Fe & Alameda intersection
- 30-inch for the Alameda & I-25 intersection
- 2-24-inch for local I-25 drainage
- 2-18-inch for local I-25 drainage
- 5-15-inch for local I-25 drainage

The storm drain infrastructure consists of a detailed network of laterals in most streets. A grid pattern of laterals is collected in Pennsylvania and Broadway streets. The inlets are old sandstone/granite catch basins with limited capacity due to design and numerous asphalt overlays throughout the years. As improvements and handicap ramps are installed in the neighborhood, these inlets are being replaced with current standard inlets. Many of these old inlets must be replaced to improve collection efficiency. Drainage from the I-25 basin is constrained by the elevation of the South Platte River and I-25, which generally reduces capacity and creates sump or surcharge conditions during major storm events.

Drainage Deficiencies:
The existing drainage system has capacity to convey an approximately 1-year storm event to the South Platte River. Rainfall runoff in excess of the storm drain capacity has a history of ponding in the sump and flat areas. Major drainage problems have been experienced in the sump on Alameda at the Sante Fe intersection. Ponding also occurs on the flat commercial areas by backing up water behind the railroad and I-25.

The basin delineation is based upon the storm drain network, which contravenes the site topography. Land east of the 5000-01 basin drains to Cherry Creek during minor storm events, and enters this basin in major events when the storm drain pipes are overwhelmed with runoff or plugged. In a major event, two additional areas drain into this basin: 384 acres from 4600-02, and 324 acres from 5000-02. This split flow contribution exacerbates the flooding experienced in the lower basin.

Proposed Capital Improvements:
The existing lakes at Washington Park could be reconfigured to act as "peaking" facilities by detaining stormwater only in major events when the pipe capacity is exceeded.

This basin requires improvements primarily to the outfall since the lateral network is currently extensive in this basin. Storm pipes through the commercial areas should have 5-year capacity, whereas the lateral network through the residential areas should have at least a 2-year capacity.

Project A: 18" Upgrades Existing 12- and 15-inch pipes along Dakota and Virginia Streets are proposed to be replaced with 18-inch pipes to meeting current drainage criteria and reduce maintenance.

Project B: Alameda Avenue Outfall The existing system should be re-used to the extent possible. Rather than replacing existing large pipe, a new parallel pipe to intercept a portion of the existing storm drains is most effective. An 8'x5' box culvert along the Center Street projected alignment from the South Platte to Pennsylvania will improve drainage conveyance. This alignment was selected as the most efficient route; however, Center Street west of Broadway is not City-owned and therefore a drainage easement will be required. Alternatively, a different alignment could be selected. Regardless of alignment, a new crossing under the railroad tracks and I-25 is necessary. This new outfall should be considered during the next phase of TREX construction for the I-25 crossing.

Project C: Dakota Avenue Improvements Existing small storm drains will be replaced with 18-inch pipe to meet current drainage criteria as the minimum pipe size on collector drains.

Project D: Alameda & Sante Fe Outfall The sump at Alameda and Santa Fe is a chronic flood problem area and will require construction of an enlarged outfall to the Platte River across I-25. Currently, the storm drain at the point of the sump is 18-inch, which should be upsized to a 30-inch pipe.

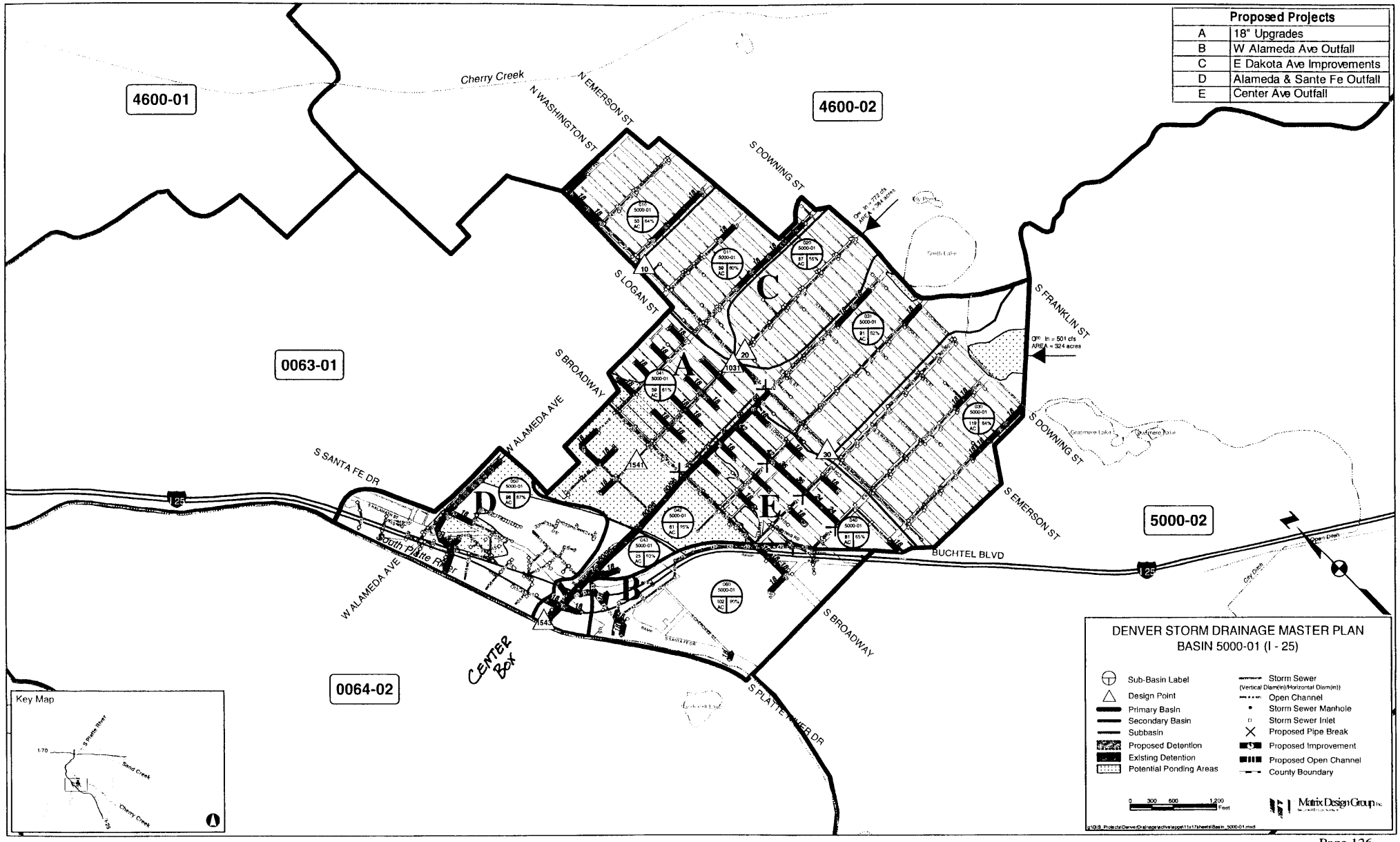
Project E: Center Avenue Outfall Existing small storm drains are proposed to be replaced with 18-inch pipes to meeting current drainage criteria and reduce maintenance. Also, a new collector drain in Grant Street is proposed that ties into the proposed Center Avenue outfall. This new collector will reduce historic flooding in Broadway by capturing sheet flow runoff. Grant Street was selected as the preferred alignment for the collector since it has the fewest existing utilities. Construction in Broadway is discouraged to avoid disruption to arterial traffic flow and existing utilities.

Hydrology:

BASIN 5000-01

Design Point Minor Event Model	Design Point Overland Flow Model	Contributing Basins Minor Event Model	Tributary Area Minor Event Model (acres)	Peak Discharge* 2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10	NA	10	50	56	93	**NA**
20	NA	20	57	45	80	**NA**
30	NA	30	119	131	218	**NA**
1031	1530	10-31	376	311	528	**2029**
1541	NA	10-41	516	378	650	**NA**
1543	120	10-43	602	387	654	**2558**

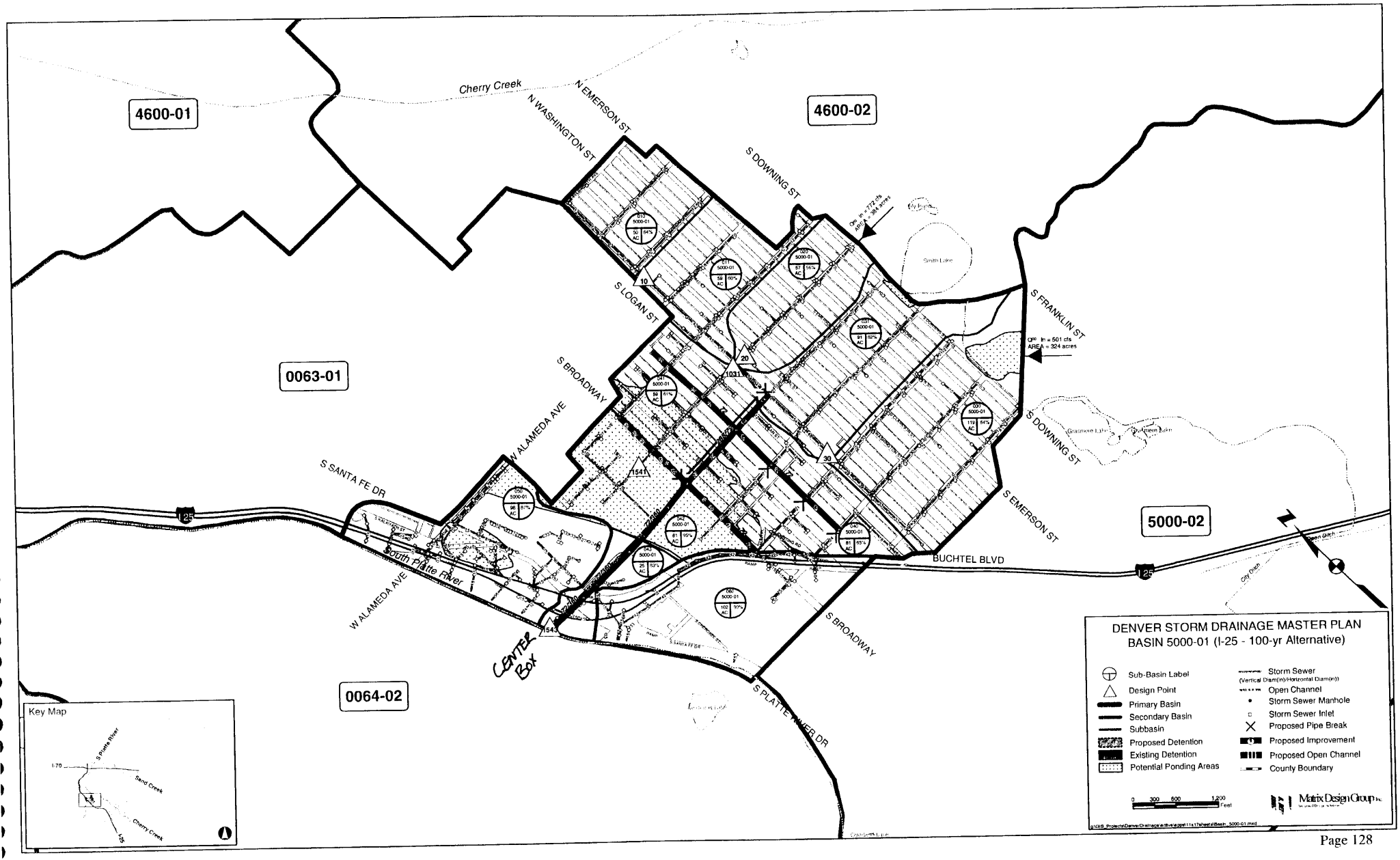
* 100-year discharge in **bold** represents analysis based on "overland" drainage paths determined from topography. Other events (2-year, 5-year, and remaining 100-year) are analyzed based on existing pipe network flow paths. Since several pipe networks do not follow overland drainage paths, this differing approach in modeling could create significant differences in peak flow distribution between storm events.


Proposed Projects
A 18" Upgrades
B W Alameda Ave Outfall
C E Dakota Ave Improvements
D Alameda & Sante Fe Outfall
E Center Ave Outfall
4600-01
4600-02
0063-01
0064-02
5000-02
Cherry Creek
N WASHINGTON ST
N EMERSON ST
S DOWNING ST
S LOGAN ST
S FRANKLIN ST
S BROADWAY
W ALAMEDA AVE
S SANTA FE DR
South Platte River
BUCHTEL BLVD
S EMERSON ST
S PLATTE RIVER DR
CENTER BOX
Key Map
DENVER STORM DRAINAGE MASTER PLAN
BASIN 5000-01 (I - 25)
Sub-Basin Label
Design Point
Primary Basin
Secondary Basin
Subbasin
Proposed Detention
Existing Detention
Potential Ponding Areas
Storm Sewer
(Vertical Diam(in)/Horizontal Diam(in))
Open Channel
Storm Sewer Manhole
Storm Sewer Inlet
Proposed Pipe Break
Proposed Improvement
Proposed Open Channel
County Boundary
Matrix Design Group Inc.

Basin 5000-01 (I-25 Basin) (Alternative 100-Year System)

Alternative 100-Year System to Reduce the Potential Ponding:
Ponding is predicted in the retail plaza and RTD Park-N-Ride area near Broadway and Alameda. During a 100-year storm, runoff beyond the capacity of the pipe network is imported into the basin, estimated to be 772 cfs from 384 acres. The combined effect from runoff in the 5000-01 basin and off-site flow from basin 4600-02 results in a 100-year flow of 2,558 cfs at the outfall. A 100-year drainage system must cross under I-25 and the railroad tracks; therefore, a box culvert system would be more appropriate than an open channel system. A triple 10'x6' box culvert constructed from the outfall in the South Platte to Broadway (2,720 lf) would convey the 100-year flow. In addition, new laterals and inlets would be required to capture the 100-year runoff (see Alternative 100-Year map on the facing page).

The approximate increase in cost to raise the level of service from a 5-year system to a 100-year system and eliminate the potential ponding in the basin is $24.1M (high cost due to jack & bore pipe under the railroad and I-25 to reach the South Platte River). The cost of the 5-year system is estimated to be $8.8M. The total cost of the 100-year system is roughly $32.9M. However, physical damage estimates are at least $4.3M from a 5-year storm event, and $9.4M from a 100-year storm event (based upon FEMA flood depth verses damage tables), which do not include indirect costs and opportunity costs.


DENVER STORM DRAINAGE MASTER PLAN
BASIN 5000-01 (I-25 - 100-yr Alternative)
Sub-Basin Label
Design Point
Primary Basin
Secondary Basin
Subbasin
Proposed Detention
Existing Detention
Potential Ponding Areas
Storm Sewer
(Vertical Diam(in)/Horizontal Diam(in))
Open Channel
Storm Sewer Manhole
Storm Sewer Inlet
Proposed Pipe Break
Proposed Improvement
Proposed Open Channel
County Boundary
0 300 600 1,200 Feet
Matrix Design Group
4600-01
4600-02
0063-01
0064-02
5000-02
Cherry Creek
N WASHINGTON ST
N EMERSON ST
S DOWNING ST
S LOGAN ST
S BROADWAY
W ALAMEDA AVE
S SANTA FE DR
S FRANKLIN ST
S EMERSON ST
BUCHTEL BLVD
South Platte River
S PLATTE RIVER DR
Smith Lake
Grasmere Lake
City Ditch
Key Map
I-70
S Platte River
Sand Creek
Cherry Creek
I-25
CENTER BOX

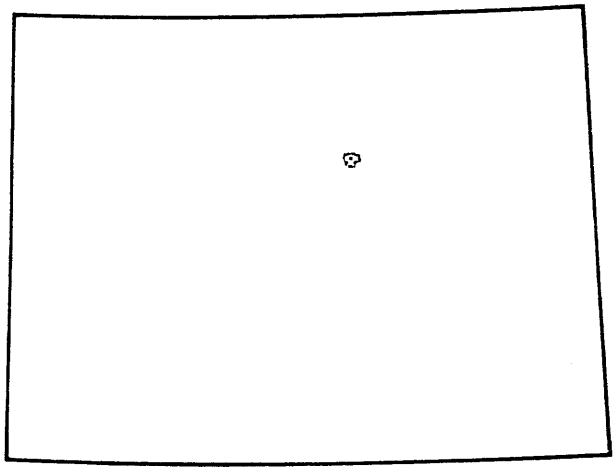
APPENDIX E FLOOD AND DRAINAGE WAY INFORMATION

Flood Insurance Study (selected sheets)
Flood Hazard Area Delineation – South Platte River (selected sheets)
Major Drainageway Planning – South Platte River – Phase B – Volume 1 (selected sheets)
Major Drainageway Planning – South Platte River – Phase B – Volume 2 (selected sheets)
Preliminary Design Report for the Upper Central Platte Valley (selected sheets)
I-25 Broadway/Santa Fe/Alameda Draft Floodplain and Drainage Assessment (selected sheets)
Existing Report List (of impacted basins) as provided by City and County of Denver
Picture of Sample Outlet Structure

FLOOD INSURANCE STUDY

CITY AND COUNTY OF DENVER, COLORADO

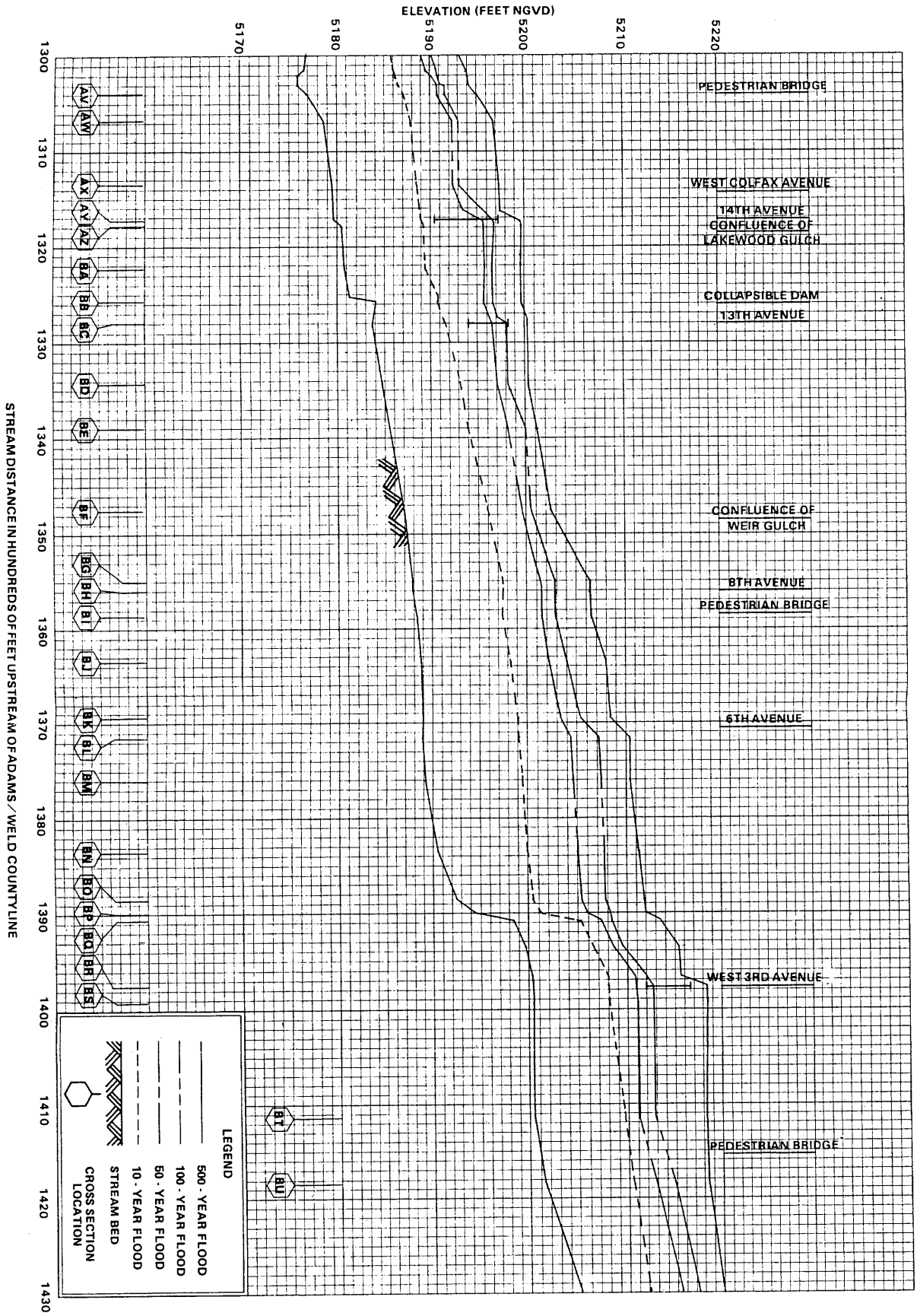
VOLUME 2 OF 2



REVISED:SEPTEMBER 28, 1990

Federal Emergency Management Agency

COMMUNITY NUMBER - 080046

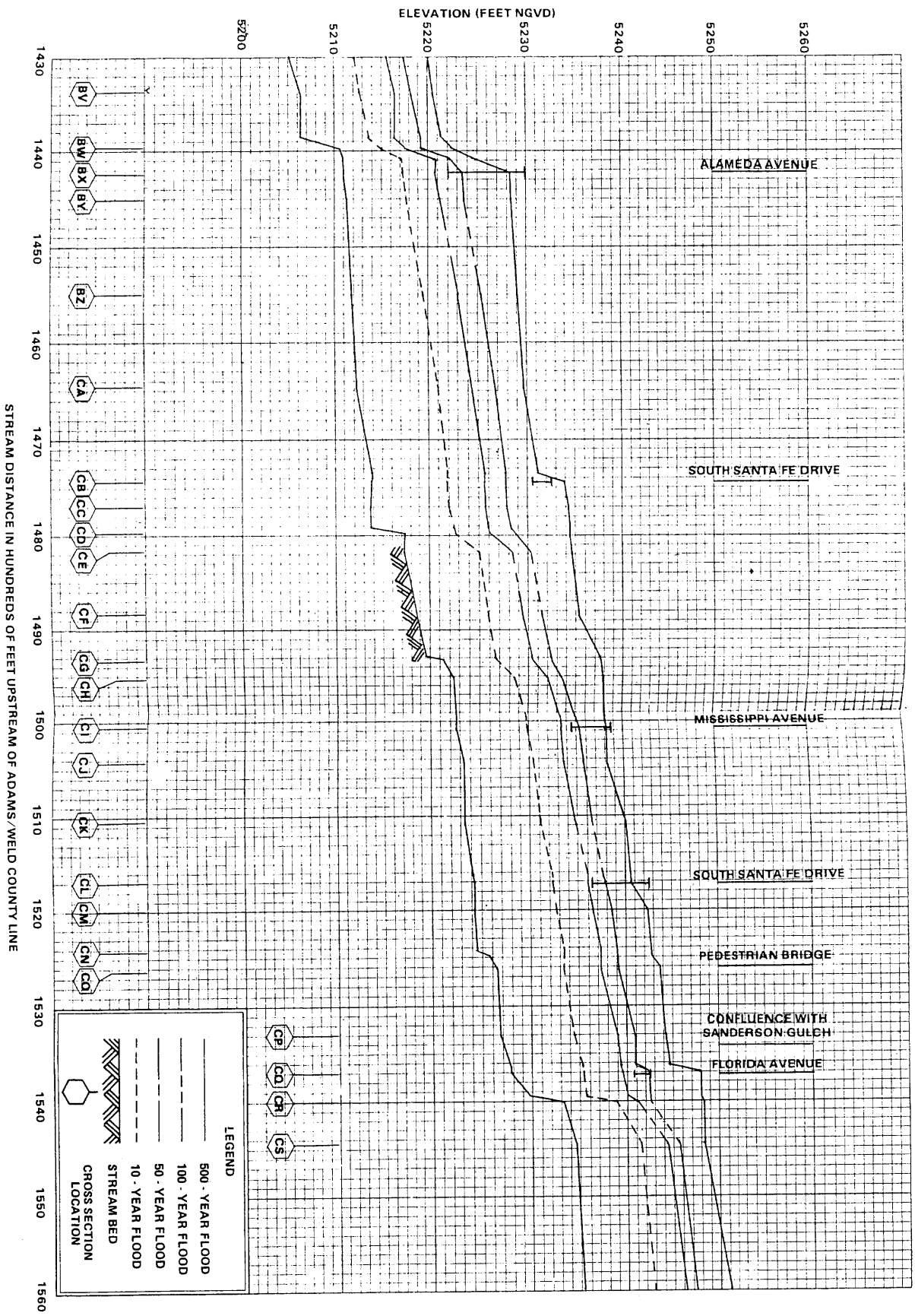


FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY AND COUNTY OF DENVER, CO

FLOOD PROFILES

SOUTH PLATTE RIVER



FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY AND COUNTY OF DENVER, CO

FLOOD PROFILES

SOUTH PLATTE RIVER

FLOOD HAZARD AREA DELINEATION

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MULLER ENGINEERING CO. INC.

SOUTH PLATTE RIVER

DENVER METROPOLITAN AREA

SAND CREEK TO OXFORD AVE.

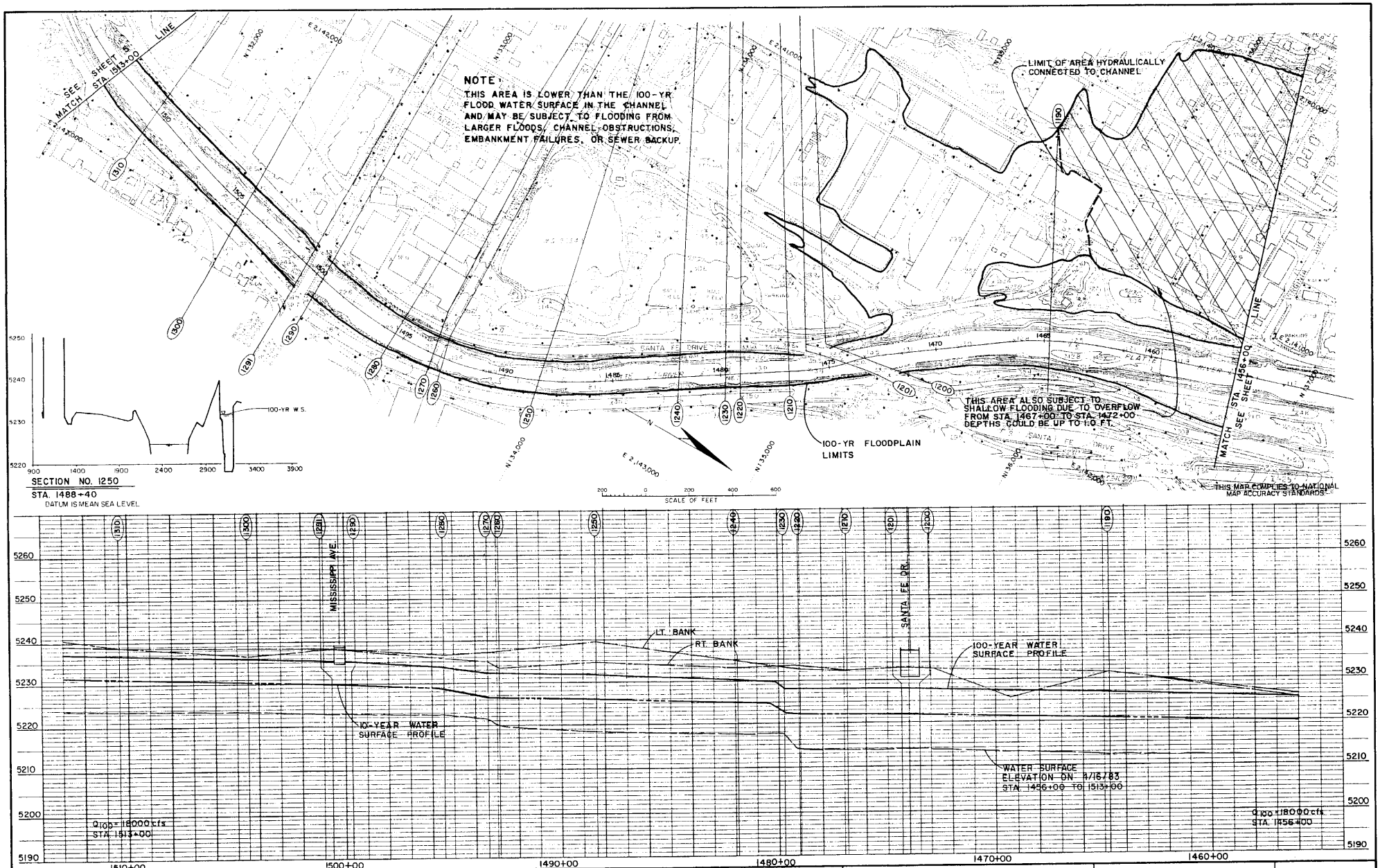
PREPARED FOR

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

PREPARED BY

WRIGHT WATER ENGINEERS, INC.

SEPTEMBER 1985



GROUND CONTROL SURVEY,
AERIAL PHOTOGRAPHY APRIL 16, 1983
TOPOGRAPHIC MAPPING BY
CONTOUR INTERVAL: 2 FEET

Delta Aerial Surveys, Inc.
2345 S. FEDERAL BLVD. SUITE 195
DENVER, COLORADO 80219
(303) 934-5500

WRIGHT WATER ENGINEERS, INC.
CONSULTING ENGINEERS
2490 W. 26th Ave. Suite 5-A
Denver, Colorado 80211
(303) 480-1700

DESIGNED WCC DATE 1/83
DRAWN JJM DATE 1/86
CHECKED WWA DATE 1/86
REVISED DATE

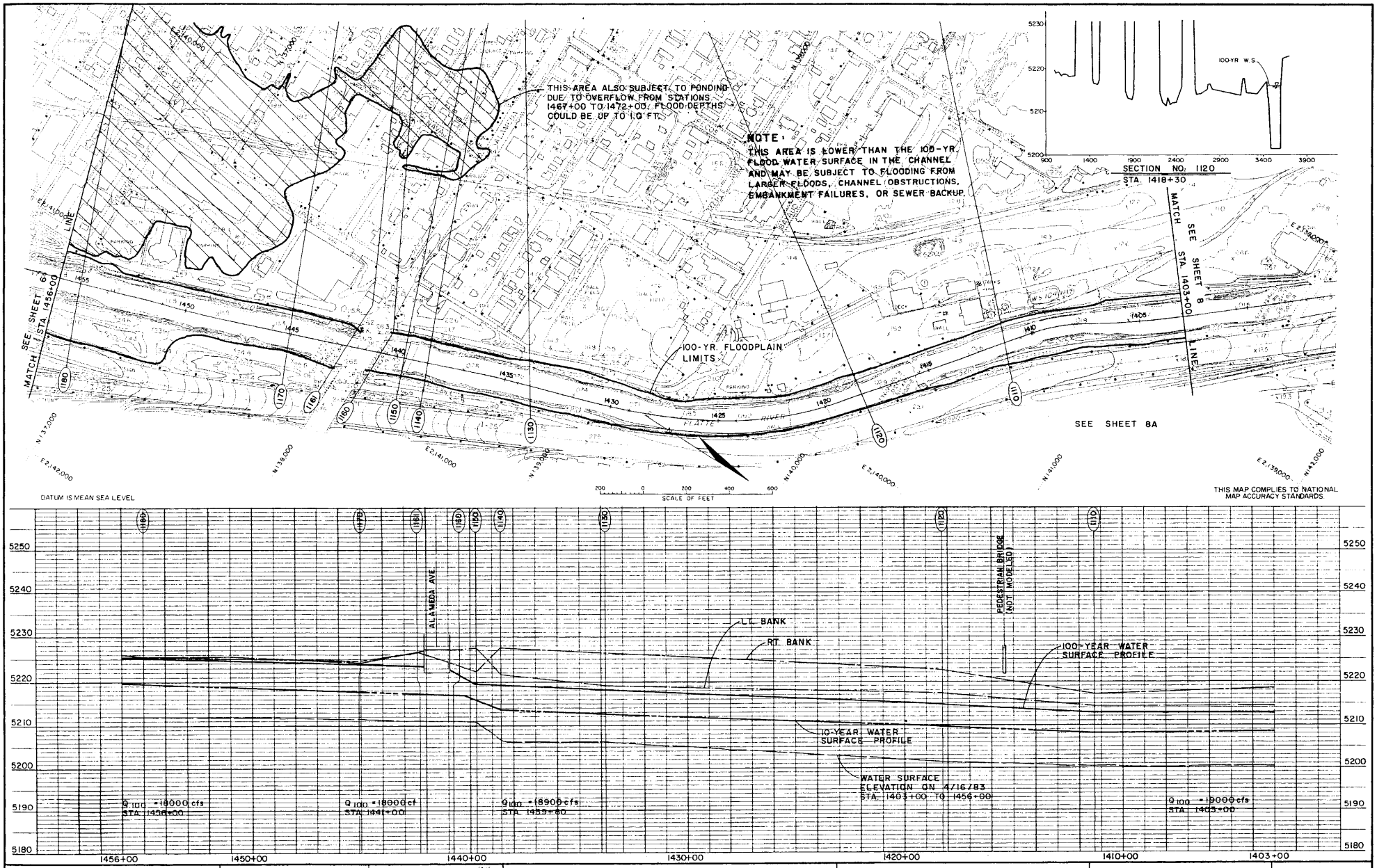
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

FLOOD HAZARD AREA DELINEATION

SOUTH PLATTE RIVER

PLAN AND PROFILE
STA. 1456+00 TO STA. 1513+00

SHEET 6 OF 25



GROUND CONTROL SURVEY, AERIAL PHOTOGRAPHY APRIL 16, 1983
TOPOGRAPHIC MAPPING BY Delta Aerial Surveys, Inc. 2345 SO. FEDERAL BLVD SUITE 195 DENVER, COLORADO 80219 (303) 934-5500
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WRIGHT WATER ENGINEERS, INC.
CONSULTING ENGINEERS
2490 W 26th Ave, Suite 55 A
Denver, Colorado 80211
(303) 480-1700

DESIGNED W.C.C. DATE 11/87
DRAWN D.L.M. DATE 1/88
CHECKED D.L.M. DATE 1/88
REVISED ____ DATE ____

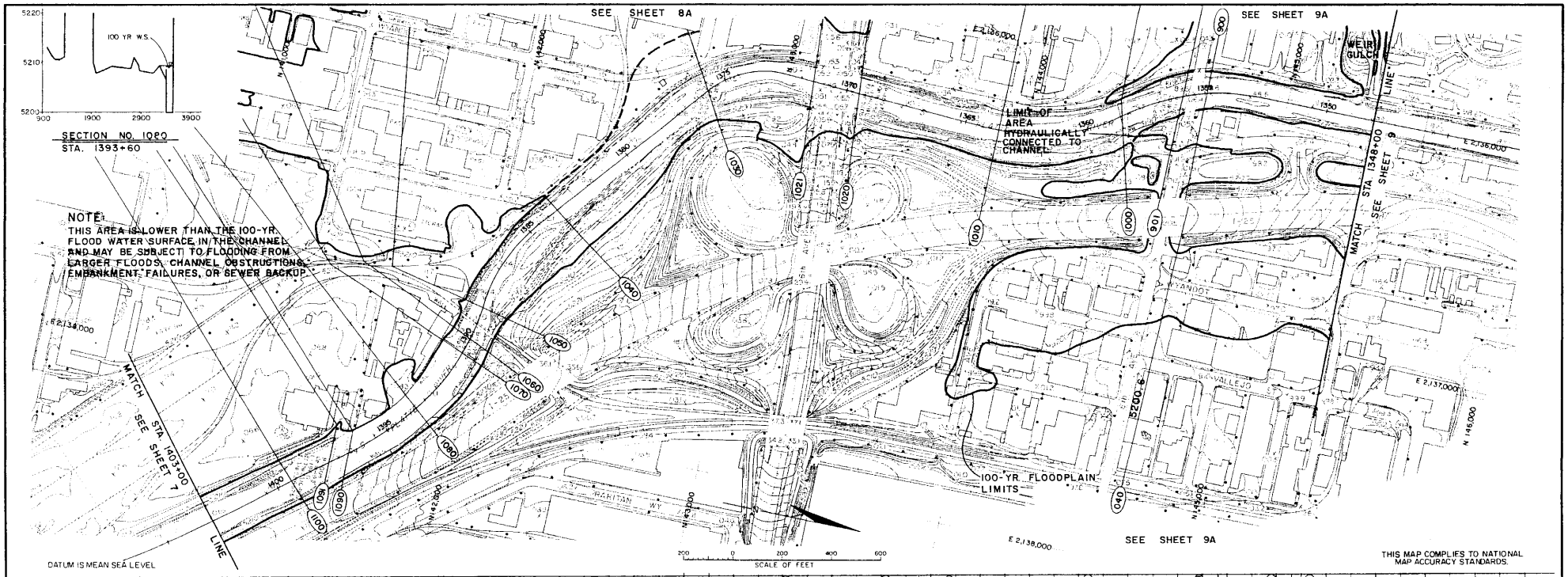
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

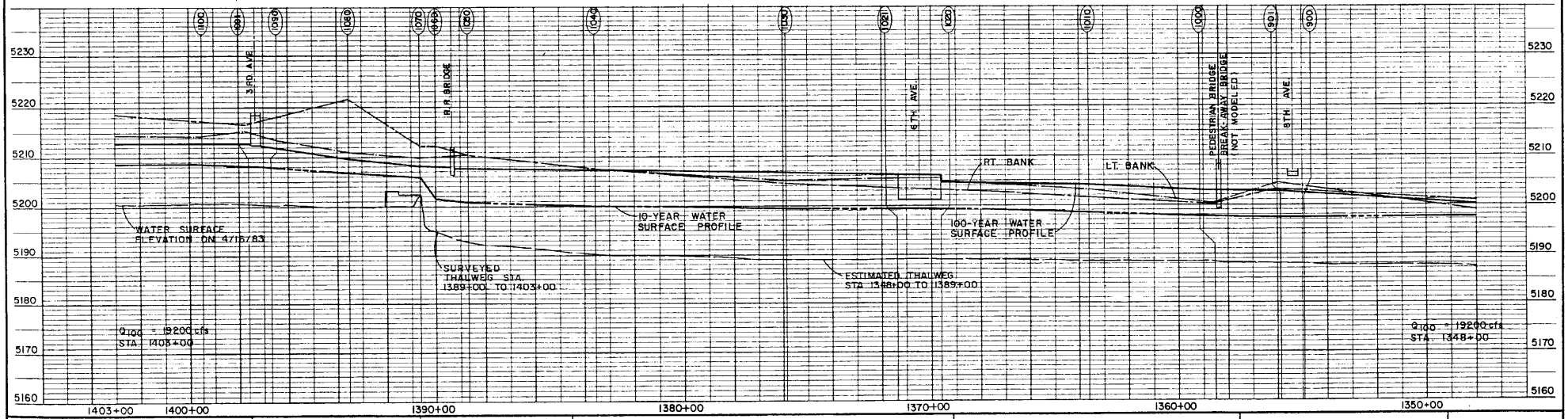
FLOOD HAZARD AREA DELINEATION

SOUTH PLATTE RIVER

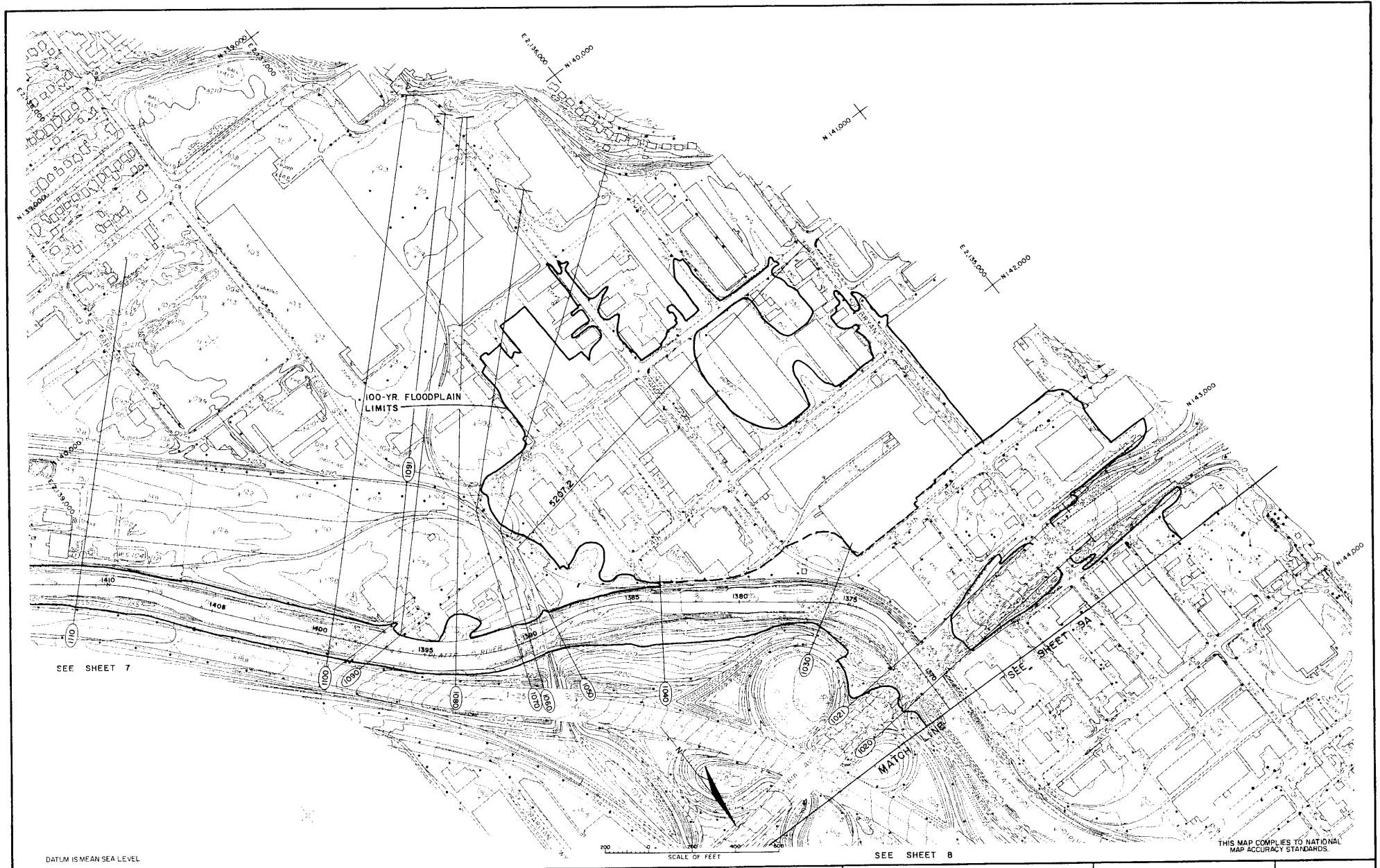
PLAN AND PROFILE
STA. 1403+00 TO STA. 1456+00

SHEET 7 OF 25





GROUND CONTROL SURVEY, AERIAL PHOTOGRAPHY APRIL 16, 1983 TOPOGRAPHIC MAPPING BY Delta Aerial Surveys, Inc. 2345 SO. FEDERAL BLVD. SUITE 195 DENVER, COLORADO 80219 (303) 934-5500 CONTOUR INTERVAL: 2 FEET	WRIGHT WATER ENGINEERS, INC. CONSULTING ENGINEERS 2490 W. 26th Ave. Suite 55 A Denver, Colorado 80211 (303) 480-1700	DESIGNED ___ DATE 11/84 DRAWN ___ DATE 11/84 CHECKED ___ DATE 11/84 REVISED ___ DATE ___	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT FLOOD HAZARD AREA DELINEATION	SOUTH PLATTE RIVER	PLAN AND PROFILE STA. 1348+00 TO STA. 1403+00	SHEET 8 OF 25



GROUND CONTROL SURVEY,
AERIAL PHOTOGRAPHY APRIL 16, 1983
TOPOGRAPHIC MAPPING BY Dalta Aerial Surveys, Inc.
5345 SO. FEDERAL BLVD. SUITE 195
DENVER, COLORADO 80219
(303) 934-5500
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WRIGHT WATER ENGINEERS, INC.
CONSULTING ENGINEERS
2490 W. 26th Ave, Suite 55-A
Denver, Colorado 80211
(303) 480-1700

DESIGNED W.C.C. DATE 11/84
DRAWN D.E.M. DATE 1/85
CHECKED D.W.M. DATE 1/85
REVISED ____ DATE ____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

FLOOD HAZARD AREA DELINEATION

SOUTH PLATTE RIVER

PLAN

FOR PROFILE SEE SHEETS 7 & 8

SHEET 8A OF 25

MAJOR DRAINAGEWAY PLANNING

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MULLER ENGINEERING CO. INC.

SOUTH PLATTE RIVER

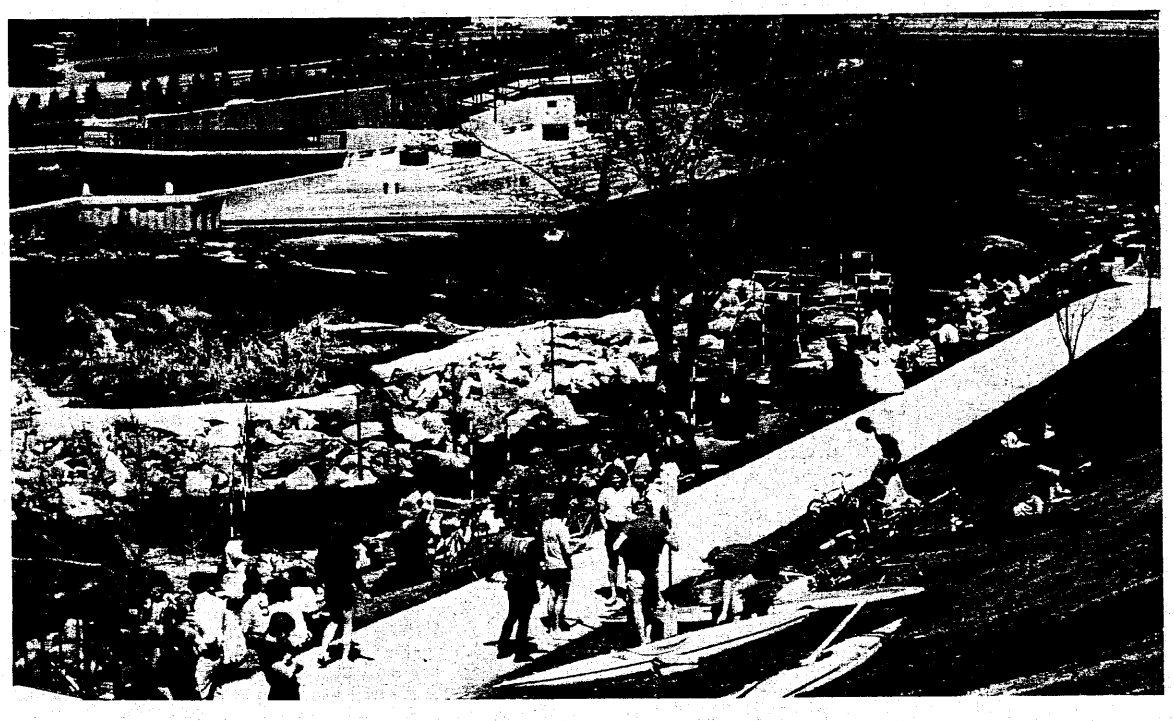
CHATFIELD DAM TO BASELINE ROAD

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

See back of repo for August '88 revi

PHASE B – VOLUME I

PRELIMINARY ENGINEERING DESIGN



PROJECT SPONSORS

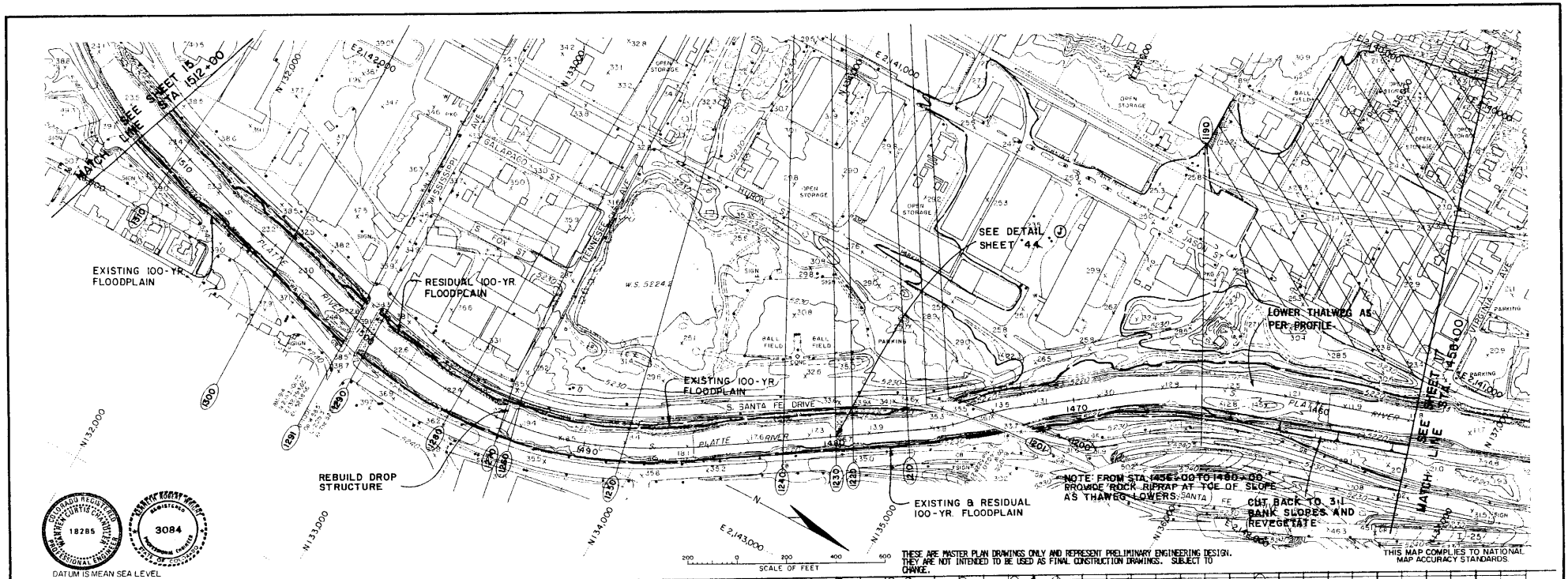
- ADAMS COUNTY
- ARAPAHOE COUNTY
- DOUGLAS COUNTY
- JEFFERSON COUNTY
- CITY AND COUNTY OF DENVER
- TOWN OF COLUMBINE VALLEY
- CITY OF BRIGHTON
- COMMERCE CITY
- CITY OF ENGLEWOOD
- CITY OF LITTLETON
- CITY OF SHERIDAN
- CITY OF THORNTON
- GREENWAY FOUNDATION

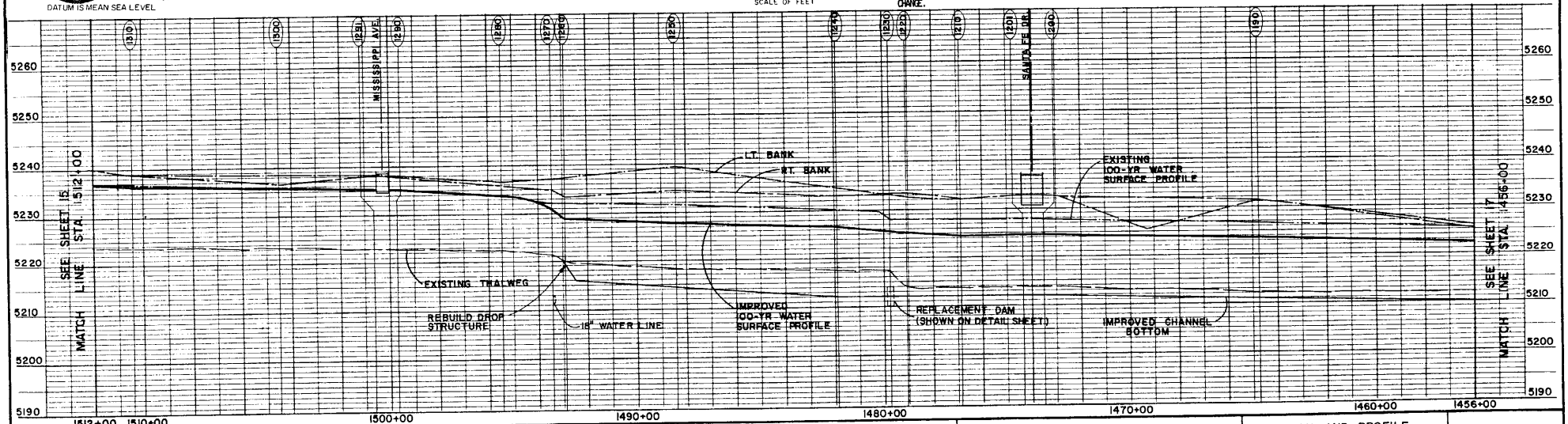
PROJECT ADVISORS

- DENVER REGIONAL COUNCIL OF GOVERNMENTS
- COLORADO WATER CONSERVATION BOARD
- SOUTH SUBURBAN PARKS AND RECREATION DISTRICT
- COLORADO DIVISION OF WILDLIFE
- U.S. ARMY CORPS OF ENGINEERS
- COLORADO DIVISION OF PARKS AND OUTDOOR RECREATION

WRIGHT WATER ENGINEERS, INC.
URBAN ENVIRONMENTS, LTD.
DENTON HARPER MARSHALL, INC.

NOVEMBER 1985





GROUND CONTROL SURVEY,
AERIAL PHOTOGRAPHY APRIL 16, 1983
TOPOGRAPHIC MAPPING BY
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Dalco Aerial Surveys, Inc.
2345 50 FEDERAL BLVD SUITE 195
DENVER, COLORADO 80219
(303) 934-5900

WRIGHT WATER ENGINEERS, INC.
2490 W 26th Ave., Suite 55-A
Denver, Colorado 80211 (303) 480-1700
URBAN ENVIRONMENTS, LTD.
DENTON HARPER MARSHALL, INC.

DESIGNED [illegible] DATE 5/85
DRAWN [illegible] DATE 5/85
CHECKED [illegible] DATE 5/85
REVISED ____ DATE ____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

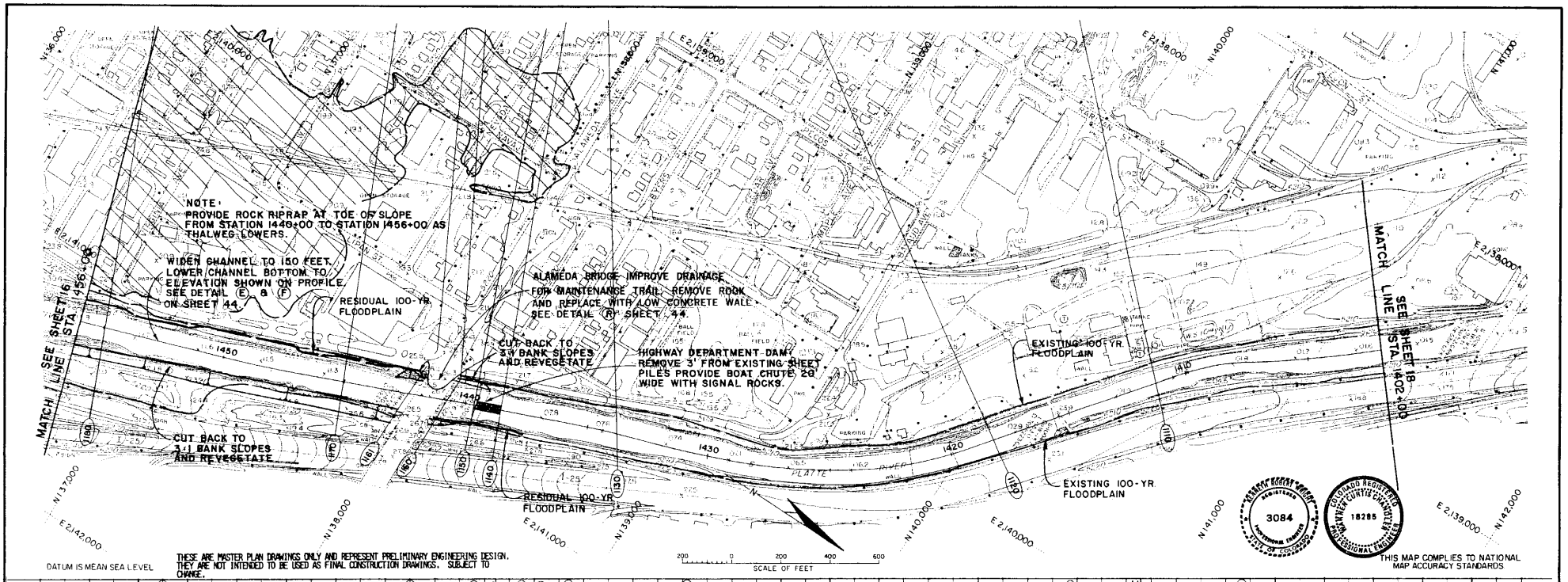
PHASE B PLAN

MAJOR DRAINAGEWAY PLANNING

SOUTH PLATTE RIVER

PLAN AND PROFILE
STA. 1456+00 TO STA. 1512+00

SHEET 16 OF 45



DATUM IS MEAN SEA LEVEL

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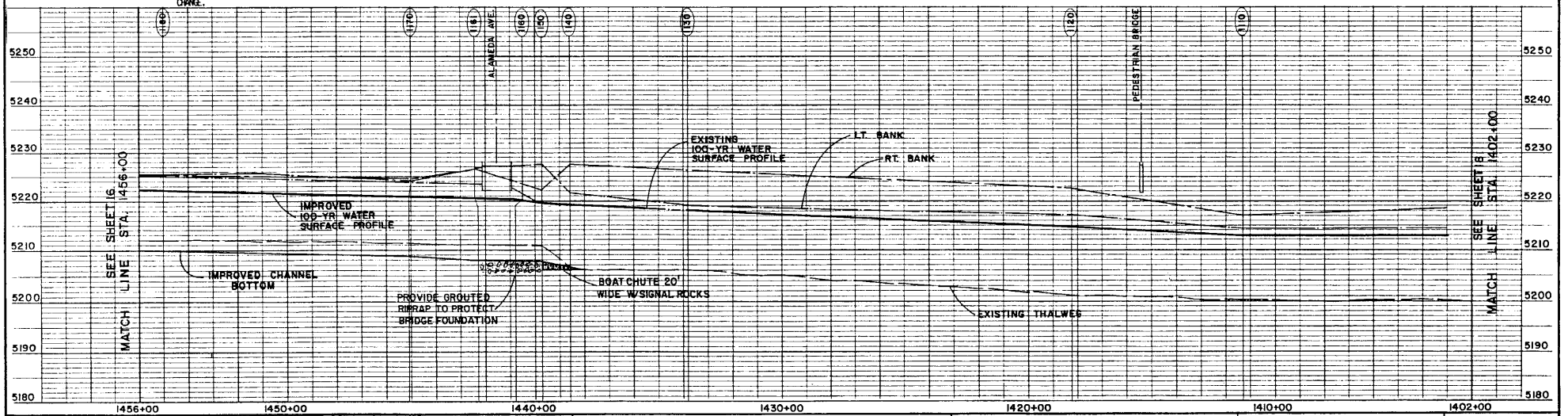
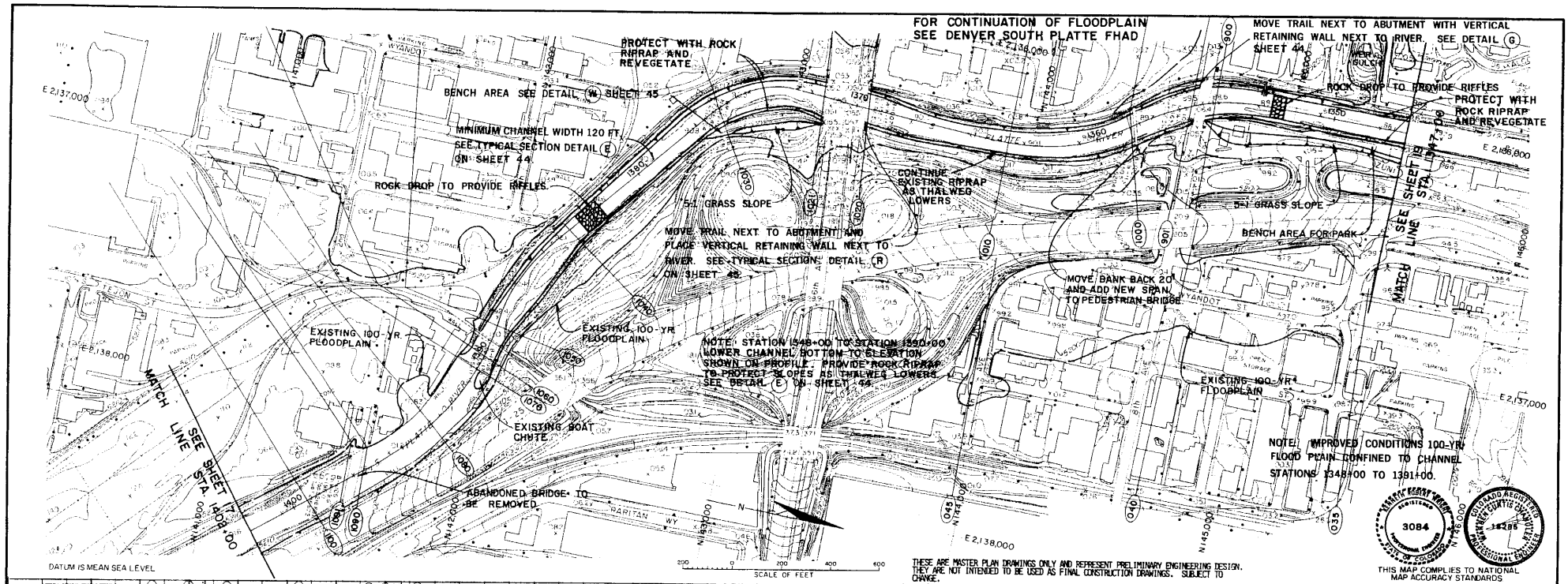
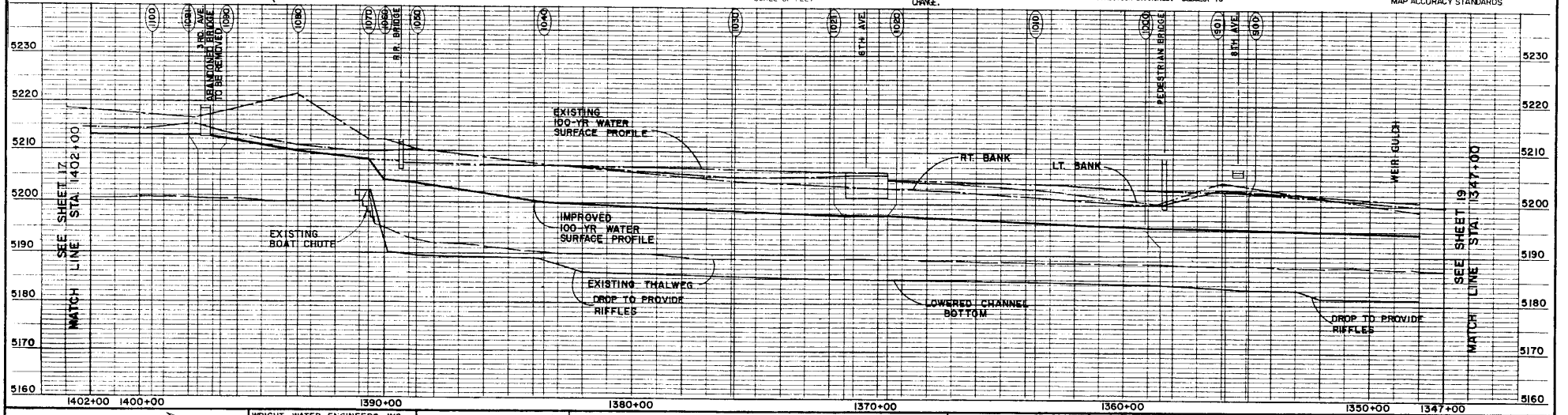
THIS MAP COMPLIES TO NATIONAL MAP ACCURACY STANDARDS



GROUND CONTROL SURVEY, AERIAL PHOTOGRAPHY APRIL 16, 1983 TOPOGRAPHIC MAPPING BY CONTOUR INTERVAL = 2 FEET	Dalta Aerial Surveys, Inc. 2345 SO FEDERAL BLVD SUITE 195 DENVER, COLORADO 80219 (303) 934-5300	WRIGHT WATER ENGINEERS, INC. 2490 W 26th Ave. Suite 55-A Denver, Colorado 80211 (303) 480-1700 URBAN ENVIRONMENTS, LTD. DENTON HARPER MARSHALL, INC.	DESIGNED DATE 5/85 DRAWN DATE 5/85 CHECKED DATE 5/85 REVISED DATE	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT PHASE B PLAN	MAJOR DRAINAGEWAY PLANNING SOUTH PLATTE RIVER	PLAN AND PROFILE STA. 1402+00 TO STA. 1456+00	SHEET 17 OF 45





GROUND CONTROL SURVEY, AERIAL PHOTOGRAPHY APRIL 16, 1983
TOPOGRAPHIC MAPPING BY Dalta Aerial Surveys, Inc. 2345 SO. FEDERAL BLVD. SUITE 195 DENVER, COLORADO 80219 (303) 934-5500
CONTOUR INTERVAL = 2 FEET

WRIGHT WATER ENGINEERS, INC. 2490 W. 26th Ave., Suite 55-A Denver, Colorado 80211 (303) 480-1700
URBAN ENVIRONMENTS, LTD.
DENTON HARPER MARSHALL, INC.

DESIGNED WWE DATE 5/85
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CHECKED WWE DATE 5/85
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URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

PHASE B PLAN

MAJOR DRAINAGEWAY PLANNING

SOUTH PLATTE RIVER

PLAN AND PROFILE
STA. 1347+00 TO STA. 1402+00

NOTE: IMPROVED CONDITIONS 100-YEAR FLOODPLAIN CONFINED TO CHANNEL STATIONS 1292+00 TO 1347+00.

FOR CONTINUATION OF FLOODPLAIN SEE DENVER SOUTH PLATTE FHAD

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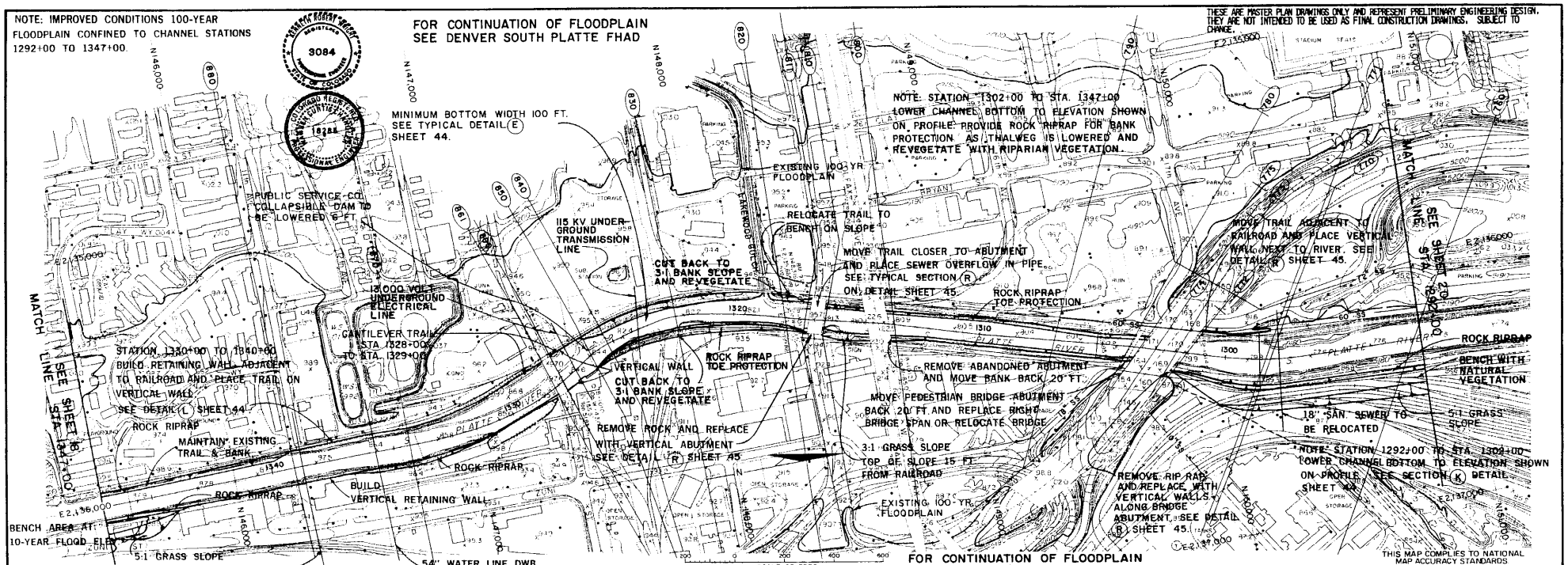
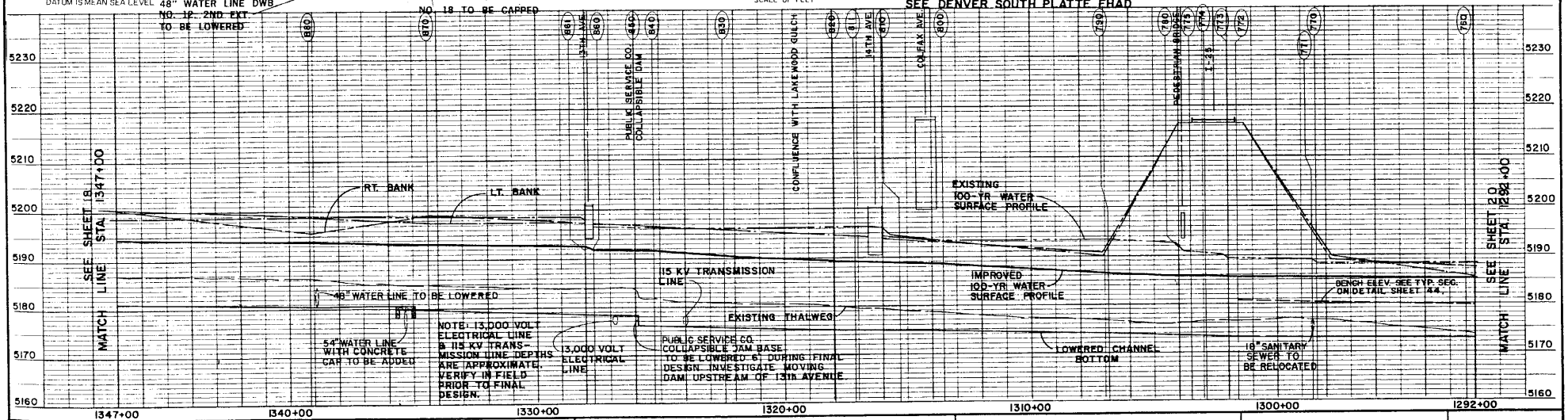




GROUND CONTROL SURVEY,
AERIAL PHOTOGRAPHY APRIL 16, 1983
TOPOGRAPHIC MAPPING BY
CONTOUR INTERVAL: 2 FEET

Delta Aerial Surveys, Inc.
2345 SO. FEDERAL BLVD. SUITE 195
DENVER COLORADO 80219
(303) 934-5500

WRIGHT WATER ENGINEERS, INC.
2490 W. 26th Ave., Suite 55-A
Denver, Colorado 80211 (303) 480-1700
URBAN ENVIRONMENTS, LTD.
DENTON HARPER MARSHALL, INC.

DESIGNED WCC, JMG DATE 5/85
DRAWN RCM, CRC DATE 5/85
CHECKED WCC, JMG DATE 5/85
REVISED _____ DATE _____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

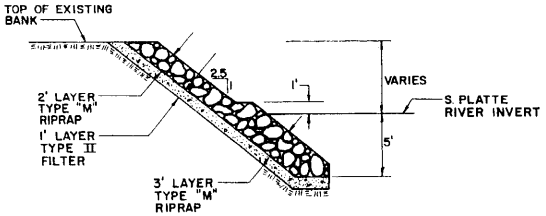
PHASE B PLAN

MAJOR DRAINAGEWAY PLANNING

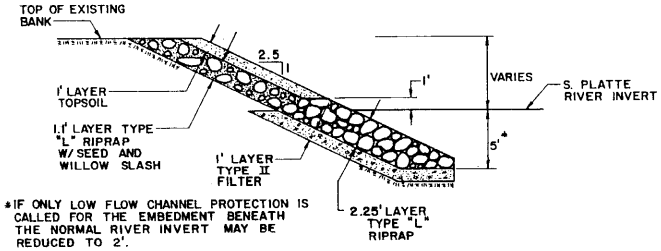
SOUTH PLATTE RIVER

PLAN AND PROFILE
STA 1292+00 TO STA. 1347+00

SHEET 19 OF 45

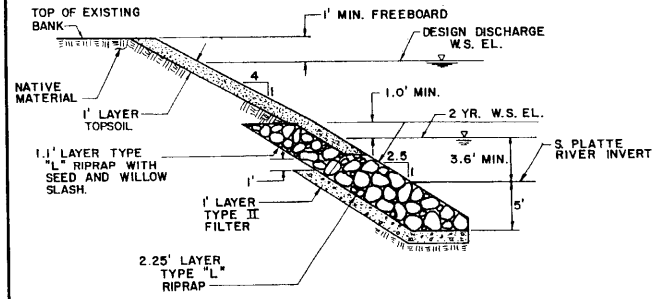


A REACH 1 — RIPRAP SLOPE PROTECTION DETAIL
1" = 5'

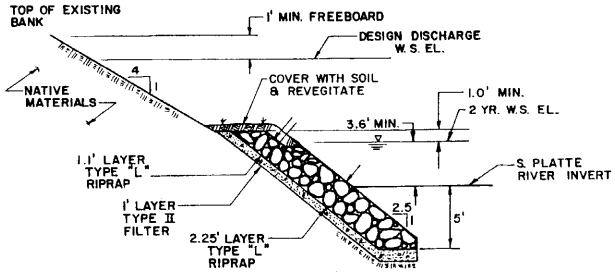


*IF ONLY LOW FLOW CHANNEL PROTECTION IS CALLED FOR THE EMBEDMENT BENEATH THE NORMAL RIVER INVERT MAY BE REDUCED TO 2'.

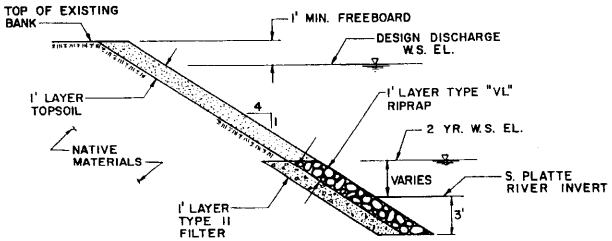
B REACH 1 — RIPRAP W/ VEGETATION SLOPE PROTECTION DETAIL
1" = 5'



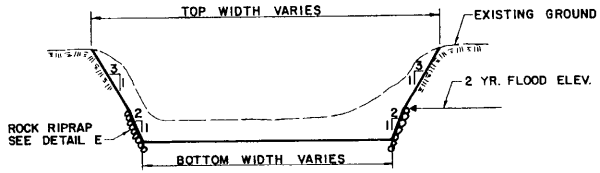
C TYPICAL RIPRAP WITH VEGETATION SLOPE PROTECTION DETAIL
1" = 5'



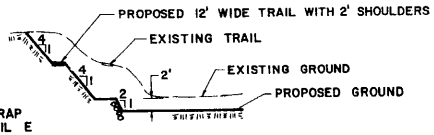
D TYPICAL RIPRAP SLOPE PROTECTION DETAIL
1" = 5'



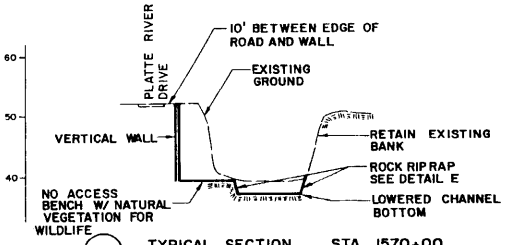
E TYPICAL CHANNEL WIDENING
1" = 5'



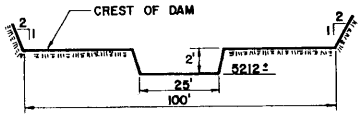
F TYPICAL CHANNEL DEEPENING
1" = 50' HORIZ. 1" = 10' VERT.



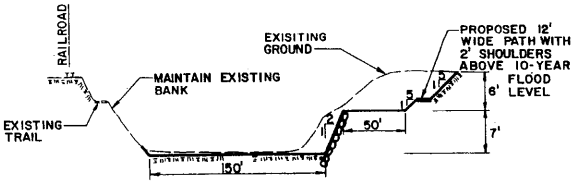
G TYPICAL SECTION AT STA. 1355+00 TO STA. 1358+00
1" = 50' HORIZ. 1" = 10' VERT.



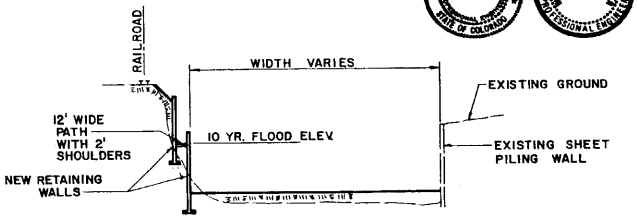
H TYPICAL SECTION STA. 1570+00
1" = 100' HORIZ. 1" = 10' VERT.



J DAM AT STA. 1479+00



K SPEER BLVD. TO I-25
1" = 50' HORIZ. 1" = 10' VERT.



L TYPICAL SECTION UPSTREAM OF 13th AVE.
1" = 50' HORIZ. 1" = 10' VERT.

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0 1 2 3
ORIGINAL SCALE IN INCHES

WRIGHT WATER ENGINEERS, INC. 2490 W. 26th Ave., Suite 55-A Denver, Colorado 80211 (303) 480-1700 URBAN ENVIRONMENTS, LTD. DENTON HARPER MARSHALL, INC.	DESIGNED RCC, RWG DATE 5/85 DRAWN RCM DATE 5/85 CHECKED RCC, RWG DATE 5/85 REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT PHASE B PLAN	MAJOR DRAINAGEWAY PLANNING SOUTH PLATTE RIVER.	TYPICAL DETAILS	SHEET 44 OF 45

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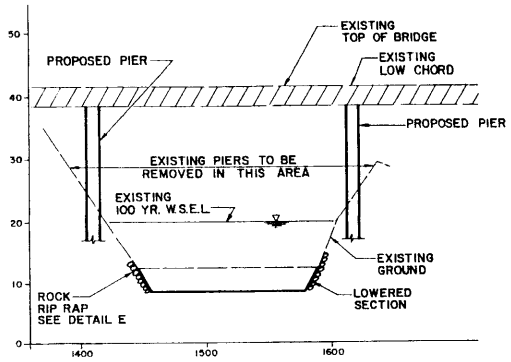

M RAILROAD BRIDGE NORTH OF YORK STREET
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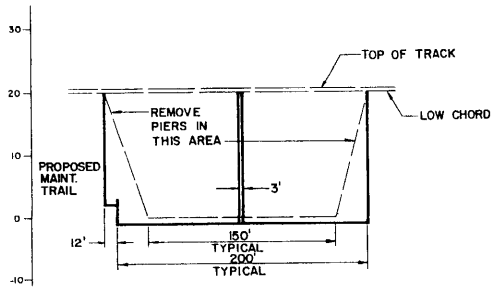

Q TYPICAL RAILROAD BRIDGE IMPROVEMENT
STA. 1108+50 TO STA. 1067+00
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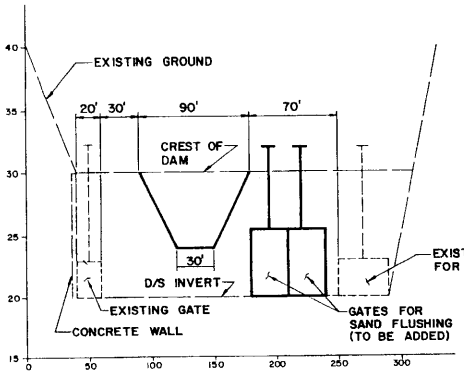
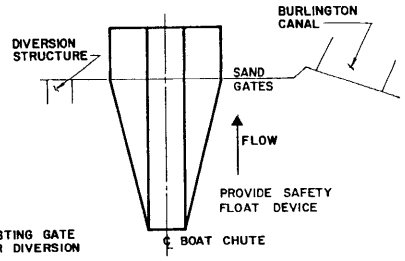
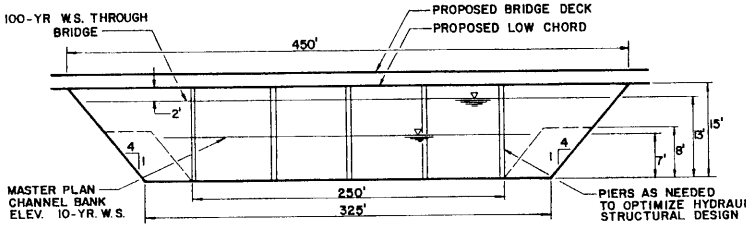


PROFILE



PLAN

S BURLINGTON DAM BOAT CHUTE
1" = 10' HORIZ. 1" = 5' VERT.



N TYPICAL ADAMS COUNTY BRIDGE DETAIL
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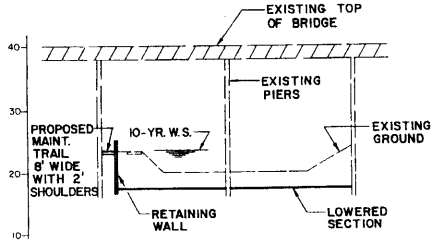
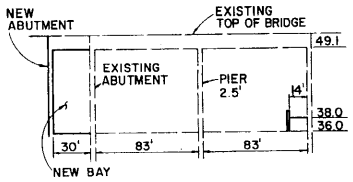
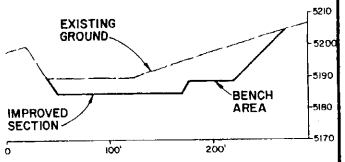


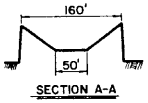
R TYPICAL BRIDGE MODIFICATION WITH TRAIL RELOCATION AND CHANNEL LOWERING



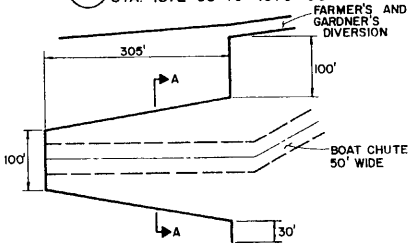
T EVANS AVE. BRIDGE
1" = 50' HORIZ. 1" = 10' VERT.

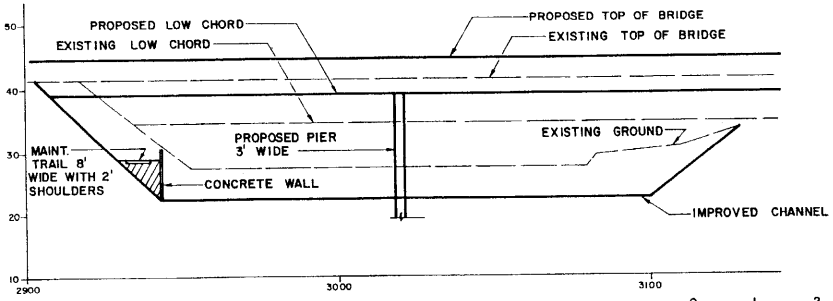


W BENCH AREA U/S OF SIXTH AVE.
STA. 1372+00 TO 1376+00



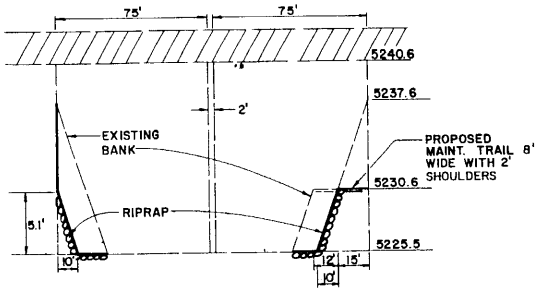
SECTION A-A



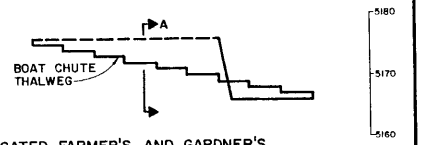


P FRANKLIN STREET BRIDGE
1" = 20' HORIZ. 1" = 10' VERT.

0 1 2 3
ORIGINAL SCALE IN INCHES



U FLORIDA AVE. BRIDGE
1" = 30' HORIZ. 1" = 5' VERT.



V RELOCATED FARMER'S AND GARDNER'S DIVERSION DAM STA. 1262+00 1" = 100'

WRIGHT WATER ENGINEERS, INC. 2490 W. 26th Ave., Suite 55-A Denver, Colorado 80211 (303) 480-1700 URBAN ENVIRONMENTS, LTD. DENTON HARPER MARSHALL, INC.	DESIGNED WCC, MWG DATE 5/85 DRAWN DCM DATE 5/85 CHECKED WCC, MWG DATE 5/85 REVISED DATE	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT PHASE B PLAN	MAJOR DRAINAGEWAY PLANNING SOUTH PLATTE RIVER	TYPICAL DETAILS	SHEET 45 OF 45

MAJOR DRAINAGEWAY PLANNING

LIBRARY COPY
MULLER ENGINEERING CO. INC

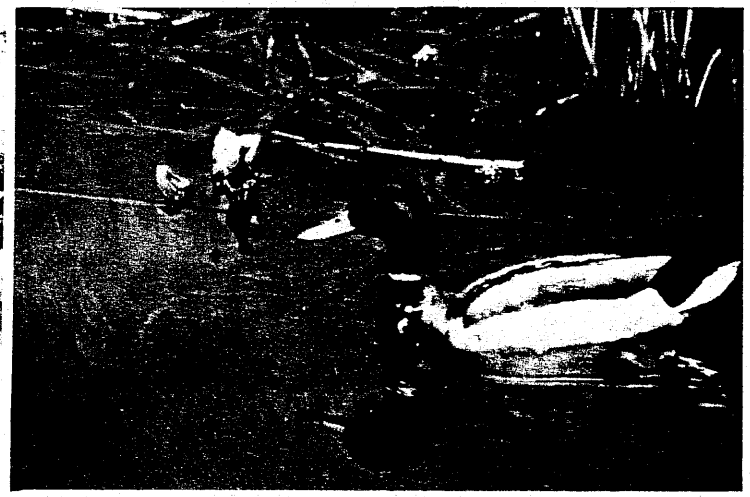
SOUTH PLATTE RIVER

CHATFIELD DAM TO BASELINE ROAD

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

PHASE B – VOLUME II

RECREATION PLAN



PROJECT SPONSORS

- ADAMS COUNTY
- ARAPAHOE COUNTY
- DOUGLAS COUNTY
- JEFFERSON COUNTY
- CITY AND COUNTY OF DENVER
- TOWN OF COLUMBINE VALLEY
- CITY OF BRIGHTON
- COMMERCE CITY
- CITY OF ENGLEWOOD
- CITY OF LITTLETON
- CITY OF SHERIDAN
- CITY OF THORNTON
- GREENWAY FOUNDATION

PROJECT ADVISORS

- DENVER REGIONAL COUNCIL OF GOVERNMENTS
- COLORADO WATER CONSERVATION BOARD
- SOUTH SUBURBAN PARKS AND RECREATION DISTRICT
- COLORADO DIVISION OF WILDLIFE
- U.S. ARMY CORPS OF ENGINEERS
- COLORADO DIVISION OF PARKS AND OUTDOOR RECREATION

WRIGHT WATER ENGINEERS, INC.
URBAN ENVIRONMENTS, LTD.
DENTON HARPER MARSHALL, INC.

NOVEMBER 1985

EXISTING LINEAR PARK
- LIMITED STRUCTURAL IMPROVEMENTS AND FLOODPLAIN MANAGEMENT
- LIMITED RECREATION IMPROVEMENTS

VANDERBILT PARK
EXISTING PARKING, JOGGING TRAILS, BASEBALL FIELDS AND POND

IMPROVE EXISTING PARKING LOT
ADD CURB AND GUTTER TO CONTROL VEHICULAR ACCESS TO PARK
PROVIDE 10 PARKING SPACES

PROVIDE PEDESTRIAN CROSSWALK AND ADD SIGNAL

EXISTING HIKE, BIKE AND MAINTENANCE TRAIL

IMPROVE HABITAT PARK
ADD BOAT LANDING
IMPROVE LANDSCAPE CHARACTER WITH NATIVE TREES AND SHRUBS

BUILD HIGH-WATER RETAINING WALL UNDER MISSISSIPPI AVE. BRIDGE

PROPOSED HIKE, BIKE AND MAINTENANCE TRAIL

EXISTING BOAT CHUTE IN 2 FT. SHEET PILE DAM

PROPOSED BOAT LANDINGS

EXISTING BOAT CHUTE IN 4 FT. SHEET PILE DAM

PROPOSED PEDESTRIAN BRIDGE

IMPROVE TRAIL SAFETY WITH GUARDRAIL SEPARATING TRAIL AND ROAD

DATUM IS MEAN SEA LEVEL

SCALE OF FEET 200 0 200 400 600

THESE ARE MASTER PLAN DRAWINGS ONLY AND REPRESENT PRELIMINARY DESIGN. THEY ARE NOT INTENDED TO BE USED AS FINAL DESIGN OR CONSTRUCTION DRAWINGS. SUBJECT TO CHANGE.

THIS MAP COMPLIES TO NATIONAL MAP ACCURACY STANDARDS

THESE ARE MASTER PLAN DRAWINGS ONLY AND REPRESENT PRELIMINARY DESIGN. THEY ARE NOT INTENDED TO BE USED AS FINAL DESIGN OR CONSTRUCTION DRAWINGS. SUBJECT TO CHANGE.

REDUCE MAJOR TRAIL FLOODING PROBLEMS
REDESIGN DAM WITH BOAT CHUTE TO MINIMIZE FLOODING AS PART OF FUTURE RECONSTRUCTION OF ALAMEDA AVE. OVERPASS
BUILD HIGH-WATER RETAINING WALL UNDER ALAMEDA AVE BRIDGE

PROPOSED BOAT LANDINGS

EXISTING HIKE, BIKE AND MAINTENANCE TRAIL

EXISTING LINEAR PARK
- LIMITED STRUCTURAL IMPROVEMENTS AND FLOODPLAIN MANAGEMENT
- LIMITED RECREATION IMPROVEMENTS

PROVIDE LOW-FLOW CHANNEL TO IMPROVE BOATING FROM ALAMEDA AVE. TO COLFAX AVE.

VALVERDE PARK
EXISTING PARKING AND BASEBALL FIELDS

EXISTING PEDESTRIAN BRIDGE

TO WASHINGTON PARK

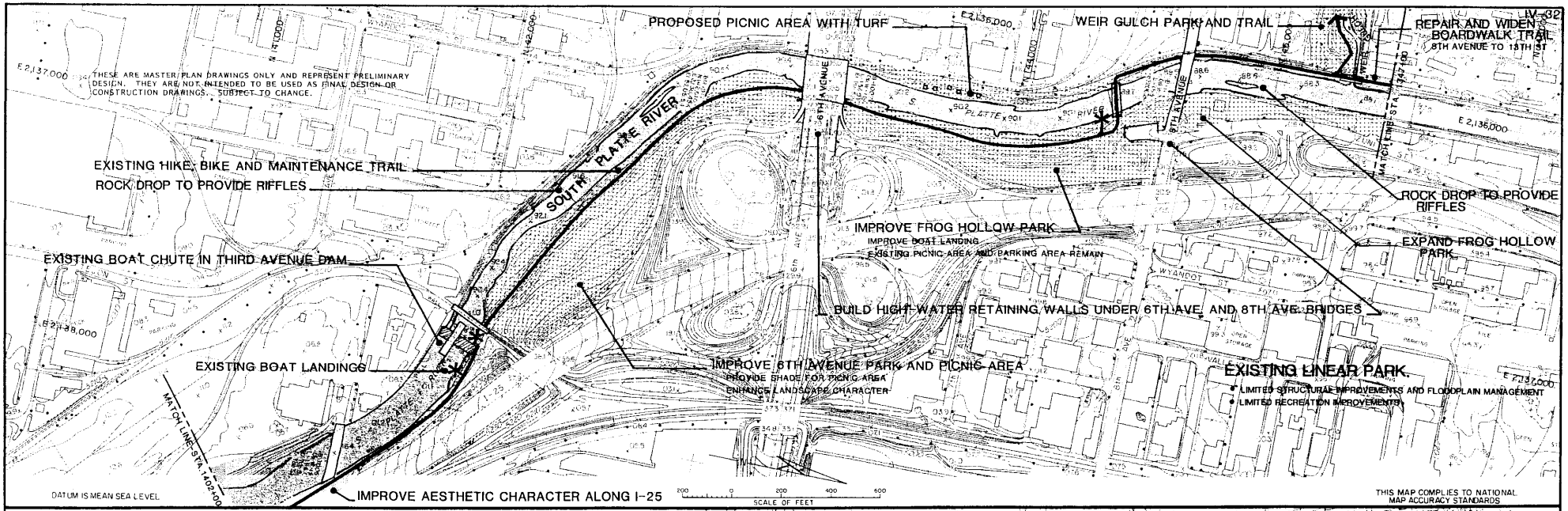
EXISTING BOAT CHUTE IN 3 FT. SHEET PILE DAM

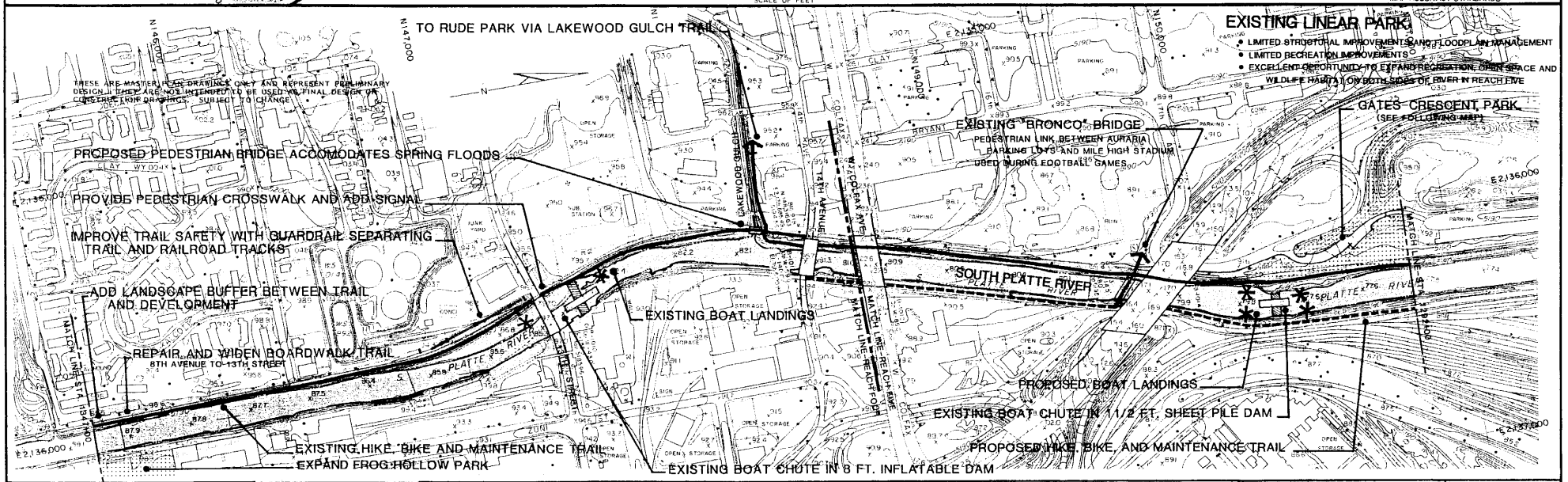
PROPOSED HIKE, BIKE AND MAINTENANCE TRAIL

GROUND CONTROL SURVEY, AERIAL PHOTOGRAPHY APRIL 16, 1983 TOPOGRAPHIC MAPPING BY CONTOUR INTERVAL = 2 FEET	Delta Aerial Surveys, Inc. 2345 SO FEDERAL BLVD SUITE 195 DENVER, COLORADO 80219 (303) 934-3500	WRIGHT WATER ENGINEERS, INC. 2490 W 26th Ave., Suite 55-A Denver, Colorado 80211 (303) 480-1700 URBAN ENVIRONMENTS, LTD. DENTON HARPER MARSHALL, INC.	DESIGNED RLG DATE 7-15-85 DRAWN PRM DATE 8-14-85 CHECKED RLG DATE 9-9-85 REVISED RLG/PRM DATE 11-6-85	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT PHASE B PLAN	MAJOR DRAINAGEWAY PLANNING SOUTH PLATTE RIVER

PARKS RECREATION & OPEN SPACE PLAN
STA. 1402+00 TO STA. 1512+00

SHEET 10 OF 23





GROUND CONTROL SURVEY, AERIAL PHOTOGRAPHY APRIL 16, 1983 TOPOGRAPHIC MAPPING BY CONTOUR INTERVAL: 2 FEET	Delta Aerial Surveys, Inc. 2345 SO FEDERAL BLVD SUITE 195 DENVER COLORADO 80219 (303) 934-5500	WRIGHT WATER ENGINEERS, INC. 2490 W 26th Ave, Suite 55-A Denver, Colorado 80211 (303) 480-1700 URBAN ENVIRONMENTS, LTD. DENTON HARPER MARSHALL, INC.	DESIGNED RLG DATE 7-15-85 DRAWN RPM DATE 8-16-85 CHECKED RLG DATE 9-9-85 REVISED RLB/PRM DATE 11-6-85	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT PHASE B PLAN	MAJOR DRAINAGEWAY PLANNING SOUTH PLATTE RIVER

PARKS RECREATION & OPEN SPACE PLAN
STA. 1292+00 TO STA. 1402+00

Preliminary Design Report for the Upper Central Platte Valley South Platte River Restoration

Prepared for:
Urban Drainage and Flood Control District
City and County of Denver

Prepared by:
McLaughlin Water Engineers, Ltd.

December 1998

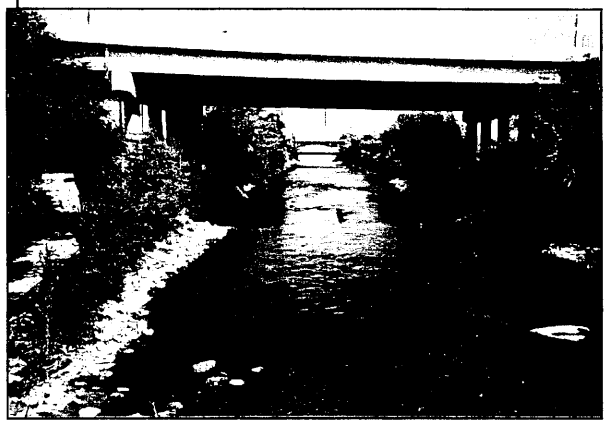
Phase 1:

Colfax Reach (Lakewood Gulch to I-25)

Implementation of the project in this reach will result in a substantial reduction in flood hazard and improvements in fish and wildlife habitat. The project could further be broken down into several components:

- Repair west bank below existing hiker/biker maintenance trail.
- Excavate east bank, provide toe lining, and create wildlife corridor.
- Shape the low flow channel and create meanders.
- Construct hiker/biker maintenance trail.
- Replace Bronco Bridge.
- Replace 14th Avenue bridge.

Total estimated cost for this reach is $3 million.



Colfax Viaduct, Looking Downstream from 14th Avenue

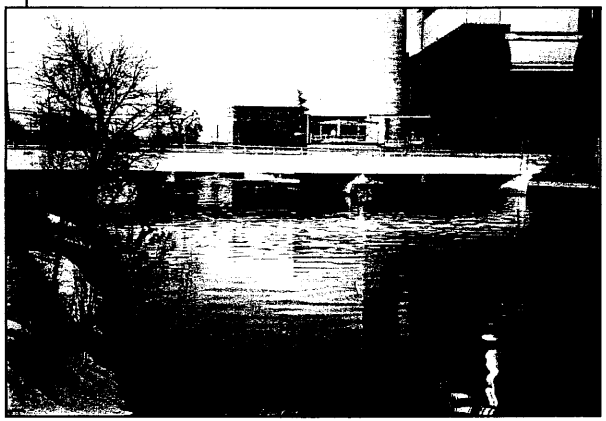
Phase 2:

Zuni Reach (11th Avenue to Lakewood Gulch).

Implementation of the project in this reach will provide the greatest flood hazard reduction benefits. Estimated costs include providing temporary diversion facilities for Zuni Power Plant and constructing the closed loop cooling system. This project could be further separated into several components including:

- Build components of closed loop cooling system in Public Service Company Zuni Power Plant outside of river.
- Remove dam and construct infiltration gallery, while providing temporary source of water supply for cooling purposes to Public Service Company.
- Excavate west bank, construct new hiker/biker maintenance trail and take out existing elevated trail.
- Shape low flow channel and create meanders.
- Create wildlife corridor on east bank.
- Construct hiker/biker maintenance trail.

Total estimated cost for this reach is $12 million.



13th Avenue and Zuni Power Plant, Pool Behind Dam

Phase 3:

Sun Valley Reach (8th Avenue to 11th Avenue)

Implementation of the project in this reach will provide improved access to the river for the Sun Valley Community Center and neighborhood. Components in this reach include:

- Lower the 48-inch water line.
- Widen the channel on the west side.
- Develop improvements at Weir Gulch Park.
- Create wildlife corridor on east bank.
- Shape low flow channel and create meanders.
- Construct hiker/biker maintenance trail.

Total estimated cost for this reach is $4 million.

West Bank Near Weir Gulch, Sun Valley Community Center

INTRODUCTION AND PURPOSE

Overview

In 1994, Mayor Wellington E. Webb formed the South Platte River Working Group to explore opportunities for restoring and enhancing the 10.5 mile corridor of the Platte River that runs through Denver. In 1995, Mayor Webb endorsed the written recommendations of the Working Group, entitled *A Vision for the South Platte River*. The goals and objectives of Denver's South Platte River project were derived from those recommendations and include assurance of water flow and quality levels needed to support recreational and environmental needs along the river, improvements for riparian and aquatic habitat, flood damage reduction, creation of additional parks, added focus on environmental education, and an increase in community awareness of the South Platte River as a resource.

The Upper Central Platte Valley Reach is a key component of Denver's 10.5 miles of the South Platte River. It extends for approximately 1 mile west of downtown Denver, from 8th Avenue to I-25 through residential, commercial, and industrial areas (Figure 1). This reach of the South Platte River has been subject to flood damage, channelization, and destruction of fish and wildlife habitat. Residential and industrial areas in this reach are still threatened by flooding. Flood waters spill from this reach of the channel and flow northeast; this overbank flow surrounds the Elitch Gardens and Pepsi Center area. Completion of the flood damage reduction measures proposed for the Upper Central Platte Valley Reach will not only benefit this reach, but will also reduce flood damage in the reach of the South Platte immediately downstream.

The Public Service Company's Zuni Power Plant dominates this reach of the river with its diversion dam for cooling water (Figures 2 and 3). This dam is the sole remaining obstacle to boating the entire 10.5 mile reach of the South Platte River through Denver. Water backup from this dam has replaced the South Platte River with a reservoir for one-half mile upstream through the Denver Metropolitan area. Riverbanks in this reach are steep, making access difficult and impairing wildlife habitat. Much of the vegetation is non-native and in a degraded condition.

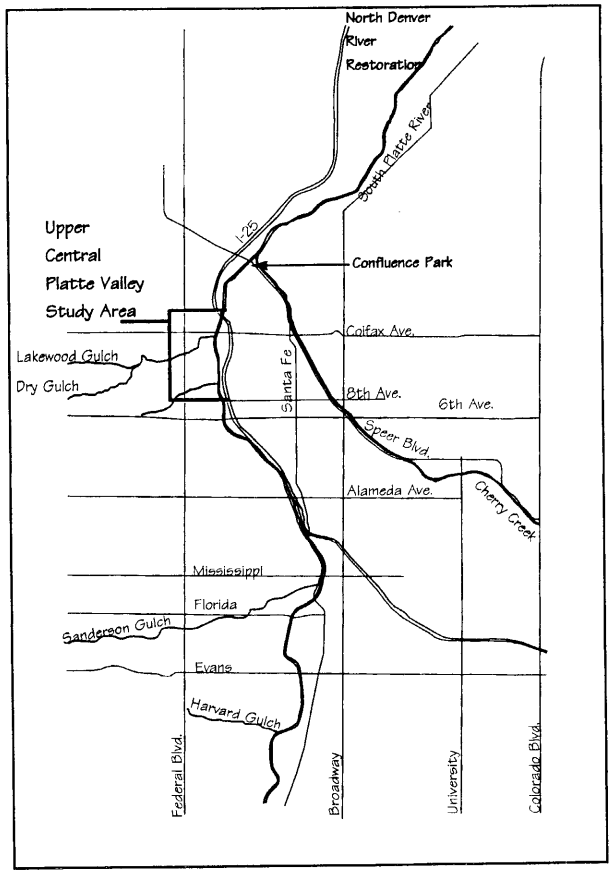


Figure 1: Location Map

In order to implement the goals of the Mayor's South Platte River Commission, a Task Force for the Upper Central Platte Valley Reach, led by the Urban Drainage and Flood Control District, has been formed and has developed a detailed plan for restoration of the South Platte River in the Upper Central Valley Reach. The Task Force has representatives from recreation, fish and wildlife, water and neighborhood interests and also includes the Public Service Company, Denver Housing Authority, U.S. Army Corp of Engineers, and the Division of Wildlife. Task Force members are listed inside the front cover, before the Table of Contents.

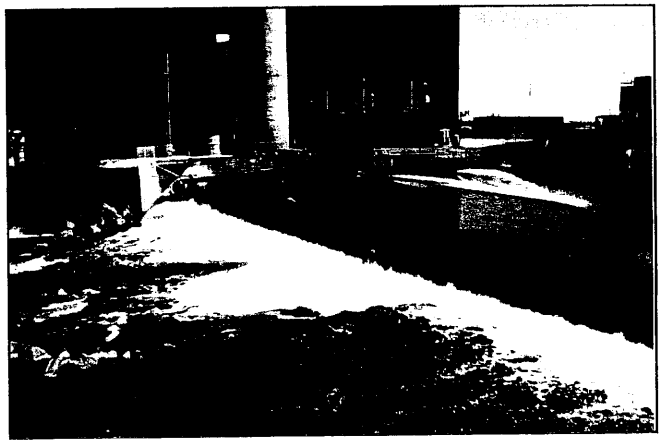
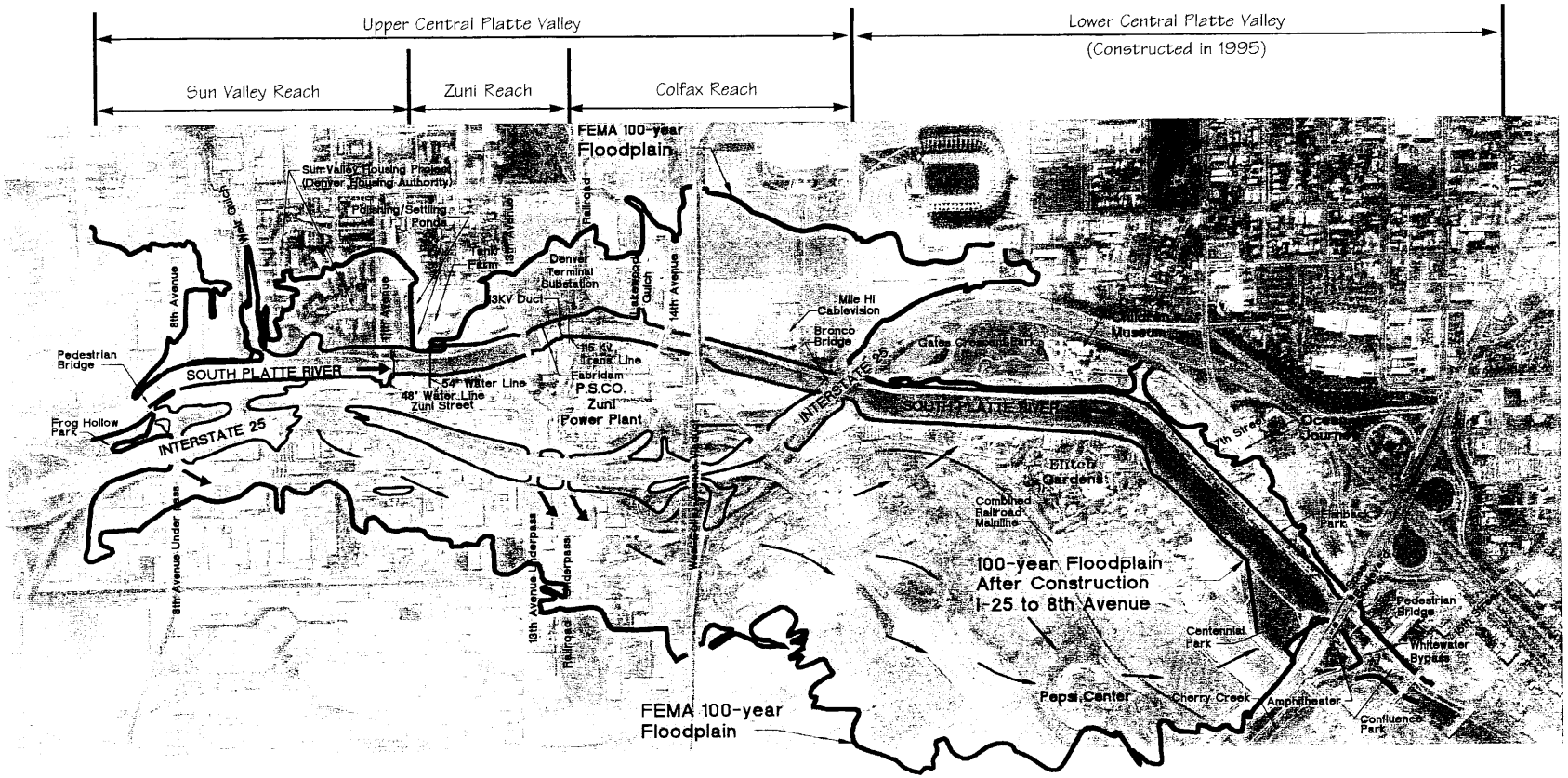


Figure 2: Zuni Power Plant/Diversion Dam

The major goals of the plan developed by this Task Force include:

- **Flood Damage Reduction.** Flood damage will be reduced for residents and businesses in the one-mile Central Platte River Valley by widening and lowering the river channel, replacing the Bronco Bridge, and replacing the 14th Avenue bridge. Also overbank flows will be reduced downstream, in the areas adjacent to Elitch Gardens and the Pepsi Center.

- **Elimination of Dam.** By removing the Zuni Power Plant dam and providing a closed loop cooling system to the power plant, fish habitat, adjacent wetland habitat and boating opportunities will be restored and improved.



LEGEND

The designated FEMA 100 year floodplain indicates the limits of the 100-year floodplain prior to construction of the flood damage reduction progject for the I-25 to Confluence Park reach.

100-year floodplain after construction of the Upper Central South Platte River Valley Restoration Project.

Figure 3: Floodplain Map

These reaches are shown in Figure 3 of Part 1 - Preliminary Design Report and plan and profile drawings are presented in Drawings 2 through 5 in Part 2 - Technical Report.

Sun Valley Reach (8th Avenue to 11th Avenue)

Flood Damage Reduction. Flood damage reduction components for the Sun Valley Reach are presented in Sheets 2 and 3. These drawings include the following project components for flood damage reduction:

- Removing the Fabridam in the Zuni Reach will help confine 100-year flood flows to the channel in the Sun Valley Reach by eliminating the backwater from the dam, which presently extends into this reach.

- A flow transition drop will occur at the 8th Avenue bridge from the existing gradient upstream to a 0.0013 foot gradient downstream of 8th Avenue to the 54-inch water line. This sloping drop will be lined with riprap and boulders.

- The stream bottom in this reach will be lowered by approximately 2 feet beginning at 8th Avenue, to 0 feet at the 54-inch water line, to approximately 3 feet at the Fabridam downstream from 13th Avenue in the Zuni Reach.

- Both the east and west banks will be toelined with riprap.

- Grade east bank slope below current water line and plant shrubs and ground cover.

- The infiltration gallery will be constructed in this reach starting at a point approximately 50 feet upstream from the 54-inch water line and running upstream for approximately 400 feet. The infiltration gallery will be connected to the PSC's Zuni plant by a collector pipeline of sufficient capacity. Water will be either pumped from a wet well collection facility, located on the east bank near the 54-inch water line, to the Zuni Power Plant cooling facilities, or if possible, flow by gravity. A final decision on gravity flow versus pumping will be made after PSC determines the design and elevation of the inlet facilities for the replacement water at the Zuni Power Plant.

- The west bank will be widened in the vicinity of the Sun Valley neighborhood and community center and will be terraced and made less steep than existing conditions in order to provide more access to the river, while adding additional conveyance through this reach. The top of the bank for the project will be graded to blend with existing topography at the community center.

- The mouth of Weir Gulch will be widened and the concrete walls will be removed.

- Two major sanitary sewers that parallel the sewer along the west bank will be protected in place.

After construction of the project as shown in Sheets 2 through 5 herein, over bank flows from floods equivalent to, or less than the 100-year frequency storm, will no longer escape from the channel near 8th Avenue to the east.

Boatability. Boatability throughout this reach will be significantly improved because of elimination of the Fabridam in the Zuni Reach. A low flow channel will be constructed that will concentrate the flow to improve boating.

Fish and Wildlife Habitat. Through this reach, the proposed project will include a low flow channel approximately 1.5 feet deep and 50 feet wide for boating and to improve fish and wildlife habitat. The slope of the channel through this reach will be approximately .0013. Sheet 11 provides details for the low flow channel structures designed to improve fish habitat. The east bank through the Sun Valley Reach will be developed as a wildlife corridor and appropriate native tree and shrub species will be planted to provide food and cover for wildlife.

Recreation. A major recreational improvement will be constructed in this reach by opening Weir Gulch and improving the park with an amphitheater as requested by nearby residents. The existing 10-foot hiker/biker maintenance trail will be removed and a new 10-foot concrete trail will be constructed along the west bank throughout this reach due to west bank excavation.

Utilities. The 16-inch Denver Water Department line presently hanging on the 8th Avenue bridge will be relocated approximately 20 feet downstream of the 8th Avenue bridge and buried approximately 4-5 feet deep in the channel in order to increase conveyance of flows through this reach. The 48-inch water line at the intersection of 11th Avenue with the South Platte will be lowered approximately 7 feet in order to improve flow conveyance in the channel and avoid the infiltration gallery.

Metro Wastewater Reclamation District owns two sanitary sewers, 48-inch and 72-inch, that parallel the river along the west banks between Weir Gulch and 13th Avenue. The 72-inch sewer line is 65 feet west of the station line and will not be affected by the widening. The 48-inch sewer line is 25 feet west of the station line and will be protected as the excavation will encroach toward the sewer line. Location of the trail and buried rock bank protection will serve to protect the sewer line after improvements.

Zuni Reach (11th Avenue to upstream of Lakewood Gulch)

Flood Damage Reduction. The following project components will be implemented in this reach to provide flood damage reduction:

- Existing overbank flooding at 13th Avenue and at the railroad underpass will be eliminated by removal of the Fabridam and channel widening and lowering.

- 100-year flows will be confined to the stream channel throughout this reach.

- Upstream of 13th Avenue the channel will be widened on the west bank by an average of approximately 50 feet. This will widen the channel back to the PSC polishing pond without affecting the

I-25 Broadway/Santa Fe/Alameda
Draft Floodplain and Drainage Assessment
Existing Conditions

January 10, 2000
Revised April 7, 2000

Prepared For:

Felsburg Holt & Ullevig
Greenwood Corporate Plaza
7951 E. Maplewood Ave. Ste. 200
Englewood, CO 80111

Prepared By:

Muller Engineering Company, Inc.
Irongate 4, Suite 100
777 South Wadsworth Blvd.
Lakewood, Colorado 80226
Project No. 9904.01

Peak flows were estimated using the Colorado Urban Hydrograph procedure as specified by the Urban Drainage and Flood Control District. The drainage area was originally subdivided into four sub-basins for which peak flows were determined. Sub-basin S1, which includes the area to the east of Smith Lake will flow into Smith Lake and will be discussed in detail in a later section of this report. The other three sub-basins were then further subdivided into 12 sub-basins. CUHP parameters for eleven of these sub-basins can be seen in Table 2. Subasin 12 was too small for CUHP and was calculated using the rational method. The peak flows for these basins were then routed using SWMM to gain a clearer understanding of the peak flows that will occur during the various storm events. The peak flows from each basin are summarized in Table 3 of this report. The CUHP and the SWMM output can be found in the Appendix. As the analysis proceeds toward final design, the pervious and impervious parameters may change as a more detailed study is completed.

Table 2: Colorado Urban Hydrograph Parameters

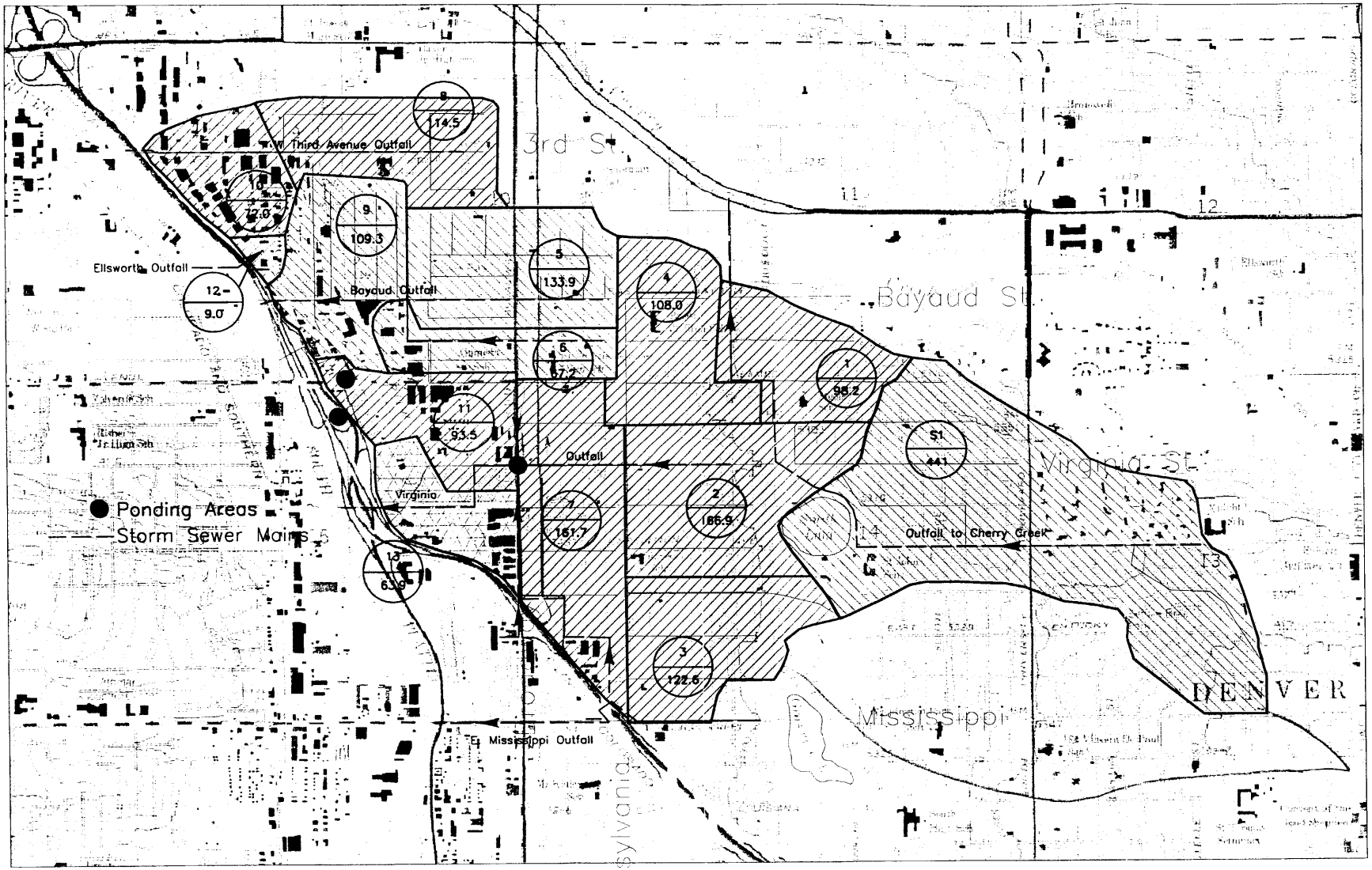
Sub-Basin	Basin Area (mi^2)	Basin Length (mi)	Centroidal Length (mi)	Percent Impervious (%)	Weighted Slope (ft/ft)	Time of Concentration (min)	Max Depression Storage (Pervious)	Max Depression Storage (Impervious)	Initial Infiltration Rate (in/in)	Final Infiltration Rate (in/in)	Horton' s Decay Coefficient
1	0.15	0.59	0.3	47	0.011		0.35	0.3	3	0.5	0.0018
2	0.26	0.78	0.49	47	0.007		0.35	0.3	3	0.5	0.0018
3	0.19	0.72	0.36	47	0.008		0.35	0.3	3	0.5	0.0018
4	0.17	0.67	0.27	50	0.01		0.35	0.3	3	0.5	0.0018
5	0.21	0.76	0.36	50	0.005		0.35	0.3	3	0.5	0.0018
6	0.11	0.85	0.45	50	0.002	35.9	0.35	0.3	3	0.5	0.0018
7	0.25	0.93	0.19	50	0.004		0.35	0.3	3	0.5	0.0018
8	0.18	0.76	0.32	50	0.006		0.35	0.3	3	0.5	0.0018
9	0.17	0.68	0.24	65	0.004		0.35	0.3	3	0.5	0.0018
10	0.11	0.55	0.23	80	0.005	34.1	0.35	0.3	3	0.5	0.0018
11	0.15	0.7	0.41	80	0.009	34.2	0.35	0.3	3	0.5	0.0018

% Imperviousness for the basins was estimated using Table 3-1 *Recommended Runoff Coefficients and Percent Impervious* Multi-Unit detached from the UD&FCDCM. The density of the Units/acre for the residential areas to the east of I-25 was estimated to be approximately 9.7 units/Acre. Extrapolating from Figure 2-1 Residential Housing Density vs. Impervious Area confirms that the % Imperviousness should be 50%.

Basin Area, Basin Length and **Centroidal Lengths** were calculated from Autocadd Drawing File 9904-basin.dwg. **Weighted Slope** was calculated using Equation 4-5 from the UD&FCDCM with data obtained from USGS mapping and data obtained from aerial photography.

Horton's Equation parameters were based on Hydrologic soils Group C and the values in Table 2-2, *Recommended Horton's Equation Parameters*. An SCS soils report has not been published for Denver County.

Pervious and Impervious Depression Retention was estimated using Table 2-1 *Typical Depression Retention for Various Land Covers*. The maximum value of 0.3 was used for the Impervious Retention due to the large amount of retention from high street crowns and very mild slopes in the subject area.



Location of Outfall	Description	Q_{100}
W Third Avenue Outfall	60" RCP	140 cfs
Ellsworth Outfall	24" RCP	58 cfs
Bayoud Outfall	36" Brick	146 cfs
Virginia Outfall	66" Brick	212 cfs
Basin 13 Outfall	Multiple RCPs	400 cfs
E. Mississippi Outfall	69" RCP	479 cfs

REVISIONS

NO	DATE	BY	CHK'D	DESCRIPTION

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I-25/BROADWAY

FIGURE 1
DRAINAGE BASINS

DESIGNED		DATE	1/10/2000
DRAWN	DLK	FILE	9904-BASIN
CHECKED	MSD	PROJ. NO.	9904
SCALE	NTS	SHEET 1 OF 1	

Table 3: Peak Flows

Basin	Peak Flow (cfs)				Cfs per Acre			
	5	10	50	100	5	10	50	100
1	117	158	291	339	1.2	1.6	3.0	3.5
2	157	217	399	472	1.6	2.2	4.1	4.8
3	132	178	321	383	1.3	1.8	3.3	3.9
4	140	188	343	398	1.4	1.9	3.5	4.1
5	144	196	353	417	1.5	2.0	3.6	4.2
6	61	81	148	178	0.6	0.8	1.5	1.8
7	190	253	447	535	1.9	2.6	4.6	5.4
8	130	174	311	371	1.3	1.8	3.2	3.8
9	165	212	370	423	1.7	2.2	3.8	4.3
10	89	112	189	219	0.9	1.1	1.9	2.2
11	166	211	353	400	1.7	2.1	3.6	4.1
				Ave:	1.4	1.8	3.3	3.8

Smith Lake and Washington Park

Drainage from Sub-basin S1, located to the east and southeast of Smith Lake will flow into Smith Lake. The hydrograph from this basin minus the capacity of the storm sewer running along Marion Pkwy was routed into Smith Lake. The volume in Smith Lake available for storm storage was conservatively estimated to be 47 acre-feet. This is based on the area of the perimeter of Smith Lake and the outlet elevations as taken from mapping obtained from the Denver Department of Parks and Recreation. The estimated time needed for Smith Lake to overflow was 60 minutes. Assuming a 1.2% constant slope and a travel velocity of 2.19 ft/sec along the 4300 foot length from Marion Pkwy to Broadway, the total time needed for water to flow from basin S1 to Broadway and Virginia was calculated to be approximately 90 minutes. The flow from basin 3 to Virginia and Broadway at 90 minutes is about 900 cfs. Therefore, the weir flow from Smith Lake of approximately 350 cfs would not create a peak flow rate greater than the peak flow from the lower basins and will therefore not be considered in the design.

Interstate 25 is affected by drainage from the east flowing toward the South Platte River. Storm sewers accept smaller flows, but larger flows run overland and affect I-25 in large, infrequent storms. Flow enters I-25 at the following locations.

Broadway Market Place

Runoff from Sub-Basins 1, 2, 3, 4 and 7 will reach a sump at Virginia & Broadway where flooding will occur. Interviews with business owners at this intersection have indicated that drainage problems occur at this intersection on a yearly basis. After the water has accumulated to the necessary volume it will flow across the Broadway Marketplace to the Northwest and exit into W. Alameda Ave. It will then flow west down W. Alameda Ave under the Light Rail to a small sump at W. Alameda Ave and Santa Fe. Interviews with business owners at this intersection have indicated that drainage problems also occur at this intersection on a yearly basis. The water will then flow southwest across the Denny's parking lot to a small detention basin on the west side of Kalamath St. When the detention basin capacity is reached the water will flow onto I-25 and into the sump under W. Alameda Ave (Figure 2). It will then be pumped into the South Platte River. For the 100-year storm event the runoff at Broadway and Virginia is expected to be approximately 1,989 cfs. Approximately 212 cfs will be routed through a 66" brick storm sewer that runs from Broadway and Virginia under the Broadway Marketplace to the South Platte River. Therefore the runoff that can be expected from Sub-Basins 1, 2, 3, 4 and 7 for the 100-year storm event is

Existing outfall along South Platte River near Invesco Field at Mile High.