Appendix A

Model Parameters

Subbasin Parameters

Subbasin Parameters			Loss Model Parameters				Unit Hydrograph Parameters	
Basin ID	Area		Exisiting Conditions	Existing Cond. Impervious	Developed Conditions	Developed Cond. Impervious	Time of concentration	Storage coefficient
	(ac)	(mi^2)	(CN)	(%)	(CN)	(%)	(h)	(h)
A_101	14.7	0.023	74	4.6	74	4.7	0.10	0.07
A_102	14.6	0.023	74	4.9	74	5.1	0.10	0.07
A_103	41.1	0.064	74	1.0	74	1.0	0.19	0.13
A_104	38.5	0.060	75	5.0	76	34.7	0.23	0.17
A_105	318.7	0.498	74	1.3	76	17.6	0.78	0.55
A_106	233.9	0.365	75	5.3	76	40.2	0.32	0.23
A_107	131.2	0.205	75	0.4	77	27.0	0.36	0.26
A_108	83.3	0.130	76	7.0	76	7.4	0.17	0.12
A_109	158.3	0.247	77	15.7	77	16.5	0.28	0.20
A_110	105.7	0.165	74	2.5	75	66.9	0.19	0.14
A_111	121.4	0.190	75	0.7	75	1.2	0.19	0.13
B_101	258.1	0.403	80	23.4	80	23.6	0.36	0.26
B_102	326.2	0.510	80	18.0	80	18.1	0.38	0.27
C_001	13.7	0.021	80	21.3	80	21.3	0.21	0.15
C_002	167.2	0.261	80	44.1	81	51.0	0.24	0.17
C_003	93.2	0.146	79	10.9	79	11.1	0.20	0.14
C_004	20.5	0.032	80	14.7	80	15.4	0.24	0.17
C_005	10.6	0.017	81	18.4	81	18.5	0.11	0.08
C_006	91.4	0.143	80	15.3	80	15.5	0.15	0.11
C_007	26.4	0.041	80	20.9	80	21.0	0.13	0.10
C_008	111.6	0.174	80	19.5	80	19.7	0.17	0.12
C_009	50.4	0.079	76	9.7	78	13.7	0.16	0.11
C_010	73.4	0.115	77	9.4	78	11.8	0.15	0.11
C_011	39.2	0.061	77	11.6	78	13.0	0.15	0.10
C_012	18.3	0.029	81	34.5	84	51.9	0.10	0.07
C_013	22.6	0.035	83	28.1	83	28.2	0.19	0.13
C_014	24.7	0.039	82	30.1	82	30.2	0.23	0.16
C_015	19.8	0.031	82	38.1	84	42.4	0.19	0.14
C_016A	55.7	0.087	78	13.5	81	54.3	0.26	0.19
C_016B	98.6	0.154	79	21.0	82	43.7	0.14	0.10
C_017	36.7	0.057	80	29.3	80	29.5	0.17	0.12
C_018	32.6	0.051	83	20.1	83	20.2	0.14	0.10
C_019	194.5	0.304	82	19.8	82	20.3	0.17	0.12
C_020	191.8	0.300	78	14.0	78	14.1	0.24	0.17
C_021	12.4	0.019	88	0.0	88	0.7	0.34	0.24
D_101	119.8	0.187	80	21.1	81	24.8	0.17	0.12
D_102	124.0	0.194	76	7.6	78	11.9	0.11	0.08
E_101	133.0	0.208	75	5.2	78	42.1	0.25	0.18
E_102	85.5	0.134	76	5.6	78	30.8	0.25	0.18
E_201	86.0	0.134	76	6.8	76	20.5	0.21	0.15
F_101	222.5	0.348	75	0.5	76	1.7	0.52	0.37
F_102	32.4	0.051	80	24.3	80	24.4	0.18	0.13
F_103	161.9	0.253	81	23.7	81	23.8	0.22	0.16

Subbasin Parameters			Loss Model Parameters				Unit Hydrograph Parameters	
Basin ID	Area		Exisiting Conditions	Existing Cond. Impervious	Developed Conditions	Developed Cond. Impervious	Time of concentration	Storage coefficient
	(ac)	(mi^2)	(CN)	(%)	(CN)	(%)	(h)	(h)
F_104	22.2	0.035	80	21.3	80	23.2	0.17	0.12
F_105	56.0	0.087	82	27.6	82	30.0	0.26	0.18
F_201	39.7	0.062	82	17.4	82	18.3	0.14	0.10
F_202	54.1	0.085	75	4.0	76	5.0	0.32	0.23
F_301	243.7	0.381	74	1.4	77	5.3	0.39	0.28
F_401	44.9	0.070	82	22.8	82	23.0	0.15	0.10
F_402	112.2	0.175	75	0.8	82	30.3	0.55	0.40
G_101	478.9	0.748	74	0.0	75	79.5	0.60	0.43
G_102	436.7	0.682	74	0.0	76	4.3	0.49	0.35
G_103	394.1	0.616	75	0.0	76	0.9	0.43	0.31
G_104	320.4	0.501	74	0.0	75	1.0	0.54	0.39
G_201	939.2	1.467	75	0.2	76	8.9	1.13	0.81
G_301	43.9	0.069	82	25.5	82	25.5	0.21	0.15
H_101	32.2	0.050	75	0.2	75	17.5	0.45	0.32
H_102	22.3	0.035	81	27.5	83	30.2	0.19	0.13
H_103	11.0	0.017	84	25.8	84	25.9	0.11	0.08
H_104	21.2	0.033	79	23.6	79	23.8	0.15	0.11
I_001	118.8	0.186	82	20.5	82	20.6	0.30	0.22
I_002	145.8	0.228	82	25.7	82	25.8	0.36	0.26
I_003	94.9	0.148	82	25.7	82	25.8	0.29	0.21
I_004	30.5	0.048	83	23.4	83	23.6	0.20	0.14
I_005	49.7	0.078	83	23.5	83	23.6	0.24	0.17
I_006	52.4	0.082	82	22.0	82	22.5	0.22	0.16
I_007	42.2	0.066	84	21.9	84	22.1	0.21	0.15
I_008	29.9	0.047	80	17.9	80	18.2	0.12	0.08
I_101	192.3	0.300	75	0.0	75	0.5	0.70	0.50
I_102	64.8	0.101	83	26.2	83	26.2	0.20	0.14
I_103	49.3	0.077	74	0.0	75	0.7	0.46	0.33
I_201	168.3	0.263	75	0.0	76	10.1	0.57	0.41
I_202	51.3	0.080	83	27.2	84	27.5	0.18	0.13
I_301A	51.2	0.080	75	2.0	83	32.1	0.37	0.26
I_301B	34.5	0.054	75	1.1	84	26.4	0.33	0.24
I_302	22.0	0.034	75	3.7	83	25.8	0.27	0.20
I_303	20.1	0.031	74	2.0	84	25.8	0.30	0.22
I_304	9.8	0.015	80	27.4	82	31.6	0.27	0.20
I_305	44.2	0.069	77	12.3	81	39.9	0.33	0.24
I_306	16.6	0.026	75	1.1	75	76.7	0.32	0.23
I_307	13.0	0.020	82	39.7	86	61.7	0.23	0.16
I_401	21.4	0.033	75	0.0	82	22.4	0.30	0.21
I_402	45.5	0.071	80	17.2	80	17.2	0.20	0.14
J_101	913.2	1.427	74	0.0	74	0.0	0.76	0.54
J_102	864.4	1.351	74	0.0	74	0.0	0.62	0.45
J_103	314.1	0.491	74	0.0	74	0.0	0.49	0.35

Subbasin Parameters			Loss Model Parameters				Unit Hydrograph Parameters	
Basin ID	Area		Exisiting Conditions	Existing Cond. Impervious	Developed Conditions	Developed Cond. Impervious	Time of concentration	Storage coefficient
	(ac)	(mi^2)	(CN)	(%)	(CN)	(%)	(h)	(h)
J_104	676.7	1.057	74	0.0	74	0.0	0.83	0.59
J_105	543.8	0.850	74	0.0	74	0.0	0.64	0.46
J_106	424.4	0.663	74	0.0	78	12.2	0.91	0.65
J_107	495.3	0.774	74	0.0	75	27.2	0.75	0.54
J_201	390.4	0.610	74	0.0	74	0.0	0.63	0.45
J_301	711.4	1.112	74	0.0	74	0.0	0.92	0.66
J_302	565.0	0.883	74	0.0	74	0.0	0.71	0.51
J_303	623.3	0.974	74	0.0	74	0.0	0.76	0.54
J_401	470.4	0.735	74	0.0	74	0.1	0.64	0.45
J_402	994.6	1.554	75	0.0	75	0.3	0.61	0.43
J_403	752.5	1.176	74	0.0	75	16.4	0.75	0.54
J_501	529.0	0.827	74	0.0	75	2.8	1.03	0.73
K_101	720.1	1.125	74	0.0	74	0.0	0.96	0.69
K_102	767.2	1.199	74	0.0	74	0.1	1.03	0.74
K_103	629.4	0.983	75	0.0	75	0.1	0.89	0.64
K_104	257.5	0.402	74	0.0	77	10.4	0.62	0.45
K_201	731.9	1.144	74	0.0	74	0.0	1.10	0.79
K_301	1076.6	1.682	74	0.0	74	0.1	1.33	0.95
L_101	1413.4	2.208	74	0.0	74	0.0	0.97	0.69
L_102	706.9	1.105	74	0.0	74	0.0	0.88	0.63
L_103	563.3	0.880	74	0.0	74	0.0	0.76	0.54
L_104	503.4	0.787	74	0.0	75	12.2	0.83	0.59
L_105	160.3	0.250	74	0.0	74	0.1	0.70	0.50
L_201	1152.7	1.801	74	0.0	74	0.0	1.33	0.95
L_202	430.0	0.672	74	0.0	74	0.0	0.55	0.39
L_301	874.5	1.366	74	0.0	74	0.0	0.98	0.70
M_101	608.8	0.951	74	0.0	75	0.5	0.59	0.42
M_102	456.7	0.714	74	0.0	75	0.2	0.47	0.34
M_103	402.6	0.629	74	0.0	74	0.1	0.46	0.33
M_201	546.8	0.854	74	0.0	74	0.0	0.80	0.57
M_202	411.4	0.643	74	0.0	74	0.0	0.55	0.40
M_203	489.0	0.764	74	0.0	74	0.0	0.62	0.44
M_204	412.3	0.644	75	0.0	75	0.1	0.83	0.59
M_301	349.7	0.546	74	0.0	74	0.0	0.52	0.37
N_101	161.2	0.252	75	0.3	81	55.0	0.38	0.27
N_102	67.8	0.106	75	1.7	82	26.6	0.55	0.39
N_103	216.7	0.339	75	0.7	81	44.6	0.45	0.32
N_201	138.7	0.217	76	10.3	78	73.0	0.36	0.26
N_301	27.8	0.043	82	20.3	83	32.0	0.15	0.11
O_101	500.3	0.782	75	0.2	81	43.4	0.98	0.70
P_101	566.2	0.885	74	0.8	83	25.1	0.86	0.61
P_201	11.9	0.019	84	23.0	85	23.6	0.18	0.13
P_202	36.3	0.057	75	6.0	84	28.6	0.14	0.10

Subbasin Parameters			Loss Model Parameters				Unit Hydrograph Parameters	
Basin ID	Area		Exisiting Conditions	Existing Cond. Impervious	Developed Conditions	Developed Cond. Impervious	Time of concentration	Storage coefficient
	(ac)	(mi^2)	(CN)	(%)	(CN)	(%)	(h)	(h)
P_301	195.1	0.305	77	8.3	76	61.1	0.42	0.30
Q_101	103.7	0.162	75	0.1	79	34.3	0.38	0.27
Q_102	236.4	0.369	79	25.3	79	26.0	0.25	0.18
R_101	161.8	0.253	78	21.8	81	61.8	0.21	0.15
R_102	124.1	0.194	78	19.9	78	20.0	0.20	0.14
R_103	140.8	0.220	79	19.2	79	19.3	0.23	0.17
R_104	185.2	0.289	79	18.1	79	19.7	0.20	0.14
R_201	60.8	0.095	80	18.0	80	18.0	0.22	0.16
R_301	131.4	0.205	78	27.9	78	37.0	0.40	0.29
S_101	47.3	0.074	76	49.8	78	76.6	0.44	0.31
S_102	32.3	0.050	88	39.0	88	39.0	0.14	0.10
T_101	56.0	0.088	75	42.7	76	57.2	0.24	0.17
T_102	68.1	0.106	88	39.3	88	39.8	0.28	0.20
T_103	95.8	0.150	75	1.6	76	16.3	0.54	0.39
U_101	168.4	0.263	76	11.3	79	79.9	0.29	0.21
U_102	282.7	0.442	76	19.5	80	69.3	0.33	0.23
U_103	446.4	0.698	75	0.4	82	43.1	0.73	0.52
U_104	157.7	0.246	75	0.2	79	9.5	0.57	0.41
U_105	442.8	0.692	75	4.0	76	10.1	0.41	0.29
U_106	156.7	0.245	75	0.5	75	0.9	0.29	0.21
U_107	195.4	0.305	76	5.9	77	9.7	0.25	0.18
U_108	82.1	0.128	75	2.2	76	14.8	0.18	0.13
U_201	20.4	0.032	81	24.8	85	28.5	0.20	0.14
U_202	415.4	0.649	75	0.9	82	31.7	0.62	0.44
U_301A	42.2	0.066	74	0.0	77	3.0	0.23	0.16
U_301B	93.4	0.146	74	0.0	77	3.0	0.38	0.27
U_302	28.2	0.044	81	23.2	84	26.3	0.17	0.12
U_401	33.9	0.053	75	0.0	77	3.0	0.31	0.22
U_402	45.9	0.072	84	26.4	84	26.8	0.13	0.09
U_501	211.5	0.330	79	3.4	75	53.8	0.33	0.24
U_601	94.0	0.147	75	0.5	83	27.4	0.60	0.43
U_602	265.9	0.416	75	1.1	77	17.0	0.65	0.46
U_603	159.3	0.249	75	0.4	75	1.3	0.32	0.23
U_701	174.8	0.273	76	2.8	77	5.1	0.70	0.50
U_702	143.6	0.224	78	21.4	78	28.5	0.22	0.15
U_703	135.7	0.212	77	4.2	77	5.2	0.39	0.28
U_801	106.4	0.166	76	9.6	77	15.1	0.38	0.27
U_901	106.9	0.167	76	8.7	77	14.4	0.50	0.36

Routing Parameters

Routing Reach ID	Length	Slope	Manning's n	Shape	Diameter	Width	Side Slope	Channel Loss
	(ft)	(ft/ft)	( )		(ft)	(ft)	(xH : 1V)	(cfs/ac)
A_101_R	2228	0.012	0.020	Rectangle		87		1.5
A_102_R1	746	0.010	0.020	Rectangle		96		1.5
A_102_R2	747	0.016	0.020	Rectangle		48		1.5
A_103_R1	708	0.012	0.020	Rectangle		70		1.5
A_103_R2	1349	0.011	0.020	Rectangle		161		1.5
A_104_R1	2759	0.012	0.020	Rectangle		173		1.5
A_104_R2	1984	0.013	0.020	Rectangle		166		1.5
A_104_R3	2228	0.014	0.020	Rectangle		143		1.5
A_104_R4	1059	0.010	0.020	Rectangle		253		1.5
A_104_R5	1110	0.014	0.020	Rectangle		174		1.5
A_105_R1	2176	0.009	0.020	Rectangle		106		1.5
A_105_R2	1856	0.012	0.020	Rectangle		123		1.5
A_105_R3	1128	0.009	0.020	Rectangle		111		1.5
A_105_R4	1604	0.012	0.020	Rectangle		185		1.5
A_105_R5	978	0.003	0.020	Rectangle		194		1.5
A_106_R1	689	0.008	0.020	Rectangle		92		1.5
A_106_R2	2186	0.012	0.020	Rectangle		141		1.5
A_106_R3	1190	0.013	0.020	Rectangle		142		1.5
A_106_R4	774	0.011	0.020	Rectangle		139		1.5
A_106_R5	783	0.014	0.020	Rectangle		126		1.5
A_107_R1	633	0.010	0.020	Rectangle		104		1.5
A_107_R2	1055	0.011	0.020	Rectangle		183		1.5
A_107_R3	423	0.013	0.020	Rectangle		149		1.5
A_107_R4	925	0.014	0.020	Rectangle		115		1.5
A_107_R5	900	0.004	0.020	Rectangle		100		1.5
A_108_R1	1270	0.013	0.020	Rectangle		93		1.5
A_108_R2	1504	0.014	0.020	Rectangle		160		1.5
A_108_R3	2167	0.015	0.020	Rectangle		115		1.5
A_108_R4	1958	0.014	0.020	Rectangle		88		1.5
A_109_R1	1953	0.013	0.020	Rectangle		85		1.5
A_109_R2	1322	0.013	0.020	Rectangle		107		1.5
A_110_R1	852	0.012	0.020	Rectangle		133		1.5
A_110_R2	1281	0.012	0.020	Rectangle		194		1.5
A_110_R3	1891	0.011	0.020	Rectangle		273		1.5
A_110_R4	1210	0.008	0.020	Rectangle		158		1.5
B_101_R	2700	0.011	0.013	Circle	7.5			0
B_102_R	3900	0.021	0.013	Circle	7.5			0
C_001_R	1962	0.041	0.020	Trapezoid		15	4	0
C_003_R	964	0.032	0.025	Circle	4.0			0
C_004_R	1290	0.046	0.025	Circle	2.0			0
C_012_R	643	0.036	0.020	Rectangle		30		0
C_013_R	912	0.037	0.025	Trapezoid		15	2	0
C_014_R	1277	0.020	0.013	Circle	4.0			0
C_015_R	2029	0.013	0.025	Rectangle		30		0

Routing Reach ID	Length	Slope	Manning's n	Shape	Diameter	Width	Side Slope	Channel Loss
	(ft)	(ft/ft)	( )		(ft)	(ft)	(xH : 1V)	(cfs/ac)
C_016_A_R	3230	0.028	0.013	Circle	4.0			0
C_018_R	1216	0.025	0.020	Trapezoid		20	4	0
D_101_R	3188	0.033	0.020	Trapezoid		20	4	0
E_101_R1	1053	0.020	0.025	Trapezoid		15	4	0
E_101_R2	2303	0.028	0.020	Trapezoid		20	4	0
E_201_R	1175	0.034	0.030	Trapezoid		15	4	0
F_101_R	1380	0.016	0.025	Trapezoid		15	4	0
F_102_R1	1844	0.020	0.020	Trapezoid		15	6	0
F_102_R2	855	0.008	0.020	Trapezoid		15	6	0
F_103_R	1475	0.014	0.020	Trapezoid		30	6	0
F_104_R	1241	0.017	0.013	Trapezoid		15	2	0
F_105_R	1388	0.020	0.020	Trapezoid		30	2	0
F_201_R	574	0.053	0.020	Trapezoid		25	4	0
F_202_R	2876	0.029	0.030	Trapezoid		15	4	0
F_301_R	619	0.024	0.025	Circle	7.0			0
F_402_R	411	0.031	0.020	Trapezoid		10	5	0
G_101_R	3726	0.015	0.020	Trapezoid		40	6	0
G_102_R	4072	0.013	0.020	Trapezoid		45	6	0
G_103_R1	4367	0.015	0.020	Trapezoid		50	6	0
G_103_R2	1879	0.015	0.020	Trapezoid		20	4	0
G_103_R3	2457	0.012	0.020	Trapezoid		90	6	0
H_101_R	575	0.020	0.013	Circle	3.5			0
H_102_R	595	0.021	0.013	Circle	3.5			0
I_101_R1	1262	0.013	0.013	Circle	2.5			0
I_101_R2	667	0.014	0.013	Circle	3.0			0
I_103_R	889	0.011	0.013	Circle	2.0			0
I_201_R	2398	0.017	0.013	Circle	4.0			0
I_301_R	708	0.008	0.013	Circle	2.5			0
I_302_R	273	0.008	0.013	Circle	2.5			0
I_303_R1	427	0.008	0.013	Circle	2.5			0
I_303_R2	834	0.008	0.013	Circle	2.5			0
I_306_R	1953	0.019	0.013	Circle	2.5			0
I_401_R	1681	0.027	0.013	Circle	2.0			0
J_101_R	8942	0.014	0.030	Trapezoid		30	6	0
J_102_R	7201	0.017	0.030	Trapezoid		40	6	0
J_103_R	7735	0.014	0.030	Trapezoid		45	6	0
J_104_R1	3896	0.014	0.025	Rectangle		76		1.5
J_104_R2	3675	0.015	0.025	Rectangle		107		1.5
J_104_R3	3317	0.014	0.025	Rectangle		71		1.5
J_105_R1	4398	0.014	0.020	Rectangle		72		1.5
J_105_R2	4443	0.012	0.020	Rectangle		101		1.5
J_105_R3	4460	0.013	0.020	Rectangle		84		1.5
J_106_R1	4343	0.012	0.020	Rectangle		85		1.5
J_106_R2	1485	0.010	0.020	Rectangle		71		1.5

Routing Reach ID	Length	Slope	Manning's n	Shape	Diameter	Width	Side Slope	Channel Loss
	(ft)	(ft/ft)	( )		(ft)	(ft)	(xH : 1V)	(cfs/ac)
J_107_R	2047	0.011	0.020	Rectangle		86		1.5
J_301_R	8516	0.017	0.030	Trapezoid		30	6	0
J_302_R	11827	0.017	0.030	Trapezoid		40	6	0
J_401_R	6843	0.018	0.035	Trapezoid		60	10	0
J_402_R1	5839	0.014	0.025	Trapezoid		30	6	0
J_402_R2	1816	0.012	0.025	Trapezoid		35	6	0
J_501_R	4518	0.015	0.035	Trapezoid		70	10	0
K_101_R1	3897	0.016	0.035	Trapezoid		70	10	0
K_101_R2	1104	0.011	0.020	Trapezoid		30	4	0
K_102_R	8188	0.014	0.035	Trapezoid		50	10	0
K_103_R	2998	0.012	0.035	Trapezoid		50	10	0
K_201_R	5078	0.019	0.035	Trapezoid		50	10	0
L_101_R	11884	0.014	0.030	Trapezoid		30	6	0
L_102_R1	2170	0.012	0.035	Trapezoid		50	10	0
L_102_R2	1958	0.010	0.025	Trapezoid		40	6	0
L_103_R	6539	0.013	0.020	Trapezoid		45	6	0
L_104_R1	5389	0.012	0.035	Trapezoid		100	6	0
L_104_R2	1026	0.010	0.025	Trapezoid		100	6	0
L_105_R1	1718	0.011	0.025	Trapezoid		100	6	0
L_105_R2	1688	0.013	0.025	Trapezoid		100	6	0
L_105_R3	609	0.012	0.025	Trapezoid		100	6	0
L_201_R	4588	0.015	0.035	Trapezoid		100	10	0
L_202_R	2141	0.017	0.035	Trapezoid		100	10	0
M_101_R	5441	0.013	0.025	Trapezoid		35	6	0
M_102_R1	3667	0.013	0.025	Trapezoid		40	6	0
M_102_R2	2511	0.013	0.025	Trapezoid		50	6	0
M_201_R	5293	0.014	0.025	Trapezoid		30	6	0
M_202_R	5387	0.013	0.035	Trapezoid		50	10	0
M_203_R	4794	0.015	0.035	Trapezoid		50	10	0
M_204_R	1258	0.015	0.020	Rectangle		30		0
N_101_R	1721	0.017	0.020	Rectangle		30		0
N_102_R	3887	0.019	0.025	Circle	4.0			0
N_201_R	2199	0.018	0.025	Circle	7.0			0
P_201_R	1495	0.033	0.020	Rectangle		30		0
P_202_R	658	0.011	0.020	Rectangle		30		0
Q_101_R1	1000	0.026	0.013	Circle	3.0			0
Q_101_R2	770	0.017	0.020	Trapezoid		15	3	0
R_101_R1	1345	0.029	0.013	Circle	4.0			0
R_101_R2	2864	0.026	0.020	Trapezoid		40	2	0
R_102_R	1864	0.021	0.025	Trapezoid		15	3	0
R_103_R1	903	0.020	0.020	Trapezoid		20	3	0
R_103_R2	3637	0.005	0.025	Trapezoid		40	2	0
S_101_R	1272	0.022	0.025	Circle	4.0			0
T_101_R	2317	0.014	0.017	Rectangle		30		0

Routing Reach ID	Length	Slope	Manning's n	Shape	Diameter	Width	Side Slope	Channel Loss
	(ft)	(ft/ft)	( )		(ft)	(ft)	(xH : 1V)	(cfs/ac)
T_102_R	3810	0.015	0.020	Trapezoid		20	6	0
U_101_R	4172	0.017	0.035	Trapezoid		40	10	0
U_102_R	4517	0.017	0.030	Trapezoid		30	4	0
U_103_R	5537	0.013	0.030	Trapezoid		35	6	0
U_104_R1	1083	0.013	0.030	Trapezoid		35	6	0
U_104_R2	5356	0.014	0.025	Trapezoid		50	6	0
U_105_R	4219	0.017	0.020	Trapezoid		80	6	0
U_106_R	2955	0.018	0.020	Trapezoid		100	4	0
U_107_R	2160	0.015	0.020	Trapezoid		120	4	0
U_201_R1	4993	0.020	0.030	Trapezoid		60	10	0
U_201_R2	1738	0.013	0.030	Trapezoid		20	6	0
U_202_R1	1056	0.013	0.030	Trapezoid		25	6	0
U_202_R2	1171	0.012	0.020	Trapezoid		25	6	0
U_301_R1	1461	0.011	0.013	Circle	5.0			0
U_301_R2	800	0.017	0.013	Circle	4.0			0
U_401_R	2734	0.030	0.017	Rectangle		30		0
U_501_R	1130	0.032	0.025	Trapezoid		15	4	0
U_601_R	5084	0.019	0.035	Trapezoid		20	2	0
U_602_R	3496	0.025	0.020	Trapezoid		40	4	0
U_701_R	2084	0.027	0.013	Circle	3.0			0
U_702_R	2962	0.026	0.020	Trapezoid		20	2	0
V_R1	1779	0.010	0.013	Rectangle		15		0
V_R2	676	0.010	0.013	Rectangle		15		0
V_R3	738	0.007	0.013	Rectangle		15		0
V_R4	3261	0.009	0.013	Rectangle		15		0
W_R1	1745	0.009	0.013	Rectangle		35		0
W_R2	939	0.007	0.013	Rectangle		40		0
W_R3	2365	0.005	0.013	Rectangle		40		0

Appendix B

Existing Ponds

Hydro ID	Source	Compiled by	Date	Drainage area (mi^2)	Emergency spillway (ft) [a]	V_{EmSp} (ac-ft)	Top of embankment (ft) [a]	V_{TOP} (ac-ft)	Existing peak depth (ft) [a]	DEVEX peak depth (ft) [a]	Note
B_102_Pond	Phase II Dam No. 4 Outfall to Dam No. 1 Record Drawings	Wilson	Nov-99	0.9	32.8	88.5	37.0	108.6	18.2	18.2	
C_002_Pond	Drainage Report for Arrowhead Ridge Subdivision	Community Sciences	May-96	0.3	6.0	7.0	8.0	10.4	7.6	7.9	Emergency spillway directly into Montoyas Arroyo
C_003_Pond	Drainage Report For Greystone Ridge Subdivision	C.L. Weiss	Oct-03	0.1			6.0	1.9	4.5	4.5	
C_006_Pond	Drainage Study For Cascades At High Resort	Cinfran	Sep-93	0.1	4.5	4.3	6.0	6.1	4.9	4.9	Emergency spillway directly into Montoyas Arroyo
C_007_Pond	Drainage Study For Cascades At High Resort	Cinfran	Sep-93	0.0	4.5	2.8	5.5	4.0	3.6	3.6	
C_008_Pond	Drainage Study For Broadmoor At High Resort Phase 2	Cinfran	Dec-92	0.2	4.0	2.9	5.5	4.3	5.4	5.4	Emergency spillway directly into Montoyas Arroyo
C_016A_Pond	*GIS*	SSCAFCA	Nov-16	0.1			6.0	4.1	4.1	4.4	
C_019_Pond	*Field Investigation*	SSCAFCA	Nov-16	0.3	10.0	4.2	12.0	5.8	10.8	10.9	Emergency spillway directly into Montoyas Arroyo
D_101_Pond	Drainage Report For Los Milagros & Record Drawings	Wilson	Dec-02	0.2	7.5	5.5	10.0	8.3	7.2	7.6	Additional upstream attenuation may be required under developed conditions
F_103_Pond	*Field Investigation*	SSCAFCA	Nov-16	0.8	10.0	18.6	12.0	25.3	8.3	8.5	
F_104_Pond	*Field Investigation*	SSCAFCA	Nov-16	0.8			8.0	6.0	6.1	6.2	
F_201_Pond	Drainage Study For Los Pinons Subdivision	Huitt-Zollars	Jul-04	0.1			5.0	1.2	5.0	5.0	
F_402_Pond	Drainage Report For Sierra Norte Unit II Subdivision	Tierra West	May-03	0.2			4.5	2.8	4.6	4.8	Pond spills onto roadway
G_301_Pond	Drainage Report North Hills Unit 14	Cinfran	Aug-93	0.1	6.0	4.7	10.0	9.1	5.4	5.4	
H_102_Pond	Master Drainage Plan For Cielo Norte Subdivison, Units I, II & III	Isaacson & Arfman	Mar-06	0.1			3.0	1.8	0.9	1.2	
H_103_Pond	Master Drainage Plan For Cielo Norte Subdivison, Units I, II & III	Isaacson & Arfman	Mar-06	0.1			2.5	0.6	1.5	1.6	

Hydro ID	*Source*	Compiled by	*Date*	*Drainage area (mi^2)*	*Emergency spillway (ft)* [a]	*V_{EmSp} (ac-ft)*	*Top of embankment (ft)* [a]	*V_{TOP} (ac-ft)*	*Existing peak depth (ft)* [a]	*DEVEX peak depth (ft)* [a]	*Note*
H_104_Pond	Master Drainage Plan For Cielo Norte Subdivison, Units I, II & III	Isaacson & Arfman	Mar-06	0.1			5.0	8.4	3.6	4.1	
I_001_Pond	Northen Meadows Phase 2 Drainage Master Plan	Wilson	Mar-04	0.2	4.0	9.9			3.3	3.4	
I_002_Pond	Final Drainage Study For Northen Meadows Unit 20A & 20B	Huitt-Zollars	Jun-04	0.2	4.0	7.4	5.0	9.8	3.8	3.8	
I_003_Pond	Final Drainage Study For Northen Meadows Unit 20A & 20B	Huitt-Zollars	Jun-04	0.1	3.0	5.3	4.0	7.5	3.7	3.7	Emergency spillway directly into Montoyas Arroyo
I_004_Pond	Drainage Report For Northen Meadows Units 12	Wilson	Dec-03	0.0	6.0	1.1	9.0	2.4	5.1	5.1	
I_005_Pond	Final Drainage Study For Northen Meadows Unit 12	Huitt-Zollars	Apr-05	0.1			3.5	2.6	1.9	1.9	
I_006_Pond	Final Drainage Study For Northern Meadows Unit 17 and 18	Huitt-Zollars	Apr-05	0.1			4.0	3.7	2.6	2.6	
I_007_Pond	Final Drainage Study For Northern Meadows Unit 16	Huitt-Zollars	Apr-05	0.1			4.0	3.0	2.2	2.2	
I_008_Pond	Drainage Report For Northen Meadows Units 14 & 18	Wilson	Aug-04	0.0	4.0	0.8	5.0	1.0	3.6	3.6	
I_101_Pond	Drainage Report For Northen Meadows Units 13	Wilson	Dec-03	0.3			7.0	16.0	4.1	4.1	
I_102_Pond	Drainage Report For Northen Meadows Units 11	Wilson	Dec-03	0.5	5.0	1.3	9.0	2.9	4.5	4.5	
I_103_Pond	Drainage Report For Northen Meadows Units 14	Wilson	Dec-03	0.1			7.0	4.4	4.4	4.6	
I_201_Pond	Northen Meadows Phase 2 Drainage Master Plan	Wilson	Mar-04	0.3			8.5	16.4	4.6	6.0	
I_202_Pond	Northen Meadows Phase 2 Drainage Master Plan	Wilson	Mar-04	0.3			5.0	1.8	5.0	5.1	
I_301_Pond_A	Final Drainage Study For Northern Meadows Unit 21	Huitt-Zollars	Apr-05	0.1			5.5	6.0	6.3	7.1	System will require re-analysis with new development
I_301_Pond_B	Final Drainage Study For Northern Meadows Unit 22	Huitt-Zollars	Apr-05	0.1			6.0	2.0	2.5	5.5	

Hydro ID	Source	Compiled by	Date	Drainage area (mi^2)	Emergency spillway (ft) [a]	V_{EmSp} (ac-ft)	Top of embankment (ft) [a]	V_{TOP} (ac-ft)	Existing peak depth (ft) [a]	DEVEX peak depth (ft) [a]	Note
I_302_Pond	Final Drainage Study For Northern Meadows Unit 20	Huitt-Zollars	Apr-05	0.0			6.0	4.4	2.0	3.8	
I_303_Pond	Final Drainage Study For Northern Meadows Unit 19	Huitt-Zollars	Apr-05	0.0			3.0	1.0	2.6	3.1	
I_304_Pond	Final Drainage Study For Northern Meadows Unit 18	Huitt-Zollars	Apr-05	0.0			5.5	1.9	3.2	3.5	
I_305_Pond	Final Drainage Study For Northern Meadows Unit 17	Huitt-Zollars	Apr-05	0.1			5.0	1.7	5.8	6.1	System will require re-analysis with new development
I_306_Pond	Drainage Report For Northen Meadows Units 14 & 15	Wilson	Aug-04	0.0			6.0	3.3	1.9	5.1	
I_401_Pond	Drainage Report For Northen Meadows Units 14 & 16	Wilson	Aug-04	0.0			9.0	10.4	2.0	2.5	
I_402_Pond	Drainage Report For Northen Meadows Units 14 & 17	Wilson	Aug-04	0.1	6.0	2.0	7.0	2.6	4.6	4.6	
N_102_Pond	Unser Blvd Phase II-A Roadway Widening Record Drawings	Wilson	Jun-13	0.6			18.0	35.6	12.2	18.4	Additional upstream attenuation may be required under developed conditions
N_301_Pond	Preliminary Drainage Study, Cielo Grande Subdivision	Huitt-Zollars	May-03	0.0			5.0	2.2	4.2	4.5	
P_201_Pond	Drainage Study, Mirador Del Sol Subdivision	Huitt-Zollars	Nov-03	0.0	3.5	0.9	5.0	1.5	2.8	2.9	
Q_101_Pond	*GIS & Field Investigation (no access to site, parameters estimated)*	SSCAFCA	Nov-16	0.2			6.0	6.7	3.6	4.7	
R_101_Pond	Master Drainage Study For Loma Colorado Subdivision	Bohannan Huston	Jul-06	0.3			8.0	9.0	8.3	9.5	Pond spills onto school property
R_102_Pond	*Field Investigation*	SSCAFCA	Nov-16	0.5	8.0	7.3	10.0	10.1	4.7	7.0	
R_104_Pond	*Field Investigation*	SSCAFCA	Nov-16	1.3			12.0	22.4	8.4	8.6	
R_201_Pond	Final Drainage Study For Diamond Ridge Subdivision	Huitt-Zollars	Sep-05	0.1			5.0	5.6	2.5	2.5	
Sportsplex	Montoyas Arroyo Sportsplex Dam OSE Submittal, Appendix A.4	Bohannan Huston	Jan-06	50.6	27.0	328.1	30.0	392.0	28.1	28.4	Pond spills across roadway

Hydro ID	*Source*	**Compiled by**	*Date*	*Drainage area (mi^2)*	*Emergency spillway (ft)* [a]	*V_{EmSp} (ac-ft)*	*Top of embankment (ft)* [a]	*V_{TOP} (ac-ft)*	*Existing peak depth (ft)* [a]	*DEVEX peak depth (ft)* [a]	*Note*
Saratoga_Pond	Design Memorandum for the Saratoga Pond	Smith Engineering	Nov-14	4.0	11.8	79.8	13.8	103.2	5.7	12.3	Planned High Range and Aloe ponds will slove deficiency
U_101_Pond	City Center Infrastructure Improvements - Record Drawings	Huitt-Zollars	Dec-09	0.3			8.0	12.9	4.9	8.9	
U_108_Pond	Corrales Watershed Floodwater Diversion No.1 Phase II Record Drawings	USDA SCS	Oct-89	5.1			15.0	60.4	5.3	6.1	
U_301_Pond_A	Final Drainage Study High Range 3 Subdivision	Huitt-Zollars	Mar-09	0.1			6.0	2.3	1.6	1.9	
U_301_Pond_B	Final Drainage Study High Range 3 Subdivision	Huitt-Zollars	Mar-09	0.1			5.0	2.0	1.3	1.5	
U_302_Pond	Final Drainage Study High Range 3 Subdivision	Huitt-Zollars	Mar-09	0.3			5.0	2.8	5.8	6.3	Pond will be incorporated into planned High Range pond
U_402_Pond	Drainage Study High Range Subdivision	Huitt-Zollars	May-03	0.1			5.0	3.6	5.1	5.2	
U_701_Pond_A	Alberta Watershed Drainage Improvements Phase 1 Record Drawings	Huitt-Zollars	Apr-08	0.3			4.0	3.8	3.2	3.4	
U_701_Pond_B	Alberta Watershed Drainage Improvements Phase 1 Record Drawings	Huitt-Zollars	Apr-08	0.3			10.0	5.1	6.0	6.7	
U_702_Pond_A	*GIS*	SSCAFCA	Nov-16	0.2	12.0	4.6	14.0	5.9	12.5	12.7	Pond routing based on GIS data - further investiagtion is recommended
U_702_Pond_B	*GIS*	SSCAFCA	Nov-16	0.2	10.0	6.9	12.0	9.4	8.2	9.1	
U_801_Pond	Tierra de Corrales Subdivision Infrastructure Improvement Plans	Huitt-Zollars	May-06	0.2			4.0	7.5	3.0	3.1	

[a] Depth vaule relative to pond invert

(green)	No concern
(yellow)	Low concern
(red)	High Concern

Appendix C

Design Storm Model Results

Notes:

(1) Model results reported in this table are for the 100-year design storm using no depth-area reduction factor.
Please modify the storm area in the HEC-HMS model for analyses with larger contributing areas.

(2) Model results area for intermediate moisture conditions (CN=74 for open space, landscaping and residential yards).

(3) Q_p and V values for ponds correspond to peak outflow and outflow volume, respectively. For detailed pond routing including peak inflow, peak storage and peak elevation values, please consult the HEC-HMS model.

Existing Conditions				DEVEX Conditions			
HMS ID	Area	Q_p	V	HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)		(mi^2)	(cfs)	(ac-ft)
A_101	0.023	26	1.3	A_101	0.023	26	1.3
A_101_J	21.566	4864	1016.4	A_101_J	21.566	5176	1103.3
A_101_R	21.566	4850	1007.7	A_101_R	21.566	5157	1093.9
A_102	0.023	26	1.3	A_102	0.023	27	1.3
A_102_J	21.589	4851	1009.1	A_102_J	21.589	5157	1095.3
A_102_R1	21.589	4843	1005.9	A_102_R1	21.589	5153	1091.8
A_102_R2	36.907	8235	1806.1	A_102_R2	36.907	8683	1916.5
A_103	0.064	51	3.5	A_103	0.064	51	3.5
A_103_J1	15.159	3458	787.1	A_103_J1	15.159	3563	811.6
A_103_J2	15.318	3486	802.3	A_103_J2	15.318	3595	826.9
A_103_J3	36.907	8238	1808.0	A_103_J3	36.907	8690	1918.5
A_103_J4	37.516	8300	1848.6	A_103_J4	37.516	8777	1975.2
A_103_R1	37.744	8350	1865.3	A_103_R1	37.744	8825	1991.8
A_103_R2	37.848	8348	1861.4	A_103_R2	37.848	8812	1988.9
A_104	0.060	48	3.7	A_104	0.060	84	6.1
A_104_J1	37.744	8355	1867.9	A_104_J1	37.744	8833	1994.5
A_104_J2	37.848	8357	1871.4	A_104_J2	37.848	8836	1999.4
A_104_J3	38.141	8395	1884.6	A_104_J3	38.141	8863	2014.5
A_104_R1	38.141	8368	1863.2	A_104_R1	38.141	8824	1992.0
A_104_R2	38.276	8356	1858.8	A_104_R2	38.276	8830	1988.3
A_104_R3	38.276	8322	1844.6	A_104_R3	38.276	8806	1973.6
A_104_R4	43.347	9223	2117.3	A_104_R4	43.347	10250	2420.5
A_104_R5	43.385	9204	2112.6	A_104_R5	43.385	10235	2414.9
A_105	0.498	165	26.9	A_105	0.498	262	40.0
A_105_J1	38.276	8388	1873.5	A_105_J1	38.276	8846	2003.6
A_105_J2	43.347	9245	2129.4	A_105_J2	43.347	10269	2433.9
A_105_J3	43.385	9225	2121.4	A_105_J3	43.385	10252	2424.5
A_105_J4	43.883	9293	2139.5	A_105_J4	43.883	10374	2454.8
A_105_J5	4.114	1278	226.2	A_105_J5	4.114	2189	336.7
A_105_R1	43.883	9256	2128.4	A_105_R1	43.883	10345	2442.6
A_105_R2	43.918	9249	2121.5	A_105_R2	43.918	10322	2434.6
A_105_R3	45.465	9534	2223.5	A_105_R3	45.465	10681	2553.6
A_105_R4	46.247	9675	2253.1	A_105_R4	46.247	11035	2633.9
A_105_R5	46.275	9659	2246.7	A_105_R5	46.275	11013	2627.3
A_106	0.365	248	22.7	A_106	0.365	464	39.3
A_106_J1	43.918	9257	2132.1	A_106_J1	43.918	10347	2446.3
A_106_J2	45.465	9540	2229.8	A_106_J2	45.465	10699	2560.3

Existing Conditions			
HMS ID	Area (mi^2)	Q_p (cfs)	V (ac-ft)
A_106_J3	46.247	9686	2266.8
A_106_J4	46.275	9676	2256.2
A_106_J5	46.641	9677	2269.4
A_106_R1	48.381	9876	2371.0
A_106_R2	48.443	9856	2360.7
A_106_R3	48.824	9870	2382.2
A_106_R4	48.939	9862	2385.2
A_106_R5	49.017	9852	2385.9
A_107	0.205	117	11.5
A_107_J1	48.381	9882	2374.3
A_107_J2	48.443	9878	2375.5
A_107_J3	48.824	9886	2390.3
A_107_J4	48.939	9874	2390.5
A_107_J5	49.017	9864	2390.7
A_107_J6	49.222	9864	2397.4
A_107_R1	49.463	9881	2414.8
A_107_R2	49.638	9868	2419.0
A_107_R3	49.841	9900	2428.4
A_107_R4	49.984	9924	2435.3
A_107_R5	50.411	9936	2471.0
A_108	0.130	139	8.8
A_108_J1	49.463	9891	2418.2
A_108_J2	49.638	9888	2428.1
A_108_J3	49.841	9903	2431.5
A_108_J4	49.984	9929	2440.4
A_108_J5	50.411	9943	2476.1
A_108_J6	50.557	9941	2481.3
A_108_R1	50.589	9893	2460.6
A_108_R2	50.735	9867	2460.6
A_108_R3	51.090	9797	2483.0
A_108_R4	51.651	9856	2527.0
A_109	0.247	247	19.8
A_109_J1	50.589	9935	2466.5
A_109_J2	50.735	9899	2472.0
A_109_J3	51.090	9885	2495.2
A_109_J4	51.651	9863	2536.0
A_109_J5	53.154	10022	2648.1
A_109_R1	53.176	9995	2641.3
A_109_R2	53.300	9962	2648.8
A_110	0.165	132	9.2
A_110_J1	53.176	10023	2650.0
A_110_J2	53.300	10003	2656.1
A_110_J3	53.465	9967	2658.0
A_110_R1	53.485	9927	2654.2

DEVEX Conditions			
HMS ID	Area (mi^2)	Q_p (cfs)	V (ac-ft)
A_106_J3	46.247	11064	2648.7
A_106_J4	46.275	11037	2637.6
A_106_J5	46.641	11041	2666.6
A_106_R1	48.381	11499	2856.4
A_106_R2	48.443	11472	2845.2
A_106_R3	48.824	11495	2869.4
A_106_R4	48.939	11488	2872.7
A_106_R5	49.017	11487	2873.9
A_107	0.205	208	19.3
A_107_J1	48.381	11507	2860.0
A_107_J2	48.443	11501	2861.3
A_107_J3	48.824	11514	2878.1
A_107_J4	48.939	11500	2878.3
A_107_J5	49.017	11490	2879.0
A_107_J6	49.222	11505	2893.1
A_107_R1	49.463	11532	2919.6
A_107_R2	49.638	11533	2923.0
A_107_R3	49.841	11579	2940.7
A_107_R4	49.984	11604	2947.2
A_107_R5	50.411	11616	2982.9
A_108	0.130	140	8.8
A_108_J1	49.463	11535	2923.2
A_108_J2	49.638	11541	2933.0
A_108_J3	49.841	11582	2944.0
A_108_J4	49.984	11610	2952.8
A_108_J5	50.411	11625	2988.3
A_108_J6	50.557	11621	2993.3
A_108_R1	50.589	11584	2970.4
A_108_R2	50.735	11582	2969.8
A_108_R3	51.090	11590	2991.8
A_108_R4	51.651	11655	3037.9
A_109	0.247	250	20.0
A_109_J1	50.589	11600	2976.6
A_109_J2	50.735	11592	2981.8
A_109_J3	51.090	11602	3004.6
A_109_J4	51.651	11667	3047.1
A_109_J5	53.154	11874	3174.1
A_109_R1	53.176	11863	3167.1
A_109_R2	53.300	11865	3176.8
A_110	0.165	350	23.0
A_110_J1	53.176	11875	3176.1
A_110_J2	53.300	11877	3184.3
A_110_J3	53.465	11873	3199.8
A_110_R1	53.485	11864	3195.7

Existing Conditions			
HMS ID	Area (mi^2)	Q_p (cfs)	V (ac-ft)
A_110_R2	54.398	10123	2722.3
A_110_R3	54.398	10093	2698.2
A_110_R4	54.741	10073	2719.7
A_111	0.190	161	10.7
A_111_J1	53.485	9968	2659.9
A_111_J2	54.398	10164	2734.4
A_111_J3	54.741	10112	2729.4
A_111_J4	54.931	10079	2730.4
B_101	0.403	412	37.5
B_101_R	0.403	411	37.5
B_102	0.510	490	45.3
B_102_Pond	0.913	263	80.3
B_102_R	0.913	263	80.2
C_001	0.021	30	2.0
C_001_R	0.021	29	2.0
C_002	0.261	420	29.6
C_002_Pond	0.261	269	29.1
C_003	0.146	179	11.6
C_003_Pond	0.146	168	11.4
C_003_R	0.146	166	11.4
C_004	0.032	39	2.8
C_004_R	0.032	38	2.8
C_005	0.017	31	1.5
C_006	0.143	208	12.3
C_006_Pond	0.143	88	12.0
C_007	0.041	69	3.8
C_007_Pond	0.041	6	3.6
C_008	0.174	258	15.8
C_008_Pond	0.174	224	13.3
C_009	0.079	89	5.5
C_010	0.115	133	8.3
C_011	0.061	77	4.6
C_012	0.029	64	3.1
C_012_R	0.029	62	3.1
C_013	0.035	60	3.7
C_013_R	0.035	59	3.7
C_014	0.039	60	4.0
C_014_R	0.039	57	4.0
C_015	0.031	54	3.5
C_015_R	0.031	53	3.5
C_016A	0.087	90	6.9
C_016A_Pond	0.087	56	6.9
C_016B	0.154	247	13.9
C_016B_J	0.241	258	20.8

DEVEX Conditions			
HMS ID	Area (mi^2)	Q_p (cfs)	V (ac-ft)
A_110_R2	54.398	12093	3263.5
A_110_R3	54.398	12054	3238.1
A_110_R4	54.741	12076	3264.0
A_111	0.190	163	10.8
A_111_J1	53.485	11875	3201.7
A_111_J2	54.398	12115	3276.1
A_111_J3	54.741	12084	3274.1
A_111_J4	54.931	12082	3274.9
B_101	0.403	413	37.6
B_101_R	0.403	412	37.6
B_102	0.510	490	45.4
B_102_Pond	0.913	263	80.4
B_102_R	0.913	263	80.4
C_001	0.021	30	2.0
C_001_R	0.021	29	2.0
C_002	0.261	456	31.9
C_002_Pond	0.261	312	31.4
C_003	0.146	179	11.6
C_003_Pond	0.146	168	11.4
C_003_R	0.146	166	11.4
C_004	0.032	39	2.8
C_004_R	0.032	38	2.8
C_005	0.017	31	1.5
C_006	0.143	209	12.3
C_006_Pond	0.143	88	12.0
C_007	0.041	69	3.8
C_007_Pond	0.041	6	3.7
C_008	0.174	259	15.9
C_008_Pond	0.174	225	13.3
C_009	0.079	104	6.4
C_010	0.115	147	9.0
C_011	0.061	83	4.9
C_012	0.029	77	3.7
C_012_R	0.029	75	3.7
C_013	0.035	60	3.7
C_013_R	0.035	59	3.7
C_014	0.039	60	4.0
C_014_R	0.039	57	4.0
C_015	0.031	59	3.7
C_015_R	0.031	57	3.7
C_016A	0.087	154	11.4
C_016A_Pond	0.087	145	11.4
C_016B	0.154	340	18.7
C_016B_J	0.241	360	30.1

Existing Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
C_016_A_R	0.087	54	6.9
C_017	0.057	93	5.8
C_018	0.051	95	5.1
C_018_R	0.051	88	5.1
C_019	0.304	488	29.5
C_019_Pond	0.304	430	29.5
C_020	0.300	326	23.9
C_021	0.019	24	1.9
DCC_gauge	6.098	1387	365.3
Diversion_Barranca	0.000	214	13.1
D_101	0.187	280	17.2
D_101_Pond	0.187	161	16.4
D_101_R	0.187	160	16.4
D_102	0.194	251	13.1
D_102_J	0.381	290	29.5
E_101	0.208	163	12.9
E_101_R1	0.208	161	12.9
E_101_R2	0.342	272	21.9
E_102	0.134	112	8.7
E_102_J1	0.342	283	21.9
E_102_J2	0.476	384	30.6
E_201	0.134	129	9.0
E_201_R	0.134	122	9.0
F_101	0.348	160	19.6
F_101_R	0.348	158	19.6
F_102	0.051	77	4.8
F_102_J	0.398	183	24.4
F_102_R1	0.398	181	24.4
F_102_R2	0.545	287	35.3
F_103	0.253	360	24.3
F_103_J1	0.545	288	35.3
F_103_J2	0.798	537	59.6
F_103_Pond	0.798	340	59.1
F_103_R	0.798	338	59.0
F_104	0.035	52	3.2
F_104_J	0.833	347	62.2
F_104_Pond	0.833	346	61.9
F_104_R	1.213	494	82.7
F_105	0.087	123	8.9
F_105_J1	1.213	495	82.7
F_105_J2	1.546	660	108.3
F_105_R	1.546	652	108.2
F_201	0.062	107	5.8
F_201_Pond	0.062	67	5.8

DEVEX Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
C_016_A_R	0.087	139	11.4
C_017	0.057	93	5.8
C_018	0.051	95	5.1
C_018_R	0.051	88	5.1
C_019	0.304	490	29.7
C_019_Pond	0.304	431	29.6
C_020	0.300	326	23.9
C_021	0.019	25	1.9
DCC_gauge	6.098	1874	532.1
Diversion_Barranca	0.000	516	37.3
D_101	0.187	300	18.4
D_101_Pond	0.187	178	17.7
D_101_R	0.187	175	17.6
D_102	0.194	301	15.3
D_102_J	0.381	350	32.9
E_101	0.208	323	23.7
E_101_R1	0.208	311	23.7
E_101_R2	0.342	461	35.0
E_102	0.134	181	13.4
E_102_J1	0.342	462	35.0
E_102_J2	0.476	635	48.4
E_201	0.134	164	11.3
E_201_R	0.134	155	11.3
F_101	0.348	177	21.2
F_101_R	0.348	175	21.2
F_102	0.051	77	4.8
F_102_J	0.398	200	26.0
F_102_R1	0.398	198	26.0
F_102_R2	0.545	309	37.4
F_103	0.253	360	24.4
F_103_J1	0.545	311	37.4
F_103_J2	0.798	554	61.7
F_103_Pond	0.798	354	61.2
F_103_R	0.798	352	61.1
F_104	0.035	53	3.3
F_104_J	0.833	360	64.4
F_104_Pond	0.833	360	64.1
F_104_R	1.213	554	90.3
F_105	0.087	126	9.1
F_105_J1	1.213	557	90.3
F_105_J2	1.546	817	125.7
F_105_R	1.546	817	125.7
F_201	0.062	108	5.9
F_201_Pond	0.062	68	5.9

Existing Conditions				DEVEX Conditions			
HMS ID	Area	Q_p	V	HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)		(mi^2)	(cfs)	(ac-ft)
F_201_R	0.062	66	5.8	F_201_R	0.062	67	5.9
F_202	0.085	56	5.1	F_202	0.085	61	5.5
F_202_J	0.147	122	11.0	F_202_J	0.147	128	11.4
F_202_R	0.147	119	10.9	F_202_R	0.147	125	11.4
F_301	0.381	197	20.8	F_301	0.381	266	26.2
F_301_R	0.381	195	20.8	F_301_R	0.381	263	26.2
F_401	0.070	123	6.8	F_401	0.070	124	6.9
F_402	0.175	78	10.0	F_402	0.175	168	19.6
F_402_Pond	0.246	113	16.7	F_402_Pond	0.246	211	26.2
F_402_R	0.246	111	16.7	F_402_R	0.246	207	26.2
GaugingStation	61.196	10969	3106.2	GaugingStation	61.196	13570	3818.9
G_101	0.748	285	39.2	G_101	0.748	959	116.4
G_101_R	0.748	283	39.2	G_101_R	0.748	950	116.3
G_102	0.682	295	35.9	G_102	0.682	378	43.9
G_102_J	1.431	550	75.0	G_102_J	1.431	1322	160.1
G_102_R	1.431	547	74.9	G_102_R	1.431	1314	159.9
G_103	0.616	314	34.4	G_103	0.616	345	37.1
G_103_J	2.046	797	109.3	G_103_J	2.046	1603	197.0
G_103_R1	2.046	793	109.1	G_103_R1	2.046	1598	196.8
G_103_R2	4.014	1257	216.2	G_103_R2	4.014	2164	326.5
G_103_R3	4.114	1269	225.9	G_103_R3	4.114	2169	336.4
G_104	0.501	204	26.3	G_104	0.501	226	28.5
G_104_J1	4.014	1259	216.3	G_104_J1	4.014	2169	326.6
G_104_J2	4.083	1266	222.7	G_104_J2	4.083	2173	333.0
G_201	1.467	380	80.9	G_201	1.467	492	101.3
G_301	0.069	105	6.9	G_301	0.069	105	6.9
G_301_Pond	0.069	9	6.5	G_301_Pond	0.069	9	6.5
HJC_gauge	54.931	10041	2730.0	HJC_gauge	54.931	12078	3274.5
HJC_J	61.196	10996	3106.5	HJC_J	61.196	13574	3819.3
H_101	0.050	25	2.8	H_101	0.050	36	3.9
H_101_R	0.050	25	2.8	H_101_R	0.050	36	3.9
H_102	0.035	56	3.5	H_102	0.035	61	3.8
H_102_Pond	0.085	61	6.3	H_102_Pond	0.085	72	7.7
H_102_R	0.085	60	6.3	H_102_R	0.085	72	7.7
H_103	0.017	38	1.8	H_103	0.017	38	1.8
H_103_Pond	0.102	78	8.1	H_103_Pond	0.102	89	9.4
H_104	0.033	52	3.1	H_104	0.033	52	3.1
H_104_Pond	0.136	21	10.3	H_104_Pond	0.136	23	11.7
I_001	0.186	223	17.8	I_001	0.186	224	17.8
I_001_Pond	0.186	93	15.4	I_001_Pond	0.186	93	15.4
I_002	0.228	254	22.8	I_002	0.228	255	22.8
I_002_Pond	0.228	199	19.3	I_002_Pond	0.228	200	19.3
I_003	0.148	189	14.8	I_003	0.148	190	14.8
I_003_Pond	0.148	80	13.9	I_003_Pond	0.148	80	14.0

Existing Conditions				DEVEX Conditions			
HMS ID	Area	Q_p	V	HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)		(mi^2)	(cfs)	(ac-ft)
I_004	0.048	76	4.8	I_004	0.048	77	4.8
I_004_Pond	0.048	70	4.5	I_004_Pond	0.048	70	4.5
I_005	0.078	115	7.9	I_005	0.078	115	7.9
I_005_Pond	0.078	91	7.9	I_005_Pond	0.078	92	7.9
I_006	0.082	119	8.0	I_006	0.082	120	8.0
I_006_Pond	0.082	69	7.9	I_006_Pond	0.082	70	8.0
I_007	0.066	106	6.8	I_007	0.066	106	6.8
I_007_Pond	0.066	75	6.7	I_007_Pond	0.066	75	6.8
I_008	0.047	82	4.1	I_008	0.047	82	4.1
I_008_Pond	0.047	65	4.1	I_008_Pond	0.047	65	4.1
I_101	0.300	111	16.7	I_101	0.300	113	16.9
I_101_Pond	0.300	21	12.6	I_101_Pond	0.300	21	12.8
I_101_R1	0.300	21	12.6	I_101_R1	0.300	21	12.8
I_101_R2	0.377	25	16.3	I_101_R2	0.377	25	16.8
I_102	0.101	166	10.5	I_102	0.101	166	10.5
I_102_J	0.377	25	16.3	I_102_J	0.377	25	16.8
I_102_Pond	0.479	150	26.5	I_102_Pond	0.479	151	26.9
I_103	0.077	35	4.1	I_103	0.077	38	4.4
I_103_Pond	0.077	4	3.7	I_103_Pond	0.077	4	4.0
I_103_R	0.077	4	3.7	I_103_R	0.077	4	4.0
I_201	0.263	111	14.7	I_201	0.263	149	18.8
I_201_Pond	0.263	13	12.7	I_201_Pond	0.263	16	16.3
I_201_R	0.263	13	12.7	I_201_R	0.263	16	16.2
I_202	0.080	137	8.4	I_202	0.080	142	8.7
I_202_Pond	0.343	106	20.7	I_202_Pond	0.343	117	24.5
I_301A	0.080	48	4.7	I_301A	0.080	104	9.3
I_301B	0.054	33	3.1	I_301B	0.054	75	6.2
I_301_Pond_A	0.134	9	5.2	I_301_Pond_A	0.134	50	12.6
I_301_Pond_B	0.080	6	4.1	I_301_Pond_B	0.080	9	8.5
I_301_R	0.134	9	5.2	I_301_R	0.134	50	12.6
I_302	0.034	25	2.1	I_302	0.034	49	3.8
I_302_J	0.168	11	7.0	I_302_J	0.168	52	15.5
I_302_Pond	0.034	2	1.8	I_302_Pond	0.034	2	2.9
I_302_R	0.168	11	7.0	I_302_R	0.168	51	15.5
I_303	0.031	19	1.7	I_303	0.031	45	3.6
I_303_J	0.200	13	8.7	I_303_J	0.200	80	19.0
I_303_Pond	0.031	5	1.7	I_303_Pond	0.031	36	3.5
I_303_R1	0.200	13	8.7	I_303_R1	0.200	79	19.0
I_303_R2	0.215	15	10.2	I_303_R2	0.215	81	20.6
I_304	0.015	20	1.5	I_304	0.015	22	1.7
I_304_Pond	0.015	2	1.5	I_304_Pond	0.015	2	1.7
I_305	0.069	59	5.2	I_305	0.069	96	8.1
I_305_Pond	0.069	32	4.9	I_305_Pond	0.069	82	7.6
I_306	0.026	16	1.5	I_306	0.026	48	4.0

Existing Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
I_306_Pond	0.026	2	1.0
I_306_R	0.310	39	16.1
I_307	0.020	34	2.3
I_307_J1	0.215	15	10.2
I_307_J2	0.310	39	16.1
I_307_J3	0.330	47	18.4
I_401	0.033	21	1.9
I_401_Pond	0.033	0	0.0
I_401_R	0.033	0	0.0
I_402	0.071	97	6.2
I_402_Pond	0.104	71	6.0
J_101	1.427	459	74.5
J_101_R	1.427	456	74.0
J_102	1.351	497	70.7
J_102_J	2.777	844	144.7
J_102_R	2.777	841	144.2
J_103	0.491	213	25.8
J_103_J1	3.268	950	170.0
J_103_J2	3.878	1122	202.0
J_103_R	3.878	1117	201.1
J_104	1.057	320	55.1
J_104_J1	4.936	1388	256.2
J_104_J2	7.904	2126	410.1
J_104_R1	7.904	2109	397.5
J_104_R2	7.904	2089	381.7
J_104_R3	7.904	2081	372.2
J_105	0.850	308	44.5
J_105_J	8.753	2240	416.7
J_105_R1	8.753	2220	403.8
J_105_R2	15.289	3679	724.6
J_105_R3	15.289	3655	709.1
J_106	0.663	188	34.6
J_106_J1	15.289	3706	743.5
J_106_J2	15.952	3782	743.6
J_106_J3	20.243	4757	971.7
J_106_R1	20.243	4722	955.9
J_106_R2	20.243	4707	951.3
J_107	0.774	250	40.5
J_107_J	21.065	4848	996.2
J_107_R	21.065	4837	988.6
J_201	0.610	225	32.0
J_301	1.112	311	57.9
J_301_R	1.112	310	57.5
J_302	0.883	298	46.2

DEVEX Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
I_306_Pond	0.026	5	3.5
I_306_R	0.310	153	31.6
I_307	0.020	43	2.9
I_307_J1	0.215	81	20.6
I_307_J2	0.310	155	31.6
I_307_J3	0.330	170	34.5
I_401	0.033	44	3.5
I_401_Pond	0.033	4	1.5
I_401_R	0.033	3	1.5
I_402	0.071	97	6.2
I_402_Pond	0.104	71	7.6
J_101	1.427	459	74.5
J_101_R	1.427	456	74.0
J_102	1.351	497	70.7
J_102_J	2.777	844	144.7
J_102_R	2.777	841	144.2
J_103	0.491	213	25.8
J_103_J1	3.268	950	170.0
J_103_J2	3.878	1122	202.0
J_103_R	3.878	1117	201.1
J_104	1.057	320	55.1
J_104_J1	4.936	1388	256.2
J_104_J2	7.904	2126	410.1
J_104_R1	7.904	2109	397.5
J_104_R2	7.904	2089	381.7
J_104_R3	7.904	2081	372.2
J_105	0.850	308	44.5
J_105_J	8.753	2240	416.7
J_105_R1	8.753	2220	403.8
J_105_R2	15.289	3709	733.6
J_105_R3	15.289	3687	717.9
J_106	0.663	309	52.7
J_106_J1	15.289	3731	752.9
J_106_J2	15.952	3878	770.5
J_106_J3	20.243	4967	1032.7
J_106_R1	20.243	4952	1014.8
J_106_R2	20.243	4935	1009.7
J_107	0.774	465	69.3
J_107_J	21.065	5170	1083.5
J_107_R	21.065	5149	1075.0
J_201	0.610	225	32.0
J_301	1.112	311	57.9
J_301_R	1.112	310	57.5
J_302	0.883	298	46.2

Existing Conditions			
HMS ID	Area (mi^2)	Q_p (cfs)	V (ac-ft)
J_302_J	1.994	536	103.7
J_302_R	1.994	533	102.9
J_303	0.974	314	50.9
J_303_J	2.968	745	153.8
J_401	0.735	270	38.5
J_401_R	0.735	266	38.3
J_402	1.554	632	86.2
J_402_J	2.289	811	124.5
J_402_R1	2.289	809	124.2
J_402_R2	4.291	1321	228.1
J_403	1.176	379	61.4
J_403_J1	0.827	214	42.7
J_403_J2	3.465	1174	185.6
J_403_J3	4.291	1326	228.3
J_501	0.827	215	43.0
J_501_R	0.827	214	42.7
K_101	1.125	305	58.5
K_101_R1	1.125	304	58.3
K_101_R2	2.269	573	117.2
K_102	1.199	308	62.2
K_102_J1	2.269	575	117.3
K_102_J2	3.468	866	179.4
K_102_R	3.468	863	178.3
K_103	0.983	304	54.3
K_103_J1	4.451	1079	232.6
K_103_J2	6.133	1434	319.3
K_103_R	6.133	1429	318.6
K_104	0.402	149	21.1
K_104_J	6.536	1494	339.7
K_201	1.144	279	59.3
K_201_R	1.144	279	59.0
K_301	1.682	355	86.6
L_101	2.208	593	114.5
L_101_R	2.208	589	113.6
L_102	1.105	320	57.5
L_102_J	3.313	850	171.1
L_102_R1	3.313	846	170.8
L_102_R2	7.152	1672	368.3
L_103	0.880	284	46.0
L_103_J1	7.152	1673	368.7
L_103_J2	8.033	1856	414.3
L_103_R	8.033	1853	413.3
L_104	0.787	239	41.1
L_104_J	8.819	2017	454.3

DEVEX Conditions			
HMS ID	Area (mi^2)	Q_p (cfs)	V (ac-ft)
J_302_J	1.994	536	103.7
J_302_R	1.994	533	102.9
J_303	0.974	314	50.9
J_303_J	2.968	745	153.8
J_401	0.735	270	38.6
J_401_R	0.735	267	38.4
J_402	1.554	636	86.8
J_402_J	2.289	816	125.2
J_402_R1	2.289	814	124.9
J_402_R2	4.291	1531	262.2
J_403	1.176	587	89.3
J_403_J1	0.827	247	48.2
J_403_J2	3.465	1363	214.2
J_403_J3	4.291	1540	262.4
J_501	0.827	247	48.5
J_501_R	0.827	247	48.2
K_101	1.125	305	58.5
K_101_R1	1.125	304	58.3
K_101_R2	2.269	573	117.2
K_102	1.199	309	62.4
K_102_J1	2.269	575	117.3
K_102_J2	3.468	866	179.6
K_102_R	3.468	864	178.5
K_103	0.983	305	54.4
K_103_J1	4.451	1080	232.9
K_103_J2	6.133	1436	319.8
K_103_R	6.133	1432	319.1
K_104	0.402	226	30.0
K_104_J	6.536	1519	349.1
K_201	1.144	279	59.3
K_201_R	1.144	279	59.0
K_301	1.682	356	86.9
L_101	2.208	593	114.5
L_101_R	2.208	589	113.6
L_102	1.105	320	57.5
L_102_J	3.313	850	171.1
L_102_R1	3.313	846	170.8
L_102_R2	7.152	1672	368.3
L_103	0.880	284	46.0
L_103_J1	7.152	1673	368.7
L_103_J2	8.033	1856	414.3
L_103_R	8.033	1853	413.3
L_104	0.787	340	55.6
L_104_J	8.819	2072	468.8

Existing Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
L_104_R1	8.819	2013	452.6
L_104_R2	14.816	3438	767.0
L_105	0.250	86	13.1
L_105_J1	9.070	2053	465.7
L_105_J2	14.816	3446	767.3
L_105_J3	14.816	3438	767.0
L_105_R1	14.816	3436	766.3
L_105_R2	15.159	3454	786.5
L_105_R3	15.318	3483	802.1
L_201	1.801	380	92.7
L_201_J	3.168	711	163.7
L_201_R	3.168	709	163.0
L_202	0.672	272	35.3
L_202_J	3.839	831	198.3
L_202_R	3.839	829	197.9
L_301	1.366	366	71.0
M_101	0.951	366	49.9
M_101_R	0.951	362	49.7
M_102	0.714	315	37.5
M_102_J	1.665	623	87.3
M_102_R1	1.665	620	87.1
M_102_R2	5.117	1660	268.5
M_103	0.629	284	33.1
M_103_J1	5.117	1663	268.9
M_103_J2	5.746	1814	301.6
M_201	0.854	266	44.6
M_201_J	1.401	462	73.3
M_201_R	1.401	460	73.1
M_202	0.643	257	33.8
M_202_J	2.044	685	106.9
M_202_R	2.044	681	106.5
M_203	0.764	286	40.1
M_203_J	2.808	921	146.5
M_203_R	2.808	919	146.1
M_204	0.644	211	35.7
M_204_J	3.452	1120	181.8
M_204_R	3.452	1114	181.7
M_301	0.546	230	28.7
NMED_gauge	37.516	8300	1848.6
N_101	0.252	141	14.2
N_101_R	0.252	138	14.2
N_102	0.106	49	6.1
N_102_Pond	0.618	89	39.7
N_102_R	0.618	89	39.6

DEVEX Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
L_104_R1	8.819	2065	467.2
L_104_R2	14.816	3548	787.7
L_105	0.250	86	13.2
L_105_J1	9.070	2105	480.3
L_105_J2	14.816	3553	788.1
L_105_J3	14.816	3548	787.7
L_105_R1	14.816	3537	787.1
L_105_R2	15.159	3562	811.0
L_105_R3	15.318	3594	826.7
L_201	1.801	380	92.7
L_201_J	3.168	711	163.7
L_201_R	3.168	709	163.0
L_202	0.672	272	35.3
L_202_J	3.839	831	198.3
L_202_R	3.839	829	197.9
L_301	1.366	366	71.0
M_101	0.951	399	53.5
M_101_R	0.951	396	53.3
M_102	0.714	343	40.0
M_102_J	1.665	678	93.3
M_102_R1	1.665	674	93.1
M_102_R2	5.117	1704	274.6
M_103	0.629	285	33.2
M_103_J1	5.117	1704	275.0
M_103_J2	5.746	1859	307.7
M_201	0.854	266	44.6
M_201_J	1.401	462	73.3
M_201_R	1.401	460	73.1
M_202	0.643	257	33.8
M_202_J	2.044	685	106.9
M_202_R	2.044	681	106.5
M_203	0.764	286	40.1
M_203_J	2.808	921	146.5
M_203_R	2.808	919	146.1
M_204	0.644	212	35.8
M_204_J	3.452	1120	181.9
M_204_R	3.452	1114	181.8
M_301	0.546	230	28.7
NMED_gauge	37.516	8777	1975.2
N_101	0.252	369	33.9
N_101_R	0.252	369	33.9
N_102	0.106	99	11.4
N_102_Pond	0.618	273	82.1
N_102_R	0.618	270	82.0

Existing Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
N_103	0.339	172	19.2
N_103_J	0.957	227	58.8
N_201	0.217	161	15.3
N_201_R	0.217	158	15.3
N_301	0.043	73	4.2
N_301_Pond	0.043	20	4.1
O_101	0.782	227	43.3
PDV_diversion	0.705	200	41.1
P_101	0.885	268	47.1
P_101_J	1.265	419	74.3
P_201	0.019	32	1.9
P_201_Pond	0.019	11	1.9
P_201_R	0.019	11	1.9
P_202	0.057	59	3.6
P_202_J	0.075	64	5.5
P_202_R	0.075	64	5.5
P_301	0.305	210	21.7
Q_101	0.162	90	9.1
Q_101_Pond	0.162	42	8.9
Q_101_R1	0.162	42	8.9
Q_101_R2	0.162	42	8.9
Q_102	0.369	474	35.0
Q_102_J	0.369	474	35.0
RioGrande	61.196	10916	3105.1
R_101	0.253	335	22.6
R_101_Pond	0.253	116	21.8
R_101_R1	0.348	180	30.2
R_101_R2	0.348	177	30.2
R_102	0.194	253	16.6
R_102_J1	0.348	180	30.2
R_102_J2	0.542	319	46.8
R_102_Pond	0.542	284	46.6
R_102_R	0.542	283	46.6
R_103	0.220	270	19.3
R_103_J	0.762	489	65.8
R_103_R1	0.762	480	65.8
R_103_R2	0.967	672	84.8
R_104	0.289	385	25.0
R_104_J	1.256	887	109.9
R_104_J1	0.967	677	85.0
R_104_Pond	1.256	871	101.2
R_201	0.095	124	8.5
R_201_Pond	0.095	70	8.4
R_301	0.205	198	19.2

DEVEX Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
N_103	0.339	414	41.9
N_103_J	0.957	501	123.9
N_201	0.217	363	32.1
N_201_R	0.217	356	32.1
N_301	0.043	84	4.8
N_301_Pond	0.043	30	4.7
O_101	0.782	553	95.1
PDV_diversion	0.705	340	67.3
P_101	0.885	619	96.2
P_101_J	1.265	902	145.0
P_201	0.019	33	2.0
P_201_Pond	0.019	11	2.0
P_201_R	0.019	11	2.0
P_202	0.057	122	6.6
P_202_J	0.075	127	8.6
P_202_R	0.075	118	8.6
P_301	0.305	413	40.2
Q_101	0.162	189	17.5
Q_101_Pond	0.162	151	17.3
Q_101_R1	0.162	149	17.3
Q_101_R2	0.162	147	17.3
Q_102	0.369	478	35.3
Q_102_J	0.369	478	35.3
RioGrande	61.196	13557	3817.8
R_101	0.253	530	35.0
R_101_Pond	0.253	395	34.1
R_101_R1	0.348	456	42.6
R_101_R2	0.348	438	42.6
R_102	0.194	254	16.6
R_102_J1	0.348	456	42.6
R_102_J2	0.542	601	59.2
R_102_Pond	0.542	487	59.0
R_102_R	0.542	484	59.0
R_103	0.220	270	19.3
R_103_J	0.762	620	78.2
R_103_R1	0.762	616	78.2
R_103_R2	0.967	815	99.3
R_104	0.289	393	25.5
R_104_J	1.256	985	124.8
R_104_J1	0.967	822	99.5
R_104_Pond	1.256	975	116.2
R_201	0.095	124	8.5
R_201_Pond	0.095	70	8.4
R_301	0.205	221	21.2

Existing Conditions			
HMS ID	Area (mi^2)	Q_p (cfs)	V (ac-ft)
Saratoga_LateralWeir	3.977	792	202.0
Saratoga_Pond	0.000	62	35.5
Sportsplex	50.557	9934	2463.7
Sportsplex_gauge	50.557	9934	2463.7
S_101	0.074	84	8.4
S_101_R	0.074	82	8.4
S_102	0.050	119	6.3
S_102_J	0.124	157	14.8
T_101	0.088	125	9.1
T_101_R	0.088	123	9.0
T_102	0.106	180	13.5
T_102_J	0.194	303	22.6
T_102_R	0.194	294	22.5
T_103	0.150	69	8.7
T_103_J	0.344	350	31.2
U_101	0.263	227	18.9
U_101_Pond	0.263	91	18.5
U_101_R	0.263	90	18.4
U_102	0.442	408	35.8
U_102_J	0.705	413	54.2
U_102_R	0.705	200	41.0
U_103	0.698	253	39.0
U_103_J	1.402	421	80.0
U_103_R	1.402	420	79.7
U_104	0.246	105	13.8
U_104_J	1.649	510	93.5
U_104_R1	1.649	509	93.4
U_104_R2	3.041	1118	182.5
U_105	0.692	394	41.7
U_105_J1	1.392	649	89.6
U_105_J2	3.041	1123	183.0
U_105_J3	3.733	1355	224.3
U_105_R	3.733	1349	223.8
U_106	0.245	159	13.8
U_106_J1	3.977	1411	237.6
U_106_J2	4.789	1124	283.1
U_106_R	4.789	1119	282.7
U_107	0.305	256	20.0
U_107_J	5.094	1189	302.7
U_107_R	5.094	1184	302.3
U_108	0.128	113	7.5
U_108_J	5.222	1171	305.6
U_108_Pond	5.094	1158	298.2
U_201	0.032	49	3.1

DEVEX Conditions			
HMS ID	Area (mi^2)	Q_p (cfs)	V (ac-ft)
Saratoga_LateralWeir	3.977	1023	275.4
Saratoga_Pond	0.000	386	101.5
Sportsplex	50.557	11598	2973.8
Sportsplex_gauge	50.557	11598	2973.8
S_101	0.074	111	10.9
S_101_R	0.074	108	10.9
S_102	0.050	119	6.3
S_102_J	0.124	179	17.2
T_101	0.088	150	10.7
T_101_R	0.088	146	10.7
T_102	0.106	180	13.5
T_102_J	0.194	325	24.2
T_102_R	0.194	320	24.2
T_103	0.150	98	11.8
T_103_J	0.344	406	36.0
U_101	0.263	517	41.2
U_101_Pond	0.263	387	40.7
U_101_R	0.263	375	40.6
U_102	0.442	776	64.0
U_102_J	0.705	856	104.6
U_102_R	0.705	333	67.1
U_103	0.698	623	86.5
U_103_J	1.402	929	153.6
U_103_R	1.402	929	153.2
U_104	0.246	162	19.7
U_104_J	1.649	1064	172.9
U_104_R1	1.649	1060	172.9
U_104_R2	3.041	2139	319.1
U_105	0.692	480	49.0
U_105_J1	1.392	1162	146.7
U_105_J2	3.041	2156	319.5
U_105_J3	3.733	2458	368.1
U_105_R	3.733	2455	367.7
U_106	0.245	160	13.9
U_106_J1	3.977	2531	381.5
U_106_J2	4.789	1552	441.4
U_106_R	4.789	1553	440.9
U_107	0.305	289	22.3
U_107_J	5.094	1653	463.2
U_107_R	5.094	1646	462.7
U_108	0.128	152	9.9
U_108_J	5.222	1615	467.4
U_108_Pond	5.094	1598	457.7
U_201	0.032	58	3.6

Existing Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
U_201_R1	0.032	46	3.1
U_201_R2	0.937	420	55.1
U_202	0.649	268	36.8
U_202_J1	0.681	308	40.0
U_202_J2	0.937	420	55.2
U_202_J3	1.062	473	65.5
U_202_R1	1.062	467	65.5
U_202_R2	1.392	647	89.5
U_301A	0.066	45	3.5
U_301B	0.146	75	7.7
U_301_Pond_A	0.146	74	7.7
U_301_Pond_B	0.066	44	3.5
U_301_R1	0.146	73	7.7
U_301_R2	0.066	42	3.5
U_302	0.044	71	4.3
U_302_Pond	0.256	113	15.2
U_401	0.053	33	3.0
U_401_R	0.053	32	3.0
U_402	0.072	148	7.6
U_402_J	0.125	83	10.4
U_402_Pond	0.125	83	10.4
U_501	0.330	273	24.1
U_501_R	0.330	271	24.1
U_601	0.147	61	8.3
U_601_R	0.147	61	8.2
U_602	0.416	166	23.5
U_602_J	0.562	220	31.7
U_602_R	0.562	219	31.7
U_603	0.249	150	13.9
U_603_J	0.811	295	45.6
U_701	0.273	114	16.7
U_701_Pond_A	0.273	91	16.5
U_701_Pond_B	0.273	71	16.4
U_701_R	0.273	71	16.4
U_702	0.224	288	19.6
U_702_Pond_A	0.224	246	19.5
U_702_Pond_B	0.224	70	18.8
U_702_R	0.224	70	18.8
U_703	0.212	143	14.1
U_703_J1	0.497	135	35.2
U_703_J2	0.710	197	49.3
U_703_J3	5.932	1350	354.9
U_801	0.166	119	11.6
U_801_J	6.098	1387	365.3

DEVEX Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
U_201_R1	0.032	57	3.6
U_201_R2	0.937	787	95.3
U_202	0.649	590	73.2
U_202_J1	0.681	643	76.8
U_202_J2	0.937	802	95.3
U_202_J3	1.062	859	106.2
U_202_R1	1.062	849	106.2
U_202_R2	1.392	1156	146.7
U_301A	0.066	60	4.4
U_301B	0.146	100	9.7
U_301_Pond_A	0.146	97	9.6
U_301_Pond_B	0.066	59	4.4
U_301_R1	0.146	97	9.6
U_301_R2	0.066	57	4.4
U_302	0.044	81	4.8
U_302_Pond	0.256	159	18.6
U_401	0.053	41	3.5
U_401_R	0.053	40	3.5
U_402	0.072	149	7.7
U_402_J	0.125	100	10.9
U_402_Pond	0.125	100	10.9
U_501	0.330	473	40.5
U_501_R	0.330	463	40.5
U_601	0.147	136	16.4
U_601_R	0.147	135	16.3
U_602	0.416	254	34.0
U_602_J	0.562	383	50.3
U_602_R	0.562	382	50.3
U_603	0.249	153	14.2
U_603_J	0.811	469	64.5
U_701	0.273	127	18.3
U_701_Pond_A	0.273	103	18.1
U_701_Pond_B	0.273	77	18.0
U_701_R	0.273	77	18.0
U_702	0.224	316	21.3
U_702_Pond_A	0.224	329	21.2
U_702_Pond_B	0.224	76	20.6
U_702_R	0.224	76	20.6
U_703	0.212	145	14.3
U_703_J1	0.497	146	38.5
U_703_J2	0.710	210	52.9
U_703_J3	5.932	1811	520.2
U_801	0.166	138	13.2
U_801_J	6.098	1874	532.1

Existing Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
U_801_Pond	0.166	39	10.5
U_901	0.167	98	11.5
U_901_J	6.265	1435	376.5
V_R1	5.094	1155	298.1
V_R2	5.222	1169	305.6
V_R3	5.932	1349	354.8
V_R4	6.098	1384	365.0
W_R1	54.931	10041	2730.0
W_R2	61.196	10969	3106.2
W_R3	61.196	10916	3105.1

DEVEX Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
U_801_Pond	0.166	71	12.0
U_901	0.167	115	13.1
U_901_J	6.265	1938	544.8
V_R1	5.094	1594	457.5
V_R2	5.222	1613	467.3
V_R3	5.932	1809	520.1
V_R4	6.098	1867	531.8
W_R1	54.931	12078	3274.5
W_R2	61.196	13570	3818.9
W_R3	61.196	13557	3817.8

Appendix D

Lateral Erosion Envelope (LEE)

Tributary	Reach	EXISTING Q_{100}	Dominant Discharge Q_d	Slope S_0	Critical Slope S_c	Maximum lateral erosion distance Δmax	Est. channel width W_D	Offset
		(cfs)	(cfs)	(ft/ft)	(ft/ft)	(ft)	(ft)	(ft)
A	A_101_J	3,485	697	0.017	0.015	192	63	224
	A_102_J	3,475	695	0.015	0.015	193	63	225
	A_103_J1	2,512	502	0.018	0.016	161	55	189
	A_103_J2	2,535	507	0.012	0.016	172	58	201
	A_103_J4	5,989	1,198	0.015	0.014	257	78	297
	A_104_J2	6,036	1,207	0.029	0.014	259	79	298
	A_104_J3	6,071	1,214	0.011	0.014	274	82	315
	A_105_J1b	6,065	1,213	0.013	0.014	264	79	304
	A_105_J1a	6,065	1,213	0.012	0.014	271	81	312
	A_105_J4a	6,718	1,344	0.013	0.014	280	83	321
	A_105_J4b	6,718	1,344	0.010	0.014	293	87	336
	A_105_J5	906	181	0.012	0.019	101	40	120
	A_106_J1	6,703	1,341	0.012	0.014	284	84	326
	A_106_J2	6,901	1,380	0.009	0.014	304	90	349
	A_106_J4	6,989	1,398	0.018	0.014	279	83	321
	A_106_J5	6,990	1,398	0.023	0.014	279	83	321
	A_107_J1	7,150	1,430	0.008	0.014	319	94	366
	A_107_J2	7,146	1,429	0.012	0.014	294	86	337
	A_107_J3	7,150	1,430	0.013	0.014	290	85	332
	A_107_J4	7,138	1,428	0.011	0.014	295	87	339
	A_107_J6	7,142	1,428	0.014	0.014	283	84	325
	A_108_J1	7,167	1,433	0.027	0.014	283	84	325
	A_108_J2	7,173	1,435	0.011	0.014	296	87	340
	A_108_J3	7,189	1,438	0.019	0.014	284	84	326
	A_108_J5	7,226	1,445	0.014	0.014	286	84	328
	A_108_J6	7,222	1,444	0.028	0.014	284	84	327
	A_109_J1	6,262	1,252	0.029	0.014	264	80	303
	A_109_J2	6,259	1,252	0.014	0.014	265	79	305
	A_109_J3	6,254	1,251	0.015	0.014	263	80	303
	A_109_J4	6,266	1,253	0.014	0.014	267	80	307
	A_109_J5	6,346	1,269	0.038	0.014	265	80	306
	A_110_J1	6,347	1,269	0.013	0.014	273	81	313
	A_110_J3	6,336	1,267	0.013	0.014	272	81	313
	A_111_J1	6,337	1,267	0.012	0.014	274	82	315
	A_111_J2	6,492	1,298	0.011	0.014	282	84	324
	A_111_J4	6,427	1,285	0.013	0.014	272	81	313
G	G_101	193	39	0.017	0.023	52	21	63
	G_102_J	374	75	0.016	0.021	68	27	82
	G_103_J	545	109	0.013	0.020	81	32	97
	G_104_J1	891	178	0.015	0.019	96	38	115
	G_104_J2	897	179	0.015	0.019	95	38	114

Tributary	Reach	EXISTING Q_{100}	Dominant Discharge Q_d	Slope S_0	Critical Slope S_c	Maximum lateral erosion distance Δmax	Est. channel width W_D	Offset
		(cfs)	(cfs)	(ft/ft)	(ft/ft)	(ft)	(ft)	(ft)
J	J_102_J	601	120	0.014	0.020	83	33	99
	J_103_J1	681	136	0.017	0.019	84	33	101
	J_104_J1	990	198	0.014	0.018	100	40	120
	J_105_J	1,586	317	0.014	0.017	130	47	153
	J_105_R1	1,573	315	0.014	0.017	130	48	154
	J_106_J2	2,714	543	0.013	0.016	177	59	206
	J_107_J	3,474	695	0.013	0.015	201	65	234
	J_303_J	536	107	0.017	0.020	77	31	92
	J_402_J	567	113	0.018	0.020	78	31	94
	J_403_J2	820	164	0.014	0.019	94	37	112
	J_403_J3	934	187	0.012	0.018	102	40	122
K	K_102_J2	624	125	0.011	0.019	88	35	106
	K_103_J1	785	157	0.014	0.019	92	36	110
	K_104_J	1,089	218	0.012	0.018	110	43	131
L	L_102_Ja	617	123	0.013	0.020	85	34	102
	L_102_Jb	617	123	0.017	0.020	81	32	98
	L_103_J2	1,363	273	0.010	0.018	127	48	151
	L_104_J	1,479	296	0.013	0.017	128	47	151
	L_105_J1	1,507	301	0.012	0.017	131	48	155
	L_105_J3	2,499	500	0.010	0.016	177	60	207
	L_202_Ja	614	123	0.015	0.020	83	33	100
	L_202_Jb	614	123	0.017	0.020	81	32	98
M	M_103_J2	1,266	253	0.013	0.018	117	44	139
	M_203_J	639	128	0.013	0.019	86	34	103
	M_204_J	775	155	0.015	0.019	91	36	109
R	R_104_J	624	125	0.006	0.019	98	39	118
U	U_103_J	313	63	0.017	0.021	63	25	76
	U_104_J	374	75	0.014	0.021	70	28	84
	U_105_J1	436	87	0.012	0.020	76	30	92
	U_105_J3	961	192	0.014	0.018	99	39	118
	U_106_J1	1,000	200	0.017	0.018	97	38	116
	U_107_J	994	199	0.019	0.018	96	38	115
	U_108_J	979	196	0.015	0.018	99	39	118
	U_202_J3	319	64	0.024	0.021	61	24	73
	U_703_J3	1,120	224	0.007	0.018	124	48	148
	U_901_J	1,174	235	0.009	0.018	120	46	143

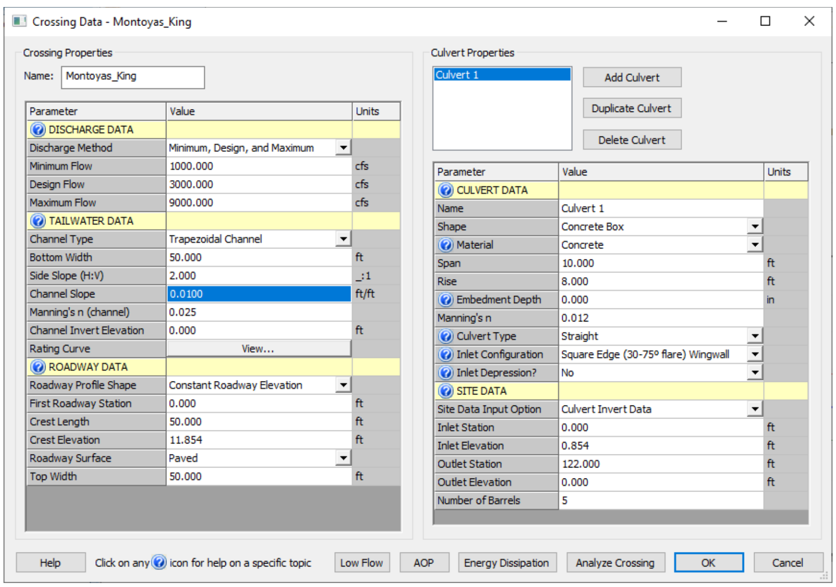
Appendix E

Capacity Calculations

This Document contains capacity analyses of culvert crossings in the Montoyas watershed at locations where flows are expected to reach or exceed 500 cfs during the 100-year storm event. Please note that this analysis was performed for planning purposes only to establish approximate maximum allowable flow rates at each location. Culvert dimensions and slopes were measured during a field visit on 11/15/2019. Capacities were estimated using HY-8 software version 7.5. The analysis was based on the following assumptions:

- Culverts are free of sediment and debris unless otherwise noted in the data tables; actual capacities may be less than those reported due to sediment accumulation, vegetation, and debris caught at culvert entrances.
- For simplicity, downstream channels were assumed to be trapezoidal with a bottom width and slope equal to that of the culvert crossing and a Manning's value of 0.025.
- Overtopping of roadways was not modeled in HY-8. Maximum capacities correspond to maximum upstream water levels before flow starts overtopping the road or break out of the channel upstream of the crossing.

Crossing 1 (Montoyas Arroyo & King Blvd)



Crossing Data - Montoyas_King

Crossing Properties

Name: Montoyas_King

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	Minimum, Design, and Maximum	
Minimum Flow	1000.000	cfs
Design Flow	3000.000	cfs
Maximum Flow	9000.000	cfs
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	50.000	ft
Side Slope (H:V)	2.000	_:1
Channel Slope	0.0100	ft/ft
Manning's n (channel)	0.025	
Channel Invert Elevation	0.000	ft
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.000	ft
Crest Length	50.000	ft
Crest Elevation	11.854	ft
Roadway Surface	Paved	
Top Width	50.000	ft

Culvert Properties

Culvert 1

Add Culvert

Duplicate Culvert

Delete Culvert

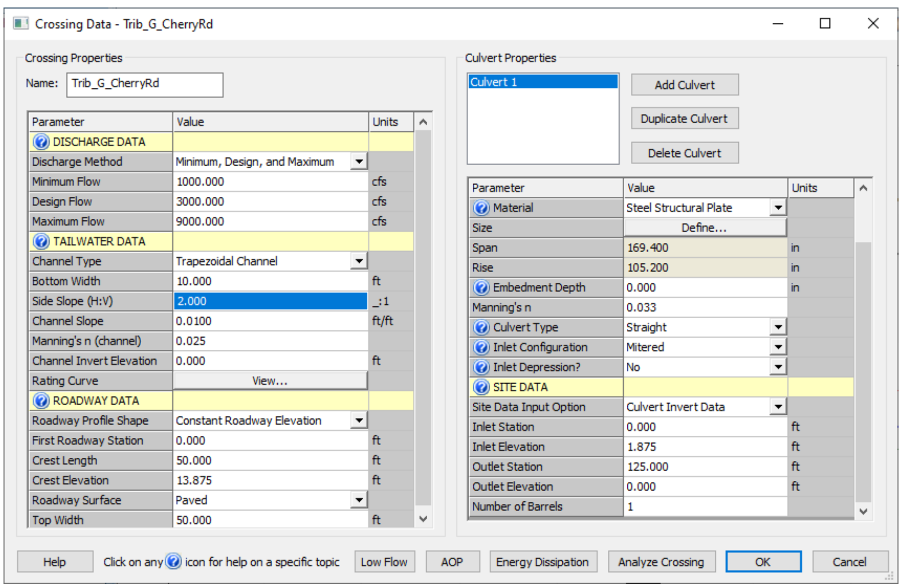
Parameter	Value	Units
CULVERT DATA		
Name	Culvert 1	
Shape	Concrete Box	
Material	Concrete	
Span	10.000	ft
Rise	8.000	ft
Embedment Depth	0.000	in
Manning's n	0.012	
Culvert Type	Straight	
Inlet Configuration	Square Edge (30-75º flare) Wingwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.000	ft
Inlet Elevation	0.854	ft
Outlet Station	122.000	ft
Outlet Elevation	0.000	ft
Number of Barrels	5	

Help | Click on any icon for help on a specific topic | Low Flow | AOP | Energy Dissipation | Analyze Crossing | OK | Cancel

Summary of Flows at Crossing - Montoyas_King

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
4.39	1000.00	1000.00	0.00	1
6.12	1800.00	1800.00	0.00	1
7.61	2600.00	2600.00	0.00	1
8.31	3000.00	3000.00	0.00	1
10.54	4200.00	4200.00	0.00	1
12.19	5000.00	4971.02	28.94	5
13.45	5800.00	5494.32	305.52	4
14.57	6600.00	5920.07	679.88	4
15.62	7400.00	6289.47	1109.74	3
16.62	8200.00	6620.41	1579.56	2
17.57	9000.00	6921.04	2078.26	2
11.85	4823.05	4823.05	0.00	Overtopping

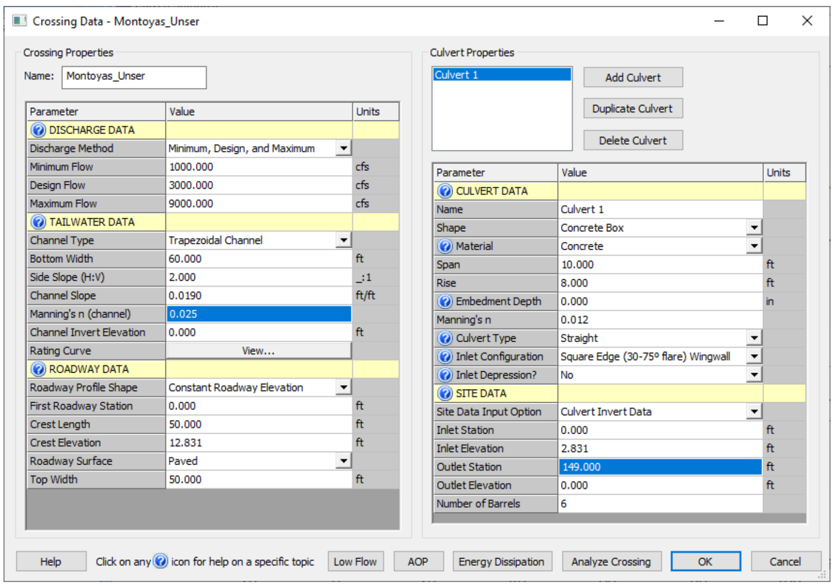
Crossing 2 (Tributary G & Cherry Rd)



Summary of Flows at Crossing - Trib_G_CherryRd

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
4.35	100.00	100.00	0.00	1
6.46	290.00	290.00	0.00	1
7.93	480.00	480.00	0.00	1
8.63	500.00	500.00	0.00	1
11.40	860.00	860.00	0.00	1
12.88	1050.00	1050.00	0.00	1
14.42	1240.00	1179.46	60.51	6
15.07	1430.00	1230.87	199.10	4
15.62	1620.00	1271.85	348.12	4
16.10	1810.00	1307.50	502.10	3
16.54	2000.00	1339.78	659.88	3
13.88	1135.58	1135.58	0.00	Overtopping

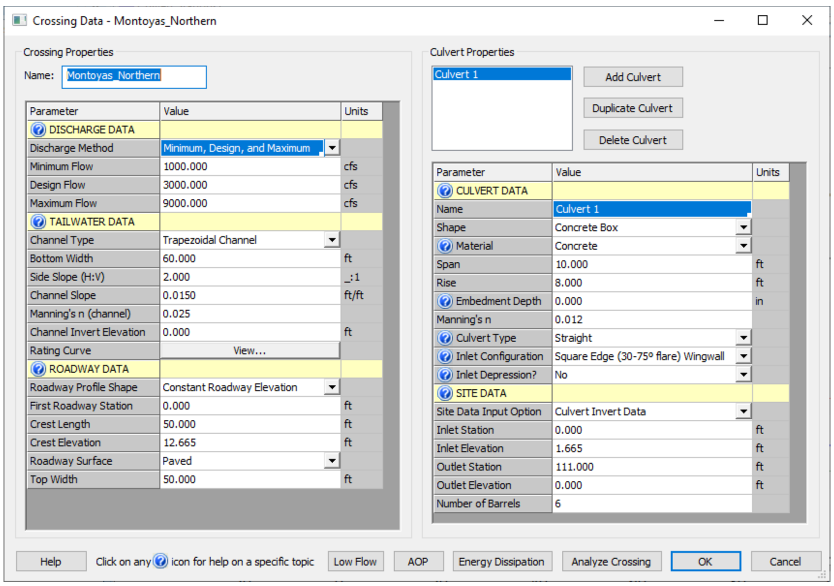
Crossing 3 (Montoyas Arroyo & Unser Blvd)



Summary of Flows at Crossing - Montoyas_Unser

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5.93	1000.00	1000.00	0.00	1
7.44	1800.00	1800.00	0.00	1
8.75	2600.00	2600.00	0.00	1
9.36	3000.00	3000.00	0.00	1
11.14	4200.00	4200.00	0.00	1
12.40	5000.00	5000.00	0.00	1
13.61	5800.00	5695.20	104.60	4
14.64	6600.00	6231.36	368.15	3
15.60	7400.00	6698.68	700.72	2
16.53	8200.00	7117.97	1082.03	3
17.43	9000.00	7499.86	1500.14	3
12.83	5254.23	5254.23	0.00	Overtopping

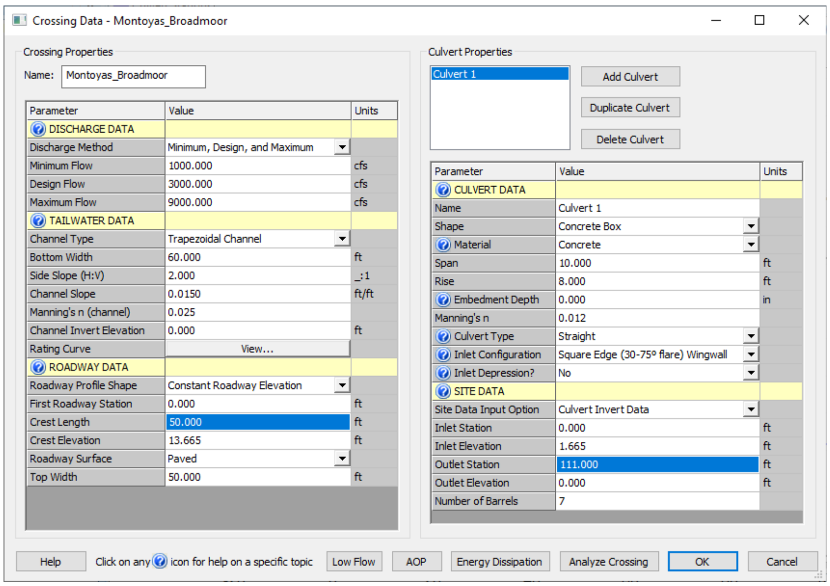
Crossing 4 (Montoyas Arroyo & Northern Blvd)



Summary of Flows at Crossing - Montoyas_Northern

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
4.77	1000.00	1000.00	0.00	1
6.29	1800.00	1800.00	0.00	1
7.60	2600.00	2600.00	0.00	1
8.21	3000.00	3000.00	0.00	1
9.99	4200.00	4200.00	0.00	1
11.25	5000.00	5000.00	0.00	1
12.66	5800.00	5800.00	0.00	1
13.84	6600.00	6406.63	193.23	4
14.89	7400.00	6897.53	502.45	4
15.87	8200.00	7328.08	871.61	2
16.81	9000.00	7715.59	1284.41	3
12.66	5804.74	5804.74	0.00	Overtopping

Crossing 5 (Montoyas Arroyo & Broadmoor Blvd)



Crossing Data - Montoyas_Broadmoor

Crossing Properties

Name: Montoyas_Broadmoor

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	Minimum, Design, and Maximum	
Minimum Flow	1000.000	cfs
Design Flow	3000.000	cfs
Maximum Flow	9000.000	cfs
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	60.000	ft
Side Slope (H:V)	2.000	_:1
Channel Slope	0.0150	ft/ft
Manning's n (channel)	0.025	
Channel Invert Elevation	0.000	ft
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.000	ft
Crest Length	50.000	ft
Crest Elevation	13.665	ft
Roadway Surface	Paved	
Top Width	50.000	ft

Culvert Properties

Culvert 1

Add Culvert

Duplicate Culvert

Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Culvert 1	
Shape	Concrete Box	
Material	Concrete	
Span	10.000	ft
Rise	8.000	ft
Embedment Depth	0.000	in
Manning's n	0.012	
Culvert Type	Straight	
Inlet Configuration	Square Edge (30-75º flare) Wingwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.000	ft
Inlet Elevation	1.665	ft
Outlet Station	111.000	ft
Outlet Elevation	0.000	ft
Number of Barrels	7	

Help | Click on any icon for help on a specific topic | Low Flow | AOP | Energy Dissipation | Analyze Crossing | OK | Cancel

Summary of Flows at Crossing - Montoyas_Broadmoor

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
4.47	1000.00	1000.00	0.00	1
5.82	1800.00	1800.00	0.00	1
7.01	2600.00	2600.00	0.00	1
7.56	3000.00	3000.00	0.00	1
9.09	4200.00	4200.00	0.00	1
10.12	5000.00	5000.00	0.00	1
11.20	5800.00	5800.00	0.00	1
12.39	6600.00	6600.00	0.00	1
13.71	7400.00	7398.53	1.29	5
14.82	8200.00	8011.93	187.97	4
15.81	9000.00	8521.65	478.23	2
13.66	7373.79	7373.79	0.00	Overtopping

Crossing 6 (Montoyas Arroyo & NM 528)

Crossing Data - Montoyas_NM528

Crossing Properties

Name: Montoyas_NM528

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	Minimum, Design, and Maximum	
Minimum Flow	1000.000	cfs
Design Flow	3000.000	cfs
Maximum Flow	9000.000	cfs
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	70.000	ft
Side Slope (H:V)	2.000	_:1
Channel Slope	0.0110	ft/ft
Manning's n (channel)	0.025	
Channel Invert Elevation	0.000	ft
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.000	ft
Crest Length	50.000	ft
Crest Elevation	13.947	ft
Roadway Surface	Paved	
Top Width	50.000	ft

Culvert Properties

Culvert 1

Add Culvert | Duplicate Culvert | Delete Culvert

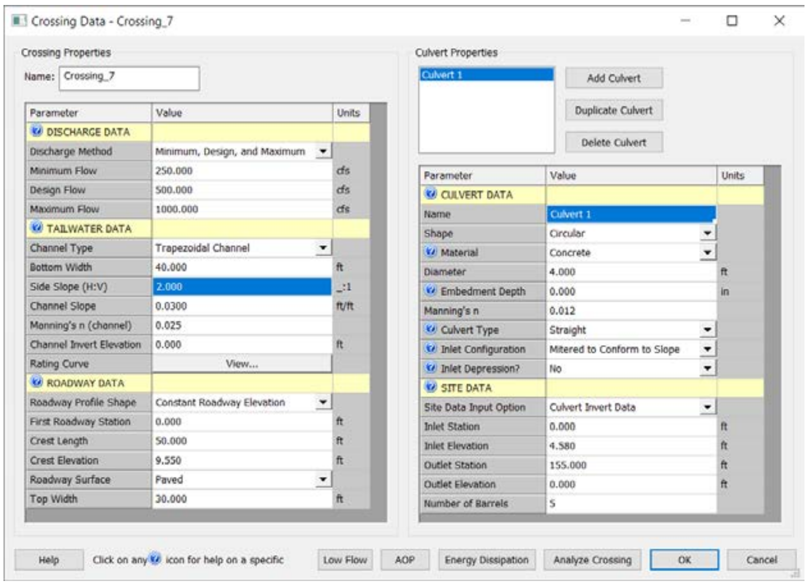
Parameter	Value	Units
CULVERT DATA		
Name	Culvert 1	
Shape	Concrete Box	
Material	Concrete	
Span	10.000	ft
Rise	10.000	ft
Embedment Depth	0.000	in
Manning's n	0.012	
Culvert Type	Straight	
Inlet Configuration	Square Edge (0º flare) Wingwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.000	ft
Inlet Elevation	1.947	ft
Outlet Station	177.000	ft
Outlet Elevation	0.000	ft
Number of Barrels	7	

Help | Click on any icon for help on a specific topic | Low Flow | AOP | Energy Dissipation | Analyze Crossing | OK | Cancel

Summary of Flows at Crossing - Montoyas_NM528

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5.06	1000.00	1000.00	0.00	1
6.55	1800.00	1800.00	0.00	1
7.78	2600.00	2600.00	0.00	1
8.35	3000.00	3000.00	0.00	1
9.97	4200.00	4200.00	0.00	1
11.02	5000.00	5000.00	0.00	1
12.09	5800.00	5800.00	0.00	1
13.21	6600.00	6600.00	0.00	1
14.32	7400.00	7364.95	34.74	4
15.26	8200.00	7971.61	228.38	3
16.13	9000.00	8509.02	490.97	3
13.95	7112.21	7112.21	0.00	Overtopping

Crossing 7 (High Range Tributary & Loma Colorado Blvd)



Crossing Data - Crossing_7

Crossing Properties

Name: Crossing_7

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	Minimum, Design, and Maximum	
Minimum Flow	250.000	cfs
Design Flow	500.000	cfs
Maximum Flow	1000.000	cfs
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	40.000	ft
Side Slope (H:V)	2.000	_:1
Channel Slope	0.0300	ft/ft
Manning's n (channel)	0.025	
Channel Invert Elevation	0.000	ft
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.000	ft
Crest Length	50.000	ft
Crest Elevation	9.550	ft
Roadway Surface	Paved	
Top Width	30.000	ft

Culvert Properties

Culvert 1

Add Culvert

Duplicate Culvert

Delete Culvert

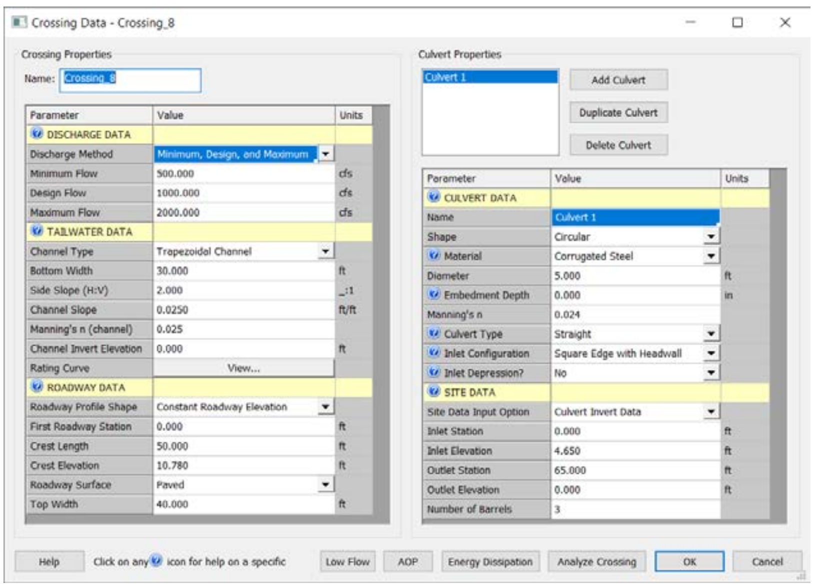
Parameter	Value	Units
CULVERT DATA		
Name	Culvert 1	
Shape	Circular	
Material	Concrete	
Diameter	4.000	ft
Embedment Depth	0.000	in
Manning's n	0.012	
Culvert Type	Straight	
Inlet Configuration	Mitered to Conform to Slope	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.000	ft
Inlet Elevation	4.580	ft
Outlet Station	155.000	ft
Outlet Elevation	0.000	ft
Number of Barrels	5	

Help | Click on any icon for help on a specific | Low Flow | AOP | Energy Dissipation | Analyze Crossing | OK | Cancel

Summary of Flows at Crossing - Crossing_7

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7.83	250.00	250.00	0.00	1
8.43	325.00	325.00	0.00	1
9.13	400.00	400.00	0.00	1
9.78	475.00	458.52	16.35	5
9.90	500.00	468.71	31.24	5
10.39	625.00	507.61	117.29	4
10.64	700.00	526.33	173.59	4
10.88	775.00	543.07	231.87	4
11.10	850.00	558.35	291.61	4
11.30	925.00	572.50	352.47	4
11.50	1000.00	585.67	413.95	3
9.55	438.57	438.57	0.00	Overtopping

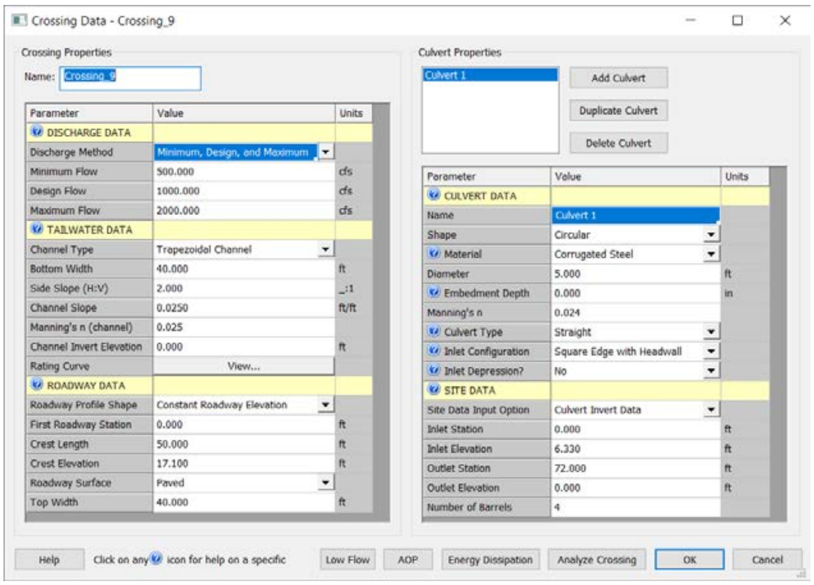
Crossing 8 (High Range Tributary & Idalia Rd)



Summary of Flows at Crossing - Crossing_8

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
10.66	500.00	500.00	0.00	1
11.45	650.00	566.92	83.04	4
11.96	800.00	606.56	193.39	4
12.39	950.00	638.88	311.09	4
12.53	1000.00	648.56	351.12	3
13.16	1250.00	691.78	557.98	3
13.51	1400.00	714.48	685.21	3
13.84	1550.00	735.40	814.33	3
14.16	1700.00	754.87	944.89	3
14.47	1850.00	773.08	1076.72	3
14.77	2000.00	790.32	1209.51	3
10.78	510.31	510.31	0.00	Overtopping

Crossing 9 (Aloe Tributary & Idalia Rd)



Crossing Data - Crossing_9

Crossing Properties

Name: Crossing_9

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	Minimum, Design, and Maximum	
Minimum Flow	500.000	cfs
Design Flow	1000.000	cfs
Maximum Flow	2000.000	cfs
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	40.000	ft
Side Slope (H:V)	2.000	_:1
Channel Slope	0.0250	ft/ft
Manning's n (channel)	0.025	
Channel Invert Elevation	0.000	ft
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.000	ft
Crest Length	50.000	ft
Crest Elevation	17.100	ft
Roadway Surface	Paved	
Top Width	40.000	ft

Culvert Properties

Culvert 1

Add Culvert

Duplicate Culvert

Delete Culvert

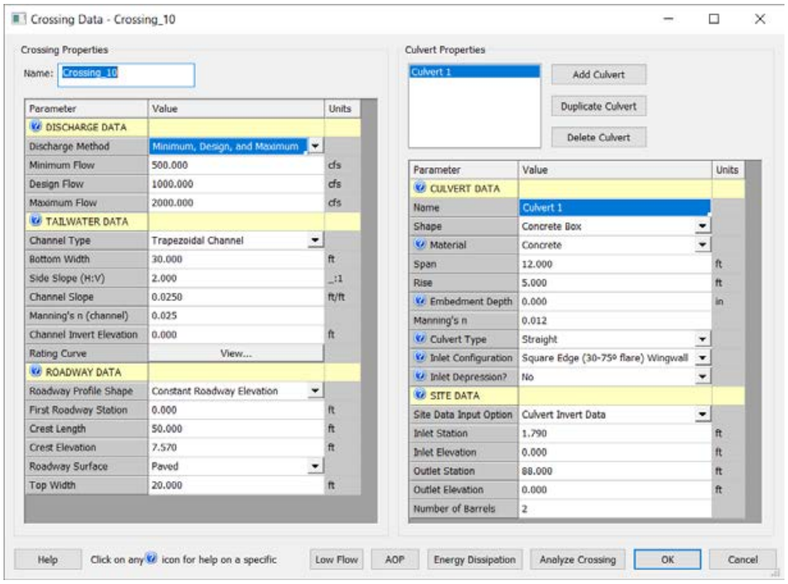
Parameter	Value	Units
CULVERT DATA		
Name	Culvert 1	
Shape	Circular	
Material	Corrugated Steel	
Diameter	5.000	ft
Embedment Depth	0.000	in
Manning's n	0.024	
Culvert Type	Straight	
Inlet Configuration	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.000	ft
Inlet Elevation	6.330	ft
Outlet Station	72.000	ft
Outlet Elevation	0.000	ft
Number of Barrels	4	

Help | Click on any icon for help on a specific | Low Flow | AOP | Energy Dissipation | Analyze Crossing | OK | Cancel

Summary of Flows at Crossing - Crossing_9

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
11.03	500.00	500.00	0.00	1
12.17	650.00	650.00	0.00	1
13.51	800.00	800.00	0.00	1
15.12	950.00	950.00	0.00	1
15.72	1000.00	1000.00	0.00	1
17.82	1250.00	1156.72	93.16	6
18.34	1400.00	1191.64	208.30	4
18.78	1550.00	1220.75	329.21	4
19.17	1700.00	1246.53	453.44	4
19.54	1850.00	1269.83	579.78	3
19.89	2000.00	1291.52	708.15	3
17.10	1105.49	1105.49	0.00	Overtopping

Crossing 10 (Lomitas Negras & Saratoga Dr)

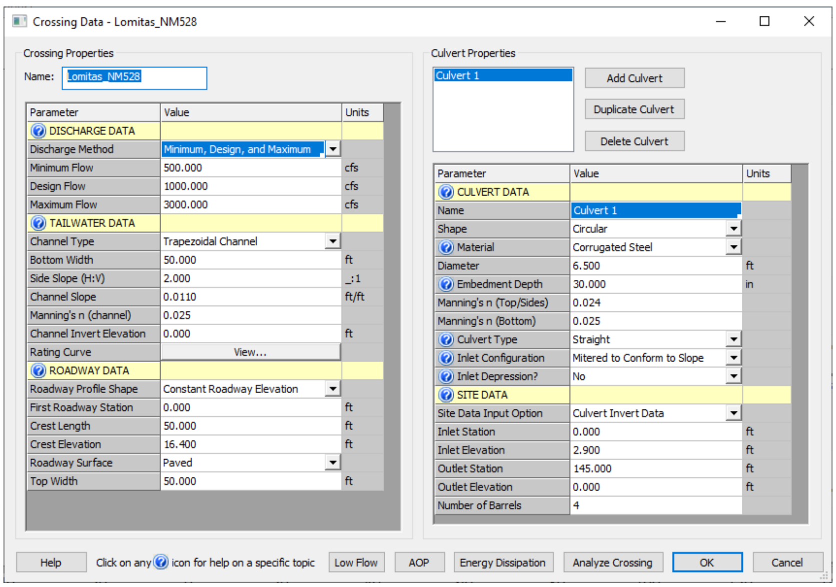


Assumption: culvert is obstructed by 1 ft of sediment

Summary of Flows at Crossing - Crossing_10

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
4.46	500.00	500.00	0.00	1
5.24	650.00	650.00	0.00	1
5.97	800.00	800.00	0.00	1
6.36	950.00	950.00	0.00	1
6.51	1000.00	1000.00	0.00	1
7.54	1250.00	1250.00	0.00	1
8.12	1400.00	1337.62	62.26	4
8.56	1550.00	1400.14	149.81	4
8.95	1700.00	1453.29	246.68	4
9.31	1850.00	1500.48	349.12	3
9.65	2000.00	1543.54	456.12	3
7.57	1254.24	1254.24	0.00	Overtopping

Crossing 11 (Lomitas Negras Arroyo & NM 528)



Summary of Flows at Crossing - Lomitas_NM528

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
8.48	500.00	500.00	0.00	1
9.75	750.00	750.00	0.00	1
12.10	1000.00	1000.00	0.00	1
14.50	1250.00	1250.00	0.00	1
16.97	1500.00	1434.02	65.73	6
17.83	1750.00	1491.67	258.19	3
18.12	2000.00	1642.38	342.17	10
18.87	2250.00	1645.79	590.72	8
19.55	2500.00	1650.55	847.21	5
20.06	2750.00	1678.32	1063.87	8
20.60	3000.00	1691.93	1307.94	6
16.40	1393.84	1393.84	0.00	Overtopping

Crossing 12 (Rockaway Channel & Turquoise Dr)

Crossing Data - RockawayChannel_Turquoise

Crossing Properties

Name: RockawayChannel_Turquoise

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	Minimum, Design, and Maximum	
Minimum Flow	100.000	cfs
Design Flow	500.000	cfs
Maximum Flow	1000.000	cfs
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	40.000	ft
Side Slope (H:V)	2.000	_:1
Channel Slope	0.0110	ft/ft
Manning's n (channel)	0.025	
Channel Invert Elevation	0.000	ft
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.000	ft
Crest Length	50.000	ft
Crest Elevation	6.780	ft
Roadway Surface	Paved	
Top Width	50.000	ft

Culvert Properties

Culvert 1

Add Culvert | Duplicate Culvert | Delete Culvert

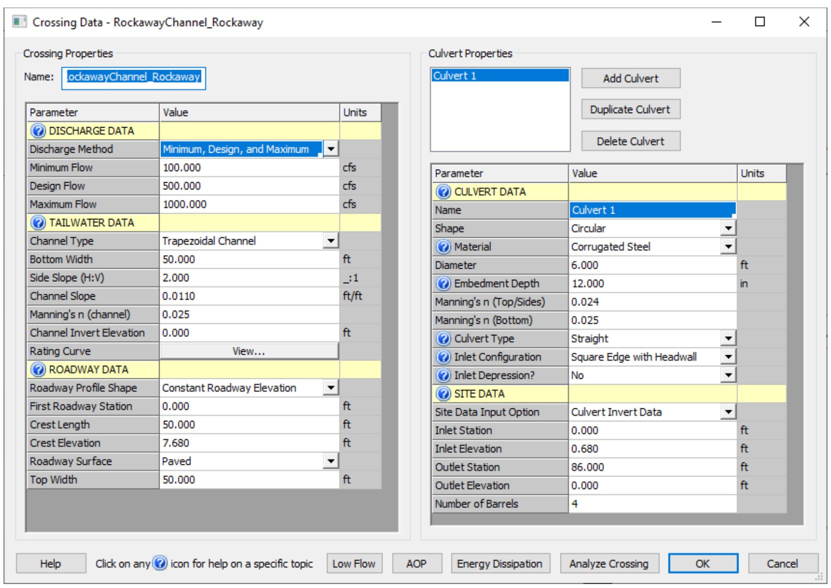
Parameter	Value	Units
CULVERT DATA		
Name	Culvert 1	
Shape	Circular	
Material	Corrugated Steel	
Diameter	5.000	ft
Embedment Depth	24.000	in
Manning's n (Top/Sides)	0.024	
Manning's n (Bottom)	0.025	
Culvert Type	Straight	
Inlet Configuration	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.000	ft
Inlet Elevation	0.780	ft
Outlet Station	65.000	ft
Outlet Elevation	0.000	ft
Number of Barrels	5	

Help | Click on any icon for help on a specific topic | Low Flow | AOP | Energy Dissipation | Analyze Crossing | OK | Cancel

Summary of Flows at Crossing - RockawayChannel_Turquoise

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
4.19	100.00	100.00	0.00	1
4.94	190.00	190.00	0.00	1
5.60	280.00	280.00	0.00	1
6.25	370.00	370.00	0.00	1
6.93	460.00	451.61	8.34	5
7.12	500.00	470.23	29.40	6
7.49	640.00	549.61	90.71	3
7.74	730.00	586.57	143.17	3
7.99	820.00	616.97	203.00	4
8.24	910.00	643.47	266.12	3
8.47	1000.00	667.47	332.16	3
6.78	435.70	435.70	0.00	Overtopping

Crossing 13 (Rockaway Channel & Rockaway Blvd)



Crossing Data - RockawayChannel_Rockaway

Crossing Properties

Name: ockawayChannel_Rockaway

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	Minimum, Design, and Maximum	
Minimum Flow	100.000	cfs
Design Flow	500.000	cfs
Maximum Flow	1000.000	cfs
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	50.000	ft
Side Slope (H:V)	2.000	_:1
Channel Slope	0.0110	ft/ft
Manning's n (channel)	0.025	
Channel Invert Elevation	0.000	ft
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.000	ft
Crest Length	50.000	ft
Crest Elevation	7.680	ft
Roadway Surface	Paved	
Top Width	50.000	ft

Culvert Properties

Culvert 1

Add Culvert

Duplicate Culvert

Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Culvert 1	
Shape	Circular	
Material	Corrugated Steel	
Diameter	6.000	ft
Embedment Depth	12.000	in
Manning's n (Top/Sides)	0.024	
Manning's n (Bottom)	0.025	
Culvert Type	Straight	
Inlet Configuration	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.000	ft
Inlet Elevation	0.680	ft
Outlet Station	86.000	ft
Outlet Elevation	0.000	ft
Number of Barrels	4	

Help | Click on any icon for help on a specific topic | Low Flow | AOP | Energy Dissipation | Analyze Crossing | OK | Cancel

Summary of Flows at Crossing - RockawayChannel_Rockaway

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
3.25	100.00	100.00	0.00	1
4.02	190.00	190.00	0.00	1
4.66	280.00	280.00	0.00	1
5.23	370.00	370.00	0.00	1
5.77	460.00	460.00	0.00	1
6.00	500.00	500.00	0.00	1
6.81	640.00	640.00	0.00	1
7.33	730.00	730.00	0.00	1
7.83	820.00	811.63	8.21	5
8.15	910.00	861.61	48.27	4
8.43	1000.00	902.31	97.55	5
7.68	788.00	788.00	0.00	Overtopping

Crossing 14 (Rockaway Channel & Sundt Rd)

Crossing Data - RockawayChannel_Sundt Rd

Crossing Properties

Name: RockawayChannel_Sundt Rd

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	Minimum, Design, and Maximum	
Minimum Flow	100.000	cfs
Design Flow	500.000	cfs
Maximum Flow	1000.000	cfs
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	50.000	ft
Side Slope (H:V)	2.000	_:1
Channel Slope	0.0110	ft/ft
Manning's n (channel)	0.025	
Channel Invert Elevation	0.000	ft
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.000	ft
Crest Length	50.000	ft
Crest Elevation	6.832	ft
Roadway Surface	Paved	
Top Width	50.000	ft

Culvert Properties

Culvert 1

Add Culvert | Duplicate Culvert | Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Culvert 1	
Shape	Circular	
Material	Corrugated Steel	
Diameter	5.000	ft
Embedment Depth	0.000	in
Manning's n	0.024	
Culvert Type	Straight	
Inlet Configuration	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.000	ft
Inlet Elevation	0.832	ft
Outlet Station	64.000	ft
Outlet Elevation	0.000	ft
Number of Barrels	6	

Help | Click on any icon for help on a specific topic | Low Flow | AOP | Energy Dissipation | Analyze Crossing | OK | Cancel

Summary of Flows at Crossing - RockawayChannel_Sundt Rd

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2.35	100.00	100.00	0.00	1
2.97	190.00	190.00	0.00	1
3.47	280.00	280.00	0.00	1
3.94	370.00	370.00	0.00	1
4.37	460.00	460.00	0.00	1
4.56	500.00	500.00	0.00	1
5.20	640.00	640.00	0.00	1
6.01	730.00	730.00	0.00	1
6.37	820.00	820.00	0.00	1
6.73	910.00	910.00	0.00	1
7.05	1000.00	984.24	15.47	4
6.83	934.80	934.80	0.00	Overtopping

Crossing 16 (Montoyas Arroyo & Serene Meadows)

Crossing Data - Montoyas_SereneMeadows

Crossing Properties

Name: Montoyas_SereneMeadows

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	Minimum, Design, and Maximum	
Minimum Flow	1000.000	cfs
Design Flow	3000.000	cfs
Maximum Flow	9000.000	cfs
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	50.000	ft
Side Slope (H:V)	2.000	_:1
Channel Slope	0.0100	ft/ft
Manning's n (channel)	0.025	
Channel Invert Elevation	0.000	ft
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.000	ft
Crest Length	50.000	ft
Crest Elevation	12.620	ft
Roadway Surface	Paved	
Top Width	50.000	ft

Culvert Properties

Culvert 1

Add Culvert | Duplicate Culvert | Delete Culvert

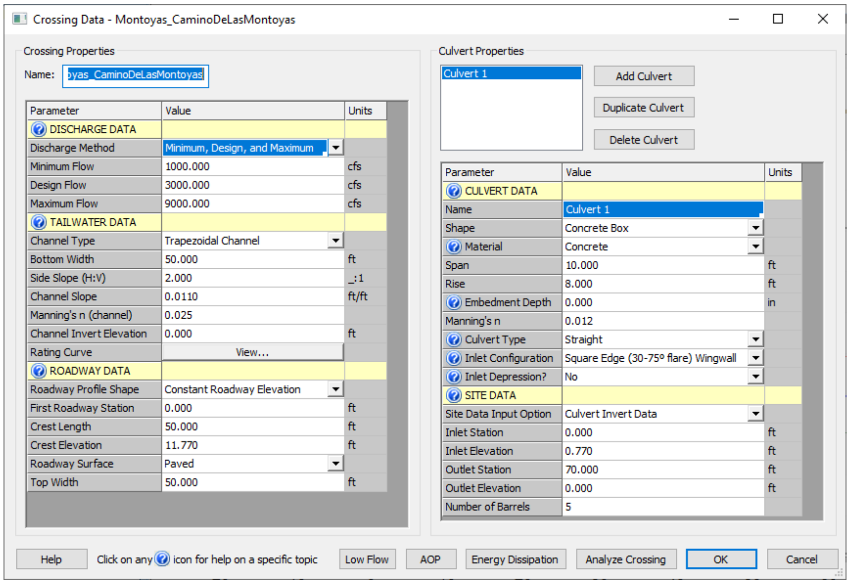
Parameter	Value	Units
CULVERT DATA		
Name	Culvert 1	
Shape	Concrete Box	
Material	Concrete	
Span	10.000	ft
Rise	8.000	ft
Embedment Depth	0.000	in
Manning's n	0.012	
Culvert Type	Straight	
Inlet Configuration	Square Edge (30-75º flare) Wingwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.000	ft
Inlet Elevation	0.620	ft
Outlet Station	62.000	ft
Outlet Elevation	0.000	ft
Number of Barrels	5	

Help | Click on any icon for help on a specific topic | Low Flow | AOP | Energy Dissipation | Analyze Crossing | OK | Cancel

Summary of Flows at Crossing - Montoyas_SereneMeadows

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
4.15	1000.00	1000.00	0.00	1
5.88	1800.00	1800.00	0.00	1
7.36	2600.00	2600.00	0.00	1
8.07	3000.00	3000.00	0.00	1
10.29	4200.00	4200.00	0.00	1
12.01	5000.00	5000.00	0.00	1
13.61	5800.00	5651.22	148.50	4
14.83	6600.00	6101.34	498.54	4
15.94	7400.00	6480.52	919.43	4
16.98	8200.00	6814.57	1384.71	3
17.97	9000.00	7116.67	1883.18	2
12.62	5258.71	5258.71	0.00	Overtopping

Crossing 17 (Montoyas Arroyo & Camino de las Montoyas)



Crossing Data - Montoyas_CaminoDeLasMontoyas

Crossing Properties

Name: yas_CaminoDeLasMontoyas

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	Minimum, Design, and Maximum	
Minimum Flow	1000.000	cfs
Design Flow	3000.000	cfs
Maximum Flow	9000.000	cfs
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	50.000	ft
Side Slope (H:V)	2.000	_:1
Channel Slope	0.0110	ft/ft
Manning's n (channel)	0.025	
Channel Invert Elevation	0.000	ft
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.000	ft
Crest Length	50.000	ft
Crest Elevation	11.770	ft
Roadway Surface	Paved	
Top Width	50.000	ft

Culvert Properties

Culvert 1

Add Culvert | Duplicate Culvert | Delete Culvert

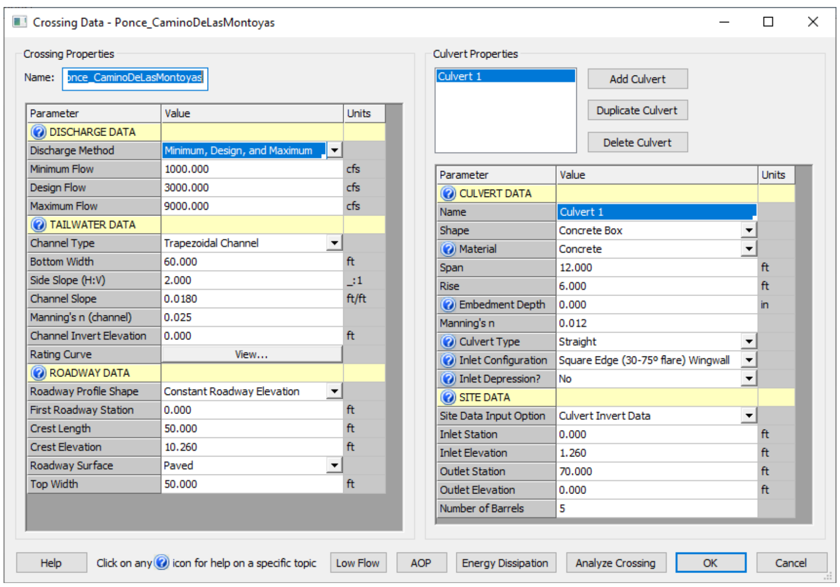
Parameter	Value	Units
CULVERT DATA		
Name	Culvert 1	
Shape	Concrete Box	
Material	Concrete	
Span	10.000	ft
Rise	8.000	ft
Embedment Depth	0.000	in
Manning's n	0.012	
Culvert Type	Straight	
Inlet Configuration	Square Edge (30-75º flare) Wingwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.000	ft
Inlet Elevation	0.770	ft
Outlet Station	70.000	ft
Outlet Elevation	0.000	ft
Number of Barrels	5	

Help | Click on any icon for help on a specific topic | Low Flow | AOP | Energy Dissipation | Analyze Crossing | OK | Cancel

Summary of Flows at Crossing - Montoyas_CaminoDeLasMontoyas

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
4.29	1000.00	1000.00	0.00	1
6.02	1800.00	1800.00	0.00	1
7.51	2600.00	2600.00	0.00	1
8.21	3000.00	3000.00	0.00	1
10.44	4200.00	4200.00	0.00	1
12.09	5000.00	4972.63	27.33	5
13.36	5800.00	5496.98	302.85	4
14.48	6600.00	5923.03	676.92	4
15.53	7400.00	6292.89	1107.09	4
16.53	8200.00	6623.53	1576.43	2
17.48	9000.00	6924.19	2075.12	2
11.77	4830.23	4830.23	0.00	Overtopping

Crossing 18 (Ponce del Leon Arroyo & Camino de las Montoyas)


Crossing Data - Ponce_CaminoDeLasMontoyas

Crossing Properties

Name: Ponce_CaminoDeLasMontoyas

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	Minimum, Design, and Maximum	
Minimum Flow	1000.000	cfs
Design Flow	3000.000	cfs
Maximum Flow	9000.000	cfs
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	60.000	ft
Side Slope (H:V)	2.000	_:1
Channel Slope	0.0180	ft/ft
Manning's n (channel)	0.025	
Channel Invert Elevation	0.000	ft
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.000	ft
Crest Length	50.000	ft
Crest Elevation	10.260	ft
Roadway Surface	Paved	
Top Width	50.000	ft

Culvert Properties

Culvert 1

Add Culvert | Duplicate Culvert | Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Culvert 1	
Shape	Concrete Box	
Material	Concrete	
Span	12.000	ft
Rise	6.000	ft
Embedment Depth	0.000	in
Manning's n	0.012	
Culvert Type	Straight	
Inlet Configuration	Square Edge (30-75º flare) Wingwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.000	ft
Inlet Elevation	1.260	ft
Outlet Station	70.000	ft
Outlet Elevation	0.000	ft
Number of Barrels	5	

Help | Click on any icon for help on a specific topic | Low Flow | AOP | Energy Dissipation | Analyze Crossing | OK | Cancel

Summary of Flows at Crossing - Ponce_CaminoDeLasMontoyas

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
4.36	1000.00	1000.00	0.00	1
5.90	1800.00	1800.00	0.00	1
7.27	2600.00	2600.00	0.00	1
7.98	3000.00	3000.00	0.00	1
10.45	4200.00	4187.97	11.87	6
11.78	5000.00	4714.80	285.02	4
12.95	5800.00	5128.49	671.43	4
14.04	6600.00	5482.00	1117.97	4
15.07	7400.00	5794.76	1604.73	3
16.06	8200.00	6077.63	2122.12	2
17.01	9000.00	6336.76	2663.24	3
10.26	4108.94	4108.94	0.00	Overtopping

Bohannan Huston

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MEMORANDUM

DATE: January 14, 2013

TO: SSCAFCA

FROM: Bohannan Huston, Inc.

SUBJECT: Harvey Jones Improvements – Hydraulic Analysis

Introduction

This memo is a supplement to the DRAFT Design Analysis Report prepared for the Harvey Jones Channel Improvements Project dated November 21, 2012. It summarizes the hydraulic analysis performed at the Harvey Jones Channel from upstream of the existing Corrales Rd. Bridge to the end of the SSCAFCA property where the Middle Rio Grande Conservancy District's (MRGCD) inverted siphon is located (see Figures 4 & 7). This memo also discusses the assumptions that are included in the hydraulic analysis along with a discussion of the results. The hydraulic analysis contained herein is assuming that there is no sediment deposition in Harvey Jones Channel (HJC). We recognize however, and as we have seen from previous storm events, that any sediment deposition under or downstream of the existing bridge degrades the hydraulic capacity of the structure, resulting in the formation of a hydraulic jump occurring upstream of the bridge, as shown in the following picture.

Existing Conditions

As discussed in Section IV.B.1 Existing Conditions of the report, the existing channel upstream of the bridge is 40 feet wide and 10 feet deep, with an upstream slope of about 1.6%. At the bridge, the channel transitions to a 0.0% slope section and the width widens to 46 feet. The bridge is comprised of two CBC's that are 22.5' x 8.3' (w x h). Downstream of the bridge, the channel then gradually transitions to 80 feet wide and remains flat for about 700 feet, ending with a concrete sill that is 3 feet in height.

Proposed Improvements

The proposed improvements contain several elements that have been analyzed in combinations of specific options. The following describes the elements:

- **Parallel 8'x6' CBC** next to the existing CBC's. The additional CBC is contained in all sub-options to Option 2.
- **Trapezoidal channel** incised inside the vertical wall channel inducing a vertical slope that continues to a sediment pond. This Option, labeled as number 1, has been deleted from further consideration as it is not eligible for federal funds and therefore no hydraulic analysis of this option is presented in this memo.
- **Concrete Sill Removal** is proposed in all sub-options of Option 2. However, there are two different ways in which the sill could be removed:
  - **Partial Floor Removal –** this would be accomplished by constructing a trapezoidal channel (40' bottom width, 1:1 side slopes) at the upstream end of the sill. The walls would be left intact and the edge of the trapezoidal channel section would cut through the concrete floor to the end of the concrete channel. The bottom of the trapezoidal channel would be vertically sloped to the sediment pond.
  - **Floor and Wall Removal –** this entails removing the concrete sill in its entirety, which includes the floor and the walls. A vertical wall channel would be reconstructed sloping from the invert upstream of where the sill was removed to the sediment pond.
- **Sediment Pond –** a sediment pond is proposed downstream of the concrete channel to provide additional temporary storage of sediment from summer thunderstorms. The goal of the sediment pond is to reduce the amount of sediment forming under the bridge and in the downstream flat vertical channel. Two different size sediment ponds are proposed:
  - 1.5 Acre Pond – construct a sediment pond (see Figure 7) maximizing the temporary storage volume, while still providing area for storage of earth to be removed from the pond and stored temporarily on site.
  - 0.7 Acre Pond – construct a more linear type pond (80' bottom width [bw], 4:1 side slopes [ss]) that provides the minimum amount of temporary storage.

The options analyzed are described as follows:

- Option 2-A – this option analyzes the hydraulic capacity of building the 8'x6' CBC, complete removal of concrete sill floor and walls, and constructing the 1.5 Acre Pond.

- Option 2-B – this option analyzes the hydraulic capacity of building the 8'x6' CBC, complete removal of the concrete sill and walls (replacing with a vertically sloping vertical wall channel) and the 0.7 acre pond.
- Option 2-C – this option analyzes the hydraulic capacity of building the 8'x6' CBC, partial sill floor removal (replacement with a downward sloping concrete trapezoidal section) and the 0.7 acre pond.

Hydraulic Modeling Assumptions

A number of assumptions are required for the HEC-RAS computer model. Discussed here are the assumptions:

- Hydraulic analysis assumed little sediment deposition under the bridge or downstream.
- BHI performed an analysis of the sediment effects on the channel roughness. Sediment samples were obtained and the procedure from the USACE manual EM 11102-1601 was used from previous SSCAFCA study and composite N value of 0.018 was calculated.
- For all gradual transitions, a 0.1 and 0.3 energy loss factor was used for contraction and expansions, respectively. Where transitions are less gradual, values of 0.3 and 0.5 for contraction and expansion were used, respectively.
- The HEC-RAS model was run using the mixed option which can help in defining locations where a hydraulic jump might occur (sudden change in state from supercritical to subcritical).
- The two existing CBC's and the proposed 8'x6' CBC were modeled using the HEC-RAS bridge routine. The following describes the assumptions used for the bridge modeling:
    - Bridge piers were modeled using an additional foot of width to reflect any debris that could be caught by piers (wall between CBC's).
    - The momentum equation and the energy equation options were used to analyze low flows when flows were below the low chord of the bridge. The option in the program to use the highest energy answer was turned on. The default (recommended) values for the momentum equation were used.
    - For high flow condition, computations were run separately for both the standard step method (energy equation) and the pressure/weir flow method. Results from both analyses are discussed.
    - The water surface option was used for testing the computations to determine if the bridge was entering a pressure flow condition (water surface above the low chord).

Oblique Waves

As discussed in the report, oblique waves can form as a result of transitions and channel obstructions such as piers or walls between CBC's when the flow is supercritical. Although a momentum balance is computed by HEC-RAS, the program does not address the formation or propagation of oblique waves. As described in the report, hydraulic affects from wave propagation could cause the flow depths upstream of the bridge to be approximately 1.0 to 1.5 feet higher than the depths predicted in HEC-RAS, upstream of the bridge. The result of this means that any water surface calculation in HEC-RAS which is within approximately 1.0 of the low chord has the potential of resulting in a hydraulic jump upstream of the bridge.

We also recognize the formation of oblique wave is possible at the entrance to the proposed 8'x6' CBC. For purposes of this study, we have assumed any flow upstream that is within 1.5 feet of the existing bridge low chord could cause a hydraulic jump.

HEC-RAS Hydraulic Results

Presented here are the results from the hydraulic computations for existing conditions and proposed channel improvement options described previously.

Existing Conditions

Figure B-1 shows the resulting hydraulic profile using the energy equation method for analyzing high flow conditions. Under this condition, it can be seen that a flow of 3,000 cfs can result in a hydraulic jump occurring at the bridge. However, flows of about 4,000 cfs and higher will result in a hydraulic jump that is moved downstream due to the higher specific energy of the upstream supercritical flow. This leads to the conclusion that lower flows have insufficient energy to "push" the hydraulic jump downstream. In addition, the concrete sill creates a flow constriction resulting in a weir flow condition at the sill, causing backwater condition upstream. For flows greater than 3,000 cfs, the backwater depth affect from the sill is higher than the low chord of the bridge.

Figure B-2 shows the hydraulic profile using the pressure/weir flow routine in HEC-RAS for the bridge modeling of high flows. This figure shows the capacity of the bridge once a hydraulic jump has formed upstream of the bridge. In this hydraulic condition, the maximum flow that can go through the bridge opening is 4,000 cfs. This capacity calculation is based on maintaining two feet of freeboard between the water surface and the top of the channel.

Proposed Improvements

This section discusses the results for the Option 2 scenarios.

Option 2-A (8'x6' CBC, Sill Fully Removed, 1.5 Acre Sediment Pond)

Figure B-3 shows the resulting water surface profile for Option 2-A using the energy equation bridge method in HEC-RAS. With the concrete sill removed, water depth for the flows downstream of the bridge are approximately 3.5 feet lower than existing conditions. However, the flow depth in the downstream is still controlled by the channel section and flat slope. The flow depth control section (weir flow) at the downstream end of the analysis is located at the MRGCD inverted siphon and is lower than the depth in the channel so it is not influencing the flow depth in the concrete channel. Based on the energy equation analysis, if supercritical flow is maintained through the bridge then the hydraulic jump will occur downstream of the bridge. In reviewing the analysis, one can see that in lower flows the hydraulic jump occurs closer to the downstream end of the bridge. The maximum capacity of the structure under this condition is 7,000 cfs. However, the flow depth downstream is equal to the low chord elevation; and therefore, any hydraulic instability that might result in the jump moving towards the bridge, would result in a reduction in the capacity at the bridge.

Figure B-4 shows the water surface profiles for Option 2-A using the pressure/weir bridge method. Under this scenario, a flow of 5,500 cfs can pass under the bridge and maintain supercritical flow. In the bridge pressure flow routine, the program is checking the potential of the flow to hit the low chord of the bridge; and for any flows greater than 5,500 cfs, the downstream subcritical flow in the concrete channel is above the low chord.

Option 2-B (8'x6' CBC, Sill Fully Removed, 0.7 Acre Sediment Pond)

Figures B-5 and Figure B-6 show the resulting water surface profiles for Option 2-B using the energy equation and pressure/weir bridge analysis methods in HEC-RAS, respectively. The hydraulic results are the same as Option 2-A as the narrower sediment pond does not affect the hydraulics, since the channel capacity (section and slope) and weir flow over the MRGCD inverted siphon are the two controlling conditions.

Option 2-C (8'x6' CBC, Trapezoidal Cut Though Sill Floor, 0.7 Acre Sediment Pond)

Figures B-7 and Figure B-8 show the resulting water surface profiles for Option 2-C using the energy equation and pressure/weir bridge analysis routines in HEC-RAS. This option is similar to Option 2-B, except that a trapezoidal section is cut through the sill without removing the walls leaving 10 feet of the existing floor next to the wall (both sides).

Under the energy equation bridge analysis, 7,000 cfs can still pass under the bridge in supercritical flow with the jump occurring downstream. However, the water surface in the downstream section is approximately 1.0 feet higher than Options 2-A and 2-B, due to the smaller trapezoidal section through the concrete sill.

With respect to the pressure/weir analysis at the bridge, the capacity is reduced to 5,400 cfs. However, the depth of flow downstream of the bridge, where the flow is subcritical, is about 0.9 feet higher than either Options 2-A or 2-B.

Conclusions

The construction of an additional 8'x6' CBC in conjunction with the removal of the concrete sill improves the hydraulic capacity of the bridge and the downstream channel. The construction of either pond (1.5 or 0.7 acres) has essentially no effect on the hydraulic capacity, which is to be expected as their purpose is for the temporary storage of sediment from summer thunderstorms.

The complete removal of the concrete sill and walls shows a small improvement in the bridge capacity over the trapezoidal section through the concrete sill floor. The complete removal (and reconstruction) of the concrete sill, results in the downstream flow depths being approximately lower by 1.0 feet in the concrete channel.

The results for the HEC-RAS runs are summarized in the following table:

Scenario	Bridge Capacity cfs	Flow Regime Upstream of Bridge	HEC-RAS High Flow Method	Sill Scenario	Pier Debris Width ft.	Delta Low Chord vs. WS Downstrm of Bridge ft.	Outlet Scenario
Existing Channel							
	4,000	Backwater	Pressure Flow	-	2	-1.2	Existing
	7,000	Supercritical	Standard Step	-	2	-3.9	Existing
Option 2 - 8x6 Concrete Box Culvert							
Option 2-A	7,000	Supercritical	Standard Step	Sill & Floor Removed	2	0.0	1.5 AC Pond
	5,500	Supercritical	Pressure Flow	Sill & Floor Removed	2	0.8	1.5 AC Pond
Option 2-B	7,000	Supercritical	Standard Step	Sill & Floor Removed	2	-0.1	0.7 AC Pond
	5,400	Supercritical	Pressure Flow	Sill & Floor Removed	2	0.9	0.7 AC Pond
Option 2-C	7,000	Supercritical	Standard Step	Trap thru Sill Floor,Trap	2	-1.2	0.7 AC Pond
	5,500	Supercritical	Pressure Flow	Trap thru Sill Floor,Trap	2	0.1	0.7 AC Pond

Appendix F

Model Calibration

Rainfall and runoff data for ten storm events that occurred between October 2008 and August 2014 were available for calibrating the hydrologic model (Table F 1).

Table F 1: Properties of 10 calibration storms observed in the Montoyas watershed.

Storm	Date	Average total rainfall (in) [a]	Duration (h)	Peak flow (ft3/s)	Runoff volume (ac-ft)	7-day antecedent rainfall (in) [b]	Antecedent flow
a	10/5/08	1.30 (1.06-1.77)	12	113	14	0.11	N
b	10/11/08	1.06 (0.75-1.34)	1	363	71	1.32	Y
c	8/23/10	1.22 (0.43-2.36)	1	2200	202	0.29	N
d	7/26/13	0.59 (0.31-1.34)	3	630	78	0.13	N
e	8/4/13	0.71 (0.20-1.50)	3	900	108	0.60	N
f	9/13/13	1.46 (0.43-2.01)	12	2030	396	1.34	N
g	9/14/13	0.91 (0.55-2.01)	3	858	140	2.35	Y
h	9/15/13	0.31 (0.08-0.63)	2	851	83	3.50	Y
i	7/3/14	0.94 (0.20-2.01)	2	680	142	0.00	N
j	8/10/14	0.31 (0.12-0.67)	3	69	8	0.22	N

[a] Average calculated in GIS based on cumulative precipitation grid (range in parentheses)

[b] Average based on available rain gauge data

Precipitation data were obtained from three sources: tipping bucket rain gages, radar derived rainfall estimates, and storm total rainfall depths measured by volunteer weather observers. Figure F 1 shows a comparison of measured rainfall and IDF curves from the location with the highest precipitation record for each storm event. Elements of two storms exceeded the 100-year recurrence interval (RI) (short dash); portions of four storms fell between the 25- and 50-year RI (solid); one storm (dash-dot) approached the 10-year RI, two storm events fell close to the annual (1-year) storm (dot), and one storm was smaller than the annual storm (long dash). Spatial extent of storms varied considerably; maps of precipitation coverage for each storm event are included in Figure F 2 through Figure F 9. It is important to note that storm data presented in Figure F 1 does not represent basin average rainfall values.

Runoff was measured in the Harvey Jones channel near the watershed outlet (2007-present), at the King Blvd. crossing in Northern Meadows and at Sportsplex Dam (2016-present). At all gaging stations, flow depth was recorded in 5-minute intervals using a pressure transducer (Level Troll 500, In-Situ, Fort Collins, CO; CS451, Campbell Scientific, Logan, UT). Flow depth was converted to discharge using a theoretical rating curve developed in HEC-RAS.

Incremental (5-minute) point precipitation data were converted to rainfall grids with the inverse distance square weighted average interpolation method using the Gageinterp program. Rain gauge data were augmented with radar derived rainfall estimates (NEXRAD Level-III DTA/172, NOAA, 2017a) for three out of ten storms. Based on the areal extent of each storm, points were selected strategically to fill in gaps in the rain gauge coverage. At each point, radar estimates were converted to 5-minute time series of incremental precipitation and bias-corrected by multiplying each time step with a bias adjustment factor.

Four observed storms (see Table F 1, storms b, f, g & h) were preceded by substantial rainfall amounts in the 7-day period leading up to the storm. The remainder of the storm events followed a relatively dry period. A recent SSCAFCA study indicates that antecedent moisture in the watershed is an important factor in the generation of runoff and contributes to model uncertainty. To account for differences in initial conditions, a range of loss parameters was tested both for the curve number and initial and constant rate loss models. The curve number loss model was run for all storms with curve number values ranging from 68 to 80 in increments of one CN for pervious, vegetated areas. For the initial and constant loss rate method, constant loss rates ranging from 0.8-1.5 in/h and initial abstraction values ranging from 0.2-1.2 in were applied to pervious, vegetated areas. Based on an initial set of 16 simulations for each storm event (not reported), it was determined that most of the variability could be accounted for by using a constant loss rate of 0.9 in/h and initial abstraction values between 0.2-1.2 in.

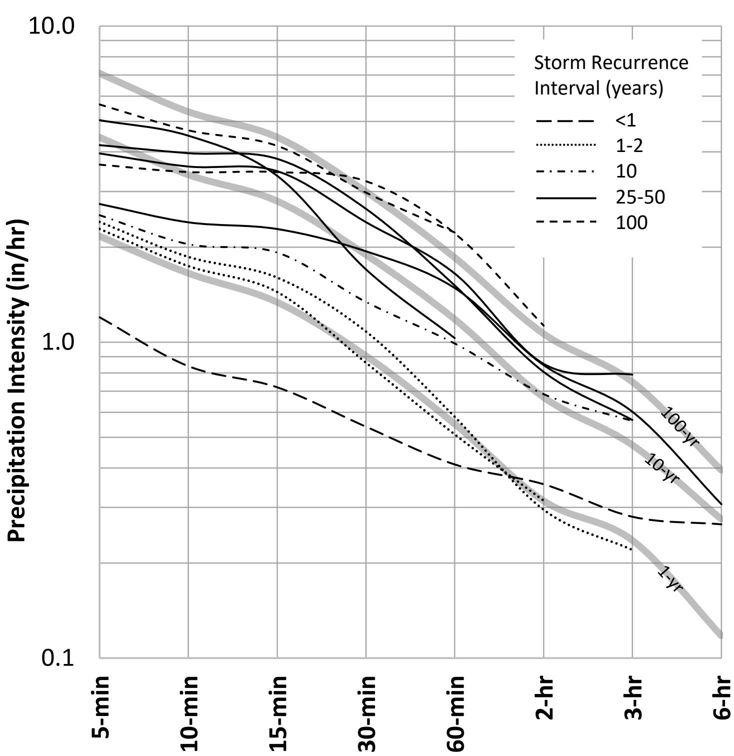
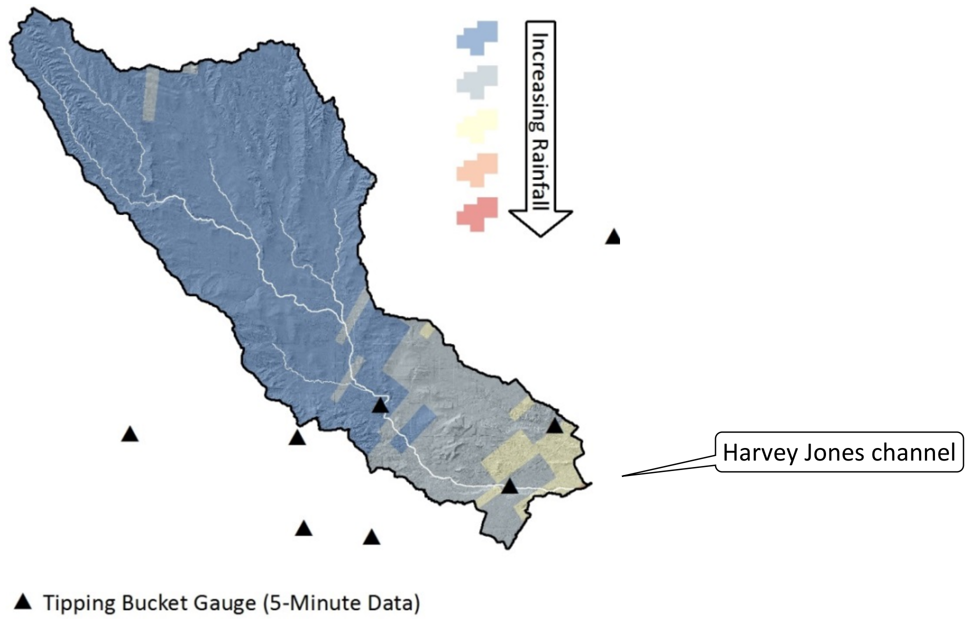


Figure F 1: Intensity-duration-frequency curves (grey) and observed calibration storms (black).

Maps for individual storm events along with model results from curve number and initial and constant loss rate models are displayed in Figure F 2 through Figure F 9. Observed discharge is plotted in red; grey areas show model results for the range of loss parameters considered; black lines represent optimal simulation results along with the corresponding loss parameter.

Optimal simulations for both loss methods yielded acceptable results for most calibration storms. In general, the range of simulated flows was smaller for the curve number method. Based on this analysis, the curve number method was selected as the preferred loss methodology for the Montoyas watershed model.

Storm a



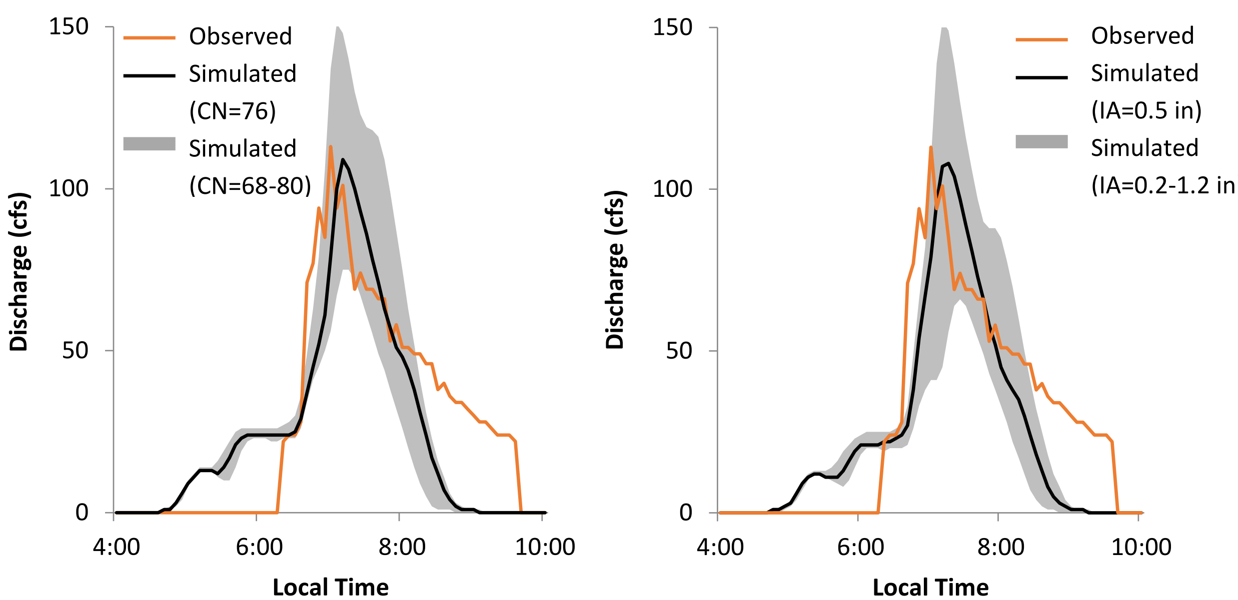


Figure F 2: Map showing the extent of storm a (top), and the comparison of observed and simulated hydrographs for the curve number loss method (bottom left) and the initial and constant loss method (bottom right).

Storm b

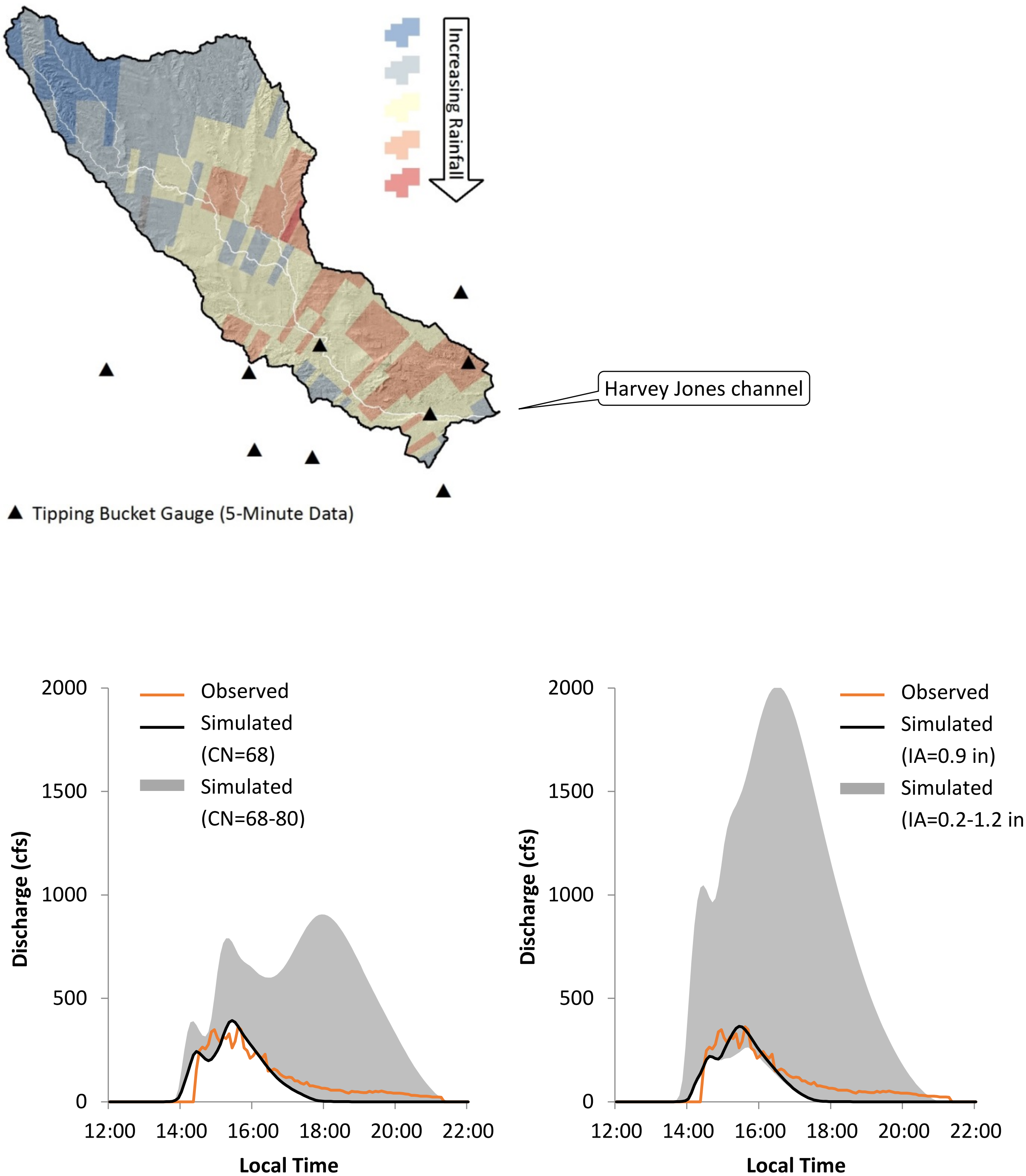
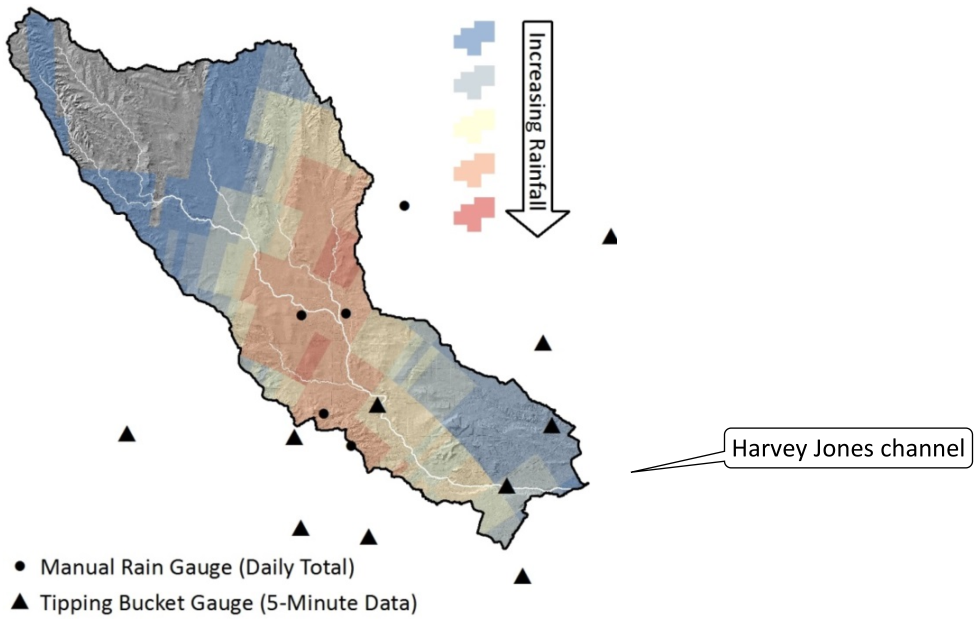
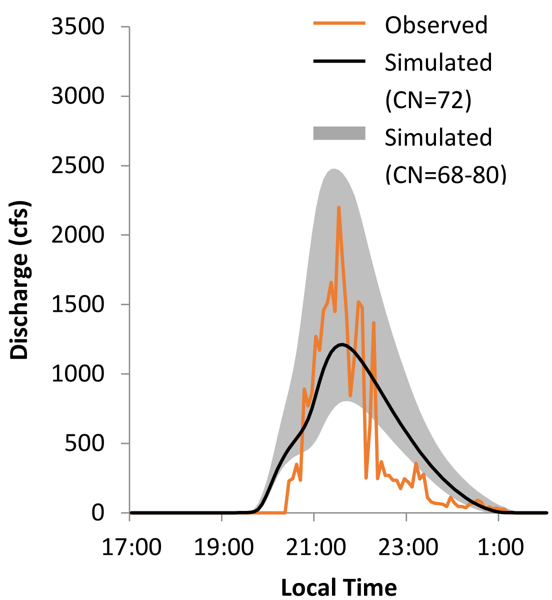


Figure F 3: Map showing the extent of storm b (top), and the comparison of observed and simulated hydrographs for the curve number loss method (bottom left) and the initial and constant loss method (bottom right).

Storm c





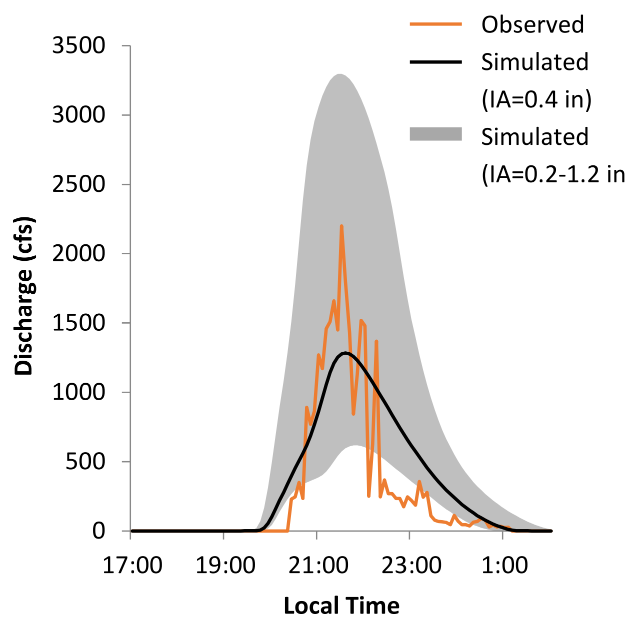


Figure F 4: Map showing the extent of storm c (top), and the comparison of observed and simulated hydrographs for the curve number loss method (bottom left) and the initial and constant loss method (bottom right).

Storm d

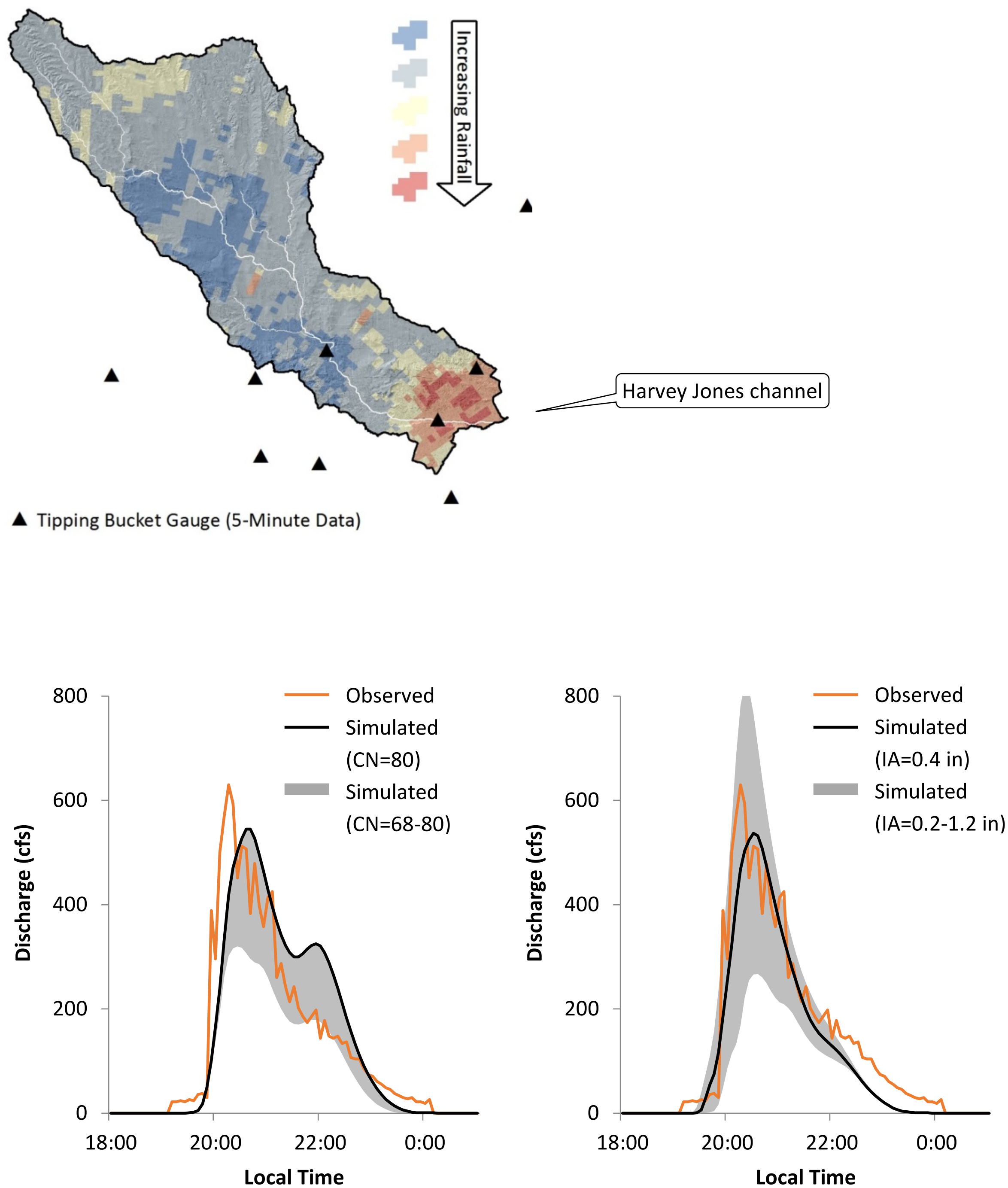
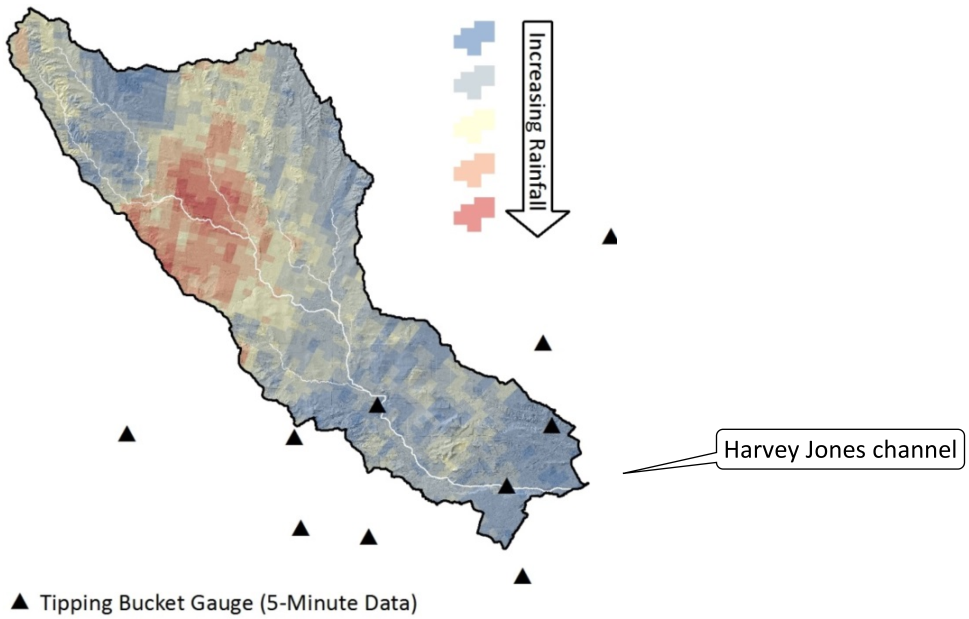


Figure F 5: Map showing the extent of storm d (top), and the comparison of observed and simulated hydrographs for the curve number loss method (bottom left) and the initial and constant loss method (bottom right).

Storm e



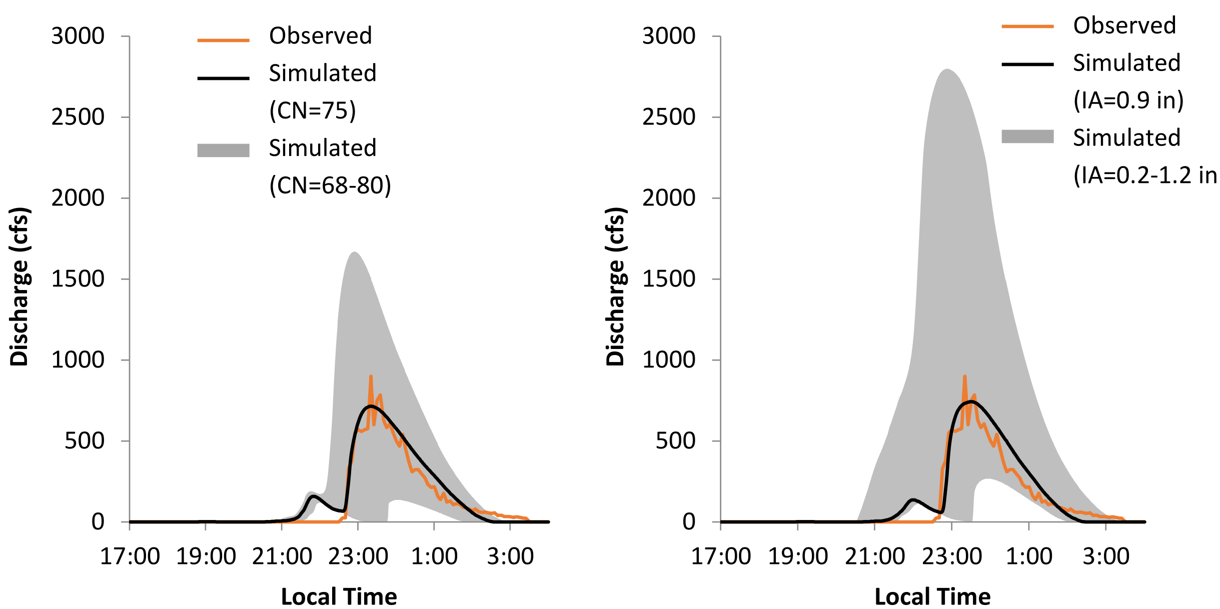
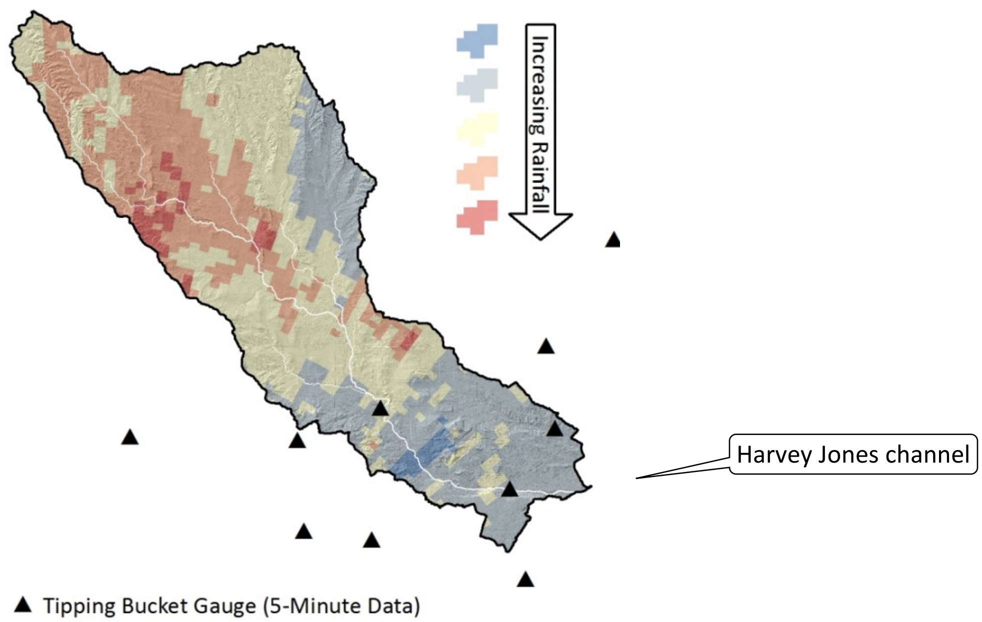
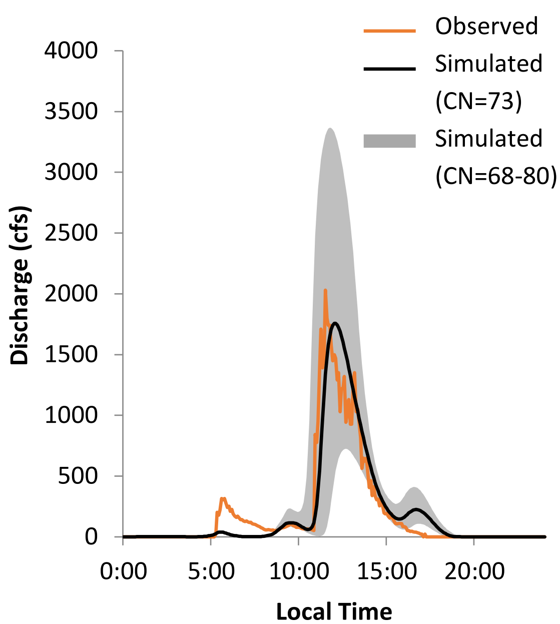


Figure F 6: Map showing the extent of storm e (top), and the comparison of observed and simulated hydrographs for the curve number loss method (bottom left) and the initial and constant loss method (bottom right).

Storm f





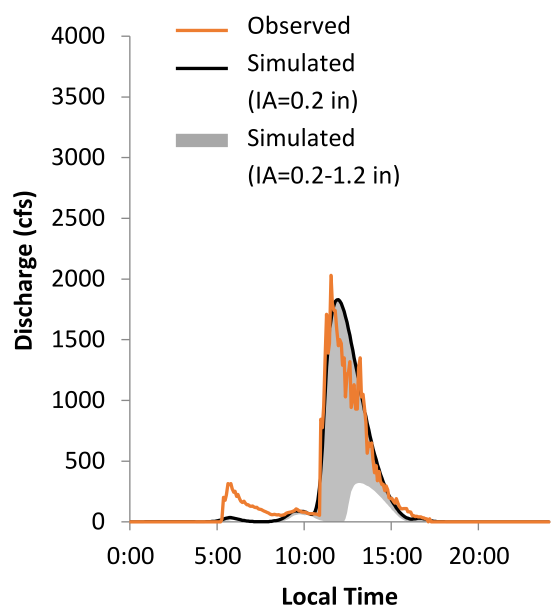


Figure F 7: Map showing the extent of storm f (top), and the comparison of observed and simulated hydrographs for the curve number loss method (bottom left) and the initial and constant loss method (bottom right).

Storm g

Storm h

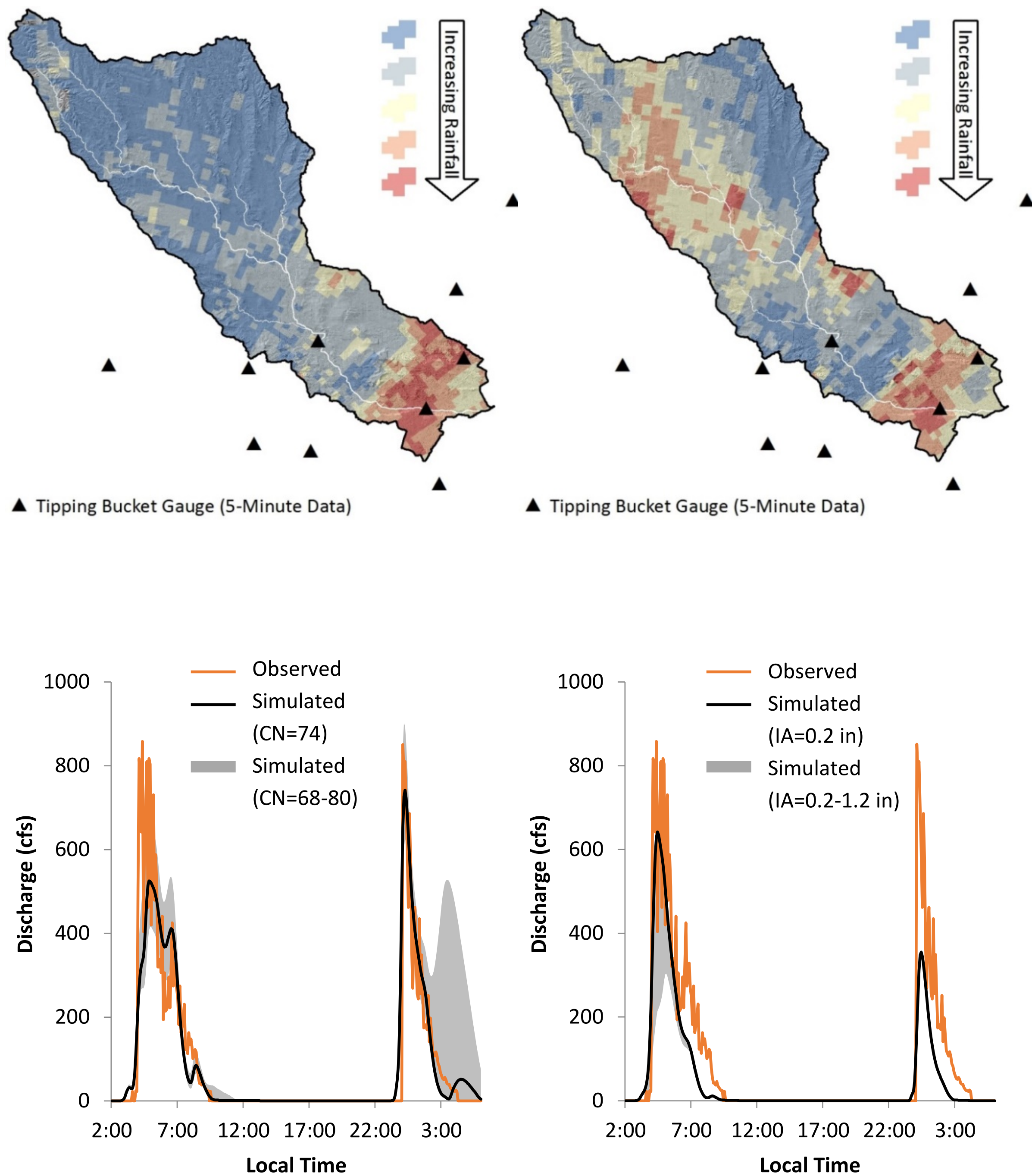
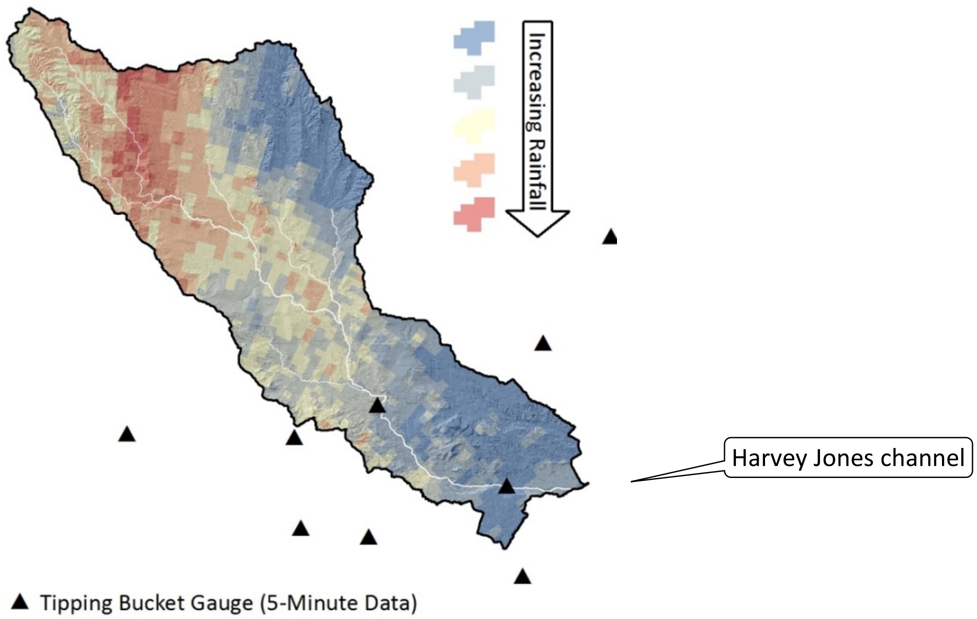
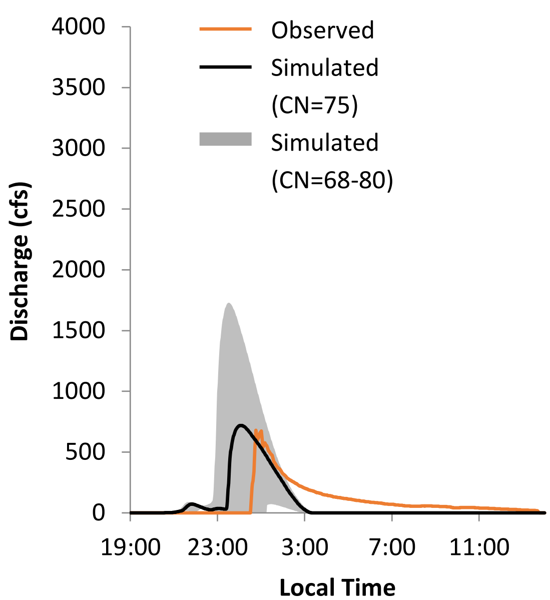


Figure F 8: Map showing the extent of storms g (top left) and h (top right), and the comparison of observed and simulated hydrographs for the curve number loss method (bottom left) and the initial and constant loss method (bottom right).

Storm i





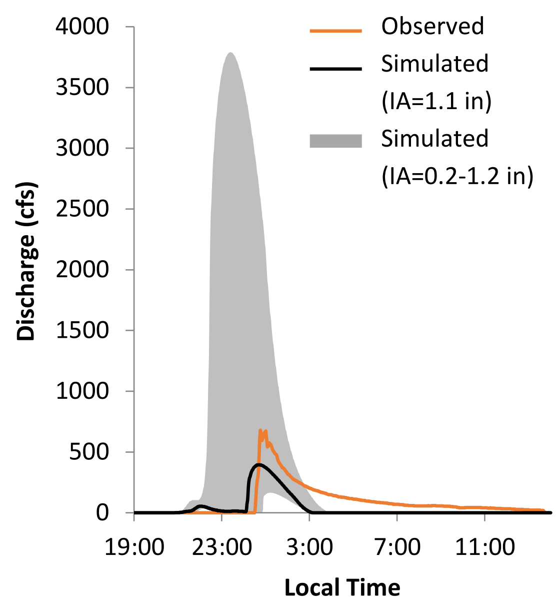


Figure F 9: Map showing the extent of storm i (top), and the comparison of observed and simulated hydrographs for the curve number loss method (bottom left) and the initial and constant loss method (bottom right).

Storm j

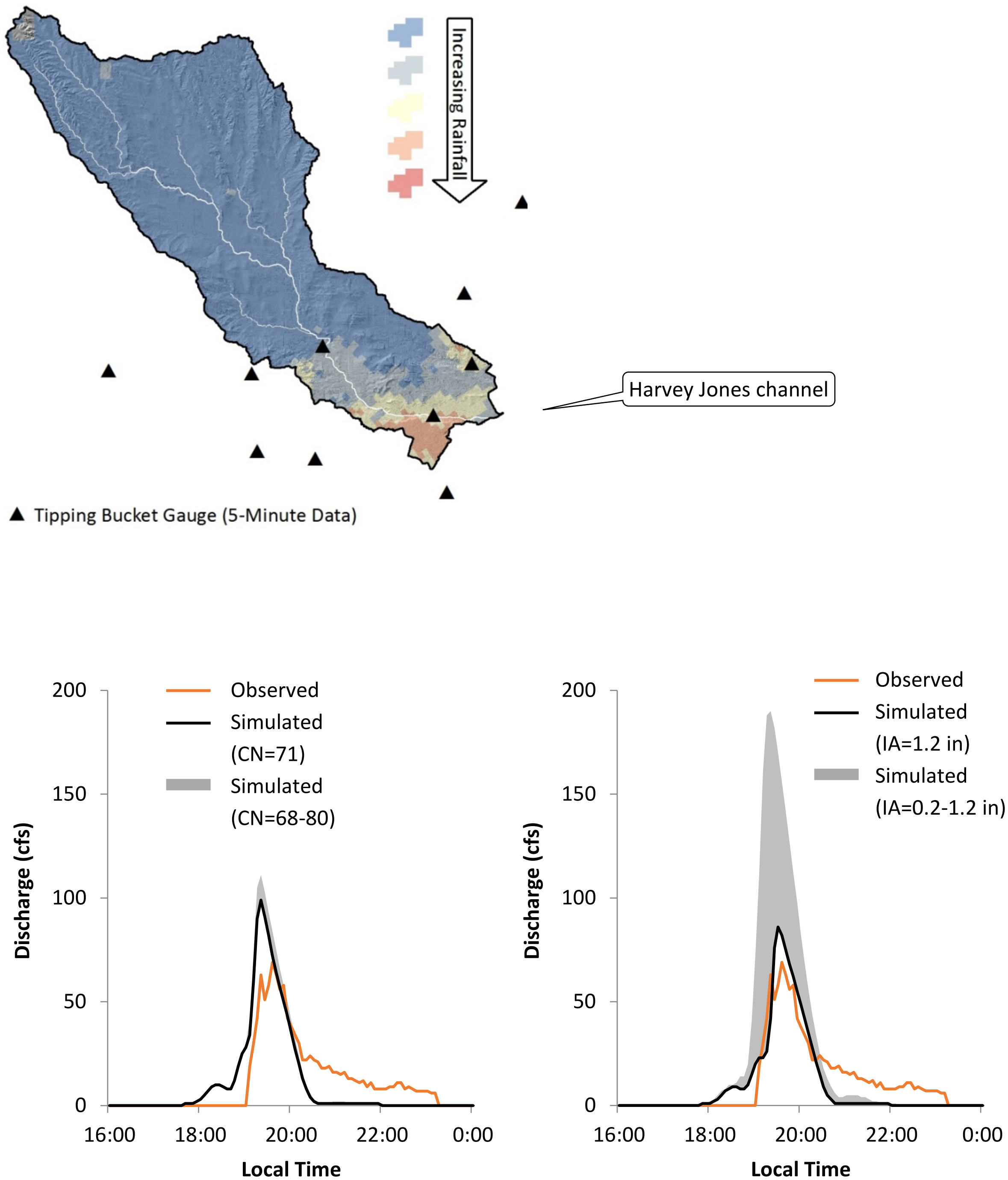


Figure F 10: Map showing the extent of storm j (top), and the comparison of observed and simulated hydrographs for the curve number loss method (bottom left) and the initial and constant loss method (bottom right).

Three runoff-producing storms occurred in the summer of 2018 and were used for model validation (Table F 2). Figure F 11 shows a comparison of measured precipitation and IDF curves from the location with the most extreme precipitation record for each storm event. Storm k approached the 100-year RI for a 60-minute duration, while storms l and m approached the 10- and 50-year RIs, respectively, for a duration of two hours.

Table F 2: Properties of 3 validation storms observed in the Montoyas watershed.

Storm	Date	Average total rainfall (in) [a]	Duration (h)	Peak flow (ft3/s) [b]	Runoff volume (ac-ft) [b]	7 / 14 / 21-day antecedent rainfall (in) [c]	Antecedent flow
k	7/5/18	0.97 (0.22-2.28)	1	166 / 58	49 / 10	0.00 / 0.00 / 0.26	N
l	7/27/18	0.67 (0.11-1.39)	2	- / 452	- / 53	0.51 / 1.09 / 1.86	Y
m	8/22/18	0.75 (0.17-1.39)	2	272 / 701	40 / 102	0.38 / 0.58 / 1.12	Y

[a] Average calculated in GIS based on cumulative precipitation grid (range in parentheses)

[b] Northern Meadows / Sportsplex Dam

[c] Average based on available rain gauge data

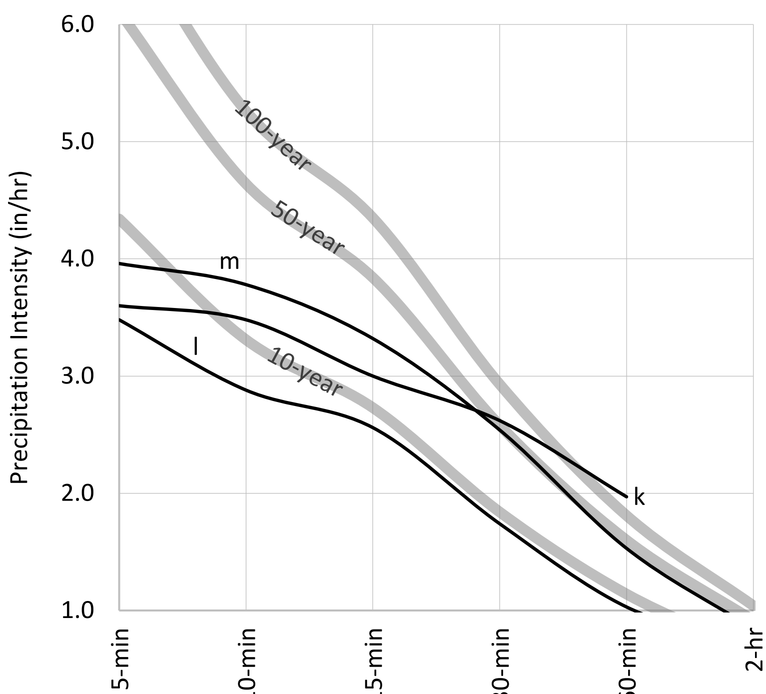


Figure F 11: Intensity-duration-frequency curves (grey) and observed validation storms (black).

Spatial extent of storm coverage varied considerably; maps of precipitation coverage for each storm event are included with Figure F 12 through Figure F 14. Please note that storm data represented on Figure F 11 does not represent basin average rainfall values.

Similar to the calibration period, 5-minute gridded rainfall time series were prepared from gauge and radar data. For the validation storms, a dense network of 23 tipping bucket rain gauges was available for the watershed and surrounding areas. Rain gauge sites and locations where radar data was interpolated are indicated with triangles and circles, respectively, on Figure F 12 through Figure F 14. Storm k was preceded by two weeks with no measurable precipitation, and below average rainfall for the period of January through June 2018. Storms l and m, on the other hand, followed a period of repeated precipitation events that covered the entire watershed. Although no direct soil moisture measurements were available for the watershed, it appears reasonable to assume that the storms represent end members of a spectrum of soil moisture in the watershed: dry conditions for storm k, and wet conditions for storms l and m. Based on results from model calibration, two model scenarios were run for each storm event: a dry condition simulation (CN=68 for pervious, vegetated areas), and a wet condition run (CN=80). Figure F 12 through Figure F 14 compare simulated and observed flow for each storm at the gaging stations in Northern Meadows and at Sportplex Dam. Data from the Harvey Jones channel gauge is not reported here because the other two stations have a higher resolution, especially for low flows.

Table F 3: Peak discharge and runoff volume errors for three validation storms at two gaging stations.

Storm	Location	Simulated (dry) error		Simulated (wet) error	
		Q_p	V	Q_p	V
k	Northern Meadows	4%	9%	1146%	704%
	Sportsplex Dam	24%	-30%	3103%	3300%
l	Northern Meadows	-	-	-	-
	Sportsplex Dam	-56%	-63%	-25%	-5%
m	Northern Meadows	-61%	-60%	-14%	56%
	Sportsplex Dam	-83%	-80%	6%	29%

Table F 3 compares model error for each scenario based on flow measurements from the Northern Meadows and Sportsplex Dam gauges. The comparison illustrates that dry conditions model predictions closely match measured discharge (within 30%) at both gaging stations for storm k, while the wet conditions model overestimated peak discharge and runoff volume by approximately one order of magnitude. The opposite is true for storms l and m. Dry conditions models underestimated peak discharge and runoff volume by between 56% and 80%. Wet conditions model runs yielded results within 30% of measured flows, with one exception: for storm m at Northern Meadows, the model overestimated runoff volume by 56%.

Model validation illustrates that the model simulates runoff from the Montoyas watershed reasonably well with respect to peak discharge, runoff volume, hydrograph shape and timing if antecedent moisture conditions are accounted for. Pervious area curve numbers (parks, residential yards, landscaping, and open space) of 68 and 80 for dry and wet initial conditions, respectively, are appropriate for this basin.

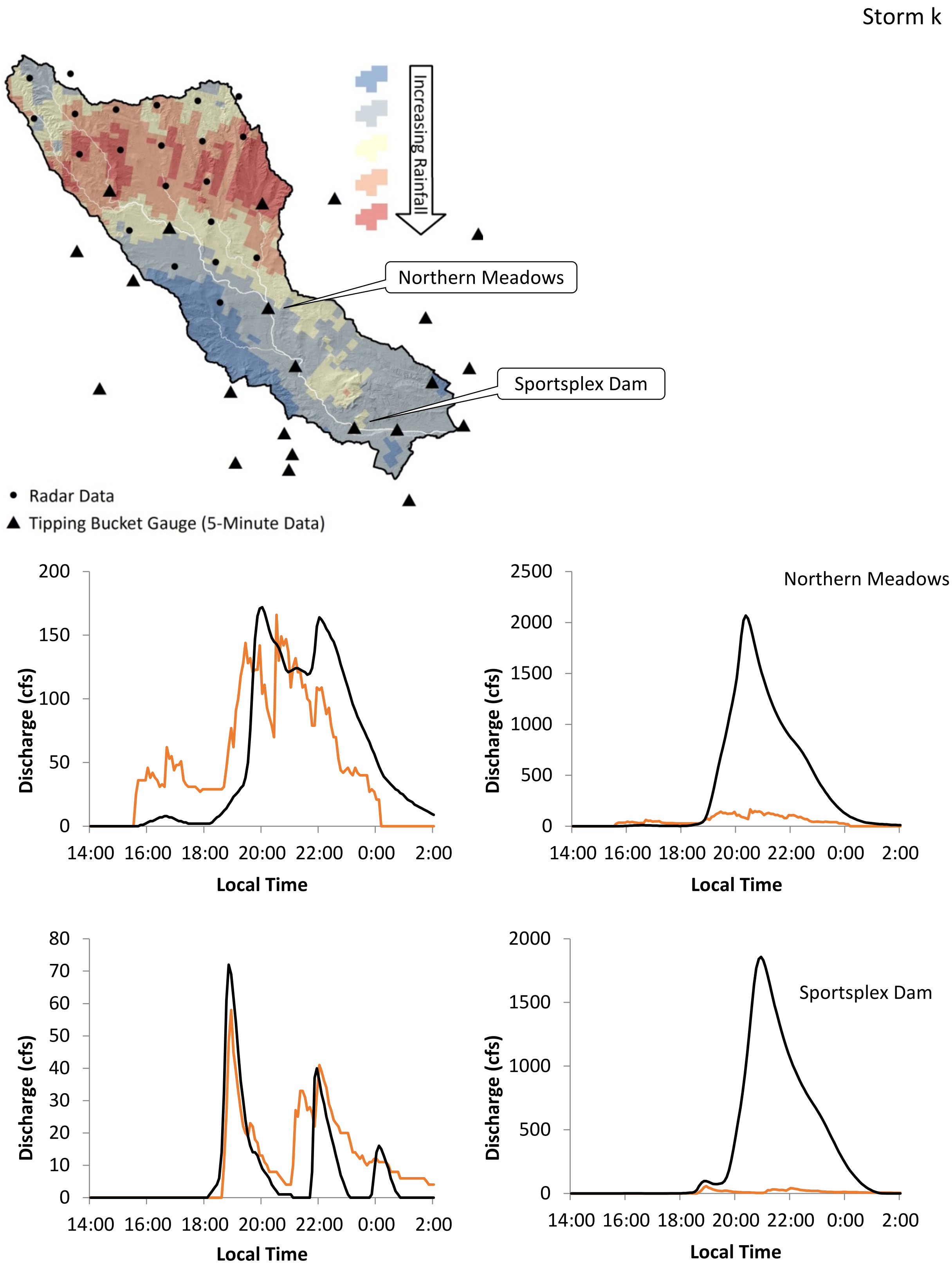
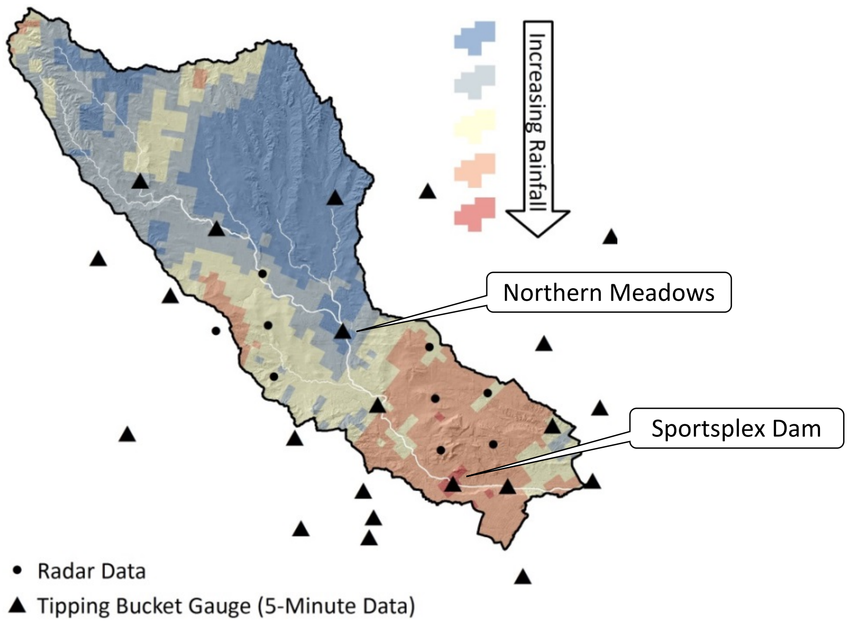


Figure F 12: Comparison of observed (red) and simulated (black) hydrographs at Northern Meadows (center) and Sportsplex Dam (bottom) for dry conditions (left) and wet conditions (right) model runs (storm k).

Storm I



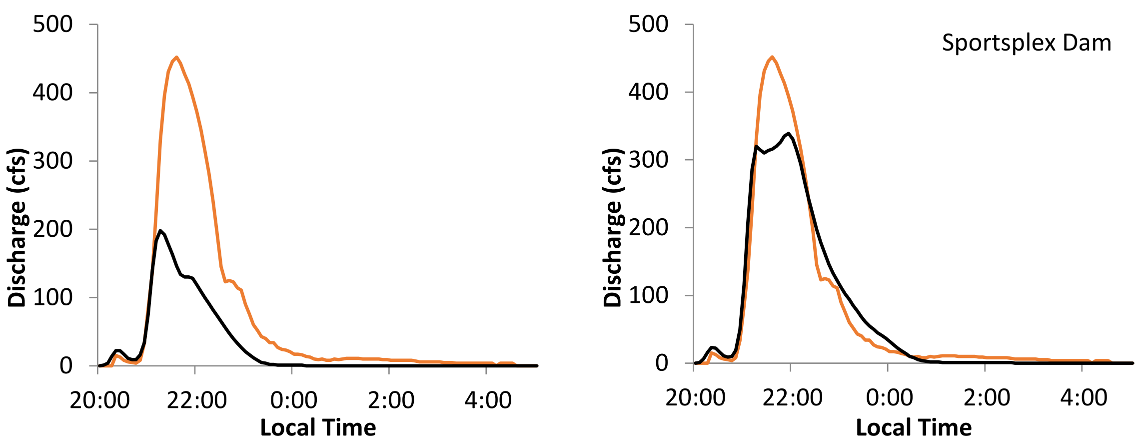
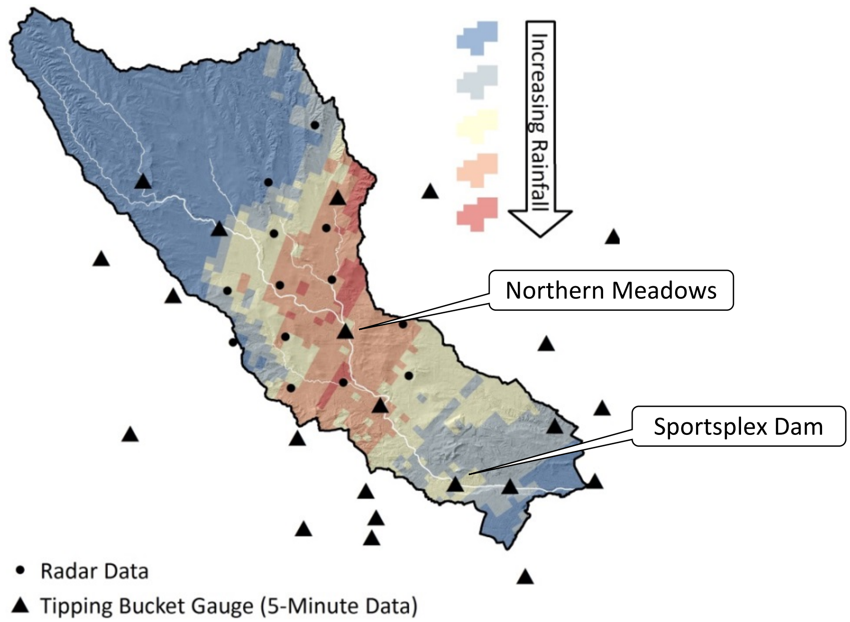


Figure F 13: Comparison of observed (red) and simulated (black) hydrographs at Sportsplex Dam for dry conditions (left) and wet conditions (right) model runs (storm I).

Storm m



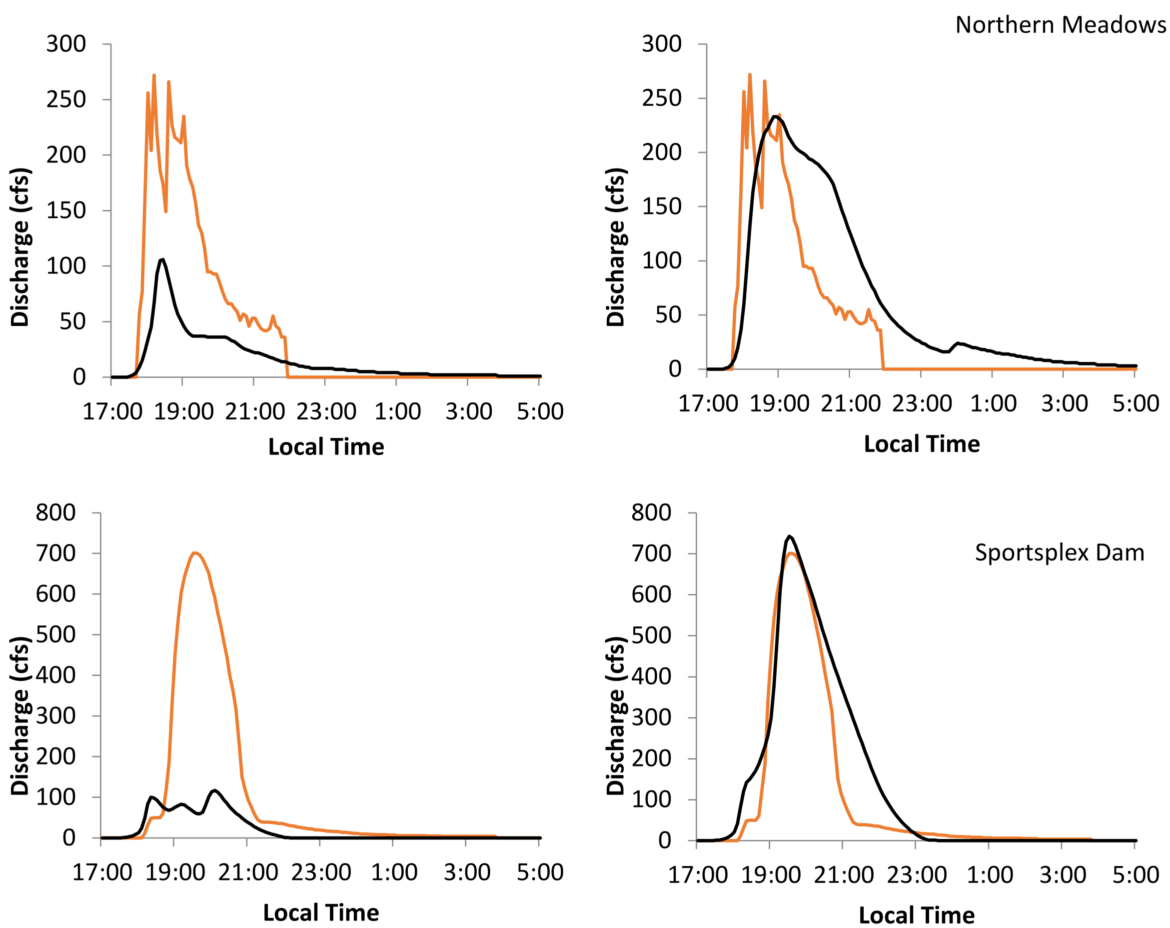


Figure F 14: Comparison of observed (red) and simulated (black) hydrographs at Northern Meadows (center) and Sportsplex Dam (bottom) for dry conditions (left) and wet conditions (right) model runs (storm m).

Appendix G

Model Technical Review by USACE Albuquerque District

USACE Albuquerque District – Hydrology and Hydraulics Section
Technical Review

Project Title:	SSCAFCA Watershed Management Plan Review
Project Sub-Title/Task:	Assess HEC-HMS assumptions, methods, and results
Authority:	Flood Risk Management Program
Project Manager:	Stephen Scissons, Ch. H&H Section, EC-HH
Reviewing Engineer:	Stephen Brown, EC-HH
Review Date:	April 15, 2019

Project Tasks

- Technical review of existing conditions hydrology reflecting urbanization and drainage infrastructure as of 2017
- Review of existing conditions model calibration based on 13 storm events with measured rainfall and discharge data
- Review of future conditions hydrology based on growth projections
- Provide review comments to SSCAFCA in a brief report
- After SSCAFCA has implemented recommendations, potentially conducted second round of review and provide comments back to SSCAFCA.

Product Reviewed

- DRAFT Montoyas Watershed Management Plan (MOWMP) Technical Addendum (October 2018)
    - File name: MOWMP_TechnicalAddendum_DRAFT_Oct2018.pdf
    - Hydrology report for the Montoyas Arroyo covering updates to the 2010 SSCAFCA HEC-HMS model.
    - Includes three storms from the summer of 2018, used for model validation.
    - Surface hydrology reflects urbanization as of 2017.
    - HEC-HMS model was calibrated using ten years of measured rainfall/runoff data.
    - Future conditions hydrology includes best available planning documents and growth projections.
    - Planned regional facilities were updated based on deficiencies and projected future needs (to be added after initial review.)

Supplementary Materials

- HEC-HMS models of Montoyas Arroyo
    - Montoyas_CurveNumber uses the curve number loss method with gridded precipitation for calibration/validation.
    - Montoyas_Initial_Const uses the initial and constant loss method with gridded precipitation for calibration/validation.

  - Montoyas_Lumped contains existing and future land use scenarios using the curve number method and our 100-year design storm.
- Memo_Storms_July2018_DRAFT.pdf
  - Storms report for July 2018 featuring storm precipitation totals and discharge estimates.
- Parameters.xlsx
  - Excel spreadsheet with loss and transform parameters for the various models.

Review Summary

Primary focus of this review consisted of investigation of assumptions and results presented in the MOWMP draft report. The MOWMP comments summarized in Appendix A. HEC-HMS models were explored to verify certain calibration events.

Parameter estimation and implementation was conducted by SSCAFCA within HEC-HMS guidelines for the available surface and hydrologic data. Calibration to observed events was conducted on historic storm events and validated with precipitation events in 2018.

Delineation of subbasins is of sufficient granularity to capture runoff in urban, rural, and undeveloped regions. Care was taken when defining land use and urbanization variability.

Many stormwater detention ponds are within the study area. A detailed summary of the structures, source of data, and hydraulic parameters is included with the report. Considerable storage is available within these ponds providing clear and sediment attenuation. Care must be taken when routing events that coincident flow estimates are accurately represented as ponds impound and spill.

The USDA Curve Number parameterization falls within accepted guidelines. Appropriate Initial Abstraction and Constant Infiltration values are critical to reaching a viable calibration. Clear guidance should be distributed with the HEC-HMS model for external use. Migrating to an alternative abstraction method may be required if SSCAFCA decides to run continuous, long term HEC-HMS simulations.

Estimating precipitation for calibration and validation has been approached from multiple directions. Ground truthing the radar data with physical collection methods on the surface is currently the most reliable way to adjust for regional radar depth estimation drift. The current methodology provides reasonable rainfall methods given the tools available for analysis. USACE has provided SSCAFCA with a beta distribution of HEC-MetVue to conduct additional interpolation of radar and surface precipitation estimates. The confidence limits of the current HEC-HMS calibration runs may be improved using HEC-MetVue for interpolation, in addition to exploring precipitation trends of storm direction, speed, and intensity.

Full review of hydrologic parameterization and verification of values entered into HEC-HMS was not conducted as part of this investigation. An internal review to ensure model parameters were correctly transferred into HEC-HMS is recommended.

Recommendations

Precipitation

Refinement of radar-based storm totals and rain gage interpolation is possible with a new software package developed by USACE, HEC-MetVue. A copy of the beta release of HEC-MetVue software was provided to SSCAFCA for precipitation analysis in April 2019. MetVue was designed to pre-process precipitation grids for HEC-HMS simulations. A hydrologist can load a subbasin shapefile and a set of precipitation grids into MetVue for automated storm depth totals by subbasin. These storm totals can be tabulated, visualized, animated, and converted to DSS hyetographs. Additional Metvue functionality includes depth-duration curves, surface-based precipitation depth validation and interpolation, and HMR 52 analysis.

Soil abstraction

Initial water content of the watershed and channels drives a considerable amount of uncertainty in final simulated discharges. Estimating the available carrying capacity of the soils is essential for calibration. Running a soil moisture accounting method in HEC-HMS will allow for long term simulations where development sensitivity can modeled. The two methods below may assist with determining antecedent soil capacity via remote sensing. Installation of soil moisture sensors at key locations will provide a valuable observed record of moisture travel time through soil and assist with determining infiltration excess runoff probabilities.

Title: "Estimating growing-season root zone soil moisture from vegetation index-based evapotranspiration fraction and soil properties in the Northwest Mountain region, USA," Pradhan 2019

URL: https://www.tandfonline.com/doi/abs/10.1080/02626667.2019.1593417.

Abstract: A soil-moisture retrieval method is proposed, in the absence of ground-based auxiliary measurements, by deriving the soil-moisture content relationship from the satellite vegetation index-based evapotranspiration fraction and soil moisture physical properties of a soil type. A temperature-vegetation dryness index threshold value is also proposed to identify water bodies and underlying saturated areas. Verification of the retrieved growing season soil moisture was performed by comparative analysis of soil moisture obtained by observed conventional *in situ* point measurements at the 239-km^2 Reynolds Creek Experimental Watershed, Idaho, USA (2006–2009), and at the US Climate Reference Network (USCRN) soil-moisture measurement sites in Sundance, Wyoming (2012–2015) and Lewistown, Montana (2014–2015). The proposed method best represented the effective root zone soil-moisture condition, at a depth between 50 and 100 cm, with an overall average R^2 value of 0.72 and average root mean square error (RMSE) of 0.042.

Title: NASA Soil Moisture Active Passive (SMAP)

URL: https://smap.jpl.nasa.gov/

Abstract: SMAP is designed to measure soil moisture over a three-year period, every 2-3 days. This permits changes, around the world, to be observed over time scales ranging from major storms to repeated measurements of changes over the seasons.

Sediment transport

HEC-HMS has robust built-in sediment functions to represent transport based on storm size and intensity. Existing soil analysis from the watershed and channels can be used to parameterize the model. Long term simulations may be run in HEC-HMS to inform O&M planning. Sediment modeling in HEC-HMS should be coupled with HEC-RAS or ERDC-AdH to capture the evolving geomorphology of the channel reaches.

Conclusion

The current and future conditions HEC-HMS have been prepared with sufficient supporting studies to provide a justified representation of the physical system. As with all models, refinement of certain inputs will improve the long term reliability of the simulation.

Additional precipitation analysis will improve runoff estimates by refining storm tracking and intensity. Investigating antecedent soil moisture via remote sensing or surface mounted precipitation gages will provide supplementary antecedent sub surface carrying capacity.

HEC-HMS and HEC-RAS, currently, have robust sediment transport routines incorporated. Use of these tools for event based sediment routing is recommended. HEC-HMS 2DH, with 2D sediment routing, is expected to be released in 2020. The advanced 2D routing is already incorporated into HEC-RAS. Should SSCAFCA choose to implement the 2D features in HMS 2DH, HEC has approved SSCAFCA's use of the beta release when available.

Disclaimer

Full review of hydrologic parameterization and verification of values entered into HEC-HMS was not conducted as part of this investigation. Additional parameterization review is recommended before using the model for design or construction, to ensure model parameters were correctly transferred into HEC-HMS.

Appendix A: MOWMP Technical Addendum DRAFT Comments

The comments below are also summarized along with narrative comments in MOWMP_TechnicalAddendum_DRAFT_Oct2018.SWB-Comments.pdf.

----------------------- Page 1-----------------------

Comment Type: Narrative
Section: Introduction

Consider revising. The variety of purposes is unclear.
1) ? Extent discharge record ?
2) Provide runoff hydrographs from analysis points throughout watershed
3) Future conditions

----------------------- Page 2-----------------------

No Technical Comments. Narrative Comments in PDF.

----------------------- Page 3-----------------------

No Comments.

----------------------- Page 4-----------------------

Comment Type: Technical
Recommendation: Antecedent conditions and storm intensity are driving factors for flood runoff.

Recommendation: Incorporate sediment transport functions within HEC-HMS instead of a bulking factors. Bulking the flows is a reasonable way to represent sediment in the system. Modifying the bulking factor based on subbasin soil parameters would be a middle ground between a full sediment model and the current 18% natural and 6% urban bulking factors.

----------------------- Page 5-----------------------

Comment Type: Technical

Recommendation: Remotely sensed or proxy soil moisture data may be helpful for antecedent conditions if sufficient resolution is available. In situ soil moisture measurements will improve antecedent soil moisture estimates and assist with determining precipitation inflection point between infiltration and saturation excess run off regimes.

----------------------- Page 6-----------------------

Comment Type: Narrative
All precipitation maps: The increasing rainfall decreasing is confusing. Although the format is sort of in hyetograph format with increasing depth down. Is the same depth symbology range used in all plots? For example, the same shade of blue is the same depth in each plot.
----------------------- Page 7-----------------------

No Comments.
----------------------- Page 8-----------------------

No Comments.
----------------------- Page 9-----------------------

No Comments.
----------------------- Page 10-----------------------

No Comments.
----------------------- Page 11-----------------------

Comment Type: Narrative
2.3 pg 11: Will guidance be included on when to use wet or dry boundary conditions?
----------------------- Page 12-----------------------

No Comments.
----------------------- Page 13-----------------------

No Comments.
----------------------- Page 14-----------------------

No Comments.
----------------------- Page 15-----------------------

No Technical Comments. Narrative Comments in PDF.
----------------------- Page 16-----------------------

Comment Type: Narrative
2.5 is the depth-area reduction based on NOAA Atlas 2 or TP50. Briefly discuss the spatial rainfall distribution difference between the design storm and a real event.

2.5 Was a single point used or an area average for the NOAA Atlas 14 depth? Including the range of depths for the watershed is helpful for bounding the statistical estimates.

2.6 Including Northern Meadows and Sportsplex Dam peaks will help illustrate the longitudinal change in Q.

---------------------- Page 17----------------------

No Technical Comments. Narrative Comments in PDF.

---------------------- Page 18----------------------

No Comments.

---------------------- Page 19----------------------

No Comments.