Evidence of Brett Sinclair

Attachment A
Figures and Tables

Before **Dunedin City Council**
Otago Regional Council
Waitaki District Council

In the Matter of the Resource Management Act 1991
AND
In the matter of applications by Oceana Gold (New Zealand) Limited for resource consents for the **Coronation North Project**

30 October 2016

Golder Associates

Figure 1:
Site location plan.

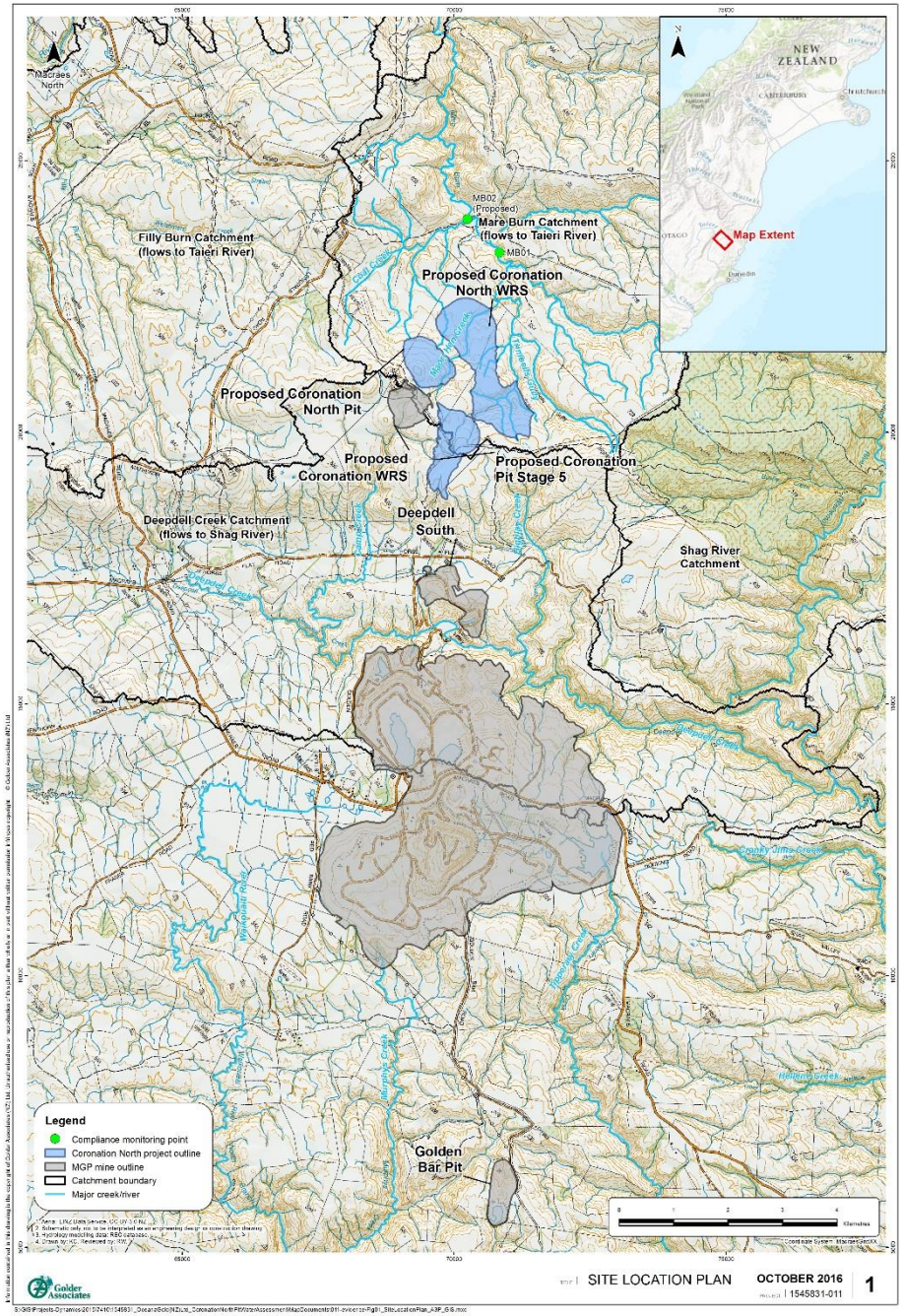

Figure 2: Site layout.

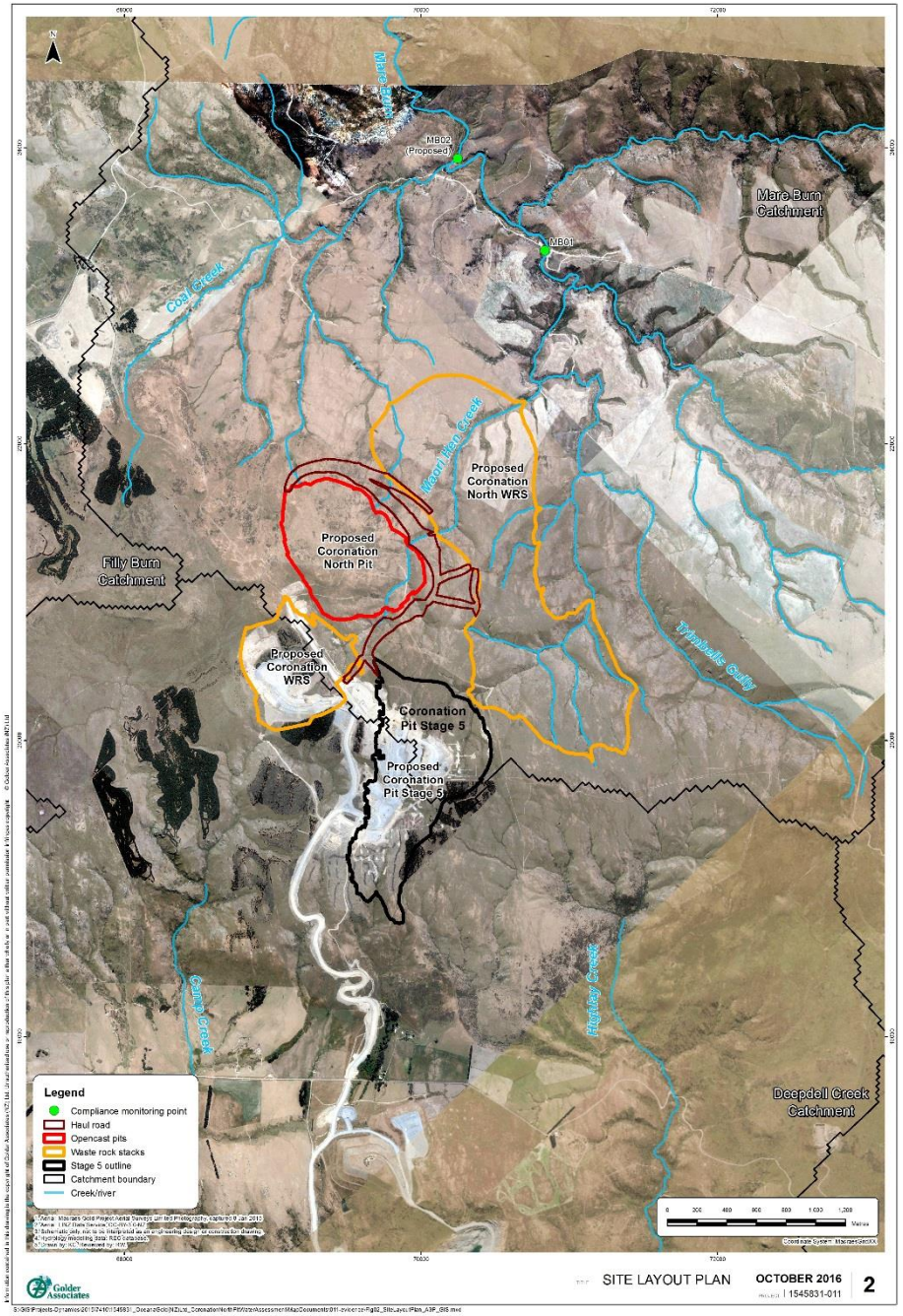

Figure 3: MGP average monthly rainfall and evaporation.

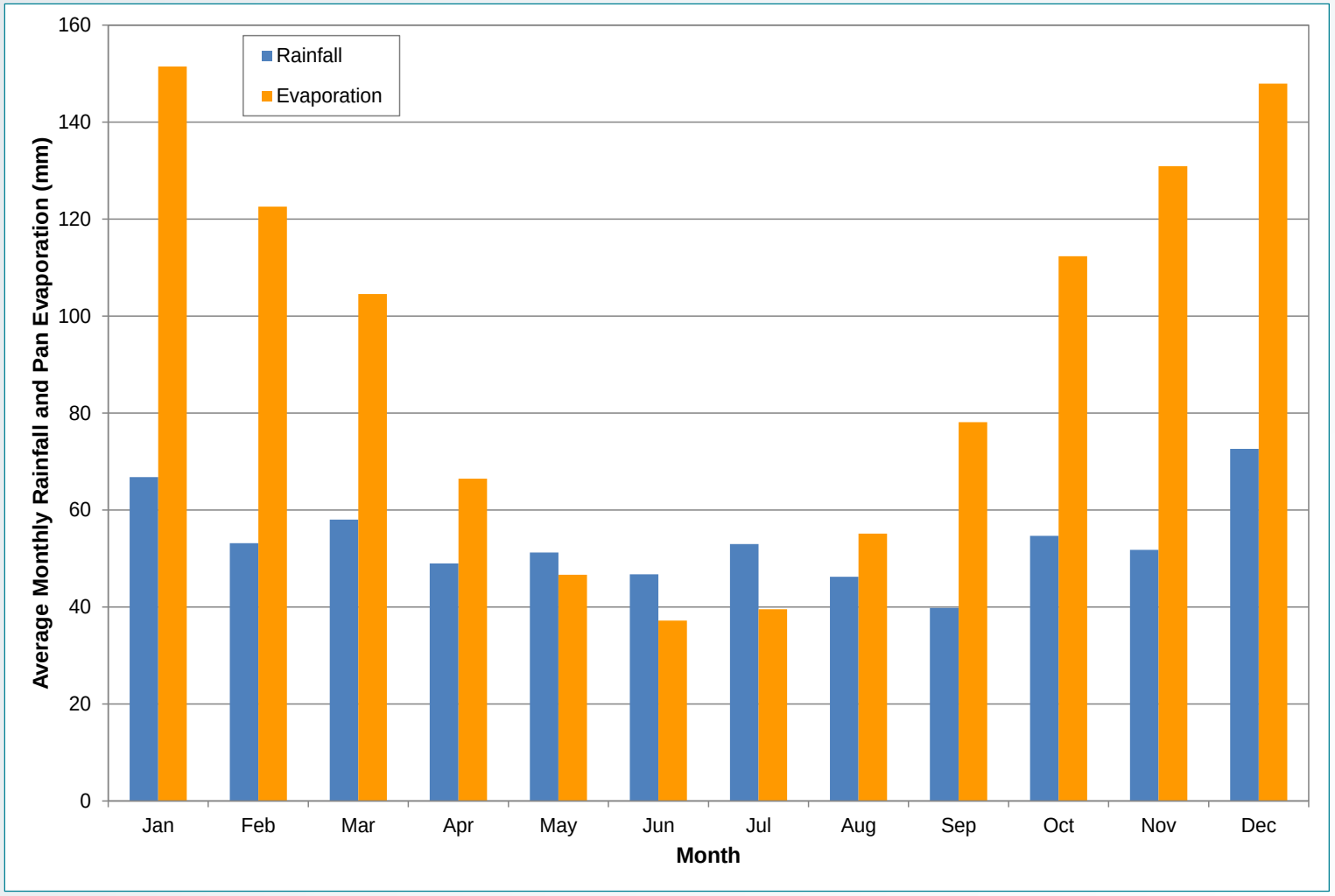

Table 1: Calculated compliance point MB02 flow statistics and percentiles.

Parameter	Minimum	Lower Quartile	Median	Average	Upper Quartile	Maximum
MB01 daily average (L/s)	0	3.6	9.7	36.6	28.8	14,960
MB02 daily average (L/s)	0	7.7	20.6	77.7	61.0	31,760

Table 2: Summary of MB01 water quality monitoring data (2014 – 2015).

Parameter (1)	Minimum	Mean	95th Percentile	Maximum	Number of samples
Arsenic	<0.0010	0.0019	0.0050	0.0050	12
Sulfate	1.3	6.4	11.1	11.6	12
Cyanide (WAD)	<0.001	0.0012	0.0015	0.0016	4
Copper	<0.0006	0.0009	0.0014	0.0016	12
Iron	0.08	0.24	0.54	0.54	12
Lead	<0.0001	0.0002	0.0010	0.0018	12
Sodium	5.5	9.3	13.3	13.5	12
Potassium	0.4	1.7	4.7	6.2	12
Calcium	4.0	11.3	19.2	19.2	12
Magnesium	1.2	2.8	4.4	4.4	12
Zinc	0.001	0.002	0.005	0.006	5
Chloride	3.9	5.3	7.7	8.8	12

Notes:
1) All units g/m^3.
2) WAD - weak acid dissociable.

Figure 4: Coronation Pit Stage 5 groundwater area of influence.

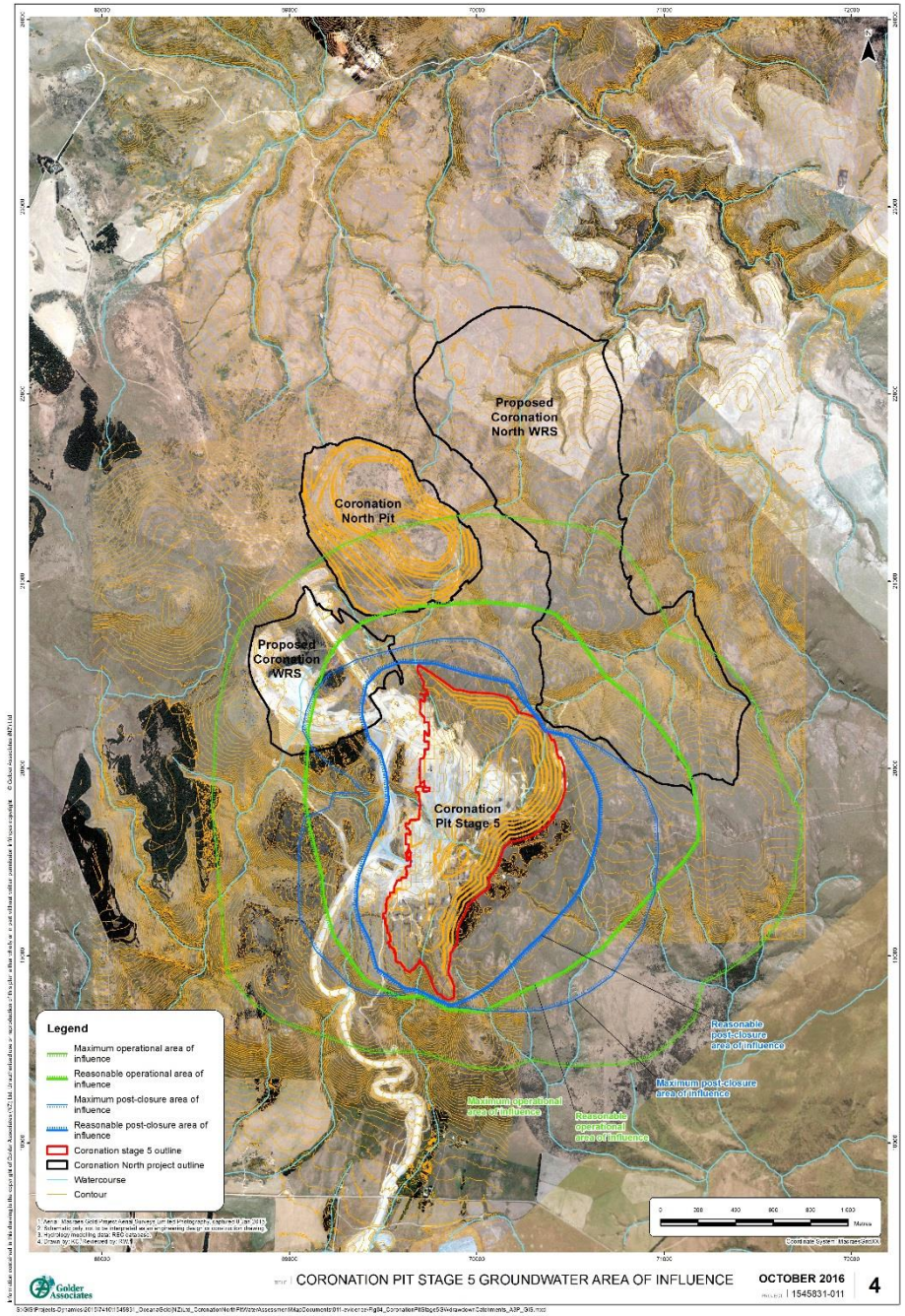

Figure 5: Coronation North Pit groundwater area of influence.

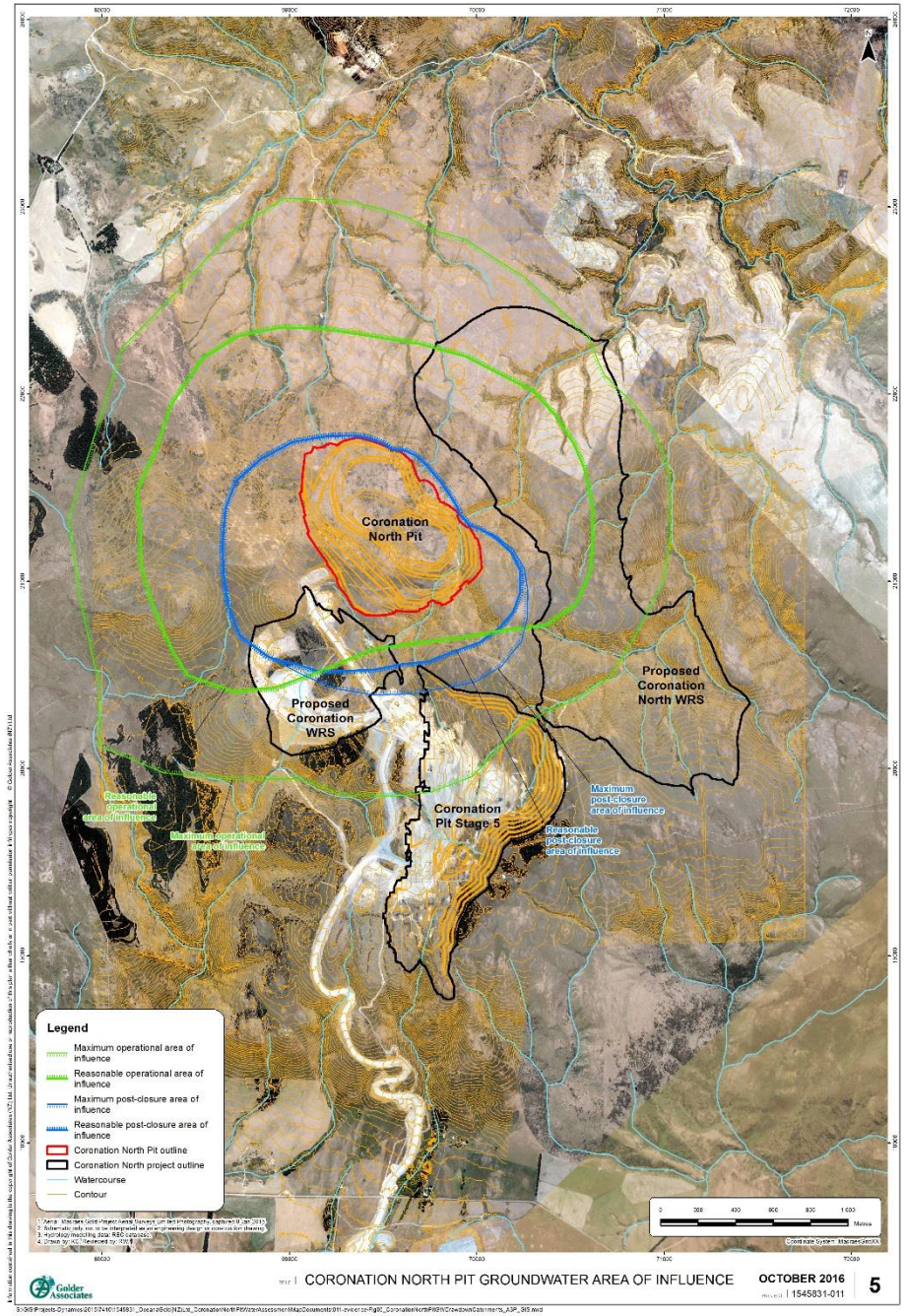

Table 3: Catchment hydrology comparison.

Scenario [1]	Catchment area (ha) [1]	Simulated flows (L/s)			
		5th percentile flow	Median flow	Average flow	Maximum flow
Baseline (MB02)	2,930	0.6	12	64	11,100
Stage 2	2,987	3.0	15	65	10,200
Stage 3	2,987	3.0	14	63	10,100

Table 4: Compliance criteria proposed by OceanaGold for MB02.

Parameter [1]	Existing at MB01 and proposed for MB02	ANZECC 2000 (stock water)	NZDWS 2008 [2]
pH (unitless)	6.0 – 9.5	-	7.0 – 8.5
Sulfate	1,000	1,000	250
$Cyanide_{WAD}$	0.1	-	0.08
Arsenic	0.15	0.5	0.01
Copper [3]	0.009	0.5	2
Iron	1.0	N/A	0.2
Lead [3]	0.0025	0.1	0.01
Zinc [3]	0.12	20	-

Notes: 1) All units g/m^3 unless stated.

2) Some of these values are maximum acceptable values while others are guideline values for aesthetic determinands.

3) Proposed copper, lead and zinc compliance criteria for MB02 are hardness related:

Copper (g/m^3) = $(0.96\exp^{0.8545[\ln(\text{hardness})] - 1.702}) / 1000$

Lead (g/m^3) = $(1.46203 - [\ln(\text{hardness})(0.145712)]\exp^{1.273[\ln(\text{hardness})] - 4.705}) / 1000$

Zinc (g/m^3) = $(0.986\exp^{0.8473[\ln(\text{hardness})] + 0.884}) / 1000$

Figure 1: Site location plan annotated with selected MGP monitoring sites.

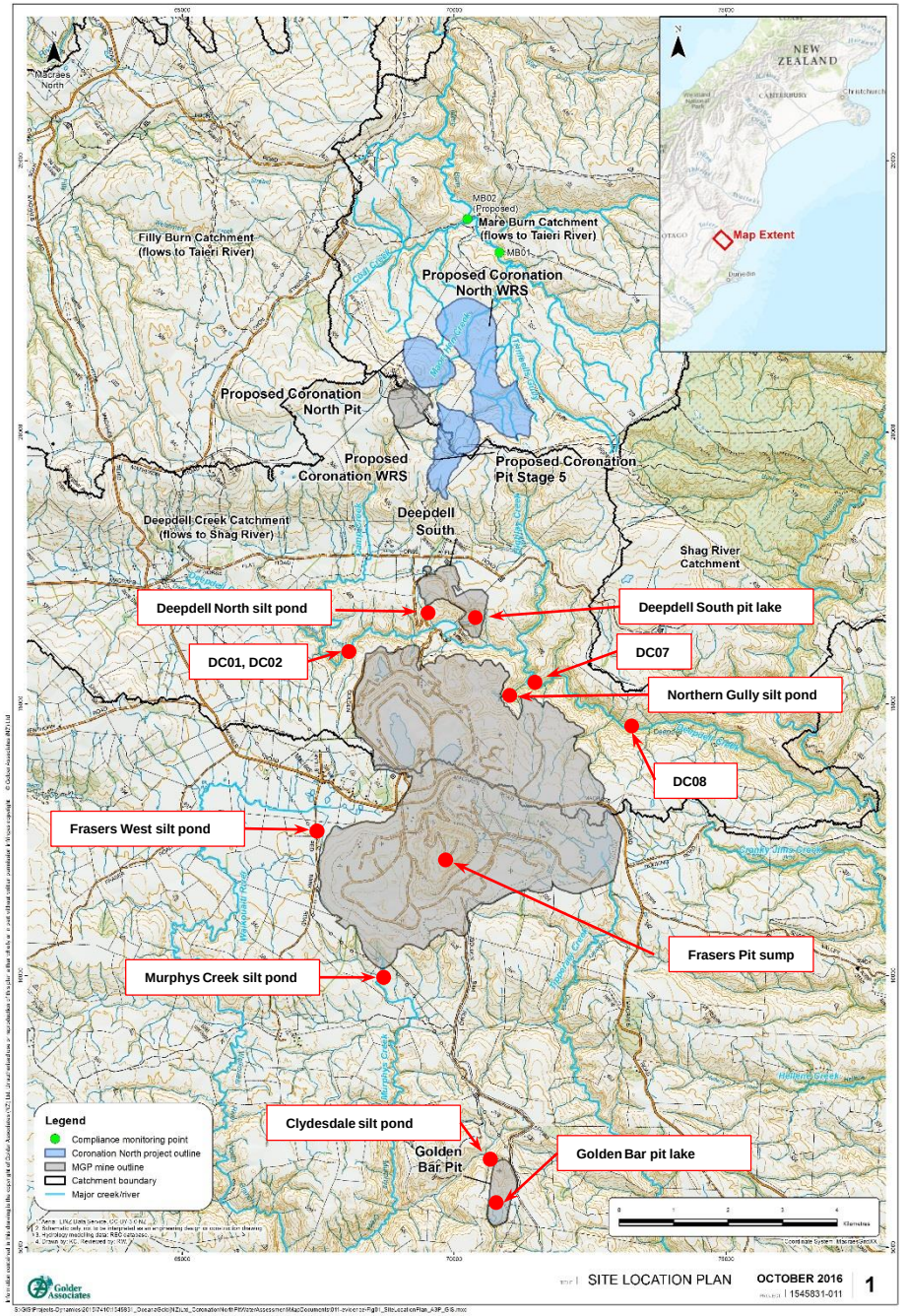

Table 5: Comparison of measured data from WRS silt dams and existing MGP pit lakes with potential ecologically relevant guidelines.

Parameter [1]	Proposed MB02 compliance criteria	Reviewer identified environmental protection guidelines	WRS discharges [2,3]	Golden Bar pit lake [2,3]	Deepdell South pit lake [2,3]
pH (unitless)	6.0 – 9.5	6.5 – 9.0	6.4 – 8.64	7.0 – 8.41	7.8 – 8.45
Dissolved copper	0.009 [5]	0.0014	<0.001 – 0.004 [4]	<0.0005 – 0.059 [4]	<0.0005 – 0.001
Dissolved zinc	0.12 [5]	0.008	<0.005 – 0.04	0.002 – 0.0093	0.0012 – 0.0038
Dissolved nickel		0.011	<0.005 – <0.01	ND	ND
Dissolved lead	0.0025 [5]	0.0034	<0.0001 – 0.00031 [4]	<0.0001 – 0.0042 [4]	<0.0001 – 0.00012
Dissolved silver		0.00005	ND	ND	ND
Arsenic	0.15	0.013, 0.024	<0.005 – 0.024 [4]	0.01 – 0.599	0.128 – 0.497
Iron	1	1	<0.04 – 0.39	<0.02 – 0.58	<0.02 – 0.16
Manganese		0.5	ND	ND	ND
Cyanide	0.1	0.007	NA	NA	NA
Sulphate	1,000	128 (429)	Up to 2,900	50 – 320 [6]	43.7 – 410
Dissolved oxygen		>7.0 (>5.0)	ND	ND	ND
Nitrate (NO_2-N)		2.4 (3.5) [7]	Refer Section 4.1 and Appendix A, Golder 2016e.		
Ammonia (NH_4-N)		<0.24 (<0.40) [7]	Refer Section 4.1 and Appendix A, Golder 2016e.		
Turbidity		30 % – 50 % change in clarity	ND	ND	ND
Suspended solids		30 % – 50 % change in clarity	ND	ND	ND

Notes: 1) All units in g/m^3 except pH. Number of samples analysed varies with site and parameter.
2) Colour definitions. Compared to potential ecological protection criteria indicated by reviewer. **Green = meets criterion; Blue = likely meets criterion but hardness dependent; Orange = possibly meets criterion but hardness dependent; Red = does not meet criterion.**

Table 6: Comparison of measured data from Deepdell Creek and Mare Burn with potential ecologically relevant guidelines.

Parameter [1]	Proposed MB02 compliance criteria	Reviewer identified environmental protection guidelines	DC01 & DC02 [2,3] Deepdell Upstream	DC07 & DC08 [2,3] Deepdell Downstream	Mare Burn MB01 & MB02 [2,3]
pH (unitless)	6.0 – 9.5	6.5 – 9.0	6.5 – 8.47	7.0 – 8.81	7.2 – 8.1
Dissolved copper	0.009	0.0014	<0.0005 – 0.002	<0.0005 – 0.0031	<0.0005 – 0.0016
Dissolved zinc	0.12	0.008	ND	<0.001 – 0.006	<0.001 – 0.0011
Dissolved nickel		0.011	ND	ND	ND
Dissolved lead	0.0025	0.0034	<0.0001 – 0.001	<0.0001 – 0.00178	<0.0001 – 0.00181
Dissolved silver		0.00005	ND	ND	ND
Arsenic	0.15	0.013, 0.024	<0.001 – 0.005	0.0015 – 0.03 [4]	<0.001 – 0.0082
Iron	1	1	0.08 – 0.58	0.02 – 0.38	0.2 – 0.84
Manganese		0.5	ND	ND	ND
Cyanide	0.1	0.007	NA	NA	NA [5]
Sulphate	1,000	128 (429)	1.3 – 29	9.9 – 1,020	1.3 – 78
Dissolved oxygen		>7.0 (>5.0)	ND	ND	ND
Nitrate		2.4 (3.5) [6]	Refer Section 4.1 and Appendix A, Golder 2016e.		
Ammonia		0.24 (0.40) [6]	Refer Section 4.1 and Appendix A, Golder 2016e.		
Turbidity		30 % – 50 % change in clarity	ND	ND	ND
Suspended solids		30 % – 50 % change in clarity	ND	ND	ND

Notes: 1) All units in g/m^3 except pH. Number of samples analysed varies with site and parameter.
2) Colour definitions. Compared to potential ecological protection criteria indicated by reviewer. **Green = meets criterion; Blue = likely meets criterion but hardness dependent; Orange = possibly meets criterion but hardness dependent; Red = does not meet criterion.**

Figure 6: Sulfate to hardness relationship in Deepdell Creek at downstream compliance point, 1990 to 2015.

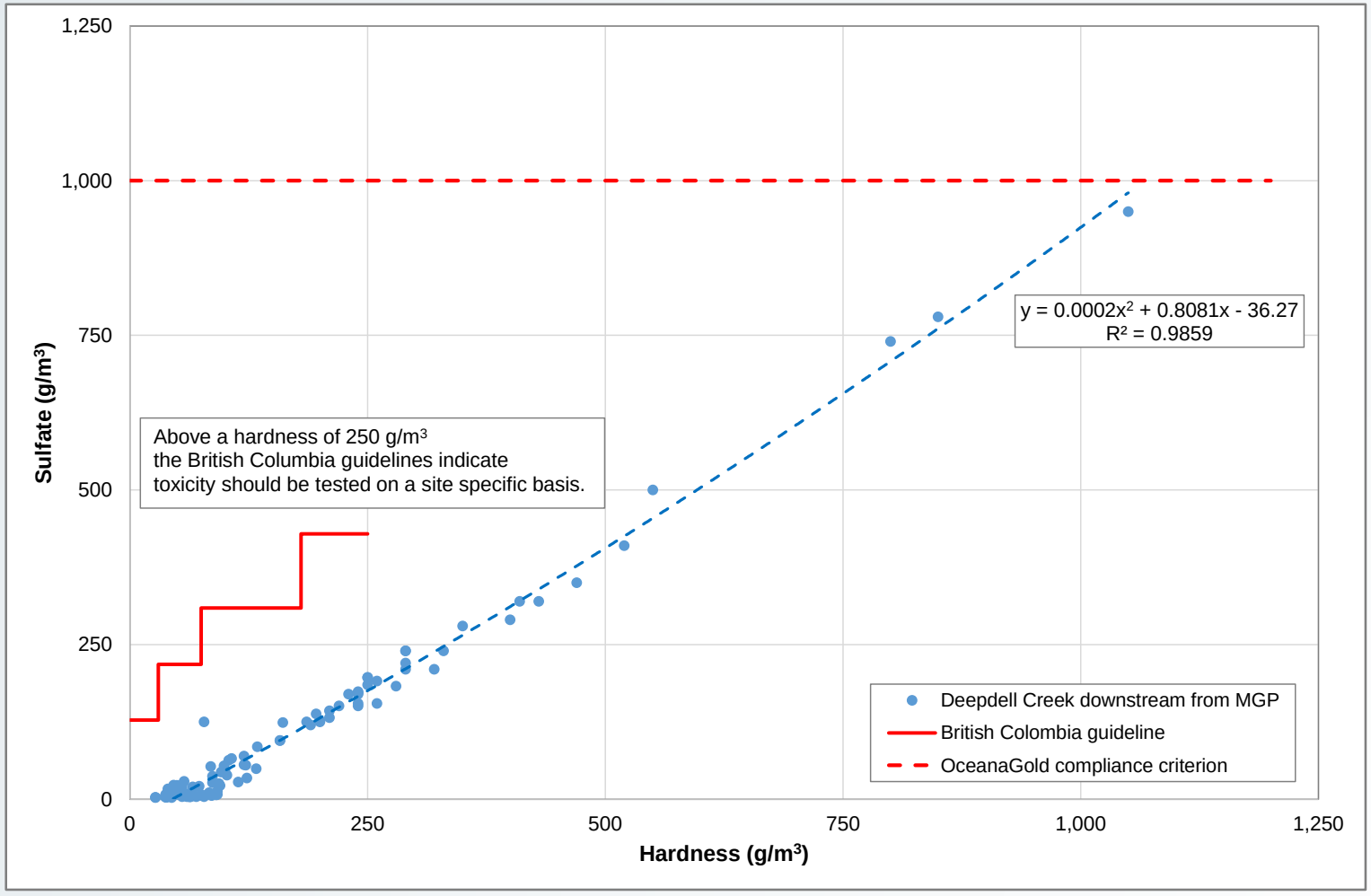

Figure 7: Frasers Pit sump nitrate-N and ammoniacal-N concentrations.

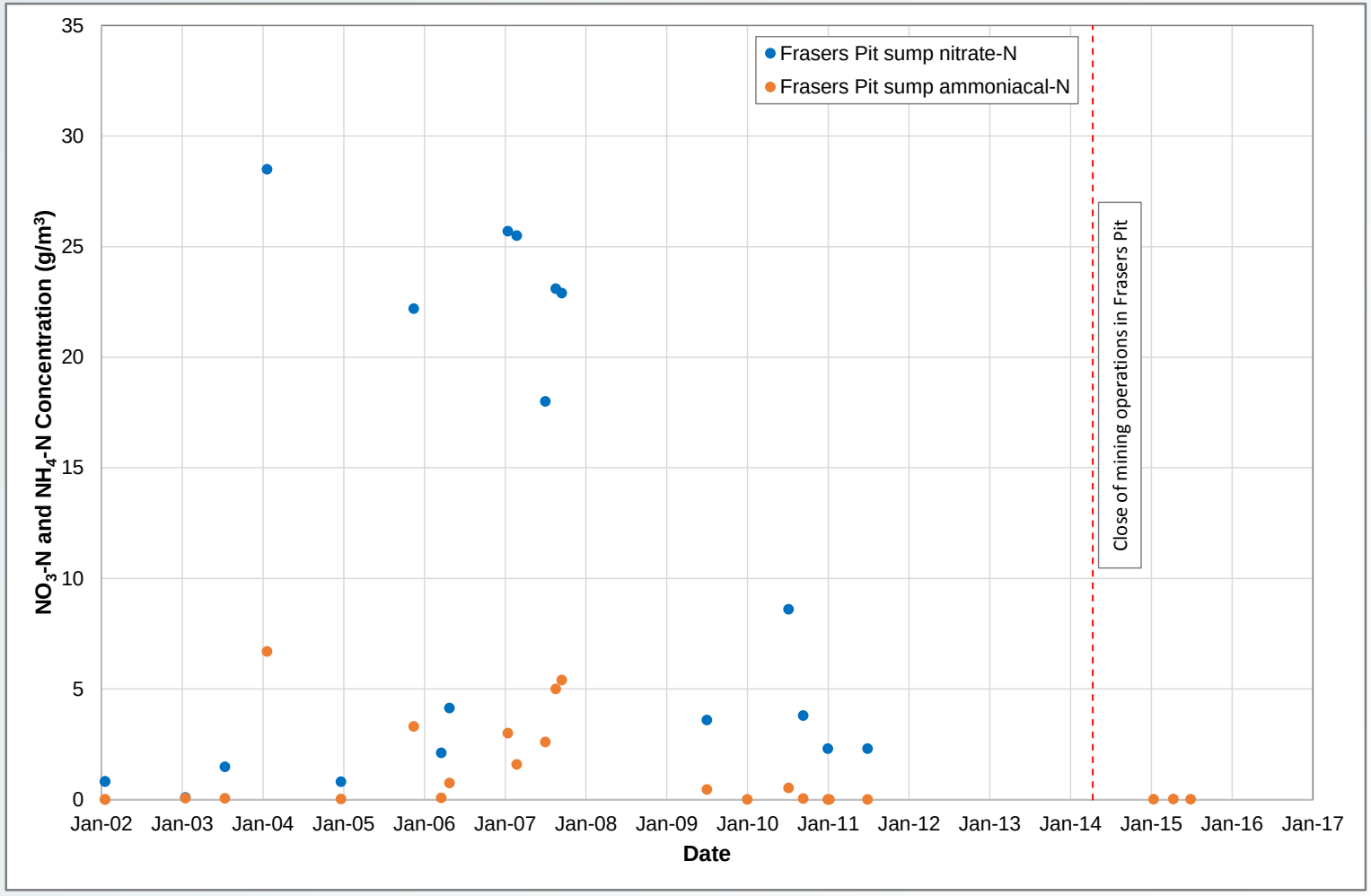

Figure 8: Waste rock stack seepage nitrate-nitrogen concentrations.

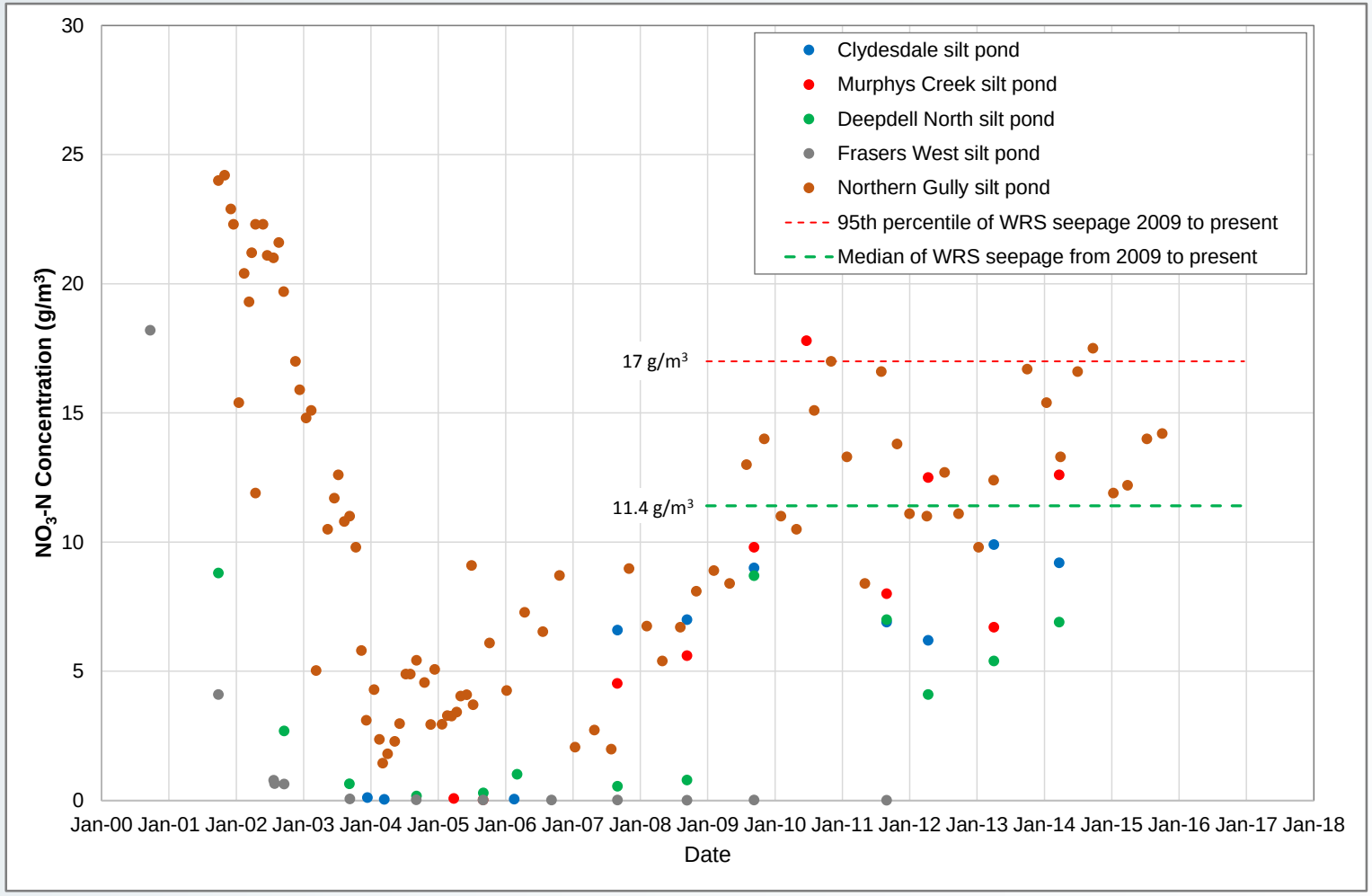

Table 7: Nitrate-N and ammoniacal-N NPS attributes for toxicity (MfE 2014).

Parameter	Attribute state	Annual median	Annual 95th percentile	Narrative attribute
Nitrate-N ($g\ NO_3\text{-}N/m^3$)	A	≤ 1.0	≤ 1.5	High conservation value system. Unlikely to be effects even on sensitive species.
	B	> 1.0 and ≤ 2.4	> 1.5 and ≤ 3.5	Some growth effect on up to 5 % of species.
Ammoniacal-N ($g\ NH_4\text{-}N/m^3$) (1)	A	≤ 0.03	≤ 0.05	99 % species protection level: no observed effect on any species tested.
	B	> 0.03 and ≤ 0.24	> 0.05 and ≤ 0.4	95 % species protection level: starts impacting occasionally on the 5 % most sensitive species.

Figure 9: Nitrate-N mitigated exceedance frequency based on median WRS leachate concentration of 11.4 g/m³.

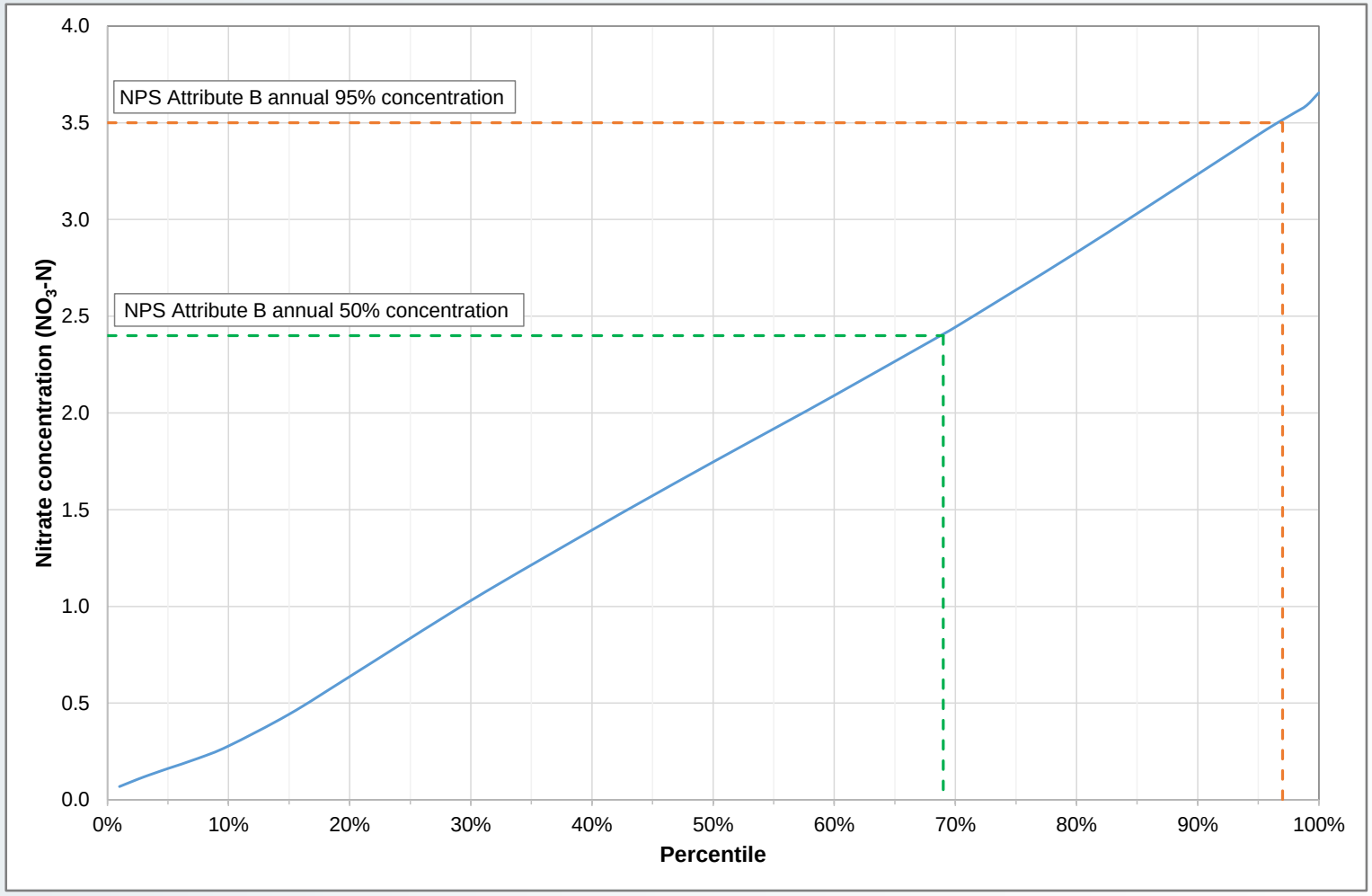

Figure 10: Coronation North WRS. Primary seepage discharge locations.

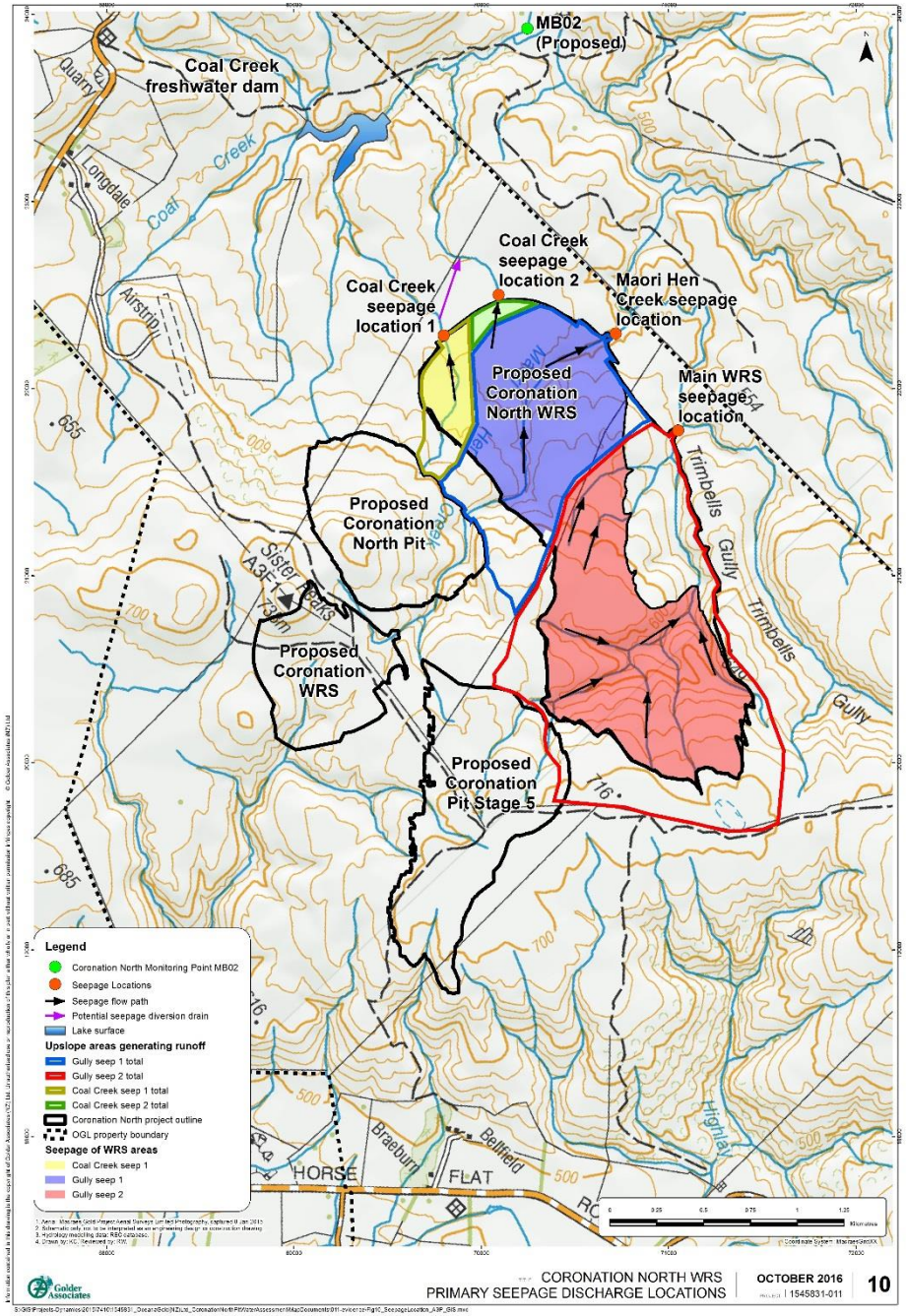

Figure 11: Coronation North Project mine water management schedule.