Appendix A: Water Balance Model Development and Calibration

A.1 Methodology

The OPSIM water balance model of the Rixs Creek Mine water management system, previously developed to assess prepare and maintain the Rixs Creek Water Management Plan (JP Environmental, 2009 and 2012), was used as the basis for the assessment. For this study, the runoff parameters in the OPSIM model were recalibrated to match recorded and storage volumes over the period 2007 to 2012. Details of the OPSIM model configuration and calibration is given in **Appendix A**. A description of the existing Mine water management system is given in **Section 3.8**.

The updated model of the Rixs Creek Mine water management system was used to determine:

- The frequency and volume of potential spills from various dams;
- The reliability of the storages to supply operational water requirements; and
- The ability to dewater the mining area

A.2 The OPSIM Model

The model has been configured to simulate the operations of all major components of the water management system. The simulated inflows and outflows included in the model are given below.

Table 23: Simulated Inflows and Outflows to Mine Water Management System

Inflows	Outflows
Direct rainfall on water surface of storages	Evaporation from water surface of storages
Catchment runoff	CHPP demand
Groundwater inflows	Dust suppression demand
External water supply: Potable; Raw and Poor	Industrial use & vehicle wash down
ROM coal	Offsite spills from storages
	Controlled Releases under the HRSTS
	Product coal
	Moisture retained in washery rejects

A.3 Meteorology

A.3.1 Rainfall

A representative long-term rainfall sequence for Rixs Creek Mine was obtained from the Bureau of Meteorology's SILO Data Drill. These synthetic data are derived by interpolation of recorded rainfall data between stations as described by Jeffreys et al (2001). Rainfall data from the SILO Data Drill is available from the late 1800s and is corrected for missing data and accumulated totals. Hence, this data is more reliable and easier to use for computer modelling than raw recorded rainfall data.

Figure 45 shows a comparison of mean monthly rainfall recorded at the Jerrys Plains Post Office (#061086), Singleton STP (061398), and Rixs Creek Mine with the SILO Data Drill rainfalls over the study area from 1889 to 31st December 2013. The comparison indicates that the SILO Data Drill (1999 to 2013) provides a good representation of recorded rainfall data at Rixs Creek Mine and Singleton Sewage Treatment Plant (STP) over the shorter period. The shape of the graph of the longer period SILO data tends towards the longer period data from Jerrys Plains PO.

A.3.2 Evaporation

The pan evaporation data for the area was obtained from the SILO Data Drill database (Jeffrey et al., 2001). Pan factors were applied to the pan evaporation data to match Morton's lake evaporation (Morton, 1983). Morton's method is regarded as suitable for the estimation of lake evaporation in non-arid areas (Mulder, 1997). **Table 24** shows the adopted pan evaporation and pan factors used to estimate evaporation from the onsite storages.

Table 24: Adopted Monthly Lake Evaporation Factors

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Average	207	163	144	105	72	55	65	90	119	157	181	212
Monthly Lake Factor	0.92	0.95	0.96	0.88	0.83	0.75	0.75	0.83	0.88	0.92	0.93	0.91

For current and former mining areas, the values shown in **Table 24** were factored by between 0.7 – 0.9 to reflect the likely reduction in evaporation due to the depth of the void cut below surface level. For AWBM soil moisture evapotranspiration, the values shown in **Table 24** were factored by 0.99 to convert to areal evapotranspiration.

Figure 46 shows a comparison of mean monthly evaporation recorded at the Jerrys Plains Post Office (#061086) and the Scone Soil Conservation Station (#061089) with the SILO Data Drill evaporation over the study area. The comparison indicates that the SILO Data Drill (1970 to 2013)[11] evaporation compares favourably with recorded evaporation data at Jerrys Plains Post Office (#061086) and the Scone Soil Conservation Station the shorter period. The shape of the graph of the longer period SILO data tends towards the longer period data from Jerrys Plains

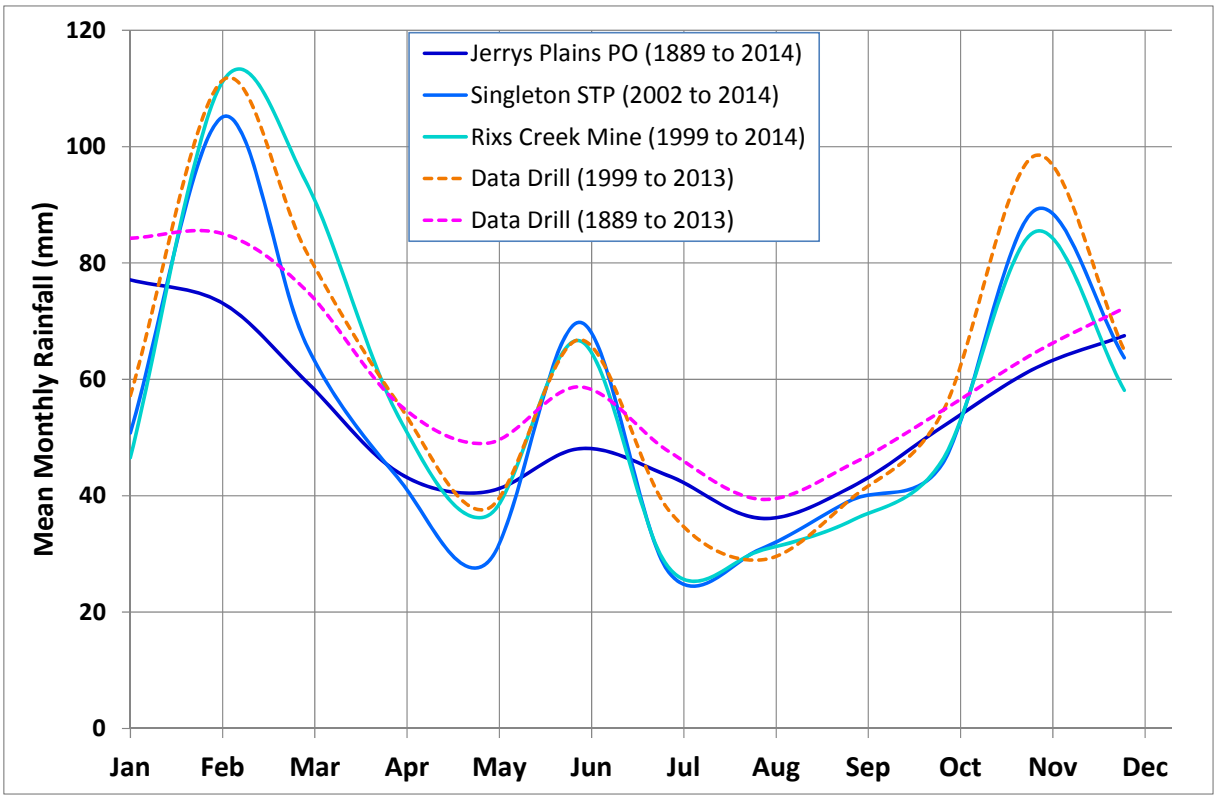


Figure 45: Comparison of Mean Monthly Rainfall

[11] It was only after 1970 that Class A Pan evaporation data was uniformly used in Australia to collect evaporation data. Prior to this several different measuring devices were used resulting in inconsistent and unreliable data. Prior to 1970, SILO evaporation data is based on daily long term means for pan evaporation.

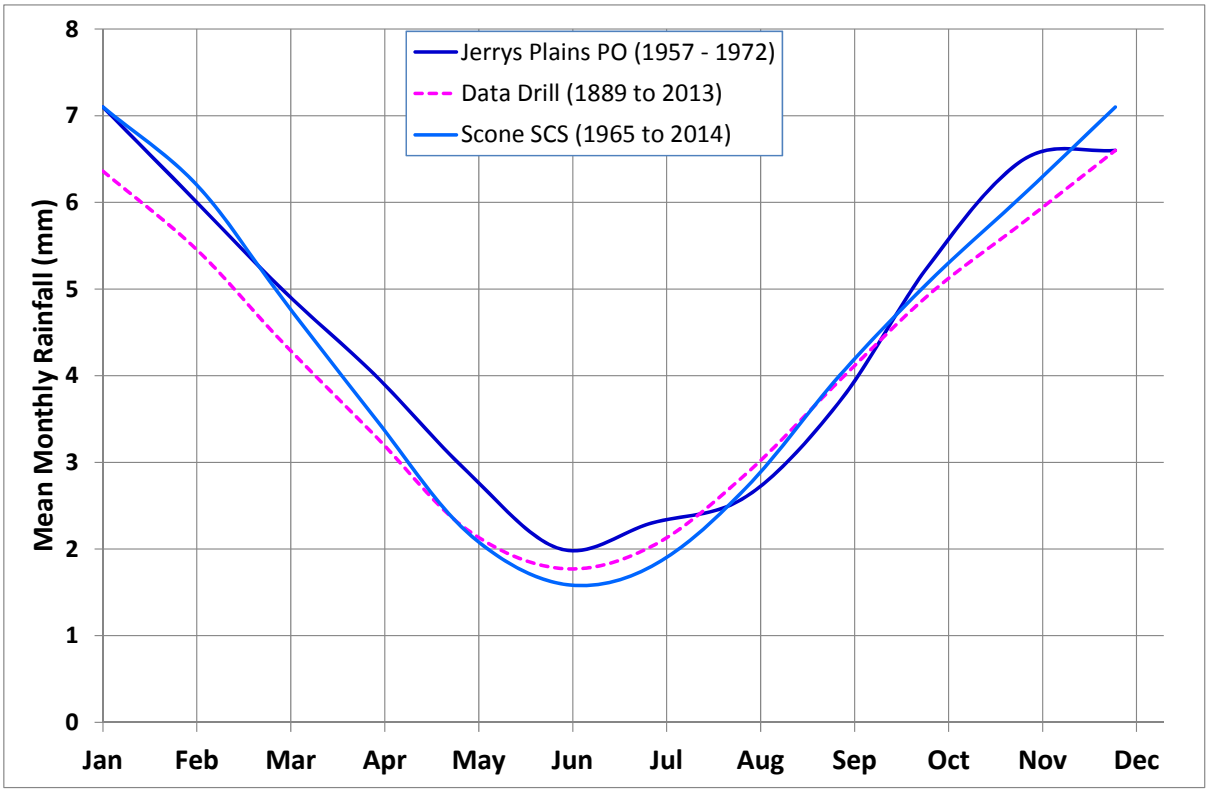


Figure 46: Comparison of Mean Monthly Evaporation

A.4 Water Balance Model Calibration

The calibration model was run over the period January 2007 to Q3 2012, for which two "solid" stored water volumes onsite were available. It was assumed that catchment areas draining to the active mining areas do not change over the calibration period. The change in catchment area over this period is only minor when compared to the total study area catchment so the impact on the water balance of this assumption is not expected to be significant.

Figure 19 in the main report shows a schematic of the Mine water management system over the calibration period. The system configuration has changed minimally since 2007. The locations of the various storages and active mining areas are shown in **Figure 18**. The summary of the main features of the water management system in Section 3.8.3 remains valid, and storage volumes are constant over the calibration period.

A.4.1 Catchment Areas

The adopted catchment areas reporting to each of the existing Rixs Creek storages are presented in **Figure 25** and detailed in **Table 25**.

Table 25: Catchment Areas and Land Classifications

Mine Storage	Catchment Area (ha)							
	Undisturbed	Spoil	Mining Areas	Roads - Industrial	Reveg	Tailings Dam	Coal Pads	TOTAL
CHPP Dams	79.8			34.1	57.7			**171.6**
North Pit	8.1	115.9	24.0	24.2	322.4			**494.6**
Old North Pit		21.9		4.7	79.3			**105.9**
Dirty Water Dam 2	10.0			4.6				**14.6**
Coal Loader	11.4			5.0			2.9	**19.3**
West Pit	11.3	42.3	140.9					**194.5**
Old South Pit		8.2		0.8		13.2		**22.2**
Dirty Water Dam 3	0.3			4.6	1.0			**5.9**

A.4.2 Groundwater Inflows

The rates of groundwater inflow into the active mining areas were adopted from the groundwater report *Rix's Creek Continuation Of Mining Project Groundwater Impact Assessment; RPS (2014)* as previously described in **Section 5.4.3 Groundwater Inflows**., summarised in **Table 26**.

Table 26: Calibration Groundwater Inflows

Mining Area	ML/year	kL/day
North Pit	11	30
South Pit	0.4	1
West Pit	47	130

A.4.3 AWBM Calibration

OPSIM uses the AWBM model to estimate runoff volumes from onsite catchments, based on available rainfall and evaporation data. The AWBM (Boughton & Chiew, 2003) is a saturated overland flow

model which allows for variable source areas of surface runoff. The model uses daily rainfalls and estimates of catchment evapotranspiration to calculate daily values of runoff using a daily water balance of soil moisture. The model has a base flow component which simulates the recharge and discharge of a shallow groundwater store. Runoff depth calculated by the AWBM model is converted into runoff volume by multiplying the depth and the contributing catchment area. The various parameters of the AWBM model are shown in **Table 27**.

Table 27: Description of AWBM Model Parameters

Parameter	Description
Partial Area Fractions	Parameters A1, A2 & A3. Fraction of catchment area represented by surface storages No. 1, 2 & 3
Soil Store Capacities	Parameters C1, C2 & C3. Soil moisture storage capacities for smallest store (No. 1), middle store (No. 2) and largest store (No. 3).
Base Flow Index	Parameter BFI. Proportion of runoff directed to base flow store.
Daily Base Flow Recession Constant	Parameter K. The rate at which water discharges from base flow store.
Lake to Evapotranspiration Factor	Factor to convert open water evaporation to evapotranspiration.

To estimate catchment runoff inflows to the OPSIM model, separate AWBM model parameters were developed for the following catchment types:

- Undisturbed;
- Industrial/hardstand/roads.
- Spoil - Unrehabilitated.
- Spoil - Rehabilitated;
- Mining area.
- Tailings Dams.
- Coal Pads.

In the absence of recorded runoff data for the different catchment types, reasonable parameter values were selected based on experience in similar previous studies and expected values of volumetric runoff coefficients. Adopted AWBM model parameter values are shown **Table 28**.

There were only two firm points that could be determined from site observations of storages: On June 6th 2007, it was estimated only 30 days of supply remained on site for coal processing and dust suppression; on 1st September 2012 a full set of storage inventory values were collected. The overall representation of catchment runoff was validated by matching the stored volume in all storages on the site over the calibration period.

Table 28: Adopted AWBM Parameters for Each Catchment Type

AWBM Model Parameter		Undisturbed	Spoil	Mining Areas	Roads - Industrial	Rehab.	Tailings Dam
Surface Store Depth (mm)	C1	40	12	5	5	19	5
	C2	120	120	22	15	190	11
	C3	160					
	Av.	120	98.4	18.6	14	172.9	10.4
Partial Areas	A1	0.2	0.2	0.2	0.1	0.1	0.1
	A2	0.4	0.8	0.8	0.9	0.9	0.9
	A3	0.4					
Base flow Index	BFI	0.02	0.3	0	0	0.15	0
Base flow recession constant	K	0.76	0.7	0	0	0.98	0
Lake to Evapotranspiration Factor		0.99	0.99	0.99	0.99	0.99	0.99
Long Term Runoff Coefficient (%)		8.0	12.7	32.9	36.2	5.7	40.5

A.4.4 Storage Volume Calibration Results

The modelled AWBM parameters were calibrated using known site performance and operations from January 2007 to December 2012 at the Rixs Creek Mine. The modelled total site inventory was compared to the recorded total inventory. The results of the calibration are shown in **Figure 47: Calibration Plot**.

SILO Data Drill rainfall was used for this calibration as it was a good match to the data for the mine and local daily rainfall gauges.

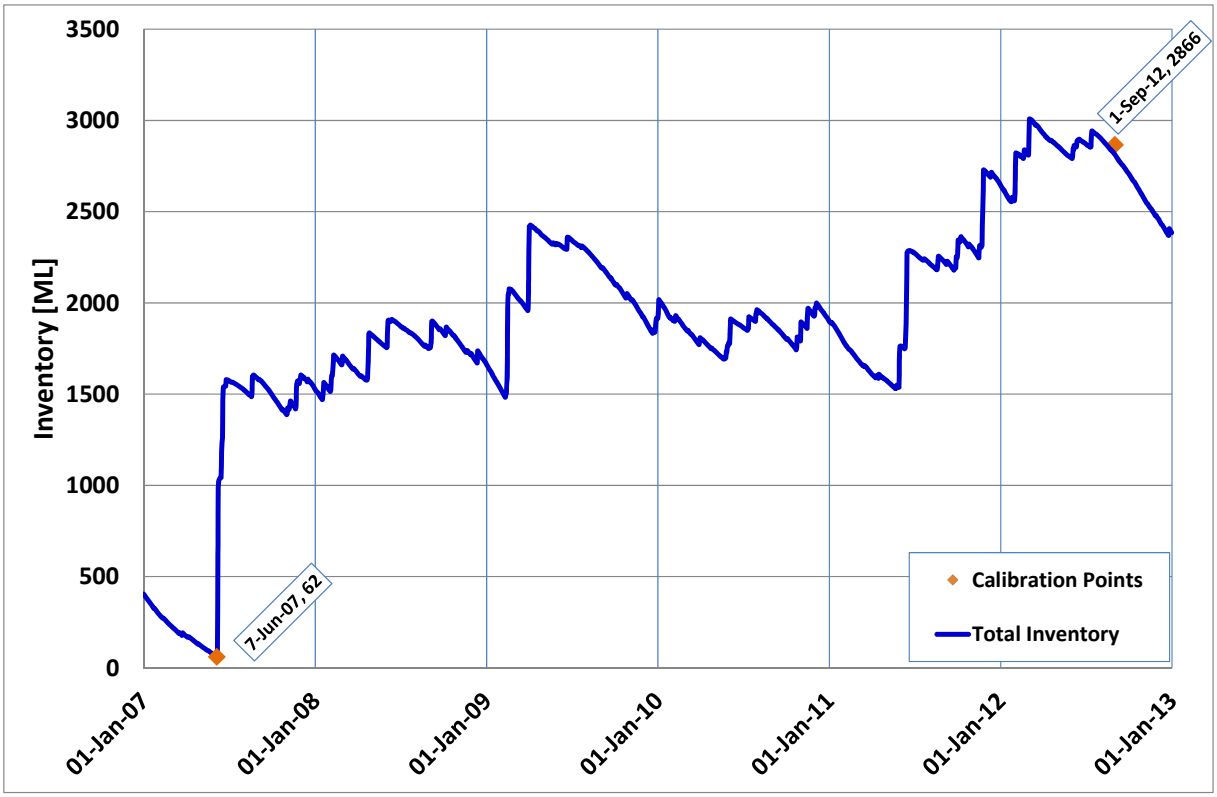


Figure 47: Calibration Plot

The following is of note with the calibration of the AWBM parameters for the OPSIM model:

- The behaviour of the modelled site inventory over January 2007 to May 2011 is in good agreement with the recorded inventory. More inventory data would been preferred for the calibration.
- All demands are met 100% of the time over the calibration period;
- No water was imported over the calibration period; and

A.4.5 Limitations of the Water Balance Model Calibration

The results of the OPSIM modelling need to be interpreted with caution. Key limitations of the OPSIM model and known discrepancies between the model and water management practice are outlined below:

- The AWBM parameters adopted for the model appear reasonable based on past experience and the available calibration data for the Mine.
- The inventory points used for calibration were estimated based on past experience of the site and calculations for spoil storage for Old North Pit and North Pit. CAD drawings of the pit shell and reconstructed surface were used to calculate spoil storage volumes for these two storage areas which were used to augment the observed site inventory values.

Appendix B: Water Quality Monitoring Data

Rixs Creek
Mine Water Monitoring Data

	Dirty Water Dam #1				Dirty Water Dam #2				Dirty Water Dam #3				Dirty Water Dam #4			
Date	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)
06-Jan-99	8.8	1	2220	3830	7.9	1	3560	5800					8.2	10	600	990
26-Feb-99	8.2	33	1200	2020	8.1	4	4410	6960					7.5	50	700	1230
26-Mar-99	8.4	3	2240	3590	8.5	4	4750	7490					8.1	130	780	1290
13-Apr-99	8.3	7	2260	3960	8.4	2	4440	7400					7.6	45	610	1210
10-May-99	7.9	2	2410	3560	8.6	4	3820	5600					7.5	50	560	912
01-Jun-99	8.3	11	2470	3800	8.5	4	3950	5990					7.9	18	540	980
12-Jul-99	8	4	2590	4180	8.4	3	3660	6070					7.6	22	690	1060
04-Aug-99	8.2	1	2390	3850	8.7	3	3570	5790					7.5	29	490	700
01-Sep-99	8.3	5	2320	3750	8.4	2	3450	5440					7.3	35	470	770
01-Oct-99	8.4	1	2210	3410	8.2	1	3830	5730					7.4	40	590	850
05-Nov-99	8.4	6	2290	3710	8.4	1	3780	6100					6.6	60	430	660
01-Dec-99	8.7	11	2350	4010	8.5	5	3670	6170					7.1	80	470	760
10-Jan-00	8.8	3	2600	4430	8.6	4	4180	6980					7.5	35	690	1160
04-Feb-00	8.3	20	2540	4160	8.3	5	4170	6690					8	20	650	1010
01-Mar-00	8.1	4	3010	4660	8.3	4	4690	7400					7.8	5	740	1110
10-Apr-00	8.1	7	2270	3790	8.8	7	3970	6540					7.4	50	500	650
10-May-00	8.4	1	2790	4550	8.5	4	3600	5940					7.1	60	430	620
07-Jun-00	8.2	1	3420	5760	8.7	2	3640	6110					7.3	50	440	720
04-Jul-00	8.2	1	2660	4520	8.4	2	4090	6830					7.5	60	460	750
29-Aug-00	8.3	19	3080	4790	8.2	7	4830	7640					8	45	580	790
18-Sep-00	8.5	6	3140	4880	8.4	60	4950	7590					8.4	24	570	990
06-Oct-00	8.4	7	3590	5180	8.2	11	5260	7600					8.2	12	610	1040
03-Nov-00	8.1	2	3600	5560	7.8	13	5280	8320					8.4	3	980	1570
06-Dec-00	8.3	7	2640	4210	8.4	8	4170	6460					7.8	23	780	1330
08-Jan-01	8.5	1	3300	5280	9.3	4	4130	6670					8.4	1	830	1480
12-Feb-01	8.4	17	2200	3620	8.9	20	3630	5790					8.5	11	1250	2120
05-Mar-01	8.3	85	2720	4010	8.7	14	3660	5540					7.9	28	870	1220
23-Apr-01	8.4	7	3050	4880	8.3	18	3230	5220					9	110	530	880
10-May-01	8.1	25	2730	4410	8.2	13	3200	5180					7.5	31	600	930
13-Jun-01	8.1	5	2960	4510	7.7	4	3560	5410					8	38	960	1630
16-Jul-01	8.3	1	2900	4380	7.9	12	4520	7100					8.8	9	1000	1650
29-Aug-01	8.2	13	3050	4790	7.9	11	4310	6700					8.6	28	1170	1840
24-Sep-01	8.6	11	3030	4900	8.2	13	4670	7430					8.4	16	1140	1910
24-Oct-01	8.5	16	3030	4890	8.2	80	1680	2990					9.1	19	1200	2110
30-Nov-01	8.3	11	3220	5000	8.1	14	4270	6820					8.5	100	1150	1980
19-Dec-01	8.5	20	3030	1990	8.1	10	2940	4850					8.7	13	1480	2300
16-Jan-02	8.4	6	3430	5240	9.1	3	3010	4890					9.1	13	2020	3460
12-Feb-02	8.5	14	2600	4200	8.8	4	2240	3750					7.9	11	1670	2680
11-Mar-02	8.4	3	3100	4610	8.5	1	3380	4850					8.2	2	1860	2920
23-Apr-02	8.4	5	2910	4680	8	3	3200	5140					7.7	5	1230	2140
15-May-02	8.3	6	3030	4890	8.2	8	3660	5890					8.2	5	1100	2220
06-Jun-02	8.4	5	2920	4580	8.1	7	3850	6040					8.3	6	1260	2100
31-Jul-02	7.9	1	3460	5620	8	2	3740	6210					8.7	1	1370	2490
20-Aug-02	8.3	1	3540	5370	8.3	1	3650	5650					8.8	4	1630	2650

Rixs Creek
Mine Water Monitoring Data

	Dirty Water Dam #1				Dirty Water Dam #2				Dirty Water Dam #3				Dirty Water Dam #4			
Date	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)
23-Sep-02	8.6	4	3500	5530	8.4	4	4370	6890					9.1	1	1580	2780
16-Oct-02	8.3	4	3670	5760	8.2	16	4750	7500					9.1	9	1800	3050
27-Nov-02	8.2	1	4250	6170	8.2	11	4530	6720					9.1	7	2750	4480
09-Dec-02	8.5	3	4030	6050	8.5	20	4450	6660					9	4	3260	5120
21-Jan-03	8.5	4	3830	8510	8.9	4	4310	6770					8.7	5	2850	4620
14-Feb-03	8.8	1	4070	6000	9	1	4110	6290					9.4	1	3050	4870
19-Mar-03	8.5	5	4010	6210	8.3	5	4180	6610					9	6	3280	5250
16-Apr-03	8.4	5	4530	6780	8.5	3	5050	7490					8.5	7	5620	8170
19-May-03	8.6	1	4650	7150	8.5	9	4990	7640					8.6	39	5740	8700
11-Jun-03	8.6	10	5090	7800	8.4	6	4850	7570					8.5	12	5990	9010
16-Jul-03	8.3	2	4540	6550	8.3	10	5070	7560					8.8	12	6020	8700
26-Aug-03	8.3	7	3880	5900	8.1	35	4890	7450					8.8	40	5460	8440
25-Sep-03	8.5	11	5095	7620	8.6	70	5830	8670					8.5	170	6195	9280
27-Oct-03	8.4	6	4670	6830	8.5	280	5090	7540					8.5	42	6350	9000
13-Nov-03	8.3	23	4800	7110	8.4	1	4740	7120					8.7	13	6400	9610
15-Dec-03	8.8	5	3760	5790	9.1	38	2360	4040					8.6	14	5630	8470
29-Jan-04	9.2	6	2930	4880	8.9	10	4620	7280					9	25	5140	8120
26-Feb-04	7.9	11	2164	3550	8.5	11	3696	5820					8.5	97	2318	3840
31-Mar-04	8.6	4	3610	5600	8.7	3	3120	5100					8.8	4	3770	5880
27-Apr-04	8.7	12	3848	7300	9	1	2862	5520					8.8	1	4320	7690
27-May-04	8.3	5	4072	6000	8.6	7	3910	6030					8.9	29	4496	6670
16-Jun-04	8.4	1	4562	6860	8.5	1	3898	6320					8.8	18	4566	7000
29-Jul-04	8.4	1	4750	7020	8.5	3	4270	6640					8.6	18	4940	7380
23-Aug-04	8.4	9	4734	7280	8.4	5	4146	6810					8.5	20	5428	8400
23-Sep-04	8.5	7	4846	7460	8.3	11	4280	7000					8.4	55	5764	8850
28-Oct-04	8.4	2	4236	6570	8.5	13	4680	7230					8.5	34	5704	8750
30-Nov-04	8.3	20	4970	7240	8.4	7	5390	7050					8.7	14	5950	8790
20-Nov-04	8.3	5	4728	7240	8.3	1	4440	7140					8.7	2	5660	8440
06-Jan-05	8.7	8	5420	7870	8.6	3	4700	7000					8.6	11	6080	8850
02-Feb-05	8.5	1	2560	4380	9.1	11	3510	4620					8.7	29	4620	5880
23-Mar-05	8.5	5	3560	5400	8.6	11	2406	4050					8.6	5	3696	5800
29-Apr-05	8.3	1	4306	6760	8.4	1	3730	6030					8.6	1	4782	7250
30-May-05	8.6	60	4632	7100	8.8	14	4764	7300					8.6	19	5380	8000
22-Jun-05	8.4	26	4960	6750	8.7	15	5070	7200					8.6	250	5100	8070
28-Jul-05	8.6	1	4680	6670	8.9	1	4970	7020					8.7	1	5160	7630
24-Aug-05	8.3	8	5150	7570	8.6	6	5050	7610					8.6	19	5470	7450
19-Sep-05	8.3	23	4990	7460	8.4	12	4880	7500					8.5	27	5800	8870
27-Oct-05	8.4	4	5150	6700	8.7	33	5250	7100					9.1	16	5040	7200
21-Nov-05	8.5	1	4640	6740	8.5	1	4614	6720					9.1	1	5164	7520
08-Dec-05	8.4	2	4930	6920	8.5	14	4840	6830					8.8	24	5330	7960
19-Jan-06	8.7	6	5220	7570	8.5	1	5370	7500					9	1	5910	9210
23-Feb-06	8.5	1	5180	7440	8.9	14	3054	9020					8.8	20	5918	9110
23-Mar-06	8.4	21	5290	7900	8.6	3	5670	8690					8.7	5	6010	9220
19-Apr-06	8.9	64	5120	8350	8.9	44	5370	8340					9.2	114	5460	9940

Rixs Creek
Mine Water Monitoring Data

	Dirty Water Dam #1				Dirty Water Dam #2				Dirty Water Dam #3				Dirty Water Dam #4			
Date	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)
18-May-06	8.8	12	5030	8370	9	8	4805	8410					9.6	12	5280	9270
22-Jun-06	8.6	24	7390	9400	8.7	12	5610	9340					8.9	15	6110	9950
20-Jul-06	8.9	14	5220	10290	9	12	5180	10190					8.8	20	5720	10870
25-Aug-06	8.2	7	5940	9520	8.5	6	5925	9650					8.9	20	6120	10530
15-Sep-06	8.6	38	4035	7040	8.9	9	4535	8050					8.8	34	2980	5540
20-Oct-06	8.5	10	5175	8310	8.5	17	12825	8430					9.4	14	5208	8330
23-Nov-06	8.9	28	5055	8860	9.2	46	5150	9035					9.8	26	5290	9500
13-Dec-06	9	75	5115	9190	9	60	5010	9260					9.8	80	5080	9650
11-Jan-07	9.4	36	5350	9900	9.2	38	4500	10170					9.8	74	5620	10680
22-Feb-07	9.2	16	6100	9800	9.4	26	6300	9920					10.1	33	5900	10240
15-Mar-07	8.9	70	5360	10840	9.2	88	5400	11470					9.8	88	4760	11730
27-Apr-07	8.8	58	5135	7930	8.5	52	4575	7290					9.6	50	2224	8850
23-May-07	8.5	5	4280	8360	8.2	36	4925	9455					8.4	13	3894	7850
28-Jun-07	8.1	8	1734	3300	8.1	20	1808	3300					7.4	26	1020	2150
30-Jul-07	8.7	11	1735	3255	8.6	26	1850	3325					8.2	16	1470	3085
23-Aug-07	7.9	22	1612	2805	8.4	3	2325	4055					7.9	8	1420	3030
26-Sep-07	8.2	4	2065	3740	8.4	2	2495	4315					8.6	4	1930	3410
17-Oct-07	8.8	10	2250	4080	8.8	8	2545	4485					8.8	7	2435	3905
15-Nov-07	8.8	6	2270	4490	10.3	38	1745	3500					9.2	6	2215	4250
10-Dec-07	9.1	334	902	4050	8.7	3	1076	4525					9	4	798	3880
24-Jan-08	9.1	13	2315	4955	8.9	10	3238	6530					9.8	12	2240	4570
06-Feb-08	8.9	10	3815	4110	9.2	51	5480	4310					9.8	13	2925	3695
25-Mar-08	8.7	10	2510	4285	8.7	89	2576	4285					9.3	88	2055	3725
28-Apr-08	8.3	27	2070	3775	8.5	33	2838	4880					8.1	28	1915	3600
20-May-08	8.1	18	3318	3880	8.4	14	3768	4805					7.8	4	2318	3510
05-Jun-08	8.4	36	2180	3645	8.2	41	2695	5110					7.9	82	2080	2265
17-Jul-08	8.5	16	1980	5450	8.6	12	2980	5700					8.6	15	2310	4640
13-Aug-08	8.5	17	3010	5705	8.5	10	2938	4845					8.6	17	2552	3405
18-Sep-08	8.7	65	2810	5840	8.8	13	2565	5390					8.8	19	2395	4870
27-Oct-08	8.9	8	3100	4900	9	31	2400	3900					9	61	2700	4300
24-Nov-08	8.6	7	3200	5800	8.8	15	3040	5600					8.8	12	2700	5100
09-Dec-08	8.6	9	3115	5320	8.7	15	3190	5180					8.9	61	2660	4570
29-Jan-09	8.7	16	3700	5800	8.5	12	3900	6300					9	14	3200	5100
16-Feb-09	7.9	190	850	1300	8.6	28	2800	5000					8.7	26	2000	3600
17-Mar-09	9	10	2400	3900	8.5	6	2900	4700					9.1	20	1900	3300
03-Apr-09	8.2	28	1900	2800	8.5	13	2600	3900					8.3	28	1600	2500
26-May-09	8.5	11	3030	4300	8.6	38	2960	4500					8.6	29	2070	3300
17-Jun-09	8.9	4	2225	4090	9.1	2	6615	4470					9.2	7	1945	3590
20-Jul-09	8.7	53	2595	4300	9	3	2615	4300					9	10	2180	3700
31-Aug-09	8.7	2	2800	4400	8.7	24	2700	4400					8.8	22	2500	4000
28-Sep-09	8.69	6	2810	4300	8.72	6	2800	4400					8.9	15	2500	3800
29-Oct-09	8.3	5	3200	4700	8.4	2	3000	4700					8.9	8	2900	4300
18-Nov-09	8.8	5	3000	5000	8.8	4	3000	2100					9.2	2	2600	4500
08-Dec-09	9.2	4	3400	4800	9.1	4	3300	5000					9.7	6	3200	2400

Rixs Creek
Mine Water Monitoring Data

	Dirty Water Dam #1				Dirty Water Dam #2				Dirty Water Dam #3				Dirty Water Dam #4			
Date	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)
22-Jan-10	9	2	3100	4200	8.8	1	4000	4800					9.3	5	2900	4400
17-Feb-10	9.4	21	2300	5100	9.1	11	3200	5400					9.6	3	2700	4600
29-Mar-10	9	5	3900	5400	8.8	7	3800	5600					9.3	8	3100	5100
29-Apr-10	8.3	4	3300	5200	8.2	12	3445	5720					8.7	13	3066	5110
28-May-10	8.2	23	2505	4470	8.5	9	3340	5625					9.1	7	3035	5165
24-Jun-10	9.1	227	2675	5230	9.2	185	2905	5400					9.6	230	2515	4820
16-Jul-10	8.1	14	2805	5125	8.6	3	2820	5285					8.9	2	2710	4870
26-Aug-10	8.7	6	3100	5315	9	22	3215	5270					9.6	28	2810	4595
27-Sep-10	8.8	5	3300	4770	8.9	47	3555	5100					9.6	14	2945	4550
26-Oct-10	8.6	2	3160	5180	8.6	5	3380	5530					9.3	1	2900	4870
17-Nov-10	8.7	8	2650	4400	8.7	4	3110	5250					9.1	7	2540	4460
09-Dec-10	8.7	5	3080	4990	8.7	15	3180	5200					8.9	19	2530	4310
24-Jan-11	9.12	13	3100	5030	8.22	9	3390	5440					9.08	9	2840	4600
28-Feb-11	8.87	5	3640	5310	8.68	6	3710	5330					9.14	5	3320	4950
25-Mar-11	8.6	6	3510	5640	8.62	16	3700	5820					8.93	6	3140	5130
29-Apr-11	8.82	44	2870	4700	8.6	6	3750	6120					8.82	5	3290	5360
31-May-11	8.49	50	1440	2400	8.51	28	3180	4980					8.75	26	2440	3830
01-Jun-11	8.68	34	2130	3470	8.59	8	2660	4620					8.82	16	2400	3920
28-Jul-11	8.35	5	2650	4590	8.52	5	2650	4600					8.35	5	2260	3850
25-Aug-11	8.26	8	2540	4440	8.61	5	2630	4540					8.52	10	2390	4090
29-Sep-11	8.49	14	2640	4290	8.66	54	2590	4120					8.8	141	2390	3890
26-Oct-11	8.51	6	2780	4490	8.72	9	2860	4520					9.01	8	2580	4050
21-Nov-11	9.2	8	2420	4140	8.75	7	2790	4710					8.74	6	2780	4560
19-Dec-11	8.88	6	2410	3800	8.65	5	2690	4210					8.81	5	2030	3360
23-Jan-12	8.67	6	2710	4290	8.52	9	2910	4550					8.7	6	2430	3930
02-Feb-12	8.56	5	2510	4030	8.61	6	2470	4160					8.6	5	2290	3880
06-Mar-12	8.39	5	2230	3580	8.52	8	2270	3610	8.4	12	745	1250	8.6	7	1810	2990
26-Apr-12	8.48	8	2740	4350	8.64	5	2900	4440	8.3	10	834	1390	8.87	5	2520	3940
28-May-12	8.68	14	2690	4100	8.68	8	2830	4500	8.2	14	900	1320	8.69	6	2720	4150
12-Jun-12	8.68	18	2270	3660	8.74	10	2670	4200	8.2	7	1240	2020	8.65	6	2490	3910
25-Jul-12	8.8	19	2550	4080	9	6	2470	4160	8.6	6	1270	2060	9	7	2500	4080
27-Aug-12	8.7	8	2890	4620	8.9	5	2890	4590	8.8	4	1420	2210	8.8	10	2730	4360
26-Sep-12	8.6	11	2970	4680	8.6	6	3290	5180	8.2	3	4380	6610	8.7	22	2930	4630
29-Oct-12	8.7	8	3490	5340	8.9	1	3470	5450	8.1	1	4960	7440	8.8	13	3370	5010
21-Nov-12	8.9	8	3560	5620	8.9	2	3390	5650	8.1	1	4990	7580	8.7	7	3360	5370
11-Dec-12	8.8	7	3600	5490	9	2	3680	5730	8.2	3	5130	7590	9	5	3500	5450
23-Jan-13	8.81	13	3600	5770	9.05	6	3570	5580	8.5	<5	5130	7140	8.76	18	3470	5400
20-Feb-13	8.89	16	2210	4370	8.72	13	3060	4630	8.5	<5	3080	4650	8.6	<5	3310	5040
26-Mar-13	8.5	6	2500	4210	9.2	14	1570	2830	8.5	5	2350	4060	9	3	2040	3640
23-Apr-13	8.8	3	2990	5100	9.2	14	2360	3990	8.3	7	3740	5920	9	4	2700	4450
28-May-13	8.8	5	3150	5000	9.3	9	2600	4220	8.3	4	3640	5230	8.6	5	3020	4730
19-Jun-13	8.8	9	3240	5090	9	16	2740	4410	8.4	4	3040	4750	8.4	6	2700	4330
22-Jul-13	8.2	3	3050	4540	8.9	5	2640	4190	8.3	1	3850	5700	8.6	2	2800	4260
27-Aug-13	8.9	3	3140	5180	9	4	3030	5000	8.4	1	4400	6910	8.9	2	3010	5090

Rixs Creek

Mine Water Monitoring Data

	Dirty Water Dam #1				Dirty Water Dam #2				Dirty Water Dam #3				Dirty Water Dam #4			
Date	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)
26-Sep-13	9.1	5	3340	5350	9.3	9	3230	5190	8.4	3	4510	6910	8.9	9	3290	5270
30-Oct-13	9.5	6	3540	5690	9.4	11	3470	5400	8.5	6	4620	7050	9.4	6	3130	5100
21-Nov-13	8.96	5	2390	4340	8.62	5	2020	3670	8.3	23	906	1700	8.76	5	2240	3860
10-Dec-13	9.4	7	2740	4440	9.4	9	2740	4370	8.5	18	3800	5790	9.1	22	3120	4900
28-Jan-14	9	7	3440	5660	9.2	7	3150	5290	8.4	3	4440	7010	9.4	7	3270	5380
13-Feb-14	8.8	5	3510	5900	8.9	5	3460	5650	8.0	2	4480	7100	9.2	5	3490	5640
31-Mar-14	9	11	2990	5010	8.8	7	3160	5030	8.5	44	1560	2740	9.2	6	3060	5370

Rixs Creek
Creek Water Monitoring Data

	Railway Underpass					New England Highway					Below Operation					Maison Dieu Bridge					Industrial Estate Tributary					RXC Above Industrial Estate Tributary				
Date	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)
06-Jan-99	Nil	7.3	30	140	220	Nil	8.4	20	1950	3380						Nil	7.7	9	2210	3660										
26-Feb-99	Nil	7.4	480	2140	3630	Nil	7.4	19	2100	3790						Nil	7.7	10	880	1520										
26-Mar-99	Nil	7.4	25	3350	5300	Nil	7.3	50	1090	1810						Nil	6.9	30	810	1340										
13-Apr-99	Nil	7.3	6	3390	5830	Flow	7.4	70	820	1390						Flow	7.1	20	610	1010										
10-May-99	Nil	7.2	20	1690	2970	Flow	7	200	510	840						Flow	6.7	280	280	530										
01-Jun-99	Nil	7.3	8	3470	5530	Nil	7.1	170	600	1004						Nil	7	100	320	476										
12-Jul-99	Nil	7.8	4	3600	5520	Nil	7.8	80	760	1180						Nil	7.3	35	430	610										
04-Aug-99	Trickle	7.2	4	3060	5290	Nil	7.4	17	1480	2260						Nil	7.1	23	390	620										
01-Sep-99	Flow	8.2	70	90	110	Flow	7.4	180	120	150						Flow	7.1	270	140	190										
01-Oct-99	Nil	7.2	7	3310	5400	Nil	7.7	8	1530	2460						Nil	7.4	34	560	930										
05-Nov-99	Nil	7.2	12	2870	4620	Nil	7.9	2	2440	3950						Nil	7.3	8	870	1550										
01-Dec-99	Nil	7.2	9	3170	4940	Nil	7.9	4	2560	3880						Nil	7.1	6	960	1540										
10-Jan-00	Trickle	7.6	40	1060	1850	Trickle	6.7	30	640	1120						Trickle	6.5	30	580	910										
10-Jan-00	Flow	6.1	90	100	130	Flow	6.9	120	440	710						Flow	6.6	180	330	520										
04-Feb-00	Nil	8.1	20	2630	4470	Nil	7.7	35	640	1070						Nil	7.4	25	540	980										
04-Feb-00	Nil					Nil	7.9	16	730	1320						Nil	7.7	20	980	1680										
01-Mar-00	Nil					Nil										Nil														
01-Mar-00	Nil					Nil										Nil														
09-Mar-00	Flow	7.4	110	630	1020	Flow	7	330	970	1600						Flow	7	60	540	860										
10-Apr-00	Flow	7.3	10	1000	1660	Flow	7.3	24	650	960						Flow	7	40	630	890										
17-Apr-00	Flow	7.5	60	300	460	Flow	7.3	460	380	470						Flow	7	1080	200	300										
10-May-00	Trickle	7.5	30	1470	2570	Flow	7.6	100	1310	1830						Flow	7.4	90	730	1200										
07-Jun-00	Nil	8.1	2	3460	6130	Flow	8.2	6	3470	5850						Flow	7.5	4	1650	2900										
04-Jul-00	Nil	8	7	3490	5880	Flow	8.3	2	3750	6300						Flow	7.7	3	3600	6050										
29-Aug-00	Trickle	7.3	110	980	1450	Nil	8.2	6	3980	5000						Nil	7.7	1	3950	6000										
18-Sep-00	Nil					Nil	8.5	10	4160	6270						Nil	7.8	4	3750	5750										
06-Oct-00	Nil					Nil	8.5	8	4510	6360						Nil	7.7	8	3870	5810										
03-Nov-00	Nil					Nil	8.5	18	4740	7100						Nil	7.4	25	4200	6450										
06-Dec-00	Nil	7.3	60	980	1610	Nil	7.3	70	530	770						Flow	7	160	650	1020										
08-Jan-01	Nil	7.4	50	750	1190	Nil	7.6	16	1160	2120						Nil	7.5	1	470	860										
12-Feb-01	Flow	6.8	130	290	360	Flow	7	160	320	450						Flow	6.9	100	330	420										
05-Mar-01	Nil	7.4	100	180	210	Nil	7.6	35	620	900						Nil	7.2	18	800	1110										
12-Mar-01	Flow	6.5	320	130	170	Flow	6.2	520	150	200						Flow	6	120	150	200										
23-Apr-01	Nil	7.6	7	280	420	Nil	7.9	6	2830	4380						Nil	7.5	4	610	1040										
10-May-01	Trickle	7.4	29	310	430	Flow	7.6	80	1890	3210						Flow	7.1	150	590	810										
13-Jun-01	Nil	7	21	400	620	Nil	7.7	12	3050	4750						Nil	7.2	50	870	1480										
16-Jul-01	Nil	7	7	390	615	Nil	8.1	21	3360	5340						Nil	7.6	4	1220	2120										
29-Aug-01	Nil	7.3	14	450	610	Nil	7	80	1060	1700						Nil	7.5	8	1470	2440										
24-Sep-01	Nil	8.1	15	310	650	Nil	7.6	130	1180	1830						Nil	8.1	6	1550	2700										
24-Oct-01	Nil	8.1	12	440	660	Nil	7.9	85	1210	2150						Nil	8.1	9	1400	2530										
30-Nov-01	Nil	7.5	17	560	790	Nil	7.8	100	1520	2620						Nil														
19-Dec-01	Nil	7.9	18	460	750	Nil	7.7	80	1650	2460						Nil														
16-Jan-02	Nil	7.6	50	590	910	Nil	8	320	2120	3390						Nil														
12-Feb-02	Nil	6.9	250	450	610	Nil	7.4	160	490	710						Nil	6.6	120	530	720										
19-Feb-02	Flow	7.4	250	330	540	Flow	7.3	360	370	590						Flow	7.5	410	390	505										
11-Mar-02	Nil	7.8	160	440	580	Nil	7	28	530	720						Nil	7.1	55	530	730										
23-Apr-02	Nil	6.6	45	220	260	Nil	6.8	33	450	690						Nil	7.1	21	450	760										
15-May-02	Nil	7.1	80	160	320	Nil	7.1	50	480	720						Nil	7.5	6	470	860										
06-Jun-02	Trickle	6.1	150	300	220	Trickle	6.5	120	610	540						Trickle	6.7	75	560	1010										
31-Jul-02	Nil	6.7	85	170	210	Nil	7.2	29	580	1060						Nil	7.4	22	720	1310										
20-Aug-02	Nil	6.5	280	570	240	Nil	7.1	30	760	1120						Nil	7.5	8	890	1380										
23-Sep-02	Nil	7.4	460	230	360	Nil	7.8	19	740	1310						Nil	7.9	11	900	1620										
09-Oct-02	Nil					Nil										Nil														
27-Nov-02	Nil					Nil										Nil														
09-Dec-02	Nil					Nil										Nil														
12-Dec-02	Flow	6	5	120	180	Flow	6.7	160	340	380						Flow	7.6	170	350	400										
21-Jan-03	Nil					Nil										Nil														
14-Feb-03	Nil					Nil										Nil														
19-Mar-03	Nil	6	230	280	250	Nil	7.7	16	790	1220						Nil	7.2	140	300	500										
16-Apr-03	Nil					Nil										Nil														
19-May-03	Nil	7	190	330	190	Nil	7	4	1060	1280						Nil	7	110	200	200										
11-Jun-03	Nil	5.5	380	330	310	Nil	7.8	4	1040	1570						Nil	7.6	130	230	290										
16-Jul-03	Nil	5.8	17	320	360	Nil	8	2	1100	1580						Nil	7.2	65	290	240										
26-Aug-03	Trickle	5.8	350	130	115	Trickle	6.7	200	980	1480						Trickle	6.5	1430	330	340										
25-Sep-03	Nil	6.8	150	480	230	Nil	7	38	1130	1700						Nil	7.1	430	440	570										
27-Oct-03	Nil	6.6	360	360	270	Nil	7.1	29	870	1580						Trickle	6.7	370	160	360										
13-Nov-03	Nil	6.9	320	400	400	Nil	7.5	2	1060	1650						Nil	6.8	37	580	510										
24-Nov-03	Flow	6.5	150	220	110	Flow	6.9	420	710	1300						Flow	7	4110	330	470										
15-Dec-03	Trickle	7.3	130	340	250	Trickle	7.2	50	710	1050						Trickle	7.1	420	590	660										
29-Jan-04	Trickle	6.4	430	300	160	Trickle	7.1	45	740	1270						Flow	6.8	390	480	740										

Rixs Creek
Creek Water Monitoring Data

	Railway Underpass					New England Highway					Below Operation					Maison Dieu Bridge					Industrial Estate Tributary					RXC Above Industrial Estate Tributary				
Date	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)
24-Feb-04	Flow	6.5	140	40	95	Flow	7	730	260	410						Flow	6.9	1120	70	280										
26-Feb-04	Flow	6.4	20	272	140	Flow	6.9	247	258	360						Flow	6.8	296	238	310										
31-Mar-04	Nil	6.5	30	236	254	Nil	7.2	26	832	1630						Nil	6.9	28	646	1290										
27-Apr-04	Nil	6.7	27	178	190	Nil	7.5	1	986	1250						Nil	7.1	1	650	852										
27-May-04	Nil	6.4	70	378	218	Nil	7.3	10	1242	1578						Nil	6.7	23	548	660										
16-Jun-04	Nil	6.8	132	202	300	Nil	7.9	1	1082	2000		8.1	39	556	1170	Nil	7.5	25	556	1160										
29-Jul-04	Nil	6.1	460	290	280	Nil	7.4	33	1180	2000		7.8	13	1720	3130	Nil	7.4	160	560	1080										
23-Aug-04	Nil	5.8	580	310	373	Nil	7.3	16	1234	2140		6.9	80	236	476	Nil	7	62	434	620										
23-Sep-04	Nil	5.7	804	374	297	Nil	7.5	9	1088	1898		7.1	24	180	320	Nil	7.2	159	476	520										
28-Oct-04	Nil	6	355	280	138	Nil	7.1	27	950	1630		7	490	402	520	Nil	6.4	454	338	260										
30-Nov-04	Nil	6.6	390	420	260	Nil	7.3	4	1660	2750		6.6	180	710	880	Nil	7	1570	490	820										
20-Dec-04	Nil	6.5	282	432	260	Nil	7.2	10	1450	2340		7.3	131	386	6.7	Nil	6.4	204	414	392										
06-Jan-05	Nil	6.6	594	420	328	Nil	7.4	3	1480	2470	Nil	7.3	27	1100	1830	Nil	6.8	127	402	440										
02-Feb-05	Flow	6.5	360	190	75	Flow	7.1	180	320	460	Flow	7.2	250	370	450	Flow	6.8	415	460	430										
23-Mar-05	Flow	6.6	131	158	140	Flow	6.9	122	442	870	Flow	7.1	282	392	420	Flow	6.8	226	296	490										
29-Apr-05	Nil	6.1	43	128	213	Nil	7.1	1	350	754	Nil	7.1	68	373	513	Nil	7.2	1	326	640										
30-May-05	Nil	6.2	350	296	152	Nil	7.2	22	766	1218	Nil	7.3	62	396	545	Nil	7.3	50	408	637										
22-Jun-05	Nil	6.9	315	260	160	Nil	7.4	8	700	1240	Nil	7.5	77	950	1390	Nil	6.9	315	260	160										
28-Jul-05	Nil	6.4	204	290	170	Nil	7	41	430	1000	Nil	7.7	73	330	530	Nil	7	59	320	650										
24-Aug-05	Nil	6.3	500	340	190	Nil	7.4	24	610	1110	Nil	7.5	9	4990	7990	Nil	7.2	35	420	710										
19-Sep-05	Nil	5.9	720	690	200	Nil	7.3	20	700	1120	Trickle	7.1	21	400	600	Nil	7.1	70	540	577										
27-Oct-05	Nil	6	160	400	130	Nil	6.8	116	560	1000	Trickle	7.5	186	194	300	Trickle	6.6	107	230	270										
21-Nov-05	Nil	6.4	236	28	188	Nil	6.9	48	704	1270	Nil	7.8	50	638	896	Trickle	6.8	29	448	775										
08-Dec-05	Nil	6.2	230	230	210	Nil	6.8	2	960	1800	Nil	7.7	36	410	600	Nil	6.7	40	540	970										
19-Jan-06	Nil	6.7	1180	440	380	Nil	7.3	45	1190	2080	Nil	7.6	4	1630	2840	Nil	7.5	21	710	1310										
23-Feb-06	Dry					Nil	7.6	24	874	1660	Nil	7.9	16	696	1100	Dry														
23-Mar-06	Dry					Dry					Dry					Dry														
19-Apr-06	Dry					Dry					Dry					Dry														
18-May-06	Dry					Dry					Dry					Dry														
22-Jun-06	Dry					Dry					Nil	7.8	16	618	873	Dry														
20-Jul-06	Dry					Dry					Trickle	8.8	16	236	340	Dry														
25-Aug-06	Dry					Dry					Dry					Dry														
15-Sep-06	Trickle	6.6	37	236	167	Flow	6.7	14	180	238	Flow	7.7	112	366	448	Flow	6.8	152	676	1119	Flow	7	80	260	243	Flow	7	80	260	243
20-Oct-06	Nil	5.5	94	324	361	Nil	6.8	18	1110	1866	Dry					Dry														
23-Nov-06	Dry					Dry					Dry					Dry														
13-Dec-06	Dry					Dry					Dry					Dry														
11-Jan-07	Dry					Dry					Dry					Dry														
22-Feb-07	Dry					Dry					Dry					Dry														
15-Mar-07	Dry					Dry					Nil	7.3	40	600	929	Dry														
27-Apr-07	Nil	6.3	48	160	215	Nil	6.8	34	1106	1802	Nil	8.6	38	596	649	Nil	6.6	48	244	409										
23-May-07	Nil	6.6	64	186	234	Nil	6.7	49	1042	1897	Nil	7.8	19	361	336	Nil	6.4	48	266	452										
28-Jun-07	Flow	6	30	246	152	Flow	6.2	52	686	580	Flow	6.5	128	626	760	Flow	6.3	56	540	961	Flow	7.3	42	280	379	Flow	6.9	147	706	420
30-Jul-07	Nil	6.7	16	74	166	Nil	6.7	32	548	1004	Nil	7.1	12	3540	5760	Nil	6.5	26	1064	1757										
23-Aug-07	Flow	6	32	186	136	Flow	6.5	109	310	511	Flow	6.5	144	338	441	Flow	6.3	171	262	403	Flow	6.6	81	298	394	Flow	6.5	144	395	373
26-Sep-07	Nil	6.5	23	184	232	Nil	6.8	8	624	1118	Nil	8	2	864	1668	Nil	7.2	5	488	951										
17-Oct-07	Nil	7.3	422	356	377	Nil	7.5	26	752	1213	Nil	7.9	20	10840	16450	Nil	7.7	6	698	1140										
15-Nov-07	Nil	8.8	642	188	304	Nil	7.8	21	680	1176	Nil	7.6	22	316	505	Nil	7.2	14	236	317										
10-Dec-07	Nil	6.3	58	108	184	Flow	7	31	888	1598	Flow	7.8	91	386	630	Flow	6.7	142	302	448										
24-Jan-08	Nil	7.3	224	30	262	Nil	7	10	1062	1679	Trickle	7.8	18	204	293	Trickle	6.8	63	246	275										
06-Feb-08	Trickle	6.2	218	290	124	Flow	6.4	73	488	504	Flow	8	91	422	485	Flow	6.5	77	400	339	Flow	7.3	127	326	233	Flow	7.1	74	422	529
25-Mar-08	Nil	7.1	55	136	152	Nil	7.3	12	695	1178	Trickle	7.8	11	398	519	Nil	7.4	14	226	373										
28-Apr-08	Flow	7.7	48	108	125	Flow	7.4	25	286	476	Flow	8.1	22	302	346	Flow	7.3	52	224	302	Flow	7.7	29	246	294	Flow	7.6	29	224	344
20-May-08	Nil	7.7	142	32	120	Nil	7.7	10	372	478	Nil	8.1	8	286	343	Nil	7.3	26	200	302										
05-Jun-08	Flow	6	28	48	78	Flow	6.7	47	226	312	Flow	7.2	73	104	189	Flow	6.8	82	128	178	Flow	6.9	78	158	198	Flow	6.9	64	98	187
17-Jul-08	Nil	7	247	80	150	Nil	7.5	8	960	1420	Trickle	7.9	8	740	1150	Nil	6.9	9	410	650										
13-Aug-08	Nil	7.3	289	192	176	Nil	7.9	6	928	1647	Nil	8.1	3	998	1782	Nil	7.6	7	482	927										
18-Sep-08	Nil	7.2	268	154	176	Nil	7.3	26	640	979	Nil	8	23	1297	2655	Nil	7.1	32	524	720										
27-Oct-08	Nil	6.8	320	320	190	Nil	7.3	18	810	490	Nil	9.6	9	480	610	Nil	7.1	16	480	712										
24-Nov-08	Nil	7	500	510	200	Nil	8.2	110	530	900	Trickle	7.9	42	340	420	Nil	7.2	9	690	1100	Trickle									
09-Dec-08	Nil	7	1124	426	150	Nil	7.4	33	620	928	Nil	7.4	14	358	620	Nil	6.9	42	610	924										
29-Jan-09	Dry					Dry					Dry					Dry														
16-Feb-09	Flow	7.1	35	160	170	Flow	6.9	46	200	220	Flow	7.3	46	180	250	Flow	6.8	61	210	240	Flow	7	56	210	220					
17-Mar-09	Trickle	6.5	330	130	140	Flow	6.9	63	260	830	Flow	8	45	430	680	Flow	6.9	80	620	980										
03-Apr-09	Flow	6.3	29	220	120	Flow	6.8	36	270	310	Flow	7.2	67	330	340	Flow	6.7	57	430	520										
26-May-09	Nil	6.4	133	230	170	Nil	7.9	5	1820	2700	Flow	7.9	3	720	1200	Flow	7.2	11	2420	3400										
17-Jun-09	Nil	6.5	150	132	165	Nil	8.4	1	1450	2730	Nil	8.3	1	554	1296	Trickle	7.5	1	1000	2120										
23-Jun-09	Nil	6.4	70	210	110	Flow	7.3	68	2480	3800	Flow	7.8	95	220	400	Flow	7.5	22	670	1250										
20-Jul-09	Nil	6.5	103	344	130	Nil	8	4	2000	4000	Trickle	8.1	5	440	730	Nil	8.1	7	868	1540										
31-Aug-09	Nil	7.4	320	210	160	Nil	8.5	2	2100	3600	Dry					Nil	8.3	2	1100	1800										
28-Sep-09	Nil	6.22	1880	2390	250	Nil	8.17	3	2130	3500	Nil	8.11	3	607	1100	Nil	7.71	5	1470	2500										

Rixs Creek
Creek Water Monitoring Data

	Railway Underpass					New England Highway					Below Operation					Maison Dieu Bridge					Industrial Estate Tributary					RXC Above Industrial Estate Tributary				
Date	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	Flow	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)
29-Oct-09	Nil	7.4	19	250	260	Nil	7.8	4	2600	3900	Trickle	7.6	7	390	610	Nil	7.4	11	1500	2300										
18-Nov-09	Dry					Dry					Dry					Dry														
08-Dec-09	Dry					Dry					Dry					Dry														
22-Jan-10	Dry					Dry					Dry					Dry														
17-Feb-10	Dry					Dry					Nil	7.8	56	550	600	Nil	6.6	52	310	450										
29-Mar-10	Dry					Dry					Dry					Dry														
29-Apr-10	Dry					Dry					Nil	7.4	4	304	639	Dry														
28-May-10	Dry					Nil	6.2	71	1006	1724	Flow	7.6	150	212	279	Nil	6.7	163	294	449	Flow	7.3	115	114	244					
24-Jun-10	Trickle	6.3	506	156	173	Nil	6.7	259	512	885	Flow	7.7	197	328	462	Nil	6.7	518	476	853										
16-Jul-10	Flow	6.7	98	180	118	Flow	6.8	84	514	856	Flow	7.8	160	300	274	Flow	6.8	93	500	1024	Flow	7.4	114	230	274	Flow	7.2	92	548	1035
26-Aug-10	Trickle	6.9	61	268	410	Nil	6.7	14	798	1368	Flow	8.6	2	486	866	Flow	6.8	22	460	784										
27-Sep-10	Nil	6.8	50	194	171	Nil	6.9	9	518	1056	Nil	8.1	7	924	1569	Nil	7.2	9	618	1197										
26-Oct-10	Nil	7.2	67	331	193	Nil	7.3	4	724	1310	Flow	7.8	42	292	294	Flow	7.1	15	214	344	Flow	7.8	34	290	291					
17-Nov-10	Flow	6.5	33	114	126	Flow	7.1	24	418	623	Flow	7.5	28	386	479	Flow	7.1	62	208	434	Flow	7.5	28	342	351	Flow	7.4	40	410	550
09-Dec-10	Trickle	8.4	31	162	177	Trickle	8.4	5	944	1690	Trickle	8.3	20	306	418	Trickle	8.5	17	212	242										
24-Jan-11	Nil	7.13	126	322	413	Nil	7.38	34	1070	1820	Dry					Dry														
28-Feb-11	Dry					Dry					Dry					Dry														
25-Mar-11	Dry					Nil	7.8	12	1080	1700	Nil	7.59	26	352	437	Nil	7.3	10	360	535										
29-Apr-11	Nil	6.32	48	321	189	Nil	7.58	14	826	1270	Nil	7.92	5	330	362	Nil	7.03	6	378	434	Flow	7.44	220	256	154					
31-May-11	Flow	7.06	338	312	91	Flow	7.43	209	354	365	Flow	7.5	492	346	275	Flow	7.22	824	476	348	Flow	6.97	69	516	335	Flow	7.37	596	308	330
01-Jun-11	Flow	5.97	110	234	82	Flow	7.37	76	450	566	Flow	6.87	109	512	375	Flow	6.73	120	488	332						Flow	6.97	103	472	376
28-Jul-11	Flow	6.65	12	88	205	Flow	7.41	11	598	1170	Flow	8.14	10	420	847	Flow	7.45	5	974	1980	Flow	7.73	38	704	623					
25-Aug-11	Flow	6.45	50	262	140	Flow	7.05	11	478	757	Flow	8.02	24	486	603	Flow	7.11	30	444	540	Flow	7.57	256	540	259	Flow	7.6	20	398	545
29-Sep-11	Flow	7.51	155	214	104	Flow	7.47	297	970	1390	Flow	7.86	164	598	615	Flow	7.49	265	386	313	Flow	7.95	14	740	1370	Flow	7.69	107	658	949
26-Oct-11	Flow	7.26	12	252	304	Flow	7.7	18	562	942	Flow	8.08	14	794	1430	Flow	7.48	18	528	854	Flow	8.08	76	424	480	Flow	7.49	9	440	655
21-Nov-11	Flow	7.48	14	262	420	Flow	7.58	14	640	1110	Flow	7.76	78	480	562	Flow	7.32	30	338	577						Flow	7.57	106	486	691
19-Dec-11	Trickle	7.62	10	291	290	Trickle	7.66	28	1060	1750	Trickle	7.38	16	1100	1720	Trickle	7.51	21	496	612										
23-Jan-12	Nil	7.75	12	228	354	Nil	7.79	91	1240	1960	Trickle	8.09	7	736	1280	Trickle	7.86	14	736	1250										
02-Feb-12	Nil	7.15	186	255	100	Flow	7.49	90	790	1120	Flow	7.79	50	612	947	Flow	7.55	47	372	370	Flow	7.64	73	308	299	Flow	7.83	31	1070	1900
06-Mar-12	Nil	7.11	100	387	157	Flow	7.51	17	414	586	Flow	7.84	22	384	477	Flow	7.42	38	442	652	Flow	7.75	39	496	551	Flow	7.87	23	400	451
26-Apr-12	Nil	7.78	21	439	328	Flow	7.72	5	3180	4540	Flow	8.19	5	2950	4310	Flow	7.76	8	2710	3940	Flow	8.29	5	818	1600	Flow	8.15	8	2980	4370
28-May-12	Nil	7.87	72	364	339	Nil	7.64	16	524	809	Nil	7.71	36	526	697	Nil	7.63	17	750	1180										
12-Jun-12	Nil	7.71	88	372	402	Trickle	7.55	15	706	1190	Flow	8.1	13	484	989	Flow	7.48	37	490	782	Flow	7.92	7	502	972	Trickle	7.5	33	472	783
25-Jul-12	Nil	7.8	41	343	499	Trickle	7.2	36	920	1541	Flow	8	46	493	791	Flow	7.1	39	833	1363	Flow	7.9	49	494	790	Trickle	7.2	78	819	1356
27-Aug-12	Nil	7.7	13	381	577	Nil	7.7	48	995	1697	Nil	7.4	101	835	1462	Nil	7.5	17	940	1652										
26-Sep-12	Nil	8	47	462	753	Nil	7.6	77	1090	1889	Nil	7.7	130	1420	2610	Nil	7.6	10	1300	2120										
29-Oct-12	Dry					Dry					Dry					Dry														
21-Nov-12	Dry					Dry					Dry					Dry														
11-Dec-12	Dry					Dry					Dry					Dry														
23-Jan-13	Nil	9.18	103	984	1600	Nil - Dry					Nil - Dry					Nil	8.41	30	1440	2450	Nil					Nil				
20-Feb-13	Nil	7.39	5	500	702	Nil	7.44	6	892	1460	Nil	7.47	9	312	536	Nil	7.33	6	356	489	Nil					Nil				
26-Mar-13	Nil	7	8	258	406	Nil	8	13	1420	2570	Nil	7.7	7	1480	2520	Nil	6.8	17	2080	3540	Nil					Nil				
23-Apr-13	Nil	7.6	10	304	507	Nil	8	8	1670	2870	Nil	7.8	13	1500	2470	Nil	7.3	13	2900	4940	Nil					Nil				
28-May-13	Nil	7.5	4	397	609	Trickle	8.2	5	3450	5200	Trickle	7.8	9	503	819	Trickle	7.4	7	2060	3710	Trickle	7.7	13	465	778	Trickle	7.8	33	1480	2300
19-Jun-13	Nil	7.6	6	465	683	Nil	8.1	5	3270	4980	Nil	7.8	3	3240	4940	Trickle	7.3	6	919	1659	Dry					Dry				
22-Jul-13	Nil	7.5	8	431	663	Nil	7.8	6	1700	2750	Nil	8.3	6	2870	4550	Trickle	7.3	16	1380	2270	Dry					Dry				
27-Aug-13	Nil	8.2	7	431	735	Nil	8.4	20	1870	3240	Nil	8.6	3	3100	4970	Nil	7.9	4	1480	2490	Dry					Dry				
26-Sep-13	Nil	9	5	586	940	Nil	8.5	23	2130	3650	Nil - Dry					Nil	8.1	14	1240	2150	Dry					Dry				
30-Oct-13	Nil	8.5	14	628	970	Nil - Dry					Nil - Dry					Nil - Dry					Dry					Dry				
21-Nov-13	Nil	7.15	36	277	330	Trickle	7.41	5	387	519	Low flow	7.62	5	379	502	Low flow	7.25	5	375	522	Trickle	7.68	5	347	425	Low flow	7.63	5	364	523
10-Dec-13	Nil	7.5	20	462	381	Nil	7.3	18	449	644	Nil	7.4	23	461	509	Nil	7.1	34	408	591	Dry					Dry				
28-Jan-14	Nil	8.4	20	365	540	Dry					Dry					Dry					Dry					Dry				
13-Feb-14	Nil	8.9	18	354	637	Dry					Dry					Dry					Dry					Dry				
31-Mar-14	Nil	7.5	51	540	448	Trickle	7.2	66	388	533	Trickle	8	74	353	445	Trickle	7	176	337	383	Trickle	8.2	41	339	397	Trickle	7.7	111	412	476

Rixs Creek

Clean Water Dams

	Clean Water Dam 1				Clean Water Dam 2				Clean Water Dam 6			
	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)
06-Jan-99	7.6	80	190	290	7.5	5	190	290	7.5	60	85	130
26-Feb-99	7.2	340	240	340	7	50	180	240	7.7	65	110	140
26-Mar-99	7.5	240	240	360	7.2	25	160	260	7.4	65	110	140
13-Apr-99	7	170	240	360	7.3	20	160	270	7.3	90	110	140
10-May-99	6.8	130	230	265	7	65	300	207	8	110	320	147
01-Jun-99	7.1	50	340	260	6.6	70	250	200	7	50	370	140
12-Jul-99	6.8	60	180	260	6.9	60	150	200	7.3	60	105	130
04-Aug-99	8.2	25	160	220	7.5	11	100	130	7.2	55	100	120
01-Sep-99	7.2	30	180	200	7.1	19	110	140	7.5	45	100	120
01-Oct-99	8	55	170	240	7	15	110	140	7.2	25	100	120
05-Nov-99	6.3	20	120	150	6	12	110	140	6.4	20	100	120
01-Dec-99	7.1	2	170	240	6.9	11	130	170	7.3	30	100	130
10-Jan-00	7.6	19	340	530	7.3	15	230	340	7.6	45	260	400
04-Feb-00	7.9	35	240	290	7.6	15	150	210	7.6	60	120	160
01-Mar-00	8.4	40	230	350	7.7	30	160	220	7.7	110	120	160
10-Apr-00	7.3	15	150	200	7.7	25	140	180	8.2	45	120	160
10-May-00	7.2	35	140	180	7	24	130	170	7.2	23	120	120
07-Jun-00	7.5	16	170	240	7	1	130	170	7.3	4	100	130
04-Jul-00	7.9	5	220	350	7.4	5	150	210	7.8	30	120	150
29-Aug-00	8.2	15	260	200	7.3	11	220	190	7	27	240	120
18-Sep-00	8.1	80	200	230	8.4	19	200	240	8.2	10	120	130
06-Oct-00	7.5	31	170	210	7.4	17	140	190	8.8	25	120	150
03-Nov-00	7.5	16	180	250	7.1	11	150	210	7.1	12	110	140
06-Dec-00	6.9	21	120	160	7.1	17	140	190	7.6	60	100	130
08-Jan-01	7.3	2	140	190	7.1	4	170	210	7.3	38	120	150
12-Feb-01	7.6	50	140	160	7.2	40	140	170	7.9	60	140	150
05-Mar-01	6.9	23	100	130	6.6	18	110	135	8.5	80	130	170
23-Apr-01	7.5	8	120	180	6.8	5	100	130	7.1	34	110	140
10-May-01	7.2	13	140	180	7.1	13	130	140	7.1	36	140	145
13-Jun-01	7	17	160	200	6.7	14	140	150	7.3	42	120	160
16-Jul-01	7.4	4	170	220	7	6	120	160	8	36	140	190
29-Aug-01	7.2	28	170	230	7.3	65	130	170	7	55	120	150

Rixs Creek

Clean Water Dams

	Clean Water Dam 1				Clean Water Dam 2				Clean Water Dam 6			
	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)
24-Sep-01	7.9	12	200	250	7.4	22	140	180	7.9	60	120	150
24-Oct-01	8.3	8	190	250	7.7	12	160	180	8.3	55	150	160
30-Nov-01	8.8	5	150	270	7.5	21	90	210	8	60	130	170
19-Dec-01	7.7	5	160	260	7.6	5	150	220	8.7	110	170	190
16-Jan-02	8.4	12	260	390	7.5	7	150	250	8.1	80	220	320
12-Feb-02	7.2	26	200	230	6.7	20	170	190	8.2	280	260	320
11-Mar-02	7.1	10	160	190	7.1	3	110	200	8.6	90	250	300
23-Apr-02	6.6	25	90	100	7.4	21	110	140	7.1	34	230	270
15-May-02	7	23	70	110	6.8	9	60	110	7.7	40	340	270
06-Jun-02	6.5	20	180	140	7.5	9	160	160	7.3	170	340	310
31-Jul-02	7.1	6	160	160	6.8	2	95	140	7.8	55	360	270
20-Aug-02	6.7	14	280	170	6.7	9	230	150	6.8	270	440	280
23-Sep-02	7.8	70	150	180	7.5	10	85	160	7.9	320	250	280
16-Oct-02	7	1	210	200	6.5	10	95	160	8.1	45	390	310
27-Nov-02	6.3	70	250	230	6.7	4	100	190	8	80	390	330
09-Dec-02	7.6	75	240	350	8.8	2	120	200	8.4	60	430	350
21-Jan-03	7.8	17	210	210	6.4	120	140	180	7.3	22	420	300
14-Feb-03	8.3	21	170	190	7.9	2	120	200	8.6	110	360	370
19-Mar-03	7.5	14	300	200	7.3	9	120	205	7.5	85	370	320
16-Apr-03	7.3	14	260	220	7	2	170	210	7.8	15	450	310
19-May-03	7	170	250	200	7	4	130	190	7.8	38	440	280
11-Jun-03	7.2	29	160	220	7.5	12	130	210	7.8	44	530	320
16-Jul-03	7.1	55	270	240	7.1	10	180	240	8	31	440	340
26-Aug-03	6.6	25	270	240	7.4	2	250	250	7.6	85	340	330
25-Sep-03	7.1	25	340	260	7.3	9	230	250	8	85	460	340
27-Oct-03	6.8	80	320	260	7.2	14	340	270	7.8	65	470	350
13-Nov-03	7.1	37	270	270	7.6	2	190	280	7.9	80	470	360
15-Dec-03	7.1	17	240	220	7.2	7	280	280	7.8	85	490	340
29-Jan-04	7.6	7	200	260	7.1	5	180	320	7.9	90	420	370
26-Feb-04	6.3	27	168	120	6.4	30	132	120	7.3	151	292	270
31-Mar-04	6.6	3	66	148	6.3	2	104	163	7.3	22	290	271
27-Apr-04	6.4	1	42	156	6.9	1	78	150	6.9	34	272	250

Rixs Creek

Clean Water Dams

	Clean Water Dam 1				Clean Water Dam 2				Clean Water Dam 6			
	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)
27-May-04	8.4	16	184	122	6.7	14	242	130	7.1	84	342	209
16-Jun-04	8.7	64	136	170	7.4	1	138	170	8	14	289	290
29-Jul-04	7.3	2	70	190	7.5	1	120	180	8.4	2	230	270
23-Aug-04	7.1	12	36	197	7.2	13	60	191	7.7	32	286	260
23-Sep-04	6.8	65	148	199	7	8	180	197	7.5	46	412	260
28-Oct-04	6.4	9	54	197	6.8	2	118	199	7.4	66	316	255
20-Nov-04	7.3	11	200	220	7.4	3	140	210	8.1	80	400	300
30-Nov-04	7.7	5	192	223	8.5	1	140	211	7.4	97	280	280
06-Jan-05	6.8	14	190	236	7.6	12	180	213	7.5	65	365	280
02-Feb-05	6.1	110	140	110	6.7	31	140	180	6.9	240	200	190
23-Mar-05	6	19	88	150	6.2	10	88	200	6.8	37	250	200
29-Apr-05	6.2	1	120	165	6.4	1	40	213	6.8	8	150	207
30-May-05	6.8	21	258	172	6.7	16	200	216	7.1	55	362	213
22-Jun-05	7.1	5	190	180	6.9	8	210	230	7.6	17	330	210
28-Jul-05	7.1	3	60	270	7	2	110	240	7.9	23	330	230
24-Aug-05	7.1	7	90	220	7.1	9	100	250	7.9	39	60	240
19-Sep-05	7.2	5	260	241	7.1	6	180	238	8.1	108	310	230
27-Oct-05	9.1	4	82	210	8.6	1	44	240	8.2	32	300	230
21-Nov-05	7.5	2	140	187	7.5	1	82	230	8.2	155	60	240
08-Dec-05	8.6	1	70	195	7.9	11	130	240	8	45	290	250
19-Jan-06	6.8	1	200	230	6.9	1	220	280	7.9	1	310	280
23-Feb-06	7.6	1	248	260	7.8	2	168	300	8.1	49	332	280
23-Mar-06	6.9	16	170	260	6.6	3	170	330	7.8	52	130	280
19-Apr-06	8.7	10	315	320	8.5	2	315	350	8.7	14	445	280
18-May-06	7	9	208	226	7.6	20	192	335	8.4	8	244	290
22-Jun-06	7.8	2	304	271	7.8	10	284	335	8.6	9	246	393
20-Jul-06	6.8	7	210	270	6.8	7	174	335	9	13	224	285
25-Aug-06	7.1	10	196	305	7.5	7	222	360	7.5	10	269	306
15-Sep-06	6.6	22	150	214	6.4	142	526	731	7.3	20	222	270
20-Oct-06	6.9	27	172	253	6.9	8	236	334	7.7	71	294	285
23-Nov-06	9.5	2	180	275	8.2	2	132	362	8.8	2	268	304
13-Dec-06	8	4	198	316	7.7	4	224	406	8.5	31	421	352

Rixs Creek

Clean Water Dams

	Clean Water Dam 1				Clean Water Dam 2				Clean Water Dam 6			
	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)
11-Jan-07												
22-Feb-07												
15-Mar-07												
27-Apr-07												
23-May-07												
28-Jun-07												
30-Jul-07												
23-Aug-07												
26-Sep-07												
17-Oct-07												
15-Nov-07												
10-Dec-07												
24-Jan-08	8.4	6	95	54	6.8	4	102	204	8.6	29	150	111
06-Feb-08	6.4	34	49	95	6.3	23	186	110	8.9	8	228	127
25-Mar-08	7.5	3	82	128	7.4	4	80	133	8.1	39	162	126
28-Apr-08	6.9	36	82	98	6.7	7	70	111	7.8	19	72	130
20-May-08	6.9	20	84	101	6.7	9	73	115	7.7	8	106	123
05-Jun-08	6.3	54	50	91	6.3	29	56	87	6.8	33	146	160
17-Jul-08	7.2	14	140	170	7.6	17	120	120	8	12	120	120
13-Aug-08	7.6	6	145	196	7.4	7	127	131	7.8	18	210	140
18-Sep-08	9	16	136	181	7.6	14	82	144	8.5	160	160	135
27-Oct-08	7.7	9	280	220	7.2	15	170	170	9.4	29	280	150
24-Nov-08	7.5	5	170	230	7.4	12	150	180	8	30	200	150
09-Dec-08	8.7	3	162	237	8.4	6	116	188	7.8	273	266	155
29-Jan-09	8.9	4	150	260	7.2	4	140	210	7.9	13	220	180
16-Feb-09	6.7	55	74	180	6.7	34	110	130	7.1	66	150	140
17-Mar-09	7.9	11	120	180	7	8	90	150	7.3	9	130	130
03-Apr-09	6.8	26	160	150	6.6	38	140	130	6.6	58	160	160
26-May-09	8.2	3	110	180	7.3	7	110	140	7.5	6	180	100
17-Jun-09	7.5	6	54	193	7.3	7	82	143	7.5	8	124	105
20-Jul-09	7.7	8	140	180	7.2	7	122	140	7.5	7	192	110
31-Aug-09	8.2	4	130	190	8	17	110	150	8.2	18	210	120

Rixs Creek

Clean Water Dams

	Clean Water Dam 1				Clean Water Dam 2				Clean Water Dam 6			
	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)
28-Sep-09	7.62	4	134	210	7.49	8	104	150	7.41	19	209	120
29-Oct-09	7.5	2	170	210	8.1	2	150	160	7.4	13	230	120
18-Nov-09	10	4	140	240	9.4	3	110	170	8.3	9	220	150
08-Dec-09	9.9	8	150	230	8.3	27	280	180	7.9	21	220	130
22-Jan-10	9.1	11	190	240	9.4	19	120	190	8.7	10	220	140
17-Feb-10	9.1	10	230	280	9.9	5	210	210	8.4	16	360	150
29-Mar-10	10.1	7	244	310	10.2	8	74	240	8.9	10	160	170
29-Apr-10	8.8	6	208	318	8.8	14	112	233	7.6	9	124	184
28-May-10	6.8	10	170	306	9	9	132	237	8.1	25	138	164
24-Jun-10	7	191	176	271	7.5	235	100	240	7.3	185	98	161
16-Jul-10	6.8	18	122	257	6.8	6	100	253	7	2	179	156
26-Aug-10	7.1	20	174	230	7.2	2	152	247	8.5	13	92	163
27-Sep-10	7.6	9	162	262	7.5	3	144	273	9.4	21	148	206
26-Oct-10	7.7	4	161	249	7.8	1	164	262	8.2	3	153	166
17-Nov-10	7.1	14	138	196	6.7	33	149	159	7.7	19	152	160
09-Dec-10	8.5	11	74	165	8.4	5	161	198	8.5	5	156	158
24-Jan-11	7.89	10	150	226	7.59	7	172	254	9.48	15	135	216
28-Feb-11	8.09	6	153	204	8.03	6	191	242	9.03	6	127	170
25-Mar-11	7.82	8	139	214	7.99	8	159	253	8.94	6	117	176
29-Apr-11	7.32	8	191	256	7.45	5	213	316	8.76	6	159	195
31-May-11	7.34	87	158	151	7.77	15	152	272	8.25	7	149	180
01-Jun-11	6.97	16	148	123	6.81	73	147	134	7.7	10	126	170
28-Jul-11	7.16	19	128	167	7.1	5	121	159	7.96	34	184	140
25-Aug-11	7.07	14	170	213	7.09	10	125	165	8.06	22	193	130
29-Sep-11	7.29	12	186	255	7.3	12	120	172	7.92	32	180	185
26-Oct-11	7.38	11	173	221	7.32	10	150	182	8.19	18	168	160
21-Nov-11	7.99	8	121	215	7.49	6	102	173	8.94	26	148	182
19-Dec-11	7.58	8	175	210	7.4	9	173	163	7.72	16	311	146
23-Jan-12	7.83	23	182	229	7.5	10	160	178	8.03	46	300	152
02-Feb-12	7.44	14	154	221	7.28	12	101	175	7.6	13	200	146
06-Mar-12	7.39	16	219	168	7.19	18	174	137	7.44	20	280	140
26-Apr-12	7.37	14	130	206	7.24	20	117	177	7.52	58	215	174

Rixs Creek

Clean Water Dams

	Clean Water Dam 1				Clean Water Dam 2				Clean Water Dam 6			
	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)
28-May-12	7.54	47	151	205	7.5	5	136	181	7.83	22	206	175
12-Jun-12	7.43	10	122	197	7.43	47	163	174	7.56	21	152	182
25-Jul-12	7.2	13	228	282	7	27	168	190	7.6	9	230	189
27-Aug-12	7.4	15	185	290	7.4	9	174	189	7.8	18	263	180
26-Sep-12	7.4	14	216	306	7.6	27	172	213	7.9	14	273	226
29-Oct-12	7.3	12	247	338	7.2	53	158	219	8.2	14	300	244
21-Nov-12	7.5	17	227	342	7.1	77	164	226	8	118	251	246
11-Dec-12	7.3	12	251	379	7.2	22	186	250	7.3	21	262	261
23-Jan-13	8.1	22	308	424	8	35	200	276	8.36	50	285	271
20-Feb-13	7.69	14	160	183	7.62	8	154	197	8.13	24	294	292
26-Mar-13	6.9	6	126	155	6.9	24	124	136	7.4	26	214	241
23-Apr-13	7.2	9	126	156	7	9	124	140	7.2	22	177	186
28-May-13	7.2	35	198	158	7	10	106	146	7.3	14	233	235
19-Jun-13	6.9	10	216	172	7	7	169	156	7.3	6	262	203
22-Jul-13	7	8	198	244	7	6	158	167	7.4	4	244	253
27-Aug-13	8	7	179	201	7.9	15	144	150	8.2	50	218	194
26-Sep-13	8	10	244	290	7.9	11	200	196	8	45	278	221
30-Oct-13	7.9	21	201	318	8	8	169	221	8.3	35	251	298
21-Nov-13	7.06	30	138	133	7.14	15	158	184	7.49	5	237	253
10-Dec-13	6.9	13	124	133	6.9	10	139	158	8	21	275	292

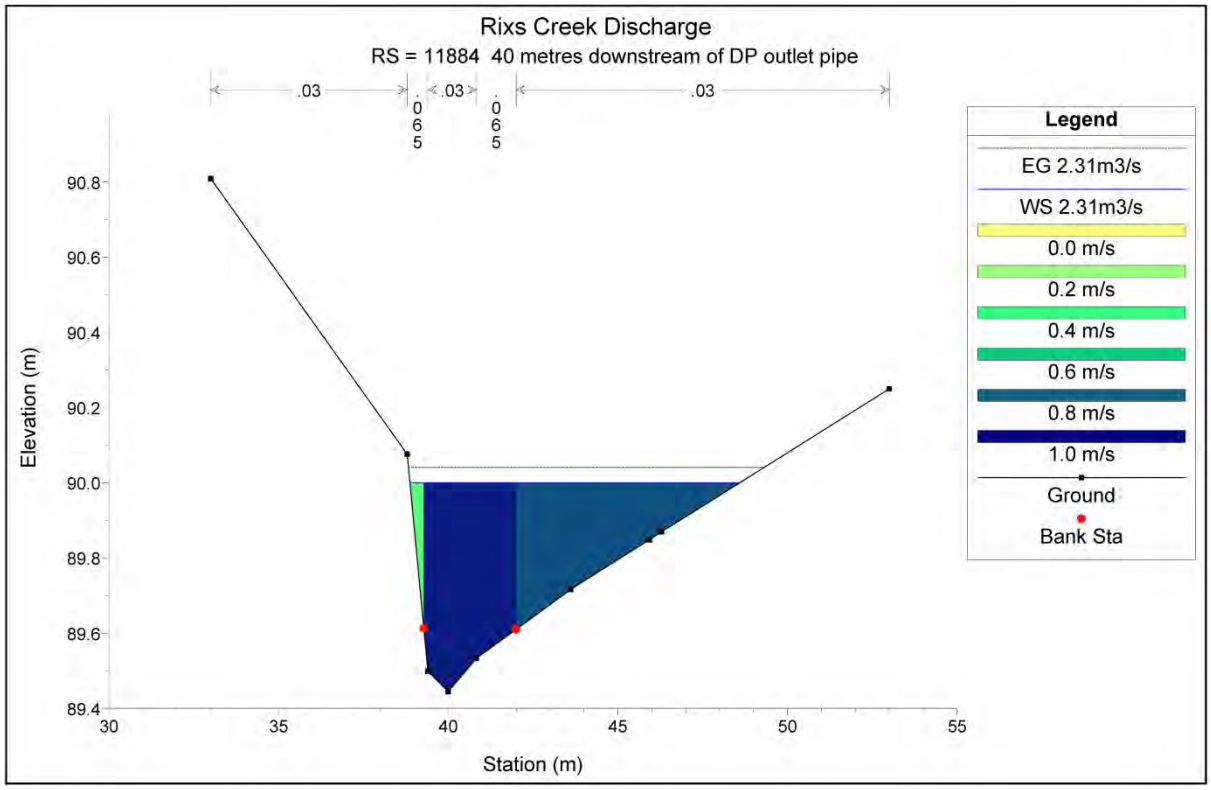
Rixs Creek
Sediment Dams

	Pit 3 - East				Pit 3 - West				Miscellaneous Sediment Dams					
Date	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	Date	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conductance (µS/cm)	Location
19-Feb-02	6.7	770	120	160	6.5	230	60	90	19-Feb-02	6.3	150	120	160	Bownan Dam (Hwy)
01-Jun-11	DNS	15	176	308	8.0	8	298	411	19-Feb-02	6.9	850	120	160	Sediment Dam - Hill
06-Mar-12	8.1	10	271	381	8.0	20	266	256	19-Feb-02	7.3	410	230	350	Sediment Dam 5 - Highway
21-Nov-13	8.3	5	297	491	8.1	12	305	356	12-Dec-02	5.7	180	310	160	Bownan Dam (Hwy)
27-Apr-15	7.61	5	220	352	7.4	212	703	230	12-Dec-02	6.3	380	500	170	Sediment Dam - Hill

Details	Date	pH	Electrical Conductivity - uS/cm	Total Dissolved Solids	Total Suspended Solids	Total Hardness as CaCO3	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Silicon	Sulphate as SO4	Chloride	Calcium	Magnesium	Sodium	Potassium	Dissolved Metals - Fe	Aluminium	Antimony	Arsenic	Beryllium	Barium	Cadmium	Cobalt	Copper	Lead	Lithium	Manganese	Nickel	Rubidium	Selenium	Strontium	Zinc	Boron	Mercury	Fluoride	Ammonia as N	Nitrate as N	Nitrate as N	Nitrite + Nitrate as N	Total Phosphorus	Total Anions	Total Cations	Ionic Balance
		Basic Analytes				Alkalinity					Major Anions			Major Cations					Total Metals																			Nutrients						Ionic Balance		
Limit of Resolution		0.01	1	10	5	1	1	1	1	1	0.05	1	1	1	1	1	1	0.5	0.01	0.001	0.001	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.001	0.01	0.001	0.005	0.05	0.0001	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Unit		pH unit	uS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	%
Site 1 Railway Underpass Rixs Creek Tributary	01-Jun-11	5.97	82	234	110	11	<1	<1	6	6	8.46	3	12	1	2	10	4	0.78	11	<0.001	0.001	<0.001	0.062	<0.0001	0.003	0.009	0.003	0.009	0.05	0.004	0.017	<0.01	0.048	0.038	<0.5	<0.0001	0.1	0.06	<0.01	0.02	--	0.13	0.52	0.75	--
	06-Mar-12	7.11	157	387	100	40	<1	<1	57	57	17.4	7	12	6	6	19	4	1.66	12	<0.001	0.004	<0.001	0.099	<0.0001	0.006	0.014	0.004	0.009	0.297	0.008	0.017	<0.01	0.147	0.037	<0.05	<0.0001	0.2	<0.01	<0.01	<0.01	<0.01	0.43	1.62	1.72	--
	21-Nov-13	7.06	133	138	30	13	<1	<1	22	22	7.54	14	15	2	2	14	4	0.44	2.99	<0.001	0.002	<0.001	0.05	<0.0001	0.001	0.003	0.002	0.004	0.05	0.002	0.005	<0.01	0.061	0.012	<0.05	<0.0001	0.2	0.15	<0.01	<0.01	<0.01	0.22			
	27-Apr-15	7.43	259	215	8	58	<1	<1	48	48	23.7	38	23	10	8	31	3	0.25	3.7	<0.001	0.002	<0.001	0.033	<0.0001	0.001	0.004	0.001	0.004	0.149	0.002	0.006	<0.01	0.108	0.01	<0.05	<0.0001	0.2	0.04	<0.01	0.09	0.09	0.05	2.4	5.58	--
Site 2 New England Highway Rixs Creek	01-Jun-11	6.58	566	450	76	56	<1	<1	37	37	3.2	61	101	6	10	85	5	0.52	5.37	<0.001	<0.001	<0.001	0.052	<0.0001	0.002	0.005	0.003	0.007	0.027	0.003	0.009	<0.01	0.223	0.017	<0.05	<0.0001	0.3	0.03	<0.01	0.08	--	0.26	4.86	4.95	0.86
	06-Mar-12	7.51	586	414	17	87	<1	<1	79	79	7.46	61	103	10	15	92	4	1.09	1.83	<0.001	0.002	<0.001	0.056	<0.0001	<0.001	0.002	<0.001	0.006	0.035	0.002	0.003	<0.01	0.234	0.007	<0.05	<0.0001	0.4	<0.01	<0.01	<0.01	<0.01	0.08	5.75	5.84	0.7
	21-Nov-13	7.41	519	387	<5	50	<1	<1	54	54	14.5	70	77	5	9	77	5	0.64	4.68	<0.001	0.003	<0.001	0.049	<0.0001	0.002	0.007	0.003	0.009	0.039	0.004	0.007	<0.01	0.298	0.016	0.05	<0.0001	0.4	0.02	<0.01	<0.01	<0.01	0.04			
	27-Apr-15	7.34	579	310	7	76	<1	<1	60	60	27.8	60	92	9	13	73	4	0.12	3.79	<0.001	0.002	<0.001	0.063	<0.0001	0.001	0.005	0.001	0.008	0.03	0.003	0.006	<0.01	0.252	0.012	<0.05	<0.0001	0.2	0.02	<0.01	0.55	0.55	0.07	5.04	4.8	2.53
Site 3 Maison Dieu Bridge Rixs Creek	01-Jun-11	6.73	332	488	120	37	<1	<1	29	29	3.45	37	56	5	6	48	4	1.05	11.9	<0.001	0.002	<0.001	0.087	<0.0001	0.004	0.01	0.006	0.011	0.049	0.007	0.02	<0.01	0.17	0.046	0.06	0.0001	0.2	0.02	<0.01	0.39	--	0.16	2.93	2.93	--
	06-Mar-12	7.42	652	442	38	116	<1	<1	71	71	8.18	56	137	15	19	94	5	1.13	3.59	<0.001	0.002	<0.001	0.073	<0.0001	0.001	0.004	0.002	0.005	0.068	0.003	0.006	<0.01	0.364	0.015	<0.05	<0.0001	0.3	0.06	<0.01	0.02	0.02	0.1	6.45	6.53	0.6
	21-Nov-13	7.25	522	375	<5	48	<1	<1	52	52	13.8	65	85	6	8	77	6	0.67	5.63	<0.001	0.003	<0.001	0.05	<0.0001	0.002	0.007	0.003	0.009	0.036	0.004	0.008	<0.01	0.265	0.021	0.05	<0.0001	0.3	0.03	<0.01	0.07	0.07	0.06			
	27-Apr-15	7.16	879	482	6	129	<1	<1	71	71	27.2	70	179	17	21	114	5	0.21	3.9	<0.001	0.002	<0.001	0.08	<0.0001	0.002	0.005	0.002	0.008	0.067	0.003	0.007	<0.01	0.438	0.018	<0.05	<0.0001	0.2	0.11	<0.01	0.3	0.3	0.06	7.92	7.66	1.7
Site 10 Below Operation Rixs Creek	01-Jun-11	6.87	375	512	109	44	<1	<1	33	33	3.81	40	66	6	7	54	4	2.95	12.6	<0.001	0.002	<0.001	0.086	0.0001	0.004	0.01	0.006	0.011	0.05	0.006	0.019	<0.01	0.191	0.055	<0.05	0.0001	0.2	0.02	<0.01	0.21	--	0.12	3.35	3.33	0.43
	06-Mar-12	7.84	477	384	22	78	<1	<1	69	69	8.03	44	85	10	13	70	4	1.04	5.86	<0.001	0.003	<0.001	0.07	<0.0001	0.001	0.006	0.002	0.007	0.033	0.004	0.009	<0.01	0.264	0.02	<0.05	<0.0001	0.3	<0.01	<0.01	<0.01	<0.01	0.11	4.69	4.72	0.23
	21-Nov-13	7.62	502	379	<5	45	<1	<1	54	54	14	66	77	5	8	74	5	0.66	4.13	<0.001	0.003	<0.001	0.043	<0.0001	0.001	0.006	0.002	0.008	0.03	0.003	0.006	<0.01	0.298	0.013	0.05	<0.0001	0.4	0.01	<0.01	0.01	0.01	0.06			
	27-Apr-15	7.65	567	342	<5	88	<1	<1	59	59	26.2	50	96	12	14	77	4	0.2	3.6	<0.001	0.001	<0.001	0.056	<0.0001	0.001	0.005	0.001	0.006	0.023	0.002	0.006	<0.01	0.264	0.014	<0.05	<0.0001	0.2	0.01	<0.01	0.29	0.29	0.05	4.93	5.2	2.69
Site 10 Above Industrial Catchment Junction Rixs Creek	01-Jun-11	6.97	376	472	103	39	<1	<1	30	30	3.19	44	64	4	7	56	5	0.28	10	<0.001	0.001	<0.001	0.066	<0.0001	0.004	0.009	0.005	0.09	0.048	0.005	0.017	<0.01	0.198	0.046	<0.05	1E-05	0.3	0.03	<0.01	0.17	--	0.03	3.32	3.34	0.26
	06-Mar-12	7.87	451	400	23	72	<1	<1	66	66	7.55	46	73	9	12	66	4	1.14	5.27	<0.001	0.002	<0.001	0.06	<0.0001	0.001	0.005	0.002	0.007	0.027	0.003	0.008	<0.01	0.228	0.02	<0.05	<0.0001	0.3	<0.01	<0.01	<0.01	<0.01	0.1	4.34	4.41	0.82
	21-Nov-13	7.63	523	364	<5	45	<1	<1	55	55	13.4	75	69	5	8	78	6	0.67	3.57	<0.001	0.002	<0.001	0.041	<0.0001	0.001	0.006	0.002	0.009	0.028	0.003	0.006	<0.01	0.327	0.013	<0.05	<0.0001	0.4	0.01	<0.01	0.01	0.01	0.04			
	27-Apr-15	7.63	498	296	7	72	<1	<1	54	54	26	53	77	9	12	62	5	0.14	3.66	<0.001	0.002	<0.001	0.053	<0.0001	0.001	0.012	0.002	0.009	0.02	0.003	0.006	<0.01	0.265	0.018	<0.05	<0.0001	0.3	0.02	<0.01	0.33	0.33	0.07	4.35	4.26	1.1
Site 10 Industrial Catchment Tributary	01-Jun-11	6.97	335	516	69	45	<1	<1	28	28	4.52	24	63	8	6	47	4	0.21	16.3	<0.001	0.002	<0.001	0.107	0.0002	0.005	0.011	0.006	0.015	0.049	0.008	0.022	<0.01	0.137	0.057	<0.05	0.0001	0.2	0.03	<0.01	0.17	--	0.13	3.04	3.04	0.04
	06-Mar-12	7.75	551	496	39	100	<1	<1	72	72	8.74	28	125	17	14	82	4	0.95	1.68	<0.001	0.001	<0.001	0.076	<0.0001	<0.001	0.004	0.001	0.003	0.03	0.003	0.003	<0.01	0.247	0.015	<0.05	<0.0001	0.3	<0.01	<0.01	<0.01	<0.01	0.11	5.55	5.67	1.08
	21-Nov-13	7.68	425	347	<5	40	<1	<1	54	54	14.3	25	84	6	6	54	4	0.3	5.62	<0.001	0.002	<0.001	0.057	<0.0001	0.002	0.006	0.002	0.006	0.025	0.004	0.008	<0.01	0.18	0.02	<0.05	<0.0001	0.3	0.02	<0.01	0.01	0.01	0.04			
	27-Apr-15	7.66	666	373	<5	100	<1	<1	77	77	26.1	33	136	17	14	89	4	0.18	3.47	<0.001	0.001	<0.001	0.069	<0.0001	0.001	0.005	0.001	0.006	0.016	0.003	0.006	<0.01	0.253	0.017	<0.05	<0.0001	0.3	0.03	<0.01	0.07	0.07	0.04	6.06	5.97	0.74
Site 4 CWD 1	01-Jun-11	6.85	123	148	16	17	<1	<1	16	16	3.33	7	21	2	3	16	4	0.33	4.61	<0.001	<0.001	<0.001	0.047	<0.0001	0.002	0.004	0.002	0.004	0.046	0.002	0.008	<0.01	0.046	0.25	<0.05	0.001	0.2	0.05	<0.01	0.09	--	0.06	1.06	1.14	--
	06-Mar-12	7.39	168	219	16	35	<1	<1	50	50	7.29	3	24	4	6	23	4	1.17	1.66	<0.001	0.002	<0.001	0.042	<0.0001	<0.001	0.003	0.001	0.003	0.024	0.002	0.003	<0.01	0.073	0.013	<0.05	<0.0001	0.4	<0.01	<0.01	<0.01	<0.01	0.12	1.74	1.8	--
	21-Nov-13	7.06	133	138	30	13	<1	<1	22	22	7.54	14	15	2	2	14	4	0.44	2.99	<0.001	0.002	<0.001	0.05	<0.0001	0.001	0.003	0.002	0.004	0.05	0.002	0.005	<0.01	0.061	0.012	<0.05	<0.0001	0.2	0.15	<0.01	<0.01	<0.01	0.22			
	27-Apr-15	7.07	158	150	8	22	<1	<1	43	43	18.3	4	19	4	3	18	4	0.6	2.55	<0.001	0.002	<0.001	0.046	<0.0001	0.001	0.003	0.001	0.003	0.058	0.002	0.004	<0.01	0.054	0.011	<0.05	<0.0001	0.4	0.14	<0.01	0.03	0.03	0.09	1.48	1.33	--
Site 5 CWD2	01-Jun-11	6.81	134	147	73	17	<1	<1	23	23	2.71	6	22	2	3	18	4	0.34	4.75	<0.001	<0.001	>0.001	0.051	<0.0001	0.002	0.003	0.002	0.004	0.049	0.002	0.008	<0.01	0.053	0.017	<0.05	<0.0001	0.2	0.06	<0.01	0.08	--	0.02	1.21	1.23	--
	06-Mar-12	7.19	137	174	18	30	<1	<1	34	34	7.85	2	21	4	5	18	4	1.04	0.46	<0.001	0.001	<0.001	0.035	<0.0001	<0.001	0.003	<0.001	0.002	0.063	0.002	0.001	<0.01	0.063	0.009	<0.05	<0.0001	0.2	<0.01	<0.01	<0.01	<0.01	0.12	1.31	1.5	--
	21-Nov-13	7.14	184	158	15	17	<1	<1	35	35	5.32	16	23	2	3	21	6	0.58	2.41	<0.001	0.002	<0.001	0.049	<0.0001	0.001	0.003	0.002	0.004	0.044	0.002	0.004	<0.01	0.08	0.009	<0.05	<0.0001	0.2	0.02	<0.01	<0.01	<0.01	0.09			
	27-Apr-15		7.01	133	154	6	22	<1	<1	32	32	16.8	3	17	4	3	16	5	0.78	3.06	<0.001	0.001	<0.001	0.047	<0.0001	0.001	0.008	0.002	0.004	0.065	0.002	0.005	<0.01	0.051	0.019	<0.05	<0.0001	0.2	0.16	<0.01	0.04	0.04	0.09	1.18	1.27
Site 6 CWD 6	01-Jun-11	7.7	170	126	10	30	<1	<1	46	46	2.65	13	12	4	5	23	3	0.26	1.43	<0.001	<0.001	<0.001	0.041	<0.0001	<0.001	0.001	<0.001	0.002	0.017	<0.001	0.002	<0.01	0.075	0.008	<0.05	<0.0001	0.5	0.03	<0.01	<0.01	--	0.04	1.53	1.69	--
	06-Mar-12	7.44	140	280	20	33	<1	<1	50	50	10.2	14	14	5	5	18	4	0.97	7.85	<0.001	0.003	<0.001	0.056	<0.0001	0.002	0.006	0.003	0.006	0.05	0.003	0.012	<0.01	0.075	0.015	<0.05	<0.0001	0.3	<0.01	<0.01	<0.01	<0.01	0.13	1.69	1.55	--
	21-Nov-13	7.49	253	237	<5	33	<1	<1	37	37	12.3	46	23	5	5	29	4	0.74	3.97	<0.001	0.004	<0.001	0.061	0.0002	0.002	0.004	0.002	0.004	0.083	0.003	0.006	<0.01	0.123	0.011	<0.05	<0.0001	0.4	0.01	<0.01	<0.01	<0.01	0.04			
	27-Apr-15		7.32	154	171	18	29	<1	<1	32	32	26.4	21	14	5	4	18	3	0.6	3.62	<0.001	0.003	<0.001	0.042	<0.0001	0.001	0.004	0.001	0.004	0.036	0.002	0.006	<0.01	0.067	0.01	<0.05	<0.0001	0.2	0.03	<0.01	0.05	0.05	0.13	1.47	1.44

Details	Date	Basic Analytes				Alkalinity					Major Anions			Major Cations					Total Metals																						Nutrients						Ionic Balance		
		pH	Electrical Conductivity - uS/cm	Total Dissolved Solids	Total Suspended Solids	Total Hardness as CaCO3	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Silicon	Sulphate as SO4	Chloride	Calcium	Magnesium	Sodium	Potassium	Dissolved Metals - Fe	Aluminium	Antimony	Arsenic	Beryllium	Barium	Cadmium	Cobalt	Copper	Lead	Lithium	Manganese	Nickel	Rubidium	Selenium	Strontium	Zinc	Boron	Mercury	Fluoride	Ammonia as N	Nitrate as N	Nitrate as N	Nitrite + Nitrate as N	Total Phosphorus	Total Anions	Total Cations	Ionic Balance
Limit of Resolution		0.01	1	10	5	1	1	1	1	1	0.05	1	1	1	1	1	1	0.5	0.01	0.001	0.001	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.01	0.001	0.005	0.05	0.0001	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Unit		pH unit	uS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	%
Site 7 Dirty Water Dam 1	01-Jun-11	8.68	3470	2130	34	464	<1	10	196	207	1.33	585	622	44	86	616	10	<0.05	0.48	0.001	0.003	<0.001	0.045	<0.0001	0.002	0.003	<0.001	0.064	0.016	0.004	0.009	0.02	4.77	0.008	<0.05	<0.0001	0.5	0.19	0.18	3.07	--	0.23	33.9	36.3	3.48
	06-Mar-12	8.39	3580	2230	<5	535	<1	33	239	272	0.53	681	721	46	102	751	12	<0.05	0.03	0.003	0.003	<0.001	0.038	<0.0001	<0.001	<0.001	<0.001	0.072	0.004	0.002	0.01	0.02	3.95	<0.005	<0.05	<0.0001	0.6	0.07	0.08	4.54	4.62	0.58	40	43.7	4.41
	21-Nov-13	8.76	3860	2240	<5	479	<1	39	174	214	1.7	732	658	37	94	710	12	<0.05	0.12	0.004	0.006	<0.001	0.034	0.0001	<0.001	0.001	<0.001	0.072	0.007	0.003	0.01	0.02	4.07	<0.005	<0.05	<0.0001	0.4	0.62	0.08	2.72	2.8	0.01			
	27-Apr-15	8.3	1990	948	16	296	<1	<1	150	150	6.3	328	335	31	53	323	7	<0.05	0.71	0.001	0.002	<0.001	0.04	<0.0001	0.001	0.003	<0.001	0.032	0.011	0.002	0.006	<0.01	2.21	0.005	<0.05	<0.0001	0.3	0.27	0.1	1.39	1.49	0.06	19.3	20.1	2.16
Site 9 Dirty Water Dam 2	01-Jun-11	8.59	4620	2660	8	586	<1	32	242	274	1.51	751	771	50	112	784	12	<0.05	0.48	0.003	0.002	<0.001	0.038	<0.0001	<0.001	0.003	<0.001	0.086	0.004	0.004	0.011	0.02	5.97	<0.005	<0.05	<0.0001	0.5	0.05	0.03	3.29	--	<0.01	42.9	46.1	3.64
	06-Mar-12	8.52	3610	2270	8	540	<1	44	235	279	2.15	682	742	48	102	766	12	<0.05	0.28	0.003	0.003	<0.001	0.043	<0.0001	<0.001	0.001	<0.001	0.066	0.006	0.003	0.01	0.02	4	<0.005	<0.05	<0.0001	0.6	0.04	0.05	4.07	4.12	0.02	40.7	44.4	4.33
	21-Nov-13	8.96	4340	2390	<5	490	<1	59	137	196	1.84	820	752	28	102	831	14	<0.05	0.25	0.005	0.003	<0.001	0.03	0.0002	<0.001	0.004	<0.001	0.084	0.006	0.003	0.01	0.03	3.07	<0.005	<0.05	<0.0001	0.4	0.02	0.01	1.29	1.3	<0.01			
	27-Apr-15	8.83	2780	1430	8	343	<1	35	153	188	4.6	436	516	22	70	454	8	<0.05	0.33	0.001	0.002	<0.001	0.036	<0.0001	<0.001	0.002	<0.001	0.041	0.008	0.001	0.004	<0.01	1.56	<0.005	<0.05	<0.0001	0.4	0.07	0.02	0.45	0.47	<0.01	27.4	26.8	1.09
Site 8 Dirty Water Dam 4 was Clean Water Dam 4	01-Jun-11	8.82	3920	2400	16	522	<1	33	222	255	0.96	671	683	36	105	707	12	<0.05	0.7	<0.001	0.002	<0.001	0.051	<0.0001	<0.001	0.003	<0.001	0.075	0.018	0.003	0.009	0.01	3.14	0.007	<0.05	<0.0001	0.5	0.11	0.06	1.22	--	0.01	38.3	41.5	3.94
	06-Mar-12	8.6	2990	1810	7	437	<1	34	207	242	1.8	507	614	38	83	612	10	0.07	0.36	0.002	0.002	<0.001	0.052	<0.0001	<0.001	<0.001	<0.001	0.048	0.01	0.001	0.007	<0.01	2.59	<0.005	<0.05	<0.0001	0.5	0.14	0.08	1.2	1.28	0.65	32.7	35.6	4.21
	21-Nov-13	8.62	3670	2020	<5	464	<1	28	194	222	2.09	681	631	29	95	672	13	<0.05	0.21	0.003	0.004	<0.001	0.033	0.0001	<0.001	0.003	<0.001	0.064	0.014	0.003	0.008	0.01	2.45	<0.005	<0.05	<0.0001	0.4	0.14	0.04	0.96	1	0.02			
	27-Apr-15	8.49	2090	1010	11	277	<1	10	147	158	6.4	321	370	22	54	350	7	<0.05	0.62	0.001	0.002	<0.001	0.035	<0.0001	<0.001	0.002	<0.001	0.032	0.008	0.002	0.004	<0.01	1.55	<0.005	<0.05	<0.0001	0.3	<0.01	0.05	0.1	0.15	0.06	20.3	20.9	1.59
Site 14 Sediment Dam Pit 3 EAST	01-Jun-11	7.96	308	176	15	39	<1	<1	81	81	1.42	9	34	4	7	42	9	0.09	1.33	<0.001	0.003	<0.001	0.059	<0.0001	<0.001	0.001	<0.001	0.002	0.024	0.001	0.003	<0.01	0.138	<0.005	<0.05	<0.0001	0.6	0.2	<0.01	0.12	--	0.06	2.76	2.83	--
	06-Mar-12	8.14	381	271	10	63	<1	<1	81	81	4.9	26	53	7	11	52	10	0.66	1.31	<0.001	0.002	<0.001	0.045	<0.0001	<0.001	0.002	<0.001	0.002	0.034	0.002	0.003	<0.01	0.161	0.01	<0.05	<0.0001	0.4	<0.01	<0.01	<0.01	<0.01	0.1	3.65	3.77	1.56
	21-Nov-13	8.25	491	297	<5	50	<1	<1	102	102	3.75	30	66	5	9	63	11	0.84	0.92	<0.001	0.004	<0.001	0.063	<0.0001	<0.001	0.002	<0.001	0.002	0.08	0.002	0.002	<0.01	0.213	<0.005	<0.05	<0.0001	0.5	0.07	<0.01	<0.01	<0.01	0.09			
	27-Apr-15	7.61	352	220	<5	54	<1	<1	85	85	11.5	15	47	7	9	49	10	0.16	1.69	<0.001	0.002	<0.001	0.049	<0.0001	<0.001	0.003	<0.001	0.002	0.051	0.002	0.004	<0.01	0.132	0.007	<0.05	<0.0001	0.5	0.18	<0.01	0.08	0.08	0.29	3.34	3.48	2.04
Site 13 Sediment Dam Pit 3 WEST	01-Jun-11	7.99	411	298	8	61	<1	<1	124	124	2.61	9	40	8	10	50	11	0.44	3.45	<0.001	0.004	<0.001	0.086	<0.0001	0.001	0.002	0.002	0.003	0.064	0.002	0.005	<0.01	0.264	0.006	<0.05	<0.0001	0.8	0.83	<0.01	0.05	--	0.09	3.79	3.68	1.56
	06-Mar-12	8	256	266	20	44	<1	<1	74	74	6.12	4	32	6	7	33	10	0.85	2.63	<0.001	0.003	<0.001	0.035	<0.0001	<0.001	0.003	0.001	0.002	0.053	0.002	0.004	<0.01	0.121	0.006	<0.05	<0.0001	0.5	<0.01	<0.01	<0.01	<0.01	0.42	2.46	2.57	--
	21-Nov-13	8.12	356	305	12	44	<1	<1	100	100	12	18	38	6	7	43	13	0.34	4.31	<0.001	0.005	<0.001	0.048	<0.0001	0.002	0.005	0.002	0.003	0.095	0.004	0.006	<0.01	0.179	0.009	0.06	<0.0001	0.7	0.03	<0.01	<0.01	<0.01	0.2			
	27-Apr-15	7.41	230	703	212	36	<1	<1	62	62	114	27	26	6	5	29	10	1.23	27.7	<0.001	0.006	<0.001	0.15	<0.0001	0.009	0.018	0.014	0.02	0.158	0.013	0.037	<0.01	0.157	0.07	<0.05	<0.0001	0.4	0.08	0.02	0.21	0.23	0.78	2.53	2.23	--
Site 16 Rail Loader Dam	01-Jun-11	7.94	1140	764	75	158	<1	<1	96	96	1.12	238	136	17	28	190	3	0.21	5.5	<0.001	0.003	<0.001	0.063	<0.0001	0.003	0.006	0.004	0.008	0.056	0.003	0.011	<0.01	0.558	0.048	<0.05	<0.0001	0.5	0.09	<0.01	0.06	--	0.18	11.5	11.5	0.07
	06-Mar-12	8.17	1210	711	9	215	<1	<1	141	141	0.78	249	160	30	34	214	4	0.12	0.44	<0.001	0.001	<0.001	0.028	<0.0001	<0.001	<0.001	<0.001	0.007	0.051	<0.001	0.002	<0.01	0.834	<0.005	<0.05	<0.0001	0.6	<0.01	<0.01	<0.01	<0.01	0.62	12.5	13.7	4.52
	21-Nov-13	7.94	1370	771	5	231	<1	<1	156	156	2.39	282	157	33	36	211	7	0.1	1.04	<0.001	0.003	<0.001	0.106	<0.0001	<0.001	0.002	<0.001	0.006	0.06	0.001	0.003	<0.01	1.07	0.011	0.07	<0.0001	0.5	0.07	<0.01	0.12	0.12	0.04			
	27-Apr-15	7.47	624	344	56	108	<1	<1	70	70	29.5	125	67	17	16	81	3	0.05	5.89	<0.001	0.003	<0.001	0.055	<0.0001	0.003	0.005	0.003	0.008	0.08	0.004	0.011	<0.01	0.442	0.023	<0.05	<0.0001	0.3	0.14	<0.01	0.11	0.11	0.07	5.89	5.76	1.1
Site 16 Dirty Water Dam 3	01-Jun-11	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	06-Mar-12	8.38	1250	745	12	260	<1	<1	87	87	2.61	352	145	30	45	203	4	<0.05	0.4	<0.001	<0.001	<0.001	0.056	<0.0001	<0.001	0.001	<0.001	0.025	0.014	0.002	0.002	<0.01	0.854	<0.005	<0.05	<0.0001	0.5	<0.01	0.02	0.17	0.19	0.02	13.2	14.1	3.55
	21-Nov-13	8.31	1700	906	23	166	<1	<1	137	137	4.69	283	266	12	33	310	5	<0.05	1.7	0.002	0.002	<0.001	0.035	<0.0001	0.002	0.004	0.001	0.036	0.011	0.003	0.008	0.02	1.63	0.007	<0.05	<0.0001	0.8	0.21	0.05	2.22	2.27	0.04			
	27-Apr-15	8.47	2800	1450	9	384	<1	14	228	242	6.4	432	450	45	66	526	7	<0.05	0.38	0.007	0.004	<0.001	0.044	<0.0001	0.002	0.002	<0.001	0.058	0.009	0.003	0.01	0.03	5.57	<0.005	<0.05	<0.0001	0.5	2.58	0.6	24.9	25.5	<0.01	28.3	4.41	--
Site 25 Dead Man's Gully	21-Nov-13	6.8	145	272	22	13	<1	<1	11	11	21.8	13	27	2	2	15	6	0.83	9.74	<0.001	0.004	<0.001	0.09	<0.0001	0.003	0.007	0.006	0.006	0.05	0.004	0.013	0.01	0.052	0.029	<0.05	<0.0001	0.2	0.01	0.01	0.51	0.52	0.18			
	27-Apr-15	6.83	111	178	18	22	<1	<1	12	12	26.5	6	19	4	3	17	5	0.82	4.32	<0.001	0.002	<0.001	0.054	<0.0001	0.001	0.005	0.002	0.004	0.039	0.003	0.006	<0.01	0.037	0.015	<0.05	<0.0001	0.2	0.02	<0.01	0.03	0.03	0.12	0.9	1.31	--

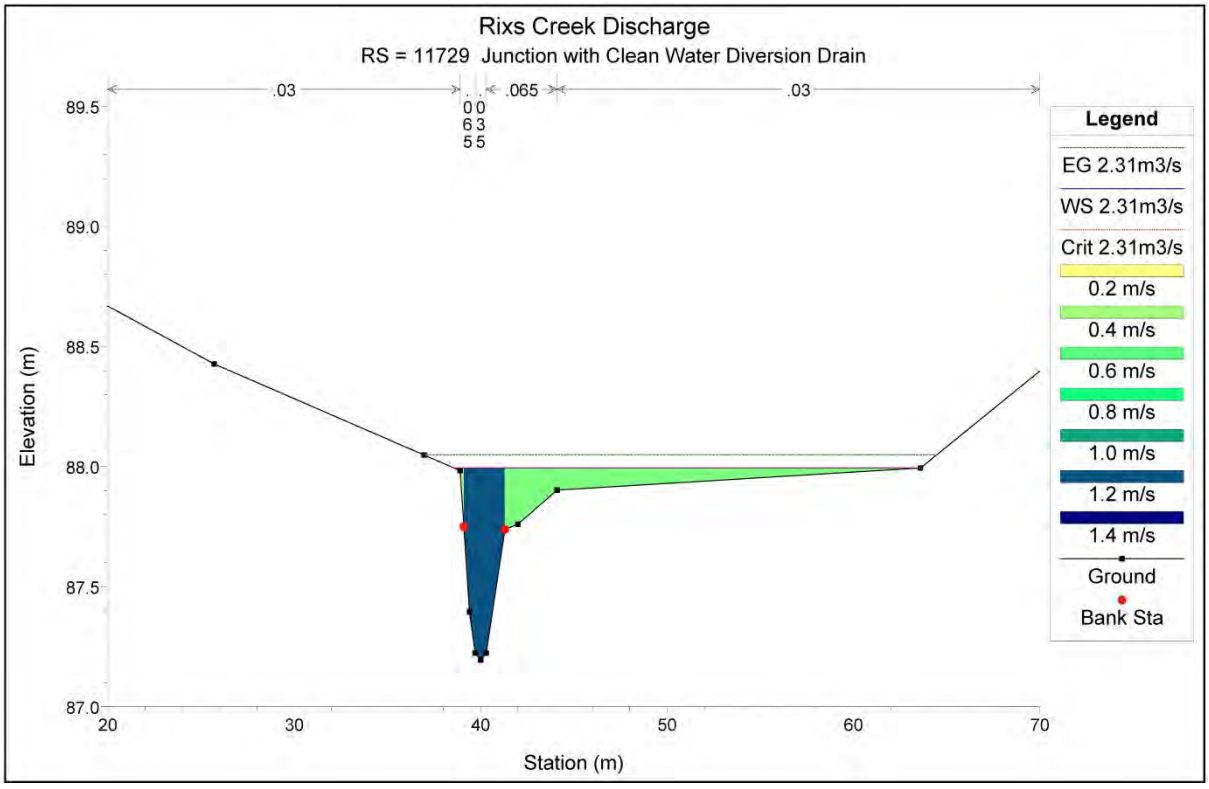
Appendix C: Reference Cross Sections for Rixs Creek



Surveyed Cross Section Chainage 11884 : Flow 200ML/day

Chainage 11870 Looking Upstream

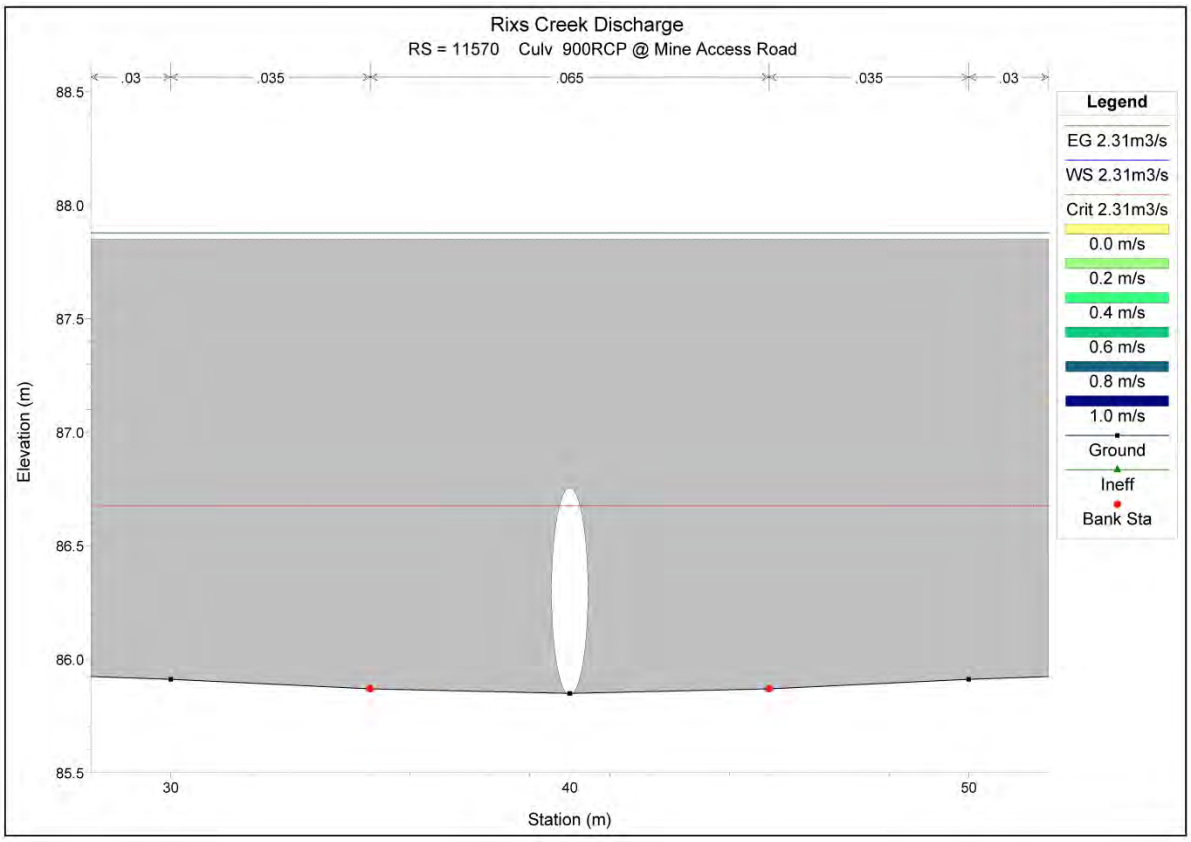
Figure 11: Cross Section Chainage 11884



Surveyed Cross Section Chainage 11729 : Flow 200ML/day

Chainage 11729 Looking Upstream

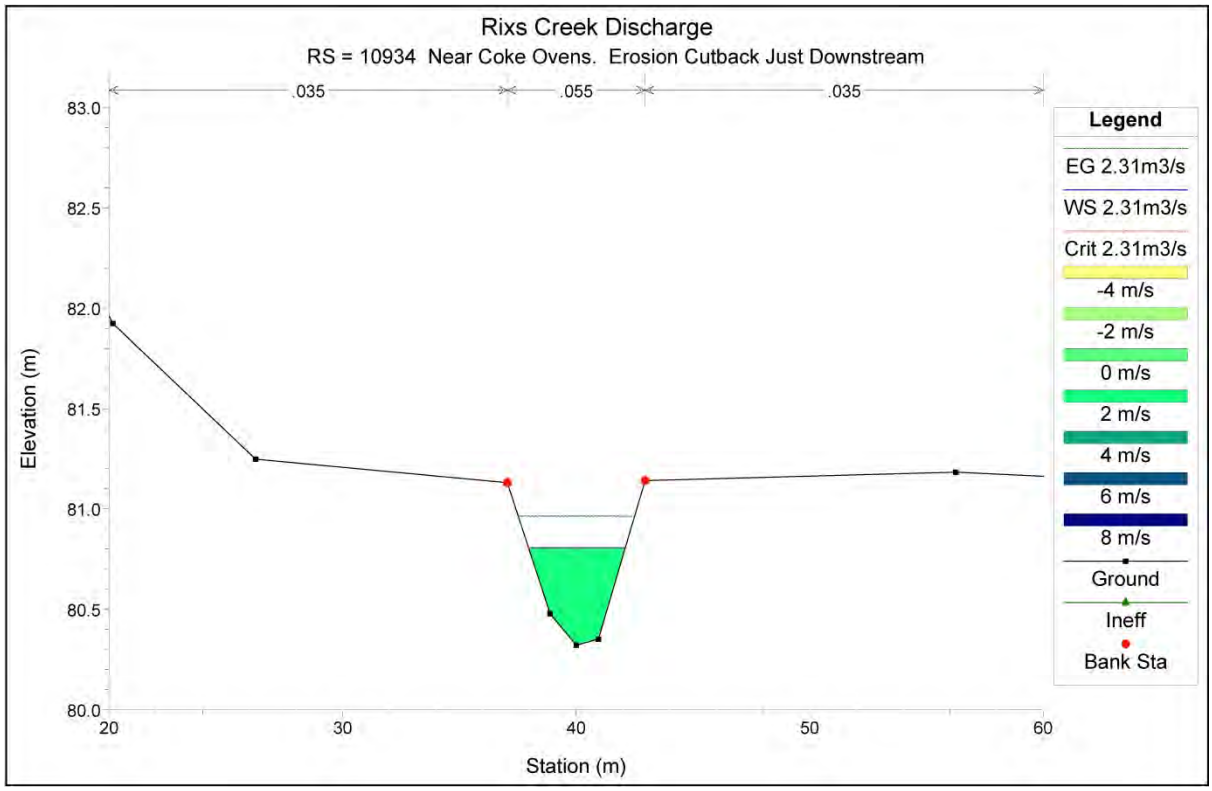
Figure 12: Cross Section Chainage 11729



Surveyed Cross Section Chainage 11570 : Flow 200ML/day

Chainage 11565 Scour Downstream of 900RCP Culvert

Figure 13: Cross Section Chainage 11570



Surveyed Cross Section Chainage 10934 : Flow 200ML/day

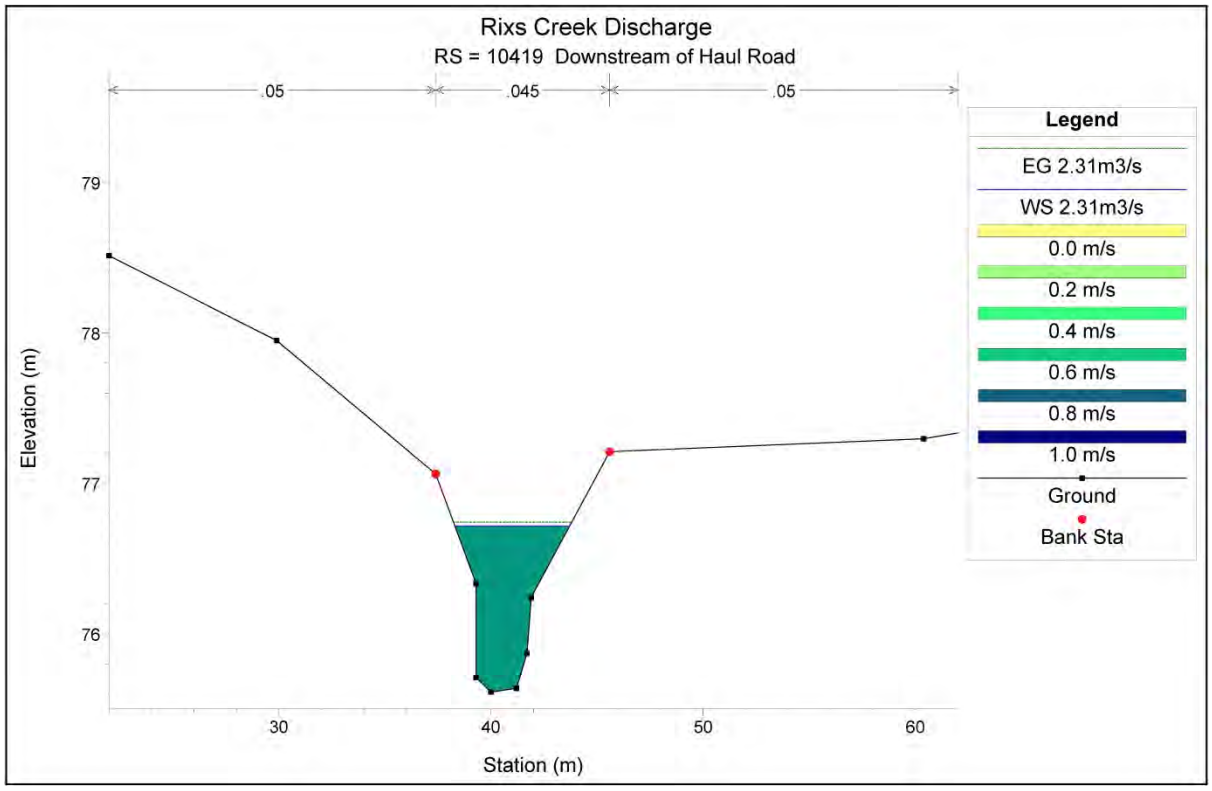
Chainage 10934: Near the Abandoned Coke Ovens - Looking Upstream

Figure 14: Cross Section Chainage 10934

Chainage 10934 : Cut Back Erosion

Chainage 10934 : Regrowth at Coke Ovens

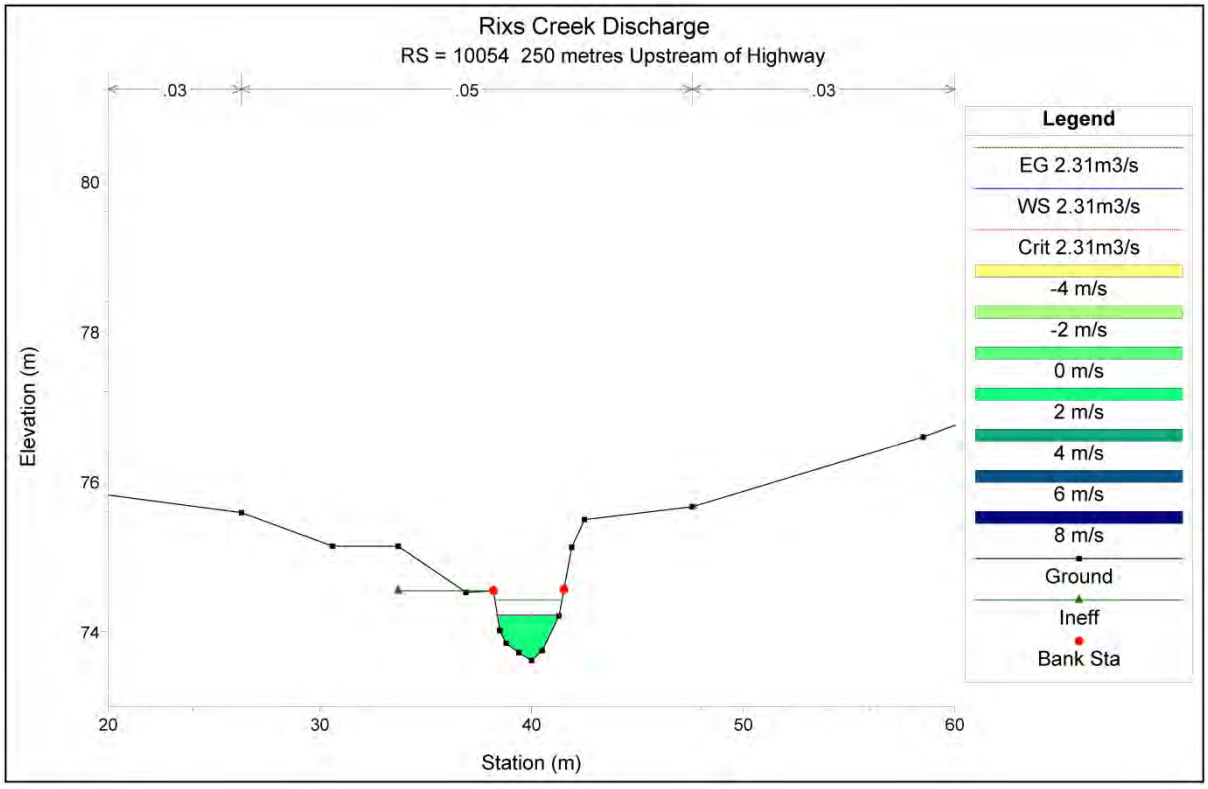
Figure 15: Features at Chainage 10934



Surveyed Cross Section Chainage 10419 : Flow 200ML/day

Chainage 10419 Looking Downstream. Undercutting on Left Bank

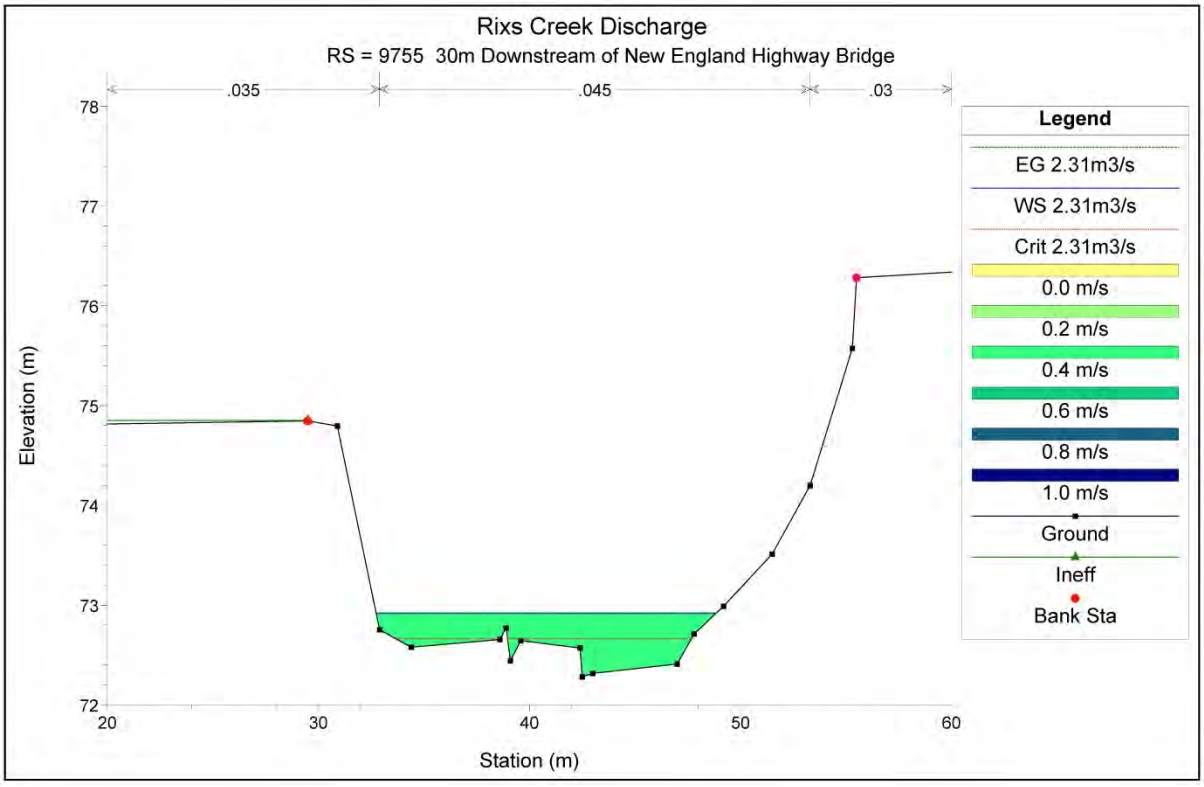
Figure 16: Cross Section Chainage 10419



Surveyed Cross Section Chainage 10054 : Flow 200ML/day

Chainage 10054 Looking Downstream

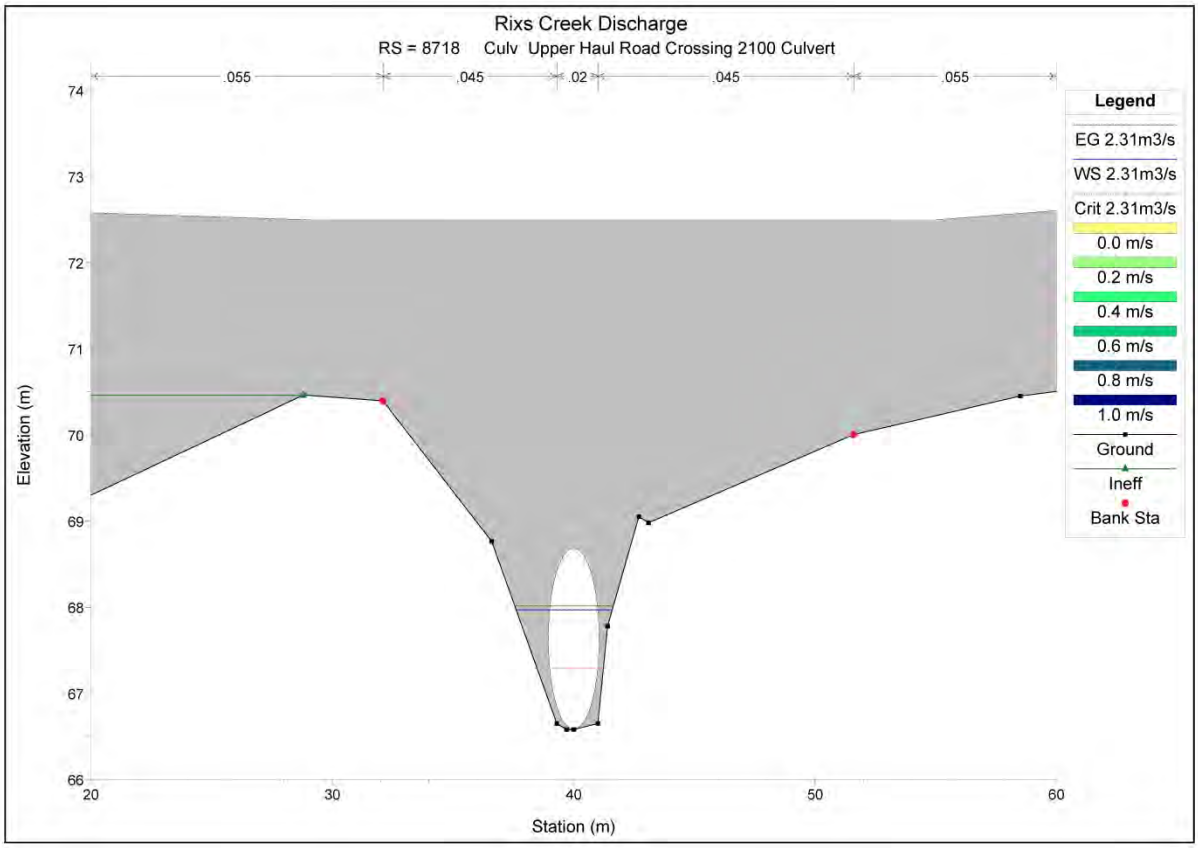
Figure 17: Cross Section Chainage 10054



Surveyed Cross Section Chainage 9755 : Flow 200ML/day

Chainage 9755 : Looking Upstream

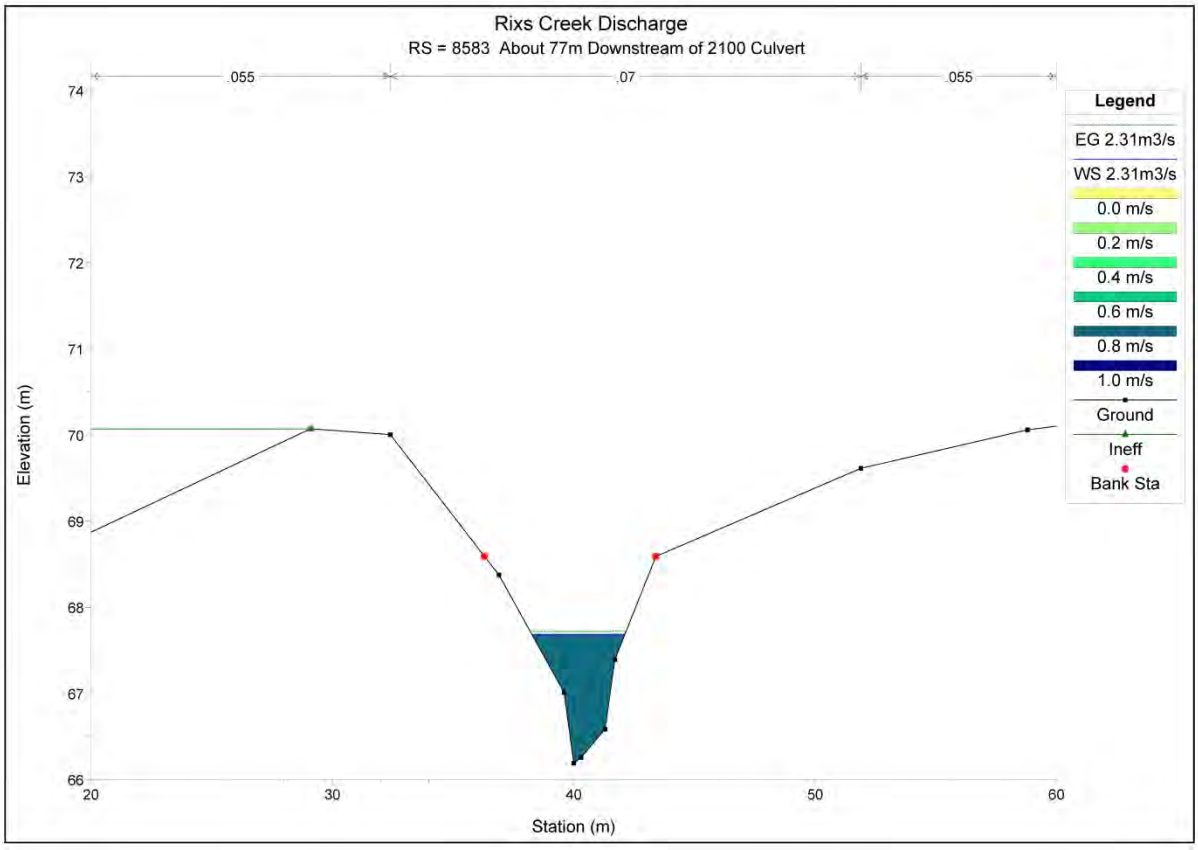
Figure 18: Cross Section Chainage 9755



Culvert Chainage 8718 : 200ML/day

Culvert Outlet Chainage 8652 : Looking Upstream

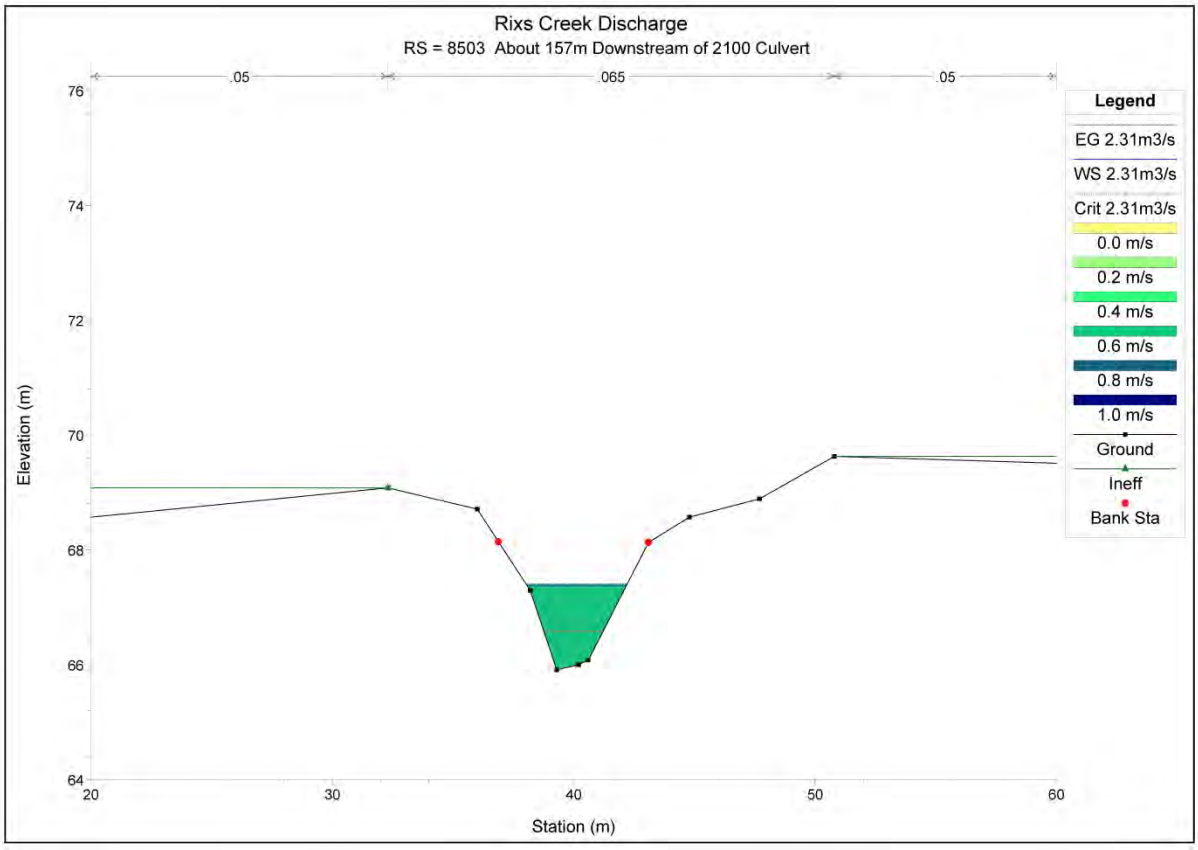
Figure 19: Cross Section Chainage 8718



Surveyed Cross Section Chainage 8583 : Flow 200ML/day

Chainage 8583 Looking Upstream

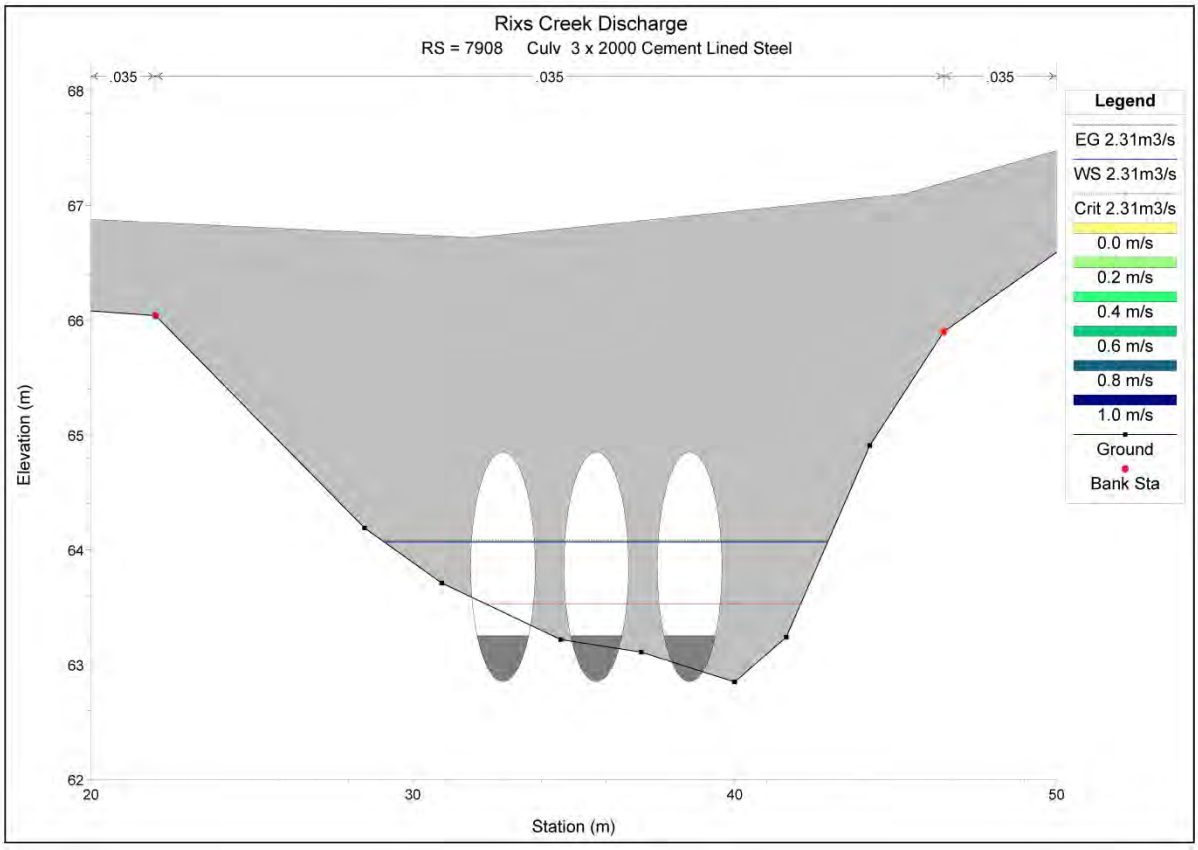
Figure 20: Cross Section Chainage 8583



Surveyed Cross Section Chainage 8503 : Flow 200ML/day

Chainage 8503 : Looking Downstream

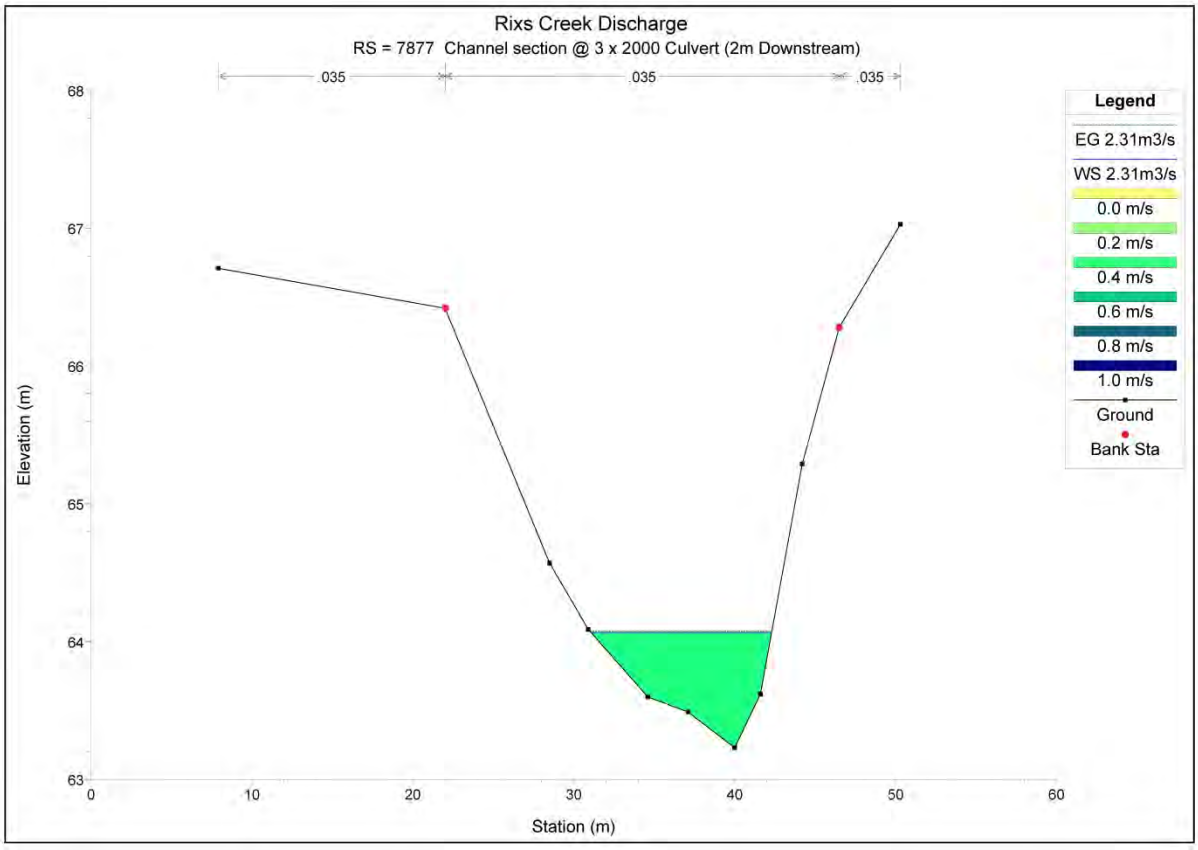
Figure 21: Cross Section Chainage 8503



Culvert Chainage 7908 : Flow 200ML/day

Culvert inlet Chainage 7908 : Looking Downstream

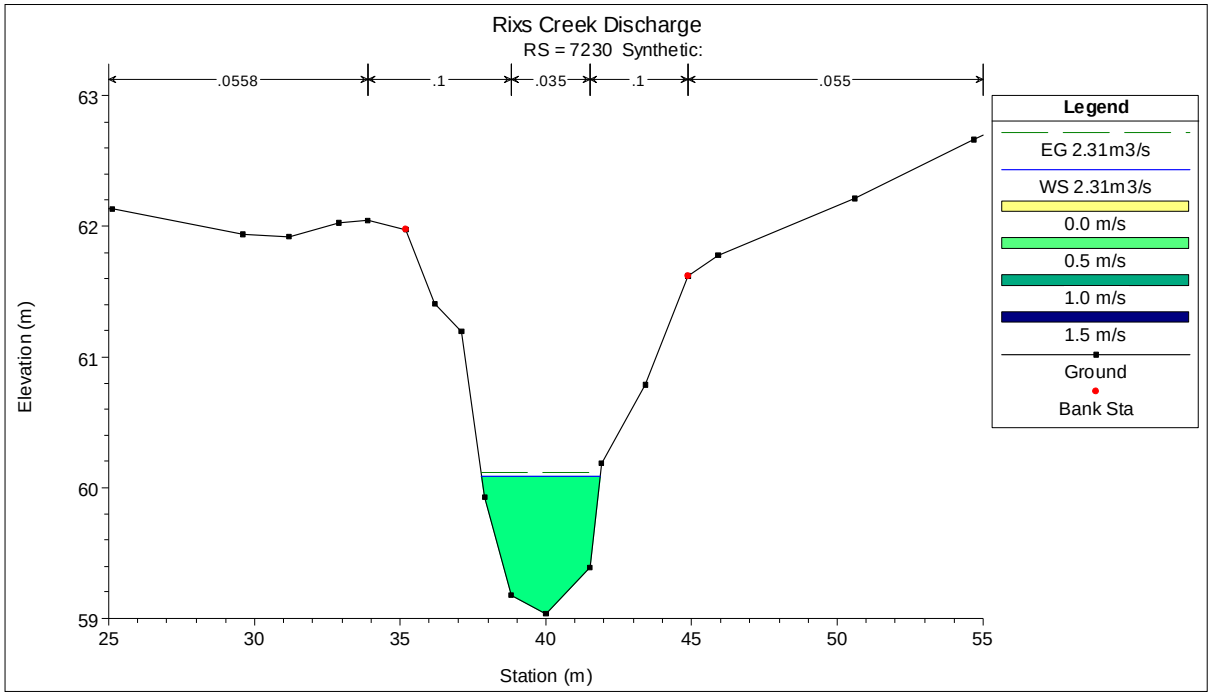
Figure 22: Cross Section Chainage 7908



Surveyed Cross Section Chainage 7877 : Flow 200ML/day

Culvert Outlet : Chainage 7877

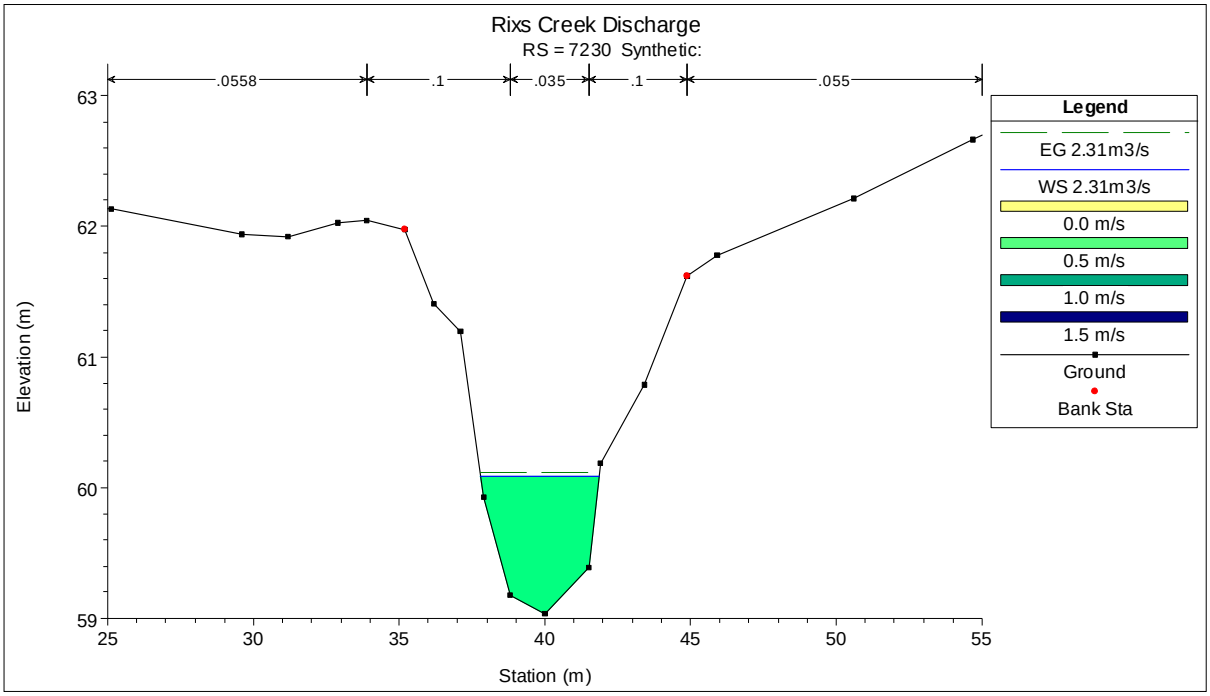
Figure 23: Cross Section Chainage 7877



Surveyed Cross Section Chainage 7498 : Flow 200ML/day

Chainage 7498 Looking Downstream : Note Sheet Rock Creek Bed extends upstream to Ch. 7600

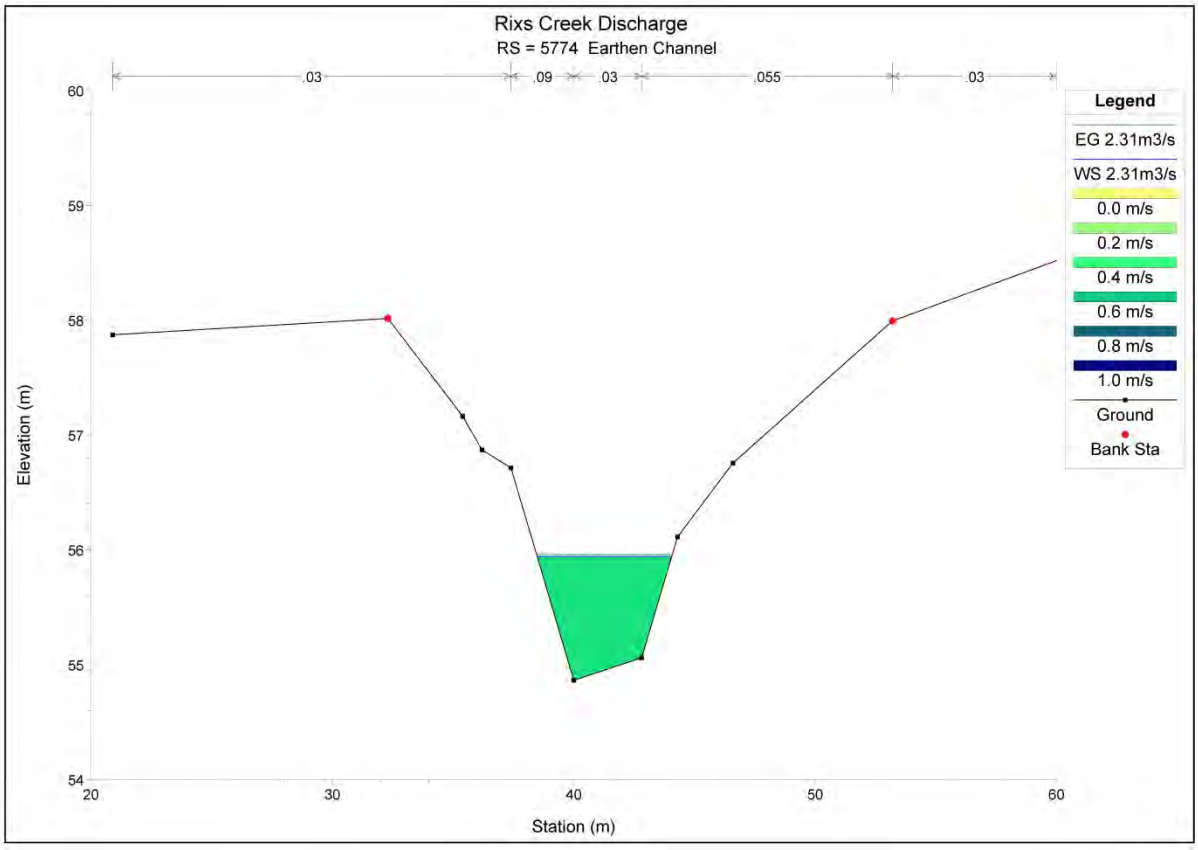
Figure 24: Cross Section Chainage 7498



Surveyed Cross Section Chainage 7230 : Flow 200ML/day

Chainage 7246 “Below Operations”: Looking Upstream from a Rock Shelf. The Sheet Rock Creek Bed Extends Upstream from the Shelf to about Chainage 7600.

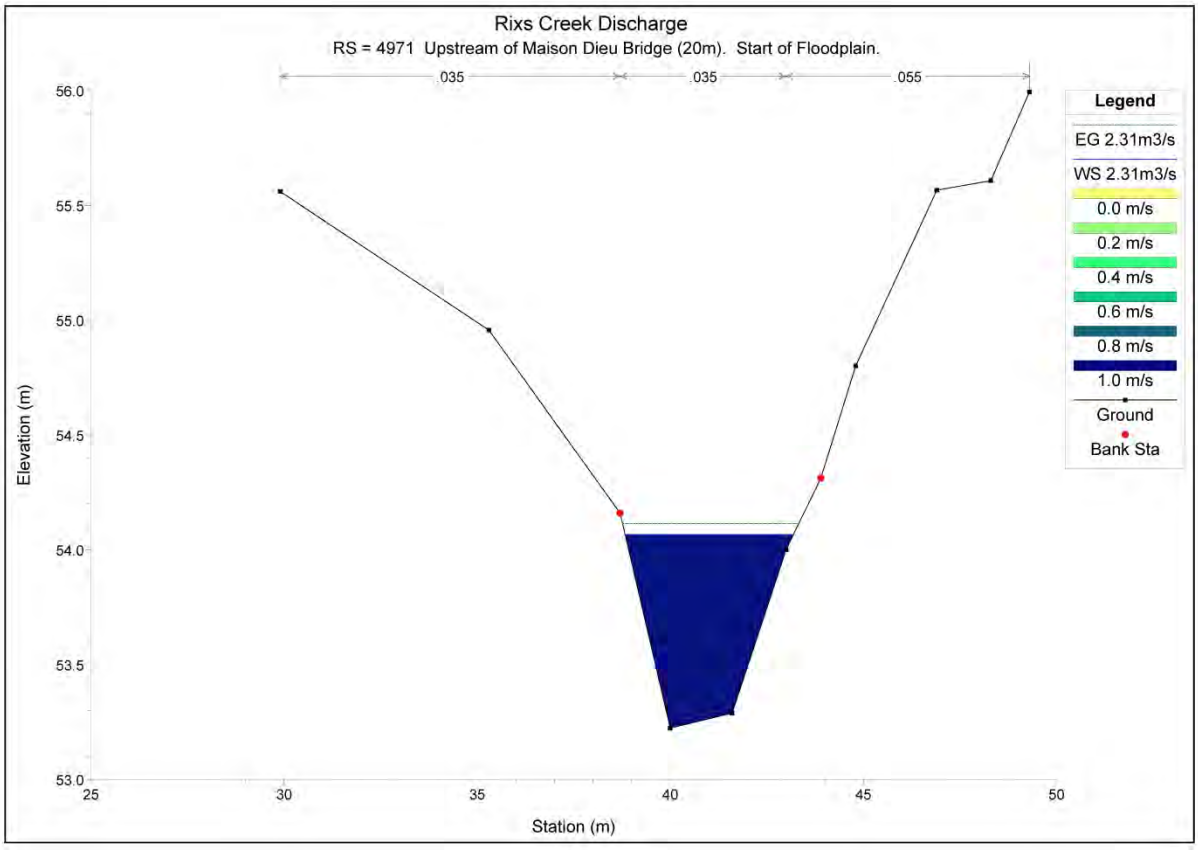
Figure 25: Cross Section Chainage 7230



Surveyed Cross Section Chainage 5774: Flow 200ML/day

Chainage 5774 : Looking Upstream

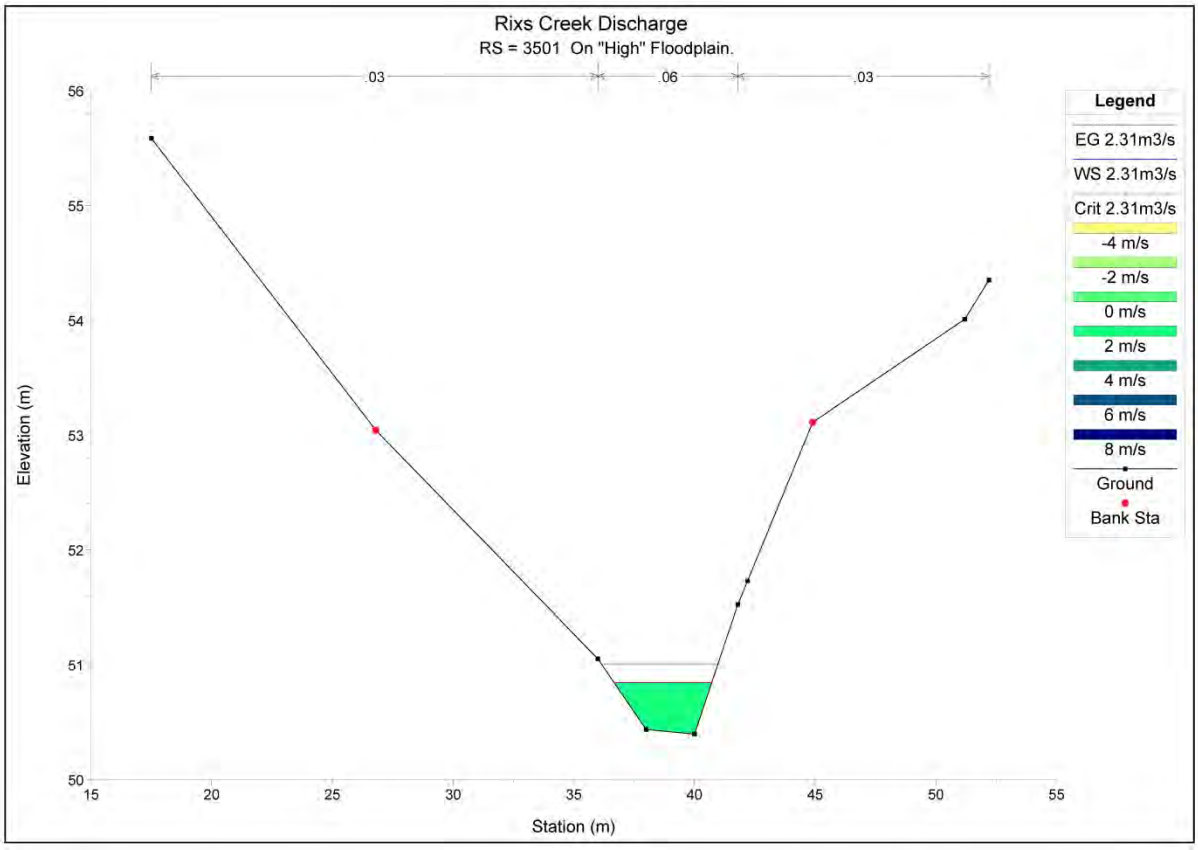
Figure 26: Cross Section Chainage 5774



Surveyed Cross Section Chainage 4971 : Flow 200ML/day

Chainage 4971 : Looking from Right Bank

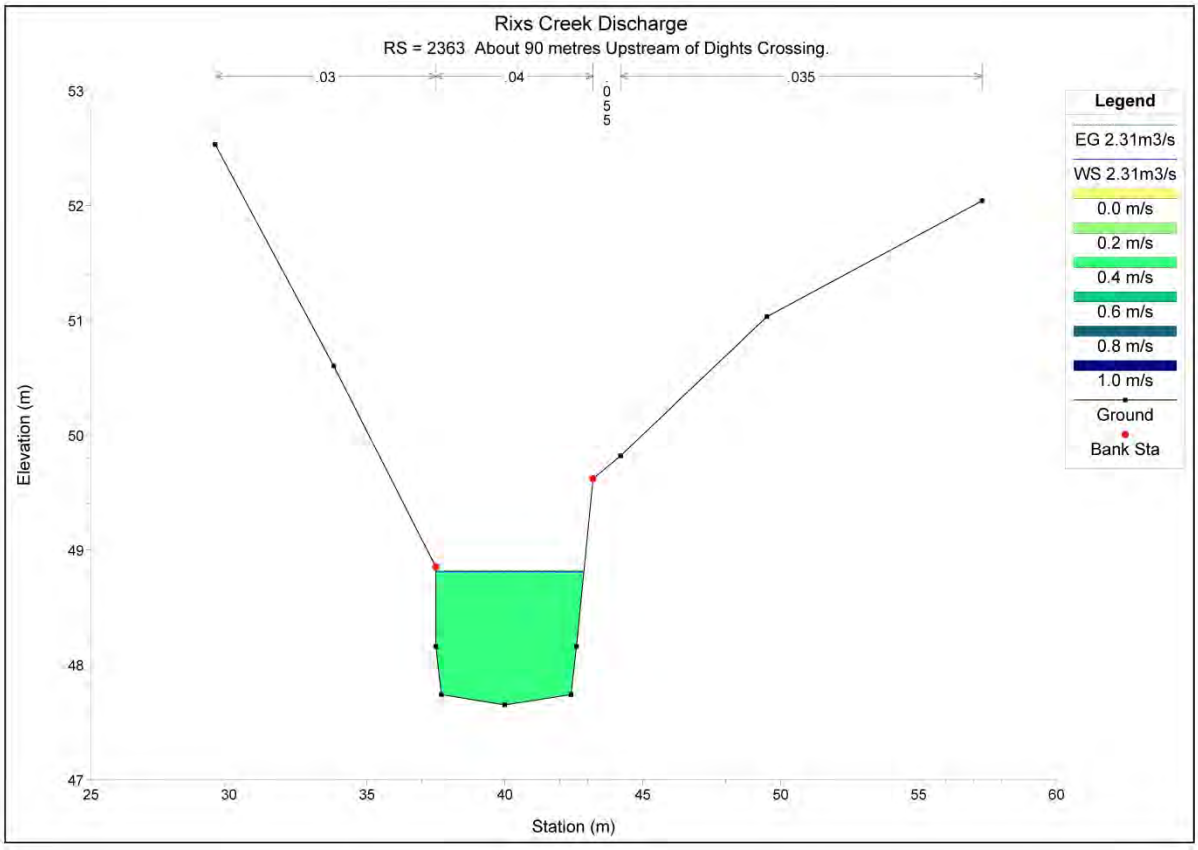
Figure 27: Cross Section Chainage 4971



Surveyed Cross Section Chainage 3501 : Flow 200ML/day

Chainage 3501 : Looking from Right Bank

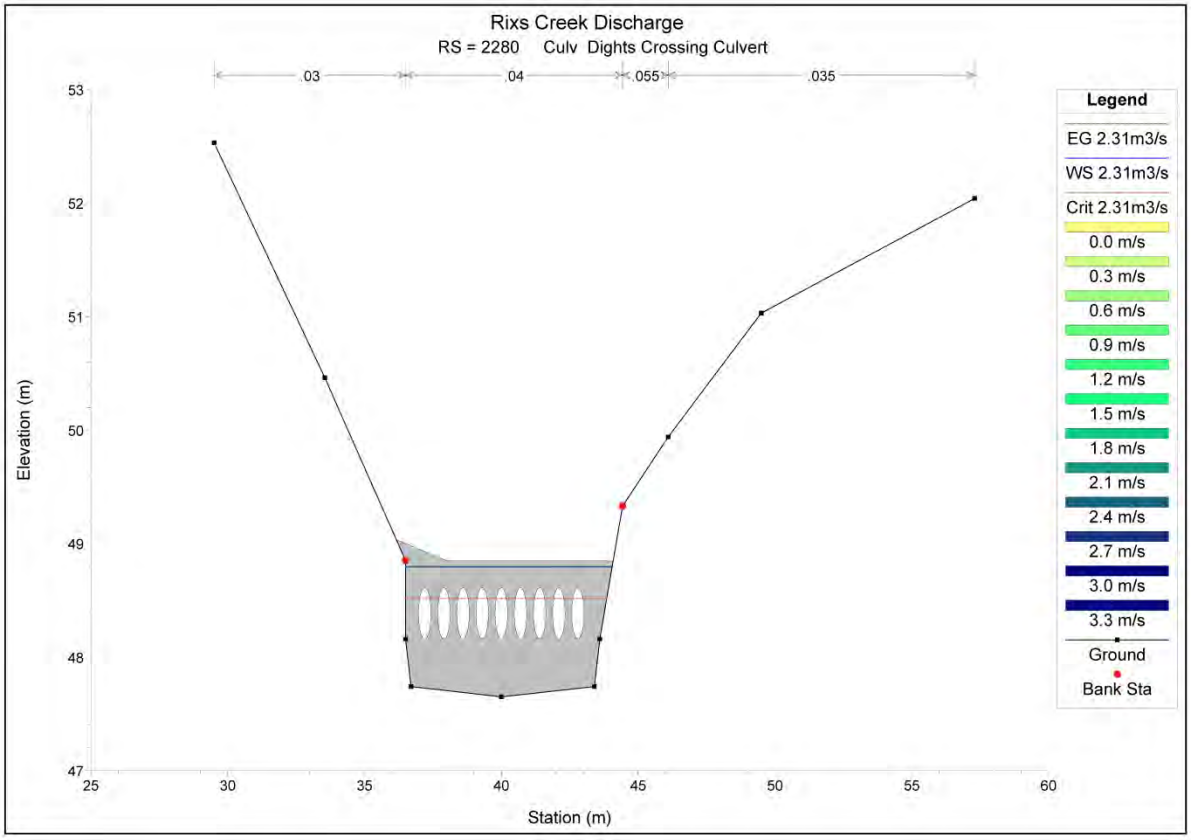
Figure 28: Cross Section Chainage 3501



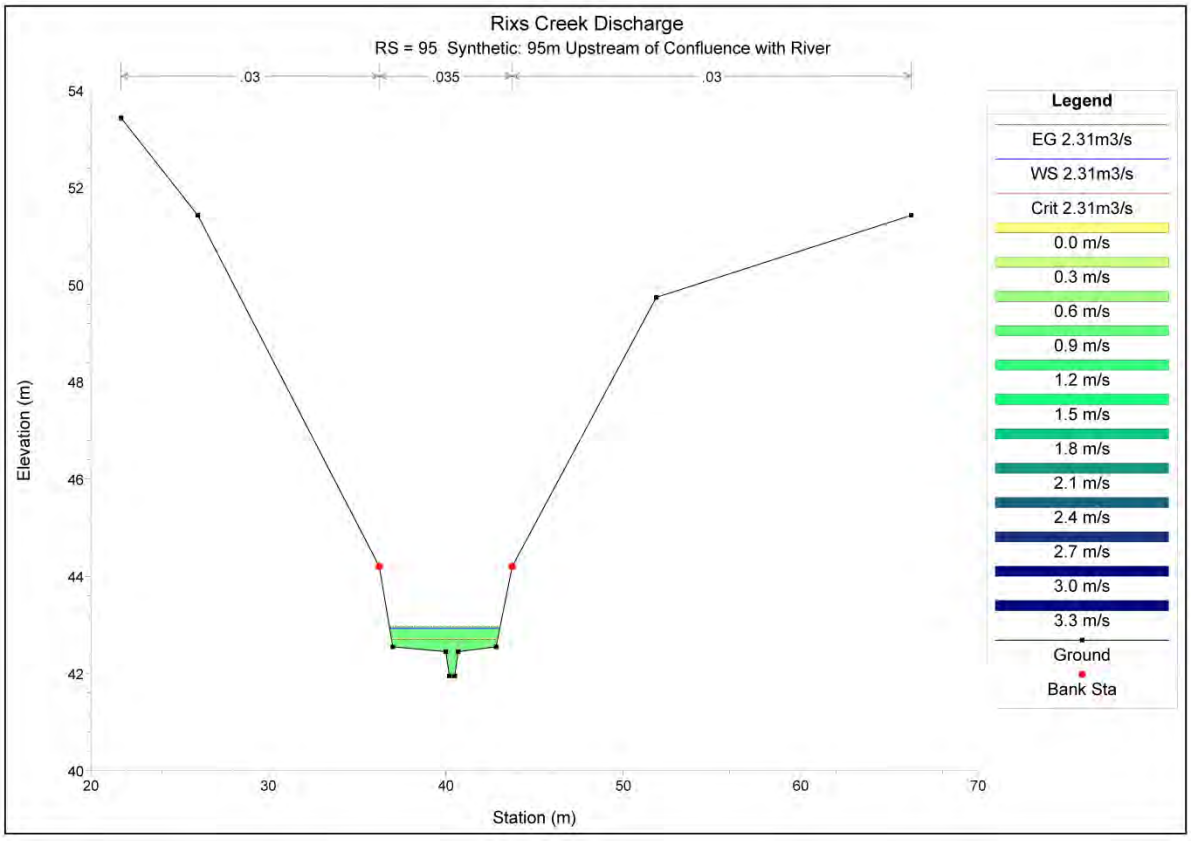
Surveyed Cross Section Chainage 2363 : Flow 200ML/day

Chainage 2363 Looking Downstream :

Figure 29: Cross Section Chainage 2363



Culvert Chainage 2280 : Flow 200ML/day



Cross Section Chainage 95 : Flow 200ML/day

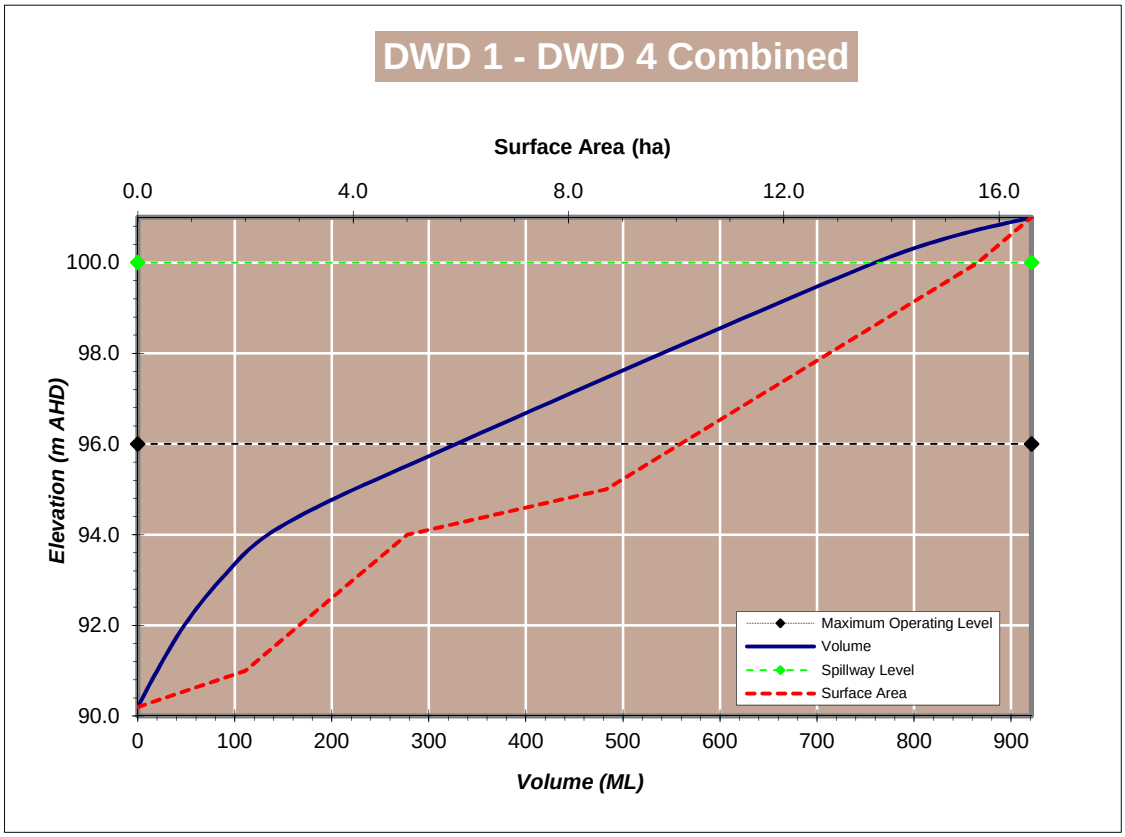
Figure 30: Culvert Chainage 2280

Appendix D: Dam Stage-Storage-Area Curves

Storage Characteristics
Name: DWD 1 - DWD 4 Combined
Period: 2014 - 2041

Source: Site Contours

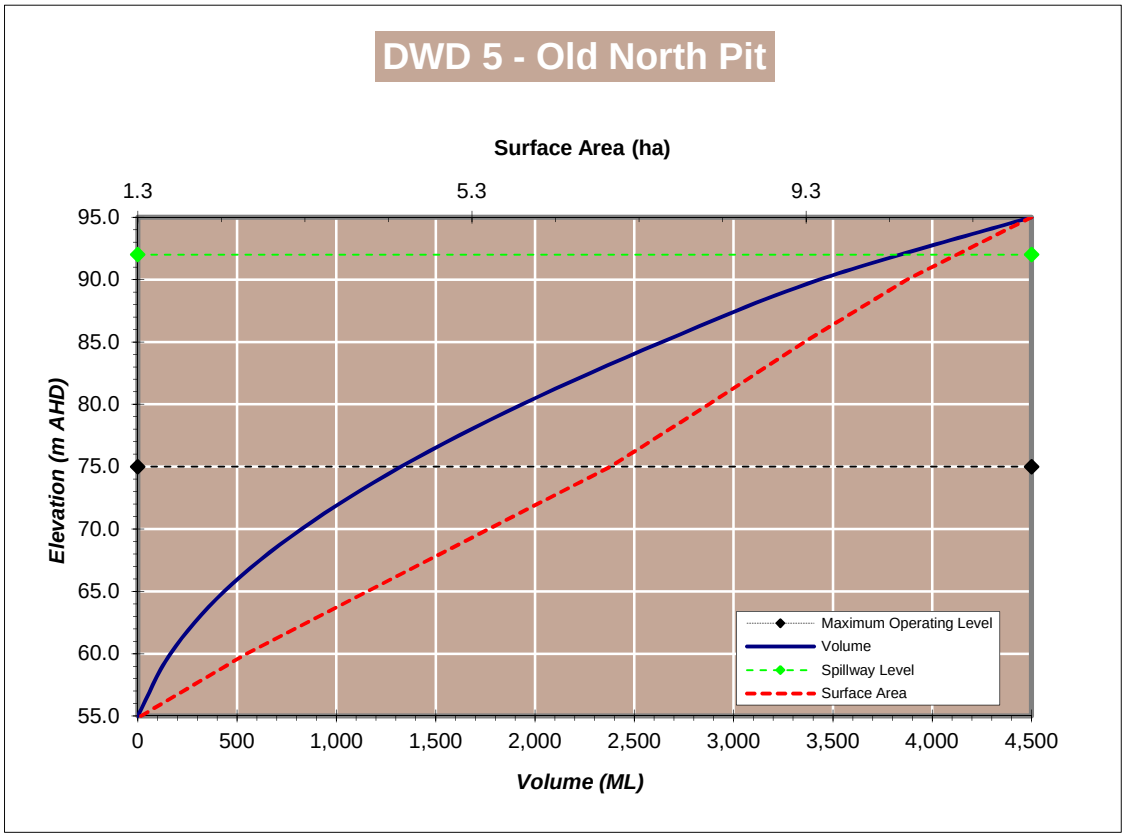
OPSIM Node	Name	Water level (mAHD)	Surface Area (ha)	Volume (ML)
300	DWD 1 - DWD 4 Combined	90.2	0.0	0
		91.0	2.0	20
		92.0	3.0	48
		93.0	4.0	85
		94.0	5.0	134
		95.0	8.7	223
		100.0	15.6	760
		101.0	16.6	921



Storage Characteristics
Name: DWD 5 - Old North Pit
Period: 2014 - 2035

Source: Site Contours

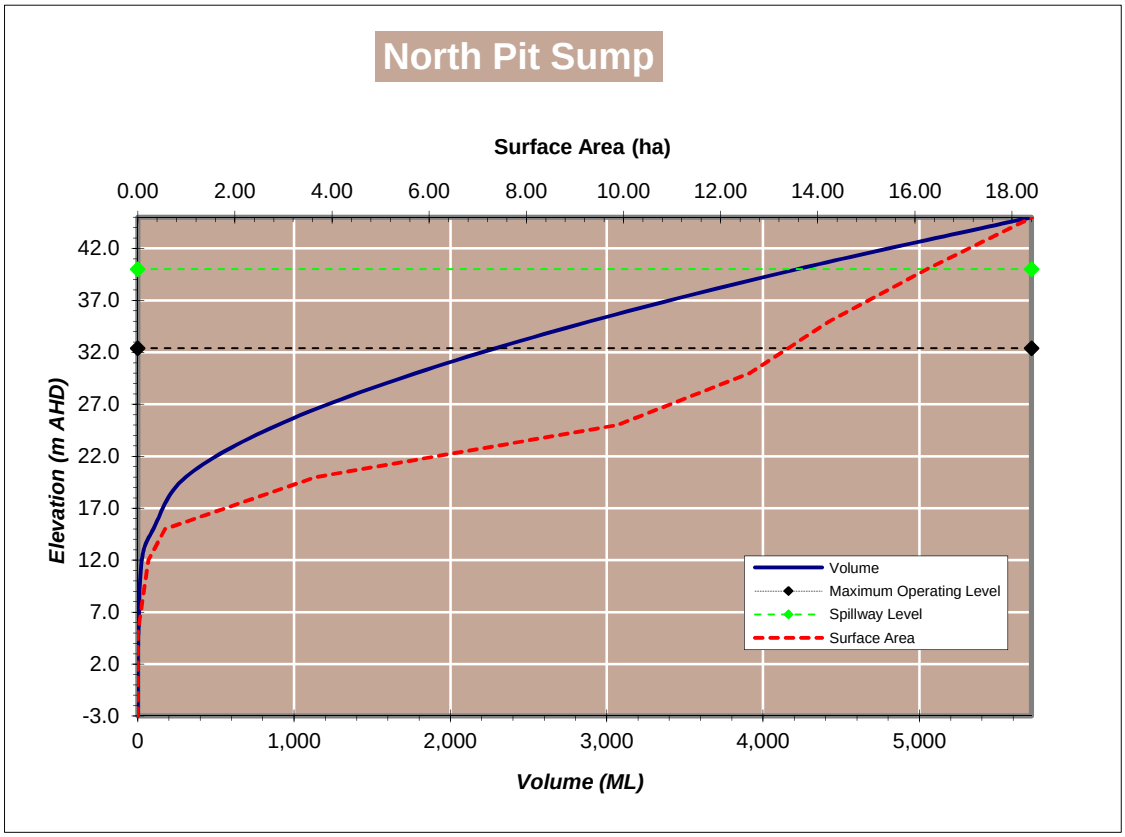
OPSIM Node	Name	Water level (mAHD)	Surface Area (ha)	Volume (ML)
310	DWD 5 - Old North Pit	55.0	1.3	0
		60.0	2.6	165
		65.0	4.1	435
		70.0	5.5	824
		75.0	7.0	1,326
		80.0	8.1	1,936
		85.0	9.3	2,641
		90.0	10.5	3,432
		95.0	12.0	4,500



Storage Characteristics
Name: North Pit Sump
Period: 2014 - 2016

Source: Mine Plan Contours

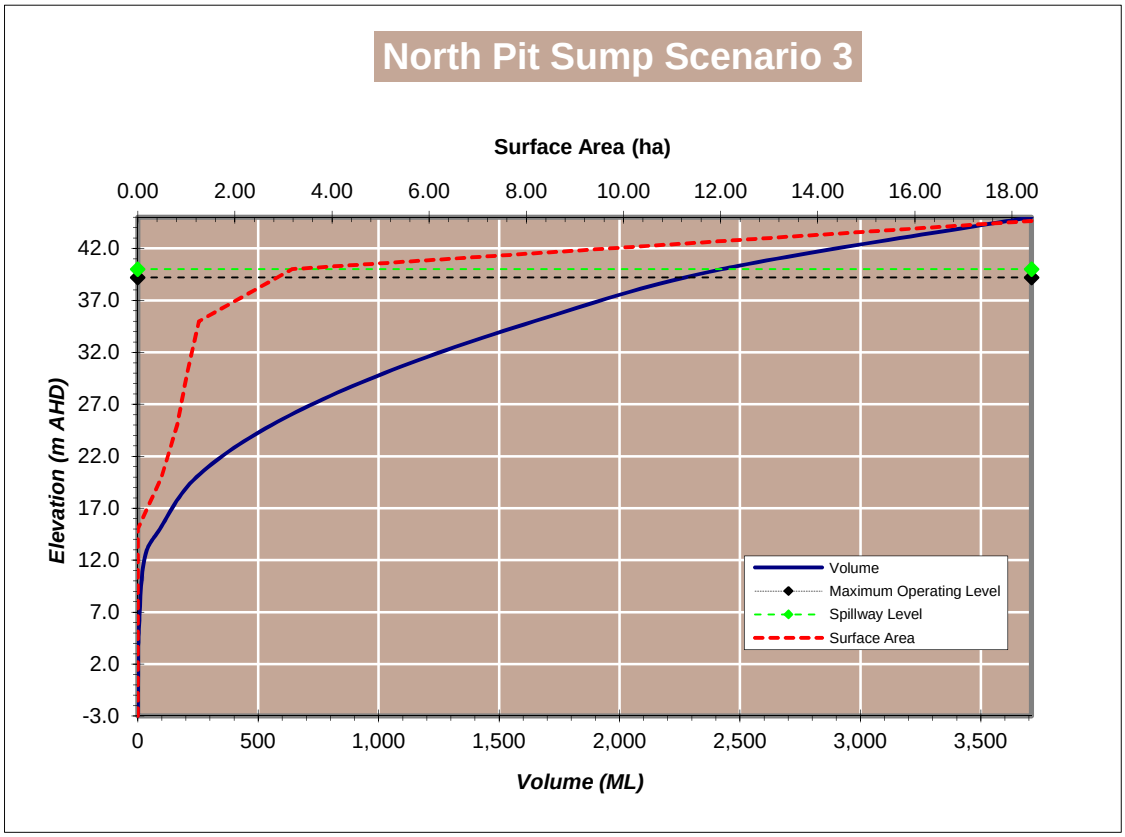
OPSIM Node	Name	Water level (mAHD)	Surface Area (ha)	Volume (ML)
304	North Pit Sump	-3.0	0.00	0
		1.0	0.00	0
		5.0	0.00	4
		12.0	0.22	26
		15.0	0.56	100
		20.0	3.66	308
		25.0	9.9	894
		30.0	12.6	1,780
		35.0	14.2	2,897
		40.0	16.3	4,218
		45.0	18.4	5,717



Storage Characteristics
Name: North Pit Sump Scenario 3
Period: 2017 - 2019

Source: Mine Plan Contours

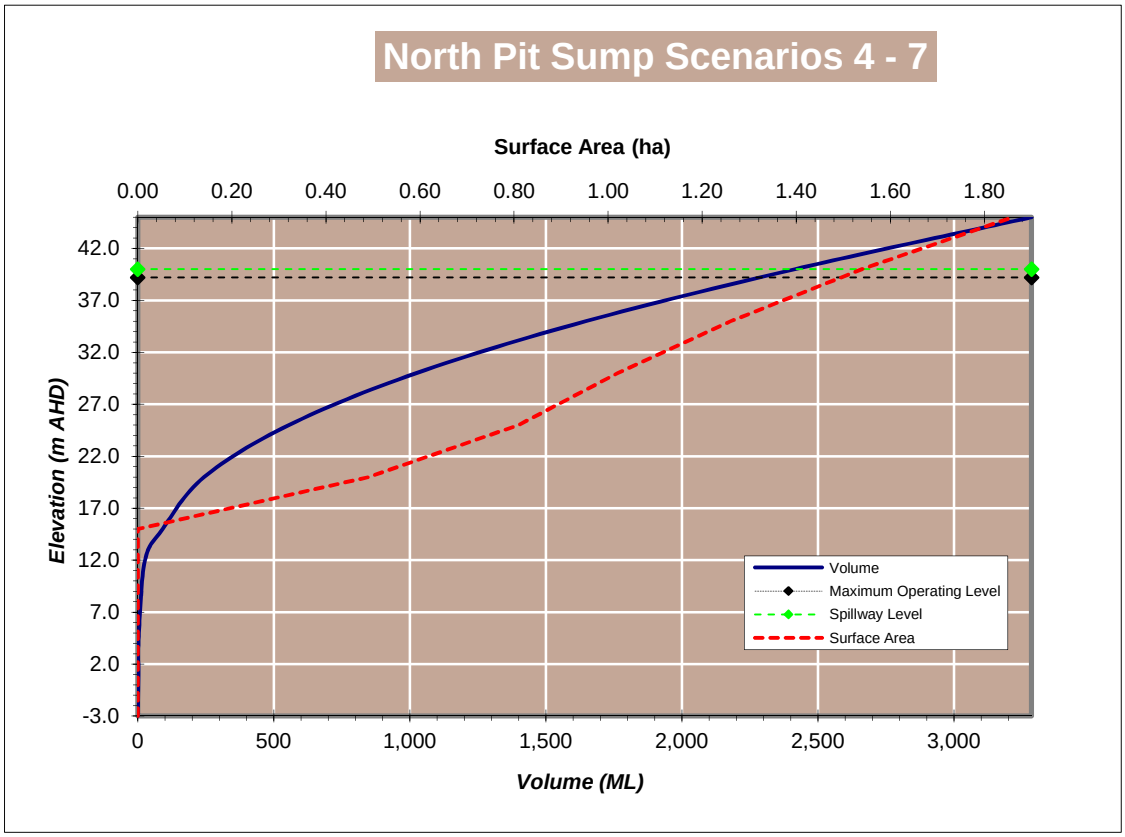
OPSIM Node	Name	Water level (mAHD)	Surface Area (ha)	Volume (ML)
304	North Pit Sump Scenario 3	-3.0	0.00	0
		1.0	0.00	2
		5.0	0.00	4
		12.0	0.00	27
		15.0	0.00	92
		20.0	0.49	244
		25.0	0.8	555
		30.0	1.0	1,023
		35.0	1.3	1,647
		40.0	3.2	2,424
		45.0	19.6	3,710



Storage Characteristics
Name: North Pit Sump Scenarios 4 - 7
Period: 2020 - 2036

Source: Mine Plan Contours

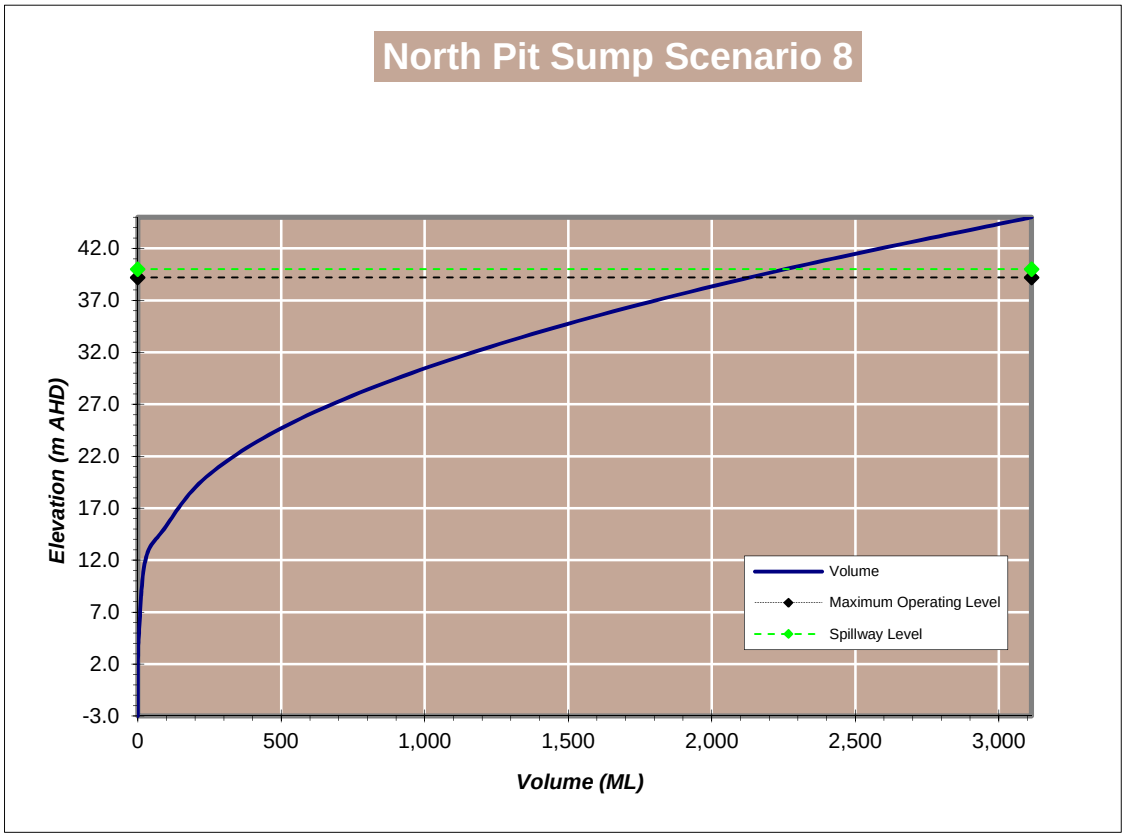
OPSIM Node	Name	Water level (mAHD)	Surface Area (ha)	Volume (ML)
304	North Pit Sump Scenarios 4 - 7	-3.0	0.00	0
		1.0	0.00	2
		5.0	0.00	4
		12.0	0.00	27
		15.0	0.00	92
		20.0	0.49	244
		25.0	0.8	555
		30.0	1.0	1,023
		35.0	1.3	1,647
		40.0	1.5	2,415
		45.0	1.9	3,285



Storage Characteristics
Name: North Pit Sump Scenario 8
Period: 2037 - 2041

Source: Mine Plan Contours

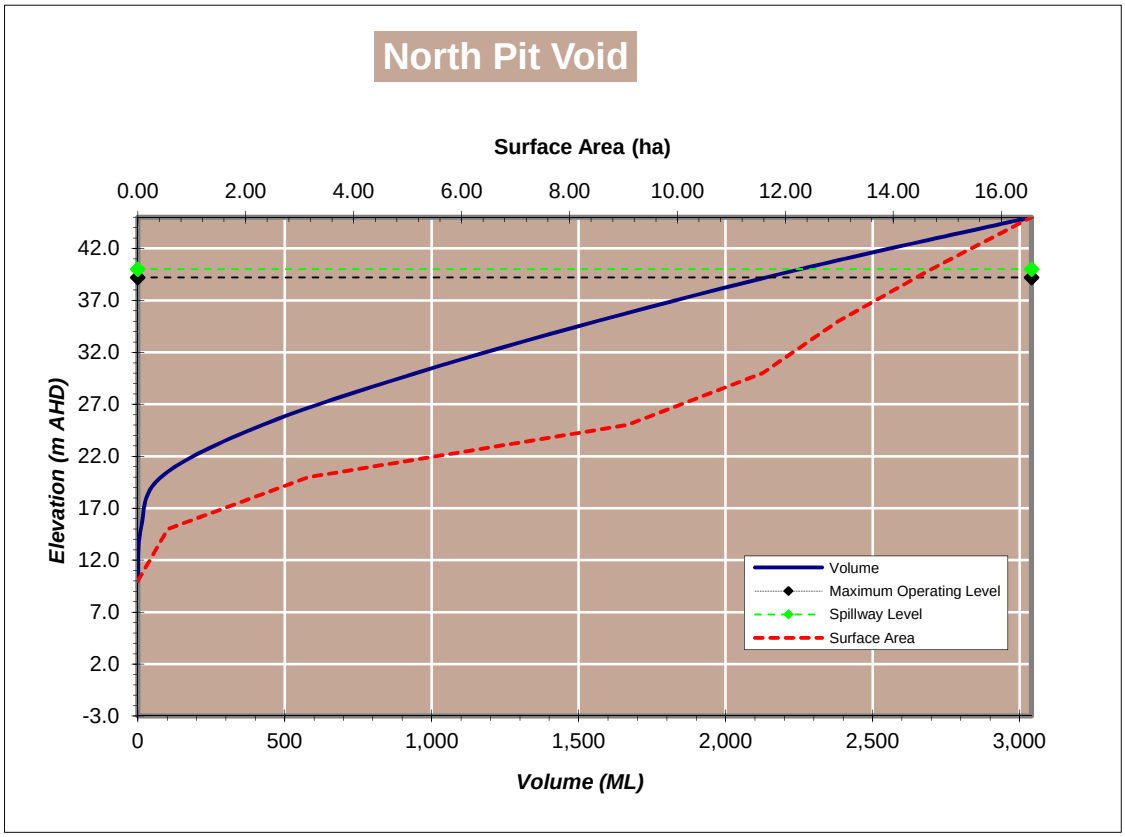
OPSIM Node	Name	Water level (mAHD)	Surface Area (ha)	Volume (ML)
304	North Pit Sump Scenario 8	-3.0	0.00	0
		1.0	0.00	0
		5.0	0.00	4
		12.0	0.00	27
		15.0	0.00	92
		20.0	0.00	239
		25.0	0.00	522
		30.0	0.00	954
		35.0	0.00	1,532
		40.0	0.00	2,256
		45.0	0.00	3,114



Storage Characteristics
Name: North Pit Void
Period: 2014 -2020

Source: Mine Plan Contours

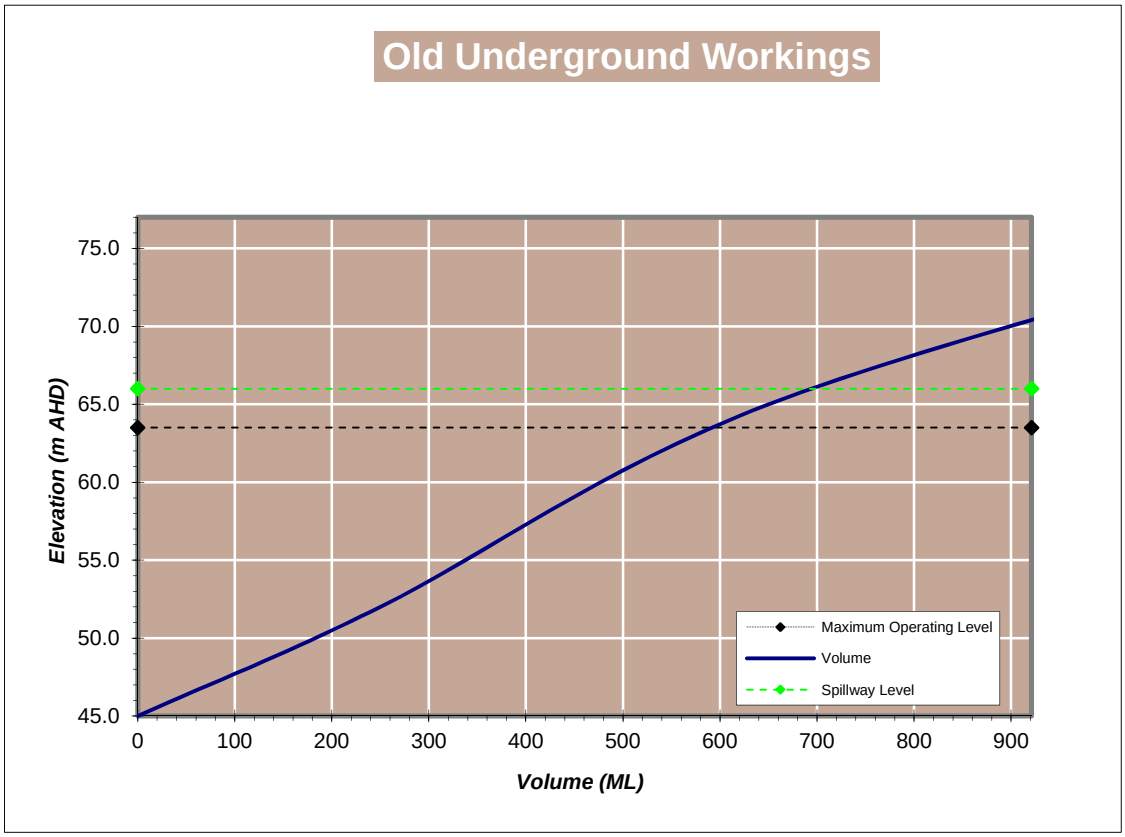
OPSIM Node	Name	Water level (mAHD)	Surface Area (ha)	Volume (ML)
305	North Pit Void	10.0	0.00	0
		15.0	0.56	11
		20.0	3.16	79
		25.0	9.07	423
		30.0	11.58	946
		35.0	12.98	1,562
		40.0	14.71	2,253
		45.0	16.56	3,041



Storage Characteristics
Name: Old Underground Workings
Period: 2014 - 2036

Source: Assumed: MOL Available Only

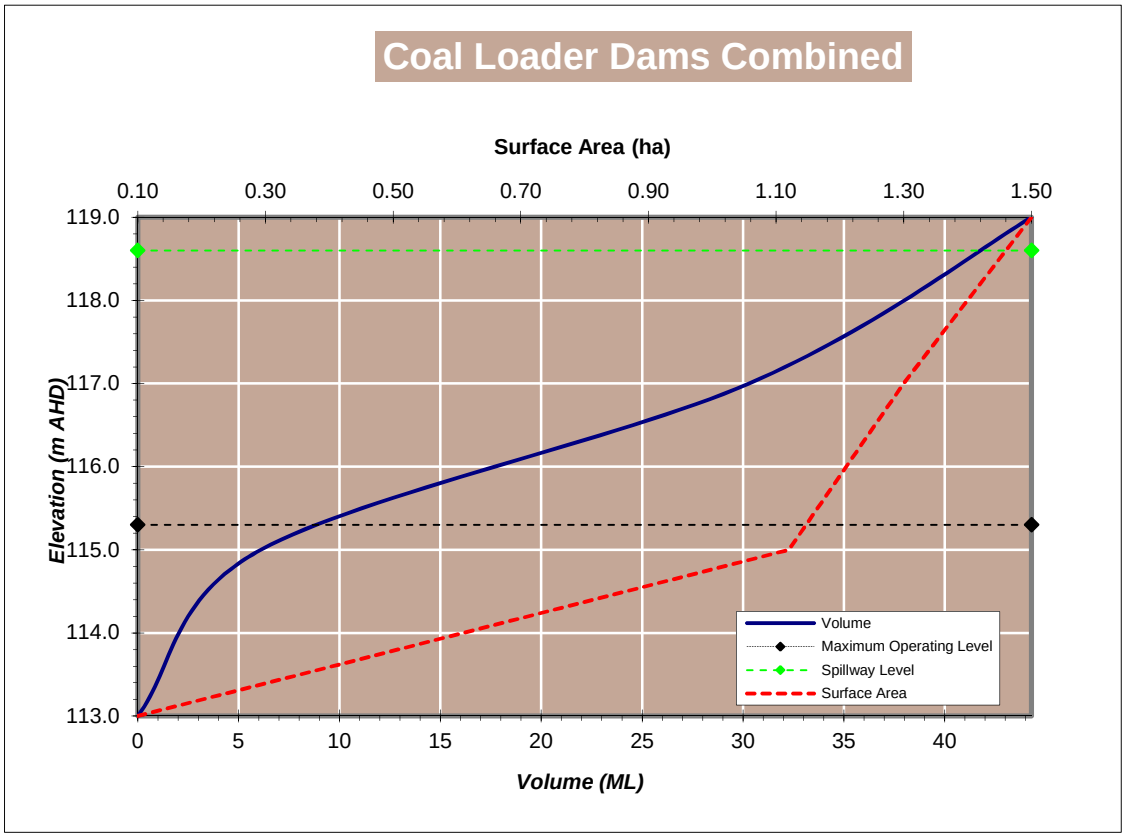
OPSIM Node	Name	Water level (mAHD)	Surface Area (ha)	Volume (ML)
315	Old Underground Workings	45.0	0.0	0
		52.0	0.0	250
		65.0	0.0	650
		77.0	0.0	1,300



Storage Characteristics
Name: Coal Loader Dams Combined
Period: 2014 - 2041

Source: Assumed from MOL & Water Surface Area

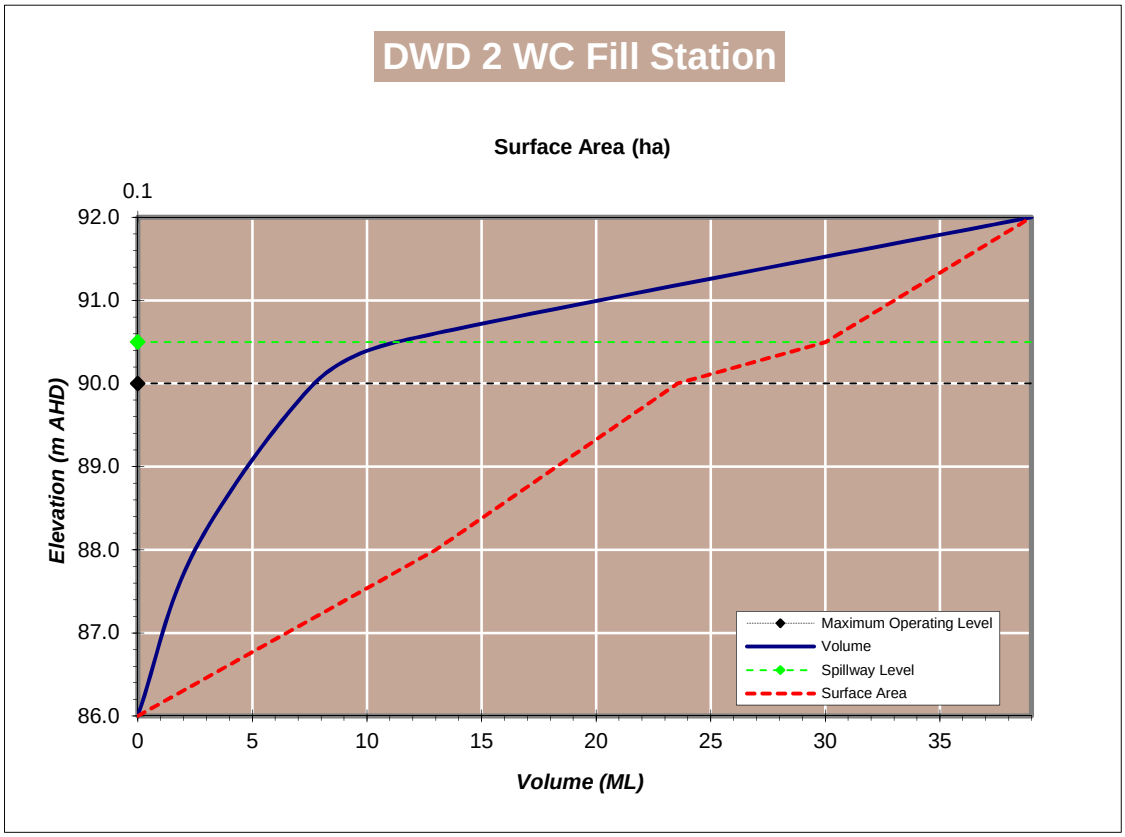
OPSIM Node	Name	Water level (mAHD)	Surface Area (ha)	Volume (ML)
330	Coal Loader Dams Combined	113.0	0.10	0.00
		115.0	1.12	6.10
		117.0	1.30	30.30
		119.0	1.50	44.30



Storage Characteristics
Name: DWD 2 WC Fill Station
Period: 2014 - 2041

Source: Assumed: MOL Available Only

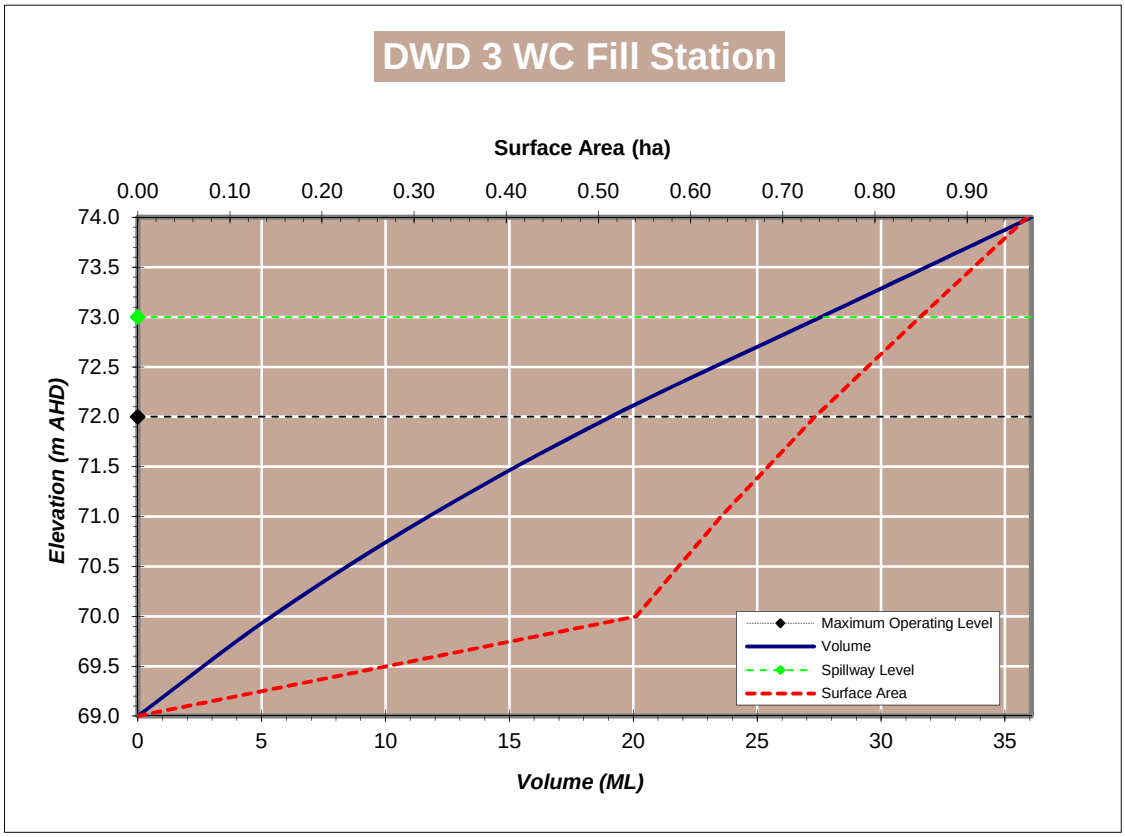
OPSIM Node	Name	Water level (mAHD)	Surface Area (ha)	Volume (ML)
325	DWD 2 WC Fill Station	86.0	0.1	0
		88.0	0.4	3
		90.0	0.6	8
		90.5	0.8	11
		92.0	1.0	39



Storage Characteristics
Name: DWD 3 WC Fill Station
Period: 2014 - 2035

Source: Site Contours

OPSIM Node	Name	Water level (mAHD)	Surface Area (ha)	Volume (ML)
355	DWD 3 WC Fill Station	69.0	0.00	0.00
		70.0	0.54	5.41
		71.0	0.63	11.73
		72.0	0.74	19.09
		73.0	0.85	27.58
		74.0	0.97	36.07



Appendix E: Catchment Areas for OPSIM Model

Table 29: Catchment Areas 2014 - 2016

Node	Storage Name	Catch Type	Mode	Area (ha)
300	CHPP Dams Combined	Undisturbed: Rixs Creek 2014	Surf+Base	79.76
300	CHPP Dams Combined	Spoil / Unconsolidated: Rix's Creek 2014	Baseflow	15.59
300	CHPP Dams Combined	Roads - Industrial: Rixs Creek 2014	Surface	34.1
300	CHPP Dams Combined	Revegetated Spoils: Rixs Creek 2014	Surface	57.67
304	North Pit	Undisturbed: Rixs Creek 2014	Surf+Base	8.13
304	North Pit	Spoil / Unconsolidated: Rix's Creek 2014	Surf+Base	108.13
304	North Pit	Mining Areas: Rix's Creek 2014	Surface	24.04
304	North Pit	Roads - Industrial: Rixs Creek 2014	Surface	15.08
304	North Pit	Revegetated Spoils: Rixs Creek 2014	Surface	38.15
304	North Pit	Revegetated Spoils: Rixs Creek 2014	Surf+Base	278
310	Old North Pit	Spoil / Unconsolidated: Rix's Creek 2014	Surf+Base	17.8
310	Old North Pit	Roads - Industrial: Rixs Creek 2014	Surface	4.72
310	Old North Pit	Revegetated Spoils: Rixs Creek 2014	Surface	79.33
310	Old North Pit	Mining Areas: Rix's Creek 2014	Surface	4.08
310	Old North Pit	Revegetated Spoils: Rixs Creek 2014	Baseflow	100.9
325	Dirty Water Dam 2	Undisturbed: Rixs Creek 2014	Surf+Base	2.148
325	Dirty Water Dam 2	Roads - Industrial: Rixs Creek 2014	Surface	3.246
330	Coal Loader	Undisturbed: Rixs Creek 2014	Surf+Base	11.37
330	Coal Loader	Roads - Industrial: Rixs Creek 2014	Surface	4.96
330	Coal Loader	Coal Pads	Surf+Base	2.87
335	West Pit	Undisturbed: Rixs Creek 2014	Surf+Base	11.26
335	West Pit	Spoil / Unconsolidated: Rix's Creek 2014	Surf+Base	42.32
335	West Pit	Mining Areas: Rix's Creek 2014	Surface	140.94
335	West Pit	Revegetated Spoils: Rixs Creek 2014	Baseflow	18.26
340	Old South Pit	Tailings Dam Surface: Rixs Creek 2014	Surface	13.15
340	Old South Pit	Spoil / Unconsolidated: Rix's Creek 2014	Surf+Base	8.15
340	Old South Pit	Roads - Industrial: Rixs Creek 2014	Surface	0.75
350	Highway Underpass (South)	Spoil / Unconsolidated: Rix's Creek 2014	Surf+Base	7.73
350	Highway Underpass (South)	Roads - Industrial: Rixs Creek 2014	Surf+Base	9.11
350	Highway Underpass (South)	Revegetated Spoils: Rixs Creek 2014	Surf+Base	6.28
355	Dirty Water Dam 3	Roads - Industrial: Rixs Creek 2014	Surface	4.57
355	Dirty Water Dam 3	Revegetated Spoils: Rixs Creek 2014	Surf+Base	0.95
355	Dirty Water Dam 3	Undisturbed: Rixs Creek 2014	Surf+Base	0.28
	Total			**1,153.82**

Table 30: Catchment Areas 2017 - 2019

Node	Storage Name	Catch Type	Mode	Area (ha)
300	CHPP Dams Combined	Undisturbed: Rixs Creek 2014	Surf+Base	79.76
300	CHPP Dams Combined	Spoil / Unconsolidated: Rix's Creek 2014	Baseflow	15.59
300	CHPP Dams Combined	Roads - Industrial: Rixs Creek 2014	Surface	34.1
300	CHPP Dams Combined	Revegetated Spoils: Rixs Creek 2014	Surface	70.47
300	CHPP Dams Combined	Revegetated Spoils: Rixs Creek 2014	Baseflow	42.12
304	North Pit	Undisturbed: Rixs Creek 2014	Surf+Base	8.13
304	North Pit	Spoil / Unconsolidated: Rix's Creek 2014	Surf+Base	114.19
304	North Pit	Mining Areas: Rix's Creek 2014	Surface	18.39
304	North Pit	Roads - Industrial: Rixs Creek 2014	Surface	8.98
304	North Pit	Revegetated Spoils: Rixs Creek 2014	Surface	38.18
304	North Pit	Revegetated Spoils: Rixs Creek 2014	Baseflow	121.74
304	North Pit	Spoil / Unconsolidated: Rix's Creek 2014	Baseflow	115.19
310	Old North Pit	Spoil / Unconsolidated: Rix's Creek 2014	Surface	11.83
310	Old North Pit	Roads - Industrial: Rixs Creek 2014	Surface	2.61
310	Old North Pit	Revegetated Spoils: Rixs Creek 2014	Surface	87.18
310	Old North Pit	Mining Areas: Rix's Creek 2014	Surface	4.08
310	Old North Pit	Revegetated Spoils: Rixs Creek 2014	Baseflow	48.82
310	Old North Pit	Spoil / Unconsolidated: Rix's Creek 2014	Baseflow	11.83
325	Dirty Water Dam 2	Undisturbed: Rixs Creek 2014	Surf+Base	2.148
325	Dirty Water Dam 2	Roads - Industrial: Rixs Creek 2014	Surface	3.246
330	Coal Loader	Undisturbed: Rixs Creek 2014	Surf+Base	11.37
330	Coal Loader	Roads - Industrial: Rixs Creek 2014	Surface	4.96
330	Coal Loader	Coal Pads	Surf+Base	2.87
335	West Pit	Undisturbed: Rixs Creek 2014	Surf+Base	2.12
335	West Pit	Spoil / Unconsolidated: Rix's Creek 2014	Surf+Base	41.75
335	West Pit	Mining Areas: Rix's Creek 2014	Surface	110.01
335	West Pit	Revegetated Spoils: Rixs Creek 2014	Baseflow	5.49
335	West Pit	Roads - Industrial: Rixs Creek 2014	Surf+Base	16.5
335	West Pit	Revegetated Spoils: Rixs Creek 2014	Baseflow	48.07
350	Highway Underpass (South)	Spoil / Unconsolidated: Rix's Creek 2014	Surf+Base	7.73
350	Highway Underpass (South)	Roads - Industrial: Rixs Creek 2014	Surf+Base	9.11
350	Highway Underpass (South)	Revegetated Spoils: Rixs Creek 2014	Surf+Base	6.28
355	Dirty Water Dam 3	Roads - Industrial: Rixs Creek 2014	Surface	4.57
355	Dirty Water Dam 3	Revegetated Spoils: Rixs Creek 2014	Surf+Base	0.95
355	Dirty Water Dam 3	Undisturbed: Rixs Creek 2014	Surf+Base	0.28
	Total			**1,110.64**

Table 31: Catchment Areas 2020 - 2022

Node	Storage Name	Catch Type	Mode	Area (ha)
300	CHPP Dams Combined	Undisturbed: Rixs Creek 2014	Surf+Base	79.7
300	CHPP Dams Combined	Spoil / Unconsolidated: Rix's Creek 2014	Surface	0.67
300	CHPP Dams Combined	Roads - Industrial: Rixs Creek 2014	Surface	33.65
300	CHPP Dams Combined	Revegetated Spoils: Rixs Creek 2014	Surface	25.01
304	North Pit	Undisturbed: Rixs Creek 2014	Surf+Base	0.5
304	North Pit	Spoil / Unconsolidated: Rix's Creek 2014	Surface	59.01
304	North Pit	Mining Areas: Rix's Creek 2014	Surface	3.48
304	North Pit	Roads - Industrial: Rixs Creek 2014	Surface	6.32
304	North Pit	Revegetated Spoils: Rixs Creek 2014	Surface	13
304	North Pit	Revegetated Spoils: Rixs Creek 2014	Baseflow	278
310	Old North Pit	Spoil / Unconsolidated: Rix's Creek 2014	Surface	11.83
310	Old North Pit	Roads - Industrial: Rixs Creek 2014	Surface	0.71
310	Old North Pit	Revegetated Spoils: Rixs Creek 2014	Surf+Base	20.74
310	Old North Pit	Mining Areas: Rix's Creek 2014	Surface	4.08
310	Old North Pit	Revegetated Spoils: Rixs Creek 2014	Baseflow	100.9
325	Dirty Water Dam 2	Undisturbed: Rixs Creek 2014	Surf+Base	2.148
325	Dirty Water Dam 2	Roads - Industrial: Rixs Creek 2014	Surface	3.246
330	Coal Loader	Undisturbed: Rixs Creek 2014	Surf+Base	11.37
330	Coal Loader	Roads - Industrial: Rixs Creek 2014	Surface	4.96
330	Coal Loader	Coal Pads	Surf+Base	2.87
335	West Pit	Undisturbed: Rixs Creek 2014	Surf+Base	0.01
335	West Pit	Spoil / Unconsolidated: Rix's Creek 2014	Surface	55.82
335	West Pit	Mining Areas: Rix's Creek 2014	Surface	104.84
335	West Pit	Revegetated Spoils: Rixs Creek 2014	Surf+Base	0.01
335	West Pit	Roads - Industrial: Rixs Creek 2014	Surface	7.36
350	Highway Underpass (South)	Spoil / Unconsolidated: Rix's Creek 2014	Surface	2.78
350	Highway Underpass (South)	Roads - Industrial: Rixs Creek 2014	Surf+Base	6.42
350	Highway Underpass (South)	Revegetated Spoils: Rixs Creek 2014	Surf+Base	3.77
355	Dirty Water Dam 3	Roads - Industrial: Rixs Creek 2014	Surface	4.57
355	Dirty Water Dam 3	Revegetated Spoils: Rixs Creek 2014	Surf+Base	0.95
355	Dirty Water Dam 3	Undisturbed: Rixs Creek 2014	Surf+Base	0.28
	Total			**849.004**

Table 32: Catchment Areas 2023 - 2025

Node	Storage Name	Catch Type	Mode	Area (ha)
300	CHPP Dams Combined	Undisturbed: Rixs Creek 2014	Surf+Base	79.7
300	CHPP Dams Combined	Spoil / Unconsolidated: Rix's Creek 2014	Surface	0.67
300	CHPP Dams Combined	Roads - Industrial: Rixs Creek 2014	Surface	33.65
300	CHPP Dams Combined	Revegetated Spoils: Rixs Creek 2014	Surface	25.01
304	North Pit Sump	Revegetated Spoils: Rixs Creek 2014	Baseflow	265.9
304	North Pit Sump	Spoil / Unconsolidated: Rix's Creek 2014	Surf+Base	12.1
307	North Sediment Dam	Undisturbed: Rixs Creek 2014	Surf+Base	2.92
307	North Sediment Dam	Spoil / Unconsolidated: Rix's Creek 2014	Surface	0.01
307	North Sediment Dam	Mining Areas: Rix's Creek 2014	Surface	0.01
307	North Sediment Dam	Roads - Industrial: Rixs Creek 2014	Surface	0.01
307	North Sediment Dam	Revegetated Spoils: Rixs Creek 2014	Surface	96.33
310	Old North Pit	Spoil / Unconsolidated: Rix's Creek 2014	Surface	11.83
310	Old North Pit	Roads - Industrial: Rixs Creek 2014	Surface	0.71
310	Old North Pit	Revegetated Spoils: Rixs Creek 2014	Surface	22.32
310	Old North Pit	Mining Areas: Rix's Creek 2014	Surface	4.09
310	Old North Pit	Revegetated Spoils: Rixs Creek 2014	Baseflow	100.9
325	Dirty Water Dam 2	Undisturbed: Rixs Creek 2014	Surf+Base	2.148
325	Dirty Water Dam 2	Roads - Industrial: Rixs Creek 2014	Surface	3.246
330	Coal Loader	Undisturbed: Rixs Creek 2014	Surf+Base	11.37
330	Coal Loader	Roads - Industrial: Rixs Creek 2014	Surface	4.96
330	Coal Loader	Coal Pads	Surf+Base	2.87
335	West Pit	Undisturbed: Rixs Creek 2014	Surf+Base	9.91
335	West Pit	Spoil / Unconsolidated: Rix's Creek 2014	Surface	123.97
335	West Pit	Mining Areas: Rix's Creek 2014	Surface	103.39
335	West Pit	Revegetated Spoils: Rixs Creek 2014	Surf+Base	0.01
335	West Pit	Roads - Industrial: Rixs Creek 2014	Surface	36.27
350	Highway Underpass (South)	Spoil / Unconsolidated: Rix's Creek 2014	Surface	6.38
350	Highway Underpass (South)	Roads - Industrial: Rixs Creek 2014	Surf+Base	11.99
350	Highway Underpass (South)	Revegetated Spoils: Rixs Creek 2014	Surf+Base	3.45
355	Dirty Water Dam 3	Roads - Industrial: Rixs Creek 2014	Surface	4.57
355	Dirty Water Dam 3	Revegetated Spoils: Rixs Creek 2014	Surf+Base	0.95
355	Dirty Water Dam 3	Undisturbed: Rixs Creek 2014	Surf+Base	0.28
	Total			**981.924**

Table 33: Catchment Areas 2026 - 2036

Node	Storage Name	Catch Type	Mode	Area (ha)
300	CHPP Dams Combined	Undisturbed: Rixs Creek 2014	Surf+Base	79.7
300	CHPP Dams Combined	Spoil / Unconsolidated: Rix's Creek 2014	Surface	0.67
300	CHPP Dams Combined	Roads - Industrial: Rixs Creek 2014	Surface	33.65
300	CHPP Dams Combined	Revegetated Spoils: Rixs Creek 2014	Surface	25.01
304	North Pit Sump	Revegetated Spoils: Rixs Creek 2014	Baseflow	265.9
304	North Pit Sump	Spoil / Unconsolidated: Rix's Creek 2014	Surf+Base	12.1
307	North Sediment Dam	Undisturbed: Rixs Creek 2014	Surf+Base	10.54
307	North Sediment Dam	Spoil / Unconsolidated: Rix's Creek 2014	Surface	0.01
307	North Sediment Dam	Mining Areas: Rix's Creek 2014	Surface	0.01
307	North Sediment Dam	Roads - Industrial: Rixs Creek 2014	Surface	0.68
307	North Sediment Dam	Revegetated Spoils: Rixs Creek 2014	Surface	88.04
310	Old North Pit	Spoil / Unconsolidated: Rix's Creek 2014	Surface	11.83
310	Old North Pit	Roads - Industrial: Rixs Creek 2014	Surface	0.71
310	Old North Pit	Revegetated Spoils: Rixs Creek 2014	Surf+Base	22.32
310	Old North Pit	Mining Areas: Rix's Creek 2014	Surface	4.09
310	Old North Pit	Revegetated Spoils: Rixs Creek 2014	Baseflow	100.9
325	Dirty Water Dam 2	Undisturbed: Rixs Creek 2014	Surf+Base	2.148
325	Dirty Water Dam 2	Roads - Industrial: Rixs Creek 2014	Surface	3.246
330	Coal Loader	Undisturbed: Rixs Creek 2014	Surf+Base	11.37
330	Coal Loader	Roads - Industrial: Rixs Creek 2014	Surface	4.96
330	Coal Loader	Coal Pads	Surf+Base	2.87
335	West Pit	Undisturbed: Rixs Creek 2014	Surf+Base	12.03
335	West Pit	Spoil / Unconsolidated: Rix's Creek 2014	Surface	89.16
335	West Pit	Mining Areas: Rix's Creek 2014	Surface	110.83
335	West Pit	Revegetated Spoils: Rixs Creek 2014	Surf+Base	0.01
335	West Pit	Roads - Industrial: Rixs Creek 2014	Surface	40.75
350	Highway Underpass (South)	Spoil / Unconsolidated: Rix's Creek 2014	Surface	6.38
350	Highway Underpass (South)	Roads - Industrial: Rixs Creek 2014	Surf+Base	11.99
350	Highway Underpass (South)	Revegetated Spoils: Rixs Creek 2014	Surf+Base	3.45
355	Dirty Water Dam 3	Roads - Industrial: Rixs Creek 2014	Surface	4.57
355	Dirty Water Dam 3	Revegetated Spoils: Rixs Creek 2014	Surf+Base	0.95
355	Dirty Water Dam 3	Undisturbed: Rixs Creek 2014	Surf+Base	0.28
	Total			**961.154**

Table 34: Catchment Areas 2037 - 2041

Node	Storage Name	Catch Type	Mode	Area
300	CHPP Dams Combined	Undisturbed: Rixs Creek 2014	Surf+Base	71.32
300	CHPP Dams Combined	Spoil / Unconsolidated: Rix's Creek 2014	Surface	0.67
300	CHPP Dams Combined	Roads - Industrial: Rixs Creek 2014	Surface	33.65
300	CHPP Dams Combined	Revegetated Spoils: Rixs Creek 2014	Surface	25.68
304	North Pit Sump	Revegetated Spoils: Rixs Creek 2014	Baseflow	278
307	North Sediment Dam	Undisturbed: Rixs Creek 2014	Surf+Base	10.54
307	North Sediment Dam	Spoil / Unconsolidated: Rix's Creek 2014	Surface	0.01
307	North Sediment Dam	Mining Areas: Rix's Creek 2014	Surface	0.01
307	North Sediment Dam	Roads - Industrial: Rixs Creek 2014	Surface	0.68
307	North Sediment Dam	Revegetated Spoils: Rixs Creek 2014	Surface	88.04
310	Underground Portal	Mining Areas: Rix's Creek 2014	Surface	20
310	Underground Portal	Undisturbed: Rixs Creek 2014	Surf+Base	40.84
310	Underground Portal	Mining Areas: Rix's Creek 2014	Surface	27.63
310	Underground Portal	Revegetated Spoils: Rixs Creek 2014	Baseflow	100.9
325	Dirty Water Dam 2	Undisturbed: Rixs Creek 2014	Surf+Base	2.148
325	Dirty Water Dam 2	Roads - Industrial: Rixs Creek 2014	Surface	3.246
330	Coal Loader	Undisturbed: Rixs Creek 2014	Surf+Base	11.37
330	Coal Loader	Roads - Industrial: Rixs Creek 2014	Surface	4.96
330	Coal Loader	Coal Pads	Surf+Base	2.87
335	West Pit (Final Void)	Undisturbed: Rixs Creek 2014	Surf+Base	0
335	West Pit (Final Void)	Spoil / Unconsolidated: Rix's Creek 2014	Surface	0
335	West Pit (Final Void)	Mining Areas: Rix's Creek 2014	Surface	152.94
335	West Pit (Final Void)	Revegetated Spoils: Rixs Creek 2014	Surf+Base	0
335	West Pit (Final Void)	Roads - Industrial: Rixs Creek 2014	Surface	4.25
	Total			**879.754**

Appendix F: Rixs Creek Ecological Impact Assessment

advitech

Report

Rixs Creek

Ecological Impact Assessment

JP Environmental

11 December 2013
Rev 0 (Final)

Report Details

Rixs Creek - Ecological Impact Assessment

Filename: 12968 Rixs Creek F&F Rev0.docx

Job #: J0130248 Folder #: F12968

Revision: 0 (Final), Date: 11 December 2013

Prepared For

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History

Date	Revision	Comments
25-11-2013	A	Draft Issue for Review
9-12-2013	0	Final Issue

Endorsements

Function	Signature	Name and Title	Date
Prepared by		Luke Pickett Senior Ecologist	11-12-2013
Checked and authorised for release by		Steven Smith Managing Director	11-12-2013

TABLE OF CONTENTS

APPENDICES

1. INTRODUCTION

Advitech Environmental was engaged by JP Environmental to prepare an Ecological Impact Assessment to address aquatic and terrestrial impacts that may arise as a result of proposed mine water discharges into Rixs Creek.

It should be noted that this report was prepared by Advitech Pty Limited for JP Environmental ("the customer") in accordance with the scope of work and specific requirements agreed between Advitech and the customer. This report was prepared with background information, terms of reference and assumptions agreed with the customer. The report is not intended for use by any other individual or organisation and as such, Advitech will not accept liability for use of the information contained in this report, other than that which was intended at the time of writing.

1.1 Project Background

Rixs Creek Colliery is an open cut mining operation located 5 km northwest of Singleton. The scope for this assessment is to assess the ecological impacts of flows of saline water from a proposed dam within the Rixs Creek Colliery. The proposed discharge point into Rixs Creek is located approximately 12km upstream from the confluence with the Hunter River.

The proposal involves the discharge of up to 200 megalitres (ML) per day (about 2300 l/s) of saline water into Rixs Creek. On average, there may be 4 days annually where there are 200ML per day flows and potentially another 13 days where flows may reach 5 ML per day.

There is currently four water quality monitoring points within Rixs Creek catchment. Annual averages for electrical conductivity range from 600 to 2000 µS/cm depending on location and prevailing rainfall. Annual averages for pH appear to be generally between 6.3 and 7.5, but most frequently below 7. Total Suspended Solids (TSS) varies, but generally the averages are less than 300 mg/l.

1.2 Study Area

Rixs Creek is a tributary of the Hunter River, approximately 12km in length to the west of Singleton (see **Figure 1**).

The following definitions are used throughout this report to refer to locations in the project area:

- The 'subject site' is areas that would be directly impacted by the works, including Rixs Creek and associated riparian zones;
- The 'study area' includes the subject site and the areas adjacent to the subject site that may be indirectly impacted by the proposed works; and
- The 'search area' refers to a 10 km radius surrounding the subject site for the purpose of database searches.

Land use adjacent to the subject site is a mixture of rural and mining land. Vegetation within the study area is generally sparse, consisting of remnant and regrowth vegetation often restricted to the riparian zone of Rixs Creek. The vegetation within the survey area is subject to high levels of weed incursion with higher levels generally recorded in areas subject to previous clearing and grazing.

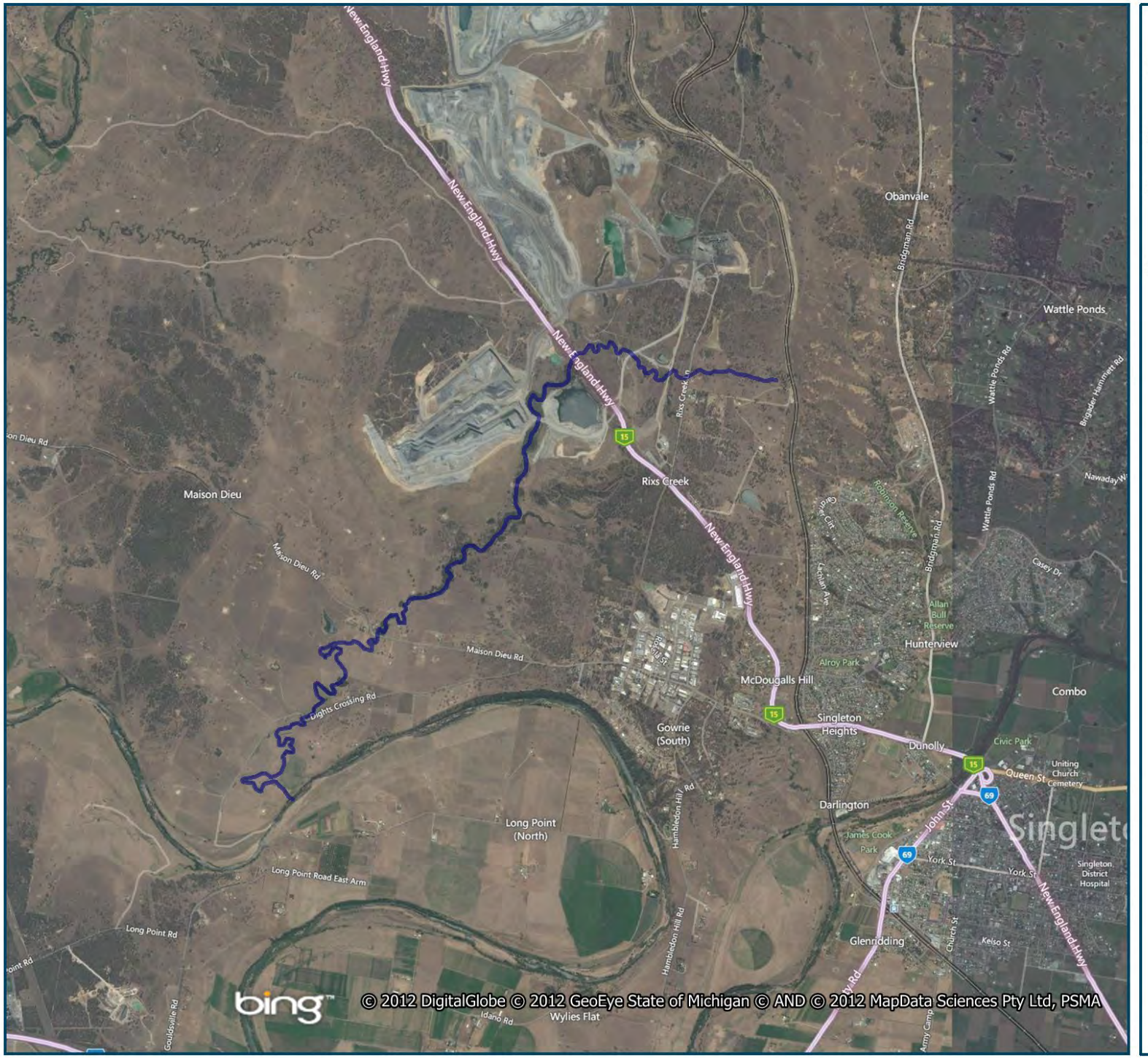

Figure 1: Location of Rixs Creek

Client: JP Environmental

Project: Rixs Creek Ecological Impact Assessment

Source: Peake (2006)

Rixs Creek

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Job Number: J0130248 Folder Number: 12968

1.3 Legislative Context

This report presents an assessment of the potential impacts to flora and fauna from the proposed release of mine water flows into Rixs Creek. In particular, this report addresses specific legislative planning requirements relating to flora and fauna, including:

- Effects on threatened species, populations and ecological communities, as listed under the *Threatened Species Conservation Act 1995* (TSC Act) and *Fisheries Management Act 1994*, pursuant to section 5A of the *Environmental Planning & Assessment Act 1979* (EPA Act); and
- Likely impacts on nationally listed threatened species, populations and ecological communities, as listed under the *Environment Protection and Biodiversity Conservation Act 1999*.

1.4 Study Aims

This study aims to assess the potential impacts of the proposed works on the biodiversity values of the local area. Specifically, it aims to:

- Determine if the project is likely to result in any significant impacts to threatened species, populations and ecological communities, or their habitats protected under Federal and State legislation ; and
- Recommend measures to minimise any potential impacts to protected biodiversity values.

2. METHODOLOGY

2.1 Database Searches and Literature Reviews

A desktop assessment included searches of databases and a review of literature relevant to the site and local area, particularly:

- Office of Environment and Heritage (OEH) Atlas of NSW Wildlife database (licensed) for records of threatened species and endangered ecological communities which have been recorded within a 10 km radius (locality) of the subject site (dated 19 April 2013);
- Department of Sustainability, Environment, Water, Populations and Communities (DSEWPC) Protected Matters Search Tool for Matters of National Environmental Significance (NES) listed under the EPBC Act within a 10 km radius from the site;
- The Vegetation of the Central Hunter Valley, New South Wales (Peake, 2006);
- Previous reports of studies undertaken within the study area.

2.2 Field Survey

Field surveys were conducted on 22 October and 5 November, 2013. The field survey targeted the Rixs Creek watercourse and associated riparian zones.

2.2.1 Flora

A terrestrial flora survey was undertaken across the subject site to identify and assess the vegetation present. The subject site was inspected utilising the 'Random Meander' method described by Cropper (1993). This involved walking in a random manner throughout the site, visiting the full range of habitats and identifying all plant species encountered. Threatened flora species recorded in the local area were also targeted as part of the survey.

Vegetation communities were determined by comparing the floristic structure and composition of the vegetation on site with vegetation profiles described in Peake (2006) and community descriptions of endangered ecological communities known to occur in the local area.

A list of all plant species recorded during fieldwork is listed in **Appendix I**.

2.2.2 Terrestrial Fauna

Fauna surveys primarily targeted species that may utilise the limited habitat available within the Rixs Creek riparian zone. These methods are detailed below in **Table 2.** Much of Rixs Creek was dry at the time of the surveys, however, targeted amphibian surveys were undertaken in sections of the creek which still contained water. Surveys for other fauna groups were restricted to opportunistic sightings and observations made during the traverse of the creek.

Table 1: Fauna surveys conducted on site

Fauna Group	Surveys	Methods and Survey Effort
Amphibians	Diurnal habitat search	All aspects of the watercourse and adjacent areas are searched during the traverse of the creek, particularly sheltering habitat including under logs and rocks, in surrounding vegetation and under bark and leaf litter.
	Nocturnal habitat search	A combination of spotlighting, listening for calls and habitat searches were used at night when frogs are generally more active. These were undertaken on two separate nights within suitable habitat on site.
	Call playback	Call playback surveys targeting threatened frogs were undertaken within suitable habitat on site over two separate nights.
	Watercourse search	A 2 person hour search along a 200m section of Rixs Creek was undertaken on two separate nights.
Mammals	Microbat roost search	An inspection of culverts along Rixs Creek was undertaken in search for active and potential microbat roosts.
All	Opportunistic sightings	Any opportunistic sightings of fauna on site were recorded.

All amphibian surveys were conducted following the Hygiene Protocol for the Control of Disease in Frogs (NPWS, 2000).

The location of fauna surveys is shown in **Figure 2**.

Figure 2: Survey locations

Client: JP Environmental

Project: Rixs Creek Ecological Impact Assessment

Source: Peake (2006)

- Frog surveys (call playback & nocturnal watercourse searches)
- Macroinvertebrate survey location
- Culvert inspection
- Rixs Creek

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Job Number: J0130248 Folder Number: 12968

2.3 Survey Effort

A summary of the time spent on site during fieldwork and the prevailing weather conditions at the time is contained below in **Table 2**.

Table 2: Survey Dates, Times, Activities and Weather Conditions

Date	Time	Activity	Weather
22/10/2013	1100 - 1730	Site Induction General site inspection **Location - NE Hwy to Maison Dieu Rd** Vegetation survey Culvert roost inspection Diurnal frog surveys	2/8 Cloud cover Wind: NW Gusty Temp: 28-36^{0}C
	1730 - 2030	Frog surveys (Maison Dieu Rd)	6/8 Cloud cover Wind: NW Gusty Localised storm activity Temp: 25-28^{0}C
05/11/2013	1400 - 1900	**Location - NE Hwy to Rixs Creek Rd & Maison Dieu Rd to Hunter River** Vegetation survey Diurnal frog surveys	4/8 Cloud cover Wind: SSW Mostly calm Temp: 24^{0}C
	1900 - 2030	Frog surveys (Dights Crossing)	2/8 Cloud cover Wind: NW Gusty Localised storm activity Temp: 16^{0}C

2.4 Habitat Assessment for Significant Species

The availability of habitat on site was assessed taking into account a number of factors including:

- structural and floral diversity;
- occurrence and extent of habitat types in the general vicinity;
- continuity with similar habitat adjacent to the site, or connection with similar habitat off site by way of corridors;
- key habitat features such as tree hollows, water bodies, caves and crevices, rocky areas;
- degree of disturbance and degradation; and
- topographic features such as aspect and slope.

This information was used to evaluate Rixs Creek as potential habitat for any listed threatened species and determine if the proposed works are likely to have any significant impact. This evaluation was based on the ecological requirements of each threatened species considered and the potential impact of the proposed works on any habitat present. The habitat assessment is provided in **Appendix III.**

2.5 Aquatic Survey & Assessment

A rapid assessment in the form of a SIGNAL test was performed within Rixs Creek to give an indication of the current water quality within the creek. The assessment of Rixs Creek involved dip netting to sample any invertebrate or fish species present. This information is then used as a bio-indicator to determine the health of the waterway by the absence or presence of certain indicator species.

Sampling of macroinvertebrates was undertaken based on the AUSRIVAS protocol for collecting and processing samples in NSW (DEC, 2004). A score for each water sample was produced via the SIGNAL method (Chessman, 2003) and this score was then used to give an indication of the water quality within the creek. The interpretation of the grading system is given below in **Table 3**.

Table 3: Interpretation of SIGNAL scores

SIGNAL II Creek Score	Grade	Grade Interpretation
≥ 6	A	Biodiversity "hot spot" with high scoring bugs Pristine water quality and habitat
4 - < 6	B	Good biodiversity and many high scoring water bugs Excellent water quality and habitat
2 - < 4	C	Fair biodiversity and loss of pollution sensitive bugs Potential disturbance to water quality or less habitat
1 - < 2	D	Poor biodiversity and most bugs sensitive to pollution have been lost Substantial disturbance to water quality or little habitat
< 1	E	Only hardy, pollutant-tolerant bugs remain Very poor water quality or no habitat

Fish surveys were limited to incidental observations made during dip-netting and other surveys as no electro-fishing or gill netting was undertaken.

2.6 Limitations

The effectiveness of a survey detecting a given species will be influenced by a range of factors. For this type of survey, such limitations are generally related to the short period of time in which the fieldwork was carried out during one season. Given the small period of time spent on site, the detection of certain species may be limited by:

- seasonal migration (particularly migratory birds);
- seasonal flowering periods (some species are cryptic and are unlikely to be detected outside of the known flowering period);
- seasonal availability of food such as blossoms;
- weather conditions during the survey period (some species may go through cycles of activity related to specific weather conditions, for example some microchiropteran bats, reptiles and frogs can be inactive during cold weather); and
- species lifecycle (cycles of activity related to breeding).

These limitations have been overcome by applying the precautionary principle in all cases where the survey methodology may have given a false negative result. All species have been assessed on the basis of the presence of their habitat and the likely significance of that habitat to a viable local population.

3. RESULTS

3.1 Flora

3.1.1 Vegetation Assemblages

Due to the high level of disturbance within the Rixs Creek catchment, much of the native vegetation in the vicinity of the subject site has been removed or is highly modified. Four vegetation communities have been previously mapped within close vicinity to Rixs Creek (Peake, 2006) as shown in **Figure 3**. These vegetation communities included:

- Central Hunter Swamp Oak Forest (CHSOF);
- Hunter Valley River Oak Forest (HVROF);
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest (CHISGGB); and
- Central Hunter Box – Ironbark Forest (CHBIF).

Each of these vegetation communities were observed within the vicinity of Rixs Creek. The riparian zone was primarily composed of CHSOF; however, this was replaced by mostly cleared CHISGGB in the drier upper reaches of the creek. No areas of CHISGGB were previously mapped within the riparian areas in the upper reaches of the creek; however, field investigations identified some small areas of this community and these have also been included in **Figure 3**. Descriptions of the vegetation communities recorded within the riparian zone are provided below.

3.1.1.1 Central Hunter Swamp Oak Forest

TSC Act Status: Not listed.
EPBC Act Status: Not listed.

This assemblage is distributed along the majority of Rixs Creek and occurs along the banks and alluvial flats. The community is characterised by a mostly monotypic canopy of swamp oak (*Casuarina glauca*); however, River Oak (*Casuarina cunninghamiana*) also occurs in the lower reaches of the creek. Specimens of forest red gum (*Eucalyptus tereticornis*), rough-barked apple (*Angophora floribunda*) and narrow-leaved ironbark (*E. crebra*) also occur sporadically throughout. The community is generally subject to high levels of disturbance given that much of the vegetation outside the riparian zone has been subject to clearing and cattle grazing. Weed species were common throughout with sharp rush (*Juncus acutus*) particularly prevalent. Aquatic vegetation was very limited due to the dry conditions encountered at the time of the survey.

Vegetation Structure – Central Hunter Swamp Oak Forest

Strata	Height	Species
Emergents	To 25m	Forest Red Gum (*Eucalyptus tereticornis*), Rough-barked Apple (*Angophora floribunda*), Narrow-leaved Ironbark (*E. crebra*)
Canopy	To 15m	Swamp Oak (*Casuarina glauca*), River Oak (*Casuarina cunninghamiana*)
Shrub	To 4m	Rough Fruit Pittosporum (*Pittosporum revolutum*)
Ground Layer	1m	Common Couch (*Cynodon dactylon*), Mat-rush (*Lomandra longifolia*), **Juncus acutus* (Sharp Rush), Common Rush (*Juncus usitatus*), Slender Bamboo Grass (*Austrostipa verticillata*), White Root (*Pratia purpurascens*)
Aquatics		Native Reed (*Phragmites australis*), Cumbungi (*Typha orientalis*), Water Ribbons (*Triglochin procera*)

* Indicates non-native species

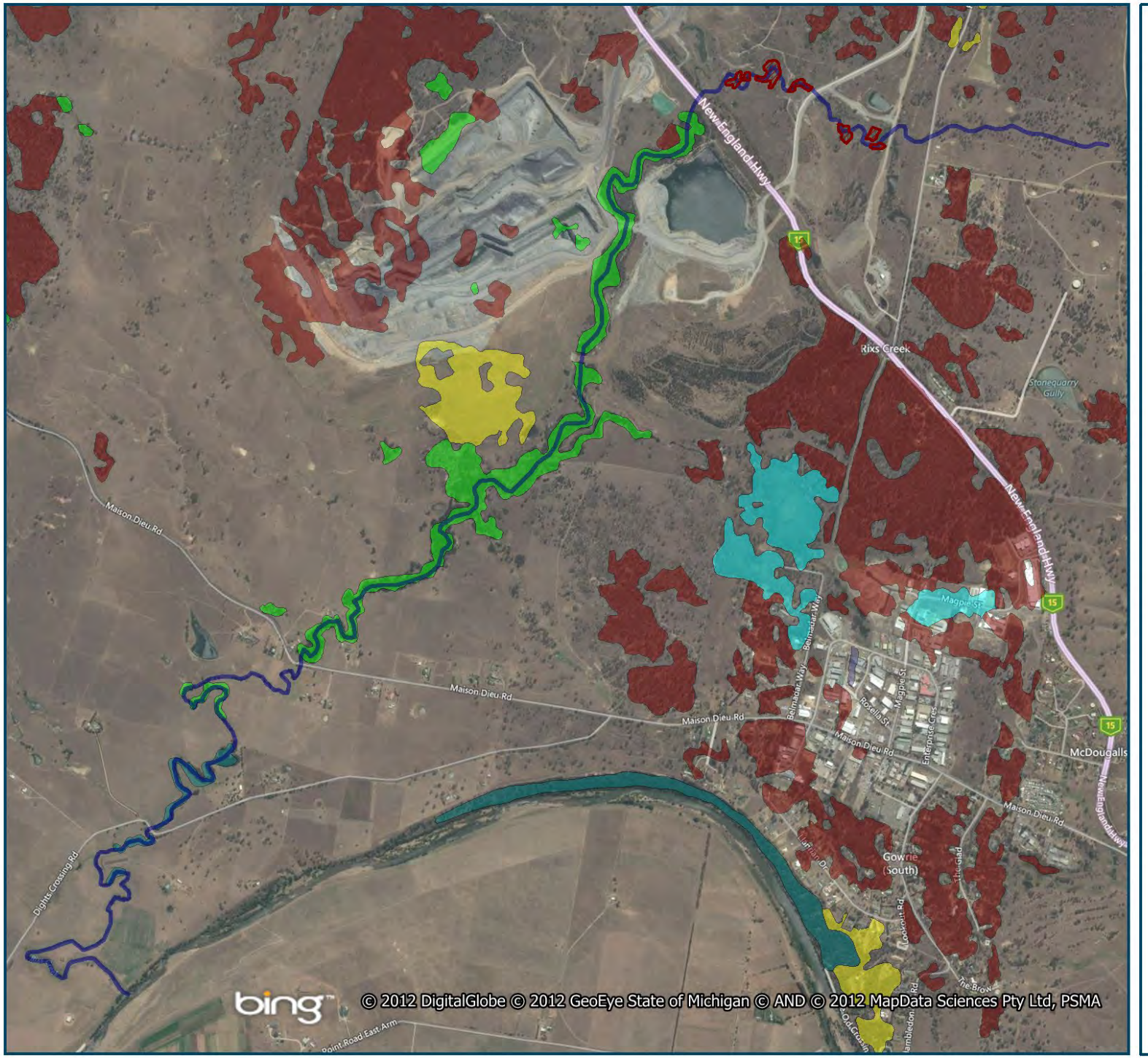

Figure 3: Extant Vegetation Communities

Client: JP Environmental

Project: Rixs Creek Ecological Impact Assessment

Source: Peake (2006)

Vegetation Communities

- Central Hunter Box - Ironbark Woodland
- Central Hunter Bulloak Forest Regeneration
- Central Hunter Ironbark - Spotted Gum - Grey Box Forest
- Central Hunter Swamp Oak Forest
- Hunter Floodplain Red Gum Woodland Complex
- Hunter Valley River Oak Forest
- Previously unmapped areas of CHISGGBF present within the upper reaches of Rixs Creek
- Rixs Creek

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Photo 1: Example of CHSOF located approximately 1km upstream of Maison Dieu Road

Photo 2: Example of CHSOF located approximately 600m downstream of New England Highway

3.1.1.2 Central Hunter Ironbark - Spotted Gum - Grey Box Forest

TSC Act Status: Endangered Ecological Community
EPBC Act Status: Not listed.

This assemblage occurs along the usually dry upper reaches of Rixs Creek. This area has been subject to clearing, resulting in this assemblage consisting of some large remnant trees along the creek bank and some areas of associated regrowth. Swamp Oak is generally absent or sparse within this area replaced with myrtaceous species including Spotted Gum (*Corymbia* maculata), Narrow-leaved Ironbark, Forest Red Gum and Rough-barked Apple. The grassy understorey was composed of a mixture of native and exotic herbs and grasses with few native shrubs present.

Vegetation Structure – Central Hunter Ironbark – Spotted Gum – Grey Box Forest

Strata	Height	Species
Canopy	To 25m	Spotted Gum (*Corymbia* maculata), Forest Red Gum (*Eucalyptus tereticornis*), Rough-barked Apple (*Angophora floribunda*), Narrow-leaved Ironbark (*E. crebra*)
Mid-canopy	To 8m	Bulloak(*Allocasuarina luehmannii*)
Shrub	To 4m	Silver-stemmed Wattle (*Acacia parvipinnula*)
Ground Layer	1m	Common Couch (*Cynodon dactylon*), **Juncus acutus* (Sharp Rush), Gorse Bitter Pea (*Daviesia ulicifolia*), Slender Bamboo Grass (*Austrostipa verticillata*), Kangaroo Grass (*Themeda australis*), White Root (Pratia *purpurascens*), Mat-rush (*Lomandra longifolia*), *Purpletop (*Verbena bonariensis*)
Aquatics		Native Reed (*Phragmites australis*), Cumbungi (*Typha orientalis*)

Photo 3: Example of CHISGGB present within upper reaches of Rixs Creek

3.1.2 Threatened Ecological Communities

CHISGGB is a listed Endangered Ecological Community (EEC) under the TSC Act. As detailed above, this community is present in the upper reaches of Rixs Creek and has the potential to be impacted by the proposed works. An assessment of significance for this EEC is provided in **Appendix IV**. No other EECs were identified within the Rixs Creek riparian zones.

Database searches also identified one EEC listed under the EPBC Act that has the potential to occur in the study area:

- White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

This EEC was not observed during the site visit and is not known to occur within the vicinity of the study area.

3.1.3 Threatened Flora and Endangered Populations

Database searches identified seven threatened flora species and three endangered populations with the potential to occur within the locality of the subject site. A habitat assessment determining the likelihood of these species to be impacted by the proposed works is provided in **Appendix III.**

The habitat assessment identified that habitat for two of these species, *Eucalyptus glaucina* (Slaty Red Gum) and *Eucalyptus camaldulensis* (River Red Gum Endangered Population in the Hunter Valley), had potential to be impacted by the proposed works and an assessment of significance for these species is provided in **Appendix IV.**

3.1.4 Noxious weeds

The study area was generally dominated by a variety of exotic grasses and herbaceous weeds. These are primarily environmental and agricultural weeds. Two noxious weeds listed in the Singleton LGA were recorded on site and are listed below in **Table 4**.

Table 4: Noxious weeds recorded on site.

Scientific Name	Common Name	Weed Class[1] Singleton LGA
Ailanthus altissima	Tree of Heaven	Class 4
Bryophyllum delagoense	Mother of Millions	Class 3
Cestrum parqui	Green Cestrum	Class 3
Lycium ferocissimum	African Boxthorn	Class 4
Opuntia aurantiaca	Tiger Pear	Class 4
Opuntia stricta	Prickly Pear	Class 4

[1] Control Classes under the Noxious Weeds Act 1993.

Class 1 & 2	This plant must be eradicated from the land and the land must be kept free of this plant.
Class 3	This plant must be fully and continuously suppressed and destroyed.
Class 4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the LCA. Must also, 'not be sold, propagated or knowingly distributed'.
Class 5	The requirements of the Noxious Weeds Act 1993 for a notifiable weed must be complied with.

Galenia pubescens (Galenia), *Olea europea* ssp. *cuspidata* (African Olive) and *Araujia sericifera* (Moth Vine) were also common within the study area and these are listed noxious weeds throughout other LGAs in NSW. Noxious weeds require appropriate control in order to comply with the Noxious Weeds Act.

3.1.5 Aquatic Survey & Assessment

The results of the rapid assessment macroinvertebrate surveys are given below.

Table 5: SIGNAL results – 'Below Operation'

Order	Family	No. of Taxa	Abundance	Weight Factor	SIGNAL Sensitivity Grade	Grade x Weight Factor
Gastropoda	Lymnaeidae	1	3	2	1	2
Decapoda	Atyidae	1	>20	5	3	15
Diptera	Culicidae	1	9	3	1	3
Coleoptera	Dytiscidae	1	>20	5	2	10
Hemiptera	Notonectidae	1	3	2	1	2
Trichoptera	Leptoceridae	1	1	1	6	6
Totals				**18**		**28**

SIGNAL SCORE = 28/18 **= 1.56**
SIGNAL GRADE = D
Gambusia present = YES

Photo 4: 'Below Operation' survey location

Table 6: SIGNAL results – Maison Dieu Bridge

Order	Family	No. of Taxa	Abundance	Weight Factor	SIGNAL Sensitivity Grade	Grade x Weight Factor
Decapoda	Atyidae	1	>20	5	3	15
Diptera	Culicidae	1	>20	5	1	5
Coleoptera	Dytiscidae	1	>20	5	2	10
Hemiptera	Notonectidae	1	16	4	1	4
Hemiptera	Corixidae	1	4	2	2	4
Odonata	Lindeniidae	1	1	1	3	3
Trichoptera	Leptoceridae	1	1	1	6	6
Diptera	Chironomidae	1	9	3	3	9
Hemiptera	Veliidae	1	14	4	3	12
Totals				**30**		**68**

SIGNAL SCORE = 68/30 **= 2.27**
SIGNAL GRADE = C
Gambusia present = YES

Photo 5: Maison Dieu Bridge survey location

Table 7: SIGNAL results – Dights Crossing

Order	Family	No. of Taxa	Abundance	Weight Factor	SIGNAL Sensitivity Grade	Grade x Weight Factor
Decapoda	Atyidae	1	>20	5	3	15
Diptera	Culicidae	1	>20	5	1	5
Coleoptera	Dytiscidae	1	>20	5	2	10
Acarina		1	3	2	6	12
Ephemeroptera	Baetidae	1	16	4	5	20
Hemiptera	Notonectidae	1	15	4	1	4
Hemiptera	Corixidae	1	10	3	2	6
Odonata	Coenagrionidae	1	1	1	2	2
Trichoptera	Leptoceridae	1	5	2	6	12
Diptera	Chironomidae	1	15	4	3	12
Hemiptera	Veliidae	1	>20	5	3	15
Totals				**40**		**113**

SIGNAL SCORE = 113/40 **= 2.825**
SIGNAL GRADE = C
Gambusia present = YES

Photo 6: Dights Crossing survey location

In general, the macroinvertebrate assessment confirms that Rixs Creek is subject to high levels of disturbance with pollutant sensitive invertebrates mostly absent. The number and diversity of invertebrates tended to increase downstream and this is likely to be related to the availability of larger pools and permanent water.

Monthly water quality testing is undertaken within Rixs Creek and also within the mine water storage dams. Data specific to the invertebrate testing locations and the mine storage dams is shown below in **Table 8**. Please note the no water quality testing is carried out at the Dights Crossing location.

Table 8: Summary of water quality data for Rixs Creek and mine water

Attribute	Maison Dieu Bridge	Below Operation	Clean Water Dam #4	Dirty Water Dam #1	Dirty Water Dam #2
pH					
Average	7.4	7.8	8.6	8.5	8.6
StdDev	0.43	0.49	0.61	0.3	0.34
5-95th %ile	6.5 - 7.8	6.9 - 8.3	7.5 - 9.6	8.1 - 9.1	8.1 - 9.1
EC (µS/cm)					
Average	1072	1131	4705	5374	6045
StdDev	1162	2046	2830	1702	1584
5-95th %ile	245 - 2880	276 - 3087	811 - 9572	3431 - 8461	3949 - 9030
TDS (mg/l)					
Average	727	750	2886	3366	3831
StdDev	728	1310	1778	1120	1230
5-95th %ile	201 - 1640	205 - 1707	534 - 5976	2010 - 5206	2374 - 5397
TSS (mg/l)					
Average	86	73	27	17	16
StdDev	408	89	37	36	29
5-95th %ile	4 - 452	3 - 195	1 - 94	1 - 59	1 - 53

Salinity within Rixs Creek appears to vary significantly depending on the testing location and prevailing rainfall conditions. Mine water currently stored within the dams on site has, on average, significantly higher salinity levels and slightly higher pH. Whilst water quality within Rixs Creek is generally poor, there is potential that mine water discharges may further decrease water quality with increased salinity levels, potentially impacting upon aquatic biodiversity. However, this impact is unlikely to be significant given that invertebrates within the creek must be well adapted to moderately saline and variable environments. Also, water quality impacts from mine water discharges will be minimised as discharges into the creek will be dictated by the Hunter River Salinity Trading Scheme (HRSTS). This is achieved by timing discharges into the creek during periods of high flow and low background salinity so that salinity targets, set under the scheme, are not exceeded.

3.2 Fauna

3.2.1 Fauna Habitat

Three broad habitat categories were identified within the study area. These include dry forest/woodland, grassland and creek habitats. Key habitat features recorded within these habitats includes:

- Culverts up to 40m in length provide potential nesting and roosting habitat for certain species of birds and microbats. During the survey, a single roosting microbat (tentatively identified as *Chalinolobus gouldii* (Gould's Wattled Bat) was observed in a mine road culvert and the presence of droppings suggest the culvert is utilised on a regular basis. *Hirundo ariel* (Fairy Martin) nests were also recorded within each culvert and these may also be utilised by some microbat species to roost.
- Creek with emergent vegetation and woody debris which provides habitat for a range of common frogs, reptiles and wetland birds. The creekline was very dry at the time of the survey with only small pools of stagnant water present within the upper reaches. Larger permanent pools became more prevalent in the lower reaches south of Dights Crossing.
- Grassland areas which provide foraging resources for a range of ground foraging birds and terrestrial mammals;
- Areas of regenerating and mature eucalypt trees – may provide roosting and/or foraging and/or breeding habitat for a range of birds, mammals, reptiles and frogs. Nests indicative of the threatened *Pomatostomus temporalis* (Grey-crowned Babbler) were observed within areas of regenerating trees adjacent to Rixs Creek.
- Limited ground cover including leaf litter and dense grasses and shrubs which may provide habitat and cover for a range of small terrestrial species.

The condition of native vegetation in the study area is generally poor due to previous clearing works. weed incursion and farm and mining activities.

A full list of fauna species observed during the survey is contained in **Appendix II**

3.2.2 Frog Survey Results

Four frog species, *Crinia signifera* (Common Eastern Froglet), *Litoria latopalmata* (Broad-palmed Tree Frog), *Litoria peronii* (Peron's Tree Frog) and *Litoria fallax* (Dwarf Tree Frog) were recorded during surveys. Each of these species was recorded at both survey locations. None of these amphibian species are listed as threatened under State or National legislation.

3.2.3 Culvert Inspections

A single microbat, tentatively identified as *Chalinolobus gouldii* (Gould's Wattled-bat), was recorded roosting within a mine road culvert along Rixs Creek. The presence of droppings suggests the culvert is utilised on a regular basis. This species is not listed as threatened under state or national legislation; however, an assessment of significance for other threatened microbat species that may utilise this habitat is provided in **Appendix IV**

3.2.4 Threatened Fauna

The database searches for the survey area identified forty threatened fauna species with the potential to occur within the locality of the subject site. A habitat assessment determining the likelihood of these species to be impacted by the proposed works is provided in **Appendix III.**

The habitat assessment identified ten threatened fauna species with the potential to be impacted by the proposed works and an assessment of significance for these species is provided in **Appendix IV**:

Fauna

- *Litoria aurea* Green And Golden Bell Frog
- *Chalinolobus dwyeri* Large-eared Pied Bat
- *Saccolaimus flaviventris* Yellow-bellied Sheathtail-bat
- *Mormopterus norfolkensis* East Coast Freetail-bat
- *Falsistrellus tasmaniensis* Eastern False Pipistrelle
- *Miniopterus australis* Little Bentwing-bat
- *Miniopterus schreibersii* ssp. *oceanensis* Large Bentwing-bat
- *Myotis macropus* Southern Myotis
- *Scoteanax rueppellii* Greater Broad-nosed Bat
- *Vespadelus troughtoni* Eastern Cave Bat

The remaining thirty threatened species assessed were unlikely to occur within the subject site or the habitat to be impacted was not considered important for their survival. Consequently no further assessment was required.

4. POTENTIAL IMPACTS

The potential impacts discussed in this section are based on a desktop assessment of the study area and field investigations. Potential impacts to ecological values (flora, fauna and vegetation communities) as a result of the proposed works may include the following.

4.1 Modification of Riparian Vegetation

Where present, the native riparian vegetation in the upper reaches of Rixs Creek is predominantly composed of remnant or regrowth Central Hunter Ironbark – Spotted Gum – Grey Box Forest, an endangered ecological community. The increased quantity and frequency of saline flows into the upper reaches may create conditions more suited to the Swamp Oak community common downstream. This may see the Swamp Oak community extend further upstream over time.

4.2 Culvert Flooding

The flooding of culverts along Rixs Creek has the potential to impact on species that may roost or nest in the culvert such as *Hirundo ariel* (Fairy Martin) and a number of microbat species. This may result in species utilising the culvert to temporarily vacate during flooding events and increase the risk of mortality if culverts are fully submerged. Substantial discharges will only occur when the creek is already flowing, thus an increased risk of mortality is minimal given that species utilising the culvert are likely to have already been displaced by naturally occurring high flows in the creek. Smaller discharge events that may occur when the Hunter River is in "high flow" will have a negligible effect on water height within the culverts, posing no risk of mortality.

4.3 Weeds

The movement of soil by increased water flows and the disturbance of soil from consequent erosion can lead to further weed infestation within the study area. Increased weed growth often results in decreased native diversity and can further degrade local native flora and fauna habitats.

4.4 Erosion

The proposed flows into Rixs Creek have the potential to increase erosion within the riparian zone, particularly in areas with minimal vegetation or unstable creek banks. During flow events, large volumes of water have the capacity to effectively wash away disturbed and unstable soils resulting in sedimentation and periods of increased turbidity.

4.5 Aquatic Impacts

Rixs Creek is already subject to high levels of disturbance from surrounding land uses. Impacts relating to the proposed discharges of mine water into Rixs Creek include potential increases to average salinity and pH and also subject the creek to sedimentation and increased turbidity from erosion.

5. IMPACT ASSESSMENT

5.1 Fisheries Management Act 1994

Part 7A of the *Fisheries Management Act 1994* (FM Act) identifies threatened species, populations and endangered ecological communities that require consideration when developments and actions have the potential to impact on fish habitats. Database searches (OEH and DoE) did not identify any protected or threatened aquatic species known to occur in the local area and given the very limited fish habitat available within Rixs Creek, a seven part test under the FM Act is not required.

However, a number of threatening processes listed under the FM Act could apply to the proposed works. These threatening processes should be considered during planning and avoided or mitigated where possible. Key threatening processes pertinent to the proposed works include:

- **The degradation of native riparian vegetation along NSW watercourses**
  The proposed flows have the potential to further degrade riparian vegetation along Rixs Creek primarily through increased erosion and weed incursion. Appropriate measures to limit erosion within the creekline should be implemented where possible and weed growth monitored and managed accordingly.

- **Instream structures and other mechanisms that alter natural flow**
  The proposed discharge of water into Rixs Creek has the potential to impact the natural flow regime by altering the magnitude and variability of flow events. The HRSTS ensures that mine discharges only occur when there are high or flood flows, thus there should be negligible affects to seasonality, frequency and timing of flows. Also, it should be noted that the Rixs Creek catchment area has been reduced by mining activities, effectively reducing total runoff by 29% and average daily flows by 27%, and the proposed discharge flows will marginally restore these values.

5.2 Threatened Species Conservation Act 1995

5.2.1 Endangered Ecological Communities

Remnant vegetation within the riparian zones of the upper reaches of Rixs Creek is consistent with the EEC – "Central Hunter Ironbark – Spotted Gum – Grey Box Forest". This community is highly disturbed within the subject site primarily as a result of historical clearing and grazing. The proposed flows into the upper reaches may create conditions more suited to the Swamp Oak community common downstream. This may result in the Swamp Oak community extending further upstream over time encroaching on the current extent of this EEC.

An assessment of significance for this EEC, pursuant to the TSC Act, is provided in **Appendix IV**. This assessment concluded that the proposed flows would not result in a significant impact to this EEC given its highly disturbed nature and the small area to be impacted.

5.2.2 Threatened Flora Species

Potential habitat for two threatened flora species, *Eucalyptus glaucina* (Slaty Red Gum) and *Eucalyptus camaldulensis* (River Red Gum Endangered Population in the Hunter Valley), was identified within the Rixs Creek riparian zone. Assessments of significance pursuant to both the TSC Act and EPBC Act for this species are provided in **Appendix IV**. This assessment concluded that the

proposed flows would not result in a significant impact to these species given the small area of habitat within the subject site and that neither of these species is likely to be directly impacted by the proposed works.

5.2.3 Threatened Fauna

The habitat assessment identified ten threatened fauna species (nine microbats and one frog) with the potential to be impacted by the proposed works. An assessment of significance pursuant to the TSC Act for these species is provided in **Appendix IV**.

The assessment on threatened microbats concluded that the increased flooding of the culverts along Rixs Creek may temporarily restrict access or disturb microbats that seasonally roost within the culvert. However, this was considered unlikely to have a significant impact on a local threatened microbat population given the absence of suitable roosting habitat within the culverts.

The assessment also noted that the proposed discharge of mine water has the potential to further degrade water quality and habitat for Green and Golden Bell Frog. However, considering the marginal nature of habitat available within Rixs Creek and limited connectivity to known populations, the assessment concluded the proposed flows are unlikely to have a significant impact on a local population.

5.3 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) requires approval of the Commonwealth Minister representing the Department for Sustainability, Environment, Water, Population and Communities, for actions that may have a significant impact on Matters of National Environmental Significance (MNES). The EPBC Act also requires Commonwealth approval for certain actions on Commonwealth land.

MNES protected under the EPBC Act include:

- World Heritage properties;
- National Heritage places;
- RAMSAR wetlands of international importance;
- threatened species or ecological communities listed in the EPBC Act;
- migratory species listed in the EPBC Act;
- the Great Barrier Reef Marine Park;
- Commonwealth marine environment; and
- nuclear actions.

With regard to flora and fauna, the only MNES relevant to the study area are nationally listed threatened species and migratory species. The DSEWPAC protected matters search for the site is provided in **Appendix V**. An assessment has been made to determine whether or not the proposal will have, or is likely to have a significant impact on these MNES and is provided below.

No nationally threatened species are known to occur on the subject site. Nationally threatened species with the potential to be impacted by the proposed flows into Rixs Creek include:

- *Eucalyptus glaucina* Slaty Red Gum
- *Litoria aurea* Green and Golden Bell Frog
- *Chalinolobus dwyeri* Large-eared Pied Bat

Each of these nationally listed species has been addressed under the provisions of State legislation (that is Section 5A of the NSW EP&A Act) and given the small area and or marginal nature of habitat to be impacted it was assessed that the proposed project was unlikely to have a significant impact on a local population of these species. As a result no further assessment under the provisions of the EPBC Act is warranted for these two species.

5.3.1 Migratory species protected under international agreements

Twelve nationally listed migratory species were recorded on the DSEWPAC on-line database or are considered to have potential habitat available within 10km of the site as listed in **Table 9**.

Table 9: Listed migratory species with the potential to occur in the local area.

Apus pacificus	Fork-tailed Swift
Ardea alba	Great Egret
Ardea ibis	Cattle Egret
Haliaeetus leucogaster	White-bellied Sea-Eagle
Hirundapus caudacutus	White-throated Needletail
Merops ornatus	Rainbow Bee-eater
Monarcha melanopsis	Black-faced Monarch
Myiagra cyanoleuca	Satin Flycatcher
Rhipidura rufifrons	Rufous Fantail
Anthochaera phrygia	Regent Honeyeater
Gallinago hardwickii	Latham's Snipe
Rostratula australis	Australian Painted Snipe

The proposed works are unlikely to impact on any area considered to be 'important habitat' for the above migratory species, or likely to impact a significant proportion of a migratory population

6. MITIGATION MEASURES

The following mitigation measures are recommended to minimise the ecological impact of the proposed flows into Rixs Creek.

6.1 Creek Protection

An erosion and sediment control plan already exists for Rixs Creek. The following measures should be considered for inclusion within the plan to minimise the potential impacts of water discharges into the creek.

- Monitoring of erosion controls should be undertaken after significant flow events to ensure their effectiveness is maintained. Should adverse erosion impacts from mine water flows be identified, these should be included within the site erosion and sediment control plan identifying suitable management options.
- Any riparian revegetation works should utilise native species (trees, shrubs and ground cover) characteristic of local vegetation communities found along Rixs Creek. Suitable species for replanting are designated by an 'R' in **Appendix I**.
- Current site weed control programs should be adapted to account for the increased weed growth that may arise as a result of increased flows.

6.2 Fauna Protection

- Increased frequency of flooding of culverts along Rixs Creek has the potential to impact on species that may roost or nest in the culvert such as *Hirundo ariel* (Fairy Martin) and a number of microbat species. When possible, flows should be managed to limit the culverts being totally inundated to minimise the mortality risk to species utilising the culvert. Partial flooding of the culverts will allow species to continue roosting and vacate as required.

7. CONCLUSION

Flora, fauna and habitat studies have been undertaken to identify and assess the potential ecological impacts resulting from the proposed mine water discharges into Rixs Creek near Singleton.

Endangered ecological communities and threatened species that may be impacted by the proposed works include:

- Central Hunter Ironbark – Spotted Gum – Grey Box Forest (EEC)
- *Eucalyptus camaldulensis* River Red Gum (Endangered Population)
- *Eucalyptus glaucina* Slaty Red Gum
- *Litoria aurea* Green and Golden Bell Frog
- *Chalinolobus dwyeri* Large-eared Pied Bat
- *Saccolaimus flaviventris* Yellow-bellied Sheathtail-bat
- *Mormopterus norfolkensis* East Coast Freetail-bat
- *Falsistrellus tasmaniensis* Eastern False Pipistrelle
- *Miniopterus australis* Little Bentwing-bat
- *Miniopterus schreibersii* ssp. *oceanensis* Large Bentwing-bat
- *Myotis macropus* Southern Myotis
- *Scoteanax rueppellii* Greater Broad-nosed Bat

This assessment has determined that the proposed project is unlikely to have a significant impact on any of the above threatened species or EECs, under State (TSC Act and FM Act) or Federal (EPBC Act) legislation, given the disturbed nature of the subject site and limited impacts to the habitat currently present.

A number of mitigation measures, listed in **Section 6**, have been provided to help limit the impact of proposed works on habitat within the study area.

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Appendix I

Flora Species List

Flora Species List

The following is a list of all flora species recorded within the site. It should be noted that such a list cannot be considered comprehensive, but rather indicative of the flora. A period of some years is often required to identify all species present in an area, particularly for cryptic or seasonally detectable species (such as orchids, some grasses and grass-like herbs).

Notes

*Indicates an exotic or non-local / planted native species
R – Indicates a species suitable for native revegetation works
Threatened or rare species are listed in **bold** font.

Scientific Name	Common Name	
CLASS FILICOPSIDA (FERNS)		
SCHIZACEAE		
Adiantum aethiopicum	Common Maidenhair Fern	
CLASS MAGNOLIOPSIDA (FLOWERING PLANTS)		
SUBCLASS LILIIDAE (Monocotyledons)		
ALLIACEAE		
**Nothoscordum gracile*	Wild Onion	
ALISMATACEAE		
Damasonium minus	Starfruit	
CYPERACEAE		
AGAVACEAE		
Aloe sp.		
JUNCACEAE		
Juncus usitatus	Common Rush	R
**Juncus acutus*		
JUNCAGINACEAE		
Triglochin procera	Water Ribbons	
LOMANDRACEAE		
Lomandra multiflora		R
Lomandra longifolia	Mat Rush	R
POACEAE		
Austrostipa verticillata	Slender Bamboo Grass	
**Avena barbata*	Bearded Oats	
**Briza minor*	Shivery Grass	

Scientific Name	Common Name
**Chloris gayana*	Rhodes Grass
Cynodon dactylon	Common Couch
Microlaena stipoides	Weeping Meadow Grass
**Paspalum dilatatum*	Paspalum
Phragmites australis	Native Reed
Poa labillardierei	Tussock Grass
Themeda australis	Kangaroo Grass
TYPHACEAE	
Typha orientalis	Cumbungi
SUBCLASS MAGNOLIIDAE (Dicotyledons)	
ACANTHACEAE	
Brunoniella australis	Blue Trumpet
AMYGDALACEAE	
Prunus sp.	
APIACEAE	
**Cyclospermum leptophyllum*	Slender Celery
APOCYNACEAE	
**Araujia sericifera*	Moth Vine
**Nerium oleander*	Oleander
ASCLEPIADACEAE	
**Gomphocarpus fruticosus*	Narrow-leaf Cotton Bush
ASTERACEAE	
**Bidens pilosa*	Cobbler's Pegs
Calotis lappulacea	Yellow Burr Daisy
**Cirsium vulgare*	Spear Thistle
**Carthamus lanatus*	Saffron Thistle
**Conyza bonariensis*	Flaxleaf Fleabane
Cotula coronopifolia	Waterbuttons
**Gnaphalium pensylvanicum*	Cudweed
**Hypochaeris radicata*	Cat's Ear
**Senecio madagascariensis*	Fireweed
**Silybum marianum*	Variegated Thistle
**Sonchus oleraceus*	Common Sowthistle
AIZOACEAE	

Scientific Name	Common Name	
**Galenia pubescens*	Galenia	
CACTACEAE		
**Opuntia aurantiaca*	Tiger Pear	
**Opuntia stricta var. stricta*	Prickly Pear	
CASUARINACEAE		
Allocasuarina luehmannii	Bulloak	
Casuarina cunninghamiana	River Oak	R
Casuarina glauca	Swamp Oak	R
CHENOPODIACEAE		
Enchylaena tomentosa	Ruby Saltbush	
CHLOANTHACEAE		
Spartothamnella juncea	Bead Bush	
COMMELINACEAE		
Commelina cyanea	Scurvy Weed	
CONVOLVULACEAE		
Dichondra repens	Kidney Weed	
CRASSULACEAE		
**Bryophyllum delagoense*	Mother of Millions	
EUPHORBIACEAE		
Breynia oblongifolia	Breynia	
FABACEAE		
Daviesia ulicifolia ssp. *ulicifolia*	Gorse Bitter Pea	
**Vicia sativa*	Common Vetch	
GENTIANACEAE		
**Centaurium erythraea*	Common Centaury	
LOBELIACEAE		
Pratia purpurascens	White Root	
MALVACEAE		
**Abutilon grandifolium*	Hairy Indian Mallow	
**Sida rhombifolia*	Paddy's Lucerne	

Scientific Name	Common Name	
MELIACEAE		
Melia azedarach var. australasica	White Cedar	
MIMOSACEAE		
**Acacia amblygona*	Fan Wattle	
**Acacia longifolia*	Sydney Golden Wattle	
Acacia parvipinnula	Silver-stemmed Wattle	R
**Acacia saligna*	Golden Wreath Wattle	
MORACEAE		
**Morus nigra*	Black Mulberry	
MYOPORACEAE		
Eremophila debilis	Winter Apple	
MYRTACEAE		
Angophora floribunda	Rough-barked Apple	R
Corymbia maculata	Spotted Gum	R
Eucalyptus crebra	Narrow-leaved Ironbark	R
Eucalyptus moluccana	Grey Box	R
Eucalyptus tereticornis	Forest Red Gum	R
ONAGRACEAE		
**Oenothera stricta*	Evening Primrose	
OLEACEAE		
**Olea europea ssp. cuspidata*	African Olive	
PITTOSPORACEAE		
Pittosporum revolutum	Rough-fruit Pittosporum	
PLANTAGINACEAE		
**Plantago lanceolata*	Ribwort / Lamb's Tongues	
POLYGONACEAE		
Persicaria decipiens	Slender Knotweed	
Rumex brownii	Swamp Dock	
**Rumex crispus*	Curled Dock	
RANUNCULACEAE		
Clematis glycinoides	Forest Clematis	
ROSACEAE		

Scientific Name	Common Name
**Rosa* sp.	
**Rubus fruticosus*	Blackberry
RUTACEAE	
Geijera salicifolia	
SALICACEAE	
**Populus sp.*	Poplar
SCROPHULARIACEAE	
**Verbascum virgatum*	Twiggy Mullein
SIMAROUBACEAE	
**Ailanthus altissima*	Tree of Heaven
SOLANACEAE	
**Cestrum parqui*	Green Cestrum
**Lycium ferocissimum*	African Boxthorn
**Solanum nigrum*	Blackberry Nightshade
Solanum prinophyllum	Forest Nightshade
STERCULIACEAE	
Brachychiton populneus	Kurrajong
ULMACEAE	
Trema tomentosa	Native Peach
VERBENACEAE	
**Verbena bonariensis*	Purple Top
**Verbena rigida*	

Appendix II

Fauna Species List

Fauna Species List

The following is a list of all fauna species recorded within the site during the survey period.

Observation Type:

O – Observed	**B** – Burnt	**F** – Tracks/scratchings
T – Trapped or netted	**H** – Hair, feathers, or skin	**Y** – Bone or teeth
R – Road kill	**P** – Scat	**D** – Dog kill
W – Heard call	**C** – Cat kill	**Z** – In raptor/owl pellet
V – Fox kill	**E** – Nest/roost	**K** – Dead
M – Miscellaneous	**X** – In scat	**U** – Bat Recording

Notes

Threatened species appear in **bold** font.

? – Indicates a species identified without certainty or to a Genus level only.

* – Indicates an introduced species.

Scientific Name	Common Name	TSC Act	EPBC Act	Obs Type
BIRDS				
Family Anatidae				
Chenonetta jubata	Australian Wood Duck			O
Family Ardeidae				
Egretta novaehollandiae	White-faced Heron			O
Family Rallidae				
Porphyrio porphyrio	Purple Swamphen			
Porzana fluminea	Australian Spotted Crake			O?
Family Accipitridae				
Aquila audax	Wedge-tailed Eagle			O
Elanus notatus	Black-shouldered Kite			O
Family Columbidae				
Ocyphaps lophotes	Crested Pigeon			O
Family Cacatuidae				
Cacatua roseicapilla	Galah			O
Family Psittacidae				
Platycercus eximius	Eastern Rosella			O
Family Halcyonidae				
Dacelo novaeguineae	Laughing Kookaburra			O
Family Coraciidae				
Eurystomus orientalis	Dollarbird			O

Scientific Name	Common Name	TSC Act	EPBC Act	Obs Type
Family Maluridae				
Malurus cyaneus	Superb Fairy-Wren			O
Family Pardalotidae				
Pardalotus punctatus	Spotted Pardalote			W
Family Meliphagidae				
Lichenostomus chrysops	Yellow-faced Honeyeater			O
Manorina melanocephala	Noisy Miner			O
Family Pomatostomidae				
Pomatostomus temporalis	**Grey-crowned Babbler**			E
Family Pachycephalidae				
Pachycephala pectoralis	Golden Whistler			O
Family Dicruridae				
Rhipidura leucophrys	Willie Wagtail			O
Grallina cyanoleuca	Magpie-lark			O
Family Artamidae				
Cracticus torquatus	Grey Butcherbird			O
Gymnorhina tibicen	Australian Magpie			O
Strepera graculina	Pied Currawong			O
Family Corvidae				
Corvus coronoides	Australian Raven			O
Family Corcoracidae				
Corcorax melanorhamphos	White-winged Chough			O
Family Hirundinidae				
Hirundo ariel	Fairy Martin			E
Hirundo neoxena	Welcome Swallow			O,E
AMPHIBIANS				
Family Myobatrachidae				
Crinia signifera	Common Eastern Froglet			O
Family Hylidae				
Litoria fallax	Dwarf Tree Frog			O
Litoria latopalmata	Broad-palmed Frog			O
Litoria peronii	Peron's Tree Frog			W

Scientific Name	Common Name	TSC Act	EPBC Act	Obs Type
REPTILES				
Family Chelidae				
Chelodina longicollis	Eastern Snake-necked Tortoise			Y
Family Agamidae				
Physignathus lesuerii	Eastern Water Dragon			O
Family Scinidae				
Carlia tetradactyla	Southern Rainbow Skink			O
Eulamprus quoyii	Eastern Water Skink			O
Family Elapidae				
Pseudechis porphyriacus	Red-bellied Black Snake			O
Pseudonaja textilis	Eastern Brown Snake			O
MAMMALS				
Family Tachyglossidae				
Tachyglossus aculeatus	Echidna			O
Family Macropodidae				
Macropus giganteus	Eastern Grey Kangaroo			Y
Family Vespertilionidae				
Chalinolobus gouldi	Gould's Wattled bat			O?
Family Canidae				
**Vulpes vulpes*	Red Fox			O
Family Leporidae				
** Oryctolagus cuniculus*	European Rabbit			P

Appendix III

Threatened Species Habitat Assessment

The habitat assessment evaluating the site as potential habitat for each of the threatened species that may occur in the local area is provided below in Table A1. Habitat descriptions and information regarding local populations are based on OEH and DSEWPC threatened species profiles and databases and relevant species specific literature. The likelihood of a threatened species occurring on site is assessed based on the habitat requirements of each species, the habitat available within the study area, previous records and connectivity to known habitat areas. A significance assessment is undertaken if the proposed works have the potential to directly or indirectly impact the life cycle of a threatened species that may occur within the subject site.

Table A1: Habitat Assessment for Threatened Species

Species[1]	Status[2]	Habitat Description and Locally Known Populations[3]	Likelihood of Occurrence/Impact	Assessment of Significance
Flora				
Cymbidium canaliculatum Tiger Orchid (Endangered Population)	TSC Act - E2	Occurs within dry sclerophyll forests and woodlands of NSW tablelands and western slopes, growing in the hollows of trees. This species is an endangered population within the Hunter River catchment. Specimens in the Hunter catchment are most commonly associated with *Eucalyptus albens* (White Box).	Potential to occur No specimens were observed during fieldwork. Habitat is generally restricted to large Eucalypts on the outskirts of the riparian zone and this is unlikely to be impacted by the proposed works.	No
Prasophyllum sp. Wybong Leek Orchid	EPBC Act - CE ROTAP 2E	Is known to occur in open eucalypt woodland and grassland from seven populations in eastern NSW near Ilford, Premer, Muswellbrook, Wybong, Yeoval, Inverell and Tenterfield.	Unlikely This species is unlikely to occur given the disturbed nature of the understorey and proximity to known populations.	No
Bothriochloa biloba Lobed Blue-Grass	EPBC Act - V	This species has a broad distribution in northern New South Wales, but most records have been from the northern portions of the Brigalow Belt South and Nandewar bioregions. Prefers clay soils and is commonly recorded along roadsides and stock routes.	Unlikely This species is unlikely to occur given the disturbed nature of the understorey and proximity to known populations.	No
Pterostylis gibbosa Illawarra Greenhood	TSC Act - E EPBC Act - E ROTAP - 2E	Known from a small number of populations in the Hunter region (Milbrodale), the Illawarra region (Albion Park and Yallah) and the Shoalhaven region (near Nowra). In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark, Forest Red Gum and Black Cypress Pine.	Unlikely This species is unlikely to occur given the disturbed nature of the understorey and proximity to known populations.	No

Species[1]	Status[2]	Habitat Description and Locally Known Populations[3]	Likelihood of Occurrence/Impact	Assessment of Significance
Cynanchum elegans White-flowered Wax Plant	TSC Act - E1 EPBC Act - E ROTAP 3ECi	Restricted to eastern NSW where it is distributed from Brunswick Heads on the north coast to Gerroa in the Illawarra region. The species has been recorded as far west as Merriwa in the upper Hunter River valley. Usually occurs on the edge of dry rainforest vegetation.	Unlikely This species is unlikely to occur given the disturbed nature of study area and lack of commonly associated vegetation types.	No
Lepidium hyssopifolium Aromatic Peppercress	TSC Act - E1 EPBC Act - E	This species occurs in a variety of habitats including woodland with a grassy understorey and grassland. There are three known populations remaining in NSW.	Unlikely This species is unlikely to occur given the disturbed nature of the understorey and proximity to known populations.	No
Acacia pendula Hunter Catchment Population	TSC Act - E2	Within the Hunter catchment the species typically occurs on heavy soils, sometimes on the margins of small floodplains, but also in more undulating locations. This Hunter population is known to occur naturally as far east as Warkworth, and extends northwest to Muswellbrook and to the west of Muswellbrook at Wybong.	Unlikely This species is large and easily observed in the field. No specimens were observed on site and this species is unlikely to occur given the lack of commonly associated vegetation types.	No
Eucalyptus camaldulensis River Red Gum Endangered population in the Hunter Valley Catchment	TSC Act - EP	Occurs from the west at Bylong, south of Merriwa, to the east at Hinton, on the bank of the Hunter River. May occur with *Eucalyptus tereticornis*, *Eucalyptus melliodora*, *Casuarina cunninghamiana* subsp. *cunninghamiana* and *Angophora floribunda*.	Potential to occur Suitable riparian habitat is available for this species particularly along the banks of the lower reaches of Rixs Creek where permanent water is present.	Yes
Eucalyptus glaucina Slaty Red Gum	TSC Act - V EPBC Act - V ROTAP 3VCa	Principally occurs in the Casino area in northern NSW and from Gloucester to Broke, in mid-northern NSW. It grows mostly on gentle slopes near drainage lines in alluvial and clayey soils, in open forest.	Potential to occur Suitable habitat is available for this species along the length of Rixs Creek; however no specimens were observed during field surveys.	Yes
Euphrasia arguta	TSC Act - CE EPBC Act - CE	Recently rediscovered near Nundle. Current known populations are located in the Nundle State Forest in eucalypt forest with a mixed grass and shrub understorey.	Unlikely This species is unlikely to occur given the proximity to known populations.	No

Species[1]	Status[2]	Habitat Description and Locally Known Populations[3]	Likelihood of Occurrence/Impact	Assessment of Significance
Thesium australe Austral Toadflax	TSC Act - V EPBC Act - V	Found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. Occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast often in association with Kangaroo Grass.	Unlikely This species is unlikely to occur given the disturbed nature of the understorey and proximity to known populations.	No
Frogs				
Litoria aurea Green and Golden Bell Frog	TSC Act-E EPBC Act-E	Inhabits a range of waterbodies including swamps, lagoons, streams and ponds as well as dams, drains and storm water basins, particularly those containing bullrushes (*Typha* sp.) or spikerushes (*Eleocharis* sp.). Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available.	Potential to occur Habitat is available within the lower reaches of Rixs Creek (near Maison Dieu Rd to Hunter River) where permanent water is available. This habitat is marginalised given that minimal emergent vegetation is present along the majority of the waterway and the Plague Minnow was prevalent throughout. The habitat on site also has limited connectivity to other habitat areas particularly given the proximity to the nearest known population at Liddell.	Yes
Litoria booroolongensis Booroolong Frog	TSC Act-E EPBC Act-E	The Booroolong Frog is restricted to NSW and north-eastern Victoria, predominantly along the western-flowing streams of the Great Dividing Range. This species lives along permanent rocky streams with some fringing vegetation cover such as ferns, sedges or grasses.	Unlikely No suitable habitat is present given the lack of permanent streams and preferred habitat attributes.	No
Birds				
Rostratula australis Australian Painted Snipe	TSC Act - E EPBC Act - V	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.	Potential to occur May occasionally forage within Rixs Creek but not considered important given the marginal nature of habitat and mobility of this species.	No

Species[1]	Status[2]	Habitat Description and Locally Known Populations[3]	Likelihood of Occurrence/Impact	Assessment of Significance
Botaurus poiciloptilus Australasian Bittern	TSC Act - E EPBC Act - E	Lives alone or in loose groups and favours permanent fresh-waters dominated by sedges, rushes, reeds or cutting grasses (eg. Phragmites, Scirpus, Eleocharis, Juncus, Typha, Baumea and Gahnia).	Unlikely No suitable habitat is present given that Rixs Creek lacks suitable cover and emergent vegetation for this species.	No
Ephippiorhynchus asiaticus Black-necked Stork	TSC Act - V	Inhabits swamps associated with river systems and large permanent pools but sometimes appears on the coast or in estuaries. It has also been recorded on farm dams and sewage treatment ponds.	Potential to occur May occasionally forage within the waterbodies that traverse the site but not considered important habitat for this species.	No
Callocephalon fimbriatum Gang-gang Cockatoo	TSC Act - V	In summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. Moves to lower altitudes in winter, preferring more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas. Often found in urban areas.	Potential to occur May forage or nest within some trees on site This habitat is unlikely to be impacted by the proposed water flows.	No
Calyptorhynchus lathami Glossy Black-Cockatoo	TSC Act - V	Inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 m in which stands of She-oak species, particularly Black She-oak (*Allocasuarina littoralis*), Forest She-oak (*A. torulosa*) or Drooping She-oak (*A. verticillata*) occur.	Potential to occur The site lacks preferred foraging habitat for this species. The species may occasionally traverse the site travelling between areas of suitable habitat.	No
Glossopsitta pusilla Little Lorikeet	TSC Act - V	Forages primarily in the canopy of open Eucalypt forest and woodland, yet also forages on Angophoras, Melaleucas and other tree species. Riparian habitats are often utilised. Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species.	Potential to occur May forage or nest within some trees on site. This habitat is unlikely to be impacted by the proposed water flows.	No

Species[1]	Status[2]	Habitat Description and Locally Known Populations[3]	Likelihood of Occurrence/Impact	Assessment of Significance
Lathamus discolor Swift Parrot	TSC Act - E EPBC Act - E	Migrates to the Australian south-east mainland between March and October. Generally occur in areas where eucalypts are flowering profusely or where there are abundant lerp infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany, Spotted Gum, Red Bloodwood, Mugga Ironbark and White Box.	Potential to occur May forage within the trees on site but not considered important habitat for this species. This habitat is unlikely to be impacted by the proposed water flows.	No
Anthochaera phrygia Regent Honeyeater	TSC Act - CE EPBC Act - E	Inhabits eucalypt open forests and woodlands, predominantly box-ironbark types, but also Spotted Gum and Swamp Mahogany on the coast. The species also inhabits River She-oak gallery forest with *Amyema cambagei* (Needle-leaf Mistletoe). It is estimated that the NSW population of Regent Honeyeaters may now be fewer than 250 mature individuals.	Potential to occur May forage or nest within some trees on site This habitat is unlikely to be impacted by the proposed water flows.	No
Climacteris picumnus ssp. *victoriae* Brown Treecreeper	TSC Act - V	Found in eucalypt woodlands and dry open forest of the inland slopes and plains generally inland of the Great Dividing Range although has been recorded less commonly, in similar woodland habitats on the coastal ranges and plains. Mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey. Requires hollows for nesting and fallen timber is an important habitat component for foraging.	Potential to occur May forage or nest within vegetated areas on site This habitat is unlikely to be impacted by the proposed water flows.	No
Chthonicola sagittata Speckled Warbler	TSC Act - V	Lives in a wide range of eucalypt-dominated vegetation that typically includes scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area. This species is most frequently reported from the hills and tablelands of the Great Dividing Range, and rarely from the coast.	Potential to occur May forage or nest within vegetated areas on site This habitat is unlikely to be impacted by the proposed water flows.	No

Species[1]	Status[2]	Habitat Description and Locally Known Populations[3]	Likelihood of Occurrence/Impact	Assessment of Significance
Daphoenositta chrysoptera Varied Sittella	TSC Act - V	Inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and *Acacia* woodland. Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees, and from small branches and twigs in the tree canopy.	Potential to occur May forage or nest within vegetated areas on site This habitat is unlikely to be impacted by the proposed water flows.	No
Grantiella picta Painted Honeyeater	TSC Act - V	Lives almost entirely on the berries of mistletoes thus its movements are regulated by the fruiting of mistletoe plants.	Potential to occur May forage or nest within vegetated areas on site This habitat is unlikely to be impacted by the proposed water flows.	No
Melanodryas cucullata ssp. *cucullata* Hooded Robin	TSC Act - V	Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. This species generally requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses.	Potential to occur May forage or nest within vegetated areas on site This habitat is unlikely to be impacted by the proposed water flows.	No
Petroica boodang Scarlet Robin	TSC Act - V	Primarily a resident in forests and woodlands, but some adults and young birds disperse to more open habitats after breeding. This species lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. Habitat usually contains abundant logs and fallen timber and these are important components of its habitat.	Potential to occur May forage or nest within vegetated areas on site This habitat is unlikely to be impacted by the proposed water flows.	No
Petroica phoenicea Flame Robin	TSC Act - V	Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes and prefers clearings or areas with open understoreys. In winter, birds migrate to drier more open habitats in the lowlands including dry forests, open woodlands and in pastures and native grasslands, with or without scattered trees.	Potential to occur May forage or nest within vegetated areas on site This habitat is unlikely to be impacted by the proposed water flows.	No

Species[1]	Status[2]	Habitat Description and Locally Known Populations[3]	Likelihood of Occurrence/Impact	Assessment of Significance
Pomatostomus temporalis ssp. *temporalis* Grey-crowned Babbler	TSC Act - V	Open forest, woodland, scrubland, farmland and outer suburbs. Prefers woodlands with regenerating trees, tall shrubs, and an intact ground cover of grass and forbs.	**Present** Two Babbler nests were observed within small eucalypts outside the Rixs Creek riparian zone. Habitat for this species is unlikely to be impacted by the proposed water flows.	No
Stagonopleura guttata Diamond Firetail	TSC Act - V	Inhabits areas with a grassy, shrubby understorey including Eucalypt woodlands, forests, *Acacia* scrubs and mallee. Often found in riparian areas, and sometimes in lightly wooded farmland.	Potential to occur May forage or nest within vegetated areas on site. This habitat is unlikely to be impacted by the proposed water flows	No
Dasyornis brachypterus Eastern Bristlebird	TSC Act - E EPBC Act - E	Habitat is characterised by dense, low vegetation including heath and open woodland with a heathy understorey; in northern NSW occurs in open forest with tussocky grass understorey; all of these vegetation types are fire prone.	Unlikely No suitable habitat is present.	No
Erythrotriorchis radiatus Red Goshawk	TSC Act - CE EPBC Act - V	Inhabits open woodland and forest, preferring a mosaic of vegetation types, a large population of birds as a source of food, and permanent water, and are often found in riparian habitats along or near watercourses or wetlands. In NSW, preferred habitats include mixed subtropical rainforest, *Melaleuca* swamp forest and riparian *Eucalyptus* forest of coastal rivers.	Unlikely This species is unlikely to occur due to the disturbed nature of the site and proximity to known populations.	No
Hieraaetus morphnoides Little Eagle	TSC Act - V	Occupies open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used.	Potential to occur May hunt throughout the study area and potentially nest in large trees. Habitat for this species is unlikely to be impacted by the proposed water flows.	No

Species[1]	Status[2]	Habitat Description and Locally Known Populations[3]	Likelihood of Occurrence/Impact	Assessment of Significance
Circus assimilis Spotted Harrier	TSC Act - V	Occurs in grassy open woodland including *Acacia* and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	Potential to occur May hunt throughout the study area and potentially nest in large trees. Habitat for this species is unlikely to be impacted by the proposed water flows.	No
Ninox connivens Barking Owl	TSC Act - V	Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend into closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (e.g. western NSW) due to the higher density of prey on these fertile soils.	Potential to occur May hunt throughout the site; however no large hollows suitable for nesting were observed during field surveys. Habitat for this species is unlikely to be impacted by the proposed water flows.	No
Mammals				
Dasyurus maculatus ssp. *maculatus* Tiger Quoll	TSC Act - V EPBC Act - E	Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites with basking and latrine sites often nearby.	Unlikely This species is unlikely to occur due to the disturbed nature of the site and surrounding area and lack of suitable den sites nearby.	No
Phascogale tapoatafa Brush-tailed Phascogale	TSC Act - V	Prefers dry sclerophyll open forest with a sparse groundcover of herbs, grasses, shrubs or leaf litter but is also known to inhabit heath, swamps, rainforest and wet sclerophyll forest. Nests and shelters in tree hollows with entrances 2.5 - 4 cm wide and uses many different hollows over a short time span.	Potential to occur May forage or nest within the dry forest areas on site. This habitat is unlikely to be impacted by the proposed water flows.	No

Species[1]	Status[2]	Habitat Description and Locally Known Populations[3]	Likelihood of Occurrence/Impact	Assessment of Significance
Phascolarctos cinereus Koala	TSC Act - V	Inhabits eucalypt woodland and forest containing suitable food trees. Key food trees in the local area include *Eucalyptus tereticornis* (Forest Red Gum), *Eucalyptus robusta* (Swamp Mahogany), *Eucalyptus microcorys* (Tallowwood) and *Eucalyptus punctata* (Grey Gum).	Potential to occur *E. tereticornis* occurs throughout the site, albeit in relatively small numbers. A small number of Koalas have been recorded in the local area and may occasionally utilise the habitat on site. Habitat for this species is unlikely to be impacted by the proposed water flows.	No
Petrogale penicillata Brush-tailed Rock-wallaby	TSC Act - E EPBC Act - V	Found in steep rocky sites in sclerophyll forests with a grassy understorey.	Unlikely The site lacks suitable habitat for this species.	No
Petaurus norfolcensis Squirrel Glider	TSC Act - V	Inhabits dry sclerophyll forests and woodlands preferably with a canopy composed of multiple species, a shrub or Acacia midstorey and a heath understorey. Requires abundant tree hollows for refuge and nest sites.	Potential to occur May forage or nest within the dry forest areas on site. This habitat is unlikely to be impacted by the proposed water flows.	No
Pseudomys novaehollandiae New Holland Mouse	EPBC Act - V	Is known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes.	Unlikely This species is unlikely to occur due to the disturbed nature of the understorey and lack of associated vegetation types.	No
Pteropus poliocephalus Grey-headed Flying-Fox	TSC Act - V EPBC Act - V	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water and in vegetation with a dense canopy.	Potential to occur May seasonally forage within the trees on site. No roosting areas were observed during field surveys. This habitat is unlikely to be impacted by the proposed water flows.	No
Chalinolobus dwyeri Large-eared Pied Bat	TSC Act - V EPBC Act - V	Occupies dry sclerophyll forest and woodland. Roosts in caves, abandoned mud-nests of Fairy Martins and mine tunnels.	Potential to occur May forage throughout the study area and roost habitat is available within the culverts along Rixs Creek.	Possible

Species[1]	Status[2]	Habitat Description and Locally Known Populations[3]	Likelihood of Occurrence/Impact	Assessment of Significance
Saccolaimus flaviventris Yellow-bellied Sheathtail-bat	TSC Act - V	Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory. Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows.	Potential to occur May forage throughout the study area and roost habitat is available within the culverts along Rixs Creek.	Possible
Mormopterus norfolkensis East Coast Freetail-bat	TSC Act - V	Occur in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures.	Potential to occur May forage throughout the study area and roost habitat is available within the culverts along Rixs Creek.	Possible
Falsistrellus tasmaniensis Eastern False Pipistrelle	TSC Act - V	Inhabits sclerophyll forests preferring moist habitats with trees taller than 20m. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings.	Potential to occur May forage throughout the study area and roost habitat is available within the culverts along Rixs Creek.	Possible
Miniopterus australis Little Bentwing-bat	TSC Act - V	Inhabits a range of generally well-timbered habitats including but not restricted to rainforest, vine thickets, wet and dry sclerophyll forest coastal forests and Banksia scrub. Requires caves for breeding but has been recorded roosting within tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings.	Potential to occur May forage throughout the study area and roost habitat is available within the culverts along Rixs Creek.	Possible
Miniopterus schreibersii ssp. *oceanensis* Large Bentwing-bat	TSC Act - V	Inhabits a range of timbered habitats. Caves are the primary roosting habitat, but may also use derelict mines, storm-water tunnels, buildings and other man-made structures.	Potential to occur May forage throughout the study area and roost habitat is available within the culverts along Rixs Creek.	Possible
Myotis macropus Southern Myotis	TSC Act - V	Various habitats of the coast and adjacent ranges with suitable waterbodies for hunting; caves or similar structures for roosting. It occasionally uses tree hollows.	Potential to occur May forage throughout the study area and roost habitat is available within the culverts along Rixs Creek.	Possible

Species[1]	Status[2]	Habitat Description and Locally Known Populations[3]	Likelihood of Occurrence/Impact	Assessment of Significance
Vespadelus troughtoni Eastern Cave Bat	TSC Act - V	A cave dweller, known from wet sclerophyll forest and tropical woodlands. It has been also been found roosting in small groups in sandstone overhangs, in mine tunnels and occasionally in buildings.	Potential to occur May forage throughout the study area and roost habitat is available within the culverts along Rixs Creek.	Possible
Scoteanax rueppellii Greater Broad-nosed Bat	TSC Act - V	Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Usually roosts in tree hollows but has also been recorded in buildings.	Potential to occur May forage throughout the study area and roost habitat is available within large trees and the culverts along Rixs Creek.	Possible

Appendix IV

Assessments of Significance

Considerations under Section 5A of the EP&A Act 1979

Threatened species that have the potential to be impacted by the proposed works have been assessed under the guidelines of Section 5A of the *Environmental Planning & Assessment Act* (1979). The assessment is provided below in the form of a seven-part test.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Flora

***Eucalyptus glaucina* (Slaty Red Gum)**

Slaty Red Gum was not recorded within the subject site despite targeted searches. Suitable habitat is present along Rixs Creek and associated low-lying areas. Whilst the proposed flows are unlikely to remove any habitat for this species, there is potential for increased weed growth and erosion to further degrade habitat within the subject site. Considering the small area of habitat to be impacted by the proposed flows, and given the lack of specimens recorded in the local area, the proposed works are unlikely to impact on the lifecycle of this species such that the local population is placed at risk of extinction.

Fauna

***Litoria aurea* (Green and Golden Bell Frog)**

The Green and Golden Bell Frog was not recorded within the subject site despite targeted nocturnal and diurnal surveys. Areas of habitat were present for this frog species within the lower reaches of Rixs Creek (near Maison Dieu Rd to Hunter River) where permanent water is available. This habitat is marginalised given that minimal emergent vegetation is present along the majority of the waterway and the Plague Minnow was prevalent throughout. The last record of this species in the local area was a single specimen recorded in 1997 at Ravensworth West (OEH, 2013) approximately 14km to the west. Rixs Creek is located within highly cleared and modified landscape with limited connectivity to other habitat areas or known populations.

The proposed discharge of mine water into Rixs Creek has the potential to further degrade water quality and habitat present within the subject site. However, considering the marginal nature of habitat available within Rixs Creek and limited connectivity to known populations, the proposed flows are unlikely to have an adverse effect on the life cycle of this frog species such that a viable local population is likely to be placed at risk of extinction.

Microchiropteran Bats

The following threatened microbat species have been previously recorded in the local area and the increased flooding of culverts along Rixs Creek has the potential to impact on these species.

- *Chalinolobus dwyeri* Large-eared Pied Bat
- *Saccolaimus flaviventris* Yellow-bellied Sheathtail-bat
- *Mormopterus norfolkensis* East Coast Freetail-bat
- *Falsistrellus tasmaniensis* Eastern False Pipistrelle
- *Miniopterus australis* Little Bentwing-bat
- *Miniopterus schreibersii* ssp. *oceanensis* Large Bentwing-bat
- *Myotis macropus* Southern Myotis
- *Scoteanax rueppellii* Greater Broad-nosed Bat

The culverts along Rixs Creek are located in sections of the creek which appear to be dry or have low water levels the majority of the time. The proposed water flows are likely to result in increased flooding of the culverts potentially impacting on species that may roost within the culverts. A single microbat (tentatively identified as *Chalinolobus gouldii*) was recorded in a culvert during surveys and the presence of droppings suggest the culvert is utilised on a regular basis. Whilst *C. gouldii* is not a threatened species there is potential for the above threatened species to roost or seek refuge in the culverts. The culverts however, are unlikely to provide breeding habitat as this is considered to be absent due to the small size and shallow depths of the fissures present within the culverts.

When possible, measures to limit total inundation of the culverts will minimise or negate potential impacts to species roosting within the culverts. Flooding events may result in species utilising the culvert to temporarily vacate; however, given the lack of breeding habitat it is unlikely that the proposed flows will have an adverse impact on the lifecycle of a local population of these species.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

<u>Flora</u>

Eucalyptus camaldulensis **(River Red Gum population in the Hunter Valley)**

River Red Gum was not recorded within the subject site despite targeted searches. Suitable habitat is present along Rixs Creek, particularly along the banks of the lower reaches of Rixs Creek where permanent water is present. Whilst the proposed flows are unlikely to remove any habitat for this species, there is potential for increased weed growth and erosion to further degrade habitat within the subject site. Considering the small area of habitat to be impacted by the proposed flows and given the lack of specimens recorded in the local area, the proposed works are unlikely to impact on the lifecycle of this species such that a viable local population is placed at risk of extinction.

No other endangered populations are likely to be impacted by the proposed works

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

The EEC 'Central Hunter Ironbark - Spotted Gum – Grey Box' occurs along the usually dry, upper reaches of Rixs Creek. This area has been subject to historical clearing and grazing resulting in this assemblage consisting of some large remnant trees along the creek bank with some areas of associated regrowth with a modified understorey.

The proposed increase of flows into the upper reaches may, in some areas, create conditions more suited to the Swamp Oak community common downstream. This may result in the Swamp Oak community extending further upstream over time potentially encroaching on the current extent of this EEC along Rixs Creek. It should be noted that the previous reduction of natural flows within the catchment due to mining may also have had the opposite effect, resulting in conditions more suited to dry forest types.

The potential impact to this EEC will be limited to the highly disturbed riparian areas of upper sections of Rixs Creek and is unlikely to adversely affect the extent or modify the composition such that its local occurrence is placed at risk of extinction.

d) In relation to the habitat of a threatened species, population or ecological community:

i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The removal of habitat for each threatened species and EEC is discussed below.

Central Hunter Ironbark - Spotted Gum – Grey Box (CHISGGB) EEC	
i)	No area CHISGGB will be directly removed or modified as a result of the proposed flows. Increased flows into the usually dry upper sections of Rixs Creek may, in some areas, create conditions more suited to the Swamp Oak community common downstream. This may result in the Swamp Oak community extending further upstream over time. The areas of CHISGGB along Rixs Creek are highly disturbed and lack a native understorey.
ii)	The subject site is situated in an area already fragmented by mining and rural areas. The proposed flows are unlikely to isolate or fragment any habitat for this EEC.
iii)	The areas of this EEC along the upper reaches of Rixs Creek are highly disturbed and generally lack a native understorey. The small areas to be potentially impacted within the Rixs Creek riparian zones are not likely to be important for the long-term survival of this EEC in the local area.

***Eucalyptus glaucina* (Slaty Red Gum) & *Eucalyptus camaldulensis* (River Red Gum)**	
i)	No habitat for these species will be directly removed. The proposed flows may further exacerbate weed growth and erosion within potential habitat for these species. Similar habitat is common along creeks throughout the local area.
ii)	The subject site is situated in an area already fragmented by mining and rural areas. The proposed flows are unlikely to impede pollinators of these species such that the local population will become isolated.
iii)	Habitat to be impacted is generally highly disturbed and is not considered important for the long-term survival of this species in the locality.

***Litoria aurea* (Green and Golden Bell Frog)**	
i)	The proposed discharge of mine water into Rixs Creek has the potential to further degrade water quality and habitat present within the subject site. Similar habitat is common within creek lines throughout the local area; however, no specimens have been recorded within the local area since 1997.
ii)	The subject site is situated in an area already fragmented by mining and rural areas. The proposed flows are unlikely to further isolate or fragment any habitat for this species.
iii)	Habitat to be impacted is generally highly disturbed and common within creek lines throughout the

local area and is not considered important for the long-term survival of this species in the locality.

Microchiropteran Bats	
i)	The proposed water flows are likely to result in increased flooding of the culverts which may temporarily restrict microchiropteran bats from utilising the culvert. Foraging habitat is unlikely to be impacted by the proposed works.
ii)	No habitat would be isolated or fragmented for these highly mobile species as a result of the proposed works.
iii)	The culverts to be impacted by the proposed works lack suitable breeding habitat and the temporary exclusion of microbats is unlikely to affect the long-term survival of these species in the local area.

e) Whether the action proposed is likely to have an adverse effect on critical habitat.

No area identified as critical habitat is present within the study area.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

No recovery action plan is available for *Eucalyptus glaucina* or *Eucalyptus camaldulensis.* The proposed project would not be inconsistent with the objectives of any relevant threat abatement plan given the small area of highly disturbed habitat to be impacted by the works.

No recovery action plan or OEH recovery actions are available for the EEC CSISGGB. The proposed project would not be inconsistent with the objectives of any relevant threat abatement plan given the small area of highly disturbed habitat to be impacted by the works.

A draft recovery action plan is available for *Litoria aurea*. The proposed project would not be inconsistent with the recovery plan or objectives of any relevant OEH recovery actions given the study area lacks a resident population and the marginal nature of habitat to be impacted.

No recovery action plan is available for any of the threatened microbats considered in this report. The proposed project would not be inconsistent with the objectives of any relevant OEH recovery actions given the proposed works are unlikely to impact upon breeding habitat.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The 'Key Threatening Processes' currently listed under Schedule 3 of the TSC Act relevant to the proposed works are listed below:

Key Threatening Process	Applicability to proposed works
Invasion and establishment of exotic vines and scramblers	This threatening process is already present with exotic vines such as *Araujia sericifera* (Moth Vine) common throughout the subject site. Weed management actions are currently undertaken throughout the mine site and exotic vine growth should be monitored and controlled accordingly.

Key Threatening Process	Applicability to proposed works
Invasion of native plant communities by exotic perennial grasses	This threatening process is already present with introduced grasses dominating the understorey throughout much of the study area. Weed management actions are currently undertaken throughout the mine site and exotic grasses should be monitored and controlled accordingly.
Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata*	This threatening process is already present with African Olive common throughout the subject site, often a common component of the understorey. Weed management actions are currently undertaken throughout the mine site and African Olive growth should be monitored and controlled accordingly.

Mitigation measures for the proposed works will be implemented to minimise the impact of these key threatening processes.

Conclusion

As detailed above, given the highly disturbed nature of the surrounding area and limited habitat for most species, the proposed discharge of mine water into Rixs Creek is unlikely to have a significant impact on any threatened species, population or EEC such that a local population is placed at risk of extinction.

Appendix V

Matters of National Environmental Significance Search