Annexure 3:

Back Road WRS Assessment – Surface water quality modelling - GHD

Back Road WRS Assessment

Surface water quality modelling

Oceana Gold New Zealand Ltd.

09 October 2024

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1. Introduction

GHD has been engaged by OceanaGold (New Zealand) Ltd. (OGL) to provide a water quality assessment that represents the construction of the unconstructed Back Road Waste Rock Stack (BRWRS). The BRWRS was consented as part of the Macraes Phase 3 Project. Currently the BRWRS is not included within the cumulative effects presented in the surface and ground water modelling report (GHD, 2024) submitted as part of the proposed Macraes Phase IV (MPIV) project. The wider MPIV project scope includes the Innes Mills Open Pit (IMOP) extension, Golden Point Pit backfilling, Frasers Tailings Storage Facility (FTSF), GPUG Expansion and Extension (authorised separately), Coronation and Golden Bar pit developments and associated waste rock disposal developments within the Deepdell Creek and the Waikouaiti River North Branch (NBWR) catchments.

This report assesses the cumulative water quality effects of the BRWRS being constructed in addition to the proposed MPIV mine plan. This is based upon geochemical modelling presented in MWM (2024), where a refined geochemical model for the BRWRS has been developed to quantify likely contaminant concentrations in seepage water discharge. The outcomes of this modelling are applied in this report to assess likely water quality within the receiving environments of Deepdell Creek and the Shag River.

The purpose of this report is to determine probabilistic water quality estimates at monitoring and compliance locations downstream of the future BRWRS to provide a basis for selecting mitigation measures that result in an acceptable outcome in terms of current surface water quality consent limits and a basis for maintaining compliance (as represented in GHD (2024)).

This report is to be read in conjunction with the assessment and model descriptions included in GHD (2024).

1.1 Scope and limitations

This report: has been prepared by GHD for OceanaGold (New Zealand) Ltd. and may only be used and relied on by OceanaGold (New Zealand) Ltd. for the purpose agreed between GHD and OceanaGold (New Zealand) Ltd. as set out in this report.

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The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by OceanaGold (New Zealand) Ltd. and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Model Description

Modelling is undertaken as per the methodology and model setup outlined in GHD (2024), with the addition of the BRWRS. The BRWRS would cover a total area of 183 ha, with part of this being constructed overtop the existing Northern Gully WRS and the remainder within tributaries of Deepdell Creek upstream of DC07 and DC08 monitoring locations. Sulphate generation from the BRWRS is determined by the concentration time series data described in MWM (2024) and as shown in Figure 1. The corresponding contaminant mass load is determined by an assumed average infiltration rate of 29.2 mm/yr across the WRS area (equivalent to the natural infiltration rock on undisturbed land). This mass loading is discharged to the receiving environment upstream of DC07 and DC08 via point discharge to silt ponds and diffuse discharge direct to Deepdell Creek.

For the purpose of modelling the effects from developing the BRWRS, it is assumed that construction would be completed at the end of the proposed Macraes Phase IV mine plan. Three key phases are represented in the modelling results which correspond to the phases as outlined in GHD (2024):

1. **Mining** – During the proposed Macraes Phase IV operational period,
2. **Closure** – A 20-year period following cessation of active mining, and
3. **Long-term** – Nominally 200 years following cessation of active mining.

For the purpose of assessing the modelling results, statistics for the closure period are taken from the 5-year period with the highest average discharge concentration based on projections shown in Figure 1.

The following assumptions are made that are specific to this assessment:

– Modelling the effects of BRWRS on receiving water quality represents ‘instantaneous’ construction, however, in practice it is expected that construction would take a number of years and through this time sections of the WRS would be unrehabilitated. It is assumed that appropriate sediment management practices are carried out through this construction period and the contaminant concentrations in runoff water are maintained below the peak values represented in the modelling.
– The relationships between sulphate and other modelled contaminants can be represented by the linear relationships presented in MWM (2024).
– All other mitigation measures and water quality assumptions as outlined in GHD (2024) are applicable for the modelling undertaken and outlined in this report.

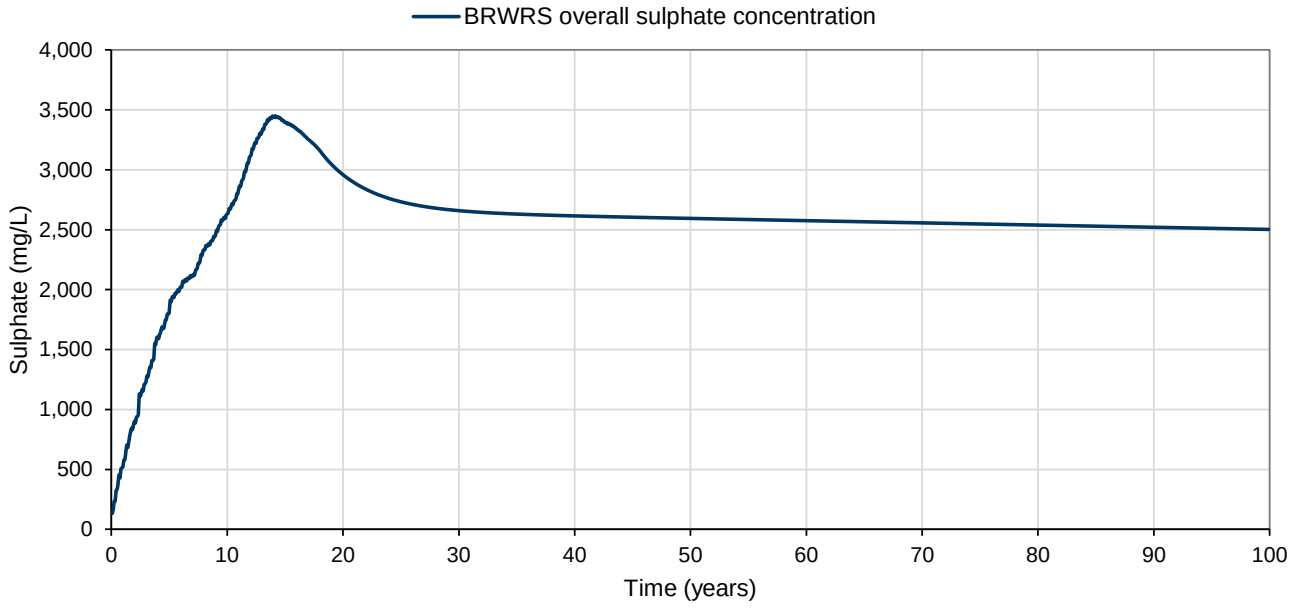

Figure 1 Sulphate concentration projections for the BRWRS (MWM, 2024)

2.1 Modelling scenarios

A summary of the modelling scenarios is provided in Table 1, where the baseline scenario is that presented in GHD (2024) for the Macraes Phase IV mine plan (i.e. no BRWRS), and the BRWRS scenario represents the updated MWM (2024) relationship with variable flow augmentation from the Camp Creek Dam. All other WRS's are modelled with the previously applied water quality projections.

Table 1 Summary of modelling scenarios

Reference	Mine Development	WRS Construction	Camp Creek Dam Flow Augmentation
Baseline	Macraes Phase IV	No BRWRS	Variable[2] 20 L/s
BRWRS	Macraes Phase IV	BRWRS constructed	Variable 20 L/s

1. See MWM (2024) for further details.
2. 20 L/s augmentation discharge where the Golden Point flow gauge reads below 20 L/s, then tapering to a minimum of 2 L/s where the gauge reads 50 L/s or greater.

3. Modelling Results

To illustrate the effects of constructing the BRWRS, model results are presented as probability exceedance charts for sulphate concentrations at the DC08 and Shag River at Loop Road compliance locations. DC07 and Shag River at McCormicks show similar responses to these two locations and on this basis are not presented as figures. Complete summary tables of the modelled water quality data are presented in Appendix A.

The results show the modelled mining phase water quality from GHD (2024) as a reference, though this phase is unchanged as the BRWRS is considered to be constructed after this mine phase.

3.1.1 DC08 Results

Modelling shows that for the Macraes Phase IV mine plan baseline scenario there is a low probability (0.1%) of exceeding the existing consent compliance limit of 1,000 g/m³ at DC08 (maximum modelled sulphate concentration of 1040 g/m³ during the mining phase) (Table 2). In the long-term, exceedance of this limit is not expected for the projected hydrological conditions and with dilution being applied at a variable rate of up to 20 L/s from the proposed Camp Creek Dam.

Where the BRWRS is included and constructed with construction methodology applied at other WRSs on site (BRWRS scenario) the sulphate concentration at DC08 is modelled to exceed a concentration of 1000 g/m³ approximately 0.1% of the time. Median concentrations could increase by up to 60% in the long-term with maximum concentrations predicted to reach 1,400 g/m³.

Table 2 Summary of Sulphate at DC08

Scenario	Phase	Median	95th %	Maximum	>1,000g/m³
Current[1]		173	773	1310	
Baseline: MPIV, Camp Creek Dilution @ 20L/s	Mining	99	360	1040	0.1%
	Closure	94	310	900	
	Long Term	100	330	920	-
BRWRS: MPIV+BRWRS, Camp Creek Dilution @ 20L/s	Closure	140	400	1400	0.1%
	Long Term	160	420	980	-

[1]. Based on actual monitoring data for period May 2020 to May 2024

The modelled flow exceedance curve at DC08 is shown in Figure 2. This shows the effect of the flow augmentation being added to the system and how mining phase flows would be somewhat lower across dry periods prior to augmentation water being added (note that the mining phase includes the effects of commissioning and initial operation of the Camp Creek Dam).

Modelled results from the BRWRS scenario are shown in Figure 3.

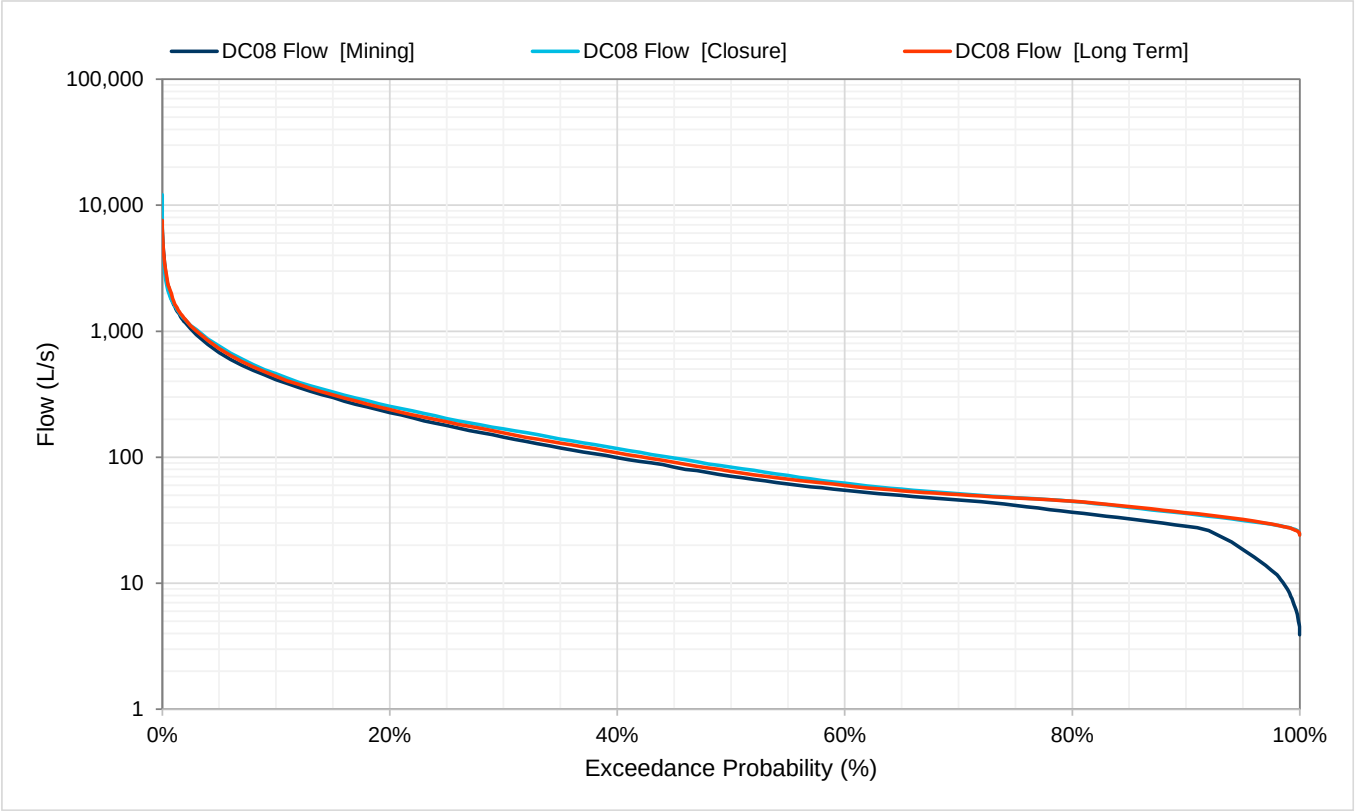

Figure 2 *DC08 flow exceedance curves – Variable flow augmentation to 20 L/s*

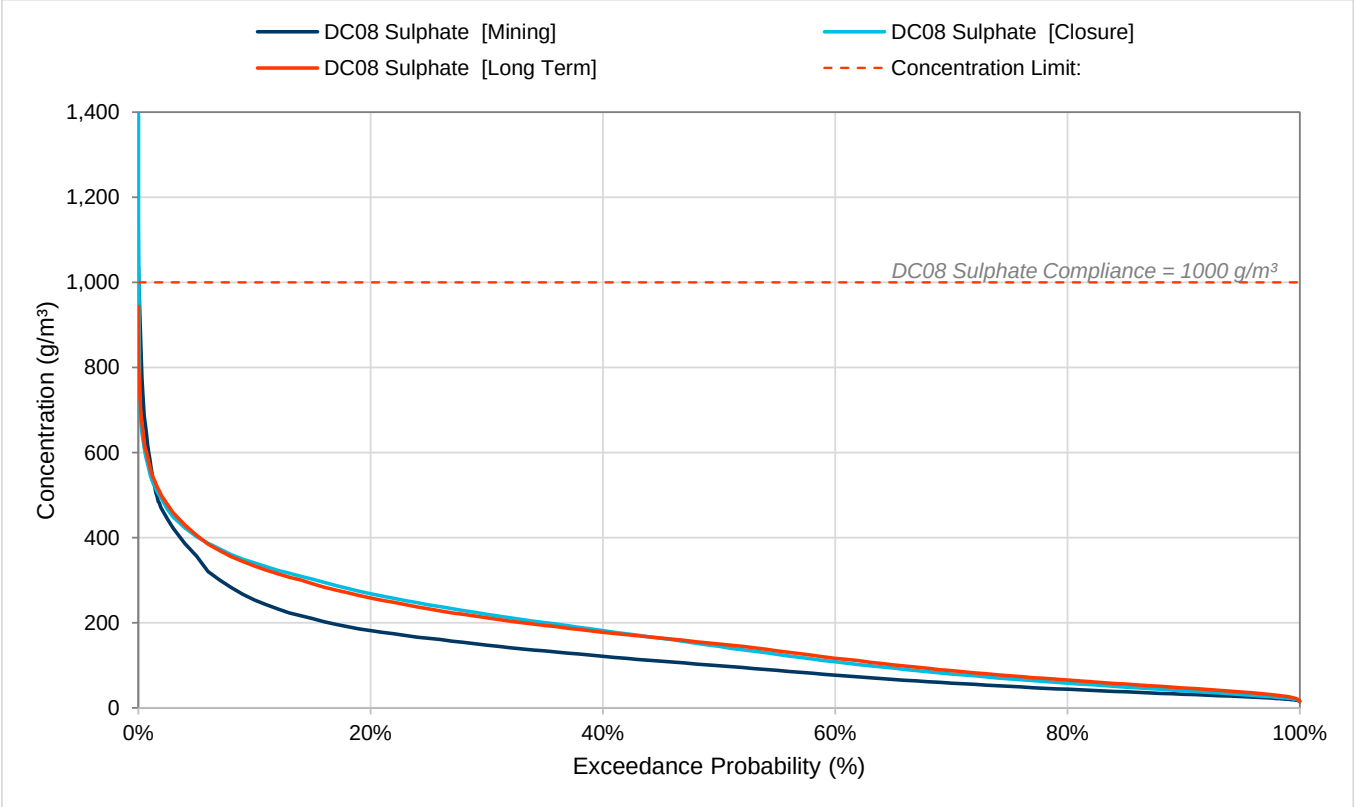

Figure 3 *DC08 Sulphate – BRWRS scenario – Modelled probability exceedance – Variable flow augmentation to 20 L/s*

3.1.2 Shag River at Loop Road Results

The modelling results for Shag River at Loop Road are presented in Table 3. In general, the median modelled sulphate concentrations are predicted to increase slightly with the addition of the BRWRS (relative to baseline) however the effect is considered small due to the considerable downstream dilution. This effect becomes more noticeable at lower flows (represented in the 95%ile and maximum results) as the seepage volumes are assumed to be relatively constant and the dilutive capacity of the receiving surface waters becomes comparatively less as the flows decrease. The Camp Creek Dam dilution has a significantly reduced influence on the overall flows (and therefore concentrations) at this downstream location (compared to locations further up catchment such as DC07 and DC08).

Table 3 Summary of Sulphate at Shag River at Loop Road

Scenario	Phase	Median	95th %	Maximum	>250 g/m³
Current[1]		25	73	95	
Baseline: MPIV, Camp Creek Dilution @ 20L/s	Mining	21	56	450	<0.2%
	Closure	21	69	610	<0.2%
	Long Term	22	74	750	<0.3%
BRWRS: MPIV+BRWRS, Camp Creek Dilution @ 20L/s	Closure	26	92	1060	<0.2%
	Long Term	28	98	800	<0.3%

[1]. Based on actual monitoring data for period May 2020 to May 2024

Model results for the BRWRS illustrate little difference in modelled sulphate concentrations due to the comparatively small influence of the augmentation flow at this downstream location. They also illustrate that modelled exceedance of the consented 250 g/m³ sulphate limit has a low probability of occurrence under all scenarios (<0.3%) (Figure 4).

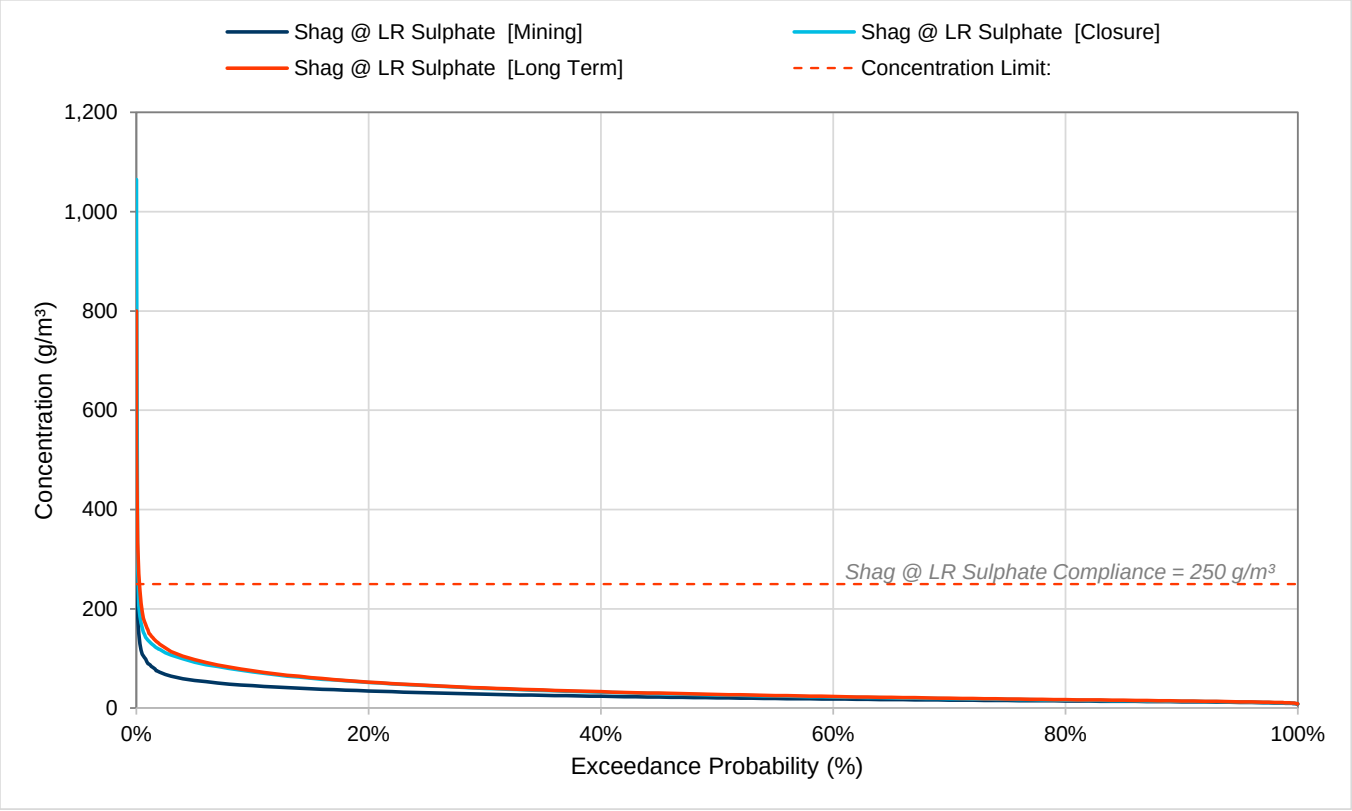

Figure 4 Shag River @ Loop Road Sulphate – BRWRS scenario – Modelled probability exceedance – Variable flow augmentation to 20 L/s

4. Conclusion

Modelling and comparison of the cumulative effects from constructing the BRWRS as part of the proposed Macraes Phase IV mine plan has been undertaken. The results show increased sulphate concentrations within Deepdell Creek are likely.

With the exception of sulphate and Nitrate-N under exceptional low flow events that generate the modelled maximum concentrations, all other contaminants are at a level that meet compliance at DC08. Exceedances are predicted <0.1 % and <0.3 % of the time for the DC08 and Shag River at Loop Road compliance locations respectively.

The effects of constructing the BRWRS on locations further down catchment (i.e. at the Shag River at Loop Road compliance location) is less noticeable due to the significant natural dilution available between the point of discharge and this compliance location.

In summary, the construction of the BRWRS combined with sufficient flow augmentation is not expected to significantly impact instream sulphate (and other contaminant) compliance within Deepdell Creek and the Shag River based on the current predictions provided for in the Macraes PhIV project.

5. References

GHD 2024. Macraes Phase IV, Stage 3 – Surface and Groundwater Assessment. Report prepared for OceanaGold (New Zealand) Ltd. 26 March 2024.

MWM 2024. BRWRS Geochem Modelling. Memorandum prepared for OceanaGold (New Zealand) Ltd. 8 October 2024. J-NZ0229-M-009-Rev1.

Appendix A

Water Quality Statistics

Table 4 Predicted Water Quality Statistics for DC07

Constituent	Statistic	DC07, Phase (g/m³)					
		MPIV Camp Creek Dilution @ 20L/s			MPIV+BRWRS Camp Creek Dilution @ 20L/s		Current
		Mining	Closure	Long Term	Closure	Long Term	(May 20 – May 24)
Sulphate	Median	110	100	110	130	140	180
	95th %	390	330	360	340	390	620
	Maximum	1090	930	920	1390	940	660
Nitrate-N	Median	0.73	0.63	0.67	0.88	0.91	0.09
	95th %	2.5	1.5	1.6	2.2	2.1	1.31
	Maximum	7.6	3.6	3.8	4.3	3.7	1.87
Amm.-N	Median	0.014	0.013	0.013	0.013	0.013	0.01
	95th %	0.028	0.02	0.02	0.018	0.019	0.21
	Maximum	0.21	0.044	0.044	0.069	0.043	0.40
Arsenic	Median	0.003	0.0032	0.0036	0.0029	0.0037	0.012
	95th %	0.012	0.0083	0.011	0.0051	0.011	0.022
	Maximum	0.25	0.023	0.024	0.019	0.024	0.023
Copper	Median	0.001	0.001	0.001	0.001	0.001	0.0006
	95th %	0.0012	0.0011	0.0012	0.0012	0.0012	0.0014
	Maximum	0.0013	0.0012	0.0013	0.0013	0.0013	0.0014
Iron	Median	0.19	0.19	0.19	0.19	0.19	0.06
	95th %	0.23	0.22	0.22	0.22	0.22	0.19
	Maximum	0.82	0.24	0.24	0.24	0.24	0.20
Lead	Median	0.00016	0.00016	0.00016	0.00017	0.00017	0.0001
	95th %	0.00019	0.00018	0.00018	0.00019	0.00019	0.0001
	Maximum	0.00026	0.00022	0.00022	0.00027	0.00024	0.0001
Zinc	Median	0.0023	0.0021	0.0022	0.0024	0.0025	0.002
	95th %	0.0045	0.0034	0.0035	0.0041	0.0039	0.004
	Maximum	0.011	0.0059	0.0062	0.0076	0.006	0.006

Table 5 Predicted Water Quality Statistics for DC08

Constituent	Statistic	DC08, Phase (g/m³)					
		MPIV Camp Creek Dilution @ 20L/s			MPIV+BRWRS Camp Creek Dilution @ 20L/s		Current
		Mining	Closure	Long Term	Closure	Long Term	(May 20 – May 24)
Sulphate	Median	99	94	100	140	160	173
	95th %	360	310	330	400	420	773
	Maximum	1040	900	920	1400	980	1310
	>1,000 g/m³	0.1%		-	0.1%	-	
Nitrate-N	Median	0.68	0.59	0.63	1	1.1	0.01
	95th %	2.3	1.5	1.6	2.7	2.6	0.34
	Maximum	7.3	3.4	3.6	5.1	4.9	0.46
Amm.-N	Median	0.014	0.012	0.013	0.012	0.013	0.01
	95th %	0.026	0.019	0.02	0.017	0.018	0.02
	Maximum	0.18	0.044	0.044	0.069	0.042	0.10
Arsenic	Median	0.003	0.0032	0.0036	0.0029	0.0033	0.018
	95th %	0.011	0.0079	0.011	0.005	0.008	0.034
	Maximum	0.22	0.023	0.024	0.017	0.024	0.037
Copper	Median	0.001	0.001	0.001	0.001	0.001	0.0007
	95th %	0.0012	0.0011	0.0011	0.0012	0.0012	0.0016
	Maximum	0.0013	0.0012	0.0012	0.0013	0.0012	0.0050
Iron	Median	0.19	0.19	0.19	0.19	0.18	0.03
	95th %	0.23	0.22	0.22	0.22	0.22	0.20
	Maximum	0.74	0.24	0.24	0.24	0.24	0.27
Lead	Median	0.00016	0.00016	0.00016	0.00017	0.00017	0.0001
	95th %	0.00019	0.00018	0.00018	0.0002	0.0002	0.0001
	Maximum	0.00025	0.00022	0.00022	0.00027	0.00024	0.0010
Zinc	Median	0.0022	0.0021	0.0022	0.0025	0.0026	0.001
	95th %	0.0043	0.0033	0.0035	0.0045	0.0044	0.002
	Maximum	0.011	0.0056	0.006	0.0077	0.0068	0.010

Table 6 Predicted Water Quality Statistics for Shag River at Loop Road

Constituent	Statistic	Shag River at Loop Road, Phase (g/m³)					
		MPIV Camp Creek Dilution @ 20L/s			MPIV+BRWRS Camp Creek Dilution @ 20L/s		Current
		Mining	Closure	Long Term	Closure	Long Term	(May 20 – May 24)
Sulphate	Median	21	21	22	26	28	25
	95th %	56	69	74	92	98	73
	Maximum	450	610	750	1060	800	95
	>1,000 g/m³						
Nitrate-N	Median	0.21	0.21	0.21	0.26	0.26	0.02
	95th %	0.44	0.45	0.48	0.68	0.69	0.43
	Maximum	1.6	1.5	1.6	2.9	1.7	0.70
Amm.-N	Median	0.011	0.011	0.01	0.01	0.01	0.01
	95th %	0.013	0.013	0.013	0.013	0.013	0.01
	Maximum	0.055	0.039	0.037	0.059	0.036	0.02
Arsenic	Median	0.0027	0.0027	0.0028	0.0026	0.0028	0.002
	95th %	0.0039	0.0036	0.0039	0.0032	0.004	0.003
	Maximum	0.053	0.019	0.02	0.015	0.02	0.010
Copper	Median	0.001	0.001	0.001	0.001	0.001	0.0006
	95th %	0.0012	0.0012	0.0012	0.0012	0.0012	0.0014
	Maximum	0.0013	0.0013	0.0013	0.0013	0.0013	0.0050
Iron	Median	0.2	0.2	0.2	0.2	0.2	0.02
	95th %	0.24	0.24	0.24	0.24	0.24	0.10
	Maximum	0.31	0.26	0.26	0.26	0.26	0.20
Lead	Median	0.00015	0.00015	0.00015	0.00015	0.00015	0.0001
	95th %	0.00018	0.00018	0.00018	0.00018	0.00018	0.0002
	Maximum	0.00021	0.00019	0.00021	0.00023	0.00021	0.0010
Zinc	Median	0.0016	0.0016	0.0016	0.0017	0.0017	0.001
	95th %	0.002	0.002	0.002	0.0022	0.0022	0.003
	Maximum	0.0037	0.0032	0.0034	0.0062	0.0032	0.010

Table 7 Predicted Water Quality Statistics for Shag River at McCormicks

Constituent	Statistic	Shag River at McCormicks, Phase (g/m³)					
		MPIV Camp Creek Dilution @ 20L/s			MPIV+BRWRS Camp Creek Dilution @ 20L/s		Current
		Mining	Closure	Long Term	Closure	Long Term	(May 20 – May 24)
Sulphate	Median	26	23	27	28	31	23
	95th %	67	65	73	85	92	47
	Maximum	280	560	600	1090	660	82
Nitrate-N	Median	0.21	0.21	0.21	0.24	0.25	0.05
	95th %	0.42	0.41	0.44	0.6	0.61	0.65
	Maximum	1.4	1.3	1.5	2.7	1.4	1.15
Amm.-N	Median	0.021	0.01	0.01	0.01	0.01	0.01
	95th %	0.052	0.012	0.012	0.012	0.012	0.02
	Maximum	0.17	0.036	0.031	0.056	0.031	0.06
Arsenic	Median	0.0064	0.0029	0.003	0.0028	0.003	0.002
	95th %	0.017	0.0037	0.0039	0.0035	0.0039	0.003
	Maximum	0.057	0.018	0.016	0.015	0.017	0.080
Copper	Median	0.0016	0.001	0.00099	0.001	0.001	0.0006
	95th %	0.0035	0.0012	0.0012	0.0012	0.0012	0.0013
	Maximum	0.011	0.0013	0.0013	0.0013	0.0013	0.0050
Iron	Median	0.24	0.2	0.2	0.2	0.2	0.05
	95th %	0.33	0.23	0.23	0.23	0.23	0.20
	Maximum	0.72	0.25	0.25	0.25	0.25	0.49
Lead	Median	0.00016	0.00015	0.00015	0.00015	0.00015	0.0001
	95th %	0.00019	0.00018	0.00018	0.00018	0.00018	0.0001
	Maximum	0.00027	0.00019	0.0002	0.00024	0.0002	0.0010
Zinc	Median	0.0016	0.0016	0.0016	0.0017	0.0016	0.001
	95th %	0.002	0.002	0.002	0.0021	0.0021	0.006
	Maximum	0.0034	0.003	0.0032	0.0059	0.0032	0.010

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