

Culvert C1

HEC-RAS Hydraulic Model - Existing Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach13_Trib	71.14858	Regional	9.19	197.35	198.44		198.45	0.74	17.61	50.46	0.29
Reach13_Trib	71.14858	100-year	5.59	197.35	198.26	198.18	198.29	0.9	9.25	44.69	0.41
Reach13_Trib	71.14858	50-year	5.03	197.35	198.25	198.15	198.28	0.85	8.77	44.33	0.39
Reach13_Trib	71.14858	25-year	4.3	197.35	198.23	198.12	198.25	0.81	7.89	43.68	0.38
Reach13_Trib	71.14858	10-year	3.41	197.35	198.21		198.23	0.74	6.81	42.86	0.36
Reach13_Trib	71.14858	5-year	2.71	197.35	198.18		198.2	0.69	5.66	39.9	0.34
Reach13_Trib	71.14858	2-year	1.83	197.35	198.14		198.15	0.57	4.18	29.86	0.3
Reach13_Trib	150.1236	Regional	9.19	197.93	198.69	198.69	198.8	1.83	7.46	30.18	0.92
Reach13_Trib	150.1236	100-year	5.59	197.93	198.6	198.6	198.7	1.6	5.01	25.47	0.91
Reach13_Trib	150.1236	50-year	5.03	197.93	198.58	198.58	198.68	1.56	4.6	24.31	0.91
Reach13_Trib	150.1236	25-year	4.3	197.93	198.56	198.56	198.65	1.49	4.06	22.99	0.91
Reach13_Trib	150.1236	10-year	3.41	197.93	198.53	198.53	198.61	1.38	3.44	21.82	0.88
Reach13_Trib	150.1236	5-year	2.71	197.93	198.5	198.5	198.58	1.3	2.86	20.67	0.88
Reach13_Trib	150.1236	2-year	1.83	197.93	198.47	198.47	198.53	1.13	2.16	19.21	0.81
Reach13_Trib	280.0153	Regional	9.19	198.71	199.58	199.54	199.65	1.43	9.87	37.83	0.59
Reach13_Trib	280.0153	100-year	5.59	198.71	199.5	199.47	199.56	1.25	6.84	35.13	0.56
Reach13_Trib	280.0153	50-year	5.03	198.71	199.48	199.46	199.54	1.22	6.29	34.75	0.55
Reach13_Trib	280.0153	25-year	4.3	198.71	199.46	199.44	199.52	1.17	5.54	34.22	0.54
Reach13_Trib	280.0153	10-year	3.41	198.71	199.43	199.3	199.48	1.11	4.4	33.12	0.53
Reach13_Trib	280.0153	5-year	2.71	198.71	199.4	199.24	199.45	1.03	3.38	30.32	0.51
Reach13_Trib	280.0153	2-year	1.83	198.71	199.31		199.35	0.94	2.09	6.95	0.51
Reach13_Trib	397.8328	Regional	9.19	199.78	200.54	200.54	200.56	0.95	14.93	39.1	0.49
Reach13_Trib	397.8328	100-year	5.59	199.78	200.54	200.54	200.55	0.58	14.92	39.1	0.3
Reach13_Trib	397.8328	50-year	5.03	199.78	200.54	200.54	200.55	0.52	14.93	39.1	0.27
Reach13_Trib	397.8328	25-year	4.3	199.78	200.54	200.54	200.55	0.44	14.93	39.1	0.23
Reach13_Trib	397.8328	10-year	3.41	199.78	200.49	200.49	200.67	1.88	1.82	4.99	0.99
Reach13_Trib	397.8328	5-year	2.71	199.78	200.42	200.42	200.59	1.81	1.49	4.47	1
Reach13_Trib	397.8328	2-year	1.83	199.78	200.32	200.32	200.47	1.69	1.08	3.7	1
Reach13_Trib	500.6567	Regional	9.19	200.44	201.5	201.5	201.68	1.92	5.63	20.68	0.88
Reach13_Trib	500.6567	100-year	5.59	200.44	201.33	201.33	201.5	1.85	3.03	9.86	1
Reach13_Trib	500.6567	50-year	5.03	200.44	201.3	201.3	201.47	1.83	2.75	8.41	1.02
Reach13_Trib	500.6567	25-year	4.3	200.44	201.2	201.2	201.41	2.02	2.12	5.34	1.03
Reach13_Trib	500.6567	10-year	3.41	200.44	201.4		201.44	0.93	3.84	15.24	0.48
Reach13_Trib	500.6567	5-year	2.71	200.44	201.34		201.37	0.88	3.09	10.09	0.48
Reach13_Trib	500.6567	2-year	1.83	200.44	201.18		201.22	0.9	2.04	5.23	0.46
Reach13_Trib	576	Regional	9.19	201.18	202.18	202.05	202.43	2.27	4.2	22.85	0.76
Reach13_Trib	576	100-year	5.59	201.18	202.03	201.86	202.17	1.67	3.48	20.44	0.61
Reach13_Trib	576	50-year	5.03	201.18	202	201.82	202.12	1.57	3.32	19.92	0.59
Reach13_Trib	576	25-year	4.3	201.18	201.95	201.77	202.06	1.47	3.05	19.01	0.57
Reach13_Trib	576	10-year	3.41	201.18	201.78	201.71	201.91	1.62	2.19	16.09	0.73
Reach13_Trib	576	5-year	2.71	201.18	201.72	201.65	201.83	1.48	1.9	15.1	0.71
Reach13_Trib	576	2-year	1.83	201.18	201.6	201.56	201.7	1.39	1.32	10.38	0.78
Reach13_Trib	594.5		Culvert								
Reach13_Trib	616.5	Regional	9.19	201.4	202.91	202.47	203.04	1.64	5.83	33.78	0.47
Reach13_Trib	616.5	100-year	5.59	201.4	202.41	202.27	202.56	1.79	3.31	27.22	0.66
Reach13_Trib	616.5	50-year	5.03	201.4	202.3	202.24	202.48	1.95	2.77	25.26	0.77
Reach13_Trib	616.5	25-year	4.3	201.4	202.19	202.19	202.4	2.12	2.18	22.31	0.93
Reach13_Trib	616.5	10-year	3.41	201.4	202.12	202.12	202.31	1.97	1.86	13.36	0.91

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HEC-RAS Hydraulic Model - Existing Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach13_Trib	616.5	5-year	2.71	201.4	202.07	202.07	202.23	1.85	1.57	10.46	0.92
Reach13_Trib	616.5	2-year	1.83	201.4	201.98	201.98	202.11	1.67	1.15	7.1	0.93
Reach13_Trib	635.2526	Regional	9.19	202.36	203.21	203.21	203.37	1.97	6.97	23.74	0.84
Reach13_Trib	635.2526	100-year	5.59	202.36	203.07	203.07	203.22	1.8	4.09	17.42	0.88
Reach13_Trib	635.2526	50-year	5.03	202.36	203.04	203.04	203.19	1.77	3.62	16.03	0.9
Reach13_Trib	635.2526	25-year	4.3	202.36	203.01	203.01	203.15	1.68	3.13	14.52	0.89
Reach13_Trib	635.2526	10-year	3.41	202.36	202.96	202.96	203.09	1.63	2.39	11.83	0.92
Reach13_Trib	635.2526	5-year	2.71	202.36	202.91	202.91	203.03	1.57	1.86	9.63	0.95
Reach13_Trib	635.2526	2-year	1.83	202.36	202.83	202.83	202.94	1.47	1.24	6.25	1.02
Reach13_Trib	744.7111	Regional	9.19	203.65	204.18	204.11	204.24	1.24	9.09	37.18	0.62
Reach13_Trib	744.7111	100-year	5.59	203.65	204.1	204.04	204.14	1.06	6.32	30.95	0.59
Reach13_Trib	744.7111	50-year	5.03	203.65	204.09	204.03	204.13	1.02	5.87	29.74	0.58
Reach13_Trib	744.7111	25-year	4.3	203.65	204.06		204.1	0.98	5.21	28.59	0.58
Reach13_Trib	744.7111	10-year	3.41	203.65	204.04		204.07	0.91	4.47	27.21	0.56
Reach13_Trib	744.7111	5-year	2.71	203.65	204.01	203.97	204.04	0.85	3.83	25.97	0.55
Reach13_Trib	744.7111	2-year	1.83	203.65	203.98	203.94	204	0.74	2.97	24.19	0.52
Reach13_Trib	824.9669	Regional	9.19	204	204.59	204.52	204.63	1.06	12.23	53.93	0.52
Reach13_Trib	824.9669	100-year	5.59	204	204.51	204.43	204.54	0.96	8.05	50.12	0.52
Reach13_Trib	824.9669	50-year	5.03	204	204.5	204.42	204.53	0.94	7.31	46.16	0.51
Reach13_Trib	824.9669	25-year	4.3	204	204.47	204.41	204.5	0.89	6.42	37.91	0.51
Reach13_Trib	824.9669	10-year	3.41	204	204.44	204.38	204.47	0.84	5.33	32.66	0.5
Reach13_Trib	824.9669	5-year	2.71	204	204.42		204.44	0.78	4.46	30.42	0.49
Reach13_Trib	824.9669	2-year	1.83	204	204.37		204.39	0.7	3.21	27.68	0.48
Reach13_Trib	877.2101	Regional	9.19	204.61	205.15	205.15	205.23	1.57	10.89	63.32	0.82
Reach13_Trib	877.2101	100-year	5.59	204.61	205.08	205.08	205.16	1.44	6.47	49.94	0.84
Reach13_Trib	877.2101	50-year	5.03	204.61	205.06	205.06	205.14	1.38	5.9	46.63	0.82
Reach13_Trib	877.2101	25-year	4.3	204.61	205.04	205.04	205.12	1.35	4.88	40.09	0.83
Reach13_Trib	877.2101	10-year	3.41	204.61	205.01	205.01	205.08	1.29	3.73	32.65	0.82
Reach13_Trib	877.2101	5-year	2.71	204.61	204.98	204.98	205.05	1.24	2.78	26.69	0.83
Reach13_Trib	877.2101	2-year	1.83	204.61	204.9	204.9	204.99	1.29	1.45	9.62	1
Reach13_Trib	983.0944	Regional	9.19	205.03	205.77		205.81	1.2	13.8	35.82	0.48
Reach13_Trib	983.0944	100-year	5.59	205.03	205.66		205.69	0.96	10.14	31.47	0.42
Reach13_Trib	983.0944	50-year	5.03	205.03	205.64		205.66	0.93	9.4	30.52	0.41
Reach13_Trib	983.0944	25-year	4.3	205.03	205.61		205.63	0.87	8.48	29.35	0.4
Reach13_Trib	983.0944	10-year	3.41	205.03	205.56		205.58	0.8	7.21	27.68	0.38
Reach13_Trib	983.0944	5-year	2.71	205.03	205.52		205.54	0.73	6.12	25.65	0.37
Reach13_Trib	983.0944	2-year	1.83	205.03	205.46		205.48	0.61	4.76	22.46	0.33
Reach13_Trib	1059.089	Regional	9.19	205.19	205.98		206.02	1.09	13.35	36.23	0.42
Reach13_Trib	1059.089	100-year	5.59	205.19	205.84		205.88	0.91	8.9	29.6	0.4
Reach13_Trib	1059.089	50-year	5.03	205.19	205.82		205.85	0.88	8.15	28.34	0.39
Reach13_Trib	1059.089	25-year	4.3	205.19	205.78		205.81	0.83	7.16	26.4	0.39
Reach13_Trib	1059.089	10-year	3.41	205.19	205.73		205.76	0.76	5.91	23.58	0.37
Reach13_Trib	1059.089	5-year	2.71	205.19	205.68		205.71	0.7	4.9	21.03	0.36
Reach13_Trib	1059.089	2-year	1.83	205.19	205.61		205.63	0.61	3.55	17	0.35

HEC-RAS Hydraulic Model - Proposed Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach13_Trib	71.14858	Regional	9.19	197.35	198.44		198.45	0.74	17.61	50.46	0.29
Reach13_Trib	71.14858	100-year	5.59	197.35	198.26	198.18	198.29	0.9	9.25	44.69	0.41
Reach13_Trib	71.14858	50-year	5.03	197.35	198.25	198.15	198.28	0.85	8.77	44.33	0.39
Reach13_Trib	71.14858	25-year	4.3	197.35	198.23	198.12	198.25	0.81	7.89	43.68	0.38
Reach13_Trib	71.14858	10-year	3.41	197.35	198.21		198.23	0.74	6.81	42.86	0.36
Reach13_Trib	71.14858	5-year	2.71	197.35	198.18		198.2	0.69	5.66	39.9	0.34
Reach13_Trib	71.14858	2-year	1.83	197.35	198.14		198.15	0.57	4.18	29.86	0.3
Reach13_Trib	150.1236	Regional	9.19	197.93	198.69	198.69	198.8	1.83	7.46	30.18	0.92
Reach13_Trib	150.1236	100-year	5.59	197.93	198.6	198.6	198.7	1.6	5.01	25.47	0.91
Reach13_Trib	150.1236	50-year	5.03	197.93	198.58	198.58	198.68	1.56	4.6	24.31	0.91
Reach13_Trib	150.1236	25-year	4.3	197.93	198.56	198.56	198.65	1.49	4.06	22.99	0.91
Reach13_Trib	150.1236	10-year	3.41	197.93	198.53	198.53	198.61	1.38	3.44	21.82	0.88
Reach13_Trib	150.1236	5-year	2.71	197.93	198.5	198.5	198.58	1.3	2.86	20.67	0.88
Reach13_Trib	150.1236	2-year	1.83	197.93	198.47	198.47	198.53	1.13	2.16	19.21	0.81
Reach13_Trib	280.0153	Regional	9.19	198.71	199.58	199.54	199.65	1.43	9.87	37.83	0.59
Reach13_Trib	280.0153	100-year	5.59	198.71	199.5	199.47	199.56	1.25	6.84	35.13	0.56
Reach13_Trib	280.0153	50-year	5.03	198.71	199.48	199.46	199.54	1.22	6.29	34.75	0.55
Reach13_Trib	280.0153	25-year	4.3	198.71	199.46	199.44	199.52	1.17	5.54	34.22	0.54
Reach13_Trib	280.0153	10-year	3.41	198.71	199.43	199.3	199.48	1.11	4.4	33.12	0.53
Reach13_Trib	280.0153	5-year	2.71	198.71	199.4	199.24	199.45	1.03	3.38	30.32	0.51
Reach13_Trib	280.0153	2-year	1.83	198.71	199.31		199.35	0.94	2.09	6.95	0.51
Reach13_Trib	397.8328	Regional	9.19	199.78	200.54	200.54	200.56	0.95	14.93	39.1	0.49
Reach13_Trib	397.8328	100-year	5.59	199.78	200.54	200.54	200.55	0.58	14.92	39.1	0.3
Reach13_Trib	397.8328	50-year	5.03	199.78	200.54	200.54	200.55	0.52	14.93	39.1	0.27
Reach13_Trib	397.8328	25-year	4.3	199.78	200.54	200.54	200.55	0.44	14.93	39.1	0.23
Reach13_Trib	397.8328	10-year	3.41	199.78	200.49	200.49	200.67	1.88	1.82	4.99	0.99
Reach13_Trib	397.8328	5-year	2.71	199.78	200.42	200.42	200.59	1.81	1.49	4.47	1
Reach13_Trib	397.8328	2-year	1.83	199.78	200.32	200.32	200.47	1.69	1.08	3.7	1
Reach13_Trib	500.6567	Regional	9.19	200.44	201.5	201.5	201.68	1.92	5.63	20.68	0.88
Reach13_Trib	500.6567	100-year	5.59	200.44	201.33	201.33	201.5	1.85	3.03	9.86	1
Reach13_Trib	500.6567	50-year	5.03	200.44	201.3	201.3	201.47	1.83	2.75	8.41	1.02
Reach13_Trib	500.6567	25-year	4.3	200.44	201.2	201.2	201.41	2.02	2.12	5.34	1.03
Reach13_Trib	500.6567	10-year	3.41	200.44	201.4		201.44	0.93	3.84	15.24	0.48
Reach13_Trib	500.6567	5-year	2.71	200.44	201.34		201.37	0.88	3.09	10.09	0.48
Reach13_Trib	500.6567	2-year	1.83	200.44	201.18		201.22	0.9	2.04	5.23	0.46
Reach13_Trib	576	Regional	9.19	201.18	202.18	202.05	202.43	2.27	4.2	22.85	0.76
Reach13_Trib	576	100-year	5.59	201.18	202.03	201.86	202.17	1.67	3.48	20.44	0.61
Reach13_Trib	576	50-year	5.03	201.18	202	201.82	202.12	1.57	3.32	19.92	0.59
Reach13_Trib	576	25-year	4.3	201.18	201.95	201.77	202.06	1.47	3.05	19.01	0.57
Reach13_Trib	576	10-year	3.41	201.18	201.78	201.71	201.91	1.62	2.19	16.09	0.73
Reach13_Trib	576	5-year	2.71	201.18	201.72	201.65	201.83	1.48	1.9	15.1	0.71
Reach13_Trib	576	2-year	1.83	201.18	201.6	201.56	201.7	1.39	1.32	10.38	0.78
Reach13_Trib	594.5	Culvert									
Reach13_Trib	616.5	Regional	9.19	201.4	202.93	202.47	203.06	1.6	5.95	34.07	0.45
Reach13_Trib	616.5	100-year	5.59	201.4	202.44	202.27	202.58	1.72	3.46	27.74	0.62
Reach13_Trib	616.5	50-year	5.03	201.4	202.34	202.24	202.49	1.83	2.94	25.87	0.71
Reach13_Trib	616.5	25-year	4.3	201.4	202.19	202.19	202.4	2.12	2.18	22.31	0.93
Reach13_Trib	616.5	10-year	3.41	201.4	202.12	202.12	202.31	1.97	1.86	13.36	0.91
Reach13_Trib	616.5	5-year	2.71	201.4	202.07	202.07	202.23	1.85	1.57	10.46	0.92
Reach13_Trib	616.5	2-year	1.83	201.4	201.98	201.98	202.11	1.67	1.15	7.1	0.93

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Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach13_Trib	635.2526	Regional	9.19	202.36	203.21	203.21	203.37	1.97	6.97	23.74	0.84
Reach13_Trib	635.2526	100-year	5.59	202.36	203.07	203.07	203.22	1.8	4.09	17.42	0.88
Reach13_Trib	635.2526	50-year	5.03	202.36	203.04	203.04	203.19	1.77	3.62	16.03	0.9
Reach13_Trib	635.2526	25-year	4.3	202.36	203.01	203.01	203.15	1.68	3.13	14.52	0.89
Reach13_Trib	635.2526	10-year	3.41	202.36	202.96	202.96	203.09	1.63	2.39	11.83	0.92
Reach13_Trib	635.2526	5-year	2.71	202.36	202.91	202.91	203.03	1.57	1.86	9.63	0.95
Reach13_Trib	635.2526	2-year	1.83	202.36	202.83	202.83	202.94	1.47	1.24	6.25	1.02
Reach13_Trib	744.7111	Regional	9.19	203.65	204.18	204.11	204.24	1.24	9.09	37.18	0.62
Reach13_Trib	744.7111	100-year	5.59	203.65	204.1	204.04	204.14	1.06	6.32	30.95	0.59
Reach13_Trib	744.7111	50-year	5.03	203.65	204.09	204.03	204.13	1.02	5.87	29.74	0.58
Reach13_Trib	744.7111	25-year	4.3	203.65	204.06		204.1	0.98	5.21	28.59	0.58
Reach13_Trib	744.7111	10-year	3.41	203.65	204.04		204.07	0.91	4.47	27.21	0.56
Reach13_Trib	744.7111	5-year	2.71	203.65	204.01	203.97	204.04	0.85	3.83	25.97	0.55
Reach13_Trib	744.7111	2-year	1.83	203.65	203.98	203.94	204	0.74	2.97	24.19	0.52
Reach13_Trib	824.9669	Regional	9.19	204	204.59	204.52	204.63	1.06	12.23	53.93	0.52
Reach13_Trib	824.9669	100-year	5.59	204	204.51	204.43	204.54	0.96	8.05	50.12	0.52
Reach13_Trib	824.9669	50-year	5.03	204	204.5	204.42	204.53	0.94	7.31	46.16	0.51
Reach13_Trib	824.9669	25-year	4.3	204	204.47	204.41	204.5	0.89	6.42	37.91	0.51
Reach13_Trib	824.9669	10-year	3.41	204	204.44	204.38	204.47	0.84	5.33	32.66	0.5
Reach13_Trib	824.9669	5-year	2.71	204	204.42		204.44	0.78	4.46	30.42	0.49
Reach13_Trib	824.9669	2-year	1.83	204	204.37		204.39	0.7	3.21	27.68	0.48
Reach13_Trib	877.2101	Regional	9.19	204.61	205.15	205.15	205.23	1.57	10.89	63.32	0.82
Reach13_Trib	877.2101	100-year	5.59	204.61	205.08	205.08	205.16	1.44	6.47	49.94	0.84
Reach13_Trib	877.2101	50-year	5.03	204.61	205.06	205.06	205.14	1.38	5.9	46.63	0.82
Reach13_Trib	877.2101	25-year	4.3	204.61	205.04	205.04	205.12	1.35	4.88	40.09	0.83
Reach13_Trib	877.2101	10-year	3.41	204.61	205.01	205.01	205.08	1.29	3.73	32.65	0.82
Reach13_Trib	877.2101	5-year	2.71	204.61	204.98	204.98	205.05	1.24	2.78	26.69	0.83
Reach13_Trib	877.2101	2-year	1.83	204.61	204.9	204.9	204.99	1.29	1.45	9.62	1
Reach13_Trib	983.0944	Regional	9.19	205.03	205.77		205.81	1.2	13.8	35.82	0.48
Reach13_Trib	983.0944	100-year	5.59	205.03	205.66		205.69	0.96	10.14	31.47	0.42
Reach13_Trib	983.0944	50-year	5.03	205.03	205.64		205.66	0.93	9.4	30.52	0.41
Reach13_Trib	983.0944	25-year	4.3	205.03	205.61		205.63	0.87	8.48	29.35	0.4
Reach13_Trib	983.0944	10-year	3.41	205.03	205.56		205.58	0.8	7.21	27.68	0.38
Reach13_Trib	983.0944	5-year	2.71	205.03	205.52		205.54	0.73	6.12	25.65	0.37
Reach13_Trib	983.0944	2-year	1.83	205.03	205.46		205.48	0.61	4.76	22.46	0.33
Reach13_Trib	1059.089	Regional	9.19	205.19	205.98		206.02	1.09	13.35	36.23	0.42
Reach13_Trib	1059.089	100-year	5.59	205.19	205.84		205.88	0.91	8.9	29.6	0.4
Reach13_Trib	1059.089	50-year	5.03	205.19	205.82		205.85	0.88	8.15	28.34	0.39
Reach13_Trib	1059.089	25-year	4.3	205.19	205.78		205.81	0.83	7.16	26.4	0.39
Reach13_Trib	1059.089	10-year	3.41	205.19	205.73		205.76	0.76	5.91	23.58	0.37
Reach13_Trib	1059.089	5-year	2.71	205.19	205.68		205.71	0.7	4.9	21.03	0.36
Reach13_Trib	1059.089	2-year	1.83	205.19	205.61		205.63	0.61	3.55	17	0.35

Culvert C2

HEC-RAS Hydraulic Model - Existing Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach13_Main1	11.2865	Regional	64.7	189.69	193.44	190.84	193.44	0.4	408.86	166.61	0.07
Reach13_Main1	11.2865	100-year	27.4	189.69	190.79	190.46	190.87	1.79	33.23	45.37	0.57
Reach13_Main1	11.2865	50-year	24.5	189.69	190.73	190.42	190.8	1.72	30.71	44.2	0.57
Reach13_Main1	11.2865	25-year	20.8	189.69	190.65	190.37	190.72	1.63	27.45	42.87	0.56
Reach13_Main1	11.2865	10-year	16.3	189.69	190.55	190.31	190.61	1.5	23.27	41.13	0.55
Reach13_Main1	11.2865	5-year	12.8	189.69	190.47	190.25	190.52	1.38	19.74	39.57	0.54
Reach13_Main1	11.2865	2-year	8.41	189.69	190.34	190.17	190.38	1.2	14.87	37.3	0.52
Reach13_Main1	100.123	Regional	64.7	190.05	193.44		193.45	0.55	241.94	110.51	0.1
Reach13_Main1	100.123	100-year	27.4	190.05	191.38	191.38	191.52	2.28	30.63	90.87	0.81
Reach13_Main1	100.123	50-year	24.5	190.05	191.35	191.35	191.49	2.19	28.35	90.54	0.8
Reach13_Main1	100.123	25-year	20.8	190.05	191.32	191.32	191.45	2.08	25.05	90.06	0.77
Reach13_Main1	100.123	10-year	16.3	190.05	191.25	191.25	191.39	2	19.66	76.26	0.78
Reach13_Main1	100.123	5-year	12.8	190.05	191.14	191.14	191.31	2.14	12.8	48.93	0.91
Reach13_Main1	100.123	2-year	8.41	190.05	191.02	191.02	191.18	1.92	8.16	34.73	0.86
Reach13_Main2	2147.76	Regional	55.2	198.96	200.39		200.5	2.08	54.13	103.13	0.64
Reach13_Main2	2147.76	100-year	23.5	198.96	200.08	200.07	200.2	2.07	24.26	86.97	0.76
Reach13_Main2	2147.76	50-year	21	198.96	200.05	200.05	200.17	2.04	22.07	86.13	0.77
Reach13_Main2	2147.76	25-year	17.8	198.96	200.02	200	200.13	1.93	19.08	80.45	0.75
Reach13_Main2	2147.76	10-year	13.9	198.96	199.97	199.94	200.07	1.77	15.46	71.33	0.71
Reach13_Main2	2147.76	5-year	10.9	198.96	199.92	199.87	200.01	1.63	12.35	58.26	0.68
Reach13_Main2	2147.76	2-year	7.21	198.96	199.88	199.81	199.93	1.25	10.06	45.28	0.54
Reach13_Main2	2240.57	Regional	55.2	198.96	200.9	200.8	201.09	2.88	55.54	79.84	0.81
Reach13_Main2	2240.57	100-year	23.5	198.96	200.65	200.5	200.74	1.85	35.86	72.6	0.59
Reach13_Main2	2240.57	50-year	21	198.96	200.61	200.47	200.7	1.77	33.45	71.54	0.57
Reach13_Main2	2240.57	25-year	17.8	198.96	200.56	200.43	200.64	1.67	29.7	69.81	0.55
Reach13_Main2	2240.57	10-year	13.9	198.96	200.48	200.37	200.56	1.55	24.38	67.23	0.54
Reach13_Main2	2240.57	5-year	10.9	198.96	200.41	200.32	200.48	1.45	19.66	65.01	0.52
Reach13_Main2	2240.57	2-year	7.21	198.96	200.28	200.19	200.36	1.4	11.61	61.02	0.55
Reach13_Main2	2340.57	Regional	55.2	199.13	201.46		201.6	2.31	70.02	96.85	0.57
Reach13_Main2	2340.57	100-year	23.5	199.13	201		201.09	1.68	34.93	62.01	0.48
Reach13_Main2	2340.57	50-year	21	199.13	200.95		201.04	1.6	31.99	59.93	0.47
Reach13_Main2	2340.57	25-year	17.8	199.13	200.88		200.96	1.5	28.03	56.32	0.45
Reach13_Main2	2340.57	10-year	13.9	199.13	200.79		200.85	1.35	23.06	51.05	0.42
Reach13_Main2	2340.57	5-year	10.9	199.13	200.7		200.76	1.2	19.04	44.78	0.39
Reach13_Main2	2340.57	2-year	7.21	199.13	200.58		200.62	0.97	14.07	38.04	0.34
Reach13_Main2	2393.29	Regional	55.2	199.25	201.61		201.81	2.53	56.83	67.38	0.6
Reach13_Main2	2393.29	100-year	23.5	199.25	201.12		201.27	1.93	26.15	51.82	0.54
Reach13_Main2	2393.29	50-year	21	199.25	201.07		201.21	1.83	23.62	47.76	0.52
Reach13_Main2	2393.29	25-year	17.8	199.25	201		201.12	1.7	20.35	42.49	0.5
Reach13_Main2	2393.29	10-year	13.9	199.25	200.89		201	1.54	16.28	37.61	0.47
Reach13_Main2	2393.29	5-year	10.9	199.25	200.8		200.89	1.39	12.88	35.12	0.45
Reach13_Main2	2393.29	2-year	7.21	199.25	200.66		200.72	1.1	9.04	21.6	0.38
Reach13_Main2	2467.86	Regional	55.2	200.03	201.94		202	1.41	54.79	82.81	0.38
Reach13_Main2	2467.86	100-year	23.5	200.03	201.46		201.57	1.83	19.32	61.24	0.6
Reach13_Main2	2467.86	50-year	21	200.03	201.39	201.38	201.53	1.98	15.5	53.4	0.67
Reach13_Main2	2467.86	25-year	17.8	200.03	201.3	201.25	201.47	2.06	11.57	37.21	0.74
Reach13_Main2	2467.86	10-year	13.9	200.03	201.19	201.18	201.37	2.06	8.2	23.68	0.8
Reach13_Main2	2467.86	5-year	10.9	200.03	201.1	201.1	201.28	1.98	6.44	19.11	0.81
Reach13_Main2	2467.86	2-year	7.21	200.03	200.96	200.96	201.14	1.89	4.16	13.62	0.86

Culvert C2

HEC-RAS Hydraulic Model - Existing Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach13_Main2	2511	Regional	55.2	200.03	202.55	202.55	203.4	4.21	13.59	62.61	0.98
Reach13_Main2	2511	100-year	23.5	200.03	201.8	201.8	202.29	3.18	7.78	40.24	0.95
Reach13_Main2	2511	50-year	21	200.03	201.73	201.73	202.18	3.05	7.25	38.85	0.94
Reach13_Main2	2511	25-year	17.8	200.03	201.63	201.63	202.04	2.89	6.47	37.1	0.93
Reach13_Main2	2511	10-year	13.9	200.03	201.55	201.5	201.86	2.53	5.77	35.44	0.85
Reach13_Main2	2511	5-year	10.9	200.03	201.47	201.38	201.71	2.19	5.19	33.95	0.77
Reach13_Main2	2511	2-year	7.21	200.03	201.36	201.21	201.51	1.7	4.39	32.73	0.64
Reach13_Main2	2537.8		Culvert	(Trafalgar Road)							
Reach13_Main2	2571	Regional	55.2	200.36	203.43	202.77	203.44	0.52	154.32	151.75	0.11
Reach13_Main2	2571	100-year	23.5	200.36	202.02	202.02	202.51	3.1	7.6	53.61	1
Reach13_Main2	2571	50-year	21	200.36	201.95	201.95	202.40	2.98	7.08	30.08	0.99
Reach13_Main2	2571	25-year	17.8	200.36	201.85	201.85	202.26	2.82	6.31	21.08	0.99
Reach13_Main2	2571	10-year	13.9	200.36	201.72	201.72	202.07	2.62	5.3	11.88	1
Reach13_Main2	2571	5-year	10.9	200.36	201.61	201.61	201.91	2.46	4.43	7.26	1.01
Reach13_Main2	2571	2-year	7.21	200.36	201.42	201.42	201.68	2.25	3.2	6.2	1
Reach13_Main2	2594.39	Regional	41.1	200.51	203.44		203.44	0.42	145.4	135.43	0.09
Reach13_Main2	2594.39	100-year	16.2	200.51	202.66		202.67	0.39	61.09	90.41	0.11
Reach13_Main2	2594.39	50-year	14.5	200.51	202.55		202.55	0.42	51.02	85.66	0.12
Reach13_Main2	2594.39	25-year	12.3	200.51	202.4		202.41	0.48	38.68	79.27	0.15
Reach13_Main2	2594.39	10-year	9.62	200.51	202.21	201.73	202.22	0.6	24.61	70.61	0.2
Reach13_Main2	2594.39	5-year	7.55	200.51	202.06		202.08	0.77	14.85	59.86	0.28
Reach13_Main2	2594.39	2-year	4.98	200.51	201.85		201.9	1.02	4.91	7.9	0.41
Reach13_Main2	2640.57	Regional	41.1	200.64	203.42		203.46	1.17	102.21	96.95	0.26
Reach13_Main2	2640.57	100-year	16.2	200.64	202.65		202.69	1.07	38.14	67.83	0.31
Reach13_Main2	2640.57	50-year	14.5	200.64	202.54		202.58	1.14	30.54	63.51	0.35
Reach13_Main2	2640.57	25-year	12.3	200.64	202.39		202.45	1.25	21.59	55.06	0.41
Reach13_Main2	2640.57	10-year	9.62	200.64	202.21		202.29	1.39	12.73	44.31	0.5
Reach13_Main2	2640.57	5-year	7.55	200.64	202.1	201.8	202.19	1.37	8.38	37.59	0.53
Reach13_Main2	2640.57	2-year	4.98	200.64	201.98		202.05	1.18	4.6	21.65	0.49
Reach13_Main2	2685.01	Regional	41.1	200.89	203.46		203.48	0.78	94.84	103.39	0.18
Reach13_Main2	2685.01	100-year	16.2	200.89	202.71		202.75	1.09	27.15	70.96	0.33
Reach13_Main2	2685.01	50-year	14.5	200.89	202.61		202.66	1.26	20.39	63.63	0.4
Reach13_Main2	2685.01	25-year	12.3	200.89	202.48		202.58	1.49	13.18	52.1	0.5
Reach13_Main2	2685.01	10-year	9.62	200.89	202.36		202.47	1.5	8.37	30.74	0.54
Reach13_Main2	2685.01	5-year	7.55	200.89	202.28		202.38	1.39	6.28	22.16	0.53
Reach13_Main2	2685.01	2-year	4.98	200.89	202.15		202.22	1.17	4.26	8.9	0.5
Reach13_Main2	2740.57	Regional	41.1	201.07	203.45		203.53	1.71	73.29	94.01	0.41
Reach13_Main2	2740.57	100-year	16.2	201.07	202.76		202.87	1.68	20.91	48.38	0.51
Reach13_Main2	2740.57	50-year	14.5	201.07	202.7		202.81	1.63	18.32	44.82	0.51
Reach13_Main2	2740.57	25-year	12.3	201.07	202.65		202.75	1.5	16.07	41.7	0.48
Reach13_Main2	2740.57	10-year	9.62	201.07	202.57		202.65	1.34	12.91	36.19	0.44
Reach13_Main2	2740.57	5-year	7.55	201.07	202.48		202.55	1.21	10.03	30.67	0.42
Reach13_Main2	2740.57	2-year	4.98	201.07	202.33		202.38	1.03	6.14	20.88	0.4
Reach13_Main2	2844.9	Regional	41.1	202.02	203.69		203.85	2.34	31.71	57.18	0.71
Reach13_Main2	2844.9	100-year	16.2	202.02	203.29	203.29	203.46	2.1	12	39.07	0.8
Reach13_Main2	2844.9	50-year	14.5	202.02	203.26	203.26	203.42	2.04	10.75	37.3	0.8
Reach13_Main2	2844.9	25-year	12.3	202.02	203.21	203.21	203.37	1.98	9.01	34.66	0.8
Reach13_Main2	2844.9	10-year	9.62	202.02	203.15	203.15	203.3	1.83	7.07	31.35	0.78

Culvert C2

HEC-RAS Hydraulic Model - Existing Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach13_Main2	2844.9	5-year	7.55	202.02	203.06	203.06	203.23	1.87	4.6	13.41	0.84
Reach13_Main2	2844.9	2-year	4.98	202.02	202.92	202.92	203.08	1.81	2.88	10.88	0.94
Reach13_Main2	2945.25	Regional	41.1	202.68	204.22		204.27	1.53	54.95	94.75	0.49
Reach13_Main2	2945.25	100-year	16.2	202.68	203.92		203.96	1.22	28.1	83.45	0.46
Reach13_Main2	2945.25	50-year	14.5	202.68	203.89		203.93	1.2	25.7	82.33	0.47
Reach13_Main2	2945.25	25-year	12.3	202.68	203.86		203.89	1.16	22.51	80.78	0.47
Reach13_Main2	2945.25	10-year	9.62	202.68	203.8		203.84	1.13	17.96	76.94	0.47
Reach13_Main2	2945.25	5-year	7.55	202.68	203.76		203.79	1.06	14.79	73.27	0.46
Reach13_Main2	2945.25	2-year	4.98	202.68	203.69	203.6	203.72	0.97	9.87	63.99	0.46
Reach13_Main2	3038.22	Regional	41.1	203.36	204.59	204.59	204.72	2.26	32.8	100.95	0.85
Reach13_Main2	3038.22	100-year	16.2	203.36	204.44	204.44	204.52	1.62	18.17	94	0.68
Reach13_Main2	3038.22	50-year	14.5	203.36	204.42	204.42	204.5	1.56	16.86	93.34	0.66
Reach13_Main2	3038.22	25-year	12.3	203.36	204.4	204.4	204.48	1.48	14.74	91.82	0.64
Reach13_Main2	3038.22	10-year	9.62	203.36	204.37	204.37	204.44	1.38	11.79	88.38	0.61
Reach13_Main2	3038.22	5-year	7.55	203.36	204.32	204.32	204.4	1.38	7.94	65.62	0.63
Reach13_Main2	3038.22	2-year	4.98	203.36	204.13	204.08	204.27	1.61	3.09	7.95	0.83
Reach13_Main2	3064.93	Regional	41.1	203.47	204.84	204.84	204.94	1.96	37.02	151.85	0.67
Reach13_Main2	3064.93	100-year	16.2	203.47	204.7	204.7	204.77	1.43	18.79	110.4	0.53
Reach13_Main2	3064.93	50-year	14.5	203.47	204.7	204.7	204.76	1.28	18.79	110.4	0.48
Reach13_Main2	3064.93	25-year	12.3	203.47	204.58	204.58	205.01	2.89	4.26	57.09	1
Reach13_Main2	3064.93	10-year	9.62	203.47	204.46	204.46	204.82	2.65	3.63	11.16	1
Reach13_Main2	3064.93	5-year	7.55	203.47	204.44	204.35	204.67	2.13	3.55	10.91	0.81
Reach13_Main2	3064.93	2-year	4.98	203.47	204.36	204.2	204.49	1.6	3.11	9.53	0.65
Reach13_Main2	3072.99		Culvert								
Reach13_Main2	3081.44	Regional	41.1	203.4	205	204.7	205.02	1.13	75.15	157.7	0.3
Reach13_Main2	3081.44	100-year	16.2	203.4	204.82	204.63	204.83	0.69	49.39	125.76	0.2
Reach13_Main2	3081.44	50-year	14.5	203.4	204.81	204.56	204.82	0.64	47.7	120.21	0.19
Reach13_Main2	3081.44	25-year	12.3	203.4	205.01	204.45	205.01	0.33	76.64	158.52	0.09
Reach13_Main2	3081.44	10-year	9.62	203.4	204.82	204.32	204.82	0.41	48.9	122.75	0.12
Reach13_Main2	3081.44	5-year	7.55	203.4	204.77	204.2	204.77	0.36	43.36	107.35	0.11
Reach13_Main2	3081.44	2-year	4.98	203.4	204.46	204.05	204.53	1.19	4.2	73.12	0.4
Reach13_Main2	3102.86	Regional	41.1	203.51	204.98	204.98	205.18	2.38	23.94	54.23	0.77
Reach13_Main2	3102.86	100-year	16.2	203.51	204.81	204.7	204.89	1.51	15.05	47.81	0.54
Reach13_Main2	3102.86	50-year	14.5	203.51	204.8	204.7	204.87	1.4	14.47	47.36	0.51
Reach13_Main2	3102.86	25-year	12.3	203.51	205.01	204.64	205.02	0.67	25.19	55.07	0.22
Reach13_Main2	3102.86	10-year	9.62	203.51	204.81	204.54	204.84	0.88	15.31	48	0.32
Reach13_Main2	3102.86	5-year	7.55	203.51	204.77	204.46	204.79	0.8	13.05	46.37	0.3
Reach13_Main2	3102.86	2-year	4.98	203.51	204.54	204.3	204.59	0.97	5.76	19.25	0.43
Reach13_Main2	3121.85	Regional	41.1	203.77	205.15	205.15	205.38	2.65	24.13	49.15	0.88
Reach13_Main2	3121.85	100-year	16.2	203.77	204.89	204.89	205.04	1.99	12.6	40	0.78
Reach13_Main2	3121.85	50-year	14.5	203.77	204.87	204.87	205.01	1.91	11.71	39.27	0.76
Reach13_Main2	3121.85	25-year	12.3	203.77	205		205.05	1.11	17.23	43.65	0.4
Reach13_Main2	3121.85	10-year	9.62	203.77	204.81	204.78	204.91	1.54	9.4	37.32	0.65
Reach13_Main2	3121.85	5-year	7.55	203.77	204.77	204.71	204.85	1.4	7.79	33.5	0.61
Reach13_Main2	3121.85	2-year	4.98	203.77	204.58	204.56	204.71	1.62	3.49	14.17	0.87
Reach13_Main2	3145.25	Regional	41.1	204.07	205.41		205.53	2.13	28.7	47.04	0.66
Reach13_Main2	3145.25	100-year	16.2	204.07	205.11		205.18	1.58	15.65	38.78	0.58
Reach13_Main2	3145.25	50-year	14.5	204.07	205.08		205.15	1.52	14.49	37.64	0.57

Culvert C2

HEC-RAS Hydraulic Model - Existing Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach13_Main2	3145.25	25-year	12.3	204.07	205.06		205.11	1.37	13.67	36.84	0.52
Reach13_Main2	3145.25	10-year	9.62	204.07	204.97		205.03	1.38	10.58	33.93	0.56
Reach13_Main2	3145.25	5-year	7.55	204.07	204.91		204.97	1.29	8.78	31.31	0.55
Reach13_Main2	3145.25	2-year	4.98	204.07	204.83		204.88	1.13	6.44	27.09	0.52
Reach13_Main2	3245.25	Regional	41.1	204.57	205.92	205.9	206.07	2.35	34.02	89.59	0.75
Reach13_Main2	3245.25	100-year	16.2	204.57	205.66	205.66	205.8	1.98	13.46	52.07	0.74
Reach13_Main2	3245.25	50-year	14.5	204.57	205.63	205.63	205.77	1.93	12.11	47.66	0.73
Reach13_Main2	3245.25	25-year	12.3	204.57	205.59	205.59	205.73	1.88	10.19	40.04	0.74
Reach13_Main2	3245.25	10-year	9.62	204.57	205.52	205.52	205.66	1.84	7.54	31.65	0.77
Reach13_Main2	3245.25	5-year	7.55	204.57	205.45	205.43	205.59	1.78	5.59	23.9	0.79
Reach13_Main2	3245.25	2-year	4.98	204.57	205.36	205.3	205.47	1.53	3.82	16	0.75
Reach13_Main2	3351	Regional	41.1	204.06	206.17		206.18	0.75	88.16	85.41	0.18
Reach13_Main2	3351	100-year	16.2	204.06	205.85		205.86	0.42	62.46	79.85	0.11
Reach13_Main2	3351	50-year	14.5	204.06	205.82		205.83	0.39	59.8	79.25	0.11
Reach13_Main2	3351	25-year	12.3	204.06	205.77		205.78	0.36	55.98	78.38	0.1
Reach13_Main2	3351	10-year	9.62	204.06	205.7		205.7	0.31	50.45	77.1	0.09
Reach13_Main2	3351	5-year	7.55	204.06	205.63		205.63	0.28	44.79	75.19	0.08
Reach13_Main2	3351	2-year	4.98	204.06	205.5		205.50	0.23	35.46	71.94	0.07
Reach13_Main2	3445.25	Regional	41.1	204.52	206.18		206.26	1.63	41.5	61.07	0.47
Reach13_Main2	3445.25	100-year	16.2	204.52	205.86		205.90	1.13	22.83	51.75	0.38
Reach13_Main2	3445.25	50-year	14.5	204.52	205.82		205.86	1.09	21.06	50.45	0.38
Reach13_Main2	3445.25	25-year	12.3	204.52	205.77		205.81	1.04	18.57	48.7	0.37
Reach13_Main2	3445.25	10-year	9.62	204.52	205.7		205.73	0.98	15.1	45.63	0.37
Reach13_Main2	3445.25	5-year	7.55	204.52	205.62		205.66	0.94	11.78	39.98	0.37
Reach13_Main2	3445.25	2-year	4.98	204.52	205.49		205.53	0.89	7.33	28.49	0.4
Reach13_Main2	3494.37	Regional	41.1	204.58	206.31		206.42	1.8	37.11	66.08	0.55
Reach13_Main2	3494.37	100-year	16.2	204.58	205.96		206.03	1.33	17.28	45.86	0.49
Reach13_Main2	3494.37	50-year	14.5	204.58	205.92		205.99	1.29	15.69	43.86	0.49
Reach13_Main2	3494.37	25-year	12.3	204.58	205.87		205.94	1.23	13.55	41.42	0.48
Reach13_Main2	3494.37	10-year	9.62	204.58	205.8		205.86	1.14	10.76	37.47	0.47
Reach13_Main2	3494.37	5-year	7.55	204.58	205.74		205.79	1.06	8.41	33.72	0.47
Reach13_Main2	3494.37	2-year	4.98	204.58	205.63		205.67	0.93	5.59	18.97	0.46
Reach13_Main2	3545.25	Regional	41.1	204.91	206.51		206.66	2.26	31.2	56.51	0.71
Reach13_Main2	3545.25	100-year	16.2	204.91	206.16	206.16	206.31	2.01	13.33	44.13	0.78
Reach13_Main2	3545.25	50-year	14.5	204.91	206.13	206.13	206.28	1.97	11.98	42.42	0.78
Reach13_Main2	3545.25	25-year	12.3	204.91	206.09	206.09	206.23	1.89	10.3	40.16	0.78
Reach13_Main2	3545.25	10-year	9.62	204.91	206.03	206.03	206.17	1.79	8.03	36.51	0.77
Reach13_Main2	3545.25	5-year	7.55	204.91	205.97	205.97	206.1	1.7	6.08	31.6	0.75
Reach13_Main2	3545.25	2-year	4.98	204.91	205.86	205.8	205.98	1.59	3.4	15.19	0.78
Reach13_Main2	3643.44	Regional	41.1	205.59	206.92		206.99	1.56	41.69	70.99	0.48
Reach13_Main2	3643.44	100-year	16.2	205.59	206.64		206.68	1.21	22.18	66.84	0.44
Reach13_Main2	3643.44	50-year	14.5	205.59	206.61		206.66	1.18	20.39	66.4	0.43
Reach13_Main2	3643.44	25-year	12.3	205.59	206.58		206.62	1.14	17.92	65.73	0.43
Reach13_Main2	3643.44	10-year	9.62	205.59	206.52		206.56	1.09	14.38	64.42	0.42
Reach13_Main2	3643.44	5-year	7.55	205.59	206.47		206.51	1.03	11.34	52.44	0.42
Reach13_Main2	3643.44	2-year	4.98	205.59	206.39		206.42	0.96	7.57	37.29	0.42
Reach13_Main2	3745.04	Regional	41.1	206.2	207.28		207.42	2.38	29.25	54.5	0.75
Reach13_Main2	3745.04	100-year	16.2	206.2	206.98		207.06	1.76	14.88	39.47	0.67
Reach13_Main2	3745.04	50-year	14.5	206.2	206.95		207.03	1.69	13.78	37.91	0.65

Culvert C2

HEC-RAS Hydraulic Model - Existing Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach13_Main2	3745.04	25-year	12.3	206.2	206.91		206.98	1.59	12.3	35.64	0.63
Reach13_Main2	3745.04	10-year	9.62	206.2	206.86		206.91	1.45	10.46	32.51	0.6
Reach13_Main2	3745.04	5-year	7.55	206.2	206.8		206.85	1.31	8.86	26.74	0.57
Reach13_Main2	3745.04	2-year	4.98	206.2	206.72		206.76	1.13	6.82	24.07	0.53
Reach13_Main2	3845.04	Regional	41.1	206.33	207.95	207.93	208.14	2.6	28.32	66.27	0.81
Reach13_Main2	3845.04	100-year	16.2	206.33	207.67	207.67	207.82	2.04	12.88	43.84	0.74
Reach13_Main2	3845.04	50-year	14.5	206.33	207.64	207.64	207.79	2.02	11.47	40.3	0.75
Reach13_Main2	3845.04	25-year	12.3	206.33	207.59	207.59	207.74	1.96	9.64	35.44	0.75
Reach13_Main2	3845.04	10-year	9.62	206.33	207.53	207.53	207.67	1.85	7.53	30.36	0.74
Reach13_Main2	3845.04	5-year	7.55	206.33	207.43	207.43	207.6	1.89	5.12	20.49	0.81
Reach13_Main2	3845.04	2-year	4.98	206.33	207.31	207.28	207.47	1.78	2.97	11.84	0.85
Reach13_Main2	3938.83	Regional	41.1	207.06	208.4		208.51	1.72	34.94	63.73	0.5
Reach13_Main2	3938.83	100-year	16.2	207.06	208.08		208.14	1.2	17.61	42.48	0.4
Reach13_Main2	3938.83	50-year	14.5	207.06	208.05		208.11	1.14	16.31	40.35	0.39
Reach13_Main2	3938.83	25-year	12.3	207.06	208		208.05	1.06	14.44	37.35	0.37
Reach13_Main2	3938.83	10-year	9.62	207.06	207.93		207.97	0.96	11.88	33.03	0.35
Reach13_Main2	3938.83	5-year	7.55	207.06	207.86		207.89	0.84	10.02	23.74	0.32
Reach13_Main2	3938.83	2-year	4.98	207.06	207.73		207.76	0.69	7.58	16.83	0.3
Reach13_Main2	4018.28	Regional	41.1	207.69	208.67		208.79	2.14	29.63	66.78	0.7
Reach13_Main2	4018.28	100-year	16.2	207.69	208.31	208.28	208.45	2.03	11.25	36.89	0.85
Reach13_Main2	4018.28	50-year	14.5	207.69	208.28	208.26	208.41	2.03	9.89	33.27	0.87
Reach13_Main2	4018.28	25-year	12.3	207.69	208.22	208.21	208.36	2.03	8.16	28.81	0.92
Reach13_Main2	4018.28	10-year	9.62	207.69	208.16	208.16	208.29	1.93	6.5	24.49	0.94
Reach13_Main2	4018.28	5-year	7.55	207.69	208.11	208.11	208.23	1.81	5.36	22.34	0.94
Reach13_Main2	4018.28	2-year	4.98	207.69	208.04	208.04	208.14	1.63	3.84	19.24	0.94
Reach13_Main2	4057.09	Regional	41.1	207.8	208.87		208.92	1.32	45.17	75.11	0.43
Reach13_Main2	4057.09	100-year	16.2	207.8	208.58		208.61	1.04	23.71	68.77	0.4
Reach13_Main2	4057.09	50-year	14.5	207.8	208.55		208.58	1.02	21.73	66.56	0.4
Reach13_Main2	4057.09	25-year	12.3	207.8	208.51		208.54	0.98	19.18	63.01	0.4
Reach13_Main2	4057.09	10-year	9.62	207.8	208.45	208.28	208.48	0.93	15.56	56.57	0.4
Reach13_Main2	4057.09	5-year	7.55	207.8	208.39	208.24	208.42	0.88	12.61	50.82	0.4
Reach13_Main2	4057.09	2-year	4.98	207.8	208.31	208.17	208.34	0.79	8.82	42.09	0.39
Reach13_Main2	4145.04	Regional	41.1	208.19	209.28	209.28	209.5	2.68	22.99	50.67	0.86
Reach13_Main2	4145.04	100-year	16.2	208.19	208.96	208.96	209.13	2.13	10.29	30.68	0.83
Reach13_Main2	4145.04	50-year	14.5	208.19	208.93	208.93	209.1	2.08	9.32	28.68	0.83
Reach13_Main2	4145.04	25-year	12.3	208.19	208.88	208.88	209.04	2.01	8.05	25.84	0.83
Reach13_Main2	4145.04	10-year	9.62	208.19	208.79	208.79	208.96	2	6.05	20.46	0.89
Reach13_Main2	4145.04	5-year	7.55	208.19	208.72	208.72	208.88	1.93	4.65	16.17	0.94
Reach13_Main2	4145.04	2-year	4.98	208.19	208.65	208.64	208.77	1.61	3.58	14.6	0.85
Reach13_Main2	4173.24	Regional	41.1	208.43	209.59	209.57	209.73	2.18	31.12	86.39	0.72
Reach13_Main2	4173.24	100-year	16.2	208.43	209.32	209.32	209.46	1.92	13.02	49.79	0.76
Reach13_Main2	4173.24	50-year	14.5	208.43	209.3	209.3	209.43	1.85	11.97	47.4	0.74
Reach13_Main2	4173.24	25-year	12.3	208.43	209.27	209.27	209.39	1.79	10.29	42.88	0.74
Reach13_Main2	4173.24	10-year	9.62	208.43	209.2	209.2	209.33	1.74	7.75	35.38	0.76
Reach13_Main2	4173.24	5-year	7.55	208.43	209.14	209.14	209.27	1.68	5.79	28.46	0.78
Reach13_Main2	4173.24	2-year	4.98	208.43	209.01	209	209.15	1.68	3.2	13.61	0.92

Culvert C2

Existing 2 cell Extended

+ 1 additional cell of 3.0 x 2.4 m

HEC-RAS Hydraulic Model - Proposed Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach13_Main1	11.28645	Regional	64.7	189.69	193.44	190.84	193.44	0.4	408.86	166.61	0.07
Reach13_Main1	11.28645	100-year	27.4	189.69	190.79	190.46	190.87	1.79	33.23	45.37	0.57
Reach13_Main1	11.28645	50-year	24.5	189.69	190.73	190.42	190.8	1.72	30.71	44.2	0.57
Reach13_Main1	11.28645	25-year	20.8	189.69	190.65	190.37	190.72	1.63	27.45	42.87	0.56
Reach13_Main1	11.28645	10-year	16.3	189.69	190.55	190.31	190.61	1.5	23.27	41.13	0.55
Reach13_Main1	11.28645	5-year	12.8	189.69	190.47	190.25	190.52	1.38	19.74	39.57	0.54
Reach13_Main1	11.28645	2-year	8.41	189.69	190.34	190.17	190.38	1.2	14.87	37.3	0.52
Reach13_Main1	100.1227	Regional	64.7	190.05	193.44		193.45	0.55	241.94	110.51	0.1
Reach13_Main1	100.1227	100-year	27.4	190.05	191.38	191.38	191.52	2.28	30.63	90.87	0.81
Reach13_Main1	100.1227	50-year	24.5	190.05	191.35	191.35	191.49	2.19	28.35	90.54	0.8
Reach13_Main1	100.1227	25-year	20.8	190.05	191.32	191.32	191.45	2.08	25.05	90.06	0.77
Reach13_Main1	100.1227	10-year	16.3	190.05	191.25	191.25	191.39	2	19.66	76.26	0.78
Reach13_Main1	100.1227	5-year	12.8	190.05	191.14	191.14	191.31	2.14	12.8	48.93	0.91
Reach13_Main1	100.1227	2-year	8.41	190.05	191.02	191.02	191.18	1.92	8.16	34.73	0.86
Reach13_Main2	2340.565	Regional	55.2	199.13	201.46		201.6	2.31	70.02	96.85	0.57
Reach13_Main2	2340.565	100-year	23.5	199.13	201		201.09	1.68	34.93	62.01	0.48
Reach13_Main2	2340.565	50-year	21	199.13	200.95		201.04	1.6	31.99	59.93	0.47
Reach13_Main2	2340.565	25-year	17.8	199.13	200.88		200.96	1.5	28.03	56.32	0.45
Reach13_Main2	2340.565	10-year	13.9	199.13	200.79		200.85	1.35	23.06	51.05	0.42
Reach13_Main2	2340.565	5-year	10.9	199.13	200.7		200.76	1.2	19.04	44.78	0.39
Reach13_Main2	2340.565	2-year	7.21	199.13	200.58		200.62	0.97	14.07	38.04	0.34
Reach13_Main2	2393.286	Regional	55.2	199.25	201.61		201.81	2.53	56.83	67.38	0.6
Reach13_Main2	2393.286	100-year	23.5	199.25	201.12		201.27	1.93	26.15	51.82	0.54
Reach13_Main2	2393.286	50-year	21	199.25	201.07		201.21	1.83	23.62	47.76	0.52
Reach13_Main2	2393.286	25-year	17.8	199.25	201		201.12	1.7	20.35	42.49	0.5
Reach13_Main2	2393.286	10-year	13.9	199.25	200.89		201	1.54	16.28	37.61	0.47
Reach13_Main2	2393.286	5-year	10.9	199.25	200.8		200.89	1.39	12.88	35.12	0.45
Reach13_Main2	2393.286	2-year	7.21	199.25	200.66		200.72	1.1	9.04	21.6	0.38
Reach13_Main2	2467.864	Regional	55.2	200.03	201.94		202	1.41	54.79	82.81	0.38
Reach13_Main2	2467.864	100-year	23.5	200.03	201.46		201.57	1.83	19.32	61.24	0.6
Reach13_Main2	2467.864	50-year	21	200.03	201.39	201.38	201.53	1.98	15.5	53.4	0.67
Reach13_Main2	2467.864	25-year	17.8	200.03	201.3	201.25	201.47	2.06	11.57	37.21	0.74
Reach13_Main2	2467.864	10-year	13.9	200.03	201.19	201.18	201.37	2.06	8.2	23.68	0.8
Reach13_Main2	2467.864	5-year	10.9	200.03	201.1	201.1	201.28	1.98	6.44	19.11	0.81
Reach13_Main2	2467.864	2-year	7.21	200.03	200.96	200.96	201.14	1.89	4.16	13.62	0.86
Reach13_Main2	2510.996	Regional	55.2	199.8	201.89	201.47	202.31	2.9	19.48	42.08	0.66
Reach13_Main2	2510.996	100-year	23.5	199.8	201.58	200.76	201.69	1.48	16.17	36.19	0.37
Reach13_Main2	2510.996	50-year	21	199.8	201.58	200.69	201.67	1.33	16.1	36.08	0.33
Reach13_Main2	2510.996	25-year	17.8	199.8	201.54	200.61	201.61	1.16	15.68	35.33	0.29
Reach13_Main2	2510.996	10-year	13.9	199.8	201.45	200.5	201.5	0.96	14.72	33.57	0.25
Reach13_Main2	2510.996	5-year	10.9	199.8	201.36	200.4	201.39	0.8	13.77	32.72	0.21
Reach13_Main2	2510.996	2-year	7.21	199.8	201.22	200.27	201.24	0.59	12.29	31.83	0.16
Reach13_Main2	2537.8		Culvert	Trafalgar Road							
Reach13_Main2	2571	Regional	55.2	199.95	202.7	201.61	202.92	2.12	26.31	94.7	0.43
Reach13_Main2	2571	100-year	23.5	199.95	201.77	200.91	201.88	1.46	16.12	14.14	0.37
Reach13_Main2	2571	50-year	21	199.95	201.72	200.85	201.81	1.34	15.64	11.91	0.34
Reach13_Main2	2571	25-year	17.8	199.95	201.65	200.76	201.72	1.2	14.85	9.84	0.31

Culvert C2

Existing 2 cell Extended

+ 1 additional cell of 3.0 x 2.4 m

HEC-RAS Hydraulic Model - Proposed Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach13_Main2	2571	10-year	13.9	199.95	201.52	200.65	201.58	1.02	13.68	9.58	0.27
Reach13_Main2	2571	5-year	10.9	199.95	201.41	200.56	201.45	0.86	12.63	9.4	0.24
Reach13_Main2	2571	2-year	7.21	199.95	201.25	200.43	201.27	0.65	11.08	9.17	0.19
Reach13_Main2	2594.387	Regional	41.1	200.51	202.99		203	0.63	93.09	104.61	0.16
Reach13_Main2	2594.387	100-year	16.2	200.51	202.06	202.06	202.16	1.68	14.49	59.36	0.62
Reach13_Main2	2594.387	50-year	14.5	200.51	202.03	202.03	202.14	1.66	12.95	57.16	0.63
Reach13_Main2	2594.387	25-year	12.3	200.51	202	202	202.1	1.61	11.02	54.08	0.62
Reach13_Main2	2594.387	10-year	9.62	200.51	201.72	201.72	202.02	2.41	3.99	6.87	1.01
Reach13_Main2	2594.387	5-year	7.55	200.51	201.62	201.62	201.88	2.29	3.3	6.19	1
Reach13_Main2	2594.387	2-year	4.98	200.51	201.45	201.45	201.68	2.11	2.36	5.22	1
Reach13_Main2	2640.565	Regional	41.1	200.64	202.96		203.05	1.84	60.87	80.36	0.48
Reach13_Main2	2640.565	100-year	16.2	200.64	202.27	202.23	202.45	2.04	15.82	48.21	0.71
Reach13_Main2	2640.565	50-year	14.5	200.64	202.25	202.19	202.41	1.89	14.94	47.12	0.67
Reach13_Main2	2640.565	25-year	12.3	200.64	202.22	202.14	202.35	1.72	13.41	45.2	0.62
Reach13_Main2	2640.565	10-year	9.62	200.64	202.24	202.03	202.31	1.31	14.03	45.99	0.47
Reach13_Main2	2640.565	5-year	7.55	200.64	202.13	201.81	202.21	1.29	9.43	39.79	0.49
Reach13_Main2	2640.565	2-year	4.98	200.64	201.95	201.63	202.03	1.23	4.15	16.25	0.51
Reach13_Main2	2685.007	Regional	41.1	200.89	203.09		203.14	1.29	58.39	90.49	0.33
Reach13_Main2	2685.007	100-year	16.2	200.89	202.57		202.66	1.55	18.08	60.9	0.5
Reach13_Main2	2685.007	50-year	14.5	200.89	202.52	202.4	202.62	1.6	15.08	57.18	0.53
Reach13_Main2	2685.007	25-year	12.3	200.89	202.45	202.32	202.56	1.61	11.47	44.88	0.55
Reach13_Main2	2685.007	10-year	9.62	200.89	202.37		202.47	1.49	8.55	31.53	0.54
Reach13_Main2	2685.007	5-year	7.55	200.89	202.29		202.38	1.38	6.33	22.36	0.53
Reach13_Main2	2685.007	2-year	4.98	200.89	202.14		202.21	1.2	4.14	7.64	0.51
Reach13_Main2	2740.565	Regional	41.1	201.07	203.06	203.04	203.32	2.77	40.32	75.93	0.74
Reach13_Main2	2740.565	100-year	16.2	201.07	202.73		202.85	1.76	19.43	46.43	0.54
Reach13_Main2	2740.565	50-year	14.5	201.07	202.7		202.81	1.64	18.2	44.64	0.51
Reach13_Main2	2740.565	25-year	12.3	201.07	202.65		202.75	1.49	16.26	41.95	0.47
Reach13_Main2	2740.565	10-year	9.62	201.07	202.57		202.65	1.34	12.93	36.21	0.44
Reach13_Main2	2740.565	5-year	7.55	201.07	202.48		202.55	1.21	10.04	30.69	0.42
Reach13_Main2	2740.565	2-year	4.98	201.07	202.33		202.38	1.05	6.01	20.46	0.4
Reach13_Main2	2844.895	Regional	41.1	202.02	203.75		203.88	2.12	35.07	58.87	0.63
Reach13_Main2	2844.895	100-year	16.2	202.02	203.29	203.29	203.46	2.1	12	39.07	0.8
Reach13_Main2	2844.895	50-year	14.5	202.02	203.26	203.26	203.42	2.04	10.75	37.3	0.8
Reach13_Main2	2844.895	25-year	12.3	202.02	203.21	203.21	203.37	1.98	9.01	34.66	0.8
Reach13_Main2	2844.895	10-year	9.62	202.02	203.15	203.15	203.3	1.83	7.07	31.35	0.78
Reach13_Main2	2844.895	5-year	7.55	202.02	203.06	203.06	203.23	1.87	4.6	13.41	0.84
Reach13_Main2	2844.895	2-year	4.98	202.02	202.92	202.92	203.08	1.81	2.88	10.88	0.94
Reach13_Main2	2945.253	Regional	41.1	202.68	204.21		204.27	1.57	53.91	94.35	0.5
Reach13_Main2	2945.253	100-year	16.2	202.68	203.92		203.96	1.22	28.1	83.45	0.46
Reach13_Main2	2945.253	50-year	14.5	202.68	203.89		203.93	1.2	25.7	82.33	0.47
Reach13_Main2	2945.253	25-year	12.3	202.68	203.86		203.89	1.16	22.51	80.78	0.47
Reach13_Main2	2945.253	10-year	9.62	202.68	203.8		203.84	1.13	17.96	76.94	0.47
Reach13_Main2	2945.253	5-year	7.55	202.68	203.76		203.79	1.06	14.79	73.27	0.46
Reach13_Main2	2945.253	2-year	4.98	202.68	203.69	203.6	203.72	0.97	9.87	63.99	0.46
Reach13_Main2	3038.216	Regional	41.1	203.36	204.59	204.59	204.72	2.24	33.09	101.08	0.84
Reach13_Main2	3038.216	100-year	16.2	203.36	204.44	204.44	204.52	1.62	18.17	94	0.68
Reach13_Main2	3038.216	50-year	14.5	203.36	204.42	204.42	204.5	1.56	16.86	93.34	0.66

Culvert C2

Existing 2 cell Extended

+ 1 additional cell of 3.0 x 2.4 m

HEC-RAS Hydraulic Model - Proposed Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach13_Main2	3038.216	25-year	12.3	203.36	204.4	204.4	204.48	1.48	14.74	91.82	0.64
Reach13_Main2	3038.216	10-year	9.62	203.36	204.37	204.37	204.44	1.38	11.79	88.38	0.61
Reach13_Main2	3038.216	5-year	7.55	203.36	204.32	204.32	204.4	1.38	7.94	65.62	0.63
Reach13_Main2	3038.216	2-year	4.98	203.36	204.13	204.08	204.27	1.61	3.09	7.95	0.83
Reach13_Main2	3064.932	Regional	41.1	203.47	204.84	204.84	204.94	1.96	37.02	151.85	0.67
Reach13_Main2	3064.932	100-year	16.2	203.47	204.7	204.7	204.77	1.43	18.79	110.4	0.53
Reach13_Main2	3064.932	50-year	14.5	203.47	204.7	204.7	204.76	1.28	18.79	110.4	0.48
Reach13_Main2	3064.932	25-year	12.3	203.47	204.58	204.58	205.01	2.89	4.26	57.09	1
Reach13_Main2	3064.932	10-year	9.62	203.47	204.46	204.46	204.82	2.65	3.63	11.16	1
Reach13_Main2	3064.932	5-year	7.55	203.47	204.44	204.35	204.67	2.13	3.55	10.91	0.81
Reach13_Main2	3064.932	2-year	4.98	203.47	204.36	204.2	204.49	1.6	3.11	9.53	0.65
Reach13_Main2	3072.992		Culvert								
Reach13_Main2	3081.443	Regional	41.1	203.4	205	204.7	205.02	1.13	75.15	157.7	0.3
Reach13_Main2	3081.443	100-year	16.2	203.4	204.82	204.63	204.83	0.69	49.39	125.76	0.2
Reach13_Main2	3081.443	50-year	14.5	203.4	204.81	204.56	204.82	0.64	47.7	120.21	0.19
Reach13_Main2	3081.443	25-year	12.3	203.4	205.01	204.45	205.01	0.33	76.64	158.52	0.09
Reach13_Main2	3081.443	10-year	9.62	203.4	204.82	204.32	204.82	0.41	48.9	122.75	0.12
Reach13_Main2	3081.443	5-year	7.55	203.4	204.77	204.2	204.77	0.36	43.36	107.35	0.11
Reach13_Main2	3081.443	2-year	4.98	203.4	204.46	204.05	204.53	1.19	4.2	73.12	0.4
Reach13_Main2	3102.862	Regional	41.1	203.51	204.98	204.98	205.18	2.38	23.94	54.23	0.77
Reach13_Main2	3102.862	100-year	16.2	203.51	204.81	204.7	204.89	1.51	15.05	47.81	0.54
Reach13_Main2	3102.862	50-year	14.5	203.51	204.8	204.7	204.87	1.4	14.47	47.36	0.51
Reach13_Main2	3102.862	25-year	12.3	203.51	205.01	204.64	205.02	0.67	25.19	55.07	0.22
Reach13_Main2	3102.862	10-year	9.62	203.51	204.81	204.54	204.84	0.88	15.31	48	0.32
Reach13_Main2	3102.862	5-year	7.55	203.51	204.77	204.46	204.79	0.8	13.05	46.37	0.3
Reach13_Main2	3102.862	2-year	4.98	203.51	204.54	204.3	204.59	0.97	5.76	19.25	0.43
Reach13_Main2	3121.847	Regional	41.1	203.77	205.15	205.15	205.38	2.65	24.13	49.15	0.88
Reach13_Main2	3121.847	100-year	16.2	203.77	204.89	204.89	205.04	1.99	12.6	40	0.78
Reach13_Main2	3121.847	50-year	14.5	203.77	204.87	204.87	205.01	1.91	11.71	39.27	0.76
Reach13_Main2	3121.847	25-year	12.3	203.77	205		205.05	1.11	17.23	43.65	0.4
Reach13_Main2	3121.847	10-year	9.62	203.77	204.81	204.78	204.91	1.54	9.4	37.32	0.65
Reach13_Main2	3121.847	5-year	7.55	203.77	204.77	204.71	204.85	1.4	7.79	33.5	0.61
Reach13_Main2	3121.847	2-year	4.98	203.77	204.58	204.56	204.71	1.62	3.49	14.17	0.87
Reach13_Main2	3145.253	Regional	41.1	204.07	205.41		205.53	2.13	28.7	47.04	0.66
Reach13_Main2	3145.253	100-year	16.2	204.07	205.11		205.18	1.58	15.65	38.78	0.58
Reach13_Main2	3145.253	50-year	14.5	204.07	205.08		205.15	1.52	14.49	37.64	0.57
Reach13_Main2	3145.253	25-year	12.3	204.07	205.06		205.11	1.37	13.67	36.84	0.52
Reach13_Main2	3145.253	10-year	9.62	204.07	204.97		205.03	1.38	10.58	33.93	0.56
Reach13_Main2	3145.253	5-year	7.55	204.07	204.91		204.97	1.29	8.78	31.31	0.55
Reach13_Main2	3145.253	2-year	4.98	204.07	204.83		204.88	1.13	6.44	27.09	0.52
Reach13_Main2	3245.253	Regional	41.1	204.57	205.92	205.9	206.07	2.35	34.02	89.59	0.75
Reach13_Main2	3245.253	100-year	16.2	204.57	205.66	205.66	205.8	1.98	13.46	52.07	0.74
Reach13_Main2	3245.253	50-year	14.5	204.57	205.63	205.63	205.77	1.93	12.11	47.66	0.73
Reach13_Main2	3245.253	25-year	12.3	204.57	205.59	205.59	205.73	1.88	10.19	40.04	0.74
Reach13_Main2	3245.253	10-year	9.62	204.57	205.52	205.52	205.66	1.84	7.54	31.65	0.77
Reach13_Main2	3245.253	5-year	7.55	204.57	205.45	205.43	205.59	1.78	5.59	23.9	0.79
Reach13_Main2	3245.253	2-year	4.98	204.57	205.36	205.3	205.47	1.53	3.82	16	0.75

Culvert C2

Existing 2 cell Extended

+ 1 additional cell of 3.0 x 2.4 m

HEC-RAS Hydraulic Model - Proposed Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach13_Main2	3350.995	Regional	41.1	204.06	206.17		206.18	0.75	88.16	85.41	0.18
Reach13_Main2	3350.995	100-year	16.2	204.06	205.85		205.86	0.42	62.46	79.85	0.11
Reach13_Main2	3350.995	50-year	14.5	204.06	205.82		205.83	0.39	59.8	79.25	0.11
Reach13_Main2	3350.995	25-year	12.3	204.06	205.77		205.78	0.36	55.98	78.38	0.1
Reach13_Main2	3350.995	10-year	9.62	204.06	205.7		205.7	0.31	50.45	77.1	0.09
Reach13_Main2	3350.995	5-year	7.55	204.06	205.63		205.63	0.28	44.79	75.19	0.08
Reach13_Main2	3350.995	2-year	4.98	204.06	205.5		205.50	0.23	35.46	71.94	0.07
Reach13_Main2	3445.253	Regional	41.1	204.52	206.18		206.26	1.63	41.5	61.07	0.47
Reach13_Main2	3445.253	100-year	16.2	204.52	205.86		205.90	1.13	22.83	51.75	0.38
Reach13_Main2	3445.253	50-year	14.5	204.52	205.82		205.86	1.09	21.06	50.45	0.38
Reach13_Main2	3445.253	25-year	12.3	204.52	205.77		205.81	1.04	18.57	48.7	0.37
Reach13_Main2	3445.253	10-year	9.62	204.52	205.7		205.73	0.98	15.1	45.63	0.37
Reach13_Main2	3445.253	5-year	7.55	204.52	205.62		205.66	0.94	11.78	39.98	0.37
Reach13_Main2	3445.253	2-year	4.98	204.52	205.49		205.53	0.89	7.33	28.49	0.4
Reach13_Main2	3494.372	Regional	41.1	204.58	206.31		206.42	1.8	37.11	66.08	0.55
Reach13_Main2	3494.372	100-year	16.2	204.58	205.96		206.03	1.33	17.28	45.86	0.49
Reach13_Main2	3494.372	50-year	14.5	204.58	205.92		205.99	1.29	15.69	43.86	0.49
Reach13_Main2	3494.372	25-year	12.3	204.58	205.87		205.94	1.23	13.55	41.42	0.48
Reach13_Main2	3494.372	10-year	9.62	204.58	205.8		205.86	1.14	10.76	37.47	0.47
Reach13_Main2	3494.372	5-year	7.55	204.58	205.74		205.79	1.06	8.41	33.72	0.47
Reach13_Main2	3494.372	2-year	4.98	204.58	205.63		205.67	0.93	5.59	18.97	0.46
Reach13_Main2	3545.253	Regional	41.1	204.91	206.51		206.66	2.26	31.2	56.51	0.71
Reach13_Main2	3545.253	100-year	16.2	204.91	206.16	206.16	206.31	2.01	13.33	44.13	0.78
Reach13_Main2	3545.253	50-year	14.5	204.91	206.13	206.13	206.28	1.97	11.98	42.42	0.78
Reach13_Main2	3545.253	25-year	12.3	204.91	206.09	206.09	206.23	1.89	10.3	40.16	0.78
Reach13_Main2	3545.253	10-year	9.62	204.91	206.03	206.03	206.17	1.79	8.03	36.51	0.77
Reach13_Main2	3545.253	5-year	7.55	204.91	205.97	205.97	206.1	1.7	6.08	31.6	0.75
Reach13_Main2	3545.253	2-year	4.98	204.91	205.86	205.8	205.98	1.59	3.4	15.19	0.78
Reach13_Main2	3643.44	Regional	41.1	205.59	206.92		206.99	1.56	41.69	70.99	0.48
Reach13_Main2	3643.44	100-year	16.2	205.59	206.64		206.68	1.21	22.18	66.84	0.44
Reach13_Main2	3643.44	50-year	14.5	205.59	206.61		206.66	1.18	20.39	66.4	0.43
Reach13_Main2	3643.44	25-year	12.3	205.59	206.58		206.62	1.14	17.92	65.73	0.43
Reach13_Main2	3643.44	10-year	9.62	205.59	206.52		206.56	1.09	14.38	64.42	0.42
Reach13_Main2	3643.44	5-year	7.55	205.59	206.47		206.51	1.03	11.34	52.44	0.42
Reach13_Main2	3643.44	2-year	4.98	205.59	206.39		206.42	0.96	7.57	37.29	0.42
Reach13_Main2	3745.041	Regional	41.1	206.2	207.28		207.42	2.38	29.25	54.5	0.75
Reach13_Main2	3745.041	100-year	16.2	206.2	206.98		207.06	1.76	14.88	39.47	0.67
Reach13_Main2	3745.041	50-year	14.5	206.2	206.95		207.03	1.69	13.78	37.91	0.65
Reach13_Main2	3745.041	25-year	12.3	206.2	206.91		206.98	1.59	12.3	35.64	0.63
Reach13_Main2	3745.041	10-year	9.62	206.2	206.86		206.91	1.45	10.46	32.51	0.6
Reach13_Main2	3745.041	5-year	7.55	206.2	206.8		206.85	1.31	8.86	26.74	0.57
Reach13_Main2	3745.041	2-year	4.98	206.2	206.72		206.76	1.13	6.82	24.07	0.53
Reach13_Main2	3845.041	Regional	41.1	206.33	207.95	207.93	208.14	2.6	28.32	66.27	0.81
Reach13_Main2	3845.041	100-year	16.2	206.33	207.67	207.67	207.82	2.04	12.88	43.84	0.74
Reach13_Main2	3845.041	50-year	14.5	206.33	207.64	207.64	207.79	2.02	11.47	40.3	0.75
Reach13_Main2	3845.041	25-year	12.3	206.33	207.59	207.59	207.74	1.96	9.64	35.44	0.75
Reach13_Main2	3845.041	10-year	9.62	206.33	207.53	207.53	207.67	1.85	7.53	30.36	0.74
Reach13_Main2	3845.041	5-year	7.55	206.33	207.43	207.43	207.6	1.89	5.12	20.49	0.81
Reach13_Main2	3845.041	2-year	4.98	206.33	207.31	207.28	207.47	1.78	2.97	11.84	0.85

Culvert C2

Existing 2 cell Extended
 + 1 additional cell of 3.0 x 2.4 m

HEC-RAS Hydraulic Model - Proposed Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach13_Main2	3938.833	Regional	41.1	207.06	208.4		208.51	1.72	34.94	63.73	0.5
Reach13_Main2	3938.833	100-year	16.2	207.06	208.08		208.14	1.2	17.61	42.48	0.4
Reach13_Main2	3938.833	50-year	14.5	207.06	208.05		208.11	1.14	16.31	40.35	0.39
Reach13_Main2	3938.833	25-year	12.3	207.06	208		208.05	1.06	14.44	37.35	0.37
Reach13_Main2	3938.833	10-year	9.62	207.06	207.93		207.97	0.96	11.88	33.03	0.35
Reach13_Main2	3938.833	5-year	7.55	207.06	207.86		207.89	0.84	10.02	23.74	0.32
Reach13_Main2	3938.833	2-year	4.98	207.06	207.73		207.76	0.69	7.58	16.83	0.3
Reach13_Main2	4018.282	Regional	41.1	207.69	208.67		208.79	2.14	29.63	66.78	0.7
Reach13_Main2	4018.282	100-year	16.2	207.69	208.31	208.28	208.45	2.03	11.25	36.89	0.85
Reach13_Main2	4018.282	50-year	14.5	207.69	208.28	208.26	208.41	2.03	9.89	33.27	0.87
Reach13_Main2	4018.282	25-year	12.3	207.69	208.22	208.21	208.36	2.03	8.16	28.81	0.92
Reach13_Main2	4018.282	10-year	9.62	207.69	208.16	208.16	208.29	1.93	6.5	24.49	0.94
Reach13_Main2	4018.282	5-year	7.55	207.69	208.11	208.11	208.23	1.81	5.36	22.34	0.94
Reach13_Main2	4018.282	2-year	4.98	207.69	208.04	208.04	208.14	1.63	3.84	19.24	0.94
Reach13_Main2	4057.091	Regional	41.1	207.8	208.87		208.92	1.32	45.17	75.11	0.43
Reach13_Main2	4057.091	100-year	16.2	207.8	208.58		208.61	1.04	23.71	68.77	0.4
Reach13_Main2	4057.091	50-year	14.5	207.8	208.55		208.58	1.02	21.73	66.56	0.4
Reach13_Main2	4057.091	25-year	12.3	207.8	208.51		208.54	0.98	19.18	63.01	0.4
Reach13_Main2	4057.091	10-year	9.62	207.8	208.45	208.28	208.48	0.93	15.56	56.57	0.4
Reach13_Main2	4057.091	5-year	7.55	207.8	208.39	208.24	208.42	0.88	12.61	50.82	0.4
Reach13_Main2	4057.091	2-year	4.98	207.8	208.31	208.17	208.34	0.79	8.82	42.09	0.39
Reach13_Main2	4145.041	Regional	41.1	208.19	209.28	209.28	209.5	2.68	22.99	50.67	0.86
Reach13_Main2	4145.041	100-year	16.2	208.19	208.96	208.96	209.13	2.13	10.29	30.68	0.83
Reach13_Main2	4145.041	50-year	14.5	208.19	208.93	208.93	209.1	2.08	9.32	28.68	0.83
Reach13_Main2	4145.041	25-year	12.3	208.19	208.88	208.88	209.04	2.01	8.05	25.84	0.83
Reach13_Main2	4145.041	10-year	9.62	208.19	208.79	208.79	208.96	2	6.05	20.46	0.89
Reach13_Main2	4145.041	5-year	7.55	208.19	208.72	208.72	208.88	1.93	4.65	16.17	0.94
Reach13_Main2	4145.041	2-year	4.98	208.19	208.65	208.64	208.77	1.61	3.58	14.6	0.85
Reach13_Main2	4173.236	Regional	41.1	208.43	209.59	209.57	209.73	2.18	31.12	86.39	0.72
Reach13_Main2	4173.236	100-year	16.2	208.43	209.32	209.32	209.46	1.92	13.02	49.79	0.76
Reach13_Main2	4173.236	50-year	14.5	208.43	209.3	209.3	209.43	1.85	11.97	47.4	0.74
Reach13_Main2	4173.236	25-year	12.3	208.43	209.27	209.27	209.39	1.79	10.29	42.88	0.74
Reach13_Main2	4173.236	10-year	9.62	208.43	209.2	209.2	209.33	1.74	7.75	35.38	0.76
Reach13_Main2	4173.236	5-year	7.55	208.43	209.14	209.14	209.27	1.68	5.79	28.46	0.78
Reach13_Main2	4173.236	2-year	4.98	208.43	209.01	209	209.15	1.68	3.2	13.61	0.92

HEC-RAS Hydraulic Model - Existing Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach1	12.4592	Regional	57.26	233.23	234.77	234.45	234.87	1.9	54.25	68.29	0.58
Reach1	12.4592	100-year	24.8	233.23	234.39	234.19	234.45	1.43	29.92	59.36	0.54
Reach1	12.4592	50-year	22.1	233.23	234.35	234.16	234.41	1.38	27.53	58.17	0.53
Reach1	12.4592	25-year	18.6	233.23	234.29	234.12	234.35	1.3	24.3	56.52	0.52
Reach1	12.4592	10-year	14.4	233.23	234.22	234.07	234.27	1.2	20.16	54.34	0.51
Reach1	12.4592	5-year	11.2	233.23	234.15	234.03	234.2	1.1	16.76	52.48	0.5
Reach1	12.4592	2-year	7.3	233.23	234.06	233.96	234.1	0.96	12.12	49.83	0.49
Reach1	3900	Regional	11.01	254.51	254.82	254.62	254.83	0.59	30.12	107.46	0.37
Reach1	3900	100-year	4.77	254.51	254.71	254.57	254.72	0.4	19.13	93.3	0.31
Reach1	3900	50-year	4.26	254.51	254.69	254.56	254.7	0.39	17.52	92.97	0.32
Reach1	3900	25-year	3.58	254.51	254.68	254.56	254.68	0.36	15.88	92.63	0.31
Reach1	3900	10-year	2.77	254.51	254.65	254.55	254.65	0.33	13.62	92.16	0.3
Reach1	3900	5-year	2.15	254.51	254.63	254.52	254.63	0.29	11.75	91.77	0.29
Reach1	3900	2-year	1.4	254.51	254.6	254.49	254.6	0.24	9.09	91.21	0.28
Reach1	4105.245	Regional	11.01	254.58	255.08	254.89	255.09	0.64	27.15	88.36	0.34
Reach1	4105.245	100-year	4.77	254.58	254.93	254.8	254.94	0.49	15.44	75.36	0.31
Reach1	4105.245	50-year	4.26	254.58	254.92	254.79	254.93	0.47	14.39	74.34	0.3
Reach1	4105.245	25-year	3.58	254.58	254.9	254.77	254.91	0.44	12.85	72.83	0.29
Reach1	4105.245	10-year	2.77	254.58	254.87	254.75	254.88	0.4	10.8	70.77	0.28
Reach1	4105.245	5-year	2.15	254.58	254.85	254.73	254.85	0.37	9.09	69.01	0.27
Reach1	4105.245	2-year	1.4	254.58	254.81	254.71	254.81	0.32	6.59	57.07	0.25
Reach1	4140	Regional	8.44	255.14	256.13	256.13	256.63	3.11	2.71	178.41	1
Reach1	4140	100-year	3.66	255.14	255.71	255.71	255.99	2.36	1.55	62.28	1
Reach1	4140	50-year	3.26	255.14	255.67	255.67	255.93	2.27	1.44	58.28	1
Reach1	4140	25-year	2.74	255.14	255.61	255.61	255.85	2.13	1.28	52.7	1
Reach1	4140	10-year	2.12	255.14	255.54	255.54	255.74	1.96	1.08	45.33	1
Reach1	4140	5-year	1.65	255.14	255.48	255.48	255.65	1.81	0.91	39.42	1
Reach1	4140	2-year	1.08	255.14	255.4	255.4	255.52	1.58	0.68	31.62	1.01
Reach1	4158.164										
Reach1	4178	Regional	8.44	255.12	257.52	256.14	257.60	1.3	6.47	260.64	0.27
Reach1	4178	100-year	3.66	255.12	257.58	255.71	257.60	0.55	6.66	265.84	0.11
Reach1	4178	50-year	3.26	255.12	257.59	255.67	257.60	0.49	6.67	266.07	0.1
Reach1	4178	25-year	2.74	255.12	257.59	255.61	257.60	0.41	6.68	266.34	0.08
Reach1	4178	10-year	2.12	255.12	257.59	255.54	257.60	0.32	6.69	266.63	0.06
Reach1	4178	5-year	1.65	255.12	257.6	255.48	257.60	0.25	6.7	266.89	0.05
Reach1	4178	2-year	1.08	255.12	256.97	255.39	256.98	0.22	4.99	62.39	0.05
Reach1	4199.265	Regional	8.44	255.42	257.65	255.76	257.65	0.1	127.09	156.27	0.02
Reach1	4199.265	100-year	3.66	255.42	257.61	255.65	257.61	0.04	120.37	145.1	0.01
Reach1	4199.265	50-year	3.26	255.42	257.61	255.64	257.61	0.04	120.08	144.6	0.01
Reach1	4199.265	25-year	2.74	255.42	257.61	255.62	257.61	0.03	119.77	144.06	0.01
Reach1	4199.265	10-year	2.12	255.42	257.6	255.6	257.6	0.03	119.47	143.54	0.01
Reach1	4199.265	5-year	1.65	255.42	257.6	255.58	257.6	0.02	119.3	143.24	0
Reach1	4199.265	2-year	1.08	255.42	256.98	255.55	256.98	0.02	61.9	70.06	0.01
Reach1	4300	Regional	8.44	256.53	257.65	257.12	257.66	0.52	33.21	121.21	0.18
Reach1	4300	100-year	3.66	256.53	257.61	256.96	257.61	0.25	28.38	118.84	0.09
Reach1	4300	50-year	3.26	256.53	257.61	256.94	257.61	0.23	28.18	118.74	0.08

HEC-RAS Hydraulic Model - Existing Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach1	4300	25-year	2.74	256.53	257.6	256.91	257.61	0.19	27.96	118.63	0.07
Reach1	4300	10-year	2.12	256.53	257.6	256.87	257.6	0.15	27.76	118.53	0.05
Reach1	4300	5-year	1.65	256.53	257.6	256.84	257.6	0.12	27.64	118.47	0.04
Reach1	4300	2-year	1.08	256.53	256.97	256.79	256.98	0.4	2.71	12.3	0.27
Reach1	4400	Regional	8.44	256.68	257.68	257.25	257.7	0.71	15.72	32.54	0.26
Reach1	4400	100-year	3.66	256.68	257.62	257.09	257.62	0.34	13.66	30.29	0.13
Reach1	4400	50-year	3.26	256.68	257.61	257.07	257.62	0.31	13.56	30.17	0.12
Reach1	4400	25-year	2.74	256.68	257.61	257.05	257.61	0.26	13.44	30.04	0.1
Reach1	4400	10-year	2.12	256.68	257.61	257.01	257.61	0.2	13.33	29.91	0.08
Reach1	4400	5-year	1.65	256.68	257.6	256.98	257.6	0.16	13.27	29.83	0.06
Reach1	4400	2-year	1.08	256.68	257.09	256.93	257.1	0.43	2.53	12.49	0.3
Reach1	4500	Regional	8.44	257.72	258.22	258.22	258.32	1.55	8.07	45.07	0.87
Reach1	4500	100-year	3.66	257.72	258.07	258.07	258.17	1.39	2.86	17.49	0.98
Reach1	4500	50-year	3.26	257.72	258.06	258.06	258.15	1.34	2.59	16.61	0.98
Reach1	4500	25-year	2.74	257.72	258.03	258.03	258.12	1.28	2.25	15.38	0.97
Reach1	4500	10-year	2.12	257.72	258	258	258.08	1.22	1.78	13.4	1
Reach1	4500	5-year	1.65	257.72	257.98	257.98	258.04	1.14	1.45	11.81	1.01
Reach1	4500	2-year	1.08	257.72	257.94	257.94	257.99	1.04	1.04	9.63	1.01
Reach1	4600	Regional	8.44	258.51	259.12	259.09	259.25	1.6	5.74	18.41	0.84
Reach1	4600	100-year	3.66	258.51	258.99	258.92	259.05	1.08	3.52	14.77	0.66
Reach1	4600	50-year	3.26	258.51	258.97	258.9	259.03	1.03	3.25	14.18	0.65
Reach1	4600	25-year	2.74	258.51	258.95	258.87	258.99	0.97	2.88	13.35	0.63
Reach1	4600	10-year	2.12	258.51	258.91	258.84	258.95	0.87	2.46	12.31	0.6
Reach1	4600	5-year	1.65	258.51	258.88	258.81	258.91	0.78	2.11	11.38	0.57
Reach1	4600	2-year	1.08	258.51	258.83	258.76	258.86	0.69	1.58	9.84	0.55
Reach1	4705.956	Regional	8.44	259.43	260.06	260.02	260.19	1.68	6.08	19.28	0.86
Reach1	4705.956	100-year	3.66	259.43	259.84	259.84	259.96	1.52	2.68	12.82	0.96
Reach1	4705.956	50-year	3.26	259.43	259.82	259.82	259.93	1.47	2.43	12.21	0.96
Reach1	4705.956	25-year	2.74	259.43	259.8	259.79	259.9	1.41	2.1	11.36	0.96
Reach1	4705.956	10-year	2.12	259.43	259.76	259.75	259.85	1.34	1.67	10.13	0.98
Reach1	4705.956	5-year	1.65	259.43	259.72	259.72	259.8	1.26	1.35	9.13	0.98
Reach1	4705.956	2-year	1.08	259.43	259.68	259.68	259.74	1.13	0.96	7.74	0.99
Reach1	4800	Regional	8.44	259.92	260.64	260.5	260.72	1.25	7.28	19.92	0.58
Reach1	4800	100-year	3.66	259.92	260.47	260.34	260.51	0.86	4.32	15.25	0.5
Reach1	4800	50-year	3.26	259.92	260.45	260.32	260.48	0.82	3.99	14.68	0.49
Reach1	4800	25-year	2.74	259.92	260.42	260.29	260.45	0.78	3.54	13.86	0.48
Reach1	4800	10-year	2.12	259.92	260.38	260.25	260.4	0.71	3	12.81	0.47
Reach1	4800	5-year	1.65	259.92	260.34	260.22	260.36	0.66	2.52	11.79	0.45
Reach1	4800	2-year	1.08	259.92	260.28	260.18	260.29	0.58	1.87	10.25	0.43
Reach1	4900	Regional	5.81	260.42	261.05	260.91	261.1	1.07	6.03	19.47	0.56
Reach1	4900	100-year	2.52	260.42	260.85	260.77	260.89	0.91	2.83	13.34	0.59
Reach1	4900	50-year	2.25	260.42	260.83	260.76	260.87	0.89	2.57	12.7	0.6
Reach1	4900	25-year	1.89	260.42	260.8	260.73	260.84	0.85	2.23	11.74	0.6
Reach1	4900	10-year	1.46	260.42	260.77	260.7	260.8	0.8	1.83	10.51	0.61
Reach1	4900	5-year	1.14	260.42	260.73	260.68	260.76	0.77	1.47	9.47	0.63
Reach1	4900	2-year	0.74	260.42	260.68	260.64	260.7	0.73	1.01	7.85	0.65
Reach1	5000	Regional	5.81	260.95	261.55	261.5	261.66	1.42	4.12	13.52	0.8
Reach1	5000	100-year	2.52	260.95	261.41	261.35	261.47	1.03	2.46	10.43	0.68

HEC-RAS Hydraulic Model - Existing Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach1	5000	50-year	2.25	260.95	261.4	261.33	261.45	0.98	2.28	10.07	0.66
Reach1	5000	25-year	1.89	260.95	261.37	261.3	261.42	0.93	2.04	9.51	0.64
Reach1	5000	10-year	1.46	260.95	261.34	261.27	261.38	0.85	1.72	8.74	0.61
Reach1	5000	5-year	1.14	260.95	261.31	261.24	261.34	0.77	1.48	8.1	0.58
Reach1	5000	2-year	0.74	260.95	261.26	261.19	261.28	0.66	1.12	7.07	0.53
Reach1	5100	Regional	5.81	261.61	262.26	262.16	262.34	1.22	4.79	14.65	0.67
Reach1	5100	100-year	2.52	261.61	262.08	262.01	262.13	1.02	2.47	10.68	0.68
Reach1	5100	50-year	2.25	261.61	262.06	261.99	262.11	1	2.24	10.18	0.68
Reach1	5100	25-year	1.89	261.61	262.02	261.97	262.07	0.98	1.94	9.47	0.69
Reach1	5100	10-year	1.46	261.61	261.98	261.93	262.03	0.93	1.56	8.5	0.69
Reach1	5100	5-year	1.14	261.61	261.94	261.9	261.99	0.91	1.26	7.63	0.71
Reach1	5100	2-year	0.74	261.61	261.89	261.86	261.93	0.86	0.87	6.32	0.74
Reach1	5200	Regional	5.81	262.14	262.51	262.29	262.51	0.47	22.5	78.99	0.25
Reach1	5200	100-year	2.52	262.14	262.36	262.23	262.36	0.39	11.5	67.8	0.27
Reach1	5200	50-year	2.25	262.14	262.34	262.22	262.35	0.37	10.56	66.76	0.27
Reach1	5200	25-year	1.89	262.14	262.32	262.21	262.32	0.36	9.17	65.18	0.28
Reach1	5200	10-year	1.46	262.14	262.29	262.2	262.3	0.34	7.5	62.74	0.28
Reach1	5200	5-year	1.14	262.14	262.27	262.2	262.28	0.31	6.2	59.93	0.28
Reach1	5200	2-year	0.74	262.14	262.24	262.18	262.25	0.27	4.49	54.81	0.28
Reach1	5300	Regional	5.81	262.52	262.68	262.58	262.69	0.69	13.43	77.15	0.55
Reach1	5300	100-year	2.52	262.52	262.6	262.54	262.6	0.47	7.29	69.62	0.56
Reach1	5300	50-year	2.25	262.52	262.59	262.54	262.6	0.44	6.76	68.95	0.56
Reach1	5300	25-year	1.89	262.52	262.58	262.52	262.59	0.39	6.16	68.19	0.53
Reach1	5300	10-year	1.46	262.52	262.57	262.5	262.57	0.33	5.31	67.15	0.5
Reach1	5300	5-year	1.14	262.52	262.56	262.49	262.56	0.27	4.63	66.31	0.47
Reach1	5300	2-year	0.74	262.52	262.54	262.47	262.55	0.17	3.58	65	0.41
Reach1	5400	Regional	5.81	261.93	262.72	262.12	262.72	0.22	59.3	159.75	0.08
Reach1	5400	100-year	2.52	261.93	262.61	262.06	262.61	0.12	43.57	150.78	0.05
Reach1	5400	50-year	2.25	261.93	262.6	262.05	262.6	0.11	42.16	149.94	0.05
Reach1	5400	25-year	1.89	261.93	262.59	262.04	262.59	0.1	40.46	148.94	0.04
Reach1	5400	10-year	1.46	261.93	262.58	262.03	262.58	0.08	38.14	147.55	0.03
Reach1	5400	5-year	1.14	261.93	262.57	262.02	262.57	0.06	36.31	146.45	0.03
Reach1	5400	2-year	0.74	261.93	262.55	262	262.55	0.04	33.64	144.6	0.02
Reach1	5506.394	Regional	5.81	261.99	262.72	262.2	262.72	0.21	51.05	104.44	0.08
Reach1	5506.394	100-year	2.52	261.99	262.62	262.13	262.62	0.11	40.42	97.79	0.05
Reach1	5506.394	50-year	2.25	261.99	262.61	262.12	262.61	0.1	39.47	97.12	0.04
Reach1	5506.394	25-year	1.89	261.99	262.59	262.11	262.6	0.09	38.33	96.31	0.04
Reach1	5506.394	10-year	1.46	261.99	262.58	262.1	262.58	0.07	36.78	95.2	0.03
Reach1	5506.394	5-year	1.14	261.99	262.57	262.09	262.57	0.06	35.57	94.32	0.02
Reach1	5506.394	2-year	0.74	261.99	262.55	262.07	262.55	0.04	33.81	93.03	0.02
Reach1	5600	Regional	5.81	262.94	263.2	263.2	263.3	1.49	4.92	27.26	0.96
Reach1	5600	100-year	2.52	262.94	263.1	263.1	263.16	1.16	2.47	20.87	0.97
Reach1	5600	50-year	2.25	262.94	263.09	263.09	263.15	1.13	2.24	20.18	0.98
Reach1	5600	25-year	1.89	262.94	263.07	263.07	263.13	1.07	1.95	19.25	0.98
Reach1	5600	10-year	1.46	262.94	263.06	263.06	263.1	0.99	1.61	18.08	0.98
Reach1	5600	5-year	1.14	262.94	263.04	263.04	263.08	0.93	1.32	17.03	1.01
Reach1	5600	2-year	0.74	262.94	263.02	263.02	263.05	0.8	0.98	15.74	0.98

HEC-RAS Hydraulic Model - Proposed Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach1	12.4592	Regional	57.26	233.23	234.77	234.45	234.87	1.9	54.25	68.29	0.58
Reach1	12.4592	100-year	24.8	233.23	234.39	234.19	234.45	1.43	29.92	59.36	0.54
Reach1	12.4592	50-year	22.1	233.23	234.35	234.16	234.41	1.38	27.53	58.17	0.53
Reach1	12.4592	25-year	18.6	233.23	234.29	234.12	234.35	1.3	24.3	56.52	0.52
Reach1	12.4592	10-year	14.4	233.23	234.22	234.07	234.27	1.2	20.16	54.34	0.51
Reach1	12.4592	5-year	11.2	233.23	234.15	234.03	234.2	1.1	16.76	52.48	0.5
Reach1	12.4592	2-year	7.3	233.23	234.06	233.96	234.1	0.96	12.12	49.83	0.49
Reach1	3900	Regional	11.01	254.51	254.82	254.62	254.83	0.59	30.12	107.46	0.37
Reach1	3900	100-year	4.77	254.51	254.71	254.57	254.72	0.4	19.13	93.3	0.31
Reach1	3900	50-year	4.26	254.51	254.69	254.56	254.7	0.39	17.52	92.97	0.32
Reach1	3900	25-year	3.58	254.51	254.68	254.56	254.68	0.36	15.88	92.63	0.31
Reach1	3900	10-year	2.77	254.51	254.65	254.55	254.65	0.33	13.62	92.16	0.3
Reach1	3900	5-year	2.15	254.51	254.63	254.52	254.63	0.29	11.75	91.77	0.29
Reach1	3900	2-year	1.4	254.51	254.6	254.49	254.6	0.24	9.09	91.21	0.28
Reach1	4105.245	Regional	11.01	254.58	255.08	254.89	255.09	0.64	27.15	88.36	0.34
Reach1	4105.245	100-year	4.77	254.58	254.93	254.8	254.94	0.49	15.44	75.36	0.31
Reach1	4105.245	50-year	4.26	254.58	254.92	254.79	254.93	0.47	14.39	74.34	0.3
Reach1	4105.245	25-year	3.58	254.58	254.9	254.77	254.91	0.44	12.85	72.83	0.29
Reach1	4105.245	10-year	2.77	254.58	254.87	254.75	254.88	0.4	10.8	70.77	0.28
Reach1	4105.245	5-year	2.15	254.58	254.85	254.73	254.85	0.37	9.09	69.01	0.27
Reach1	4105.245	2-year	1.4	254.58	254.81	254.71	254.81	0.32	6.59	57.07	0.25
Reach1	4140	Regional	8.44	255.14	255.82	255.82	256.15	2.54	3.32	73.61	1
Reach1	4140	100-year	3.66	255.14	255.54	255.54	255.73	1.93	1.9	45.38	1
Reach1	4140	50-year	3.26	255.14	255.51	255.51	255.69	1.86	1.75	42.57	1
Reach1	4140	25-year	2.74	255.14	255.47	255.47	255.63	1.75	1.57	39.07	1
Reach1	4140	10-year	2.12	255.14	255.42	255.42	255.56	1.61	1.32	34.36	1
Reach1	4140	5-year	1.65	255.14	255.38	255.38	255.5	1.47	1.12	30.55	0.99
Reach1	4140	2-year	1.08	255.14	255.33	255.33	255.41	1.28	0.84	25.24	1
Reach1	4158.164		Culvert C11								
Reach1	4178	Regional	8.44	255.12	256.89	255.83	256.94	0.98	8.59	58.65	0.24
Reach1	4178	100-year	3.66	255.12	256.23	255.55	256.25	0.69	5.27	44.42	0.22
Reach1	4178	50-year	3.26	255.12	256.16	255.52	256.18	0.66	4.93	43.06	0.21
Reach1	4178	25-year	2.74	255.12	256.07	255.49	256.09	0.61	4.48	38.47	0.21
Reach1	4178	10-year	2.12	255.12	255.95	255.44	255.97	0.54	3.91	34.71	0.2
Reach1	4178	5-year	1.65	255.12	255.86	255.4	255.87	0.48	3.43	31.5	0.19
Reach1	4178	2-year	1.08	255.12	255.73	255.34	255.74	0.39	2.78	27.11	0.17
Reach1	4199.265	Regional	8.44	255.42	256.97	255.76	256.97	0.16	61.21	69.43	0.05
Reach1	4199.265	100-year	3.66	255.42	256.26	255.65	256.27	0.18	22.35	41.51	0.07
Reach1	4199.265	50-year	3.26	255.42	256.19	255.63	256.19	0.18	19.45	39.33	0.08
Reach1	4199.265	25-year	2.74	255.42	256.1	255.62	256.1	0.18	15.87	36.47	0.08
Reach1	4199.265	10-year	2.12	255.42	255.98	255.6	255.98	0.19	11.7	32.53	0.09
Reach1	4199.265	5-year	1.65	255.42	255.88	255.58	255.88	0.19	8.65	28.85	0.11
Reach1	4199.265	2-year	1.08	255.42	255.74	255.55	255.75	0.21	5.09	23.76	0.15
Reach1	4300	Regional	8.44	256.53	257.12	257.12	257.28	1.8	4.78	16.37	1
Reach1	4300	100-year	3.66	256.53	256.96	256.96	257.06	1.46	2.51	11.83	1.01
Reach1	4300	50-year	3.26	256.53	256.94	256.94	257.04	1.43	2.28	11.29	1.01

HEC-RAS Hydraulic Model - Proposed Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach1	4300	25-year	2.74	256.53	256.91	256.91	257.01	1.38	1.99	10.53	1.01
Reach1	4300	10-year	2.12	256.53	256.87	256.87	256.96	1.31	1.62	9.5	1.01
Reach1	4300	5-year	1.65	256.53	256.84	256.84	256.92	1.25	1.32	8.59	1.02
Reach1	4300	2-year	1.08	256.53	256.79	256.79	256.86	1.15	0.94	7.25	1.02
Reach1	4400	Regional	8.44	256.68	257.55	257.25	257.59	0.88	11.84	28.14	0.35
Reach1	4400	100-year	3.66	256.68	257.33	257.09	257.35	0.62	6.5	20.18	0.31
Reach1	4400	50-year	3.26	256.68	257.31	257.07	257.33	0.59	6.01	19.4	0.3
Reach1	4400	25-year	2.74	256.68	257.27	257.05	257.29	0.55	5.35	18.29	0.29
Reach1	4400	10-year	2.12	256.68	257.22	257.01	257.24	0.5	4.47	16.69	0.28
Reach1	4400	5-year	1.65	256.68	257.18	256.98	257.19	0.45	3.75	15.26	0.27
Reach1	4400	2-year	1.08	256.68	257.11	256.93	257.12	0.39	2.81	13.19	0.26
Reach1	4500	Regional	8.44	257.72	258.22	258.22	258.32	1.55	8.07	45.07	0.87
Reach1	4500	100-year	3.66	257.72	258.07	258.07	258.17	1.39	2.86	17.49	0.98
Reach1	4500	50-year	3.26	257.72	258.06	258.06	258.15	1.34	2.59	16.61	0.98
Reach1	4500	25-year	2.74	257.72	258.03	258.03	258.12	1.28	2.25	15.38	0.97
Reach1	4500	10-year	2.12	257.72	258	258	258.08	1.22	1.78	13.4	1
Reach1	4500	5-year	1.65	257.72	257.98	257.98	258.04	1.14	1.45	11.81	1.01
Reach1	4500	2-year	1.08	257.72	257.94	257.94	257.99	1.04	1.04	9.63	1.01
Reach1	4600	Regional	8.44	258.51	259.12	259.09	259.25	1.6	5.74	18.41	0.84
Reach1	4600	100-year	3.66	258.51	258.99	258.92	259.05	1.08	3.52	14.77	0.66
Reach1	4600	50-year	3.26	258.51	258.97	258.9	259.03	1.03	3.25	14.18	0.65
Reach1	4600	25-year	2.74	258.51	258.95	258.87	258.99	0.97	2.88	13.35	0.63
Reach1	4600	10-year	2.12	258.51	258.91	258.84	258.95	0.87	2.46	12.31	0.6
Reach1	4600	5-year	1.65	258.51	258.88	258.81	258.91	0.78	2.11	11.38	0.57
Reach1	4600	2-year	1.08	258.51	258.83	258.76	258.86	0.69	1.58	9.84	0.55
Reach1	4705.956	Regional	8.44	259.43	260.06	260.02	260.19	1.68	6.08	19.28	0.86
Reach1	4705.956	100-year	3.66	259.43	259.84	259.84	259.96	1.52	2.68	12.82	0.96
Reach1	4705.956	50-year	3.26	259.43	259.82	259.82	259.93	1.47	2.43	12.21	0.96
Reach1	4705.956	25-year	2.74	259.43	259.8	259.79	259.9	1.41	2.1	11.36	0.96
Reach1	4705.956	10-year	2.12	259.43	259.76	259.75	259.85	1.34	1.67	10.13	0.98
Reach1	4705.956	5-year	1.65	259.43	259.72	259.72	259.8	1.26	1.35	9.13	0.98
Reach1	4705.956	2-year	1.08	259.43	259.68	259.68	259.74	1.13	0.96	7.74	0.99
Reach1	4800	Regional	8.44	259.92	260.64	260.5	260.72	1.25	7.28	19.92	0.58
Reach1	4800	100-year	3.66	259.92	260.47	260.34	260.51	0.86	4.32	15.25	0.5
Reach1	4800	50-year	3.26	259.92	260.45	260.32	260.48	0.82	3.99	14.68	0.49
Reach1	4800	25-year	2.74	259.92	260.42	260.29	260.45	0.78	3.54	13.86	0.48
Reach1	4800	10-year	2.12	259.92	260.38	260.25	260.4	0.71	3	12.81	0.47
Reach1	4800	5-year	1.65	259.92	260.34	260.22	260.36	0.66	2.52	11.79	0.45
Reach1	4800	2-year	1.08	259.92	260.28	260.18	260.29	0.58	1.87	10.25	0.43
Reach1	4900	Regional	5.81	260.42	261.05	260.91	261.1	1.07	6.03	19.47	0.56
Reach1	4900	100-year	2.52	260.42	260.85	260.77	260.89	0.91	2.83	13.34	0.59
Reach1	4900	50-year	2.25	260.42	260.83	260.76	260.87	0.89	2.57	12.7	0.6
Reach1	4900	25-year	1.89	260.42	260.8	260.73	260.84	0.85	2.23	11.74	0.6
Reach1	4900	10-year	1.46	260.42	260.77	260.7	260.8	0.8	1.83	10.51	0.61
Reach1	4900	5-year	1.14	260.42	260.73	260.68	260.76	0.77	1.47	9.47	0.63
Reach1	4900	2-year	0.74	260.42	260.68	260.64	260.7	0.73	1.01	7.85	0.65
Reach1	5000	Regional	5.81	260.95	261.55	261.5	261.66	1.42	4.12	13.52	0.8
Reach1	5000	100-year	2.52	260.95	261.41	261.35	261.47	1.03	2.46	10.43	0.68

HEC-RAS Hydraulic Model - Proposed Conditions

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #
Reach1	5000	50-year	2.25	260.95	261.4	261.33	261.45	0.98	2.28	10.07	0.66
Reach1	5000	25-year	1.89	260.95	261.37	261.3	261.42	0.93	2.04	9.51	0.64
Reach1	5000	10-year	1.46	260.95	261.34	261.27	261.38	0.85	1.72	8.74	0.61
Reach1	5000	5-year	1.14	260.95	261.31	261.24	261.34	0.77	1.48	8.1	0.58
Reach1	5000	2-year	0.74	260.95	261.26	261.19	261.28	0.66	1.12	7.07	0.53
Reach1	5100	Regional	5.81	261.61	262.26	262.16	262.34	1.22	4.79	14.65	0.67
Reach1	5100	100-year	2.52	261.61	262.08	262.01	262.13	1.02	2.47	10.68	0.68
Reach1	5100	50-year	2.25	261.61	262.06	261.99	262.11	1	2.24	10.18	0.68
Reach1	5100	25-year	1.89	261.61	262.02	261.97	262.07	0.98	1.94	9.47	0.69
Reach1	5100	10-year	1.46	261.61	261.98	261.93	262.03	0.93	1.56	8.5	0.69
Reach1	5100	5-year	1.14	261.61	261.94	261.9	261.99	0.91	1.26	7.63	0.71
Reach1	5100	2-year	0.74	261.61	261.89	261.86	261.93	0.86	0.87	6.32	0.74
Reach1	5200	Regional	5.81	262.14	262.51	262.29	262.51	0.47	22.5	78.99	0.25
Reach1	5200	100-year	2.52	262.14	262.36	262.23	262.36	0.39	11.5	67.8	0.27
Reach1	5200	50-year	2.25	262.14	262.34	262.22	262.35	0.37	10.56	66.76	0.27
Reach1	5200	25-year	1.89	262.14	262.32	262.21	262.32	0.36	9.17	65.18	0.28
Reach1	5200	10-year	1.46	262.14	262.29	262.2	262.3	0.34	7.5	62.74	0.28
Reach1	5200	5-year	1.14	262.14	262.27	262.2	262.28	0.31	6.2	59.93	0.28
Reach1	5200	2-year	0.74	262.14	262.24	262.18	262.25	0.27	4.49	54.81	0.28
Reach1	5300	Regional	5.81	262.52	262.68	262.58	262.69	0.69	13.43	77.15	0.55
Reach1	5300	100-year	2.52	262.52	262.6	262.54	262.6	0.47	7.29	69.62	0.56
Reach1	5300	50-year	2.25	262.52	262.59	262.54	262.6	0.44	6.76	68.95	0.56
Reach1	5300	25-year	1.89	262.52	262.58	262.52	262.59	0.39	6.16	68.19	0.53
Reach1	5300	10-year	1.46	262.52	262.57	262.5	262.57	0.33	5.31	67.15	0.5
Reach1	5300	5-year	1.14	262.52	262.56	262.49	262.56	0.27	4.63	66.31	0.47
Reach1	5300	2-year	0.74	262.52	262.54	262.47	262.55	0.17	3.58	65	0.41
Reach1	5400	Regional	5.81	261.93	262.72	262.12	262.72	0.22	59.3	159.75	0.08
Reach1	5400	100-year	2.52	261.93	262.61	262.06	262.61	0.12	43.57	150.78	0.05
Reach1	5400	50-year	2.25	261.93	262.6	262.05	262.6	0.11	42.16	149.94	0.05
Reach1	5400	25-year	1.89	261.93	262.59	262.04	262.59	0.1	40.46	148.94	0.04
Reach1	5400	10-year	1.46	261.93	262.58	262.03	262.58	0.08	38.14	147.55	0.03
Reach1	5400	5-year	1.14	261.93	262.57	262.02	262.57	0.06	36.31	146.45	0.03
Reach1	5400	2-year	0.74	261.93	262.55	262	262.55	0.04	33.64	144.6	0.02
Reach1	5506.394	Regional	5.81	261.99	262.72	262.2	262.72	0.21	51.05	104.44	0.08
Reach1	5506.394	100-year	2.52	261.99	262.62	262.13	262.62	0.11	40.42	97.79	0.05
Reach1	5506.394	50-year	2.25	261.99	262.61	262.12	262.61	0.1	39.47	97.12	0.04
Reach1	5506.394	25-year	1.89	261.99	262.59	262.11	262.6	0.09	38.33	96.31	0.04
Reach1	5506.394	10-year	1.46	261.99	262.58	262.1	262.58	0.07	36.78	95.2	0.03
Reach1	5506.394	5-year	1.14	261.99	262.57	262.09	262.57	0.06	35.57	94.32	0.02
Reach1	5506.394	2-year	0.74	261.99	262.55	262.07	262.55	0.04	33.81	93.03	0.02
Reach1	5600	Regional	5.81	262.94	263.2	263.2	263.3	1.49	4.92	27.26	0.96
Reach1	5600	100-year	2.52	262.94	263.1	263.1	263.16	1.16	2.47	20.87	0.97
Reach1	5600	50-year	2.25	262.94	263.09	263.09	263.15	1.13	2.24	20.18	0.98
Reach1	5600	25-year	1.89	262.94	263.07	263.07	263.13	1.07	1.95	19.25	0.98
Reach1	5600	10-year	1.46	262.94	263.06	263.06	263.1	0.99	1.61	18.08	0.98
Reach1	5600	5-year	1.14	262.94	263.04	263.04	263.08	0.93	1.32	17.03	1.01
Reach1	5600	2-year	0.74	262.94	263.02	263.02	263.05	0.8	0.98	15.74	0.98

Existing Conditions

Reach	River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude #
TR2B001	1718.7	Regional	117.9	234.80	236.13	235.86	236.23	2.56	107.74	144.33	0.74
TR2B001	1718.7	100 Year	37.1	234.80	235.69	235.57	235.74	1.80	49.96	118.71	0.65
TR2B001	1718.7	50 Year	31.4	234.80	235.62	235.54	235.68	1.85	41.76	115.67	0.70
TR2B001	1718.7	25 Year	25.2	234.80	235.60	235.50	235.64	1.59	39.35	114.77	0.61
TR2B001	1718.7	10 Year	16.7	234.80	235.51	235.43	235.55	1.46	29.14	110.78	0.60
TR2B001	1718.7	5 Year	12.1	234.80	235.43	235.39	235.48	1.43	21.27	99.53	0.63
TR2B001	1718.7	2 Year	6.1	234.80	235.33	235.30	235.37	1.21	11.93	80.76	0.59
TR2B001	1817.4	Regional	117.9	235.30	237.04	237.04	237.33	4.24	75.73	107.84	1.06
TR2B001	1817.4	100 Year	37.1	235.30	236.55	236.55	236.76	3.04	31.38	71.54	0.91
TR2B001	1817.4	50 Year	31.4	235.30	236.50	236.50	236.69	2.86	27.70	67.89	0.87
TR2B001	1817.4	25 Year	25.2	235.30	236.43	236.43	236.61	2.66	23.21	64.32	0.84
TR2B001	1817.4	10 Year	16.7	235.30	236.28	236.28	236.46	2.45	14.78	49.01	0.83
TR2B001	1817.4	5 Year	12.1	235.30	236.14	236.14	236.34	2.43	8.90	32.73	0.90
TR2B001	1817.4	2 Year	6.1	235.30	235.96	235.87	236.08	1.74	5.18	12.87	0.74
TR2B001	2017.9	Regional	117.9	236.80	238.80	238.72	239.02	3.63	83.51	118.04	0.84
TR2B001	2017.9	100 Year	37.1	236.80	238.17	238.14	238.37	2.87	29.15	56.49	0.81
TR2B001	2017.9	50 Year	31.4	236.80	238.09	237.96	238.29	2.80	24.91	52.75	0.82
TR2B001	2017.9	25 Year	25.2	236.80	237.98	237.93	238.18	2.64	19.70	41.10	0.81
TR2B001	2017.9	10 Year	16.7	236.80	237.83	237.75	237.99	2.29	14.10	32.89	0.76
TR2B001	2017.9	5 Year	12.1	236.80	237.75	237.57	237.87	1.95	11.42	28.10	0.68
TR2B001	2017.9	2 Year	6.1	236.80	237.47	237.36	237.56	1.65	5.61	14.31	0.70
TR2B001	2197.6	Regional	117.9	237.80	239.96	239.96	240.19	3.61	102.69	160.51	0.80
TR2B001	2197.6	100 Year	37.1	237.80	239.35	239.27	239.67	3.11	23.69	54.51	0.82
TR2B001	2197.6	50 Year	31.4	237.80	239.27	239.17	239.55	2.87	21.14	49.20	0.78
TR2B001	2197.6	25 Year	25.2	237.80	239.16	239.02	239.40	2.63	17.71	41.59	0.75
TR2B001	2197.6	10 Year	16.7	237.80	238.95	238.79	239.14	2.27	12.47	21.77	0.71
TR2B001	2197.6	5 Year	12.1	237.80	238.78	238.61	238.95	2.08	9.17	17.82	0.71
TR2B001	2197.6	2 Year	6.1	237.80	238.54	238.37	238.64	1.52	5.57	12.15	0.61
TR2B001	2230.6	Regional	117.9	237.66	240.67	240.67	240.98	3.15	99.37	146.32	0.62
TR2B001	2230.6	100 Year	37.1	237.66	239.49	239.11	239.86	2.74	14.34	14.23	0.67
TR2B001	2230.6	50 Year	31.4	237.66	239.41	238.97	239.71	2.43	13.64	13.92	0.61
TR2B001	2230.6	25 Year	25.2	237.66	239.32	238.81	239.54	2.07	12.84	13.57	0.53
TR2B001	2230.6	10 Year	16.7	237.66	239.14	238.56	239.26	1.57	11.21	12.85	0.43
TR2B001	2230.6	5 Year	12.1	237.66	238.98	238.41	239.07	1.29	9.85	12.25	0.37
TR2B001	2230.6	2 Year	6.1	237.66	238.68	238.18	238.72	0.87	7.20	11.12	0.29
TR2B001	2231	Bridge at Trafalgar Road									
TR2B001	2250.1	Regional	117.9	237.79	241.32	240.83	241.39	1.93	188.61	173.73	0.33
TR2B001	2250.1	100 Year	37.1	237.79	239.79	239.29	240.13	2.79	15.98	16.29	0.64
TR2B001	2250.1	50 Year	31.4	237.79	239.62	239.16	239.92	2.60	14.48	15.46	0.63
TR2B001	2250.1	25 Year	25.2	237.79	239.51	238.99	239.73	2.24	13.48	14.91	0.56
TR2B001	2250.1	10 Year	16.7	237.79	239.20	238.75	239.35	1.86	10.75	13.79	0.52
TR2B001	2250.1	5 Year	12.1	237.79	239.04	238.60	239.15	1.55	9.35	13.23	0.46
TR2B001	2250.1	2 Year	6.1	237.79	238.74	238.35	238.79	1.08	6.69	12.16	0.37
TR2B001	2293.3	Regional	117.9	238.80	241.45	241.45	241.86	3.94	76.39	110.52	0.79
TR2B001	2293.3	100 Year	37.1	238.80	240.30	240.30	240.74	3.34	18.48	24.75	0.90
TR2B001	2293.3	50 Year	31.4	238.80	240.18	240.18	240.60	3.23	15.51	22.18	0.91
TR2B001	2293.3	25 Year	25.2	238.80	240.04	240.04	240.42	3.03	12.62	19.46	0.91
TR2B001	2293.3	10 Year	16.7	238.80	239.79	239.79	240.13	2.77	8.27	14.92	0.94
TR2B001	2293.3	5 Year	12.1	238.80	239.61	239.61	239.92	2.61	5.89	11.68	0.99
TR2B001	2293.3	2 Year	6.1	238.80	239.36	239.36	239.56	2.09	3.41	8.94	0.99

Existing Conditions

Reach	River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude #
TR2B001	2317.1	Regional	117.9	239.40	242.27	242.27	242.61	3.76	97.92	125.47	0.71
TR2B001	2317.1	100 Year	37.1	239.40	240.91	240.91	241.60	4.04	11.47	12.95	1.05
TR2B001	2317.1	50 Year	31.4	239.40	240.77	240.77	241.38	3.80	10.30	12.19	1.04
TR2B001	2317.1	25 Year	25.2	239.40	240.59	240.59	241.13	3.53	8.88	11.26	1.03
TR2B001	2317.1	10 Year	16.7	239.40	240.32	240.32	240.74	3.11	6.63	10.11	1.04
TR2B001	2317.1	5 Year	12.1	239.40	240.15	240.15	240.49	2.80	5.28	9.51	1.03
TR2B001	2317.1	2 Year	6.1	239.40	239.88	239.88	240.11	2.25	3.23	8.49	1.04
TR2B001	2317.5	Bridge at Stewartown Road									
TR2B001	2337.3	Regional	117.9	239.40	242.39	242.14	242.62	3.30	106.27	107.91	0.61
TR2B001	2337.3	100 Year	37.1	239.40	241.61	240.91	241.80	2.37	38.52	68.33	0.51
TR2B001	2337.3	50 Year	31.4	239.40	241.41	240.77	241.68	2.58	15.57	24.31	0.58
TR2B001	2337.3	25 Year	25.2	239.40	241.24	240.59	241.45	2.27	14.21	22.29	0.53
TR2B001	2337.3	10 Year	16.7	239.40	240.69	240.31	240.89	2.20	9.67	17.72	0.62
TR2B001	2337.3	5 Year	12.1	239.40	240.48	240.14	240.63	1.93	7.95	16.62	0.59
TR2B001	2337.3	2 Year	6.1	239.40	240.14	239.88	240.23	1.44	5.29	14.92	0.53
TR2B001	2368.9	Regional	117.9	239.18	242.58	241.41	242.71	2.69	136.61	128.50	0.48
TR2B001	2368.9	100 Year	37.1	239.18	241.81	240.64	241.86	1.38	65.43	58.37	0.28
TR2B001	2368.9	50 Year	31.4	239.18	241.71	240.55	241.74	1.21	59.88	50.56	0.25
TR2B001	2368.9	25 Year	25.2	239.18	241.48	240.42	241.50	1.04	49.67	36.92	0.23
TR2B001	2368.9	10 Year	16.7	239.18	240.93	240.24	240.96	1.10	30.53	32.29	0.28
TR2B001	2368.9	5 Year	12.1	239.18	240.67	240.12	240.70	1.07	22.57	30.20	0.30
TR2B001	2368.9	2 Year	6.1	239.18	240.27	239.88	240.30	0.96	11.75	23.28	0.32
TR2B001	2448.1	Regional	111.9	239.19	242.73	241.15	242.80	1.92	129.24	67.00	0.33
TR2B001	2448.1	100 Year	34.5	239.19	241.87	240.44	241.89	0.92	79.71	50.75	0.18
TR2B001	2448.1	50 Year	29.2	239.19	241.76	240.37	241.77	0.83	73.94	49.02	0.17
TR2B001	2448.1	25 Year	23.4	239.19	241.52	240.29	241.53	0.77	62.64	45.31	0.17
TR2B001	2448.1	10 Year	15.4	239.19	240.98	240.14	241.00	0.78	40.25	39.59	0.19
TR2B001	2448.1	5 Year	10.9	239.19	240.74	240.05	240.75	0.71	30.83	36.49	0.19
TR2B001	2448.1	2 Year	5.2	239.19	240.35	239.82	240.36	0.58	17.57	30.99	0.19
TR2B001	2502.3	Regional	111.9	239.50	242.78	241.12	242.84	1.39	138.21	59.07	0.25
TR2B001	2502.3	100 Year	34.5	239.50	241.89	240.41	241.90	0.66	88.13	53.33	0.14
TR2B001	2502.3	50 Year	29.2	239.50	241.77	240.32	241.78	0.60	81.90	52.53	0.13
TR2B001	2502.3	25 Year	23.4	239.50	241.53	240.20	241.54	0.56	69.47	50.86	0.12
TR2B001	2502.3	10 Year	15.4	239.50	241.00	239.99	241.01	0.56	43.59	47.05	0.15
TR2B001	2502.3	5 Year	10.9	239.50	240.75	239.91	240.77	0.52	32.31	44.24	0.15
TR2B001	2502.3	2 Year	5.2	239.50	240.37	239.75	240.37	0.42	16.26	34.56	0.14
TR2B001	2524.1	Regional	111.9	243.20	244.57	244.57	244.83	3.31	74.48	122.31	0.90
TR2B001	2524.1	100 Year	34.5	243.20	244.22	244.22	244.37	2.16	33.28	115.71	0.68
TR2B001	2524.1	50 Year	29.2	243.20	244.07	244.07	244.33	2.57	18.40	42.97	0.88
TR2B001	2524.1	25 Year	23.4	243.20	243.98	243.98	244.22	2.42	14.78	36.39	0.87
TR2B001	2524.1	10 Year	15.4	243.20	243.83	243.83	244.04	2.15	9.94	29.18	0.86
TR2B001	2524.1	5 Year	10.9	243.20	243.72	243.72	243.91	1.98	6.94	23.66	0.88
TR2B001	2524.1	2 Year	5.2	243.20	243.51	243.51	243.66	1.71	3.09	13.55	0.97
TR2B001	2607.6	Regional	111.9	242.80	244.91	243.57	244.93	0.90	237.35	135.79	0.20
TR2B001	2607.6	100 Year	34.5	242.80	244.41	243.28	244.41	0.39	170.09	132.21	0.10
TR2B001	2607.6	50 Year	29.2	242.80	244.38	243.25	244.38	0.34	165.41	131.94	0.09
TR2B001	2607.6	25 Year	23.4	242.80	244.26	243.22	244.26	0.30	150.43	131.07	0.08
TR2B001	2607.6	10 Year	15.4	242.80	244.08	243.18	244.08	0.24	126.01	129.64	0.07
TR2B001	2607.6	5 Year	10.9	242.80	243.94	243.14	243.94	0.20	108.27	128.11	0.06
TR2B001	2607.6	2 Year	5.2	242.80	243.69	243.09	243.69	0.14	76.63	124.20	0.05

Existing Conditions

Reach	River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude #
TR2B001	2693.1	Regional	111.9	242.77	244.94	243.65	244.95	0.93	234.37	136.39	0.21
TR2B001	2693.1	100 Year	34.5	242.77	244.42	243.35	244.42	0.42	164.24	133.08	0.11
TR2B001	2693.1	50 Year	29.2	242.77	244.38	243.32	244.38	0.37	159.33	132.72	0.10
TR2B001	2693.1	25 Year	23.4	242.77	244.27	243.28	244.27	0.33	144.18	131.62	0.09
TR2B001	2693.1	10 Year	15.4	242.77	244.08	243.22	244.08	0.26	119.54	129.90	0.08
TR2B001	2693.1	5 Year	10.9	242.77	243.94	243.18	243.94	0.22	101.69	128.18	0.07
TR2B001	2693.1	2 Year	5.2	242.77	243.69	243.11	243.69	0.16	69.97	123.81	0.06
TR2B001	2806.3	Regional	111.9	242.79	244.97	243.81	244.99	0.89	254.39	156.89	0.20
TR2B001	2806.3	100 Year	34.5	242.79	244.43	243.47	244.43	0.43	169.81	153.53	0.11
TR2B001	2806.3	50 Year	29.2	242.79	244.39	243.48	244.39	0.38	163.79	153.15	0.10
TR2B001	2806.3	25 Year	23.4	242.79	244.28	243.43	244.28	0.34	146.17	152.03	0.09
TR2B001	2806.3	10 Year	15.4	242.79	244.09	243.35	244.09	0.29	117.48	150.18	0.08
TR2B001	2806.3	5 Year	10.9	242.79	243.95	243.21	243.95	0.25	96.71	148.60	0.08
TR2B001	2806.3	2 Year	5.2	242.79	243.69	243.14	243.69	0.21	59.63	144.87	0.07
TR2B001	3014.1	Regional	111.9	242.80	245.03	243.85	245.04	0.82	293.59	189.97	0.18
TR2B001	3014.1	100 Year	34.5	242.80	244.45	243.61	244.45	0.42	186.01	182.00	0.11
TR2B001	3014.1	50 Year	29.2	242.80	244.41	243.58	244.41	0.37	178.26	181.09	0.10
TR2B001	3014.1	25 Year	23.4	242.80	244.29	243.55	244.29	0.34	157.30	178.63	0.09
TR2B001	3014.1	10 Year	15.4	242.80	244.10	243.50	244.10	0.30	123.49	174.59	0.09
TR2B001	3014.1	5 Year	10.9	242.80	243.96	243.47	243.96	0.27	99.33	170.49	0.08
TR2B001	3014.1	2 Year	5.2	242.80	243.71	243.24	243.71	0.24	57.81	159.45	0.08
TR2B001	3119.2	Regional	111.9	243.21	245.02	244.85	245.19	3.29	95.20	133.74	0.78
TR2B001	3119.2	100 Year	34.5	243.21	244.37	244.32	244.55	2.83	30.58	62.82	0.84
TR2B001	3119.2	50 Year	29.2	243.21	244.34	244.25	244.49	2.52	28.82	60.78	0.76
TR2B001	3119.2	25 Year	23.4	243.21	244.21	244.16	244.38	2.61	21.16	50.44	0.84
TR2B001	3119.2	10 Year	15.4	243.21	244.01	244.01	244.21	2.57	12.68	35.69	0.93
TR2B001	3119.2	5 Year	10.9	243.21	243.92	243.92	244.09	2.28	9.60	30.66	0.87
TR2B001	3119.2	2 Year	5.2	243.21	243.72	243.72	243.86	1.88	4.68	20.42	0.85
TR2B001	3171.1	Regional	111.9	243.30	245.19	245.01	245.33	3.16	101.31	115.81	0.74
TR2B001	3171.1	100 Year	34.5	243.30	244.58	244.56	244.74	2.73	37.43	86.06	0.78
TR2B001	3171.1	50 Year	29.2	243.30	244.51	244.51	244.68	2.70	31.72	81.64	0.79
TR2B001	3171.1	25 Year	23.4	243.30	244.42	244.42	244.61	2.63	25.00	71.20	0.80
TR2B001	3171.1	10 Year	15.4	243.30	244.29	244.29	244.46	2.36	16.55	54.20	0.77
TR2B001	3171.1	5 Year	10.9	243.30	244.15	244.15	244.34	2.28	10.32	36.96	0.80
TR2B001	3171.1	2 Year	5.2	243.30	243.96	243.86	244.06	1.56	5.55	16.92	0.62
TR2B001	3224.5	Regional	111.9	243.66	246.50	246.50	246.81	2.93	99.60	175.84	0.57
TR2B001	3224.5	100 Year	34.5	243.66	244.95	244.89	245.43	3.07	11.25	13.32	0.92
TR2B001	3224.5	50 Year	29.2	243.66	244.91	244.77	245.28	2.68	10.90	13.17	0.82
TR2B001	3224.5	25 Year	23.4	243.66	244.85	244.64	245.11	2.28	10.24	12.89	0.72
TR2B001	3224.5	10 Year	15.4	243.66	244.71	244.45	244.86	1.74	8.85	12.29	0.59
TR2B001	3224.5	5 Year	10.9	243.66	244.62	244.32	244.72	1.36	8.03	11.91	0.48
TR2B001	3224.5	2 Year	5.2	243.66	244.33	244.11	244.39	1.02	5.12	10.40	0.45
TR2B001	3226	Bridge									

Modelling with Subcritical Flow Regime

Reach	River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude #
TR2B001	1718.7	Regional	117.9	234.80	236.13	235.86	236.23	2.56	107.74	144.33	0.74
TR2B001	1718.7	100 Year	37.1	234.80	235.69	235.57	235.74	1.80	49.96	118.71	0.65
TR2B001	1718.7	50 Year	31.4	234.80	235.62	235.54	235.68	1.85	41.76	115.67	0.70
TR2B001	1718.7	25 Year	25.2	234.80	235.60	235.50	235.64	1.59	39.35	114.77	0.61
TR2B001	1718.7	10 Year	16.7	234.80	235.51	235.43	235.55	1.46	29.14	110.78	0.60
TR2B001	1718.7	5 Year	12.1	234.80	235.43	235.39	235.48	1.43	21.27	99.53	0.63
TR2B001	1718.7	2 Year	6.1	234.80	235.33	235.30	235.37	1.21	11.93	80.76	0.59
TR2B001	1817.4	Regional	117.9	235.30	237.04	237.04	237.33	4.24	75.73	107.84	1.06
TR2B001	1817.4	100 Year	37.1	235.30	236.55	236.55	236.76	3.04	31.38	71.54	0.91
TR2B001	1817.4	50 Year	31.4	235.30	236.50	236.50	236.69	2.86	27.70	67.89	0.87
TR2B001	1817.4	25 Year	25.2	235.30	236.43	236.43	236.61	2.66	23.21	64.32	0.84
TR2B001	1817.4	10 Year	16.7	235.30	236.28	236.28	236.46	2.45	14.78	49.01	0.83
TR2B001	1817.4	5 Year	12.1	235.30	236.14	236.14	236.34	2.43	8.90	32.73	0.90
TR2B001	1817.4	2 Year	6.1	235.30	235.96	235.87	236.08	1.74	5.18	12.87	0.74
TR2B001	2017.9	Regional	117.9	236.80	238.80	238.72	239.02	3.63	83.51	118.04	0.84
TR2B001	2017.9	100 Year	37.1	236.80	238.17	238.14	238.37	2.87	29.15	56.49	0.81
TR2B001	2017.9	50 Year	31.4	236.80	238.09	237.96	238.29	2.80	24.91	52.75	0.82
TR2B001	2017.9	25 Year	25.2	236.80	237.98	237.93	238.18	2.64	19.70	41.10	0.81
TR2B001	2017.9	10 Year	16.7	236.80	237.83	237.75	237.99	2.29	14.10	32.89	0.76
TR2B001	2017.9	5 Year	12.1	236.80	237.75	237.57	237.87	1.95	11.42	28.10	0.68
TR2B001	2017.9	2 Year	6.1	236.80	237.47	237.36	237.56	1.65	5.61	14.31	0.70
TR2B001	2197.6	Regional	117.9	237.80	239.96	239.96	240.19	3.61	102.69	160.51	0.80
TR2B001	2197.6	100 Year	37.1	237.80	239.35	239.27	239.67	3.11	23.69	54.51	0.82
TR2B001	2197.6	50 Year	31.4	237.80	239.27	239.17	239.55	2.87	21.14	49.20	0.78
TR2B001	2197.6	25 Year	25.2	237.80	239.16	239.02	239.40	2.63	17.71	41.59	0.75
TR2B001	2197.6	10 Year	16.7	237.80	238.95	238.79	239.14	2.27	12.47	21.77	0.71
TR2B001	2197.6	5 Year	12.1	237.80	238.78	238.61	238.95	2.08	9.17	17.82	0.71
TR2B001	2197.6	2 Year	6.1	237.80	238.54	238.37	238.64	1.52	5.57	12.15	0.61
TR2B001	2230.6	Regional	117.9	237.66	240.51	240.51	240.85	3.23	93.98	140.84	0.63
TR2B001	2230.6	100 Year	37.1	237.66	239.57	239.05	239.78	2.16	23.11	21.95	0.52
TR2B001	2230.6	50 Year	31.4	237.66	239.48	238.91	239.66	1.95	21.17	20.85	0.48
TR2B001	2230.6	25 Year	25.2	237.66	239.36	238.75	239.50	1.71	18.81	19.41	0.44
TR2B001	2230.6	10 Year	16.7	237.66	239.14	238.53	239.23	1.36	14.77	16.67	0.38
TR2B001	2230.6	5 Year	12.1	237.66	238.97	238.39	239.04	1.15	12.15	14.62	0.34
TR2B001	2230.6	2 Year	6.1	237.66	238.66	238.17	238.70	0.80	8.24	11.11	0.28
TR2B001	2231	Bridge at Trafalgar Road									
TR2B001	2250.1	Regional	117.9	237.79	241.05	240.28	241.30	3.04	71.16	167.04	0.54
TR2B001	2250.1	100 Year	37.1	237.79	239.72	239.21	239.88	2.18	30.07	26.95	0.51
TR2B001	2250.1	50 Year	31.4	237.79	239.60	239.09	239.74	2.03	26.87	25.65	0.49
TR2B001	2250.1	25 Year	25.2	237.79	239.45	238.97	239.57	1.85	23.19	24.07	0.47
TR2B001	2250.1	10 Year	16.7	237.79	239.20	238.76	239.29	1.56	17.38	21.33	0.43
TR2B001	2250.1	5 Year	12.1	237.79	239.02	238.60	239.09	1.38	13.76	19.44	0.41
TR2B001	2250.1	2 Year	6.1	237.79	238.70	238.35	238.75	1.08	8.07	15.93	0.38
TR2B001	2293.3	Regional	117.9	238.80	241.45	241.45	241.86	3.94	76.39	110.52	0.79
TR2B001	2293.3	100 Year	37.1	238.80	240.30	240.30	240.74	3.34	18.48	24.75	0.90
TR2B001	2293.3	50 Year	31.4	238.80	240.18	240.18	240.60	3.23	15.51	22.18	0.91
TR2B001	2293.3	25 Year	25.2	238.80	240.04	240.04	240.42	3.03	12.62	19.46	0.91
TR2B001	2293.3	10 Year	16.7	238.80	239.79	239.79	240.13	2.77	8.27	14.92	0.94
TR2B001	2293.3	5 Year	12.1	238.80	239.61	239.61	239.92	2.61	5.89	11.68	0.99
TR2B001	2293.3	2 Year	6.1	238.80	239.36	239.36	239.56	2.09	3.41	8.94	0.99

Modelling with Subcritical Flow Regime

Reach	River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude #
TR2B001	2317.1	Regional	117.9	239.40	242.27	242.27	242.61	3.76	97.92	125.47	0.71
TR2B001	2317.1	100 Year	37.1	239.40	240.91	240.91	241.60	4.04	11.47	12.95	1.05
TR2B001	2317.1	50 Year	31.4	239.40	240.77	240.77	241.38	3.80	10.30	12.19	1.04
TR2B001	2317.1	25 Year	25.2	239.40	240.59	240.59	241.13	3.53	8.88	11.26	1.03
TR2B001	2317.1	10 Year	16.7	239.40	240.32	240.32	240.74	3.11	6.63	10.11	1.04
TR2B001	2317.1	5 Year	12.1	239.40	240.15	240.15	240.49	2.80	5.28	9.51	1.03
TR2B001	2317.1	2 Year	6.1	239.40	239.88	239.88	240.11	2.25	3.23	8.49	1.04
TR2B001	2317.5	Bridge at Stewartown Road									
TR2B001	2337.3	Regional	117.9	239.40	242.39	242.14	242.62	3.30	106.27	107.91	0.61
TR2B001	2337.3	100 Year	37.1	239.40	241.61	240.91	241.80	2.37	38.52	68.33	0.51
TR2B001	2337.3	50 Year	31.4	239.40	241.41	240.77	241.68	2.58	15.57	24.31	0.58
TR2B001	2337.3	25 Year	25.2	239.40	241.24	240.59	241.45	2.27	14.21	22.29	0.53
TR2B001	2337.3	10 Year	16.7	239.40	240.69	240.31	240.89	2.20	9.67	17.72	0.62
TR2B001	2337.3	5 Year	12.1	239.40	240.48	240.14	240.63	1.93	7.95	16.62	0.59
TR2B001	2337.3	2 Year	6.1	239.40	240.14	239.88	240.23	1.44	5.29	14.92	0.53
TR2B001	2368.9	Regional	117.9	239.18	242.58	241.41	242.71	2.69	136.61	128.50	0.48
TR2B001	2368.9	100 Year	37.1	239.18	241.81	240.64	241.86	1.38	65.43	58.37	0.28
TR2B001	2368.9	50 Year	31.4	239.18	241.71	240.55	241.74	1.21	59.88	50.56	0.25
TR2B001	2368.9	25 Year	25.2	239.18	241.48	240.42	241.50	1.04	49.67	36.92	0.23
TR2B001	2368.9	10 Year	16.7	239.18	240.93	240.24	240.96	1.10	30.53	32.29	0.28
TR2B001	2368.9	5 Year	12.1	239.18	240.67	240.12	240.70	1.07	22.57	30.20	0.30
TR2B001	2368.9	2 Year	6.1	239.18	240.27	239.88	240.30	0.96	11.75	23.28	0.32
TR2B001	2448.1	Regional	111.9	239.19	242.73	241.15	242.80	1.92	129.24	67.00	0.33
TR2B001	2448.1	100 Year	34.5	239.19	241.87	240.44	241.89	0.92	79.71	50.75	0.18
TR2B001	2448.1	50 Year	29.2	239.19	241.76	240.37	241.77	0.83	73.94	49.02	0.17
TR2B001	2448.1	25 Year	23.4	239.19	241.52	240.29	241.53	0.77	62.64	45.31	0.17
TR2B001	2448.1	10 Year	15.4	239.19	240.98	240.14	241.00	0.78	40.25	39.59	0.19
TR2B001	2448.1	5 Year	10.9	239.19	240.74	240.05	240.75	0.71	30.83	36.49	0.19
TR2B001	2448.1	2 Year	5.2	239.19	240.35	239.82	240.36	0.58	17.57	30.99	0.19
TR2B001	2502.3	Regional	111.9	239.50	242.78	241.12	242.84	1.39	138.21	59.07	0.25
TR2B001	2502.3	100 Year	34.5	239.50	241.89	240.41	241.90	0.66	88.13	53.33	0.14
TR2B001	2502.3	50 Year	29.2	239.50	241.77	240.32	241.78	0.60	81.90	52.53	0.13
TR2B001	2502.3	25 Year	23.4	239.50	241.53	240.20	241.54	0.56	69.47	50.86	0.12
TR2B001	2502.3	10 Year	15.4	239.50	241.00	239.99	241.01	0.56	43.59	47.05	0.15
TR2B001	2502.3	5 Year	10.9	239.50	240.75	239.91	240.77	0.52	32.31	44.24	0.15
TR2B001	2502.3	2 Year	5.2	239.50	240.37	239.75	240.37	0.42	16.26	34.56	0.14
TR2B001	2524.1	Regional	111.9	243.20	244.57	244.57	244.83	3.31	74.48	122.31	0.90
TR2B001	2524.1	100 Year	34.5	243.20	244.22	244.22	244.37	2.16	33.28	115.71	0.68
TR2B001	2524.1	50 Year	29.2	243.20	244.07	244.07	244.33	2.57	18.40	42.97	0.88
TR2B001	2524.1	25 Year	23.4	243.20	243.98	243.98	244.22	2.42	14.78	36.39	0.87
TR2B001	2524.1	10 Year	15.4	243.20	243.83	243.83	244.04	2.15	9.94	29.18	0.86
TR2B001	2524.1	5 Year	10.9	243.20	243.72	243.72	243.91	1.98	6.94	23.66	0.88
TR2B001	2524.1	2 Year	5.2	243.20	243.51	243.51	243.66	1.71	3.09	13.55	0.97
TR2B001	2607.6	Regional	111.9	242.80	244.91	243.57	244.93	0.90	237.35	135.79	0.20
TR2B001	2607.6	100 Year	34.5	242.80	244.41	243.28	244.41	0.39	170.09	132.21	0.10
TR2B001	2607.6	50 Year	29.2	242.80	244.38	243.25	244.38	0.34	165.41	131.94	0.09
TR2B001	2607.6	25 Year	23.4	242.80	244.26	243.22	244.26	0.30	150.43	131.07	0.08
TR2B001	2607.6	10 Year	15.4	242.80	244.08	243.18	244.08	0.24	126.01	129.64	0.07
TR2B001	2607.6	5 Year	10.9	242.80	243.94	243.14	243.94	0.20	108.27	128.11	0.06
TR2B001	2607.6	2 Year	5.2	242.80	243.69	243.09	243.69	0.14	76.63	124.20	0.05

Modelling with Subcritical Flow Regime

Reach	River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude #
TR2B001	2693.1	Regional	111.9	242.77	244.94	243.65	244.95	0.93	234.37	136.39	0.21
TR2B001	2693.1	100 Year	34.5	242.77	244.42	243.35	244.42	0.42	164.24	133.08	0.11
TR2B001	2693.1	50 Year	29.2	242.77	244.38	243.32	244.38	0.37	159.33	132.72	0.10
TR2B001	2693.1	25 Year	23.4	242.77	244.27	243.28	244.27	0.33	144.18	131.62	0.09
TR2B001	2693.1	10 Year	15.4	242.77	244.08	243.22	244.08	0.26	119.54	129.90	0.08
TR2B001	2693.1	5 Year	10.9	242.77	243.94	243.18	243.94	0.22	101.69	128.18	0.07
TR2B001	2693.1	2 Year	5.2	242.77	243.69	243.11	243.69	0.16	69.97	123.81	0.06
TR2B001	2806.3	Regional	111.9	242.79	244.97	243.81	244.99	0.89	254.39	156.89	0.20
TR2B001	2806.3	100 Year	34.5	242.79	244.43	243.47	244.43	0.43	169.81	153.53	0.11
TR2B001	2806.3	50 Year	29.2	242.79	244.39	243.48	244.39	0.38	163.79	153.15	0.10
TR2B001	2806.3	25 Year	23.4	242.79	244.28	243.43	244.28	0.34	146.17	152.03	0.09
TR2B001	2806.3	10 Year	15.4	242.79	244.09	243.35	244.09	0.29	117.48	150.18	0.08
TR2B001	2806.3	5 Year	10.9	242.79	243.95	243.21	243.95	0.25	96.71	148.60	0.08
TR2B001	2806.3	2 Year	5.2	242.79	243.69	243.14	243.69	0.21	59.63	144.87	0.07
TR2B001	3014.1	Regional	111.9	242.80	245.03	243.85	245.04	0.82	293.59	189.97	0.18
TR2B001	3014.1	100 Year	34.5	242.80	244.45	243.61	244.45	0.42	186.01	182.00	0.11
TR2B001	3014.1	50 Year	29.2	242.80	244.41	243.58	244.41	0.37	178.26	181.09	0.10
TR2B001	3014.1	25 Year	23.4	242.80	244.29	243.55	244.29	0.34	157.30	178.63	0.09
TR2B001	3014.1	10 Year	15.4	242.80	244.10	243.50	244.10	0.30	123.49	174.59	0.09
TR2B001	3014.1	5 Year	10.9	242.80	243.96	243.47	243.96	0.27	99.33	170.49	0.08
TR2B001	3014.1	2 Year	5.2	242.80	243.71	243.24	243.71	0.24	57.81	159.45	0.08
TR2B001	3119.2	Regional	111.9	243.21	245.02	244.85	245.19	3.29	95.20	133.74	0.78
TR2B001	3119.2	100 Year	34.5	243.21	244.37	244.32	244.55	2.83	30.58	62.82	0.84
TR2B001	3119.2	50 Year	29.2	243.21	244.34	244.25	244.49	2.52	28.82	60.78	0.76
TR2B001	3119.2	25 Year	23.4	243.21	244.21	244.16	244.38	2.61	21.16	50.44	0.84
TR2B001	3119.2	10 Year	15.4	243.21	244.01	244.01	244.21	2.57	12.68	35.69	0.93
TR2B001	3119.2	5 Year	10.9	243.21	243.92	243.92	244.09	2.28	9.60	30.66	0.87
TR2B001	3119.2	2 Year	5.2	243.21	243.72	243.72	243.86	1.88	4.68	20.42	0.85
TR2B001	3171.1	Regional	111.9	243.30	245.19	245.01	245.33	3.16	101.31	115.81	0.74
TR2B001	3171.1	100 Year	34.5	243.30	244.58	244.56	244.74	2.73	37.43	86.06	0.78
TR2B001	3171.1	50 Year	29.2	243.30	244.51	244.51	244.68	2.70	31.72	81.64	0.79
TR2B001	3171.1	25 Year	23.4	243.30	244.42	244.42	244.61	2.63	25.00	71.20	0.80
TR2B001	3171.1	10 Year	15.4	243.30	244.29	244.29	244.46	2.36	16.55	54.20	0.77
TR2B001	3171.1	5 Year	10.9	243.30	244.15	244.15	244.34	2.28	10.32	36.96	0.80
TR2B001	3171.1	2 Year	5.2	243.30	243.96	243.86	244.06	1.56	5.55	16.92	0.62
TR2B001	3224.5	Regional	111.9	243.66	246.50	246.50	246.81	2.93	99.60	175.84	0.57
TR2B001	3224.5	100 Year	34.5	243.66	244.95	244.89	245.43	3.07	11.25	13.32	0.92
TR2B001	3224.5	50 Year	29.2	243.66	244.91	244.77	245.28	2.68	10.90	13.17	0.82
TR2B001	3224.5	25 Year	23.4	243.66	244.85	244.64	245.11	2.28	10.24	12.89	0.72
TR2B001	3224.5	10 Year	15.4	243.66	244.71	244.45	244.86	1.74	8.85	12.29	0.59
TR2B001	3224.5	5 Year	10.9	243.66	244.62	244.32	244.72	1.36	8.03	11.91	0.48
TR2B001	3224.5	2 Year	5.2	243.66	244.33	244.11	244.39	1.02	5.12	10.40	0.45
TR2B001	3226	Bridge									

Appendix D

**CulvertMaster Outputs
Existing Conditions**

Culvert Designer/Analyzer Report

C3 - 50 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	0.6700 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	0.6700 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+13	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	232.50
0+08	232.00
0+13	232.50

Tailwater conditions for Design Storm.			
Discharge	0.6700 m ³ /s	Actual Depth	0.20 m
Velocity	1.24 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-500 mm Circular	0.5118 m ³ /s	234.75 m	2.69 m/s
Weir	Roadway	0.1598 m ³ /s	234.75 m	N/A
Total	-----	0.6716 m ³ /s	234.75 m	N/A

Culvert Designer/Analyzer Report

C3 - 50 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	234.75 m	Discharge	0.5118 m ³ /s
Inlet Control HW Elev.	234.75 m	Tailwater Elevation	232.20 m
Outlet Control HW Elev.	234.71 m	Control Type	Inlet Control
Headwater Depth/Height	2.98		

Grades			
Upstream Invert	233.26 m	Downstream Invert	232.21 m
Length	21.70 m	Constructed Slope	0.048387 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.46 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.46 m
Velocity Downstream	2.69 m/s	Critical Slope	0.054189 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.50 m
Section Size	500 mm	Rise	0.50 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	234.71 m	Upstream Velocity Head	0.35 m
Ke	0.90	Entrance Loss	0.31 m

Inlet Control Properties			
Inlet Control HW Elev.	234.75 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.2 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C3 - 50 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.1598 m ³ /s	Allowable HW Elevation	234.75 m
Roadway Width	9.00 m	Overtopping Coefficient	1.61 SI
Low Point	234.71 m	Headwater Elevation	234.75 m
Discharge Coefficient (Cr)	2.91	Submergence Factor (Kt)	1.00
Tailwater Elevation	232.20 m		

Sta (m)	Elev. (m)
2,640.00	235.10
2,660.00	235.00
2,680.00	234.89
2,700.00	234.77
2,720.00	234.71
2,740.00	234.75
2,760.00	234.84
2,780.00	234.98
2,800.00	235.10

Culvert Designer/Analyzer Report

C3 - 100 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	0.7410 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	0.7410 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+13	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	232.50
0+08	232.00
0+13	232.50

Tailwater conditions for Design Storm.			
Discharge	0.7410 m ³ /s	Actual Depth	0.21 m
Velocity	1.27 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-500 mm Circular	0.5131 m ³ /s	234.76 m	2.70 m/s
Weir	Roadway	0.2295 m ³ /s	234.76 m	N/A
Total	-----	0.7425 m ³ /s	234.76 m	N/A

Culvert Designer/Analyzer Report

C3 - 100 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	234.76 m	Discharge	0.5131 m ³ /s
Inlet Control HW Elev.	234.76 m	Tailwater Elevation	232.21 m
Outlet Control HW Elev.	234.72 m	Control Type	Inlet Control
Headwater Depth/Height	2.99		

Grades			
Upstream Invert	233.26 m	Downstream Invert	232.21 m
Length	21.70 m	Constructed Slope	0.048387 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.46 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.46 m
Velocity Downstream	2.70 m/s	Critical Slope	0.054439 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.50 m
Section Size	500 mm	Rise	0.50 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	234.72 m	Upstream Velocity Head	0.35 m
Ke	0.90	Entrance Loss	0.31 m

Inlet Control Properties			
Inlet Control HW Elev.	234.76 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.2 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C3 - 100 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.2295 m ³ /s	Allowable HW Elevation	234.76 m
Roadway Width	9.00 m	Overtopping Coefficient	1.61 SI
Low Point	234.71 m	Headwater Elevation	234.76 m
Discharge Coefficient (Cr)	2.91	Submergence Factor (Kt)	1.00
Tailwater Elevation	232.21 m		

Sta (m)	Elev. (m)
2,640.00	235.10
2,660.00	235.00
2,680.00	234.89
2,700.00	234.77
2,720.00	234.71
2,740.00	234.75
2,760.00	234.84
2,780.00	234.98
2,800.00	235.10

Culvert Designer/Analyzer Report

C3 - Regional - Existing

Analysis Component			
Storm Event	Design	Discharge	0.7610 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	0.7610 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+13	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	232.50
0+08	232.00
0+13	232.50

Tailwater conditions for Design Storm.			
Discharge	0.7610 m ³ /s	Actual Depth	0.21 m
Velocity	1.28 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-500 mm Circular	0.5134 m ³ /s	234.76 m	2.70 m/s
Weir	Roadway	0.2483 m ³ /s	234.76 m	N/A
Total	-----	0.7617 m ³ /s	234.76 m	N/A

Culvert Designer/Analyzer Report

C3 - Regional - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	234.76 m	Discharge	0.5134 m ³ /s
Inlet Control HW Elev.	234.76 m	Tailwater Elevation	232.21 m
Outlet Control HW Elev.	234.72 m	Control Type	Inlet Control
Headwater Depth/Height	3.00		

Grades			
Upstream Invert	233.26 m	Downstream Invert	232.21 m
Length	21.70 m	Constructed Slope	0.048387 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.46 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.46 m
Velocity Downstream	2.70 m/s	Critical Slope	0.054501 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.50 m
Section Size	500 mm	Rise	0.50 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	234.72 m	Upstream Velocity Head	0.35 m
Ke	0.90	Entrance Loss	0.31 m

Inlet Control Properties			
Inlet Control HW Elev.	234.76 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.2 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C3 - Regional - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.2483	m ³ /s	Allowable HW Elevation 234.76 m
Roadway Width	9.00	m	Overtopping Coefficient 1.61 SI
Low Point	234.71	m	Headwater Elevation 234.76 m
Discharge Coefficient (Cr)	2.91		Submergence Factor (Kt) 1.00
Tailwater Elevation	232.21	m	

Sta (m)	Elev. (m)
2,640.00	235.10
2,660.00	235.00
2,680.00	234.89
2,700.00	234.77
2,720.00	234.71
2,740.00	234.75
2,760.00	234.84
2,780.00	234.98
2,800.00	235.10

Culvert Designer/Analyzer Report

C5 - 50 Yr & 100 Yr - Existing

Peak Discharge Method: User-Specified

Design Discharge	0.4680 m ³ /s	Check Discharge	0.5250 m ³ /s
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Grades Model: Inverts

Invert Upstream	241.24 m	Invert Downstream	240.93 m
Length	20.60 m	Slope	0.015049 m/m
Drop	0.31 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+19	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	239.50
0+09	239.00
0+19	239.50

Tailwater conditions for Design Storm.

Discharge	0.4680 m ³ /s	Actual Depth	0.15 m
Velocity	1.03 m/s		

Tailwater conditions for Check Storm.

Discharge	0.5250 m ³ /s	Actual Depth	0.16 m
Velocity	1.06 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-600 mm Circular	0.4680 m ³ /s	242.07 m	2.04 m/s
Trial-2	1-600 mm Circular	0.5250 m ³ /s	242.24 m	2.16 m/s

Culvert Designer/Analyzer Report

C5 - 50 Yr & 100 Yr - Existing

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev.	242.07 m	Discharge	0.4680 m ³ /s
Headwater Depth/Height	1.36	Tailwater Elevation	239.15 m
Inlet Control HW Elev.	242.05 m	Control Type	Outlet Control
Outlet Control HW Elev.	242.07 m		

Grades			
Upstream Invert	241.24 m	Downstream Invert	240.93 m
Length	20.60 m	Constructed Slope	0.015049 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.45 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.45 m
Velocity Downstream	2.04 m/s	Critical Slope	0.023116 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	Aluminum	Span	0.61 m
Section Size	600 mm	Rise	0.61 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	242.07 m	Upstream Velocity Head	0.14 m
Ke	0.90	Entrance Loss	0.13 m

Inlet Control Properties			
Inlet Control HW Elev.	242.05 m	Flow Control	Transition
Inlet Type	Projecting	Area Full	0.3 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C5 - 50 Yr & 100 Yr - Existing

Design: Trial-2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Check
Computed Headwater Elev:	242.24 m	Discharge	0.5250 m ³ /s
Headwater Depth/Height	1.64	Tailwater Elevation	239.16 m
Inlet Control HW Elev.	242.15 m	Control Type	Outlet Control
Outlet Control HW Elev.	242.24 m		

Grades			
Upstream Invert	241.24 m	Downstream Invert	240.93 m
Length	20.60 m	Constructed Slope	0.015049 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.47 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.47 m
Velocity Downstream	2.16 m/s	Critical Slope	0.025571 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	Aluminum	Span	0.61 m
Section Size	600 mm	Rise	0.61 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	242.24 m	Upstream Velocity Head	0.16 m
Ke	0.90	Entrance Loss	0.15 m

Inlet Control Properties			
Inlet Control HW Elev.	242.15 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.3 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C5 - Regional - Existing

Peak Discharge Method: User-Specified

Design Discharge	0.7060 m ³ /s	Check Discharge	0.0000 m ³ /s
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Grades Model: Inverts

Invert Upstream	241.24 m	Invert Downstream	240.93 m
Length	20.60 m	Slope	0.015049 m/m
Drop	0.31 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+19	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	239.50
0+09	239.00
0+19	239.50

Tailwater conditions for Design Storm.

Discharge	0.7060 m ³ /s	Actual Depth	0.18 m
Velocity	1.15 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-600 mm Circular	0.7060 m ³ /s	242.93 m	2.60 m/s

Culvert Designer/Analyzer Report

C5 - Regional - Existing

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	242.93 m	Discharge	0.7060 m ³ /s
Headwater Depth/Height	2.77	Tailwater Elevation	239.18 m
Inlet Control HW Elev.	242.63 m	Control Type	Outlet Control
Outlet Control HW Elev.	242.93 m		

Grades			
Upstream Invert	241.24 m	Downstream Invert	240.93 m
Length	20.60 m	Constructed Slope	0.015049 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.54 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.54 m
Velocity Downstream	2.60 m/s	Critical Slope	0.037257 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	Aluminum	Span	0.61 m
Section Size	600 mm	Rise	0.61 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	242.93 m	Upstream Velocity Head	0.30 m
Ke	0.90	Entrance Loss	0.27 m

Inlet Control Properties			
Inlet Control HW Elev.	242.63 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.3 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C6 - 50 Yr & 100 Yr - Existing

Peak Discharge Method: User-Specified

Design Discharge	1.3790 m ³ /s	Check Discharge	1.5450 m ³ /s
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Grades Model: Inverts

Invert Upstream	241.07 m	Invert Downstream	240.42 m
Length	23.30 m	Slope	0.027897 m/m
Drop	0.65 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+16	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	240.50
0+11	240.00
0+16	240.50

Tailwater conditions for Design Storm.

Discharge	1.3790 m ³ /s	Actual Depth	0.23 m
Velocity	1.65 m/s		

Tailwater conditions for Check Storm.

Discharge	1.5450 m ³ /s	Actual Depth	0.24 m
Velocity	1.69 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-900 mm Circular	1.3790 m ³ /s	242.41 m	2.90 m/s
Trial-2	1-900 mm Circular	1.5450 m ³ /s	242.56 m	2.95 m/s

Culvert Designer/Analyzer Report

C6 - 50 Yr & 100 Yr - Existing

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	242.41 m	Discharge	1.3790 m ³ /s
Headwater Depth/Height	1.46	Tailwater Elevation	240.23 m
Inlet Control HW Elev.	242.35 m	Control Type	Entrance Control
Outlet Control HW Elev.	242.41 m		

Grades			
Upstream Invert	241.07 m	Downstream Invert	240.42 m
Length	23.30 m	Constructed Slope	0.027897 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.62 m
Slope Type	Steep	Normal Depth	0.62 m
Flow Regime	Supercritical	Critical Depth	0.69 m
Velocity Downstream	2.90 m/s	Critical Slope	0.021359 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	Aluminum	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	242.41 m	Upstream Velocity Head	0.34 m
Ke	0.90	Entrance Loss	0.31 m

Inlet Control Properties			
Inlet Control HW Elev.	242.35 m	Flow Control	Transition
Inlet Type	Projecting	Area Full	0.7 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C6 - 50 Yr & 100 Yr - Existing

Design: Trial-2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Check
Computed Headwater Elev.	242.56 m	Discharge	1.5450 m ³ /s
Headwater Depth/Height	1.62	Tailwater Elevation	240.24 m
Inlet Control HW Elev.	242.56 m	Control Type	Inlet Control
Outlet Control HW Elev.	242.53 m		

Grades			
Upstream Invert	241.07 m	Downstream Invert	240.42 m
Length	23.30 m	Constructed Slope	0.027897 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.68 m
Slope Type	Steep	Normal Depth	0.68 m
Flow Regime	Supercritical	Critical Depth	0.73 m
Velocity Downstream	2.95 m/s	Critical Slope	0.023907 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	Aluminum	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	242.53 m	Upstream Velocity Head	0.38 m
Ke	0.90	Entrance Loss	0.35 m

Inlet Control Properties			
Inlet Control HW Elev.	242.56 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.7 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C6 - Regional - Existing

Analysis Component			
Storm Event	Design	Discharge	2.6440 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	2.6440 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+16	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	240.50
0+11	240.00
0+16	240.50

Tailwater conditions for Design Storm.			
Discharge	2.6440 m ³ /s	Actual Depth	0.29 m
Velocity	1.94 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	2.1166 m ³ /s	243.44 m	3.39 m/s
Weir	Roadway	0.5289 m ³ /s	243.44 m	N/A
Total	-----	2.6455 m ³ /s	243.44 m	N/A

Culvert Designer/Analyzer Report

C6 - Regional - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	243.44 m	Discharge	2.1166 m ³ /s
Inlet Control HW Elev.	243.44 m	Tailwater Elevation	240.29 m
Outlet Control HW Elev.	243.29 m	Control Type	Inlet Control
Headwater Depth/Height	2.59		

Grades			
Upstream Invert	241.07 m	Downstream Invert	240.42 m
Length	23.30 m	Constructed Slope	0.027897 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.83 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.83 m
Velocity Downstream	3.39 m/s	Critical Slope	0.037511 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	243.29 m	Upstream Velocity Head	0.53 m
Ke	0.90	Entrance Loss	0.48 m

Inlet Control Properties			
Inlet Control HW Elev.	243.44 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.7 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C6 - Regional - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.5289 m ³ /s	Allowable HW Elevation	243.44 m
Roadway Width	9.00 m	Overtopping Coefficient	1.62 SI
Low Point	243.30 m	Headwater Elevation	243.44 m
Discharge Coefficient (Cr)	2.93	Submergence Factor (Kt)	1.00
Tailwater Elevation	240.29 m		

Sta (m)	Elev. (m)
4,150.00	243.30
4,160.00	243.38
4,180.00	243.55
4,200.00	243.69
4,220.00	243.84
4,240.00	243.98

Culvert Designer/Analyzer Report

C7 - 50 Yr & 100 Yr - Existing

Peak Discharge Method: User-Specified

Design Discharge	1.4890 m ³ /s	Check Discharge	1.6680 m ³ /s
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Grades Model: Inverts

Invert Upstream	245.39 m	Invert Downstream	245.27 m
Length	26.50 m	Slope	0.004528 m/m
Drop	0.12 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+31	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	245.77
0+13	245.27
0+31	245.77

Tailwater conditions for Design Storm.

Discharge	1.4890 m ³ /s	Actual Depth	0.23 m
Velocity	0.94 m/s		

Tailwater conditions for Check Storm.

Discharge	1.6680 m ³ /s	Actual Depth	0.24 m
Velocity	0.97 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-1390 x 970 mm Arch	1.4890 m ³ /s	246.37 m	2.22 m/s
Trial-2	1-1390 x 970 mm Arch	1.6680 m ³ /s	246.45 m	2.32 m/s

Culvert Designer/Analyzer Report

C7 - 50 Yr & 100 Yr - Existing

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	246.37 m	Discharge	1.4890 m ³ /s
Headwater Depth/Height	1.01	Tailwater Elevation	245.50 m
Inlet Control HW Elev.	246.29 m	Control Type	Outlet Control
Outlet Control HW Elev.	246.37 m		

Grades			
Upstream Invert	245.39 m	Downstream Invert	245.27 m
Length	26.50 m	Constructed Slope	0.004528 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.52 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.52 m
Velocity Downstream	2.22 m/s	Critical Slope	0.013524 m/m

Section			
Section Shape	Arch	Mannings Coefficient	0.024
Section Material	CMP	Span	1.45 m
Section Size	1390 x 970 mm	Rise	0.97 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	246.37 m	Upstream Velocity Head	0.13 m
Ke	0.90	Entrance Loss	0.12 m

Inlet Control Properties			
Inlet Control HW Elev.	246.29 m	Flow Control	Unsubmerged
Inlet Type	Thin wall projecting	Area Full	1.1 m ²
K	0.03400	HDS 5 Chart	34
M	1.50000	HDS 5 Scale	3
C	0.04960	Equation Form	1
Y	0.57000		

Culvert Designer/Analyzer Report

C7 - 50 Yr & 100 Yr - Existing

Design: Trial-2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Check
Computed Headwater Elev:	246.45 m	Discharge	1.6680 m ³ /s
Headwater Depth/Height	1.10	Tailwater Elevation	245.51 m
Inlet Control HW Elev.	246.38 m	Control Type	Outlet Control
Outlet Control HW Elev.	246.45 m		

Grades			
Upstream Invert	245.39 m	Downstream Invert	245.27 m
Length	26.50 m	Constructed Slope	0.004528 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.56 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.56 m
Velocity Downstream	2.32 m/s	Critical Slope	0.014205 m/m

Section			
Section Shape	Arch	Mannings Coefficient	0.024
Section Material	CMP	Span	1.45 m
Section Size	1390 x 970 mm	Rise	0.97 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	246.45 m	Upstream Velocity Head	0.15 m
Ke	0.90	Entrance Loss	0.13 m

Inlet Control Properties			
Inlet Control HW Elev.	246.38 m	Flow Control	Unsubmerged
Inlet Type	Thin wall projecting	Area Full	1.1 m ²
K	0.03400	HDS 5 Chart	34
M	1.50000	HDS 5 Scale	3
C	0.04960	Equation Form	1
Y	0.57000		

Culvert Designer/Analyzer Report

C7 - Regional - Existing

Analysis Component			
Storm Event	Design	Discharge	2.7930 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	2.7930 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+31	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	245.77
0+13	245.27
0+31	245.77

Tailwater conditions for Design Storm.			
Discharge	2.7930 m ³ /s	Actual Depth	0.29 m
Velocity	1.10 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1390 x 970 mm Arch	2.3569 m ³ /s	246.91 m	2.71 m/s
Weir	Roadway	0.4378 m ³ /s	246.91 m	N/A
Total	-----	2.7947 m ³ /s	246.91 m	N/A

Culvert Designer/Analyzer Report

C7 - Regional - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	246.91 m	Discharge	2.3569 m ³ /s
Inlet Control HW Elev.	246.72 m	Tailwater Elevation	245.56 m
Outlet Control HW Elev.	246.91 m	Control Type	Outlet Control
Headwater Depth/Height	1.58		

Grades			
Upstream Invert	245.39 m	Downstream Invert	245.27 m
Length	26.50 m	Constructed Slope	0.004528 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.68 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.68 m
Velocity Downstream	2.71 m/s	Critical Slope	0.017656 m/m

Section			
Section Shape	Arch	Mannings Coefficient	0.024
Section Material	CMP	Span	1.45 m
Section Size	1390 x 970 mm	Rise	0.97 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	246.91 m	Upstream Velocity Head	0.24 m
Ke	0.90	Entrance Loss	0.22 m

Inlet Control Properties			
Inlet Control HW Elev.	246.72 m	Flow Control	Submerged
Inlet Type	Thin wall projecting	Area Full	1.1 m ²
K	0.03400	HDS 5 Chart	34
M	1.50000	HDS 5 Scale	3
C	0.04960	Equation Form	1
Y	0.57000		

Culvert Designer/Analyzer Report

C7 - Regional - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.4378 m ³ /s	Allowable HW Elevation	246.91 m
Roadway Width	9.00 m	Overtopping Coefficient	1.61 SI
Low Point	246.82 m	Headwater Elevation	246.91 m
Discharge Coefficient (Cr)	2.92	Submergence Factor (Kt)	1.00
Tailwater Elevation	245.56 m		

Sta (m)	Elev. (m)
4,860.00	246.82
4,880.00	246.89
4,900.00	246.98
4,920.00	247.11
4,940.00	247.24
4,960.00	247.34

Culvert Designer/Analyzer Report C8 - 50 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	0.8670 m ³ /s
Peak Discharge Method: User-Specified			
Design Discharge	0.8670 m ³ /s	Check Discharge	0.0000 m ³ /s
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	253.79 m		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-600 mm Circular	0.4519 m ³ /s	254.62 m	2.01 m/s
Weir	Roadway	0.4162 m ³ /s	254.62 m	N/A
Total	-----	0.8680 m ³ /s	254.62 m	N/A

Culvert Designer/Analyzer Report

C8 - 50 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	254.62 m	Discharge	0.4519 m ³ /s
Inlet Control HW Elev.	254.38 m	Tailwater Elevation	253.79 m
Outlet Control HW Elev.	254.62 m	Control Type	Outlet Control
Headwater Depth/Height	1.70		

Grades			
Upstream Invert	253.59 m	Downstream Invert	253.52 m
Length	21.00 m	Constructed Slope	0.003333 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.44 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.44 m
Velocity Downstream	2.01 m/s	Critical Slope	0.022497 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.61 m
Section Size	600 mm	Rise	0.61 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	254.62 m	Upstream Velocity Head	0.12 m
Ke	0.90	Entrance Loss	0.11 m

Inlet Control Properties			
Inlet Control HW Elev.	254.38 m	Flow Control	Transition
Inlet Type	Projecting	Area Full	0.3 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C8 - 50 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.4162 m ³ /s	Allowable HW Elevation	254.62 m
Roadway Width	9.00 m	Overtopping Coefficient	1.61 SI
Low Point	254.51 m	Headwater Elevation	254.62 m
Discharge Coefficient (Cr)	2.92	Submergence Factor (Kt)	1.00
Tailwater Elevation	253.79 m		

Sta (m)	Elev. (m)
6,240.00	254.97
6,260.00	254.90
6,280.00	254.86
6,300.00	254.72
6,320.00	254.63
6,340.00	254.51

Culvert Designer/Analyzer Report C8 - 100 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	0.9770 m ³ /s
Peak Discharge Method: User-Specified			
Design Discharge	0.9770 m ³ /s	Check Discharge	0.0000 m ³ /s
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	253.79 m		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-600 mm Circular	0.4553 m ³ /s	254.63 m	2.02 m/s
Weir	Roadway	0.5236 m ³ /s	254.63 m	N/A
Total	-----	0.9789 m ³ /s	254.63 m	N/A

Culvert Designer/Analyzer Report

C8 - 100 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	254.63 m	Discharge	0.4553 m ³ /s
Inlet Control HW Elev.	254.38 m	Tailwater Elevation	253.79 m
Outlet Control HW Elev.	254.63 m	Control Type	Outlet Control
Headwater Depth/Height	1.71		

Grades			
Upstream Invert	253.59 m	Downstream Invert	253.52 m
Length	21.00 m	Constructed Slope	0.003333 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.44 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.44 m
Velocity Downstream	2.02 m/s	Critical Slope	0.022625 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.61 m
Section Size	600 mm	Rise	0.61 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	254.63 m	Upstream Velocity Head	0.12 m
Ke	0.90	Entrance Loss	0.11 m

Inlet Control Properties			
Inlet Control HW Elev.	254.38 m	Flow Control	Transition
Inlet Type	Projecting	Area Full	0.3 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C8 - 100 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.5236 m ³ /s	Allowable HW Elevation	254.63 m
Roadway Width	9.00 m	Overtopping Coefficient	1.61 SI
Low Point	254.51 m	Headwater Elevation	254.63 m
Discharge Coefficient (Cr)	2.92	Submergence Factor (Kt)	1.00
Tailwater Elevation	253.79 m		

Sta (m)	Elev. (m)
6,240.00	254.97
6,260.00	254.90
6,280.00	254.86
6,300.00	254.72
6,320.00	254.63
6,340.00	254.51

Culvert Designer/Analyzer Report C8 - Regional - Existing

Analysis Component				
Storm Event	Design	Discharge	1.4530 m ³ /s	
Peak Discharge Method: User-Specified				
Design Discharge	1.4530 m ³ /s	Check Discharge	0.0000 m ³ /s	
Tailwater Conditions: Constant Tailwater				
Tailwater Elevation	253.79 m			

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-600 mm Circular	0.4658 m ³ /s	254.67 m	2.04 m/s
Weir	Roadway	0.9872 m ³ /s	254.67 m	N/A
Total	-----	1.4530 m ³ /s	254.67 m	N/A

Culvert Designer/Analyzer Report

C8 - Regional - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	254.67 m	Discharge	0.4658 m ³ /s
Inlet Control HW Elev.	254.40 m	Tailwater Elevation	253.79 m
Outlet Control HW Elev.	254.67 m	Control Type	Outlet Control
Headwater Depth/Height	1.76		

Grades			
Upstream Invert	253.59 m	Downstream Invert	253.52 m
Length	21.00 m	Constructed Slope	0.003333 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.45 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.45 m
Velocity Downstream	2.04 m/s	Critical Slope	0.023030 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.61 m
Section Size	600 mm	Rise	0.61 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	254.67 m	Upstream Velocity Head	0.13 m
Ke	0.90	Entrance Loss	0.12 m

Inlet Control Properties			
Inlet Control HW Elev.	254.40 m	Flow Control	Transition
Inlet Type	Projecting	Area Full	0.3 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C8 - Regional - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.9872 m ³ /s	Allowable HW Elevation	254.67 m
Roadway Width	9.00 m	Overtopping Coefficient	1.62 SI
Low Point	254.51 m	Headwater Elevation	254.67 m
Discharge Coefficient (Cr)	2.93	Submergence Factor (Kt)	1.00
Tailwater Elevation	253.79 m		

Sta (m)	Elev. (m)
6,240.00	254.97
6,260.00	254.90
6,280.00	254.86
6,300.00	254.72
6,320.00	254.63
6,340.00	254.51

Culvert Designer/Analyzer Report C9 - 50 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	3.9500 m ³ /s
Peak Discharge Method: User-Specified			
Design Discharge	3.9500 m ³ /s	Check Discharge	0.0000 m ³ /s
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	251.24 m		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	1.9514 m ³ /s	253.08 m	3.69 m/s
Weir	Roadway	2.0103 m ³ /s	253.08 m	N/A
Total	-----	3.9617 m ³ /s	253.08 m	N/A

Culvert Designer/Analyzer Report

C9 - 50 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	253.08 m	Discharge	1.9514 m ³ /s
Inlet Control HW Elev.	253.08 m	Tailwater Elevation	251.24 m
Outlet Control HW Elev.	252.93 m	Control Type	Inlet Control
Headwater Depth/Height	2.27		

Grades			
Upstream Invert	251.00 m	Downstream Invert	250.00 m
Length	22.90 m	Constructed Slope	0.043668 m/m

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	0.69 m
Slope Type	N/A	Normal Depth	0.69 m
Flow Regime	N/A	Critical Depth	0.81 m
Velocity Downstream	3.69 m/s	Critical Slope	0.032701 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	252.93 m	Upstream Velocity Head	0.52 m
Ke	0.90	Entrance Loss	0.41 m

Inlet Control Properties			
Inlet Control HW Elev.	253.08 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.7 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C9 - 50 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	2.0103	m ³ /s	Allowable HW Elevation 253.08 m
Roadway Width	9.00	m	Overtopping Coefficient 1.62 SI
Low Point	253.02	m	Headwater Elevation 253.08 m
Discharge Coefficient (Cr)	2.93		Submergence Factor (Kt) 1.00
Tailwater Elevation	251.24	m	

Sta (m)	Elev. (m)
6,700.00	253.16
6,720.00	253.09
6,740.00	253.02
6,760.00	253.03
6,780.00	253.05
6,800.00	253.04
6,820.00	253.02
6,840.00	253.04
6,860.00	253.04
6,880.00	253.04
6,900.00	253.10
6,920.00	253.18

Culvert Designer/Analyzer Report C9 - 100 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	4.5080 m ³ /s
Peak Discharge Method: User-Specified			
Design Discharge	4.5080 m ³ /s	Check Discharge	0.0000 m ³ /s
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	251.24 m		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	1.9555 m ³ /s	253.08 m	3.69 m/s
Weir	Roadway	2.5589 m ³ /s	253.08 m	N/A
Total	-----	4.5144 m ³ /s	253.08 m	N/A

Culvert Designer/Analyzer Report

C9 - 100 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	253.08 m	Discharge	1.9555 m ³ /s
Inlet Control HW Elev.	253.08 m	Tailwater Elevation	251.24 m
Outlet Control HW Elev.	252.94 m	Control Type	Inlet Control
Headwater Depth/Height	2.28		

Grades			
Upstream Invert	251.00 m	Downstream Invert	250.00 m
Length	22.90 m	Constructed Slope	0.043668 m/m

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	0.69 m
Slope Type	N/A	Normal Depth	0.69 m
Flow Regime	N/A	Critical Depth	0.81 m
Velocity Downstream	3.69 m/s	Critical Slope	0.032813 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	252.94 m	Upstream Velocity Head	0.52 m
Ke	0.90	Entrance Loss	0.41 m

Inlet Control Properties			
Inlet Control HW Elev.	253.08 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.7 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C9 - 100 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	2.5589 m ³ /s	Allowable HW Elevation	253.08 m
Roadway Width	9.00 m	Overtopping Coefficient	1.62 SI
Low Point	253.02 m	Headwater Elevation	253.08 m
Discharge Coefficient (Cr)	2.94	Submergence Factor (Kt)	1.00
Tailwater Elevation	251.24 m		

Sta (m)	Elev. (m)
6,700.00	253.16
6,720.00	253.09
6,740.00	253.02
6,760.00	253.03
6,780.00	253.05
6,800.00	253.04
6,820.00	253.02
6,840.00	253.04
6,860.00	253.04
6,880.00	253.04
6,900.00	253.10
6,920.00	253.18

Culvert Designer/Analyzer Report C9 - Regional - Existing

Analysis Component			
Storm Event	Design	Discharge	7.6330 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	7.6330 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	251.24 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	1.9738 m ³ /s	253.11 m	3.69 m/s
Weir	Roadway	5.6733 m ³ /s	253.11 m	N/A
Total	-----	7.6471 m ³ /s	253.11 m	N/A

Culvert Designer/Analyzer Report

C9 - Regional - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	253.11 m	Discharge	1.9738 m ³ /s
Inlet Control HW Elev.	253.11 m	Tailwater Elevation	251.24 m
Outlet Control HW Elev.	252.97 m	Control Type	Inlet Control
Headwater Depth/Height	2.31		

Grades			
Upstream Invert	251.00 m	Downstream Invert	250.00 m
Length	22.90 m	Constructed Slope	0.043668 m/m

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	0.69 m
Slope Type	N/A	Normal Depth	0.69 m
Flow Regime	N/A	Critical Depth	0.81 m
Velocity Downstream	3.69 m/s	Critical Slope	0.033309 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	252.97 m	Upstream Velocity Head	0.53 m
Ke	0.90	Entrance Loss	0.41 m

Inlet Control Properties			
Inlet Control HW Elev.	253.11 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.7 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C9 - Regional - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	5.6733	m ³ /s	Allowable HW Elevation 253.11 m
Roadway Width	9.00	m	Overtopping Coefficient 1.63 SI
Low Point	253.02	m	Headwater Elevation 253.11 m
Discharge Coefficient (Cr)	2.96		Submergence Factor (Kt) 1.00
Tailwater Elevation	251.24	m	

Sta (m)	Elev. (m)
6,700.00	253.16
6,720.00	253.09
6,740.00	253.02
6,760.00	253.03
6,780.00	253.05
6,800.00	253.04
6,820.00	253.02
6,840.00	253.04
6,860.00	253.04
6,880.00	253.04
6,900.00	253.10
6,920.00	253.18

Culvert Designer/Analyzer Report C10 - 50 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	2.5480 m ³ /s
Peak Discharge Method: User-Specified			
Design Discharge	2.5480 m ³ /s	Check Discharge	0.0000 m ³ /s
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	252.56 m		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-700 mm Circular	0.8109 m ³ /s	254.00 m	2.43 m/s
Weir	Roadway (Constant Elevation)	1.7423 m ³ /s	254.00 m	N/A
Total	-----	2.5532 m³/s	254.00 m	N/A

Culvert Designer/Analyzer Report

C10 - 50 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	254.00 m	Discharge	0.8109 m ³ /s
Inlet Control HW Elev.	253.50 m	Tailwater Elevation	252.56 m
Outlet Control HW Elev.	254.00 m	Control Type	Outlet Control
Headwater Depth/Height	2.40		

Grades			
Upstream Invert	252.32 m	Downstream Invert	252.24 m
Length	26.50 m	Constructed Slope	0.003019 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.57 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.57 m
Velocity Downstream	2.43 m/s	Critical Slope	0.026825 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.70 m
Section Size	700 mm	Rise	0.70 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	254.00 m	Upstream Velocity Head	0.23 m
Ke	0.90	Entrance Loss	0.20 m

Inlet Control Properties			
Inlet Control HW Elev.	253.50 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.4 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C10 - 50 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway (Constant Elevation)

Discharge	1.7423 m ³ /s	Allowable HW Elevation	254.00 m
Roadway Width	5.00 m	Overtopping Coefficient	1.64 SI
Length	50.00 m	Crest Elevation	253.92 m
Headwater Elevation	254.00 m	Discharge Coefficient (Cr)	2.97
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	253.92
50.00	253.92

Culvert Designer/Analyzer Report C10 - 100 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	2.8490 m ³ /s
Peak Discharge Method: User-Specified			
Design Discharge	2.8490 m ³ /s	Check Discharge	0.0000 m ³ /s
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	252.56 m		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-700 mm Circular	0.8137 m ³ /s	254.01 m	2.44 m/s
Weir	Roadway (Constant Elevation)	2.0365 m ³ /s	254.01 m	N/A
Total	-----	2.8502 m³/s	254.01 m	N/A

Culvert Designer/Analyzer Report

C10 - 100 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	254.01 m	Discharge	0.8137 m ³ /s
Inlet Control HW Elev.	253.51 m	Tailwater Elevation	252.56 m
Outlet Control HW Elev.	254.01 m	Control Type	Outlet Control
Headwater Depth/Height	2.41		

Grades			
Upstream Invert	252.32 m	Downstream Invert	252.24 m
Length	26.50 m	Constructed Slope	0.003019 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.57 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.57 m
Velocity Downstream	2.44 m/s	Critical Slope	0.026930 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.70 m
Section Size	700 mm	Rise	0.70 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	254.01 m	Upstream Velocity Head	0.23 m
Ke	0.90	Entrance Loss	0.21 m

Inlet Control Properties			
Inlet Control HW Elev.	253.51 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.4 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C10 - 100 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway (Constant Elevation)

Discharge	2.0365 m ³ /s	Allowable HW Elevation	254.01 m
Roadway Width	5.00 m	Overtopping Coefficient	1.64 SI
Length	50.00 m	Crest Elevation	253.92 m
Headwater Elevation	254.01 m	Discharge Coefficient (Cr)	2.97
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	253.92
50.00	253.92

Culvert Designer/Analyzer Report C10 - Regional - Existing

Analysis Component			
Storm Event	Design	Discharge	4.9340 m ³ /s
Peak Discharge Method: User-Specified			
Design Discharge	4.9340 m ³ /s	Check Discharge	0.0000 m ³ /s
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	252.56 m		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-700 mm Circular	0.8303 m ³ /s	254.05 m	2.47 m/s
Weir	Roadway (Constant Elevation)	4.1095 m ³ /s	254.05 m	N/A
Total	-----	4.9398 m³/s	254.05 m	N/A

Culvert Designer/Analyzer Report

C10 - Regional - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	254.06 m	Discharge	0.8303 m ³ /s
Inlet Control HW Elev.	253.54 m	Tailwater Elevation	252.56 m
Outlet Control HW Elev.	254.06 m	Control Type	Outlet Control
Headwater Depth/Height	2.48		

Grades			
Upstream Invert	252.32 m	Downstream Invert	252.24 m
Length	26.50 m	Constructed Slope	0.003019 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.57 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.57 m
Velocity Downstream	2.47 m/s	Critical Slope	0.027575 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.70 m
Section Size	700 mm	Rise	0.70 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	254.06 m	Upstream Velocity Head	0.24 m
Ke	0.90	Entrance Loss	0.21 m

Inlet Control Properties			
Inlet Control HW Elev.	253.54 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.4 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C10 - Regional - Existing

Component: Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	4.1095 m ³ /s	Allowable HW Elevation	254.05 m
Roadway Width	5.00 m	Overtopping Coefficient	1.66 SI
Length	50.00 m	Crest Elevation	253.92 m
Headwater Elevation	254.06 m	Discharge Coefficient (Cr)	3.00
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	253.92
50.00	253.92

Culvert Designer/Analyzer Report

C12 - 50 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	1.9310 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	1.9310 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+31	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	245.77
0+13	245.27
0+31	245.77

Tailwater conditions for Design Storm.			
Discharge	1.9310 m ³ /s	Actual Depth	0.25 m
Velocity	1.01 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	1.6702 m ³ /s	262.58 m	2.87 m/s
Weir	Roadway	0.2612 m ³ /s	262.58 m	N/A
Total	-----	1.9315 m ³ /s	262.58 m	N/A

Culvert Designer/Analyzer Report

C12 - 50 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	262.58 m	Discharge	1.6702 m ³ /s
Inlet Control HW Elev.	262.40 m	Tailwater Elevation	245.52 m
Outlet Control HW Elev.	262.58 m	Control Type	Outlet Control
Headwater Depth/Height	2.02		

Grades			
Upstream Invert	260.74 m	Downstream Invert	260.42 m
Length	26.40 m	Constructed Slope	0.012121 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.76 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.76 m
Velocity Downstream	2.87 m/s	Critical Slope	0.026195 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	Aluminum	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	262.58 m	Upstream Velocity Head	0.33 m
Ke	0.90	Entrance Loss	0.30 m

Inlet Control Properties			
Inlet Control HW Elev.	262.40 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C12 - 50 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.2612	m ³ /s	Allowable HW Elevation 262.58 m
Roadway Width	9.00	m	Overtopping Coefficient 1.61 SI
Low Point	262.47	m	Headwater Elevation 262.58 m
Discharge Coefficient (Cr)	2.91		Submergence Factor (Kt) 1.00
Tailwater Elevation	245.52	m	

Sta (m)	Elev. (m)
8,560.00	262.47
8,580.00	262.66
8,600.00	262.78
8,620.00	262.91
8,640.00	263.03
8,660.00	263.16
8,680.00	263.32
8,700.00	263.44

Culvert Designer/Analyzer Report

C12 - 100 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	2.1670 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	2.1670 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+31	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	245.77
0+13	245.27
0+31	245.77

Tailwater conditions for Design Storm.			
Discharge	2.1670 m ³ /s	Actual Depth	0.26 m
Velocity	1.04 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	1.6881 m ³ /s	262.62 m	2.89 m/s
Weir	Roadway	0.4795 m ³ /s	262.62 m	N/A
Total	-----	2.1676 m ³ /s	262.62 m	N/A

Culvert Designer/Analyzer Report

C12 - 100 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	262.62 m	Discharge	1.6881 m ³ /s
Inlet Control HW Elev.	262.43 m	Tailwater Elevation	245.53 m
Outlet Control HW Elev.	262.62 m	Control Type	Outlet Control
Headwater Depth/Height	2.05		

Grades			
Upstream Invert	260.74 m	Downstream Invert	260.42 m
Length	26.40 m	Constructed Slope	0.012121 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.76 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.76 m
Velocity Downstream	2.89 m/s	Critical Slope	0.026551 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	Aluminum	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	262.62 m	Upstream Velocity Head	0.34 m
Ke	0.90	Entrance Loss	0.30 m

Inlet Control Properties			
Inlet Control HW Elev.	262.43 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.7 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C12 - 100 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.4795 m ³ /s	Allowable HW Elevation	262.62 m
Roadway Width	9.00 m	Overtopping Coefficient	1.61 SI
Low Point	262.47 m	Headwater Elevation	262.61 m
Discharge Coefficient (Cr)	2.91	Submergence Factor (Kt)	1.00
Tailwater Elevation	245.53 m		

Sta (m)	Elev. (m)
8,560.00	262.47
8,580.00	262.66
8,600.00	262.78
8,620.00	262.91
8,640.00	263.03
8,660.00	263.16
8,680.00	263.32
8,700.00	263.44

Culvert Designer/Analyzer Report

C12 - Regional - Existing

Analysis Component			
Storm Event	Design	Discharge	4.0470 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	4.0470 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+31	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	245.77
0+13	245.27
0+31	245.77

Tailwater conditions for Design Storm.			
Discharge	4.0470 m ³ /s	Actual Depth	0.33 m
Velocity	1.21 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	1.7531 m ³ /s	262.73 m	2.96 m/s
Weir	Roadway	2.2976 m ³ /s	262.73 m	N/A
Total	-----	4.0507 m ³ /s	262.73 m	N/A

Culvert Designer/Analyzer Report

C12 - Regional - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	262.73 m	Discharge	1.7531 m ³ /s
Inlet Control HW Elev.	262.52 m	Tailwater Elevation	245.60 m
Outlet Control HW Elev.	262.73 m	Control Type	Outlet Control
Headwater Depth/Height	2.18		

Grades			
Upstream Invert	260.74 m	Downstream Invert	260.42 m
Length	26.40 m	Constructed Slope	0.012121 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.77 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.77 m
Velocity Downstream	2.96 m/s	Critical Slope	0.027905 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	Aluminum	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	262.73 m	Upstream Velocity Head	0.36 m
Ke	0.90	Entrance Loss	0.33 m

Inlet Control Properties			
Inlet Control HW Elev.	262.52 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.7 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C12 - Regional - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	2.2976 m ³ /s	Allowable HW Elevation	262.73 m
Roadway Width	9.00 m	Overtopping Coefficient	1.62 SI
Low Point	262.47 m	Headwater Elevation	262.73 m
Discharge Coefficient (Cr)	2.93	Submergence Factor (Kt)	1.00
Tailwater Elevation	245.60 m		

Sta (m)	Elev. (m)
8,560.00	262.47
8,580.00	262.66
8,600.00	262.78
8,620.00	262.91
8,640.00	263.03
8,660.00	263.16
8,680.00	263.32
8,700.00	263.44

Culvert Designer/Analyzer Report

C14 - 50 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	1.5620 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	1.5620 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+12	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	268.00
0+06	267.50
0+08	267.50
0+12	268.00

Tailwater conditions for Design Storm.			
Discharge	1.5620 m ³ /s	Actual Depth	0.26 m
Velocity	1.45 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	1.1116 m ³ /s	268.96 m	3.14 m/s
Weir	Roadway	0.4516 m ³ /s	268.96 m	N/A
Total	-----	1.5632 m ³ /s	268.96 m	N/A

Culvert Designer/Analyzer Report

C14 - 50 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	268.96 m	Discharge	1.1116 m ³ /s
Inlet Control HW Elev.	268.86 m	Tailwater Elevation	267.76 m
Outlet Control HW Elev.	268.96 m	Control Type	Entrance Control
Headwater Depth/Height	1.14		

Grades			
Upstream Invert	267.92 m	Downstream Invert	267.64 m
Length	24.10 m	Constructed Slope	0.011618 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.49 m
Slope Type	Steep	Normal Depth	0.46 m
Flow Regime	Supercritical	Critical Depth	0.62 m
Velocity Downstream	3.14 m/s	Critical Slope	0.004550 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.012
Section Material	HDPE (Smooth Interior)	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	268.96 m	Upstream Velocity Head	0.28 m
Ke	0.50	Entrance Loss	0.14 m

Inlet Control Properties			
Inlet Control HW Elev.	268.86 m	Flow Control	Unsubmerged
Inlet Type	Groove end projecting	Area Full	0.7 m ²
K	0.00450	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	3
C	0.03170	Equation Form	1
Y	0.69000		

Culvert Designer/Analyzer Report

C14 - 50 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.4516 m ³ /s	Allowable HW Elevation	268.96 m
Roadway Width	9.00 m	Overtopping Coefficient	1.61 SI
Low Point	268.79 m	Headwater Elevation	268.96 m
Discharge Coefficient (Cr)	2.92	Submergence Factor (Kt)	1.00
Tailwater Elevation	267.76 m		

Sta (m)	Elev. (m)
11,120.00	268.79
11,140.00	269.09
11,160.00	269.84
11,180.00	270.57
11,200.00	271.33

Culvert Designer/Analyzer Report

C14 - 100 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	1.7650 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	1.7650 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+12	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	268.00
0+06	267.50
0+08	267.50
0+12	268.00

Tailwater conditions for Design Storm.			
Discharge	1.7650 m ³ /s	Actual Depth	0.28 m
Velocity	1.50 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	1.1487 m ³ /s	268.98 m	3.17 m/s
Weir	Roadway	0.6178 m ³ /s	268.98 m	N/A
Total	-----	1.7665 m ³ /s	268.98 m	N/A

Culvert Designer/Analyzer Report

C14 - 100 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	268.98 m	Discharge	1.1487 m ³ /s
Inlet Control HW Elev.	268.88 m	Tailwater Elevation	267.78 m
Outlet Control HW Elev.	268.98 m	Control Type	Entrance Control
Headwater Depth/Height	1.16		

Grades			
Upstream Invert	267.92 m	Downstream Invert	267.64 m
Length	24.10 m	Constructed Slope	0.011618 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.50 m
Slope Type	Steep	Normal Depth	0.47 m
Flow Regime	Supercritical	Critical Depth	0.63 m
Velocity Downstream	3.17 m/s	Critical Slope	0.004646 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.012
Section Material	HDPE (Smooth Interior)	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	268.98 m	Upstream Velocity Head	0.29 m
Ke	0.50	Entrance Loss	0.14 m

Inlet Control Properties			
Inlet Control HW Elev.	268.88 m	Flow Control	Unsubmerged
Inlet Type	Groove end projecting	Area Full	0.7 m ²
K	0.00450	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	3
C	0.03170	Equation Form	1
Y	0.69000		

Culvert Designer/Analyzer Report

C14 - 100 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.6178 m ³ /s	Allowable HW Elevation	268.98 m
Roadway Width	9.00 m	Overtopping Coefficient	1.62 SI
Low Point	268.79 m	Headwater Elevation	268.98 m
Discharge Coefficient (Cr)	2.93	Submergence Factor (Kt)	1.00
Tailwater Elevation	267.78 m		

Sta (m)	Elev. (m)
11,120.00	268.79
11,140.00	269.09
11,160.00	269.84
11,180.00	270.57
11,200.00	271.33

Culvert Designer/Analyzer Report

C14 - Regional - Existing

Analysis Component			
Storm Event	Design	Discharge	4.4200 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	4.4200 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+12	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	268.00
0+06	267.50
0+08	267.50
0+12	268.00

Tailwater conditions for Design Storm.			
Discharge	4.4200 m ³ /s	Actual Depth	0.42 m
Velocity	1.89 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	1.4120 m ³ /s	269.14 m	3.33 m/s
Weir	Roadway	3.0102 m ³ /s	269.14 m	N/A
Total	-----	4.4222 m ³ /s	269.14 m	N/A

Culvert Designer/Analyzer Report

C14 - Regional - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	269.14 m	Discharge	1.4120 m ³ /s
Inlet Control HW Elev.	269.03 m	Tailwater Elevation	267.92 m
Outlet Control HW Elev.	269.14 m	Control Type	Entrance Control
Headwater Depth/Height	1.34		

Grades			
Upstream Invert	267.92 m	Downstream Invert	267.64 m
Length	24.10 m	Constructed Slope	0.011618 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.56 m
Slope Type	Steep	Normal Depth	0.53 m
Flow Regime	Supercritical	Critical Depth	0.70 m
Velocity Downstream	3.33 m/s	Critical Slope	0.005457 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.012
Section Material	HDPE (Smooth Interior)	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	269.14 m	Upstream Velocity Head	0.35 m
Ke	0.50	Entrance Loss	0.17 m

Inlet Control Properties			
Inlet Control HW Elev.	269.03 m	Flow Control	Submerged
Inlet Type	Groove end projecting	Area Full	0.7 m ²
K	0.00450	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	3
C	0.03170	Equation Form	1
Y	0.69000		

Culvert Designer/Analyzer Report

C14 - Regional - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	3.0102	m ³ /s	Allowable HW Elevation 269.14 m
Roadway Width	9.00	m	Overtopping Coefficient 1.63 SI
Low Point	268.79	m	Headwater Elevation 269.14 m
Discharge Coefficient (Cr)	2.95		Submergence Factor (Kt) 1.00
Tailwater Elevation	267.92	m	

Sta (m)	Elev. (m)
11,120.00	268.79
11,140.00	269.09
11,160.00	269.84
11,180.00	270.57
11,200.00	271.33

Culvert Designer/Analyzer Report

C15 - 50 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	1.8450 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	1.8450 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+04	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	269.00
0+02	268.50
0+03	268.50
0+04	269.00

Tailwater conditions for Design Storm.			
Discharge	1.8450 m ³ /s	Actual Depth	0.40 m
Velocity	2.33 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-600 mm Circular	1.7986 m ³ /s	274.09 m	6.17 m/s
Weir	Roadway	0.0466 m ³ /s	274.09 m	N/A
Total	-----	1.8452 m ³ /s	274.09 m	N/A

Culvert Designer/Analyzer Report

C15 - 50 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	274.09 m	Discharge	1.7986 m ³ /s
Inlet Control HW Elev.	274.03 m	Tailwater Elevation	268.90 m
Outlet Control HW Elev.	274.09 m	Control Type	Outlet Control
Headwater Depth/Height	7.26		

Grades			
Upstream Invert	269.67 m	Downstream Invert	268.68 m
Length	28.30 m	Constructed Slope	0.034982 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.61 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.61 m
Velocity Downstream	6.17 m/s	Critical Slope	0.063755 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.012
Section Material	HDPE (Smooth Interior)	Span	0.61 m
Section Size	600 mm	Rise	0.61 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	274.09 m	Upstream Velocity Head	1.94 m
Ke	0.50	Entrance Loss	0.97 m

Inlet Control Properties			
Inlet Control HW Elev.	274.03 m	Flow Control	Submerged
Inlet Type	Groove end projecting	Area Full	0.3 m ²
K	0.00450	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	3
C	0.03170	Equation Form	1
Y	0.69000		

Culvert Designer/Analyzer Report

C15 - 50 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.0466 m ³ /s	Allowable HW Elevation	274.09 m
Roadway Width	9.00 m	Overtopping Coefficient	1.61 SI
Low Point	274.04 m	Headwater Elevation	274.09 m
Discharge Coefficient (Cr)	2.91	Submergence Factor (Kt)	1.00
Tailwater Elevation	268.90 m		

Sta (m)	Elev. (m)
11,820.00	274.67
11,840.00	274.35
11,860.00	274.04
11,880.00	274.41
11,900.00	274.99
11,920.00	275.69

Culvert Designer/Analyzer Report

C15 - 100 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	2.0780 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	2.0780 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+04	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	269.00
0+02	268.50
0+03	268.50
0+04	269.00

Tailwater conditions for Design Storm.			
Discharge	2.0780 m ³ /s	Actual Depth	0.42 m
Velocity	2.40 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-600 mm Circular	1.8089 m ³ /s	274.15 m	6.20 m/s
Weir	Roadway	0.2695 m ³ /s	274.15 m	N/A
Total	-----	2.0785 m ³ /s	274.15 m	N/A

Culvert Designer/Analyzer Report

C15 - 100 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	274.15 m	Discharge	1.8089 m ³ /s
Inlet Control HW Elev.	274.08 m	Tailwater Elevation	268.92 m
Outlet Control HW Elev.	274.15 m	Control Type	Outlet Control
Headwater Depth/Height	7.35		

Grades			
Upstream Invert	269.67 m	Downstream Invert	268.68 m
Length	28.30 m	Constructed Slope	0.034982 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.61 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.61 m
Velocity Downstream	6.20 m/s	Critical Slope	0.064525 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.012
Section Material	HDPE (Smooth Interior)	Span	0.61 m
Section Size	600 mm	Rise	0.61 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	274.15 m	Upstream Velocity Head	1.96 m
Ke	0.50	Entrance Loss	0.98 m

Inlet Control Properties			
Inlet Control HW Elev.	274.08 m	Flow Control	Submerged
Inlet Type	Groove end projecting	Area Full	0.3 m ²
K	0.00450	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	3
C	0.03170	Equation Form	1
Y	0.69000		

Culvert Designer/Analyzer Report

C15 - 100 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.2695 m ³ /s	Allowable HW Elevation	274.15 m
Roadway Width	9.00 m	Overtopping Coefficient	1.61 SI
Low Point	274.04 m	Headwater Elevation	274.15 m
Discharge Coefficient (Cr)	2.93	Submergence Factor (Kt)	1.00
Tailwater Elevation	268.92 m		

Sta (m)	Elev. (m)
11,820.00	274.67
11,840.00	274.35
11,860.00	274.04
11,880.00	274.41
11,900.00	274.99
11,920.00	275.69

Culvert Designer/Analyzer Report

C15 - Regional - Existing

Analysis Component			
Storm Event	Design	Discharge	4.1400 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	4.1400 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+04	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	269.00
0+02	268.50
0+03	268.50
0+04	269.00

Tailwater conditions for Design Storm.			
Discharge	4.1400 m ³ /s	Actual Depth	0.55 m
Velocity	2.94 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-600 mm Circular	1.8363 m ³ /s	274.30 m	6.29 m/s
Weir	Roadway	2.3066 m ³ /s	274.30 m	N/A
Total	-----	4.1429 m ³ /s	274.30 m	N/A

Culvert Designer/Analyzer Report

C15 - Regional - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	274.30 m	Discharge	1.8363 m ³ /s
Inlet Control HW Elev.	274.20 m	Tailwater Elevation	269.05 m
Outlet Control HW Elev.	274.30 m	Control Type	Outlet Control
Headwater Depth/Height	7.59		

Grades			
Upstream Invert	269.67 m	Downstream Invert	268.68 m
Length	28.30 m	Constructed Slope	0.034982 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.61 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.61 m
Velocity Downstream	6.29 m/s	Critical Slope	0.066591 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.012
Section Material	HDPE (Smooth Interior)	Span	0.61 m
Section Size	600 mm	Rise	0.61 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	274.30 m	Upstream Velocity Head	2.02 m
Ke	0.50	Entrance Loss	1.01 m

Inlet Control Properties			
Inlet Control HW Elev.	274.20 m	Flow Control	Submerged
Inlet Type	Groove end projecting	Area Full	0.3 m ²
K	0.00450	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	3
C	0.03170	Equation Form	1
Y	0.69000		

Culvert Designer/Analyzer Report

C15 - Regional - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	2.3066 m ³ /s	Allowable HW Elevation	274.30 m
Roadway Width	9.00 m	Overtopping Coefficient	1.63 SI
Low Point	274.04 m	Headwater Elevation	274.30 m
Discharge Coefficient (Cr)	2.95	Submergence Factor (Kt)	1.00
Tailwater Elevation	269.05 m		

Sta (m)	Elev. (m)
11,820.00	274.67
11,840.00	274.35
11,860.00	274.04
11,880.00	274.41
11,900.00	274.99
11,920.00	275.69

Culvert Designer/Analyzer Report

C16 - 50 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	3.9590 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	3.9590 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+07	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	270.30
0+02	269.80
0+03	269.29
0+04	269.29
0+06	269.80
0+07	270.30

Tailwater conditions for Design Storm.			
Discharge	3.9590 m ³ /s	Actual Depth	0.63 m
Velocity	2.13 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1800 mm Circular	3.9596 m ³ /s	271.16 m	2.77 m/s
Weir	Roadway	0.0000 m ³ /s	271.16 m	N/A
Total	-----	3.9596 m ³ /s	271.16 m	N/A

Culvert Designer/Analyzer Report

C16 - 50 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	271.16 m	Discharge	3.9596 m ³ /s
Inlet Control HW Elev.	271.02 m	Tailwater Elevation	269.92 m
Outlet Control HW Elev.	271.16 m	Control Type	Outlet Control
Headwater Depth/Height	0.92		

Grades			
Upstream Invert	269.48 m	Downstream Invert	269.29 m
Length	50.20 m	Constructed Slope	0.003785 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.98 m
Slope Type	Mild	Normal Depth	1.48 m
Flow Regime	Subcritical	Critical Depth	0.98 m
Velocity Downstream	2.77 m/s	Critical Slope	0.011891 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.83 m
Section Size	1800 mm	Rise	1.83 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	271.16 m	Upstream Velocity Head	0.20 m
Ke	0.90	Entrance Loss	0.18 m

Inlet Control Properties			
Inlet Control HW Elev.	271.02 m	Flow Control	Unsubmerged
Inlet Type	Projecting	Area Full	2.6 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C16 - 50 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.0000	m ³ /s	Allowable HW Elevation 271.16 m
Roadway Width	6.16	m	Overtopping Coefficient 1.60 SI
Low Point	273.00	m	Headwater Elevation N/A m
Discharge Coefficient (Cr)	2.90		Submergence Factor (Kt) 1.00
Tailwater Elevation	269.92	m	

Sta (m)	Elev. (m)
20,060.00	274.00
20,080.00	273.50
20,100.00	273.00
20,120.00	273.00
20,140.00	273.50

Culvert Designer/Analyzer Report

C16 - 100 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	4.4910 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	4.4910 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+07	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	270.30
0+02	269.80
0+03	269.29
0+04	269.29
0+06	269.80
0+07	270.30

Tailwater conditions for Design Storm.			
Discharge	4.4910 m ³ /s	Actual Depth	0.67 m
Velocity	2.20 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1800 mm Circular	4.4904 m ³ /s	271.30 m	2.90 m/s
Weir	Roadway	0.0000 m ³ /s	271.30 m	N/A
Total	-----	4.4904 m ³ /s	271.30 m	N/A

Culvert Designer/Analyzer Report

C16 - 100 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	271.30 m	Discharge	4.4904 m ³ /s
Inlet Control HW Elev.	271.16 m	Tailwater Elevation	269.96 m
Outlet Control HW Elev.	271.30 m	Control Type	Outlet Control
Headwater Depth/Height	1.00		

Grades			
Upstream Invert	269.48 m	Downstream Invert	269.29 m
Length	50.20 m	Constructed Slope	0.003785 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.04 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	1.04 m
Velocity Downstream	2.90 m/s	Critical Slope	0.012360 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.83 m
Section Size	1800 mm	Rise	1.83 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	271.30 m	Upstream Velocity Head	0.22 m
Ke	0.90	Entrance Loss	0.20 m

Inlet Control Properties			
Inlet Control HW Elev.	271.16 m	Flow Control	Unsubmerged
Inlet Type	Projecting	Area Full	2.6 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C16 - 100 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.0000	m ³ /s	Allowable HW Elevation 271.30 m
Roadway Width	6.16	m	Overtopping Coefficient 1.60 SI
Low Point	273.00	m	Headwater Elevation N/A m
Discharge Coefficient (Cr)	2.90		Submergence Factor (Kt) 1.00
Tailwater Elevation	269.96	m	

Sta (m)	Elev. (m)
20,060.00	274.00
20,080.00	273.50
20,100.00	273.00
20,120.00	273.00
20,140.00	273.50

Culvert Designer/Analyzer Report

C16 - Regional - Existing

Analysis Component			
Storm Event	Design	Discharge	10.2300 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	10.2300 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+07	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	270.30
0+02	269.80
0+03	269.29
0+04	269.29
0+06	269.80
0+07	270.30

Tailwater conditions for Design Storm.			
Discharge	10.2300 m ³ /s	Actual Depth	0.97 m
Velocity	2.71 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1800 mm Circular	9.0956 m ³ /s	273.10 m	3.97 m/s
Weir	Roadway	1.1372 m ³ /s	273.10 m	N/A
Total	-----	10.2328 m ³ /s	273.10 m	N/A

Culvert Designer/Analyzer Report

C16 - Regional - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	273.10 m	Discharge	9.0956 m ³ /s
Inlet Control HW Elev.	272.64 m	Tailwater Elevation	270.26 m
Outlet Control HW Elev.	273.10 m	Control Type	Outlet Control
Headwater Depth/Height	1.98		

Grades			
Upstream Invert	269.48 m	Downstream Invert	269.29 m
Length	50.20 m	Constructed Slope	0.003785 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	1.49 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	1.49 m
Velocity Downstream	3.97 m/s	Critical Slope	0.019853 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.83 m
Section Size	1800 mm	Rise	1.83 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	273.10 m	Upstream Velocity Head	0.61 m
Ke	0.90	Entrance Loss	0.55 m

Inlet Control Properties			
Inlet Control HW Elev.	272.64 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	2.6 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C16 - Regional - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	1.1372	m ³ /s	Allowable HW Elevation 273.10 m
Roadway Width	6.16	m	Overtopping Coefficient 1.63 SI
Low Point	273.00	m	Headwater Elevation 273.10 m
Discharge Coefficient (Cr)	2.95		Submergence Factor (Kt) 1.00
Tailwater Elevation	270.26	m	

Sta (m)	Elev. (m)
20,060.00	274.00
20,080.00	273.50
20,100.00	273.00
20,120.00	273.00
20,140.00	273.50

Culvert Designer/Analyzer Report

C17 - 25 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	0.9320 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	0.9320 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+08	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	275.00
0+05	273.50
0+06	273.50
0+08	274.50

Tailwater conditions for Design Storm.			
Discharge	0.9320 m ³ /s	Actual Depth	0.39 m
Velocity	1.12 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.9320 m ³ /s	275.47 m	2.18 m/s
Weir	Roadway	0.0000 m ³ /s	275.47 m	N/A
Total	-----	0.9320 m ³ /s	275.47 m	N/A

Culvert Designer/Analyzer Report

C17 - 25 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	275.47 m	Discharge	0.9320 m ³ /s
Inlet Control HW Elev.	275.40 m	Tailwater Elevation	273.89 m
Outlet Control HW Elev.	275.47 m	Control Type	Outlet Control
Headwater Depth/Height	1.10		

Grades			
Upstream Invert	274.46 m	Downstream Invert	273.50 m
Length	65.50 m	Constructed Slope	0.014656 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.57 m
Slope Type	Mild	Normal Depth	0.59 m
Flow Regime	Subcritical	Critical Depth	0.57 m
Velocity Downstream	2.18 m/s	Critical Slope	0.016588 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	275.47 m	Upstream Velocity Head	0.22 m
Ke	0.90	Entrance Loss	0.20 m

Inlet Control Properties			
Inlet Control HW Elev.	275.40 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C17 - 25 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.0000	m ³ /s	Allowable HW Elevation 275.47 m
Roadway Width	9.00	m	Overtopping Coefficient 1.60 SI
Low Point	276.41	m	Headwater Elevation N/A m
Discharge Coefficient (Cr)	2.90		Submergence Factor (Kt) 1.00
Tailwater Elevation	273.89	m	

Sta (m)	Elev. (m)
12,730.00	276.89
12,740.00	276.89
12,760.00	276.89
12,780.00	276.85
12,797.00	276.41

Culvert Designer/Analyzer Report

C17 - 100 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	1.2740 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	1.2740 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+08	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	275.00
0+05	273.50
0+06	273.50
0+08	274.50

Tailwater conditions for Design Storm.			
Discharge	1.2740 m ³ /s	Actual Depth	0.45 m
Velocity	1.22 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	1.2740 m ³ /s	275.68 m	2.49 m/s
Weir	Roadway	0.0000 m ³ /s	275.68 m	N/A
Total	-----	1.2740 m ³ /s	275.68 m	N/A

Culvert Designer/Analyzer Report

C17 - 100 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	275.68 m	Discharge	1.2740 m ³ /s
Inlet Control HW Elev.	275.66 m	Tailwater Elevation	273.95 m
Outlet Control HW Elev.	275.68 m	Control Type	Outlet Control
Headwater Depth/Height	1.34		

Grades			
Upstream Invert	274.46 m	Downstream Invert	273.50 m
Length	65.50 m	Constructed Slope	0.014656 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.67 m
Slope Type	Mild	Normal Depth	0.78 m
Flow Regime	Subcritical	Critical Depth	0.67 m
Velocity Downstream	2.49 m/s	Critical Slope	0.019997 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	275.68 m	Upstream Velocity Head	0.23 m
Ke	0.90	Entrance Loss	0.21 m

Inlet Control Properties			
Inlet Control HW Elev.	275.66 m	Flow Control	Transition
Inlet Type	Projecting	Area Full	0.7 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C17 - 100 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.0000	m ³ /s	Allowable HW Elevation 275.68 m
Roadway Width	9.00	m	Overtopping Coefficient 1.60 SI
Low Point	276.41	m	Headwater Elevation N/A m
Discharge Coefficient (Cr)	2.90		Submergence Factor (Kt) 1.00
Tailwater Elevation	273.95	m	

Sta (m)	Elev. (m)
12,730.00	276.89
12,740.00	276.89
12,760.00	276.89
12,780.00	276.85
12,797.00	276.41

Culvert Designer/Analyzer Report

C17 - Regional - Existing

Analysis Component			
Storm Event	Design	Discharge	2.1500 m ³ /s

Peak Discharge Method: User-Specified			
Design Discharge	2.1500 m ³ /s	Check Discharge	0.0000 m ³ /s

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+08	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	275.00
0+05	273.50
0+06	273.50
0+08	274.50

Tailwater conditions for Design Storm.			
Discharge	2.1500 m ³ /s	Actual Depth	0.58 m
Velocity	1.40 m/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	1.6463 m ³ /s	276.63 m	2.85 m/s
Weir	Roadway	0.5028 m ³ /s	276.63 m	N/A
Total	-----	2.1491 m ³ /s	276.63 m	N/A

Culvert Designer/Analyzer Report

C17 - Regional - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	276.63 m	Discharge	1.6463 m ³ /s
Inlet Control HW Elev.	276.09 m	Tailwater Elevation	274.08 m
Outlet Control HW Elev.	276.63 m	Control Type	Outlet Control
Headwater Depth/Height	2.37		

Grades			
Upstream Invert	274.46 m	Downstream Invert	273.50 m
Length	65.50 m	Constructed Slope	0.014656 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.75 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.75 m
Velocity Downstream	2.85 m/s	Critical Slope	0.025730 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	276.63 m	Upstream Velocity Head	0.32 m
Ke	0.90	Entrance Loss	0.29 m

Inlet Control Properties			
Inlet Control HW Elev.	276.09 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.7 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C17 - Regional - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.5028 m ³ /s	Allowable HW Elevation	276.63 m
Roadway Width	9.00 m	Overtopping Coefficient	1.62 SI
Low Point	276.41 m	Headwater Elevation	276.63 m
Discharge Coefficient (Cr)	2.93	Submergence Factor (Kt)	1.00
Tailwater Elevation	274.08 m		

Sta (m)	Elev. (m)
12,730.00	276.89
12,740.00	276.89
12,760.00	276.89
12,780.00	276.85
12,797.00	276.41

Culvert Designer/Analyzer Report C18 - 10 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	2.4290 m ³ /s
Peak Discharge Method: User-Specified			
Design Discharge	2.4290 m ³ /s	Check Discharge	0.0000 m ³ /s
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	270.75 m		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1800 mm Circular	2.4292 m ³ /s	271.79 m	2.36 m/s
Weir	Roadway	0.0000 m ³ /s	271.79 m	N/A
Total	-----	2.4292 m ³ /s	271.79 m	N/A

Culvert Designer/Analyzer Report

C18 - 10 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	271.79 m	Discharge	2.4292 m ³ /s
Inlet Control HW Elev.	271.62 m	Tailwater Elevation	270.75 m
Outlet Control HW Elev.	271.79 m	Control Type	Outlet Control
Headwater Depth/Height	0.70		

Grades			
Upstream Invert	270.50 m	Downstream Invert	270.00 m
Length	49.20 m	Constructed Slope	0.010163 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.76 m
Slope Type	Mild	Normal Depth	0.77 m
Flow Regime	Subcritical	Critical Depth	0.76 m
Velocity Downstream	2.36 m/s	Critical Slope	0.010863 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.83 m
Section Size	1800 mm	Rise	1.83 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	271.79 m	Upstream Velocity Head	0.27 m
Ke	0.90	Entrance Loss	0.24 m

Inlet Control Properties			
Inlet Control HW Elev.	271.62 m	Flow Control	Unsubmerged
Inlet Type	Projecting	Area Full	2.6 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C18 - 10 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.0000	m ³ /s	Allowable HW Elevation 271.79 m
Roadway Width	6.16	m	Overtopping Coefficient 1.60 SI
Low Point	272.75	m	Headwater Elevation N/A m
Discharge Coefficient (Cr)	2.90		Submergence Factor (Kt) 1.00
Tailwater Elevation	270.75	m	

Sta (m)	Elev. (m)
20,060.00	274.00
20,080.00	273.50
20,100.00	272.75
20,120.00	272.75
20,140.00	273.50

Culvert Designer/Analyzer Report C18 - 100 Yr - Existing

Analysis Component			
Storm Event	Design	Discharge	4.4190 m ³ /s
Peak Discharge Method: User-Specified			
Design Discharge	4.4190 m ³ /s	Check Discharge	0.0000 m ³ /s
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	271.30 m		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1800 mm Circular	4.4196 m ³ /s	272.29 m	2.21 m/s
Weir	Roadway	0.0000 m ³ /s	272.29 m	N/A
Total	-----	4.4196 m ³ /s	272.29 m	N/A

Culvert Designer/Analyzer Report

C18 - 100 Yr - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	272.29 m	Discharge	4.4196 m ³ /s
Inlet Control HW Elev.	272.16 m	Tailwater Elevation	271.30 m
Outlet Control HW Elev.	272.29 m	Control Type	Outlet Control
Headwater Depth/Height	0.98		

Grades			
Upstream Invert	270.50 m	Downstream Invert	270.00 m
Length	49.20 m	Constructed Slope	0.010163 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	1.30 m
Slope Type	Mild	Normal Depth	1.10 m
Flow Regime	Subcritical	Critical Depth	1.04 m
Velocity Downstream	2.21 m/s	Critical Slope	0.012293 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.83 m
Section Size	1800 mm	Rise	1.83 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	272.29 m	Upstream Velocity Head	0.36 m
Ke	0.90	Entrance Loss	0.33 m

Inlet Control Properties			
Inlet Control HW Elev.	272.16 m	Flow Control	Unsubmerged
Inlet Type	Projecting	Area Full	2.6 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C18 - 100 Yr - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	0.0000 m ³ /s	Allowable HW Elevation	272.29 m
Roadway Width	6.16 m	Overtopping Coefficient	1.60 SI
Low Point	272.75 m	Headwater Elevation	N/A m
Discharge Coefficient (Cr)	2.90	Submergence Factor (Kt)	1.00
Tailwater Elevation	271.30 m		

Sta (m)	Elev. (m)
20,060.00	274.00
20,080.00	273.50
20,100.00	272.75
20,120.00	272.75
20,140.00	273.50

Culvert Designer/Analyzer Report C18 - Regional - Existing

Analysis Component				
Storm Event	Design	Discharge	9.9800 m ³ /s	
Peak Discharge Method: User-Specified				
Design Discharge	9.9800 m ³ /s	Check Discharge	0.0000 m ³ /s	
Tailwater Conditions: Constant Tailwater				
Tailwater Elevation	273.10 m			

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1800 mm Circular	1.0144 m ³ /s	273.13 m	0.39 m/s
Weir	Roadway	8.9630 m ³ /s	273.13 m	N/A
Total	-----	9.9774 m ³ /s	273.13 m	N/A

Culvert Designer/Analyzer Report

C18 - Regional - Existing

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	273.13 m	Discharge	1.0144 m ³ /s
Inlet Control HW Elev.	273.10 m	Tailwater Elevation	273.10 m
Outlet Control HW Elev.	273.13 m	Control Type	Outlet Control
Headwater Depth/Height	1.44		

Grades			
Upstream Invert	270.50 m	Downstream Invert	270.00 m
Length	49.20 m	Constructed Slope	0.010163 m/m

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	3.10 m
Slope Type	N/A	Normal Depth	0.49 m
Flow Regime	N/A	Critical Depth	0.48 m
Velocity Downstream	0.39 m/s	Critical Slope	0.010555 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.83 m
Section Size	1800 mm	Rise	1.83 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	273.13 m	Upstream Velocity Head	0.01 m
Ke	0.90	Entrance Loss	0.01 m

Inlet Control Properties			
Inlet Control HW Elev.	273.10 m	Flow Control	Unsubmerged
Inlet Type	Projecting	Area Full	2.6 m ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report

C18 - Regional - Existing

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	8.9630 m ³ /s	Allowable HW Elevation	273.13 m
Roadway Width	6.16 m	Overtopping Coefficient	1.43 SI
Low Point	272.75 m	Headwater Elevation	273.13 m
Discharge Coefficient (Cr)	3.02	Submergence Factor (Kt)	0.86
Tailwater Elevation	273.10 m		

Sta (m)	Elev. (m)
20,060.00	274.00
20,080.00	273.50
20,100.00	272.75
20,120.00	272.75
20,140.00	273.50

Appendix D

**CulvertMaster Outputs
Proposed Conditions**

Culvert Designer/Analyzer Report

C3 - 50 Yr & 100 Yr - Proposed

Peak Discharge Method: User-Specified

Design Discharge	0.6700 m ³ /s	Check Discharge	0.7410 m ³ /s
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Grades Model: Inverts

Invert Upstream	233.00 m	Invert Downstream	232.21 m
Length	40.50 m	Slope	0.019506 m/m
Drop	0.79 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+13	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	232.50
0+08	232.00
0+13	232.50

Tailwater conditions for Design Storm.

Discharge	0.6700 m ³ /s	Actual Depth	0.20 m
Velocity	1.24 m/s		

Tailwater conditions for Check Storm.

Discharge	0.7410 m ³ /s	Actual Depth	0.21 m
Velocity	1.27 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-750 mm Circular	0.6700 m ³ /s	233.84 m	3.35 m/s
Trial-2	1-750 mm Circular	0.7410 m ³ /s	233.90 m	3.43 m/s

Culvert Designer/Analyzer Report

C3 - 50 Yr & 100 Yr - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	233.84 m	Discharge	0.6700 m ³ /s
Headwater Depth/Height	1.10	Tailwater Elevation	232.20 m
Inlet Control HW Elev.	233.79 m	Control Type	Entrance Control
Outlet Control HW Elev.	233.84 m		

Grades			
Upstream Invert	233.00 m	Downstream Invert	232.21 m
Length	40.50 m	Constructed Slope	0.019506 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.34 m
Slope Type	Steep	Normal Depth	0.34 m
Flow Regime	Supercritical	Critical Depth	0.50 m
Velocity Downstream	3.35 m/s	Critical Slope	0.005509 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.76 m
Section Size	750 mm	Rise	0.76 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	233.84 m	Upstream Velocity Head	0.22 m
Ke	0.50	Entrance Loss	0.11 m

Inlet Control Properties			
Inlet Control HW Elev.	233.79 m	Flow Control	Unsubmerged
Inlet Type	Square edge w/headwall	Area Full	0.5 m ²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Designer/Analyzer Report

C3 - 50 Yr & 100 Yr - Proposed

Design: Trial-2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Check
Computed Headwater Elev:	233.90 m	Discharge	0.7410 m ³ /s
Headwater Depth/Height	1.18	Tailwater Elevation	232.21 m
Inlet Control HW Elev.	233.85 m	Control Type	Entrance Control
Outlet Control HW Elev.	233.90 m		

Grades			
Upstream Invert	233.00 m	Downstream Invert	232.21 m
Length	40.50 m	Constructed Slope	0.019506 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.37 m
Slope Type	Steep	Normal Depth	0.36 m
Flow Regime	Supercritical	Critical Depth	0.53 m
Velocity Downstream	3.43 m/s	Critical Slope	0.005860 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.76 m
Section Size	750 mm	Rise	0.76 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	233.90 m	Upstream Velocity Head	0.24 m
Ke	0.50	Entrance Loss	0.12 m

Inlet Control Properties			
Inlet Control HW Elev.	233.85 m	Flow Control	Unsubmerged
Inlet Type	Square edge w/headwall	Area Full	0.5 m ²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Designer/Analyzer Report

C3 - Regional - Proposed

Peak Discharge Method: User-Specified

Design Discharge	0.9820 m ³ /s	Check Discharge	0.0000 m ³ /s
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Grades Model: Inverts

Invert Upstream	233.00 m	Invert Downstream	232.21 m
Length	40.50 m	Slope	0.019506 m/m
Drop	0.79 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+13	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	232.50
0+08	232.00
0+13	232.50

Tailwater conditions for Design Storm.

Discharge	0.9820 m ³ /s	Actual Depth	0.23 m
Velocity	1.37 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-750 mm Circular	0.9820 m ³ /s	234.11 m	3.64 m/s

Culvert Designer/Analyzer Report

C3 - Regional - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	234.11 m	Discharge	0.9820 m ³ /s
Headwater Depth/Height	1.45	Tailwater Elevation	232.23 m
Inlet Control HW Elev.	234.11 m	Control Type	Inlet Control
Outlet Control HW Elev.	234.09 m		

Grades			
Upstream Invert	233.00 m	Downstream Invert	232.21 m
Length	40.50 m	Constructed Slope	0.019506 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.44 m
Slope Type	Steep	Normal Depth	0.43 m
Flow Regime	Supercritical	Critical Depth	0.61 m
Velocity Downstream	3.64 m/s	Critical Slope	0.007475 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.76 m
Section Size	750 mm	Rise	0.76 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	234.09 m	Upstream Velocity Head	0.32 m
Ke	0.50	Entrance Loss	0.16 m

Inlet Control Properties			
Inlet Control HW Elev.	234.11 m	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	0.5 m ²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Designer/Analyzer Report

C5 - 50 Yr & 100 Yr - Proposed

Peak Discharge Method: User-Specified

Design Discharge	0.5090 m ³ /s	Check Discharge	0.5690 m ³ /s
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Grades Model: Inverts

Invert Upstream	241.24 m	Invert Downstream	240.93 m
Length	40.60 m	Slope	0.007635 m/m
Drop	0.31 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+19	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	239.50
0+09	239.00
0+19	239.50

Tailwater conditions for Design Storm.

Discharge	0.5090 m ³ /s	Actual Depth	0.16 m
Velocity	1.06 m/s		

Tailwater conditions for Check Storm.

Discharge	0.5690 m ³ /s	Actual Depth	0.17 m
Velocity	1.09 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-600 mm Circular	0.5090 m ³ /s	242.05 m	2.17 m/s
Trial-2	1-600 mm Circular	0.5690 m ³ /s	242.14 m	2.26 m/s

Culvert Designer/Analyzer Report

C5 - 50 Yr & 100 Yr - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	242.05 m	Discharge	0.5090 m ³ /s
Headwater Depth/Height	1.33	Tailwater Elevation	239.16 m
Inlet Control HW Elev.	242.04 m	Control Type	Entrance Control
Outlet Control HW Elev.	242.05 m		

Grades			
Upstream Invert	241.24 m	Downstream Invert	240.93 m
Length	40.60 m	Constructed Slope	0.007635 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.46 m
Slope Type	Steep	Normal Depth	0.46 m
Flow Regime	Supercritical	Critical Depth	0.47 m
Velocity Downstream	2.17 m/s	Critical Slope	0.007286 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.61 m
Section Size	600 mm	Rise	0.61 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	242.05 m	Upstream Velocity Head	0.23 m
Ke	0.50	Entrance Loss	0.12 m

Inlet Control Properties			
Inlet Control HW Elev.	242.04 m	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	0.3 m ²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Designer/Analyzer Report

C5 - 50 Yr & 100 Yr - Proposed

Design: Trial-2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Check
Computed Headwater Elev:	242.14 m	Discharge	0.5690 m ³ /s
Headwater Depth/Height	1.48	Tailwater Elevation	239.17 m
Inlet Control HW Elev.	242.14 m	Control Type	Inlet Control
Outlet Control HW Elev.	242.11 m		

Grades			
Upstream Invert	241.24 m	Downstream Invert	240.93 m
Length	40.60 m	Constructed Slope	0.007635 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.49 m
Slope Type	Mild	Normal Depth	0.51 m
Flow Regime	Subcritical	Critical Depth	0.49 m
Velocity Downstream	2.26 m/s	Critical Slope	0.008162 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.61 m
Section Size	600 mm	Rise	0.61 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	242.11 m	Upstream Velocity Head	0.24 m
Ke	0.50	Entrance Loss	0.12 m

Inlet Control Properties			
Inlet Control HW Elev.	242.14 m	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	0.3 m ²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Designer/Analyzer Report

C5 - Regional - Proposed

Peak Discharge Method: User-Specified

Design Discharge	0.7220 m ³ /s	Check Discharge	0.0000 m ³ /s
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Grades Model: Inverts

Invert Upstream	241.24 m	Invert Downstream	240.93 m
Length	40.60 m	Slope	0.007635 m/m
Drop	0.31 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+19	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	239.50
0+09	239.00
0+19	239.50

Tailwater conditions for Design Storm.

Discharge	0.7220 m ³ /s	Actual Depth	0.18 m
Velocity	1.15 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-600 mm Circular	0.7220 m ³ /s	242.49 m	2.64 m/s

Culvert Designer/Analyzer Report

C5 - Regional - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	242.49 m	Discharge	0.7220 m ³ /s
Headwater Depth/Height	2.05	Tailwater Elevation	239.18 m
Inlet Control HW Elev.	242.45 m	Control Type	Outlet Control
Outlet Control HW Elev.	242.49 m		

Grades			
Upstream Invert	241.24 m	Downstream Invert	240.93 m
Length	40.60 m	Constructed Slope	0.007635 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.54 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.54 m
Velocity Downstream	2.64 m/s	Critical Slope	0.011334 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.61 m
Section Size	600 mm	Rise	0.61 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	242.49 m	Upstream Velocity Head	0.31 m
Ke	0.50	Entrance Loss	0.16 m

Inlet Control Properties			
Inlet Control HW Elev.	242.45 m	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	0.3 m ²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Designer/Analyzer Report

C6 - 50 Yr & 100 Yr - Proposed

Peak Discharge Method: User-Specified

Design Discharge	1.4390 m ³ /s	Check Discharge	1.6100 m ³ /s
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Grades Model: Inverts

Invert Upstream	241.07 m	Invert Downstream	240.42 m
Length	40.60 m	Slope	0.016010 m/m
Drop	0.65 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+16	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	240.50
0+11	240.00
0+16	240.50

Tailwater conditions for Design Storm.

Discharge	1.4390 m ³ /s	Actual Depth	0.23 m
Velocity	1.66 m/s		

Tailwater conditions for Check Storm.

Discharge	1.6100 m ³ /s	Actual Depth	0.24 m
Velocity	1.71 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-975 mm Circular	1.4390 m ³ /s	242.25 m	3.67 m/s
Trial-2	1-975 mm Circular	1.6100 m ³ /s	242.35 m	3.77 m/s

Culvert Designer/Analyzer Report

C6 - 50 Yr & 100 Yr - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	242.25 m	Discharge	1.4390 m ³ /s
Headwater Depth/Height	1.21	Tailwater Elevation	240.23 m
Inlet Control HW Elev.	242.20 m	Control Type	Entrance Control
Outlet Control HW Elev.	242.25 m		

Grades			
Upstream Invert	241.07 m	Downstream Invert	240.42 m
Length	40.60 m	Constructed Slope	0.016010 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.51 m
Slope Type	Steep	Normal Depth	0.49 m
Flow Regime	Supercritical	Critical Depth	0.70 m
Velocity Downstream	3.67 m/s	Critical Slope	0.005579 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.98 m
Section Size	975 mm	Rise	0.98 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	242.25 m	Upstream Velocity Head	0.32 m
Ke	0.50	Entrance Loss	0.16 m

Inlet Control Properties			
Inlet Control HW Elev.	242.20 m	Flow Control	Transition
Inlet Type	Square edge w/headwall	Area Full	0.7 m ²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Designer/Analyzer Report

C6 - 50 Yr & 100 Yr - Proposed

Design: Trial-2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Check
Computed Headwater Elev:	242.35 m	Discharge	1.6100 m ³ /s
Headwater Depth/Height	1.31	Tailwater Elevation	240.24 m
Inlet Control HW Elev.	242.32 m	Control Type	Entrance Control
Outlet Control HW Elev.	242.35 m		

Grades			
Upstream Invert	241.07 m	Downstream Invert	240.42 m
Length	40.60 m	Constructed Slope	0.016010 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.54 m
Slope Type	Steep	Normal Depth	0.53 m
Flow Regime	Supercritical	Critical Depth	0.74 m
Velocity Downstream	3.77 m/s	Critical Slope	0.006104 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.98 m
Section Size	975 mm	Rise	0.98 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	242.35 m	Upstream Velocity Head	0.36 m
Ke	0.50	Entrance Loss	0.18 m

Inlet Control Properties			
Inlet Control HW Elev.	242.32 m	Flow Control	Transition
Inlet Type	Square edge w/headwall	Area Full	0.7 m ²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Designer/Analyzer Report C6 - Regional - Proposed

Peak Discharge Method: User-Specified

Design Discharge	2.6700 m ³ /s	Check Discharge	0.0000 m ³ /s
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Grades Model: Inverts

Invert Upstream	241.07 m	Invert Downstream	240.42 m
Length	40.60 m	Slope	0.016010 m/m
Drop	0.65 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+16	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	240.50
0+11	240.00
0+16	240.50

Tailwater conditions for Design Storm.

Discharge	2.6700 m ³ /s	Actual Depth	0.29 m
Velocity	1.94 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-975 mm Circular	2.6700 m ³ /s	243.39 m	4.21 m/s

Culvert Designer/Analyzer Report

C6 - Regional - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	243.39 m	Discharge	2.6700 m ³ /s
Headwater Depth/Height	2.37	Tailwater Elevation	240.29 m
Inlet Control HW Elev.	243.39 m	Control Type	Inlet Control
Outlet Control HW Elev.	243.02 m		

Grades			
Upstream Invert	241.07 m	Downstream Invert	240.42 m
Length	40.60 m	Constructed Slope	0.016010 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.77 m
Slope Type	Steep	Normal Depth	0.75 m
Flow Regime	Supercritical	Critical Depth	0.90 m
Velocity Downstream	4.21 m/s	Critical Slope	0.012299 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.98 m
Section Size	975 mm	Rise	0.98 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	243.02 m	Upstream Velocity Head	0.70 m
Ke	0.50	Entrance Loss	0.35 m

Inlet Control Properties			
Inlet Control HW Elev.	243.39 m	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	0.7 m ²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Designer/Analyzer Report

C7 - 50 Yr & 100 Yr - Proposed

Peak Discharge Method: User-Specified

Design Discharge	1.4910 m ³ /s	Check Discharge	1.6700 m ³ /s
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Grades Model: Inverts

Invert Upstream	245.20 m	Invert Downstream	245.00 m
Length	50.80 m	Slope	0.003937 m/m
Drop	0.20 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+31	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	245.77
0+13	245.27
0+31	245.77

Tailwater conditions for Design Storm.

Discharge	1.4910 m ³ /s	Actual Depth	0.23 m
Velocity	0.94 m/s		

Tailwater conditions for Check Storm.

Discharge	1.6700 m ³ /s	Actual Depth	0.24 m
Velocity	0.97 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-2130 x 910 mm Box	1.4910 m ³ /s	245.87 m	1.41 m/s
Trial-2	1-2130 x 910 mm Box	1.6700 m ³ /s	245.92 m	1.55 m/s

Culvert Designer/Analyzer Report

C7 - 50 Yr & 100 Yr - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	245.87 m	Discharge	1.4910 m ³ /s
Headwater Depth/Height	0.73	Tailwater Elevation	245.50 m
Inlet Control HW Elev.	245.82 m	Control Type	Outlet Control
Outlet Control HW Elev.	245.87 m		

Grades			
Upstream Invert	245.20 m	Downstream Invert	245.00 m
Length	50.80 m	Constructed Slope	0.003937 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.50 m
Slope Type	Mild	Normal Depth	0.55 m
Flow Regime	Subcritical	Critical Depth	0.37 m
Velocity Downstream	1.41 m/s	Critical Slope	0.012698 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	2.13 m
Section Size	2130 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	245.87 m	Upstream Velocity Head	0.09 m
Ke	0.50	Entrance Loss	0.04 m

Inlet Control Properties			
Inlet Control HW Elev.	245.82 m	Flow Control	Unsubmerged
Inlet Type	90 and 15° wingwall flares	Area Full	2.0 m ²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	2
C	0.04000	Equation Form	1
Y	0.80000		

Culvert Designer/Analyzer Report

C7 - 50 Yr & 100 Yr - Proposed

Design: Trial-2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Check
Computed Headwater Elev:	245.92 m	Discharge	1.6700 m ³ /s
Headwater Depth/Height	0.79	Tailwater Elevation	245.51 m
Inlet Control HW Elev.	245.87 m	Control Type	Outlet Control
Outlet Control HW Elev.	245.92 m		

Grades			
Upstream Invert	245.20 m	Downstream Invert	245.00 m
Length	50.80 m	Constructed Slope	0.003937 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.51 m
Slope Type	Mild	Normal Depth	0.59 m
Flow Regime	Subcritical	Critical Depth	0.40 m
Velocity Downstream	1.55 m/s	Critical Slope	0.012715 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	2.13 m
Section Size	2130 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	245.92 m	Upstream Velocity Head	0.09 m
Ke	0.50	Entrance Loss	0.05 m

Inlet Control Properties			
Inlet Control HW Elev.	245.87 m	Flow Control	Unsubmerged
Inlet Type	90 and 15° wingwall flares	Area Full	2.0 m ²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	2
C	0.04000	Equation Form	1
Y	0.80000		

Culvert Designer/Analyzer Report

C7 - Regional - Proposed

Peak Discharge Method: User-Specified			
Design Discharge	2.7900 m ³ /s	Check Discharge	0.0000 m ³ /s

Grades Model: Inverts			
Invert Upstream	245.20 m	Invert Downstream	245.00 m
Length	50.80 m	Slope	0.003937 m/m
Drop	0.20 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	0+31	0.035

Natural Channel Points	
Station (m)	Elevation (m)
0+00	245.77
0+13	245.27
0+31	245.77

Tailwater conditions for Design Storm.			
Discharge	2.7900 m ³ /s	Actual Depth	0.29 m
Velocity	1.10 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-2130 x 910 mm Box	2.7900 m ³ /s	246.21 m	2.34 m/s

Culvert Designer/Analyzer Report

C7 - Regional - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	246.21 m	Discharge	2.7900 m ³ /s
Headwater Depth/Height	1.10	Tailwater Elevation	245.56 m
Inlet Control HW Elev.	246.15 m	Control Type	Outlet Control
Outlet Control HW Elev.	246.21 m		

Grades			
Upstream Invert	245.20 m	Downstream Invert	245.00 m
Length	50.80 m	Constructed Slope	0.003937 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.56 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.56 m
Velocity Downstream	2.34 m/s	Critical Slope	0.013048 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	2.13 m
Section Size	2130 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	246.21 m	Upstream Velocity Head	0.13 m
Ke	0.50	Entrance Loss	0.07 m

Inlet Control Properties			
Inlet Control HW Elev.	246.15 m	Flow Control	Unsubmerged
Inlet Type	90 and 15° wingwall flares	Area Full	2.0 m ²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	2
C	0.04000	Equation Form	1
Y	0.80000		

Culvert Designer/Analyzer Report

C8 - 50 Yr & 100 Yr - Proposed

Peak Discharge Method: User-Specified			
Design Discharge	0.8580 m ³ /s	Check Discharge	0.9760 m ³ /s
Grades Model: Inverts			
Invert Upstream	253.45 m	Invert Downstream	253.35 m
Length	40.60 m	Slope	0.002463 m/m
Drop	0.10 m		
Headwater Model: Unspecified			
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	253.79 m		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-1520 x 700 mm Box	0.8580 m ³ /s	254.06 m	1.28 m/s
Trial-2	1-1520 x 700 mm Box	0.9760 m ³ /s	254.11 m	1.46 m/s

Culvert Designer/Analyzer Report

C8 - 50 Yr & 100 Yr - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	254.06 m	Discharge	0.8580 m ³ /s
Headwater Depth/Height	0.88	Tailwater Elevation	253.79 m
Inlet Control HW Elev.	253.95 m	Control Type	Outlet Control
Outlet Control HW Elev.	254.06 m		

Grades			
Upstream Invert	253.45 m	Downstream Invert	253.35 m
Length	40.60 m	Constructed Slope	0.002463 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.44 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.32 m
Velocity Downstream	1.28 m/s	Critical Slope	0.013192 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.024
Section Material	Concrete	Span	1.52 m
Section Size	1520 x 700 mm	Rise	0.70 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	254.06 m	Upstream Velocity Head	0.06 m
Ke	0.50	Entrance Loss	0.03 m

Inlet Control Properties			
Inlet Control HW Elev.	253.95 m	Flow Control	N/A
Inlet Type	45° wingwall flares - offset	Area Full	1.1 m ²
K	0.49700	HDS 5 Chart	13
M	0.66700	HDS 5 Scale	1
C	0.03020	Equation Form	2
Y	0.83500		

Culvert Designer/Analyzer Report

C8 - 50 Yr & 100 Yr - Proposed

Design: Trial-2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Check
Computed Headwater Elev:	254.11 m	Discharge	0.9760 m ³ /s
Headwater Depth/Height	0.95	Tailwater Elevation	253.79 m
Inlet Control HW Elev.	254.00 m	Control Type	Outlet Control
Outlet Control HW Elev.	254.11 m		

Grades			
Upstream Invert	253.45 m	Downstream Invert	253.35 m
Length	40.60 m	Constructed Slope	0.002463 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.44 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.35 m
Velocity Downstream	1.46 m/s	Critical Slope	0.013275 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.024
Section Material	Concrete	Span	1.52 m
Section Size	1520 x 700 mm	Rise	0.70 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	254.11 m	Upstream Velocity Head	0.07 m
Ke	0.50	Entrance Loss	0.03 m

Inlet Control Properties			
Inlet Control HW Elev.	254.00 m	Flow Control	N/A
Inlet Type	45° wingwall flares - offset	Area Full	1.1 m ²
K	0.49700	HDS 5 Chart	13
M	0.66700	HDS 5 Scale	1
C	0.03020	Equation Form	2
Y	0.83500		

Culvert Designer/Analyzer Report C8 - Regional - Proposed

Peak Discharge Method: User-Specified

Design Discharge	1.4300 m ³ /s	Check Discharge	0.0000 m ³ /s
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Grades Model: Inverts

Invert Upstream	253.45 m	Invert Downstream	253.35 m
Length	40.60 m	Slope	0.002463 m/m
Drop	0.10 m		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	253.79 m
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Name	Description	Discharge	HW Elev.	Velocity
x Trial-2	1-1520 x 700 mm Box	1.4300 m ³ /s	254.34 m	2.10 m/s

Culvert Designer/Analyzer Report

C8 - Regional - Proposed

Design: Trial-2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	254.34 m	Discharge	1.4300 m ³ /s
Headwater Depth/Height	1.26	Tailwater Elevation	253.79 m
Inlet Control HW Elev.	254.16 m	Control Type	Outlet Control
Outlet Control HW Elev.	254.34 m		

Grades			
Upstream Invert	253.45 m	Downstream Invert	253.35 m
Length	40.60 m	Constructed Slope	0.002463 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.45 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.45 m
Velocity Downstream	2.10 m/s	Critical Slope	0.013696 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.024
Section Material	Concrete	Span	1.52 m
Section Size	1520 x 700 mm	Rise	0.70 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	254.34 m	Upstream Velocity Head	0.09 m
Ke	0.50	Entrance Loss	0.05 m

Inlet Control Properties			
Inlet Control HW Elev.	254.16 m	Flow Control	N/A
Inlet Type	45° wingwall flares - offset	Area Full	1.1 m ²
K	0.49700	HDS 5 Chart	13
M	0.66700	HDS 5 Scale	1
C	0.03020	Equation Form	2
Y	0.83500		

Culvert Designer/Analyzer Report C9 - 50 Yr & 100 Yr - Proposed

Peak Discharge Method: User-Specified			
Design Discharge	2.0900 m ³ /s	Check Discharge	2.3300 m ³ /s

Grades Model: Inverts			
Invert Upstream	251.00 m	Invert Downstream	250.83 m
Length	39.00 m	Slope	0.004359 m/m
Drop	0.17 m		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	251.24 m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1830 x 910 mm	2.0900 m ³ /s	251.92 m	2.24 m/s
	Trial-2	1-1830 x 910 mm	2.3300 m ³ /s	251.99 m	2.32 m/s

Culvert Designer/Analyzer Report

C9 - 50 Yr & 100 Yr - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	251.92 m	Discharge	2.0900 m ³ /s
Headwater Depth/Height	1.00	Tailwater Elevation	251.24 m
Inlet Control HW Elev.	251.80 m	Control Type	Outlet Control
Outlet Control HW Elev.	251.92 m		

Grades			
Upstream Invert	251.00 m	Downstream Invert	250.83 m
Length	39.00 m	Constructed Slope	0.004359 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.51 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.51 m
Velocity Downstream	2.24 m/s	Critical Slope	0.013855 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	1.83 m
Section Size	1830 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	251.92 m	Upstream Velocity Head	0.12 m
Ke	0.50	Entrance Loss	0.06 m

Inlet Control Properties			
Inlet Control HW Elev.	251.80 m	Flow Control	Unsubmerged
Inlet Type	90° headwall w 45° bevels	Area Full	1.7 m ²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

Culvert Designer/Analyzer Report

C9 - 50 Yr & 100 Yr - Proposed

Design: Trial-2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Check
Computed Headwater Elev:	251.99 m	Discharge	2.3300 m ³ /s
Headwater Depth/Height	1.08	Tailwater Elevation	251.24 m
Inlet Control HW Elev.	251.86 m	Control Type	Outlet Control
Outlet Control HW Elev.	251.99 m		

Grades			
Upstream Invert	251.00 m	Downstream Invert	250.83 m
Length	39.00 m	Constructed Slope	0.004359 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.55 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.55 m
Velocity Downstream	2.32 m/s	Critical Slope	0.014013 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	1.83 m
Section Size	1830 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	251.99 m	Upstream Velocity Head	0.14 m
Ke	0.50	Entrance Loss	0.07 m

Inlet Control Properties			
Inlet Control HW Elev.	251.86 m	Flow Control	Unsubmerged
Inlet Type	90° headwall w 45° bevels	Area Full	1.7 m ²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

Culvert Designer/Analyzer Report C9 - Regional - Proposed

Peak Discharge Method: User-Specified

Design Discharge	4.2700 m ³ /s	Check Discharge	0.0000 m ³ /s
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Grades Model: Inverts

Invert Upstream	251.00 m	Invert Downstream	250.83 m
Length	39.00 m	Slope	0.004359 m/m
Drop	0.17 m		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	251.24 m
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Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-1830 x 910 mm	4.2700 m ³ /s	253.00 m	2.84 m/s

Culvert Designer/Analyzer Report

C9 - Regional - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	253.00 m	Discharge	4.2700 m ³ /s
Headwater Depth/Height	2.18	Tailwater Elevation	251.24 m
Inlet Control HW Elev.	252.42 m	Control Type	Outlet Control
Outlet Control HW Elev.	253.00 m		

Grades			
Upstream Invert	251.00 m	Downstream Invert	250.83 m
Length	39.00 m	Constructed Slope	0.004359 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.82 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.82 m
Velocity Downstream	2.84 m/s	Critical Slope	0.015387 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	1.83 m
Section Size	1830 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	253.00 m	Upstream Velocity Head	0.33 m
Ke	0.50	Entrance Loss	0.17 m

Inlet Control Properties			
Inlet Control HW Elev.	252.42 m	Flow Control	Submerged
Inlet Type	90° headwall w 45° bevels	Area Full	1.7 m ²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

Culvert Designer/Analyzer Report

C10 - 50 Yr & 100 Yr - Proposed

Peak Discharge Method: User-Specified

Design Discharge	2.5200 m ³ /s	Check Discharge	2.8200 m ³ /s
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Grades Model: Inverts

Invert Upstream	252.32 m	Invert Downstream	252.24 m
Length	43.30 m	Slope	0.001848 m/m
Drop	0.08 m		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	252.56 m
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	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-2130 x 910 mm	2.5200 m ³ /s	253.30 m	2.26 m/s
	Trial-2	1-2130 x 910 mm	2.8200 m ³ /s	253.37 m	2.35 m/s

Culvert Designer/Analyzer Report

C10 - 50 Yr & 100 Yr - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	253.30 m	Discharge	2.5200 m ³ /s
Headwater Depth/Height	1.07	Tailwater Elevation	252.56 m
Inlet Control HW Elev.	253.14 m	Control Type	Outlet Control
Outlet Control HW Elev.	253.30 m		

Grades			
Upstream Invert	252.32 m	Downstream Invert	252.24 m
Length	43.30 m	Constructed Slope	0.001848 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.52 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.52 m
Velocity Downstream	2.26 m/s	Critical Slope	0.012947 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	2.13 m
Section Size	2130 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	253.30 m	Upstream Velocity Head	0.10 m
Ke	0.50	Entrance Loss	0.05 m

Inlet Control Properties			
Inlet Control HW Elev.	253.14 m	Flow Control	N/A
Inlet Type	90° headwall w 45° bevels	Area Full	2.0 m ²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

Culvert Designer/Analyzer Report

C10 - 50 Yr & 100 Yr - Proposed

Design: Trial-2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Check
Computed Headwater Elev:	253.37 m	Discharge	2.8200 m ³ /s
Headwater Depth/Height	1.15	Tailwater Elevation	252.56 m
Inlet Control HW Elev.	253.21 m	Control Type	Outlet Control
Outlet Control HW Elev.	253.37 m		

Grades			
Upstream Invert	252.32 m	Downstream Invert	252.24 m
Length	43.30 m	Constructed Slope	0.001848 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.56 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.56 m
Velocity Downstream	2.35 m/s	Critical Slope	0.013060 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	2.13 m
Section Size	2130 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	253.37 m	Upstream Velocity Head	0.11 m
Ke	0.50	Entrance Loss	0.06 m

Inlet Control Properties			
Inlet Control HW Elev.	253.21 m	Flow Control	N/A
Inlet Type	90° headwall w 45° bevels	Area Full	2.0 m ²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

Culvert Designer/Analyzer Report C10 - Regional - Proposed

Analysis Component			
Storm Event	Design	Discharge	4.9300 m ³ /s
Peak Discharge Method: User-Specified			
Design Discharge	4.9300 m ³ /s	Check Discharge	0.0000 m ³ /s
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	252.56 m		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2130 x 910 mm Box	4.1107 m ³ /s	253.97 m	2.66 m/s
Weir	Roadway (Constant Elevation)	0.8234 m ³ /s	253.97 m	N/A
Total	-----	4.9341 m³/s	253.97 m	N/A

Culvert Designer/Analyzer Report

C10 - Regional - Proposed

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	253.97 m	Discharge	4.1107 m ³ /s
Inlet Control HW Elev.	253.68 m	Tailwater Elevation	252.56 m
Outlet Control HW Elev.	253.97 m	Control Type	Outlet Control
Headwater Depth/Height	1.80		

Grades			
Upstream Invert	252.32 m	Downstream Invert	252.24 m
Length	43.30 m	Constructed Slope	0.001848 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.72 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.72 m
Velocity Downstream	2.66 m/s	Critical Slope	0.013615 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	2.13 m
Section Size	2130 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	253.97 m	Upstream Velocity Head	0.23 m
Ke	0.50	Entrance Loss	0.11 m

Inlet Control Properties			
Inlet Control HW Elev.	253.68 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	2.0 m ²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Designer/Analyzer Report

C10 - Regional - Proposed

Component: Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.8234 m ³ /s	Allowable HW Elevation	253.97 m
Roadway Width	5.00 m	Overtopping Coefficient	1.63 SI
Length	50.00 m	Crest Elevation	253.92 m
Headwater Elevation	253.97 m	Discharge Coefficient (Cr)	2.95
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	253.92
50.00	253.92

Culvert Designer/Analyzer Report

C12 - 50 Yr & 100 Yr - Proposed

Peak Discharge Method: User-Specified

Design Discharge	1.9000 m ³ /s	Check Discharge	2.1200 m ³ /s
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Grades Model: Inverts

Invert Upstream	260.74 m	Invert Downstream	260.42 m
Length	43.50 m	Slope	0.007356 m/m
Drop	0.32 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+31	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	245.77
0+13	245.27
0+31	245.77

Tailwater conditions for Design Storm.

Discharge	1.9000 m ³ /s	Actual Depth	0.25 m
Velocity	1.00 m/s		

Tailwater conditions for Check Storm.

Discharge	2.1200 m ³ /s	Actual Depth	0.26 m
Velocity	1.03 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-2130 x 910 mm Box	1.9000 m ³ /s	261.48 m	2.06 m/s
Trial-2	1-2130 x 910 mm Box	2.1200 m ³ /s	261.54 m	2.14 m/s

Culvert Designer/Analyzer Report

C12 - 50 Yr & 100 Yr - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	261.48 m	Discharge	1.9000 m ³ /s
Headwater Depth/Height	0.81	Tailwater Elevation	245.52 m
Inlet Control HW Elev.	261.42 m	Control Type	Outlet Control
Outlet Control HW Elev.	261.48 m		

Grades			
Upstream Invert	260.74 m	Downstream Invert	260.42 m
Length	43.50 m	Constructed Slope	0.007356 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.43 m
Slope Type	Mild	Normal Depth	0.52 m
Flow Regime	Subcritical	Critical Depth	0.43 m
Velocity Downstream	2.06 m/s	Critical Slope	0.012759 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	2.13 m
Section Size	2130 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	261.48 m	Upstream Velocity Head	0.15 m
Ke	0.50	Entrance Loss	0.07 m

Inlet Control Properties			
Inlet Control HW Elev.	261.42 m	Flow Control	Unsubmerged
Inlet Type	90° headwall w 45° bevels	Area Full	2.0 m ²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

Culvert Designer/Analyzer Report

C12 - 50 Yr & 100 Yr - Proposed

Design: Trial-2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Check
Computed Headwater Elev:	261.54 m	Discharge	2.1200 m ³ /s
Headwater Depth/Height	0.88	Tailwater Elevation	245.53 m
Inlet Control HW Elev.	261.47 m	Control Type	Outlet Control
Outlet Control HW Elev.	261.54 m		

Grades			
Upstream Invert	260.74 m	Downstream Invert	260.42 m
Length	43.50 m	Constructed Slope	0.007356 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.47 m
Slope Type	Mild	Normal Depth	0.56 m
Flow Regime	Subcritical	Critical Depth	0.47 m
Velocity Downstream	2.14 m/s	Critical Slope	0.012816 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	2.13 m
Section Size	2130 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	261.54 m	Upstream Velocity Head	0.16 m
Ke	0.50	Entrance Loss	0.08 m

Inlet Control Properties			
Inlet Control HW Elev.	261.47 m	Flow Control	Unsubmerged
Inlet Type	90° headwall w 45° bevels	Area Full	2.0 m ²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

Culvert Designer/Analyzer Report

C12 - Regional - Proposed

Peak Discharge Method: User-Specified

Design Discharge	4.0400 m ³ /s	Check Discharge	0.0000 m ³ /s
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Grades Model: Inverts

Invert Upstream	260.74 m	Invert Downstream	260.42 m
Length	43.50 m	Slope	0.007356 m/m
Drop	0.32 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+31	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	245.77
0+13	245.27
0+31	245.77

Tailwater conditions for Design Storm.

Discharge	4.0400 m ³ /s	Actual Depth	0.33 m
Velocity	1.21 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-2130 x 910 mm Box	4.0400 m ³ /s	262.33 m	2.65 m/s

Culvert Designer/Analyzer Report

C12 - Regional - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	262.33 m	Discharge	4.0400 m ³ /s
Headwater Depth/Height	1.74	Tailwater Elevation	245.60 m
Inlet Control HW Elev.	261.92 m	Control Type	Outlet Control
Outlet Control HW Elev.	262.33 m		

Grades			
Upstream Invert	260.74 m	Downstream Invert	260.42 m
Length	43.50 m	Constructed Slope	0.007356 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.72 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.72 m
Velocity Downstream	2.65 m/s	Critical Slope	0.019560 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.030
Section Material	Concrete	Span	2.13 m
Section Size	2130 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	262.33 m	Upstream Velocity Head	0.22 m
Ke	0.50	Entrance Loss	0.11 m

Inlet Control Properties			
Inlet Control HW Elev.	261.92 m	Flow Control	N/A
Inlet Type	90° headwall w 45° bevels	Area Full	2.0 m ²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

Culvert Designer/Analyzer Report

C14 - 50 Yr & 100 Yr - Proposed

Peak Discharge Method: User-Specified

Design Discharge	1.6020 m ³ /s	Check Discharge	1.8100 m ³ /s
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Grades Model: Inverts

Invert Upstream	267.45 m	Invert Downstream	267.20 m
Length	46.00 m	Slope	0.005435 m/m
Drop	0.25 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+12	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	268.00
0+06	267.50
0+08	267.50
0+12	268.00

Tailwater conditions for Design Storm.

Discharge	1.6020 m ³ /s	Actual Depth	0.27 m
Velocity	1.46 m/s		

Tailwater conditions for Check Storm.

Discharge	1.8100 m ³ /s	Actual Depth	0.28 m
Velocity	1.50 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-2130 x 1220 mm B60 20	m ³ /s	268.13 m	1.33 m/s
Trial-2	1-2130 x 1220 mm B61 00	m ³ /s	268.19 m	1.46 m/s

Culvert Designer/Analyzer Report

C14 - 50 Yr & 100 Yr - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	268.13 m	Discharge	1.6020 m ³ /s
Headwater Depth/Height	0.56	Tailwater Elevation	267.77 m
Inlet Control HW Elev.	268.06 m	Control Type	Outlet Control
Outlet Control HW Elev.	268.13 m		

Grades			
Upstream Invert	267.45 m	Downstream Invert	267.20 m
Length	46.00 m	Constructed Slope	0.005435 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.57 m
Slope Type	Mild	Normal Depth	0.52 m
Flow Regime	Subcritical	Critical Depth	0.39 m
Velocity Downstream	1.33 m/s	Critical Slope	0.012707 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	2.13 m
Section Size	2130 x 1220 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	268.13 m	Upstream Velocity Head	0.11 m
Ke	0.50	Entrance Loss	0.05 m

Inlet Control Properties			
Inlet Control HW Elev.	268.06 m	Flow Control	Unsubmerged
Inlet Type	90° headwall w 45° bevels	Area Full	2.6 m ²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

Culvert Designer/Analyzer Report

C14 - 50 Yr & 100 Yr - Proposed

Design: Trial-2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Check
Computed Headwater Elev:	268.19 m	Discharge	1.8100 m ³ /s
Headwater Depth/Height	0.60	Tailwater Elevation	267.78 m
Inlet Control HW Elev.	268.11 m	Control Type	Outlet Control
Outlet Control HW Elev.	268.19 m		

Grades			
Upstream Invert	267.45 m	Downstream Invert	267.20 m
Length	46.00 m	Constructed Slope	0.005435 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.58 m
Slope Type	Mild	Normal Depth	0.56 m
Flow Regime	Subcritical	Critical Depth	0.42 m
Velocity Downstream	1.46 m/s	Critical Slope	0.012739 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	2.13 m
Section Size	2130 x 1220 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	268.19 m	Upstream Velocity Head	0.12 m
Ke	0.50	Entrance Loss	0.06 m

Inlet Control Properties			
Inlet Control HW Elev.	268.11 m	Flow Control	Unsubmerged
Inlet Type	90° headwall w 45° bevels	Area Full	2.6 m ²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

Culvert Designer/Analyzer Report

C14 - Regional - Proposed

Peak Discharge Method: User-Specified

Design Discharge	4.5290 m ³ /s	Check Discharge	0.0000 m ³ /s
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Grades Model: Inverts

Invert Upstream	267.45 m	Invert Downstream	267.20 m
Length	46.00 m	Slope	0.005435 m/m
Drop	0.25 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+12	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	268.00
0+06	267.50
0+08	267.50
0+12	268.00

Tailwater conditions for Design Storm.

Discharge	4.5290 m ³ /s	Actual Depth	0.42 m
Velocity	1.90 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-2130 x 1220 mm	4.5290 m ³ /s	268.81 m	2.75 m/s

Culvert Designer/Analyzer Report

C14 - Regional - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	268.81 m	Discharge	4.5290 m ³ /s
Headwater Depth/Height	1.12	Tailwater Elevation	267.92 m
Inlet Control HW Elev.	268.67 m	Control Type	Outlet Control
Outlet Control HW Elev.	268.81 m		

Grades			
Upstream Invert	267.45 m	Downstream Invert	267.20 m
Length	46.00 m	Constructed Slope	0.005435 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.77 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.77 m
Velocity Downstream	2.75 m/s	Critical Slope	0.013807 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	2.13 m
Section Size	2130 x 1220 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	268.81 m	Upstream Velocity Head	0.21 m
Ke	0.50	Entrance Loss	0.11 m

Inlet Control Properties			
Inlet Control HW Elev.	268.67 m	Flow Control	Unsubmerged
Inlet Type	90° headwall w 45° bevels	Area Full	2.6 m ²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

Culvert Designer/Analyzer Report

C15 - 50 Yr & 100 Yr - Proposed

Peak Discharge Method: User-Specified

Design Discharge	1.8140 m ³ /s	Check Discharge	2.0420 m ³ /s
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Grades Model: Inverts

Invert Upstream	269.97 m	Invert Downstream	268.68 m
Length	43.50 m	Slope	0.029655 m/m
Drop	1.29 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+04	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	269.00
0+02	268.50
0+03	268.50
0+04	269.00

Tailwater conditions for Design Storm.

Discharge	1.8140 m ³ /s	Actual Depth	0.39 m
Velocity	2.32 m/s		

Tailwater conditions for Check Storm.

Discharge	2.0420 m ³ /s	Actual Depth	0.41 m
Velocity	2.39 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-1520 x 910 mm Box	1.8140 m ³ /s	270.89 m	2.87 m/s
Trial-2	1-1520 x 910 mm Box	2.0420 m ³ /s	270.96 m	2.97 m/s

Culvert Designer/Analyzer Report

C15 - 50 Yr & 100 Yr - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	270.89 m	Discharge	1.8140 m ³ /s
Headwater Depth/Height	1.00	Tailwater Elevation	268.89 m
Inlet Control HW Elev.	270.85 m	Control Type	Entrance Control
Outlet Control HW Elev.	270.89 m		

Grades			
Upstream Invert	269.97 m	Downstream Invert	268.68 m
Length	43.50 m	Constructed Slope	0.029655 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.42 m
Slope Type	Steep	Normal Depth	0.42 m
Flow Regime	Supercritical	Critical Depth	0.52 m
Velocity Downstream	2.87 m/s	Critical Slope	0.015280 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	1.52 m
Section Size	1520 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	270.89 m	Upstream Velocity Head	0.26 m
Ke	0.50	Entrance Loss	0.13 m

Inlet Control Properties			
Inlet Control HW Elev.	270.85 m	Flow Control	Unsubmerged
Inlet Type	0° wingwall flares	Area Full	1.4 m ²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Designer/Analyzer Report

C15 - 50 Yr & 100 Yr - Proposed

Design: Trial-2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Check
Computed Headwater Elev:	270.96 m	Discharge	2.0420 m ³ /s
Headwater Depth/Height	1.09	Tailwater Elevation	268.91 m
Inlet Control HW Elev.	270.93 m	Control Type	Entrance Control
Outlet Control HW Elev.	270.96 m		

Grades			
Upstream Invert	269.97 m	Downstream Invert	268.68 m
Length	43.50 m	Constructed Slope	0.029655 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.45 m
Slope Type	Steep	Normal Depth	0.45 m
Flow Regime	Supercritical	Critical Depth	0.57 m
Velocity Downstream	2.97 m/s	Critical Slope	0.015552 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	1.52 m
Section Size	1520 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	270.96 m	Upstream Velocity Head	0.28 m
Ke	0.50	Entrance Loss	0.14 m

Inlet Control Properties			
Inlet Control HW Elev.	270.93 m	Flow Control	Unsubmerged
Inlet Type	0° wingwall flares	Area Full	1.4 m ²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Designer/Analyzer Report

C15 - Regional - Proposed

Peak Discharge Method: User-Specified

Design Discharge	4.0720 m ³ /s	Check Discharge	0.0000 m ³ /s
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Grades Model: Inverts

Invert Upstream	269.00 m	Invert Downstream	268.68 m
Length	43.50 m	Slope	0.007356 m/m
Drop	0.32 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+04	0.030

Natural Channel Points

Station (m)	Elevation (m)
0+00	269.00
0+02	268.50
0+03	268.50
0+04	269.00

Tailwater conditions for Design Storm.

Discharge	4.0720 m ³ /s	Actual Depth	0.52 m
Velocity	3.22 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-1520 x 910 mm Box	4.0720 m ³ /s	271.48 m	2.97 m/s

Culvert Designer/Analyzer Report

C15 - Regional - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	271.48 m	Discharge	4.0720 m ³ /s
Headwater Depth/Height	2.71	Tailwater Elevation	269.02 m
Inlet Control HW Elev.	270.93 m	Control Type	Outlet Control
Outlet Control HW Elev.	271.48 m		

Grades			
Upstream Invert	269.00 m	Downstream Invert	268.68 m
Length	43.50 m	Constructed Slope	0.007356 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.90 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.90 m
Velocity Downstream	2.97 m/s	Critical Slope	0.017953 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	1.52 m
Section Size	1520 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	271.48 m	Upstream Velocity Head	0.44 m
Ke	0.50	Entrance Loss	0.22 m

Inlet Control Properties			
Inlet Control HW Elev.	270.93 m	Flow Control	Submerged
Inlet Type	0° wingwall flares	Area Full	1.4 m ²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Designer/Analyzer Report

C16 - 50 Yr & 100 Yr - Proposed

Peak Discharge Method: User-Specified

Design Discharge	3.9550 m ³ /s	Check Discharge	4.4860 m ³ /s
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Grades Model: Inverts

Invert Upstream	269.40 m	Invert Downstream	269.20 m
Length	78.00 m	Slope	0.002564 m/m
Drop	0.20 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+07	0.030

Natural Channel Points

Station (m)	Elevation (m)
0+00	270.30
0+02	269.80
0+03	269.20
0+04	269.20
0+06	269.80
0+07	270.30

Tailwater conditions for Design Storm.

Discharge	3.9550 m ³ /s	Actual Depth	0.61 m
Velocity	2.45 m/s		

Tailwater conditions for Check Storm.

Discharge	4.4860 m ³ /s	Actual Depth	0.64 m
Velocity	2.53 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-3050 x 1520 mm	3.9550 m ³ /s	270.43 m	2.14 m/s
Trial-2	1-3050 x 1520 mm	4.4860 m ³ /s	270.52 m	2.28 m/s

Culvert Designer/Analyzer Report

C16 - 50 Yr & 100 Yr - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	270.43 m	Discharge	3.9550 m ³ /s
Headwater Depth/Height	0.68	Tailwater Elevation	269.81 m
Inlet Control HW Elev.	270.34 m	Control Type	Outlet Control
Outlet Control HW Elev.	270.43 m		

Grades			
Upstream Invert	269.40 m	Downstream Invert	269.20 m
Length	78.00 m	Constructed Slope	0.002564 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.61 m
Slope Type	Mild	Normal Depth	0.93 m
Flow Regime	Subcritical	Critical Depth	0.56 m
Velocity Downstream	2.14 m/s	Critical Slope	0.011284 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	3.05 m
Section Size	3050 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	270.43 m	Upstream Velocity Head	0.12 m
Ke	0.50	Entrance Loss	0.06 m

Inlet Control Properties			
Inlet Control HW Elev.	270.34 m	Flow Control	Unsubmerged
Inlet Type	0° wingwall flares	Area Full	4.6 m ²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Designer/Analyzer Report

C16 - 50 Yr & 100 Yr - Proposed

Design: Trial-2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Check
Computed Headwater Elev:	270.52 m	Discharge	4.4860 m ³ /s
Headwater Depth/Height	0.74	Tailwater Elevation	269.84 m
Inlet Control HW Elev.	270.43 m	Control Type	Outlet Control
Outlet Control HW Elev.	270.52 m		

Grades			
Upstream Invert	269.40 m	Downstream Invert	269.20 m
Length	78.00 m	Constructed Slope	0.002564 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.64 m
Slope Type	Mild	Normal Depth	1.01 m
Flow Regime	Subcritical	Critical Depth	0.60 m
Velocity Downstream	2.28 m/s	Critical Slope	0.011317 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	3.05 m
Section Size	3050 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	270.52 m	Upstream Velocity Head	0.13 m
Ke	0.50	Entrance Loss	0.06 m

Inlet Control Properties			
Inlet Control HW Elev.	270.43 m	Flow Control	Unsubmerged
Inlet Type	0° wingwall flares	Area Full	4.6 m ²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Designer/Analyzer Report

C16 - Regional - Proposed

Peak Discharge Method: User-Specified

Design Discharge	10.2000 m ³ /s	Check Discharge	0.0000 m ³ /s
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Grades Model: Inverts

Invert Upstream	269.40 m	Invert Downstream	269.20 m
Length	78.00 m	Slope	0.002564 m/m
Drop	0.20 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+07	0.030

Natural Channel Points

Station (m)	Elevation (m)
0+00	270.30
0+02	269.80
0+03	269.20
0+04	269.20
0+06	269.80
0+07	270.30

Tailwater conditions for Design Storm.

Discharge	10.2000 m ³ /s	Actual Depth	0.95 m
Velocity	3.08 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-3050 x 1520 mm	10.2000 m ³ /s	271.43 m	3.20 m/s

Culvert Designer/Analyzer Report

C16 - Regional - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	271.43 m	Discharge	10.2000 m ³ /s
Headwater Depth/Height	1.33	Tailwater Elevation	270.15 m
Inlet Control HW Elev.	271.19 m	Control Type	Outlet Control
Outlet Control HW Elev.	271.43 m		

Grades			
Upstream Invert	269.40 m	Downstream Invert	269.20 m
Length	78.00 m	Constructed Slope	0.002564 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	1.05 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	1.05 m
Velocity Downstream	3.20 m/s	Critical Slope	0.012118 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	3.05 m
Section Size	3050 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	271.43 m	Upstream Velocity Head	0.25 m
Ke	0.50	Entrance Loss	0.12 m

Inlet Control Properties			
Inlet Control HW Elev.	271.19 m	Flow Control	Unsubmerged
Inlet Type	0° wingwall flares	Area Full	4.6 m ²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Designer/Analyzer Report

C17 -25 Yr & 100 Yr - Proposed

Peak Discharge Method: User-Specified

Design Discharge	0.9220 m ³ /s	Check Discharge	1.2610 m ³ /s
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Grades Model: Inverts

Invert Upstream	274.46 m	Invert Downstream	273.50 m
Length	65.50 m	Slope	0.014656 m/m
Drop	0.96 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+08	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	275.00
0+05	273.50
0+06	273.50
0+08	274.50

Tailwater conditions for Design Storm.

Discharge	0.9220 m ³ /s	Actual Depth	0.39 m
Velocity	1.12 m/s		

Tailwater conditions for Check Storm.

Discharge	1.2610 m ³ /s	Actual Depth	0.45 m
Velocity	1.22 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-975 mm Circular	0.9220 m ³ /s	275.35 m	3.29 m/s
Trial-2	1-975 mm Circular	1.2610 m ³ /s	275.54 m	3.57 m/s

Culvert Designer/Analyzer Report

C17 -25 Yr & 100 Yr - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	275.35 m	Discharge	0.9220 m ³ /s
Headwater Depth/Height	0.92	Tailwater Elevation	273.89 m
Inlet Control HW Elev.	275.28 m	Control Type	Entrance Control
Outlet Control HW Elev.	275.35 m		

Grades			
Upstream Invert	274.46 m	Downstream Invert	273.50 m
Length	65.50 m	Constructed Slope	0.014656 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.39 m
Slope Type	Steep	Normal Depth	0.39 m
Flow Regime	Supercritical	Critical Depth	0.55 m
Velocity Downstream	3.29 m/s	Critical Slope	0.004458 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.98 m
Section Size	975 mm	Rise	0.98 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	275.35 m	Upstream Velocity Head	0.23 m
Ke	0.50	Entrance Loss	0.11 m

Inlet Control Properties			
Inlet Control HW Elev.	275.28 m	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	0.7 m ²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Designer/Analyzer Report

C17 -25 Yr & 100 Yr - Proposed

Design: Trial-2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Check
Computed Headwater Elev:	275.54 m	Discharge	1.2610 m ³ /s
Headwater Depth/Height	1.11	Tailwater Elevation	273.95 m
Inlet Control HW Elev.	275.48 m	Control Type	Entrance Control
Outlet Control HW Elev.	275.54 m		

Grades			
Upstream Invert	274.46 m	Downstream Invert	273.50 m
Length	65.50 m	Constructed Slope	0.014656 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.47 m
Slope Type	Steep	Normal Depth	0.47 m
Flow Regime	Supercritical	Critical Depth	0.65 m
Velocity Downstream	3.57 m/s	Critical Slope	0.005122 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.98 m
Section Size	975 mm	Rise	0.98 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	275.54 m	Upstream Velocity Head	0.29 m
Ke	0.50	Entrance Loss	0.14 m

Inlet Control Properties			
Inlet Control HW Elev.	275.48 m	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	0.7 m ²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Designer/Analyzer Report

C17 - Regional - Proposed

Peak Discharge Method: User-Specified

Design Discharge	2.1480 m ³ /s	Check Discharge	0.0000 m ³ /s
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Grades Model: Inverts

Invert Upstream	274.46 m	Invert Downstream	273.50 m
Length	65.50 m	Slope	0.014656 m/m
Drop	0.96 m		

Headwater Model: Unspecified

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+08	0.035

Natural Channel Points

Station (m)	Elevation (m)
0+00	275.00
0+05	273.50
0+06	273.50
0+08	274.50

Tailwater conditions for Design Storm.

Discharge	2.1480 m ³ /s	Actual Depth	0.58 m
Velocity	1.40 m/s		

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-975 mm Circular	2.1480 m ³ /s	276.19 m	3.99 m/s

Culvert Designer/Analyzer Report

C17 - Regional - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	276.19 m	Discharge	2.1480 m ³ /s
Headwater Depth/Height	1.77	Tailwater Elevation	274.08 m
Inlet Control HW Elev.	276.19 m	Control Type	Inlet Control
Outlet Control HW Elev.	276.05 m		

Grades			
Upstream Invert	274.46 m	Downstream Invert	273.50 m
Length	65.50 m	Constructed Slope	0.014656 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.66 m
Slope Type	Steep	Normal Depth	0.65 m
Flow Regime	Supercritical	Critical Depth	0.84 m
Velocity Downstream	3.99 m/s	Critical Slope	0.008511 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.98 m
Section Size	975 mm	Rise	0.98 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	276.05 m	Upstream Velocity Head	0.50 m
Ke	0.50	Entrance Loss	0.25 m

Inlet Control Properties			
Inlet Control HW Elev.	276.19 m	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	0.7 m ²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Designer/Analyzer Report

C18 - 10 Yr - Proposed

Peak Discharge Method: User-Specified				
Design Discharge	2.4290 m ³ /s	Check Discharge	0.0000 m ³ /s	
Grades Model: Inverts				
Invert Upstream	270.00 m	Invert Downstream	269.80 m	
Length	22.00 m	Slope	0.009091 m/m	
Drop	0.20 m			
Headwater Model: Unspecified				
Tailwater Conditions: Constant Tailwater				
Tailwater Elevation	270.16 m			
Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-3050 x 1520 mm	2.4290 m ³ /s	270.69 m	1.98 m/s

Culvert Designer/Analyzer Report

C18 - 10 Yr - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	270.69 m	Discharge	2.4290 m ³ /s
Headwater Depth/Height	0.45	Tailwater Elevation	270.16 m
Inlet Control HW Elev.	270.63 m	Control Type	Outlet Control
Outlet Control HW Elev.	270.69 m		

Grades			
Upstream Invert	270.00 m	Downstream Invert	269.80 m
Length	22.00 m	Constructed Slope	0.009091 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.40 m
Slope Type	Mild	Normal Depth	0.43 m
Flow Regime	Subcritical	Critical Depth	0.40 m
Velocity Downstream	1.98 m/s	Critical Slope	0.011348 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	3.05 m
Section Size	3050 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	270.69 m	Upstream Velocity Head	0.17 m
Ke	0.50	Entrance Loss	0.09 m

Inlet Control Properties			
Inlet Control HW Elev.	270.63 m	Flow Control	Unsubmerged
Inlet Type	90° headwall w 45° bevels	Area Full	4.6 m ²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

Culvert Designer/Analyzer Report

C18 - 100 Yr - Proposed

Peak Discharge Method: User-Specified

Design Discharge	4.4190 m ³ /s	Check Discharge	0.0000 m ³ /s
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Grades Model: Inverts

Invert Upstream	270.00 m	Invert Downstream	269.80 m
Length	22.00 m	Slope	0.009091 m/m
Drop	0.20 m		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	270.52 m
---------------------	----------

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-3050 x 1520 mm	4.4190 m ³ /s	271.03 m	2.01 m/s

Culvert Designer/Analyzer Report

C18 - 100 Yr - Proposed

Design: Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	N/A m	Storm Event	Design
Computed Headwater Elev:	271.03 m	Discharge	4.4190 m ³ /s
Headwater Depth/Height	0.68	Tailwater Elevation	270.52 m
Inlet Control HW Elev.	270.94 m	Control Type	Outlet Control
Outlet Control HW Elev.	271.03 m		

Grades			
Upstream Invert	270.00 m	Downstream Invert	269.80 m
Length	22.00 m	Constructed Slope	0.009091 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.72 m
Slope Type	Mild	Normal Depth	0.64 m
Flow Regime	Subcritical	Critical Depth	0.60 m
Velocity Downstream	2.01 m/s	Critical Slope	0.011312 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	3.05 m
Section Size	3050 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	271.03 m	Upstream Velocity Head	0.26 m
Ke	0.50	Entrance Loss	0.13 m

Inlet Control Properties			
Inlet Control HW Elev.	270.94 m	Flow Control	Unsubmerged
Inlet Type	90° headwall w 45° bevels	Area Full	4.6 m ²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

Culvert Designer/Analyzer Report C18 - Regional - Proposed

Analysis Component				
Storm Event	Design	Discharge	9.9820 m ³ /s	
Peak Discharge Method: User-Specified				
Design Discharge	9.9820 m ³ /s	Check Discharge	0.0000 m ³ /s	
Tailwater Conditions: Constant Tailwater				
Tailwater Elevation	271.43 m			

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-3050 x 1520 mm Box	8.9540 m ³ /s	271.84 m	1.93 m/s
Weir	Roadway	1.0240 m ³ /s	271.84 m	N/A
Total	-----	9.9780 m ³ /s	271.84 m	N/A

Culvert Designer/Analyzer Report

C18 - Regional - Proposed

Component: Culvert-1

Culvert Summary			
Computed Headwater Elev:	271.84 m	Discharge	8.9540 m ³ /s
Inlet Control HW Elev.	271.51 m	Tailwater Elevation	271.43 m
Outlet Control HW Elev.	271.84 m	Control Type	Outlet Control
Headwater Depth/Height	1.21		

Grades			
Upstream Invert	270.00 m	Downstream Invert	269.80 m
Length	22.00 m	Constructed Slope	0.009091 m/m

Hydraulic Profile			
Profile	Pressure Profile	Depth, Downstream	1.63 m
Slope Type	N/A	Normal Depth	1.06 m
Flow Regime	N/A	Critical Depth	0.96 m
Velocity Downstream	1.93 m/s	Critical Slope	0.011914 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.025
Section Material	Concrete	Span	3.05 m
Section Size	3050 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	271.84 m	Upstream Velocity Head	0.19 m
Ke	0.50	Entrance Loss	0.09 m

Inlet Control Properties			
Inlet Control HW Elev.	271.51 m	Flow Control	N/A
Inlet Type	90° headwall w 45° bevels	Area Full	4.6 m ²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

Culvert Designer/Analyzer Report

C18 - Regional - Proposed

Component: Weir

Hydraulic Component(s): Roadway			
Discharge	1.0240 m ³ /s	Allowable HW Elevation	271.84 m
Roadway Width	11.00 m	Overtopping Coefficient	1.63 SI
Low Point	271.70 m	Headwater Elevation	271.84 m
Discharge Coefficient (Cr)	2.94	Submergence Factor (Kt)	1.00
Tailwater Elevation	271.43 m		

Sta (m)	Elev. (m)
20,108.00	272.92
20,120.00	272.48
20,131.00	272.01
20,147.00	271.70
20,160.00	271.76
20,169.00	272.05

MMM Group Limited



**Trafalgar Road Transportation Corridor
Improvements, From Steeles Avenue to
Highway 7**

Class Environmental Assessment Study

**Appendix E - Geomorphology
Assessment Report - FINAL**

COMMUNITIES
TRANSPORTATION
BUILDINGS
INFRASTRUCTURE

May 2016 | 3214006-000

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APPENDICES

Appendix E-1 – Reach Descriptions

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1.0 INTRODUCTION

The Regional Municipality of Halton is proposing to widen Trafalgar Road from Steeles Avenue to Highway 7. The total length of the project is approximately 12.8 km with the northern section of 5.1 km located in the Credit River watershed and the southern section of 7.7 km located in the Sixteen Mile Creek watershed. Details of the existing and proposed highway drainage and stormwater management are provided under a separate report (MMM March 2016). This report describes the fluvial geomorphic assessment that was conducted to describe the existing conditions of the various watercourses within the study area along the preferred alignment of Trafalgar Road, to assess the possible impacts of the proposed works on the watercourses and to provide preliminary design recommendations for the proposed watercourse crossings. The report is intended to be read with the accompanying “Drainage and Stormwater Management Report”.

1.1 Study Area

The project study area is illustrated in Figure 1. This section of Trafalgar Road crosses four subwatersheds; three are within the Sixteen Mile Creek watershed while one, Black Creek, is within the Credit River Watershed.

2.0 ASSESSMENT METHODOLOGY

2.1 Background Review

- Relevant background information was reviewed to provide context and fill any data gaps. This included available topographic data, drainage and hydraulic data from the Drainage and Stormwater Management Report (MMM 2016), surficial geology mapping, project correspondence with CVC and CH, and relevant guidance documents, such as CVC’s Fluvial Geomorphic Guidelines (April 2015) and CVC’s Slope Stability Definition & Determination Guideline (February 2014).

In addition, the following background studies were reviewed:

- The Club at North Halton Irrigation Water Management and Golf Course Routing Impact Assessment, Burnside & Associates Ltd, November 2015
- Black Creek Subwatershed Study - Subwatershed 10 Background document, CVC, February 2009
- CVC Dam Assessment Study, PEIL, June 2005
- Silver Creek Phase 1 Characterization Report, Town of Halton Hills, August 2002
- These background studies are described on the following page.

2.1.1 Golf Course at North Halton Irrigation Report, Burnside & Associates, 2015

This report included history of the North Halton Golf and Country Club. The golf course dates back to 1916, and was expanded twice by 1964. Historically the golf course used Black Creek as a source for irrigation. A proposed water taking strategy from Black Creek is being investigated.

2.1.2 Black Creek Subwatershed Study, CVC, February 2009

The purpose of the Subwatershed study report was to review available information pertinent to the Subwatershed, and to identify data gaps. The report outlines the physical characteristics of the Subwatershed and summarizes previous geomorphic studies that have been undertaken on watercourses within the catchment.

2.1.3 CVC Dam Assessment Study, PEIL, June 2005

This study provided an inventory of all dams within the Credit River watershed to inform its management. All structures were identified and categorized as major or minor dams. A major dam was identified on the main branch of Black Creek upstream of Trafalgar Road.

2.1.4 Silver Creek Phase 1 Characterization Report, Town of Halton Hills, 2002

The study covers environmental and water related issues within the Silver Creek Subwatershed, and includes information about Black Creek, a major tributary to Silver Creek. A geomorphology component was included covering several types of channel classification on Silver Creek, and provided streambed profiles and flow data for Silver Creek and Black Creek.

2.2 Field Assessment

The geomorphic assessment included nine culvert crossings, one bridge crossing of Black Creek and one reach assessment on a Tributary to Black Creek. Site visits were conducted on December 2 and 3, 2015 as well as on February 3, 2016. At culvert crossings, the watercourses were walked approximately 100 m upstream and downstream of Trafalgar Road where property access was permitted. Several hundred meters of channel length were walked for the detailed site assessments at Black Creek and the Tributary to Black Creek. In reaches with no defined channel, bankfull measurements could not be obtained. There was no snow cover on the days of the site visits. Flows were below bankfull at the time of observation.

Watercourse crossing locations are presented on Figure 2. The study reaches on Black Creek and the Tributary to Black Creek are presented on Figure 3.

2.3 Erosion Hazard Assessments

To fulfill requirements stated in written correspondence by the CVC, preliminary assessments of erosion hazard limits were conducted on Black Creek and on the Tributary to Black Creek downstream of C14. The assessment of Black Creek was undertaken on the reach crossing Trafalgar Road to inform the preliminary design of the replacement Trafalgar Road Bridge. The assessment of the Tributary to Black Creek was conducted between the CN railway to Maple Avenue to provide context for the preliminary design of the proposed grade separation of Trafalgar Road at the CN railway.

3.0 EXISTING GEOMORPHIC CONDITIONS

3.1 Sixteen Mile Creek (Conservation Halton)

Five culvert crossings located in the portion of the study area managed by CH were included in the field assessment. The findings of the field assessment are summarized below in Table 1. Additional detail is given in Table 3 (at end of report), and reach descriptions are found in Appendix E-1.

There are three regulated watercourses within this portion of the study area. Sixteen Mile Creek Mideast Reach 13 Tributary (C1) is an intermittent channel with a drainage area of 0.89 km². Hornby Tributary or Sixteen Mile Creek Mideast Reach 13 Main (C2) flows north to south and has a drainage area of 7.1 km². Sixteen Mile Creek Mideast Reach 1 North (C11) is ditched and has a drainage area of 1.36 km².

The remaining features (C9 and C12) are intermittent headwater features with small drainage areas of 0.30-0.39 km². Both are swales and ditches with no natural bankfull indicators and minimal ongoing geomorphic processes.

Table 1 Summary of Reach Characteristics – Sixteen Mile Creek Watershed

CA	Culvert No.	Drainage area (km ²)	Representative bankfull width (m)	Planform	Description
Conservation Halton	C1	0.89	1	Meandering	Small meandering channel upstream. Downstream, multiple flow paths through grassy area. Loose silt and clay bed.
	C2	7.10	5 (modified)	Straight	Bankfull width modified (over-widened). Channel previously straightened, straight planform persists. Cobble-gravel bed. Poorly developed bedforms, silt and alga-covered bed.
	C9	0.30	N/A	Straight	No defined channel downstream of roadside ditch.
	C11	1.36	N/A	Straight	Ditch is up to 2.5 m wide, no natural bankfull indicators. Erosion present at outlet due to undersized culvert.
	C12	0.39	N/A	Straight	No defined channel outside of roadside ditches.

3.2 Black Creek (Credit Valley Conservation)

Four culvert crossings, one bridge (Black Creek) and one reach (Tributary to Black Creek) located in the portion of the study area managed by CVC were included in the field assessment. The findings of the field assessment are summarized below in Table 2. Additional detail is given in Table 3 (at end of report), and reach descriptions are found in Appendix E-1.

Black Creek (B1) is the only regulated watercourse within this portion of the study area, and is the largest watercourse within the Trafalgar Road project area. At Trafalgar Road the creek has a drainage area of 73.2 km². The watercourse is permanent and within the study reach the channel appears to have been straightened and locally stabilized.

The study reach on the Tributary to Black Creek downstream of C14 is classified as a permanent watercourse. It has a defined channel and is undergoing incision and lateral adjustment within a narrow forested valley.

The reaches associated with the four culvert crossings (C14, C15, C16 and C18) are intermittent headwater features with small drainage areas of 1.00 km² or less. These reaches are swales and ditches with no natural bankfull indicators and minimal ongoing geomorphic processes.

Table 2 Summary of Reach Characteristics – Black Creek Watershed

CA	Culvert No.	Drainage area (km ²)	Representative bankfull width (m)	Planform	Description
Credit Valley Conservation	B1	73.20	6-9	Straightened reach in meandering system	Black Creek has tendency to meander but is straightened near Trafalgar Road. Partial bank protection present, limited bank erosion. Cobble-gravel bed with riffle-run morphology. Reach is located downstream of Stewarttown Bridge.
	C14	0.54	1.3	Straight	Upstream is a wetland with no defined channel. Downstream channel is modified.
	Downstream of C14	Unknown	1.7-2.5	Meandering	CN railway culvert outlet perched by approx. 1 m. Downstream channel is sinuous within confined valley. Active erosion on banks. Ongoing lateral adjustment and incision. Cobble-gravel bed. Creek valley is adjacent to proposed CN railway grade separation.
	C15	0.41	N/A	Straight	Swale flowing to forest floor. No defined channel in Trafalgar Road ROW.
	C16	1.00	2	Straight	No defined channel upstream. Straightened channel downstream: vegetated banks, fine gravel substrate.
	C18	1.00	N/A	Straight	No defined channel.

3.2.1 Black Creek Erosion Hazard Assessment

In a letter to MMM dated May 13, 2014, CVC requested that “new bridges and where possible replacement bridges span the calculated meander belt of the watercourse.” Potential lateral migration should be considered during the design of new crossings to ensure that the crossing does not impede natural channel processes and to ensure that potential erosion hazards to the crossing structure are mitigated. To that end, available background documents, historic aerial photographs from 1954 and 1978, contemporary satellite imagery and 0.5 m contour data were reviewed.

The headwaters of Black Creek emerge from a wetland complex near the Town of Erin. From there the creek flows through predominantly agricultural lands to Georgetown, where it joins Silver Creek downstream of the Main Street. The Black Creek valley was formed by glacial processes and the contemporary creek is underfit for the large valley it occupies. The surficial geology of Black Creek near Trafalgar Road consists of alluvium within the Black Creek channel, glaciofluvial gravel on adjacent floodplain, and silt to clay till in the wider valley. The reach is classified as coldwater.

The reach crossing Trafalgar Road begins approximately 250 m upstream at the Stewarttown Dam, which is a significant structure that forms a drop of over 4 m. The dam was a historical source of power in the area. It was built before 1954, which is the earliest aerial photograph available. Downstream of the dam is a large scour pool from which the creek flows through a vegetated floodplain for approximately 75 m. The creek then enters an urbanized residential area which extends from approximately 75 m upstream of the Stewarttown Road Bridge Trafalgar Road. Downstream of Trafalgar Road the reach continues through residential properties and into the manicured lands of the North Halton Golf and Country Club. The reach ends at the confluence with the Tributary to Black Creek midway through the golf course property.

Within the study reach the geomorphic form and function of the channel has been heavily impacted by historical and contemporary infrastructure. This includes the Stewarttown Dam, the Stewarttown Road Bridge and the Trafalgar Road Bridge, several pedestrian bridges within the golf course property, a stormwater outfall downstream of the Stewarttown Road Bridge and several roadside ditch outfalls. The Stewarttown Dam controls the grade and channel planform at the upstream extent of the reach, and also alters sediment transport processes downstream. Between the dam and Stewarttown Road, the channel may have been historically impacted by a millrace. The Stewarttown Road and Trafalgar Road bridges also impose local limits on lateral channel migration. Embankment and grading works associated with the adjacent properties appear to contribute to the partial confinement of the channel, particularly upstream of Trafalgar Road.

The planform within the study reach appears to have been straightened. The historic aerial photographs reviewed indicate that the creek has occupied the same planform since the earliest aerial photograph date of 1954. Given the close proximity of urban buildings upstream of Trafalgar Road and the golf course downstream, it is likely that the existing planform has been maintained by property management activities throughout the period of the photographic record and will continue to be maintained under future conditions. This was supported by the site assessment, which identified stone bank protection on the left creek bank between the Stewarttown Road Bridge and Trafalgar Road.

The straightened channel planform, lack of historic pre-disturbance planform information and the likelihood that the existing planform will be maintained precludes the measurement of bank migration from the aerial photographs. Because of the urbanized conditions, calculation of a meander belt from empirical models is also not considered applicable to this reach. Instead, it is recommended that the replacement Trafalgar Road Bridge meet other geomorphic considerations for crossing design as outlined in the CVC Fluvial Geomorphic Guidelines (2015).

3.2.2 Tributary to Black Creek Erosion Hazard Assessment

A grade separation is proposed at the intersection of Trafalgar Road and the CN railway crossing. At the intersection Trafalgar Road will be lowered and realigned to the east. The proposed road alignment will encroach toward a Tributary to Black Creek which is located east of Trafalgar Road near the Town of Halton Hills property.

The encroachment toward the Tributary will be greatest between the CN railway and Maple Avenue. Flows to this reach are contributed from C14 and from the ditch flowing along the north side of the CN railway embankment. The creek crosses the CN railway embankment and an access road to flow southeast through a deep, well-defined valley toward Maple Avenue. From Maple Avenue the creek is piped into the North Halton Golf and Country Club. Due to valley confinement there is limited opportunity to realign the Tributary away from the proposed alignment of Trafalgar Road.

The future road will be closest to the creek at Station 10+860. In this location:

- The road centerline is approximately 259.0 m.
- The creek centerline is 257.9 m, approximately 1.1 m lower than the road centerline
- The lowered road will be protected by a retaining wall, which is approximately 2.7 m high to tie into the existing valley. The distance from the retaining wall to the creek centerline is approximately 9.0 m.
- The site assessment identified active bank erosion on the toe of the valley slope.
- At the top of the valley slope the riparian forest is sparse.

A preliminary assessment of the erosion hazard limit of the creek was completed within this reach with guidance from CVC's Slope Stability Definition & Determination Guideline (2014), following the procedure for confined valleys. Resources reviewed in support of this assessment included field data, available background documents, historic aerial photographs from 1954 and 1978, contemporary satellite imagery and 0.5 m contour data. Detailed topographic information was not available within the creek valley.

The erosion hazard limit is composed of:

- An erosion component to account for the 100 year erosion limit. This is required where the creek is within 15 m of the valley wall, which is the case within this reach.
- A slope stability component indicating the geotechnical stable top of slope line.

3.2.2.1 Stability Component

The site assessment found that the banks are composed primarily of clay and silt with minor gravel and sand. Provincial surficial geology mapping of the Tributary indicates that surficial materials are composed of red to brown gritty silt to clayey silt till. This is part of the Halton Till and has low permeability.

The Generalized Stability Setback Guidelines prescribes a 2.5:1 setback gradient line for clay tills.

3.2.2.2 Erosion Component

The floodplain within the valley is less than 15 m, so an erosion setback is required. The 100-year erosion rate could not be delineated because the channel is obscured by vegetation in both the 1978 and 1954 aerial photographs, and the resolution of the 1954 aerial photograph is of poor quality.

As such a setback was employed as per CVC guidelines. Active bank erosion was identified during the field assessment. The suggested design toe erosion allowance for channels with active bank erosion, in which banks are composed of cohesive soils (silty clays and clayey silts) is 8 m.

3.2.2.3 Preliminary Erosion Hazard Limit

This assessment is presented for general purposes only and is not intended to be used for detailed mapping or setback delineation. The assessment is based on coarse topographic data and standard offsets and a slope stability study has not been completed. The final design of the proposed retaining wall shall be completed in consultation with a Geotechnical Engineer.

The preliminary assessment indicates that parts of the proposed road alignment will fall within the preliminary erosion hazard limit of the creek between the CN railway and Maple Avenue where the road is nearest to the valley. Based on the preliminary road alignment, the minimum distance between the retaining wall and the creek centerline is approximately 9 m, (Station 10+860), while the erosion setback based on CVC guidelines is 8 m. Based on this erosion setback, the proposed horizontal alignment of the retaining wall will have a negligible impact on the lateral migration of the creek. With the addition of the slope stability component, the road alignment intersects the final erosion hazard limit.

At detailed design, an assessment of the change in the vertical alignment of the creek (i.e. scour analysis, knickpoint migration, etc.) shall be undertaken on the Tributary to Black Creek within the reach between the CN railway and Maple Avenue. As there is limited opportunity to realign the Tributary due to valley confinement, opportunities for local bank and valley slope protection and post-construction monitoring should be explored at detailed design. The assessment will inform the need for and design of appropriate stabilization measures as required. Any in-channel works shall be designed by a qualified Geomorphologist using natural channel design principles with guidance from CVC's Geomorphic Guidelines. Commitments for detailed design are included in Section 4.2 of this report.

4.0 PROPOSED WORKS

4.1 Sixteen Mile Creek (Conservation Halton)

The proposed structure dimensions are presented in Table 3.

In a letter to MMM dated November 26, 2015, CH stated that 3 x bankfull width is required as a starting point for new and replacement culverts. A reduction of this standard may be considered provided it is justified by a fluvial geomorphology study prepared by a qualified professional. The following section provides a discussion of the proposed structures in relation to existing channel dimensions and geomorphic processes.

Culvert C1 will be extended. The existing culvert span is approximately three times the average channel bankfull width (where the channel is defined). The structure is well aligned with the defined channel upstream and is not impeding ongoing geomorphic processes. As such, culvert extension is considered appropriate.

It is understood that the replacement of the C2 crossing would conflict with sensitive forest land adjacent to the crossing and would impact the road profile. To avoid these impacts, extension of culvert C2 was advanced as the preferred option. The existing C2 culvert is located on a straight reach and is well aligned with the existing channel planform. Although the closed-foot twin culvert cells (2.75 m span) are narrower than the modified bankfull width of 5.0 m, geomorphic processes at the existing crossing are predominantly stable to depositional. The bankfull channel width of 5.0 m appears to be modified and over-widened for normal flows, based on the extensive presence of algae and silt deposits within the channel. The absence of outflanking around the existing culvert footings and the presence of mature trees on the bank tops indicates that the planform has been stable since the construction of C2 in 1980. Over-widening appears to have reduced energy within the channel under normal flows, slowing the rate of channel recovery. Given the over-widened condition of the channel, a span of less than three times the modified bankfull width is appropriate to maintain existing geomorphic processes through the crossing.

Based on this analysis, the existing C2 culvert will be extended and a third culvert cell with an open footing and a span of 3.00 m will be added to the existing structure, resulting in a total span of 8.5 m (1.7x the modified bankfull channel width). The proposed structure will not increase the erosion hazard, but will maintain similar geomorphic conditions under low flows and reduce constriction of high flows by providing additional hydraulic capacity. Low flows shall be realigned through the third cell rather than being distributed through the entire crossing to maintain water depths for fish passage. The bed of the channel within the open foot cell will be composed of natural channel substrate which is better suited for fish passage than the existing closed-foot cells and which will allow sediment transport through the crossing. The channel invert within the open foot cell will be lower than the existing culvert invert to focus low flows through the new cell.

A geomorphic review of hydraulic modeling data will be undertaken at detailed design when additional hydraulic information becomes available based on detailed survey of the Hornby Tributary and C2

crossing. The analysis will confirm that the proposed structure will maintain the existing sediment transport regime and fish passability. The analysis will provide input to the bed elevation of the proposed culvert cells to ensure to meet their intended functions (such as fish passage and conveyance of low flows, conveyance of higher flows and wildlife passage). The analysis will also inform appropriate substrate sizing within the proposed open-foot cell and channel realignment. Opportunities to improve fish passability shall be investigated.

Culvert crossings C9, C11 and C12 will be replaced with open foot structures. This will allow sediment transport to occur unimpeded through the crossings. As well, these replacement structures will be wider than the existing culverts. The proposed spans are considered sufficient to maintain ongoing geomorphic processes (primarily the transfer of fine sediment from upstream to downstream), and will not increase erosion risk. At culverts C9 and C12 there is no defined channel present, and span criteria based on multiples of bankfull width are not applicable.

At crossing C11, an open-foot culvert with a 3.05 m span is proposed to replace the existing 0.75 m diameter culvert. The existing C11 culvert is narrower than the width of the ditch (2.0 m - 2.5 m) and conveys only the 2-year flow. This has led to local scour at the outlet. Outside of the scoured area the channel is stable with few ongoing geomorphic processes and features. The watercourse has been ditched upstream and downstream of the crossing, which limits potential channel migration. The wider span will be an improvement over existing conditions and will help to address downstream bank scour. Based on available hydraulic modeling, the replacement structure will reduce velocities at the outlet of the culvert under all flows (2-year to Regional). The in-channel velocity at the 2 year flow is 1.58 m/s under existing conditions, and 1.28 m/s under proposed conditions. At detailed design the detailed topographic model will be obtained from CH and the hydrologic and hydraulic analysis of the C11 culvert may be revised and refined. Should updated hydraulic analysis be carried out at detailed design, the recommendations for the C11 culvert will be revisited and confirmed.

On watercourses with a defined channel (C1, C2 and C11), low flow channels shall be created within the replacement structures, structure extensions and additional culvert cells. The dimensions, substrate and inverts of the low flow channels should be designed to tie in smoothly with the existing channels upstream and downstream. The substrate should be composed of an appropriately sized gradation which is well-mixed to ensure that voids are filled.

The following site specific works shall be considered at detailed design:

C1

- Minor tie in work may be required to connect the in-structure low flow channel through the culvert extension to the existing channel.

C2

- Minor realignment works will be required both upstream and downstream to convey the low flow through the third culvert cell. This would provide the opportunity to create several meters of additional channel length, and to improve bedforms by introducing greater diversity in channel morphology (such as riffles and pools) within the realignment footprint. The upstream and downstream tie-ins should join the existing channel at a gentle angle. Substrate should be composed of natural stone that has been appropriately sized by a fluvial geomorphologist. The detailed realignment design shall be completed in consultation with aquatic biologists to ensure the crossing meets fish passage standards.
- Minor stabilization of the channel bed with appropriately sized substrate is recommended where the channel bed is locally scoured at the inlet of the eastern culvert cell. This stabilization will be completed as part of the channel realignment works, during which flows will be directed away from the existing flow path through the eastern cell to pass through the third culvert cell.
- Consider improving the angle at which the roadside ditch enters the creek from the northeast corner of the crossing to mitigate future bed scour at the culvert inlet.
- Consider removing sediment from the western cell to increase culvert capacity.

C 9

- Realignment of the upstream roadside ditch will be required as the existing ditch will be removed.
- Minor tie in works will be required to connect the culvert to the downstream swale.

C11

- Realignment of the upstream and downstream roadside ditches will be required as existing ditches will be removed.
- At the culvert outlet, a stable scour pool shall be constructed to allow dissipation of energy.
- Consider improving the culvert angle to reduce its skew to the ditch planform upstream and downstream.

C12

- Realignment of the upstream and downstream roadside ditches will be required as existing ditches will be removed.

4.2 Black Creek (Credit Valley Conservation)

The proposed structure dimensions are presented in Table 3.

CVC Fact Sheet III: Geomorphological Considerations with Regards to Crossing Design outlines best practices for the location, crossing opening and type of crossing for new crossing structures. The guidelines state that crossing opening should not impact sediment transport processes for frequent storm events, and spans the potential future location of the watercourse, taking into consideration potential future channel migration. The following section provides a discussion of the proposed structures in relation to existing channel dimensions and geomorphic processes.

All culvert crossings included in the geomorphology assessment will be replaced with open foot structures. This will allow sediment transport to occur unimpeded through the crossings. As well, the replacement structures will be wider than the existing crossings. The proposed spans are considered sufficient to maintain ongoing geomorphic processes (primarily the transfer of fine sediment from upstream to downstream), and will not increase erosion risk. At C15 and C18 there is no defined channel present, and span criteria based on multiples of bankfull width are not applicable.

The proposed span of C14 will be approximately 1.5 times the channel width downstream. It should be noted that the channel width is modified. The upstream feature consists of a swale, and the downstream reach is hardened and confined by residential landscaping (with no erosion issues under existing conditions). As the existing crossing structure is narrower than bankfull width downstream, the wider span will be an improvement over existing conditions.

The proposed span of C16 will also be approximately 1.5 times the channel width downstream. The upstream feature consists of a swale, and the downstream reach is straight and confined by the railway embankment (with no erosion issues under existing conditions). As the existing crossing structure is narrower than bankfull width downstream, the wider span will be an improvement over existing conditions.

Where there is a defined channel (C14 and C16), low flow channels shall be created within the replacement structures. The dimensions, substrate and inverts of the low flow channels should be designed to tie in smoothly with the existing channels upstream and downstream of the crossings. The substrate should be composed of an appropriately sized gradation which is well-mixed to ensure that voids are filled.

The existing 8.8 m span bridge at Black Creek will be replaced with a 30.0 m wide single span structure. The bridge abutments will be placed well outside of the bankfull channel. The creek on both sides of the bridge has been straightened, and the channel has been prevented from migrating laterally by the installation of local bank protection. The additional span will not increase erosion hazards within the creek. The proposed span is anticipated to provide ample room to allow existing geomorphic processes to continue unimpeded, particularly as significant lateral adjustment is likely to be prevented by continued management of the surrounding properties.

A defined channel and floodplain will be created below the future bridge. Channel dimensions, substrate and inverts should be designed to tie in smoothly with the existing creek upstream and downstream of the

bridge. The floodplain shall be graded to appropriate elevations so as to tie in smoothly with the existing floodplain upstream and downstream; this will also provide wildlife passage. The substrate should be composed of an appropriately sized gradation which is well-mixed to ensure that voids are filled. The channel shall be designed by a geomorphologist with input from fisheries biologists to ensure that the substrate is sized appropriately for resident fish species.

The following site specific works shall be considered at detailed design:

B1 (Black Creek)

- Minor tie in works will be required to connect the new channel below the bridge to the existing creek upstream and downstream.

C14

- The proposed crossing will be lowered by approximately 0.5 m. The inlet elevation will be lowered from 267.92 m to 267.45 m, and the outlet elevation will be lowered from 267.64 m to 267.20 m. As the existing culvert outlet is perched, the proposed invert will tie in smoothly to the existing channel. Tie in works will be required at the culvert inlet. Note that there is a swale and wetland area upstream of the crossing under existing conditions.

Tributary to Black Creek downstream of C14

- The final design of the proposed retaining wall shall be completed in consultation with a Geotechnical Engineer.
- At detailed design, an assessment of the change in the vertical alignment of the creek (i.e. scour analysis, knickpoint migration, etc.) shall be undertaken by a qualified Fluvial Geomorphologist or Professional Engineer. The analysis will inform the design of stabilization measures if required.
- At detailed design, opportunities for local bank and valley slope protection should be explored to stabilize the creek valley in areas nearest the future road alignment. Natural stabilization works such as plantings should be considered when possible. Incorporating plantings into the stabilization works could improve creek shading and riparian vegetation quality where the existing riparian vegetation is sparse. Any in-channel works shall be designed by a qualified Geomorphologist using natural channel design principles with guidance from CVC's Geomorphic Guidelines.
- The valley slope should be monitored after construction to ensure that the stabilization works are effective and any potential slope instability issues are identified and addressed.

C15

- No tie in works required.

C16

- The proposed road alignment will shift to the west near the intersection with Side Road 20. The future footprint of C16 will also shift to the west. This provides the opportunity to create a length of open channel within the downstream portion of the existing C16 footprint. Channel dimensions, inverts and substrate should be designed to tie in smoothly with the channel downstream. A scour pool could be created at the culvert outlet.

- Minor tie in works may also be required to connect to the swale upstream.

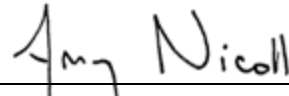
C18

- Minor tie in works may be required to connect to the swale downstream.
- Creation of a scour pool could be considered at the culvert outlet.

**Respectively submitted by
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Table 3 Existing reach characteristics and proposed works

CA	Culvert No.	Watercourse	Flow regime	Drainage area (km ²)	Bankfull width (m)			Planform	Description	Proposed Works
					Upstream	Downstream	Representative			
Conservation Halton	C1	Tributary to Middle Sixteen Mile Creek (Sixteen Mile Creek Mideast Reach 13 Tributary)	Intermittent	0.89	0.7-1.3	0.6	1	Meandering	Small meandering channel upstream. Downstream, multiple flow paths through grassy area. Loose silt and clay bed.	Extend 8 m
	C2	Hornby Tributary to Middle Sixteen Mile Creek (Sixteen Mile Creek Mideast Reach 13 Main)	Permanent	7.10	5.1	4.6	5 (modified)	Straight	Bankfull width modified (over-widened), no unmodified bankfull indicators present. Channel previously straightened, straight planform persists. Cobble-gravel bed. Poorly developed bedforms, silt and alga-covered bed.	Extend 18 m. Additional cell 3000 x 2400 mm Open Footing structure.
	C9	Tributary to Middle East Sixteen Mile Creek	Intermittent	0.30	Ditch (1.0 - 2.0)	Swale	N/A	Straight	No defined channel downstream of roadside ditch.	Replace with 1830 x 910 mm Open Footing structure
	C11	Tributary to Middle East Sixteen Mile Creek (Sixteen Mile Creek Mideast Reach 1 North)	Intermittent	1.36	Swale	Ditch (2.0 - 2.5)	N/A	Straight	Ditch is up to 2.5 m wide, no natural bankfull indicators. Erosion present at outlet due to undersized culvert.	Replace with 3050 x 1530 mm Open Footing structure
	C12	Tributary to Middle East Sixteen Mile Creek	Intermittent	0.39	Ditch (1.0 - 1.5)	No feature	N/A	Straight	No defined channel outside of roadside ditches.	Replace with 2130 x 910 mm Open Footing structure
Credit Valley Conservation	B1	Black Creek	Permanent	73.20	6-9			Straightened reach in meandering system	Black Creek has tendency to meander but is straightened near Trafalgar Road. Partial bank protection present, limited bank erosion. Cobble-gravel bed with riffle-run morphology. Reach is located downstream of Stewarttown Bridge.	Replace with Single Span Bridge (30 m)
	C14	Tributary to Black Creek	Intermittent	0.54	Swale	1.3	1.3	Straight	Upstream is a wetland with no defined channel. Downstream channel is modified.	Replace with 2130 x 1220 mm Open Footing Structure
	Downstream of C14	Tributary to Black Creek	Permanent	Unknown	1.7 - 2.5			Meandering	CN railway culvert outlet perched by approx. 1 m. Downstream channel is sinuous within confined valley. Active erosion on banks. Lateral adjustment and incision. Cobble-gravel bed. Creek valley is adjacent to proposed CN railway grade separation.	Local bank stabilization recommended where valley is in proximity to future retaining wall
	C15	Tributary to Black Creek	Intermittent	0.41	Swale	Swale	N/A	Straight	Swale flowing to forest floor. No defined channel in Trafalgar Road ROW.	Replace with 1520 x 910 mm Open Footing structure
	C16	Tributary to Black Creek	Intermittent	1.00	Swale	2.0	2.0	Straight	Straightened channel downstream. Vegetated, fine gravel substrate.	Replace with 3050 x 1520 mm Open Footing structure
	C18	Tributary to Black Creek	Intermittent	1.00	Swale	Swale	N/A	Straight	No defined channel.	Replace with 3050 x 1520 mm Open Footing structure

FIGURES

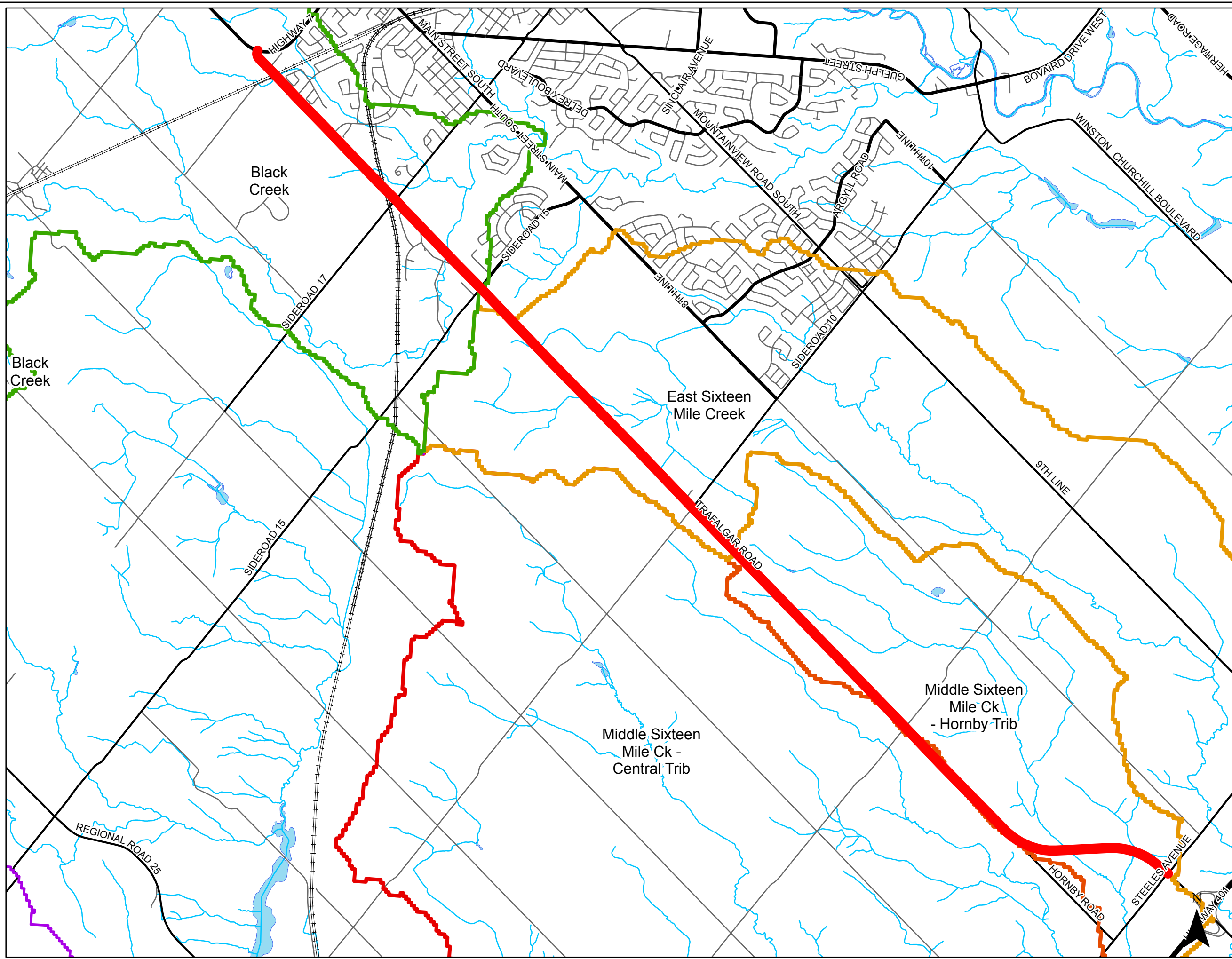


Figure 1. Location of study area - Trafalgar Road (Steeles Avenue to Hwy 7) - and associated subwatersheds.

Legend

- StudyArea
- RailwayTrackORWN
- Major
- Arterial
- Minor
- WatercourseOHN
- Major Waterbody
- Minor Waterbody

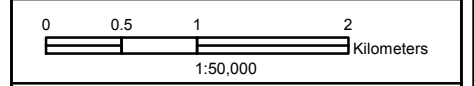


Figure 1
 Project No.: 3214006-001
 Date Created: 11/03/2016
 Date Modified: 3/24/2016
 Coord. System: WGS 1984 Web Mercator Auxiliary Sphere
 Source: ESRI Basemaps, MMM, LIO



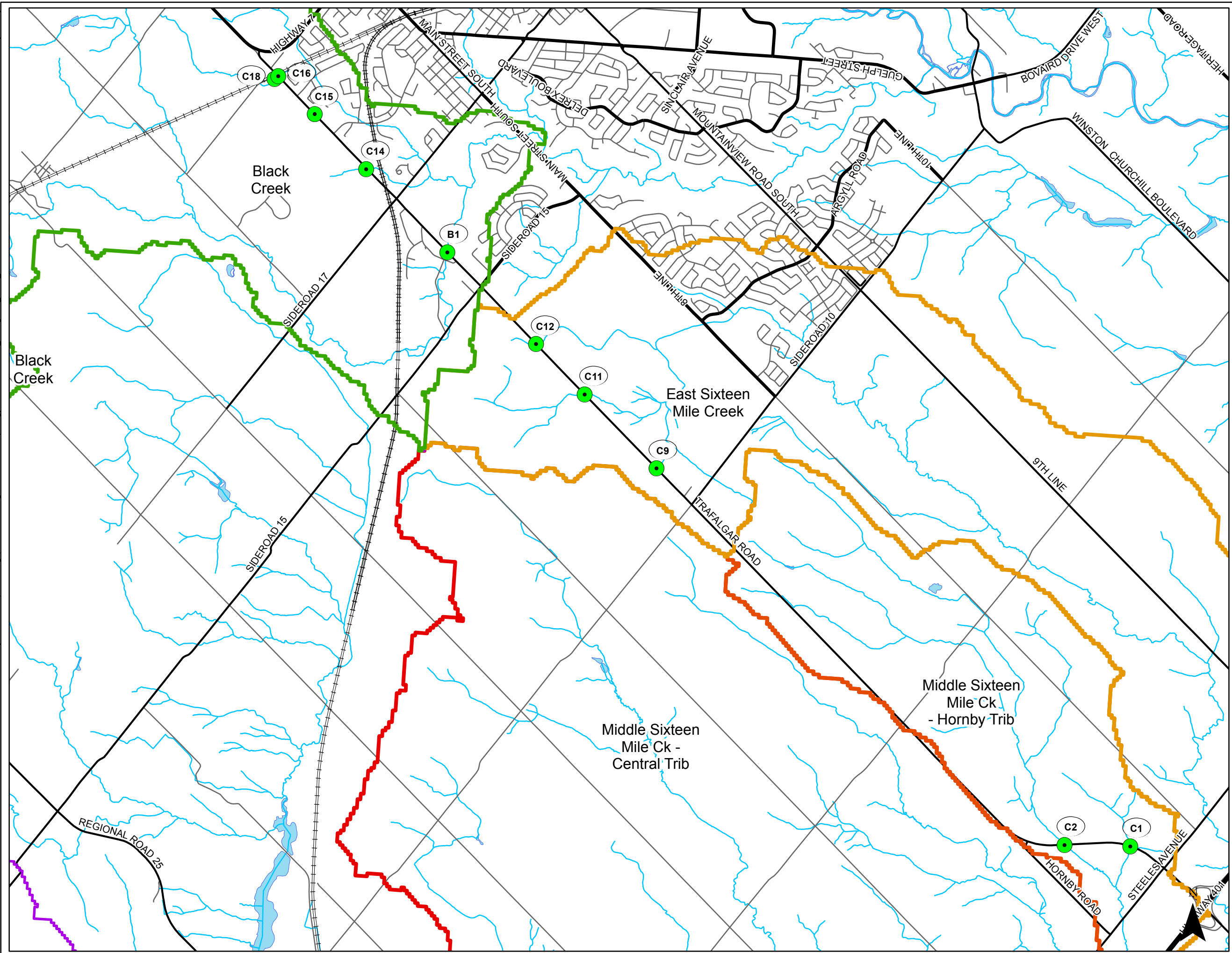


Figure 2. Location of watercourse crossings included in the geomorphology assessment.

Legend

- Crossings
- RailwayTrackORWN
- Major
- Arterial
- Minor
- WatercourseOHN
- Major Waterbody
- Minor Waterbody

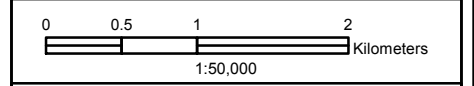
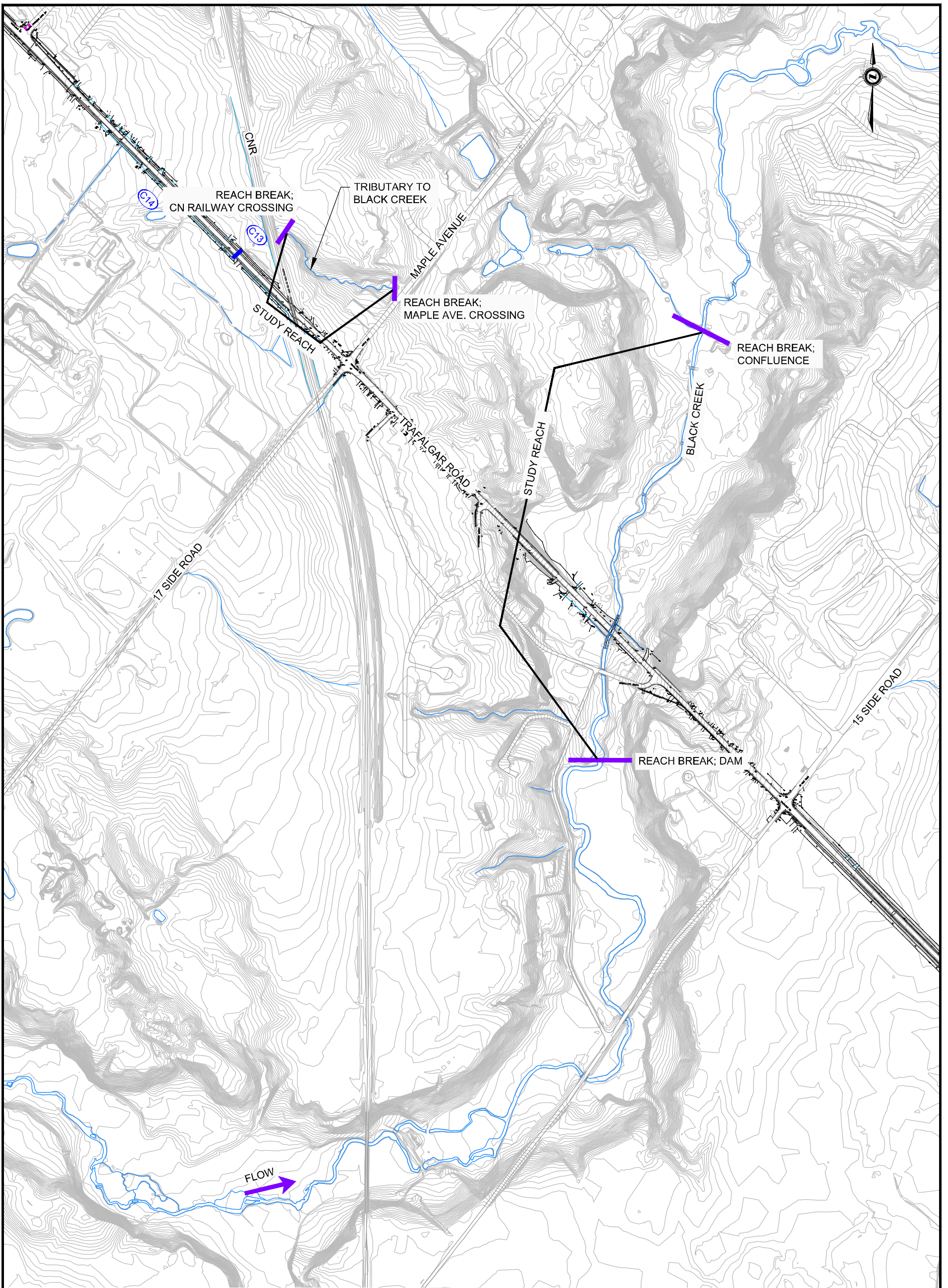


Figure: 2
 Project No.: 3214006-001
 Date Created: 11/03/2016
 Date Modified: 3/24/2016
 Coord. System: WGS 1984 Web Mercator Auxiliary Sphere
 Source: ESRI Basemaps, MMM, LIO





BLACK CREEK EXISTING PLANFORM

TRAFALGAR ROAD EA

FIGURE

3



APPENDIX E-1

Reach Descriptions

Appendix E-1: Reach Descriptions

Culvert No.	C1
Sediment transport function	Exchange
Process	Lateral adjustment
Bank material	Silt and clay
Substrate	Silt and clay
Bankfull width (m)	0.6 - 1.3
Channel Geometry	Meandering where defined

The reach extends upstream and downstream of C1, and is located in a wide gentle valley. Riparian vegetated consists of a grassy buffer strip with scattered shrubs.

Upstream there is a defined single thread channel with a gently meandering planform. Roadside ditches connect to swale from north and south. Downstream is a poorly defined multi-thread channel. The reach is well-connected to the floodplain, which is flat and marshy. The reach is low gradient.

The cross section is unmodified. Where defined the channel is 0.6 m and varies from 0.6 - 1.3 m wide. The banks are well vegetated and generally stable. Where the channel is defined, some local bank erosion and slumps are found on outer bends

Within culvert is a low flow channel flanked by benches. There is no scour pool at the outlet.



View upstream from inlet



View inside of culvert



Typical defined channel

Culvert No.	C2
Sediment transport function	Source
Process	Lateral adjustment
Bank material	Clay and silt
Substrate	Sub-angular cobble with gravel, sand, silt
Bankfull width (m)	4.6 - 5.1
Channel Geometry	Straight (modified)

The channel flows through a deciduous forest upstream of Trafalgar Road. Downstream, it flows between a farm property to the west and a deciduous forest to the east. The channel is low gradient, slightly entrenched and appears to have been historically straightened.

The reach has poorly developed riffle-pool morphology. Banks 1.0 - 1.7 m high, but bankfull depth is 0.4 - 0.6 m based on change in vegetation. The bankfull width of 4.6 - 5.1 m appears to be modified. The channel is recovering a less uniform cross section through local bank adjustment. Exposed banks, leaning trees, exposed tree roots and stable, vegetated bank slumps are common. The reach appears to be in the early stages of lateral adjustment, but sinuosity has not yet developed. The absence of outflanking around the existing culvert footings and the presence of mature trees on the bank tops indicates that the planform has been stable overall since the culvert was constructed. Over-widening may have impeded the recovery of a more natural cross section. The combination of bank erosion and an algae- and silt-covered bed indicate that the reach may be subject to flashy flows, while under normal flows the channel is stable to depositional.

The crossing is a 2 cell closed-foot concrete culvert. Its alignment is sharply skewed to Trafalgar Road but it is fairly well aligned with the channel planform. The geomorphic conditions within the culvert are stable to depositional. The left cell is the main flow path. The right cell is accessed less frequently and contains deposited silt. Banks are protected by 200 mm riprap at the culvert inlet and outlet, and banks are stable. The inlet of the left cell is perched by 0.23 m. This appears to be local scour where a ditch joins from the left bank.



View looking downstream to C1 inlet



View upstream from inlet



Culvert outlet

Culvert No.	C9
Sediment transport function	Transfer
Process	Stable
Bank material	Silt and clay
Substrate	Silt
Bankfull width (m)	Not applicable
Channel Geometry	Straight (modified)

Upstream the feature consists of a ditch running parallel to the road. Ditch is reedy and approximately 1.0 - 2.0 m wide.

The culvert inlet was ponded at the time of survey. The culvert outlet has partially collapsed.

The culvert outlets to a poorly defined, partially vegetated pool (standing water at the time of survey) which leads into a linear swale running through agricultural fields. The swale was partially obscured by tall grass and no property access was available, however there does not appear to be a defined channel in the field.



View upstream: culvert inlet



View downstream: Pool and linear swale

Culvert No.	C11
Sediment transport function	Transfer
Process	Stable
Bank material	Clay, silt, gravel, cobble
Substrate	Silt
Bankfull width (m)	Not applicable
Channel Geometry	Straight (modified)

Upstream is a vegetated roadside ditch which is fed by a vegetated swale flowing from an agricultural field. The swale is approximately 2.5 m wide and appears to be stable. The ditch enters the culvert at a sharp angle.

Downstream the culvert outlets to a roadside ditch flowing south. The original CSP culvert was lined with a narrower pipe which appears to have caused scouring at the outlet. The outlet of the culvert is perched due to culvert lining; however the concrete apron ties into the existing ditch bed. At the outlet a scour pool (approximately 4 m wide, 8 m long) has formed by erosion of the eastern bank, which is 1.3 m high. The eroding bank is partially lined by 200 mm riprap which has failed, but has not been transported out of the scour pool. A large bank slump occupies the middle of the scour pool.

Downstream of the scour pool, the ditch is entrenched, low gradient and was stagnant at the time of survey. The ditch is approximately 2.0 - 2.5 m wide and 0.6 - 1.0 m deep. High flows may access the floodplain but there is no direct channel connection to the field drain located in the adjacent agricultural field.



View downstream of outlet and eroding bank



Eroding bank downstream of culvert outlet



Typical view of downstream ditch

Culvert No.	C12
Sediment transport function	Transfer
Process	Stable
Bank material	Silt and clay
Substrate	Gravel
Bankfull width (m)	Not applicable
Channel Geometry	Straight

No defined channel is present outside of the roadside ditches found upstream and downstream of the culvert. There are no bankfull indicators.

Upstream of the ROW a 1.5 m wide, 0.5 m deep swale flows to the ditch from an agricultural field. The ditches within the ROW are approximately 1.0 - 1.5 m wide, 0.5 m deep with vertical banks and minor bank erosion. The bank tops are well vegetated bank tops.

The CSP culvert inlet is corroded and elevated above the bed by 0.2 m. Some gravel deposited inside and below culvert. Riprap is present at inlet and outlet. At the outlet a scour pool has formed downstream of the riprap protection; this is 1.5 m wide and 2.5 m long.



Ditch and agricultural swale looking upstream



C12 inlet

Bridge No.	B1 (Black Creek)
Sediment transport function	Transfer
Process	Stable with meandering tendencies
Bank material	Clay, silt with sand and organics
Substrate	Gravel, cobble with sand
Bankfull width (m)	6 - 9
Channel Geometry	Straight

The reach is lined by a narrow and discontinuous riparian buffer strip, beyond which are suburban and manicured properties. Its planform and channel cross section appear to have been modified.

The channel is partially confined on both banks upstream of Stewarttown Road and on the left bank upstream of Trafalgar Road. Floodplain connectivity is semi-continuous on the right bank upstream of Trafalgar Road, and on both banks downstream. The reach has riffle-run morphology, with a well-imbricated bed composed of gravel and cobble. Banks are gentle to vertical, and vary between 0.4 - 2.0 m high. The supply of sediment, particularly of bedload material, is limited by the Stewarttown Dam upstream. Few depositional features (such as point bars) were observed in the channel.

The reach has the tendency to meander but the straight planform has been maintained by local bank protection in areas that may develop into outer bends. Bank protection includes stone of various sizes (D_{50} approx. 400 mm upstream of Trafalgar Road, D_{50} approx. 200 mm at bridge abutments) and wood. Old vegetated bank slumps are also common. A sign indicates that tree planting for stream rehabilitation has been completed on a portion of the channel downstream of Trafalgar Road. No evidence of floodplain deposits or relic floodplain features were observed.

Below the Trafalgar Bridge, the thalweg angles toward the right bank at the downstream bridge face. Without maintaining existing bank protection, the channel could potentially migrate in this direction downstream.

A scour pool is present near the downstream face of the Trafalgar Bridge, but only consists of a change in depth. This may be caused by flow concentration by a pile of riprap deposited or placed in channel. There is no siltation in the pool.

A road rain joins from left bank just upstream of the Trafalgar Bridge. A steep informal drain joins the creek from the right bank approximately 10 m downstream of downstream bridge face.



View upstream from Stewarttown Bridge



View downstream to inlet of Trafalgar Road bridge



View upstream from Trafalgar Road Bridge



Left bank with large stone bank protection upstream of Trafalgar Road



View looking downstream from Trafalgar Road Bridge



Typical view of channel in North Halton Country Club

Culvert No.	C14
Sediment transport function	Transfer
Process	Stable
Bank material	Riprap, obscured
Substrate	Riprap, silt
Bankfull width (m)	1.3
Channel Geometry	Straight

Upstream of Trafalgar Road the reach consists of diffuse flow leading to a poorly defined swale (1.5 m wide).

Downstream of Trafalgar within the ROW is a defined channel lined with riprap.

The culvert is lined, and the outlet is elevated above the channel bed. A concrete apron ties the outlet into the channel bed. A scour pool lined with riprap is located at outlet (1.3 m wide x 1.5 m long). The D_{50} of the riprap is approx. 100 mm. Downstream the channel flows around a stone garden wall, then into a residential property. Property access was not permitted downstream of the ROW.

At the outlet a sideroad culvert conveys flow from a roadside ditch. There is a 0.4 m drop from sideroad culvert outlet to main channel bed. The ditch is lined with riprap.



Culvert inlet



Culvert outlet



View downstream of outlet

Culvert No.	Downstream of C14 Tributary to Black Creek
Sediment transport function	Source
Process	Lateral adjustment and incision
Bank material	Clay and silt with minor gravel and sand
Substrate	Gravel and cobble
Bankfull width (m)	1.7 - 2.5
Channel Geometry	Meandering

Drainage from C14 joins drainage flowing along the north side of the CN rail embankment. This crosses the CN rail through a 900 mm culvert, and then through another 900 mm culvert crossing an access road. A scour pool (approximately 8 m long and 6 m wide) has formed at the outlet of the access road culvert. The outlet is perched by approximately 1 m, and is lined with bricks in poor condition. A debris jam has partially blocked the scour pool.

Downstream to Maple Avenue, the channel flows within a deep forested valley which widens toward Maple Avenue. The valley is generally well vegetated, however the forest is sparse on the western slope where the creek is closest to Trafalgar Road. The planform is gently meandering within a narrow corridor. The channel has a moderate gradient and debris jams are common. The channel is partially confined by the valley slopes, particularly to the west. Bankfull width is 1.7 - 2.5 m and bankfull depth is 0.5 m. There is active erosion on banks throughout the reach, and eroding areas are up to 2.0 m high. In areas the toe of the valley slope is undercut. The dominant geomorphic processes are lateral adjustment and incision. The reach ends are the Maple Avenue crossing where it is piped into the North Halton Golf and Country Club.



Outlet of access road culvert



Erosion on western valley slope



Typical view downstream

Culvert No.	C15
Sediment transport function	Transfer
Process	Stable
Bank material	Earth
Substrate	Earth, riprap
Bankfull width (m)	Not applicable
Channel Geometry	Straight

Upstream, the feature consists of a swale running from a forested area into the ROW, perpendicular to Trafalgar Road. The swale is has a 2 m wide depression with very gentle banks connecting to the forest floor. Wetted width was 0.4 m at the time of survey. The bed is composed of soil. Some riprap is present throughout the ROW. Poorly defined ditches connect to the feature from the north and south. The feature is stable with no evidence of erosion.

The culvert is aligned with the swale.

Downstream the culvert outlets partway down a hillslope and flows into a forested valley onto a residential property. Within the ROW there is no defined channel, and the bed is protected with 300 - 500 mm riprap which is stable. Downstream the channel is defined and meanders through the forest floor. Channel measurements could not be obtained downstream (no property access).



View upstream from inlet



Outlet with bed protection



View downstream into valley

Culvert No.	C16
Sediment transport function	Transfer
Process	Stable
Bank material	Obscured by vegetation
Substrate	Gravel
Bankfull width (m)	2.0
Channel Geometry	Straight

Upstream, the reach consists of a swale draining from a residential property. The swale is 1.5 m wide, grassy and partially vegetated. Some riprap is present. The swale is stable with no erosion concerns. Riprap bed protection is present at the inlet and outlet, and is stable.

Downstream a defined channel is present. This runs parallel to the railway embankment. The cross section is modified and the planform is straight. The channel is 2.0 m wide and 0.5 m deep, with vegetated banks. Banks are generally stable with minor local erosion. The channel was dry at the time of survey.



Culvert inlet



Culvert inlet



View downstream from culvert outlet

Culvert No.	C18
Sediment transport function	Transfer
Process	Stable
Bank material	Obscured by vegetation
Substrate	Gravel
Bankfull width (m)	Not applicable
Channel Geometry	Straight

The reach consists of a swale draining from a residential property. The outlet of the culvert is perched by 0.2 m. A 1.5 m wide and 0.5 m deep scour pool has formed at the outlet.

Downstream of the culvert there is a poorly defined swale. This is 1.5 m wide, grassy and partially vegetated. Some riprap is present. The swale is stable with no erosion concerns. Riprap bed protection is present and stable.



C18 outlet to C16 inlet



C18 outlet

Trafalgar Road EA

Stage-Storage-Discharge Summary - Wet SWM Facility for Catchments 105-1

Pond # 2N

Stage (m)	Discharge (m³/s)	Storage		Stage (m)	Forebays			Main Pool (Excluding Forebay)			Storage		Estimated Detention Time (hrs)
		Active (m³)	Total (m³)		Area (m²)	Incremental Volume (m³)	Accumulated Volume (m³)	Area (m²)	Incremental Volume (m³)	Accumulated Volume (m³)	Sediment (m³)	Total (m³)	
202.80	0.0000	0	0	202.80				938	0	0		0	
203.80	0.0000	0	1,156	203.80				1,374	1,156	1,156	0	1,156	
204.00	0.0166	287	1,443	204.00				1,500	287	1,443	0	1,443	
204.20	0.0268	600	1,756	204.20				1,630	313	1,756	0	1,756	
204.40	0.0340	940	2,096	204.40				1,764	339	2,096	0	2,096	
204.60	0.0400	1,306	2,462	204.60				1,902	367	2,462	0	2,462	
204.80	0.3493	1,701	2,857	204.80				2,044	395	2,857	0	2,857	
205.00	2.0469	2,124	3,280	205.00				2,190	423	3,280	0	3,280	

Trafalgar Road EA

Detailed Outlet Structure Discharge Calculations

Elevation (m)	Discharge (m³/s)							DICB	Total Discharge	Parameters		
	Spillway			Outlet Riser						Overflow Weir 1	Orifice 1	
	Weir 1	Weir 2	Total	Orifice 1	Weir 1	Orifice 2	Total		Crest Elevation	Orifice Centre	Perimeter	
202.80	0.000	0.000	0.000	0.00000	0.000	0.000	0.000	0.000	204.70 m	203.88 m	471 mm	
203.80	0.000	0.000	0.000	0.00000	0.000	0.000	0.000	0.000				
204.00	0.000	0.000	0.000	0.01660	0.000	0.000	0.017	0.000				
204.20	0.000	0.000	0.000	0.02677	0.000	0.000	0.027	0.000	Crest Width 5 m	Orifice Invert 203.80 m	Area 17,671 mm²	
204.40	0.000	0.000	0.000	0.03403	0.000	0.000	0.034	0.000	Slope (x:1) 10	Orifice Diameter 150 mm	Orifice Coeff. 0.6	
204.60	0.000	0.000	0.000	0.03999	0.000	0.000	0.040	0.000	Weir Coeff. 1.670	Weir Top Width (m) 11.0	Orientation Vertical	
204.80	0.304	0.000	0.304	0.04517	0.000	0.000	0.045	0.000				
205.00	1.997	0.000	1.997	0.04981	0.000	0.000	0.050	0.000	Overflow Weir 2			
									Crest Elevation 9999.00 m	Weir 1		
									Crest Width 3 m	Top of Weir Structure 9999.30 m	Max Perimeter 1,400 mm	
									Slope (x:1) 3	Weir Crest Invert 9999.00 m	Max Open Area 240,000 mm²	
									Weir Coeff. 1.670	Weir Dimensions (Height x Length)		
									Weir Top Width (m) -58941.000	300 mm Height	800 mm L	
									DICB	Side Walls Vertical	Weir Coeff. 1.670	
									T/G Invert 9999.00 m	Orifice 2		
									CB Size 1200 mm	Orifice Centre 9999.13 m	Perimeter 785 mm	
									by 600 mm	Orifice Invert 9999.00 m	Area 49,087 mm²	
									Grate Slope 4 :1	Orifice Diameter 250 mm	Orifice Coeff. 0.6	
									Area (m²) 0.720	Orientation Vertical	Operates Above (m) 9999.13	
									Perimeter (m) 3.600			
									$Q = CA \sqrt{2g \left(h_2 - h_1 + \frac{D}{2000} \right)}$			
									$Q = CL(h_2 - h_1)^{1.5} + 1.268z(h_2 - h_1)^{2.5}$			

Where, h2 = elevation at stage 2 (m)
 h1 = elevation at stage 1 (m)
 D = orifice diameter (mm)
 C = orifice coefficient
 A = orifice open area (m²)

h2 = elevation at stage 2 (m)
 h1 = elevation at stage 1 (m)
 L = weir crest length (m)
 C = weir coefficient
 z = weir side slope (z:1)

Trafalgar Road EA

Stage-Storage-Discharge Summary - Dry, Linear SWM Facility for Catchments 105-3

Pond # 2S

Stage (m)	Discharge (m³/s)	Storage		Stage (m)	Forebays			Main Pool (Excluding Forebay)			Storage		Estimated Detention Time (hrs)
		Active (m³)	Total (m³)		Area (m²)	Incremental Volume (m³)	Accumulated Volume (m³)	Area (m²)	Incremental Volume (m³)	Accumulated Volume (m³)	Sediment (m³)	Total (m³)	
202.70	0.0000	0	0	202.70				300	0	0		0	
202.90	0.0420	75	75	202.90				453	75	75		75	
203.10	0.0939	181	181	203.10				608	106	181		181	
203.30	0.1260	319	319	203.30				765	137	319		319	
203.50	0.1515	488	488	203.50				924	169	488		488	
203.70	0.3906	688	688	203.70				1,085	201	688		688	

Trafalgar Road EA

Detailed Outlet Structure Discharge Calculations

Elevation (m)	Discharge (m³/s)								Parameters				
	Spillway			Outlet Riser				DICB	Total Discharge	Overflow Weir 1		Orifice 1	
	Weir 1	Weir 2	Total	Orifice 1	Weir 1	Orifice 2	Total			Crest Elevation	Orifice Centre	Perimeter	
202.70	0.000	0.000	0.000	0.00000	0.000	0.000	0.000	0.000	0.0000	203.50 m	202.85 m	942 mm	
202.90	0.000	0.000	0.000	0.04201	0.000	0.000	0.042	0.000	0.0420				
203.10	0.000	0.000	0.000	0.09393	0.000	0.000	0.094	0.000	0.0939				
203.30	0.000	0.000	0.000	0.12602	0.000	0.000	0.126	0.000	0.1260	Crest Width 1 m	Orifice Invert 202.70 m	Area 70,686 mm²	
203.50	0.000	0.000	0.000	0.15146	0.000	0.000	0.151	0.000	0.1515	Slope (x:1) 3	Orifice Diameter 300 mm	Orifice Coeff. 0.6	
203.70	0.217	0.000	0.217	0.17320	0.000	0.000	0.173	0.000	0.3906	Weir Coeff. 1.670	Orientation Vertical		
										Weir Top Width (m) 2.2			
										Overflow Weir 2			
										Crest Elevation 9999.00 m	Weir 1		
										Crest Width 3 m	Top of Weir Structure 9999.30 m	Max Perimeter 1,400 mm	
										Slope (x:1) 3	Weir Crest Invert 9999.00 m	Max Open Area 240,000 mm²	
										Weir Coeff. 1.670	Weir Dimensions (Height x Length)		
										Weir Top Width (m) -58941.000	300 mm Height	800 mm L	
										DICB	Side Walls Vertical	Weir Coeff. 1.670	
										T/G Invert 9999.00 m	Orifice 2		
										CB Size 1200 mm	Orifice Centre 9999.11 m	Perimeter 707 mm	
										by 600 mm	Orifice Invert 9999.00 m	Area 39,761 mm²	
										Grate Slope 4 :1	Orifice Diameter 225 mm	Orifice Coeff. 0.6	
										Area (m²) 0.720	Orientation Vertical	Operates Above (m) 9999.11	
										Perimeter (m) 3.600			

$$Q = CA \sqrt{2g \left(h_2 - h_1 + \frac{D}{2000} \right)}$$

$$Q = CL(h_2 - h_1)^{1.5} + 1.268z(h_2 - h_1)^{2.5}$$

Where, h2 = elevation at stage 2 (m)
 h1 = elevation at stage 1 (m)
 D = orifice diameter (mm)
 C = orifice coefficient
 A = orifice open area (m²)

h2 = elevation at stage 2 (m)
 h1 = elevation at stage 1 (m)
 L = weir crest length (m)
 C = weir coefficient
 z = weir side slope (z:1)

Trafalgar Road EA

Stage-Storage-Discharge Summary - Dry, Linear SWM Facility for Catchment 110-1, 110-2 and 115

Pond # 3N

Stage (m)	Discharge (m³/s)	Storage		Stage (m)	Forebays			Main Pool (Excluding Forebay)			Storage		Estimated Detention Time (hrs)
		Active (m³)	Total (m³)		Area (m²)	Incremental Volume (m³)	Accumulated Volume (m³)	Area (m²)	Incremental Volume (m³)	Accumulated Volume (m³)	Sediment (m³)	Total (m³)	
232.50	0.0000	0	0	232.50				990	0	0		0	
232.70	0.0340	210	210	232.70				1,112	210	210		210	
232.90	0.0636	445	445	232.90				1,238	235	445		445	
233.10	0.0833	706	706	233.10				1,366	260	706		706	
233.30	0.1573	992	992	233.30				1,496	286	992		992	
233.50	0.2208	1,305	1,305	233.50				1,632	313	1,305		1,305	
233.70	0.6384	1,645	1,645	233.70				1,770	340	1,645		1,645	

Trafalgar Road EA

Detailed Outlet Structure Discharge Calculations

Elevation (m)	Discharge (m³/s)								Parameters				
	Spillway			Outlet Riser				DICB	Total Discharge	Overflow Weir 1		Orifice 1	
	Weir 1	Weir 2	Total	Orifice 1	Weir 1	Orifice 2	Total			Crest Elevation	Orifice Centre	Perimeter	
232.50	0.000	0.000	0.000	0.00000	0.000	0.000	0.000	0.000	0.0000	233.45 m	232.62 m	754 mm	
232.70	0.000	0.000	0.000	0.03401	0.000	0.000	0.034	0.000	0.0340				
232.90	0.000	0.000	0.000	0.06362	0.000	0.000	0.064	0.000	0.0636				
233.10	0.000	0.000	0.000	0.08330	0.000	0.000	0.083	0.000	0.0833	Crest Width 1 m	Orifice Invert 232.50 m	Area 45,239 mm²	
233.30	0.000	0.000	0.000	0.09914	0.000	0.058	0.157	0.000	0.1573	Slope (x:1) 5	Orifice Diameter 240 mm	Orifice Coeff. 0.6	
233.50	0.022	0.000	0.022	0.11279	0.000	0.086	0.199	0.000	0.2208	Weir Coeff. 1.670	Orientation Vertical		
233.70	0.407	0.000	0.407	0.12495	0.000	0.107	0.231	0.000	0.6384	Weir Top Width (m) 3.5			
										Overflow Weir 2			
										Crest Elevation 9999.00 m	Weir 1		
										Crest Width 3 m	Top of Weir Structure 9999.30 m	Max Perimeter 1,400 mm	
										Slope (x:1) 3	Weir Crest Invert 9999.00 m	Max Open Area 240,000 mm²	
										Weir Coeff. 1.670	Weir Dimensions (Height x Length)		
										Weir Top Width (m) -58941.000	300 mm Height	800 mm L	
										DICB	Side Walls Vertical	Weir Coeff. 1.670	
										T/G Invert 9999.00 m	Orifice 2		
										CB Size 1200 mm	Orifice Centre 233.13 m	Perimeter 817 mm	
										by 600 mm	Orifice Invert 233.00 m	Area 53,093 mm²	
										Grate Slope 4 :1	Orifice Diameter 260 mm	Orifice Coeff. 0.6	
										Area (m²) 0.720	Orientation Vertical	Operates Above (m) 233.13	
										Perimeter (m) 3.600			

$$Q = CA \sqrt{2g \left(h_2 - h_1 + \frac{D}{2000} \right)}$$

$$Q = CL(h_2 - h_1)^{1.5} + 1.268z(h_2 - h_1)^{2.5}$$

Where, h2 = elevation at stage 2 (m)
 h1 = elevation at stage 1 (m)
 D = orifice diameter (mm)
 C = orifice coefficient
 A = orifice open area (m²)

h2 = elevation at stage 2 (m)
 h1 = elevation at stage 1 (m)
 L = weir crest length (m)
 C = weir coefficient
 z = weir side slope (z:1)

Trafalgar Road EA

Stage-Storage-Discharge Summary - Dry, Linear SWM Facility for Catchment 135-1

Pond # 8S

Stage (m)	Discharge (m³/s)	Storage		Stage (m)	Forebays			Main Pool (Excluding Forebay)			Storage		Estimated Detention Time (hrs)
		Active (m³)	Total (m³)		Area (m²)	Incremental Volume (m³)	Accumulated Volume (m³)	Area (m²)	Incremental Volume (m³)	Accumulated Volume (m³)	Sediment (m³)	Total (m³)	
254.00	0.0000	0	0	254.00				312	0	0		0	
254.20	0.0357	78	78	254.20				468	78	78	0	78	
254.40	0.0684	187	187	254.40				624	109	187	0	187	
254.60	0.0899	328	328	254.60				784	141	328	0	328	
254.80	0.1800	501	501	254.80				948	173	501	0	501	
255.00	0.7090	707	707	255.00				1,114	206	707	0	707	

Trafalgar Road EA

Detailed Outlet Structure Discharge Calculations

Elevation (m)	Discharge (m³/s)								Parameters					
	Spillway			Outlet Riser				DIBC	Total Discharge	Overflow Weir 1		Orifice 1		
	Weir 1	Weir 2	Total	Orifice 1	Weir 1	Orifice 2	Total			Crest Elevation	Orifice Centre	Perimeter		
254.00	0.000	0.000	0.000	0.00000	0.000	0.000	0.000	0.000	0.0000	254.70 m	254.125 m	785 mm		
254.20	0.000	0.000	0.000	0.03573	0.000	0.000	0.036	0.000	0.0357					
254.40	0.000	0.000	0.000	0.06841	0.000	0.000	0.068	0.000	0.0684	Crest Width 1 m	Orifice Invert 254.00 m	Area 49,087 mm²		
254.60	0.000	0.000	0.000	0.08991	0.000	0.000	0.090	0.000	0.0899	Slope (x:1) 5	Orifice Diameter 250 mm	Orifice Coeff. 0.6		
254.80	0.073	0.000	0.073	0.10718	0.000	0.000	0.107	0.000	0.1800	Weir Coeff. 1.670	Orientation Vertical			
255.00	0.587	0.000	0.587	0.12203	0.000	0.000	0.122	0.000	0.7090	Weir Top Width (m) 4.0				
										Overflow Weir 2				
										Crest Elevation 9999.00 m	Weir 1			
										Crest Width 3 m	Top of Weir Structure 9999.3 m	Max Perimeter 2,600 mm		
										Slope (x:1) 3	Weir Crest Invert 9999.0 m	Max Open Area 600,000 mm²		
										Weir Coeff. 1.670	Weir Dimensions (Height x Length)			
										Weir Top Width (m) -58941.000	300 mm Height	2000 mm L		
										DIBC	Side Walls Vertical	Weir Coeff. 1.670		
										T/G Invert 9999.00 m	Orifice 2			
										CB Size 1200 mm	Orifice Centre 9999.23 m	Perimeter 1,414 mm		
										by 600 mm	Orifice Invert 9999.00 m	Area 159,043 mm²		
										Grate Slope 4 :1	Orifice Diameter 450 mm	Orifice Coeff. 0.6		
										Area (m²) 0.720	Orientation Vertical	Operates Above (m) 9999.23		
										Perimeter (m) 3.600				
										$Q = CA \sqrt{2g \left(h_2 - h_1 + \frac{D}{2000} \right)}$				
										$Q = CL(h_2 - h_1)^{1.5} + 1.268z(h_2 - h_1)^{2.5}$				

Where, h2 = elevation at stage 2 (m)
 h1 = elevation at stage 1 (m)
 D = orifice diameter (mm)
 C = orifice coefficient
 A = orifice open area (m²)

h2 = elevation at stage 2 (m)
 h1 = elevation at stage 1 (m)
 L = weir crest length (m)
 C = weir coefficient
 z = weir side slope (z:1)

Trafalgar Road EA

Stage-Storage-Discharge Summary - Dry, Linear SWM Facility for Catchment 140-1

Pond # 9S

Stage (m)	Discharge (m³/s)	Storage		Stage (m)	Forebays			Main Pool (Excluding Forebay)			Storage		Estimated Detention Time (hrs)
		Active (m³)	Total (m³)		Area (m²)	Incremental Volume (m³)	Accumulated Volume (m³)	Area (m²)	Incremental Volume (m³)	Accumulated Volume (m³)	Sediment (m³)	Total (m³)	
251.00	0.0000	0	0	251.00				300	0	0	0	0	
251.20	0.0313	72	72	251.20				424	72	72	0	72	
251.40	0.0567	170	170	251.40				552	98	170	0	170	
251.60	0.0738	293	293	251.60				682	123	293	0	293	
251.80	0.0876	443	443	251.80				816	150	443	0	443	
252.00	0.0995	620	620	252.00				954	177	620	0	620	

Trafalgar Road EA
Detailed Outlet Structure Discharge Calculations

Elevation (m)	Discharge (m³/s)								Parameters				
	Spillway			Outlet Riser				DICB	Total Discharge	Overflow Weir 1		Orifice 1	
	Weir 1	Weir 2	Total	Orifice 1	Weir 1	Orifice 2	Total			Crest Elevation	Orifice Centre	Perimeter	
251.00	0.000	0.000	0.000	0.00000	0.000	0.000	0.000	0.000	0.0000	9999.00 m	251.1125 m	707 mm	
251.20	0.000	0.000	0.000	0.03126	0.000	0.000	0.031	0.000	0.0313				
251.40	0.000	0.000	0.000	0.05666	0.000	0.000	0.057	0.000	0.0567	Crest Width 2 m	Orifice Invert 251.00 m	Area 39,761 mm²	
251.60	0.000	0.000	0.000	0.07378	0.000	0.000	0.074	0.000	0.0738	Slope (x:1) 2	Orifice Diameter 225 mm	Orifice Coeff. 0.6	
251.80	0.000	0.000	0.000	0.08762	0.000	0.000	0.088	0.000	0.0876	Weir Coeff. 1.670	Orientation Vertical		
252.00	0.000	0.000	0.000	0.09955	0.000	0.000	0.100	0.000	0.0995	Weir Top Width (m) -38986.0			
										Overflow Weir 2			
										Crest Elevation 9999.00 m	Weir 1		
										Crest Width 3 m	Top of Weir Structure 9999.3 m	Max Perimeter 2,600 mm	
										Slope (x:1) 3	Weir Crest Invert 9999.0 m	Max Open Area 600,000 mm²	
										Weir Coeff. 1.670	Weir Dimensions (Height x Length) 300 mm Height 2000 mm L	Weir Coeff. 1.670	
										Weir Top Width (m) -58941.000			
										DICB	Orifice 2		
										T/G Invert 9999.00 m	Orifice Centre 9999.12 m	Perimeter 754 mm	
										CB Size 1200 mm by 600 mm	Orifice Invert 9999.00 m	Area 45,239 mm²	
										Grate Slope 4 :1	Orifice Diameter 240 mm	Orifice Coeff. 0.6	
										Area (m²) 0.720	Orientation Vertical	Operates Above (m) 9999.12	
										Perimeter (m) 3.600			
										$Q = CA \sqrt{2g \left(h_2 - h_1 + \frac{D}{2000} \right)}$			$Q = CL(h_2 - h_1)^{1.5} + 1.268z(h_2 - h_1)^{2.5}$

Where, h2 = elevation at stage 2 (m)
h1 = elevation at stage 1 (m)
D = orifice diameter (mm)
C = orifice coefficient
A = orifice open area (m²)
h2 = elevation at stage 2 (m)
h1 = elevation at stage 1 (m)
L = weir crest length (m)
C = weir coefficient
z = weir side slope (z:1)

Trafalgar Road EA

Stage-Storage-Discharge Summary - Dry, Linear SWM Facility for Catchment 145-1

Pond # 10N

Stage (m)	Discharge (m³/s)	Storage		Stage (m)	Forebays			Main Pool (Excluding Forebay)			Storage		Estimated Detention Time (hrs)
		Active (m³)	Total (m³)		Area (m²)	Incremental Volume (m³)	Accumulated Volume (m³)	Area (m²)	Incremental Volume (m³)	Accumulated Volume (m³)	Sediment (m³)	Total (m³)	
252.60	0.0000	0	0	252.60				250	0	0		0	
252.80	0.0166	62	62	252.80				374	62	62		62	
253.00	0.0268	150	150	253.00				502	88	150		150	
253.20	0.0340	263	263	253.20				632	113	263		263	
253.40	0.0400	403	403	253.40				766	140	403		403	
253.60	0.2626	570	570	253.60				900	167	570		570	

Trafalgar Road EA

Detailed Outlet Structure Discharge Calculations

Elevation (m)	Discharge (m³/s)								Parameters			
	Spillway			Outlet Riser				DICB	Total Discharge	Overflow Weir 1		Orifice 1
Weir 1	Weir 2	Total	Orifice 1	Weir 1	Orifice 2	Total	Crest Elevation			Orifice Centre	Perimeter	
252.60	0.000	0.000	0.000	0.00000	0.000	0.000	0.000	0.000	0.0000	253.40 m	252.675 m	471 mm
252.80	0.000	0.000	0.000	0.01660	0.000	0.000	0.017	0.000	0.0166			
253.00	0.000	0.000	0.000	0.02677	0.000	0.000	0.027	0.000	0.0268	Crest Width 1 m	Orifice Invert 252.60 m	Area 17,671 mm²
253.20	0.000	0.000	0.000	0.03403	0.000	0.000	0.034	0.000	0.0340	Slope (x:1) 3	Orifice Diameter 150 mm	Orifice Coeff. 0.6
253.40	0.000	0.000	0.000	0.03999	0.000	0.000	0.040	0.000	0.0400	Weir Coeff. 1.670	Orientation Vertical	
253.60	0.217	0.000	0.217	0.04517	0.000	0.000	0.045	0.000	0.2626	Weir Top Width (m) 2.2		
										Overflow Weir 2		
										Crest Elevation 9999.00 m	Weir 1	
										Crest Width 3 m	Top of Weir Structure 9999.3 m	Max Perimeter 2,600 mm
										Slope (x:1) 3	Weir Crest Invert 9999.0 m	Max Open Area 600,000 mm²
										Weir Coeff. 1.670	Weir Dimensions (Height x Length)	
										Weir Top Width (m) -58941.000	300 mm Height	2000 mm L
										DICB	Side Walls Vertical	Weir Coeff. 1.670
										T/G Invert 9999.00 m	Orifice 2	
										CB Size 1200 mm	Orifice Centre 9999.15 m	Perimeter 942 mm
										by 600 mm	Orifice Invert 9999.00 m	Area 70,686 mm²
										Grate Slope 4 :1	Orifice Diameter 300 mm	Orifice Coeff. 0.6
										Area (m²) 0.720	Orientation Vertical	Operates Above (m) 9999.15
										Perimeter (m) 3.600		
										$Q = CA \sqrt{2g \left(h_2 - h_1 + \frac{D}{2000} \right)}$		
										$Q = CL(h_2 - h_1)^{1.5} + 1.268z(h_2 - h_1)^{2.5}$		

Where, h2 = elevation at stage 2 (m)
 h1 = elevation at stage 1 (m)
 D = orifice diameter (mm)
 C = orifice coefficient
 A = orifice open area (m²)

h2 = elevation at stage 2 (m)
 h1 = elevation at stage 1 (m)
 L = weir crest length (m)
 C = weir coefficient
 z = weir side slope (z:1)

Trafalgar Road EA

Stage-Storage-Discharge Summary - Dry, Linear SWM Facility for Catchment 150-1

Pond # 11N

Stage (m)	Discharge (m³/s)	Storage		Stage (m)	Forebays			Main Pool (Excluding Forebay)			Storage		Estimated Detention Time (hrs)
		Active (m³)	Total (m³)		Area (m²)	Incremental Volume (m³)	Accumulated Volume (m³)	Area (m²)	Incremental Volume (m³)	Accumulated Volume (m³)	Sediment (m³)	Total (m³)	
256.30	0.0000	0	0	256.30				250	0	0		0	
256.50	0.0328	65	65	256.50				404	65	65	0	65	
256.70	0.1353	162	162	256.70				560	96	162	0	162	
256.90	0.1885	290	290	256.90				720	128	290	0	290	
257.10	0.2297	450	450	257.10				882	160	450	0	450	
257.30	0.2646	643	643	257.30				1,048	193	643	0	643	

Trafalgar Road EA

Detailed Outlet Structure Discharge Calculations

Elevation (m)	Discharge (m³/s)								Parameters				
	Spillway			Outlet Riser				DICB	Total Discharge	Overflow Weir 1		Orifice 1	
Weir 1	Weir 2	Total	Orifice 1	Weir 1	Orifice 2	Total	Crest Elevation			Orifice Centre	Perimeter		
256.30	0.000	0.000	0.000	0.00000	0.000	0.000	0.000	0.000	0.0000	9999.00 m	256.4875 m	1178 mm	
256.50	0.000	0.000	0.000	0.03282	0.000	0.000	0.033	0.000	0.0328				
256.70	0.000	0.000	0.000	0.13531	0.000	0.000	0.135	0.000	0.1353	Crest Width 2 m	Orifice Invert 256.30 m	Area 110,447 mm²	
256.90	0.000	0.000	0.000	0.18852	0.000	0.000	0.189	0.000	0.1885	Slope (x:1)	2	Orifice Diameter 375 mm	Orifice Coeff. 0.6
257.10	0.000	0.000	0.000	0.22972	0.000	0.000	0.230	0.000	0.2297	Weir Coeff.	1.670	Orientation Vertical	
257.30	0.000	0.000	0.000	0.26458	0.000	0.000	0.265	0.000	0.2646	Weir Top Width (m)	-38964.8		
										Overflow Weir 2			
										Crest Elevation	9999.00 m	Weir 1	
										Crest Width	3 m	Top of Weir Structure	Max Perimeter
										Slope (x:1)	3	Weir Crest Invert	Max Open Area
										Weir Coeff.	1.670	9999.0 m	600,000 mm²
										Weir Top Width (m)	-58941.000	Weir Dimensions (Height x Length)	
										DICB		300 mm Height	2000 mm L
										T/G Invert	9999.00 m	Side Walls	Weir Coeff.
												Vertical	1.670
										Orifice 2			
										CB Size	1200 mm	Orifice Centre	Perimeter
										by	600 mm	9999.14 m	864 mm
										Grate Slope	4 : 1	Orifice Invert	Area
												9999.00 m	59,396 mm²
												Orifice Diameter	Orifice Coeff.
												275 mm	0.6
										Area (m²)	0.720	Orientation	Operates Above (m)
										Perimeter (m)	3.600	Vertical	9999.14

$$Q = CA \sqrt{2g \left(h_2 - h_1 + \frac{D}{2000} \right)}$$

$$Q = CL(h_2 - h_1)^{1.5} + 1.268z(h_2 - h_1)^{2.5}$$

- Where, h2 = elevation at stage 2 (m)
- h1 = elevation at stage 1 (m)
- D = orifice diameter (mm)
- C = orifice coefficient
- A = orifice open area (m²)
- h2 = elevation at stage 2 (m)
- h1 = elevation at stage 1 (m)
- L = weir crest length (m)
- C = weir coefficient
- z = weir side slope (z:1)

Trafalgar Road EA

Stage-Storage-Discharge Summary - Dry, Linear SWM Facility for Catchment 155-1

Pond # 12N

Stage (m)	Discharge (m ³ /s)	Storage		Stage (m)	Forebays			Main Pool (Excluding Forebay)			Storage		Estimated Detention Time (hrs)
		Active (m ³)	Total (m ³)		Area (m ²)	Incremental Volume (m ³)	Accumulated Volume (m ³)	Area (m ²)	Incremental Volume (m ³)	Accumulated Volume (m ³)	Sediment (m ³)	Total (m ³)	
261.50	0.0000	0	0	261.50				250	0	0		0	
261.70	0.0166	65	65	261.70				404	65	65	0	65	
261.90	0.0268	162	162	261.90				560	96	162	0	162	
262.10	0.0340	290	290	262.10				720	128	290	0	290	
262.30	0.0608	450	450	262.30				882	160	450	0	450	
262.50	0.3728	643	643	262.50				1,048	193	643	0	643	

Trafalgar Road EA

Detailed Outlet Structure Discharge Calculations

Elevation (m)	Discharge (m ³ /s)								Parameters					
	Spillway			Outlet Riser				DICB	Total Discharge	Overflow Weir 1		Orifice 1		
	Weir 1	Weir 2	Total	Orifice 1	Weir 1	Orifice 2	Total			Crest Elevation	Orifice Centre	Perimeter		
261.50	0.000	0.000	0.000	0.00000	0.000	0.000	0.000	0.000	0.0000	262.25 m	261.575 m	471 mm		
261.70	0.000	0.000	0.000	0.01660	0.000	0.000	0.017	0.000	0.0166					
261.90	0.000	0.000	0.000	0.02677	0.000	0.000	0.027	0.000	0.0268	Crest Width 1 m	Orifice Invert 261.50 m	Area 17,671 mm ²		
262.10	0.000	0.000	0.000	0.03403	0.000	0.000	0.034	0.000	0.0340	Slope (x:1) 3	Orifice Diameter 150 mm	Orifice Coeff. 0.6		
262.30	0.021	0.000	0.021	0.03999	0.000	0.000	0.040	0.000	0.0608	Weir Coeff. 1.670				
262.50	0.328	0.000	0.328	0.04517	0.000	0.000	0.045	0.000	0.3728	Weir Top Width (m) 2.5	Orientation Vertical			
										Overflow Weir 2	Weir 1			
										Crest Elevation 9999.00 m	Top of Weir Structure 9999.3 m	Max Perimeter 2,600 mm		
										Crest Width 3 m	Weir Crest Invert 9999.0 m	Max Open Area 600,000 mm ²		
										Slope (x:1) 3	Weir Dimensions (Height x Length)			
										Weir Coeff. 1.670	300 mm Height	2000 mm L		
										Weir Top Width (m) -58941.000	Side Walls Vertical	Weir Coeff. 1.670		
										DICB	Orifice 2			
										T/G Invert 9999.00 m	Orifice Centre 9999.14 m	Perimeter 864 mm		
										CB Size 1200 mm by 600 mm	Orifice Invert 9999.00 m	Area 59,396 mm ²		
										Grate Slope 4 :1	Orifice Diameter 275 mm	Orifice Coeff. 0.6		
										Area (m ²) 0.720	Orientation Vertical	Operates Above (m) 9999.14		
										Perimeter (m) 3.600				
										$Q = CA \sqrt{2g \left(h_2 - h_1 + \frac{D}{2000} \right)}$		$Q = CL(h_2 - h_1)^{1.5} + 1.268z(h_2 - h_1)^{2.5}$		

Where, h2 = elevation at stage 2 (m)
 h1 = elevation at stage 1 (m)
 D = orifice diameter (mm)
 C = orifice coefficient
 A = orifice open area (m²)

h2 = elevation at stage 2 (m)
 h1 = elevation at stage 1 (m)
 L = weir crest length (m)
 C = weir coefficient
 z = weir side slope (z:1)

Trafalgar Road EA

Stage-Storage-Discharge Summary - Pipe Storage Facility for Catchments CNR Underpass

Pond # 14S

Stage (m)	Discharge (m ³ /s)	Storage		Stage (m)	Forebays			Main Pool (Excluding Forebay)			Storage		Estimated Detention Time (hrs)
		Active (m ³)	Total (m ³)		Area (m ²)	Incremental Volume (m ³)	Accumulated Volume (m ³)	Area (m ²)	Incremental Volume (m ³)	Accumulated Volume (m ³)	Sediment (m ³)	Total (m ³)	
256.80	0.0000	0	0	256.80					0	0		0	
257.10	0.0728	27	27	257.10					27	27		0	27
257.40	0.1260	103	103	257.40					76	103		0	103
257.70	0.2784	227	227	257.70					124	227		0	227
258.00	0.4513	373	373	258.00					146	373		0	373
258.30	0.5655	467	467	258.30					94	467		0	467
258.60	0.6587	512	512	258.60					45	512		0	512
258.90	0.7396	518	518	258.90					6	518		0	518

Trafalgar Road EA

Detailed Outlet Structure Discharge Calculations

Elevation (m)	Discharge (m ³ /s)							DICB	Total Discharge	Parameters								
	Spillway			Outlet Riser						Overflow Weir 1		Orifice 1		Weir 1		Orifice 2		
256.80	0.000	0.000	0.000	0.00000	0.000	0.000	0.000	0.000	0.0000	Crest Elevation	9999.00 m	Orifice Centre	256.95 m	Perimeter		942 mm		
257.10	0.000	0.000	0.000	0.07276	0.000	0.000	0.073	0.000	0.0728	Crest Width	5 m	Orifice Invert	256.80 m	Area		70,686 mm ²		
257.40	0.000	0.000	0.000	0.12602	0.000	0.000	0.126	0.000	0.1260			Slope (x:1)	10	Orifice Diameter	300 mm	Orifice Coeff.		0.6
257.70	0.000	0.000	0.000	0.16269	0.000	0.116	0.278	0.000	0.2784	Weir Coeff.	1.670	Orientation	Vertical					
258.00	0.000	0.000	0.000	0.19250	0.000	0.259	0.451	0.000	0.4513	Weir Top Width (m)	-194797.0	Weir Dimensions (Height x Length)						
258.30	0.000	0.000	0.000	0.21827	0.000	0.347	0.566	0.000	0.5655			300 mm Height	800 mm L	Side Walls	Vertical	Weir Coeff.		1.670
258.60	0.000	0.000	0.000	0.24131	0.000	0.417	0.659	0.000	0.6587									
258.90	0.000	0.000	0.000	0.26233	0.000	0.477	0.740	0.000	0.7396	Weir Top Width (m)	-58941.000							
												DICB	9999.00 m	Weir 1				
														Top of Weir Structure	9999.30 m	Max Perimeter	1,400 mm	
												Crest Width	3 m	Weir Crest Invert	9999.00 m		Max Open Area	240,000 mm ²
												Slope (x:1)	3					
										Weir Coeff.	1.670							
										Orifice 2	1200 mm	Orifice Centre	257.63 m	Perimeter		1,414 mm		
												by	600 mm	Orifice Invert	257.40 m		Area	159,043 mm ²
										Grate Slope	4 : 1	Orifice Diameter	450 mm		Orifice Coeff.		0.6	
										Area (m ²)	0.720	Orientation	Vertical		Operates Above (m)		257.63	
										Perimeter (m)	3.600							
										$Q = CA \sqrt{2g \left(h_2 - h_1 + \frac{D}{2000} \right)}$								

Where, h₂ = elevation at stage 2 (m)
h₁ = elevation at stage 1 (m)
D = orifice diameter (mm)
C = orifice coefficient
A = orifice open area (m²)

h₂ = elevation at stage 2 (m)
h₁ = elevation at stage 1 (m)
L = weir crest length (m)
C = weir coefficient
z = weir side slope (z:1)

$$Q = CL(h_2 - h_1)^{1.5} + 1.268z(h_2 - h_1)^{2.5}$$