Klohn Crippen Berger
65 years of service

November 25, 2016

Mount Isa Mines Limited
Private Mail Bag 6
Mount Isa QLD 4825

Ms. Tamara Groves
ZOPS Environmental Advisor

Dear Ms. Groves:

BSOC WRD Environmental Evaluation
Site Investigation Report
Final

Klohn Crippen Berger (KCB) is pleased to provide Mount Isa Mines (MIM) with this final site investigation report for the Black Star Open Cut Waste Rock Dump Environmental Evaluation.

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Yours truly,

KLOHN CRIPPEN BERGER LTD.

C. Strachotta

Chris Strachotta
Project Manager

CK:CS

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1 INTRODUCTION

Klohn Crippen Berger Ltd (KCB) was commissioned by Mount Isa Mines (MIM) to undertake an Environmental Evaluation investigation regarding seepage at the Black Star Open Cut (BSOC) Waste Rock Dump (WRD). MIM were issued an Environmental Evaluation notice in December 2014 by the Department of Environment and Heritage Protection (EHP), requiring an environmental investigation into the release of contaminants through surface and sub-surface flows from the BSOC WRD.

As part of the Environmental Evaluation project, site investigations were undertaken in August and December, 2015 with the aim of addressing data gaps identified as part of the preliminary site understanding and data gap assessment (KCB, 2016).

This deliverable reports two phases of site investigation as part of Task 3, identify the source, cause and extent:

- Phase 1: Site observations and field mapping, undertaken in August, 2015.
- Phase 2: Drilling, testing and sampling, undertaken in December, 2015 by KCB personnel and January, 2016 by MIM personnel.

It should also be noted that this report is a factual report and presents only the data collected and analysis of results. Interpretation of this information will be included in the Task 7 – Reporting deliverable (final report).

2 PHASE 1 SITE INVESTIGATION

2.1 Overview

The Phase 1 site investigation was completed between August 24, and August 28, 2015. The aim of the Phase 1 investigation was to undertake observations of the project site and conduct a field mapping exercise. The investigations included inspection of site infrastructure and an assessment of any potential evidence of seepage in and/or from the following locations:

- MIM Landfill and Sludge Pits;
- BSOC WRD upper surface;
- BSOC WRD toe;
- Northern extent of TSF5;
- King Gully Dam;
- King Gully Pond and downstream watercourses; and,
- BSOC WRD Diversion Drain.

Field mapping was also conducted during the Phase 1 investigations and included:

- Mapping of the alluvial extent;
- Mapping of seepage locations;
- Visual assessment of seepage extent and impact; and,
- Mapping of potential flow paths within the bedrock.

During the Phase 1 site investigation, soil and water samples were collected from selected locations across the focus area, and points of interest were mapped. Photographs from the Phase 1 investigation are provided in Appendix I. Further discussion on the site investigation and results of the sampling and mapping is included in the following sections.

During the site investigation, preliminary locations for drilling and bore installations, to be conducted as part of the Phase 2 site investigation, were selected. Drilling contractor accessibility and logistics issues associated with establishing site access were also identified to allow ground preparations prior to the Phase 2 program.

2.2 Site Observations and Field Mapping

Site observations and field mapping conducted across the focus area focussed on the various site infrastructure associated with the BSOC WRD seepage; downstream water courses where evidence of seepage is anticipated to be present; and, bedrock outcrops along “breaks-in-slope” (abrupt change in topography) where potential bedrock seepage is anticipated to be present.

The site observations and field mapping were completed as part of a four-day (August 24 to 27, 2015) field survey program which included a detailed site walkover and aerial photograph correlation during the site walkover. Key areas that were targeted during the field survey included:

- Periphery of the BSOC WRD
    - Site reconnaissance and field mapping along the periphery of the BSOC WRD was conducted to confirm the location and lateral extent (seepage front) of the current seepages from the BSOC WRD (TD3, BSOC WRD North, BSOC WRD South); and, to determine any additional seepages along the BSOC WRD toe. The field mapping exercise also confirmed the location and extent of alluvium underlying the BSOC WRD along the periphery of the infrastructure.

      Results from the site reconnaissance and field mapping confirm that no additional seepages, beyond the previously identified seepages (TD3, BSOC WRD North, BSOC WRD South), occur along the BSOC WRD downstream toe. Additionally, the field mapping of the alluvium along the periphery of the BSOC WRD has been used to define the extent of the alluvium within the vicinity of the WRD (Figure 1).
- BSOC WRD Diversion Drain
    - Field mapping was undertaken along the alignment of the BSOC WRD diversion drain to identify zones of BSOC WRD seepage "daylighting" within the drain and to map the extent of alluvium within the drain.

      Excavation activities into the bedrock geology were required during the installation of the diversion drain, which supported the mapping of the alluvium extent. Results from the field mapping were used to define the extent of the alluvium downstream of the BSOC WRD (Figure 1). Seepages identified during the field mapping within the diversion drain were observed directly downstream of the BSOC WRD North Seepage and TD3 Seepage.
- Downstream of BSOC WRD Diversion Drain
    - Field mapping / reconnaissance was conducted downstream of the BSOC WRD diversion drain to identify the extent of alluvium within the focus area and evidence of BSOC WRD seepage (e.g. ponding, mineral precipitation on the surface) beyond the diversion drain.

      Results of the field mapping of the alluvium extent were used to define the extent of the alluvium downstream of the BSOC WRD within the focus area (Figure 1). During the field reconnaissance ponding was not observed downstream of the BSOC WRD diversion drain, however, areas of mineral precipitation on the surface were identified. These areas of mineral precipitation were sampled for chemical analyses (Section 2.3.2) to allow assessment of source contribution to the precipitation (i.e. BSOC WRD seepage source or natural mineral precipitation).

Soil and water samples were collected during the site observation and field mapping program to support the characterisation of potential seepage and identify background (non-impacted) concentrations. A total of nine water samples and fourteen soil samples were collected during the Phase 1 site investigation. Further details of these water and soil samples are provided in Section 2.3.

The alluvium associated with the water courses downstream of the BSOC WRD has been identified as a potential pathway for WRD seepage migration. Therefore, mapping the extent of the alluvium downstream of the WRD and the morphology of the alluvium relative to the BSOC WRD Diversion

Drain was a critical component to this investigation. Figure 1 presents the extent of the alluvium within the focus area.

Mineral precipitation on the alluvium and bedrock surfaces were observed across the focus area. The presence of precipitation may represent evidence of WRD seepage, however, natural precipitation on bedrock surfaces has previously been identified across the MIM site. As a result, soil samples were collected from the identified precipitation locations and from background locations to support the assessment of the WRD seepage extent. A summary of the soil sampling results and locations are presented in Section 2.3.2.

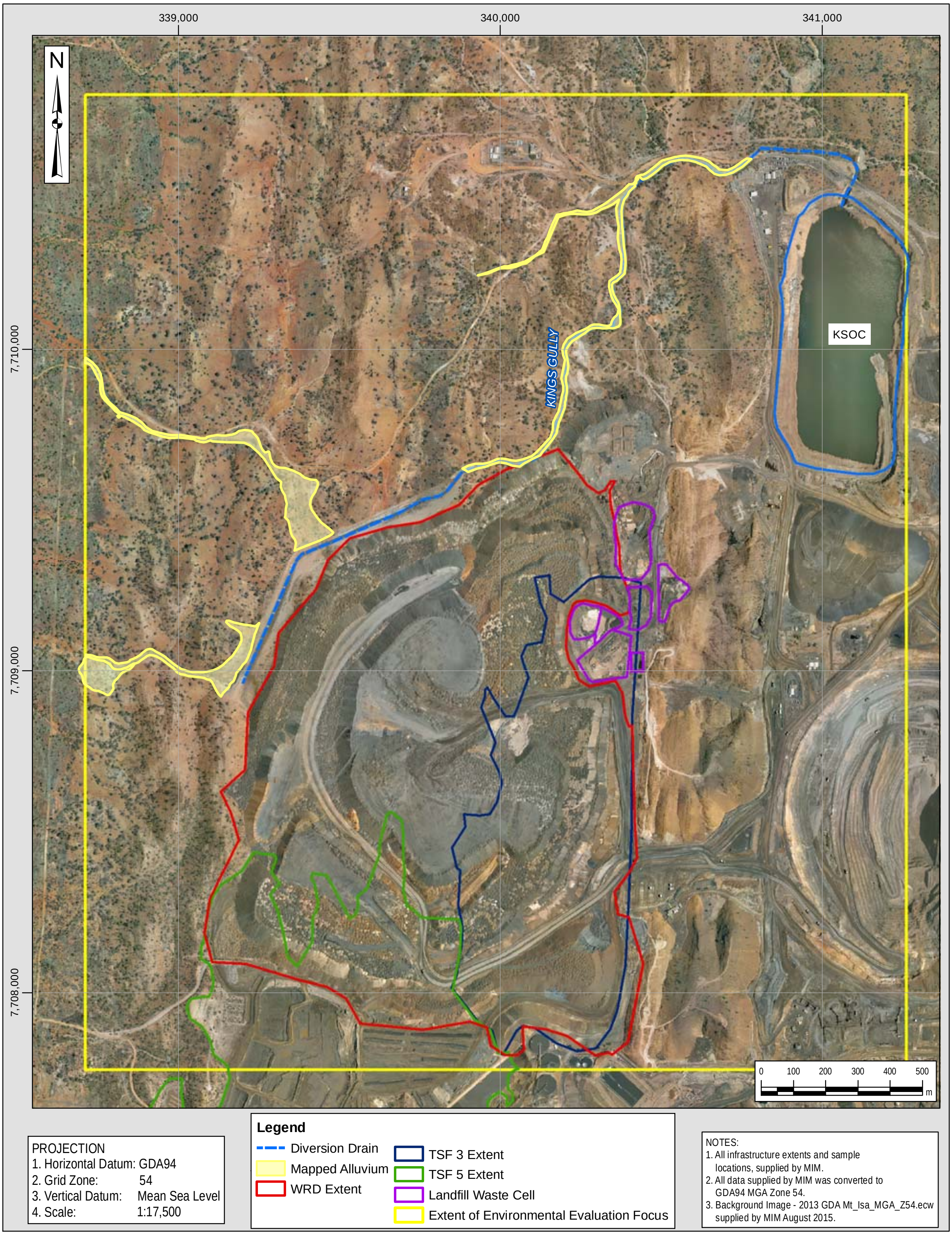

Figure 1: Location of Mapped Alluvium

2.3 Sample Collection

Water and soil samples were collected during the Phase 1 site investigation. The samples were dispatched to ALS Environmental Division in Brisbane for analysis. Certificates of analysis for the samples are presented in Appendix II, with further detail provided in the following sections.

2.3.1 Water Samples

Water samples were collected from nine locations across the focus area. Sample locations are shown in Figure 2 with location details and sample names provided in Table 1.

Table 1: Water Sample Location Details

Location Description	Sample ID	Easting	Northing
		m	*m*
BSOC South Toe	WRD_Sth_2	339224	7708902
BSOC WRD South Seepage	WRD_Sth_3	339214	7708859
	WRD_Sth_4	339245	7708923
BSOC WRD North Seepage (downstream)	WRD_Nth_1	339510	7709429
TD3 Seepage (upstream)	TD3_Sth_1	339884	7709620
	TD3_Sth_2	340050	7709641
TD3 seepage	TD3_Seepage	340115	7709666
Water pooling at confluence of Kings Gully and tributary	TD3_Nth_4	340356	7710456
Downstream of Dyno. Pool in alluvium	KG_DS_1	340572	7710599

The samples were analysed for the following parameters:

- Physico-chemical parameters: pH, EC (at 25°C).
- Major and minor ionic species: calcium, magnesium, sodium, potassium, sulphate as SO_4 (turbidimetric), chloride, fluoride, bromide, and total alkalinity (as $CaCO_3$).
- Dissolved metals and metalloids: aluminium, antimony, arsenic, bismuth, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, strontium, thorium, uranium, vanadium, and zinc.
- Dissolved non-metals: ammonia [as nitrogen (N)], nitrate (as N), total nitrogen (as N), and silica.

A summary of the location details, field water quality parameters and selected ions and metals is presented in Table 2.

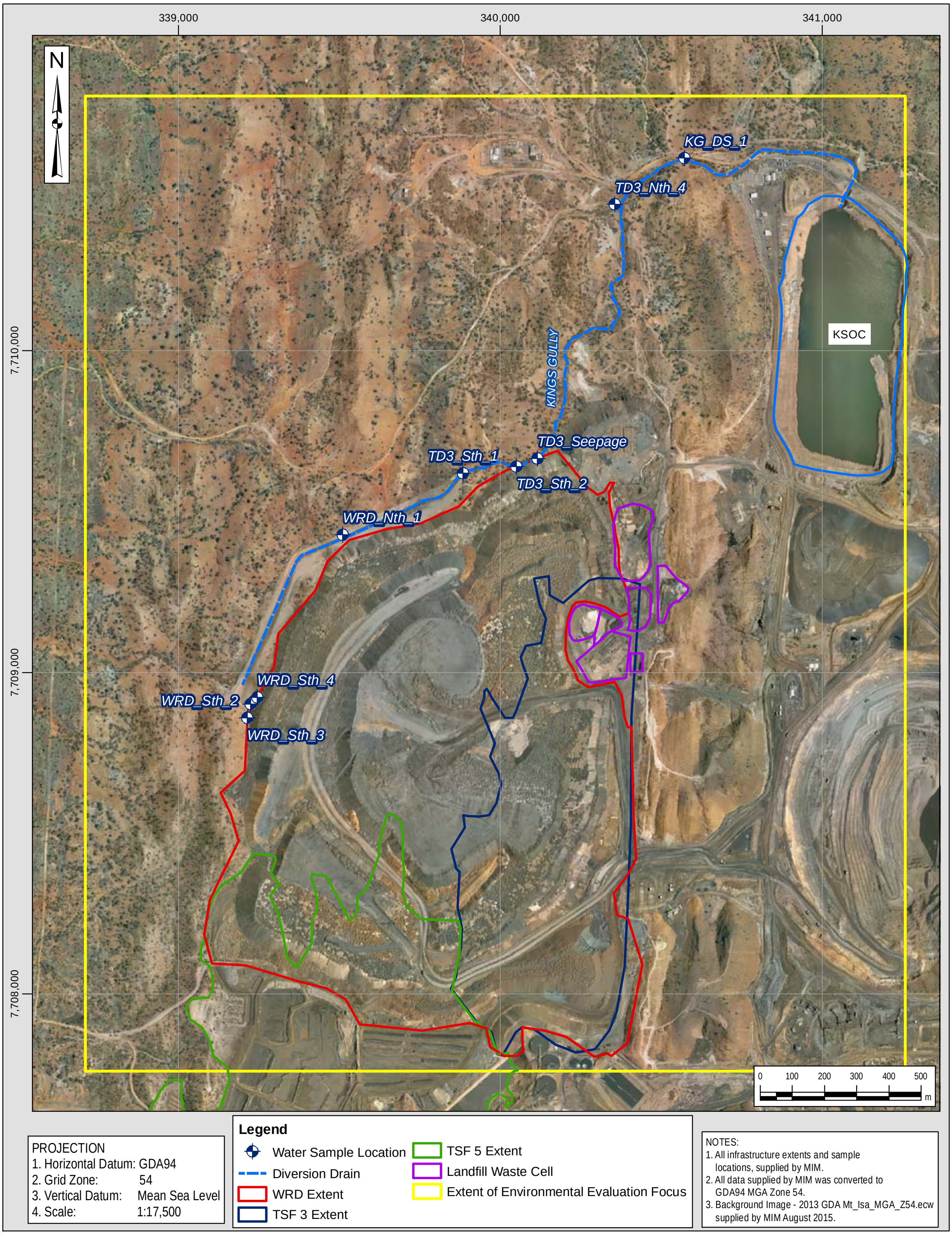

Figure 2: Phase 1 Water Sampling Locations

Table 2: Summary of Phase 1 Water Sample Results

Sample ID	Temp	pH	EC	SO_4	F	Al	As	Cd	Co	Cu	Pb	Ni	Zn
	°C	-	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
WRD_Sth_2	19.7	8.64	12,828	9,460	2.7	0.06	0.018	0.0026	0.002	0.158	0.03	0.002	0.245
WRD_Sth_3	28.1	8.24	7,099	3,130	5.7	0.18	0.003	0.0003	<0.001	0.018	0.008	<0.001	0.01
WRD_Sth_4	23.0	8.64	15,630	9,820	4.5	0.02	0.008	0.0018	0.002	0.048	<0.05	0.001	0.015
WRD_Nth_1	29.4	8.69	15,161	6,240	3.9	0.06	0.011	0.0017	<0.001	0.048	0.07	<0.001	0.032
TD3_Sth_1	29.5	8.80	5,535	1,130	1.8	0.02	0.003	0.0006	<0.001	0.032	0.009	<0.001	0.012
TD3_Sth_2	34.7	8.98	20,040	6,320	3.9	2.17	0.058	0.0048	0.007	0.825	0.272	0.005	0.476
TD3_Seepage	28.6	7.32	15,306	9,440	1.3	<0.05	<0.005	0.0426	0.007	0.019	<0.005	0.0045	9.57
TD3_Nth_4	19.0	8.42	24,339	16,700	2.4	<0.05	0.024	0.0035	<0.005	0.211	0.075	<0.005	0.092
KG_DS_1	23.8	9.24	8,924	900	6.2	0.05	0.054	0.0011	0.002	0.217	0.064	<0.001	0.031

Metals as total
Temperature, pH and EC measured in the field

2.3.2 Soil Samples

Details of the sample locations are provided in Table 3 and locations are shown on Figure 3. Analysis of the soil samples included the following parameters:

- Physico-chemical parameters: pH, EC (at 25°C), moisture content (dried at 103°C).
- Soluble major ionic species: calcium, magnesium, chloride, sodium, potassium, chloride, sulphate as SO_4.
- Total Metals: aluminium, boron, iron, arsenic, selenium, silver, barium, thallium, beryllium, cadmium, bismuth, cobalt, chromium, copper, thorium, manganese, strontium, molybdenum, nickel, lead, antimony, uranium, zinc, lithium, vanadium, tin.
- Nitrogen species: ammonia as N, nitrite as N, nitrate as N, total nitrogen as N, total Kjeldahl nitrogen.

A summary of the results for selected analytes are presented in Table 4, with full sample results provided in Appendix II.

Table 3: Description and Location Details of Soil Samples

Sample ID	Location Description	Easting	Northing
		m	*m*
WRD_Sth_Dn_1	Soil sample taken from alluvial tributary downstream of BSOC WRD South seepage, close to the MIM boundary	338681	7709026
WRD_Sth_Dn_2	Soil sample taken from alluvial tributary downstream of BSOC WRD South seepage	338860	7708992
WRD_Sth_Dn_3	Soil sample taken from alluvial tributary downstream of BSOC WRD South seepage, east of the diversion drain / south sump.	339110	7708943
WRD_Nth_Drain_2	Soil sample taken from alluvial tributary downstream of BSOC WRD North seepage. Precipitate was identified on the northern creek bed	339323	7709607
WRD_Nth_Drain_4	Soil sample taken from alluvial tributary downstream of BSOC WRD North seepage, close to the MIM boundary	338652	7709968
WRD_Nth_Drain_5	Soil sample taken from alluvial tributary downstream of BSOC WRD North seepage, upstream from confluence with main channel	339385	7709571
BSOC WRD Drain NW_1	Soil sample taken from northwestern side of the collection pit, adjacent to BSOC WRD North seepage	339428	7709405
KG_Clean_1	Soil sample taken from within the King Gully clean catchment. Location identified as an inferred fault / conduit	339951	7710240
KG_Clean_2	Soil sample taken from within the King Gully clean catchment. Location identified as an inferred fault / conduit	340117	7710303
KG_Clean_3	Soil sample taken from within the King Gully clean catchment, on the south side of King Gully. Location of weathered sediments in contact with coarse intrusive and alluvium	340117	7710295
KG_Clean_4	Soil sample taken from within the King Gully clean catchment, on the southern bank of alluvium with precipitate present	340190	7710393
KG_Clean_5	Soil sample taken from a notable precipitate zone, around 30m upstream of pool-confluence	340272	7710396
KG_Clean_6	Soil sample taken from within the King Gully clean catchment, sample with precipitate crust, located at confluence and pool	340345	7710410
Dyno_1	Soil sample taken from bedrock (schist, quartzite) / alluvial interface with precipitation, southeast of Dyno Nobel facility	340220	7710530

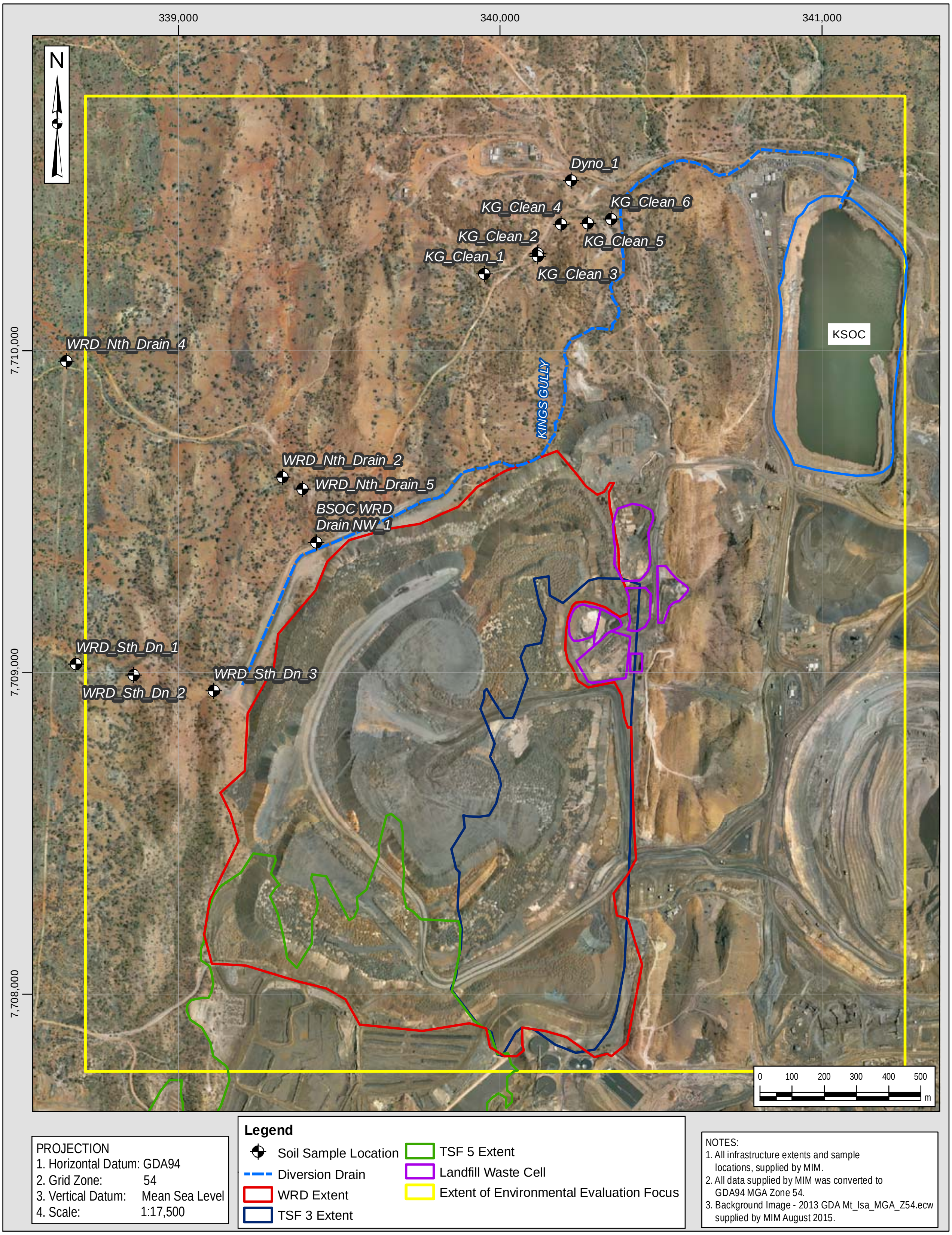

Figure 3: Phase 1 Soil Sampling Locations

Table 4: Summary of Phase 1 Soil Sample Location Details and Results

Sample ID	pH	EC	SO_4	Ca	Mg	Na	K	Cu	Pb	Zn
	-	*µS/cm*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
WRD_Sth_Dn_1	8.6	90	90	30	30	10	10	489	145	97.9
WRD_Sth_Dn_2	8.9	3,290	7,920	80	1,520	3,510	700	2,110	609	356
WRD_Sth_Dn_3	7.8	43,900	245,000	1660	33,600	63,800	7,160	400	635	813
WRD_Nth_Drain_2	9.4	14,300	55,000	700	6,840	15,200	430	222	104	103
WRD_Nth_Drain_4	8	79	120	40	60	90	20	241	102	80
WRD_Nth_Drain_5	8.5	168	270	90	30	40	10	373	138	119
BSOC WRD Drain NW_1	6.8	31,000	61,500	4,040	18,500	21,800	300	1,210	634	410
KG_Clean_1	9.3	97	190	60	30	50	10	261	82	69
KG_Clean_2	10.5	38,800	91,500	30	10	73,400	920	534	132	162
KG_Clean_3	10.2	7,430	17,600	160	190	10,300	320	443	149	144
KG_Clean_4	9.8	17,900	45,300	40	60	25,700	1,540	1,660	505	530
KG_Clean_5	9.8	6,730	17,200	580	490	7,740	130	364	142	146
KG_Clean_6	9.2	24,100	91,700	2,420	8,300	27,300	1,170	495	173	145
Dyno_1	9.9	28,800	44,000	30	10	53,600	1,530	438	137	113

2.3.3 MIM Landfill and Sludge Pits

The landfill and sludge pits were visited on August 24, 2015. Figure 4 shows the location of the landfill and sludge pits and selected photographs from this location.

Water samples were collected from both sludge pits. Certificate of analysis for these samples are presented in Appendix II, with a summary of selected parameters provided in Table 5.

Table 5: Summary of Sludge Pit Sample Results

Analyte	pH	EC	SO_4	F	Al	As	Cd	Co	Cu	Pb	Ni	Zn
Unit	pH units	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sludge Pit 1	9.03	28,700	13,400	3.3	0.11	1.45	0.15	0.027	0.187	1.12	0.124	0.607
Sludge Pit 2	5.43	4,650	2,540	6.3	2.59	0.858	2.66	0.568	44.2	3.51	0.446	15.3

Metals as total
EC and pH – lab values

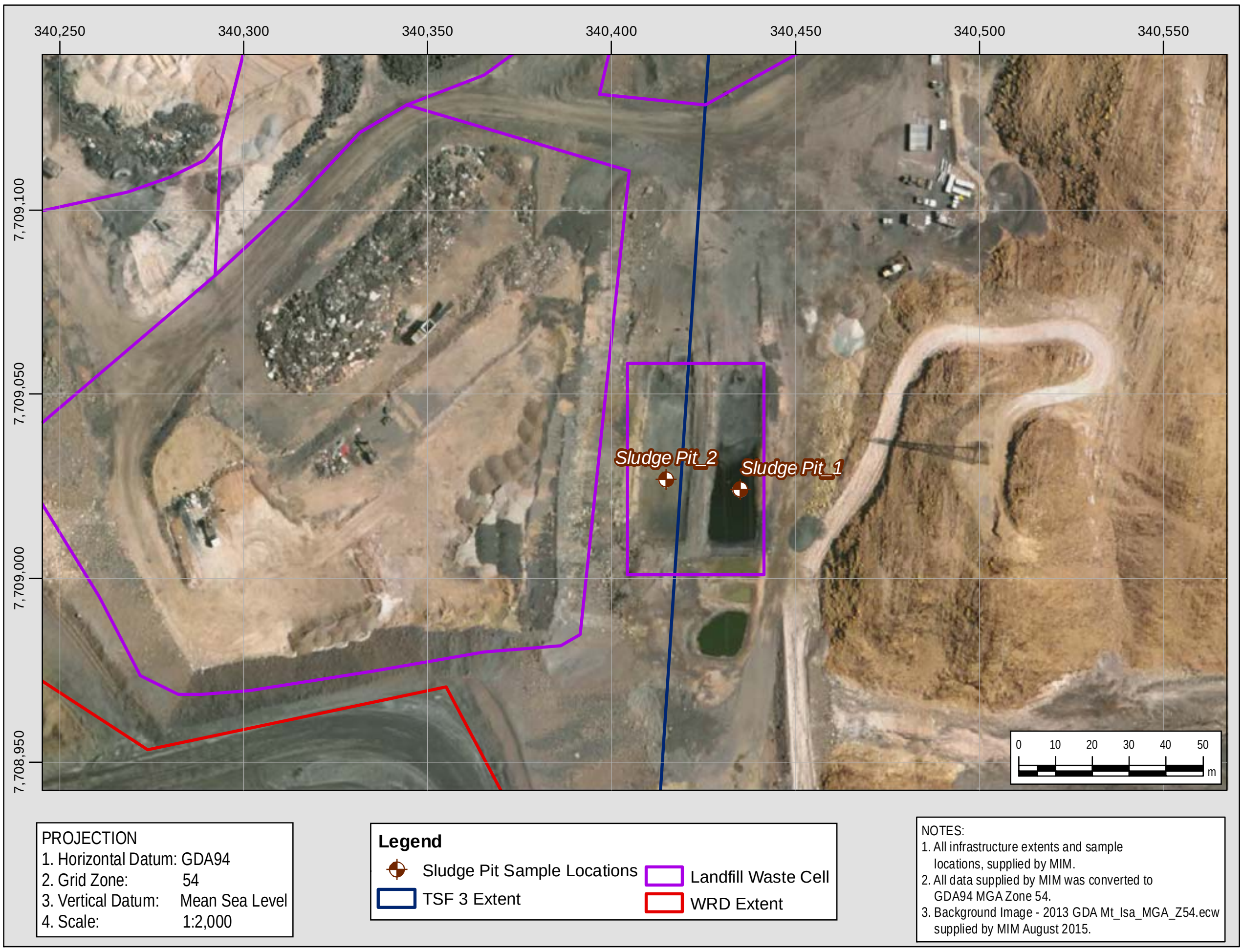

Figure 4: Landfill and Sludge Pit Locations

3 PHASE 2 SITE INVESTIGATION

3.1 Overview

The Phase 2 site investigation was completed between December 7, and December 22, 2015 by KCB Hydrogeologists. Additional components were conducted in January and February, 2016 by MIM personnel. The Phase 2 site investigation comprised the following:

- Drilling and construction of six bedrock monitoring bores;
- Packer testing of the bedrock bores, with two to three tests conducted per hole;
- Drilling and construction of five alluvial monitoring bores located within the creek beds;
- Development of the 11 new bores (conducted by MIM personnel);
- Hydaulic testing of existing monitoring bores (conducted by MIM personnel);
- Groundwater sampling of the new monitoring bores (conducted by MIM personnel); and,
- Infiltration testing on the WRD.

The following sections provide details and results of each of the Phase 2 site investigation components.

3.2 Drilling Program

3.2.1 Drilling Target Selection

The drilling targets were selected based on the conceptual understanding of the site developed during the data gap assessment (KCB, 2016) and the findings from the Phase 1 site investigation as described previously. Table 6 provides details of the rationale for each of the drilling targets with their final locations shown Figure 5.

Table 6: Drilling Target Rationale

Target Formation	Bore ID	Rationale
Alluvium	BSOC_A1	To investigate seepage movement through the alluvial associated with BSOC WRD South Seepage and the diversion drain
	BSOC_A2	To investigate seepage movement through the alluvial associated with BSOC WRD South Seepage and the diversion drain
	BSOC_A3	To investigate seepage movement through the alluvial associated with BSOC WRD North Seepage and the diversion drain
	BSOC_A4	To investigate seepage movement through the alluvial associated with BSOC WRD North Seepage and the diversion drain
	BSOC_A5	To investigate seepage movement through the alluvial associated with TD3 Seepage, downstream of King Gully Dam
Bedrock	BSOC_B1	To investigate seepage movement through the bedrock associated with BSOC WRD South Seepage
	BSOC_B2	To investigate seepage movement through the bedrock associated with BSOC WRD North Seepage
	BSOC_B3	To investigate seepage movement through the bedrock associated with BSOC WRD North Seepage
	BSOC_B4	To investigate seepage movement through the bedrock associated with BSOC WRD North Seepage
	BSOC_B5	To investigate seepage movement through the bedrock associated with TD3 Seepage
	BSOC_B6	To investigate seepage movement through the bedrock and possible fault structure

Figure 5: BSOC EE Bore Drilling Locations

3.2.2 Drilling and Construction

The drilling program was completed between December 10, and December 20, 2015 by Tulla Drilling, under the supervision of a KCB Hydrogeologist. Location, drilling and construction details are presented in Table 7.

Table 7: Location and Completion Details for Monitoring Bores

Target Formation	Bore ID	GDA94 MGA Zone 54*		Ground Elevation* (mAHD)	Stick up (m)	Drilled Depth (mbGL)	Water Strike (mbGL)	Screened Interval (mbGL)	Screened Geology
		Easting (m)	Northing (m)						
Alluvium	BSOC_A1	338873	7709022	368	0.94	4	-	1.3 to 2.8	Alluvium, clayey gravel
	BSOC_A2	339122	7708981	375	0.70	10	7	3.6 to 9.6	Alluvium, silty gravel
	BSOC_A3	339373	7709550	378	0.94	5.5	-	0.8 to 2.8	Alluvium, clayey gravel
	BSOC_A4	338990	7709729	366	0.84	5.0	-	0.7 to 1.7	Alluvium, gravel and sand
	BSOC_A5	340475	7710561	362	0.85	5.0	-	0.5 to 1.5	Alluvium, gravel and sand
Bedrock	BSOC_B1	339153	7708920	384	0.75	29.2	9	11.0 to 29.0	Metasediments, fresh, fractured
	BSOC_B2	339177	7709783	388	1.06	26.2	9	7.8 to 25.8	Metasediments, fresh, fractured
	BSOC_B3	339446	7709681	381	0.29	35.3	20	17.2 to 35.2	Metasediments, fresh, fractured
	BSOC_B4	339676	7709695	386	1.11	36.3	20	18.3 to 36.3	Metasediments, fresh, fractured
	BSOC_B5	340255	7710381	367	1.07	35.0	14	14.3 to 32.3	Metasediments, fresh, fractured
	BSOC_B6	340189	7710685	369	0.75	72.0	42	37.0 to 55.0	Metasediments, fresh, fractured

* Bores surveyed using MIM handheld GPS.

Drilling was performed using a Verasdrill rig (TD05) using a 123mm hammer bit, with the exception of BSOC_B4, which was drilled using a poly-crystalline diamond (PCD) drill bit. Drilling cuttings were returned to the surface using air circulation, with the addition of water[1] to BSOC_B3 and BSOC_B2 to aid removal of the drill cuttings.

The final depth of the drill hole was determined based on the first water strike interval with an additional 18m of drilling to allow for installation of the slotted screen over the water inflow zones. Cuttings were collected and logged at 1m intervals. Photographs of drill cuttings are included in Appendix IV, with geological logs and detailed bore schematics provided in Appendix III.

Bores were constructed with 50 mm uPVC Class 12 threaded plain casing and 1mm aperture machine slotted casing. A gravel pack was installed adjacent to the screens and a bentonite seal placed on top. Backfill was then installed to ~6mbGL and a cement grout to surface. Protective bore monuments and a 2m x 2m plinth for each site were also constructed. All bores were

[1] Water was sourced from the Dyno Nobel facility. Water Quality was 26.8°C, 453µS/cm and 8.37pH

constructed in accordance to the 'Minimum Construction Requirements for Water Bores in Australia' (NUDLC, 2012).

3.2.3 Airlift Development

Airlift development was completed by MIM personnel on January 14 and January 15, 2016. The development procedure involved delivering compressed air into each bore via a HDPE hose, allowing air / water to be lifted and directed away from the bore. Field water quality parameters (pH, EC, temperature, DO, ORP) were recorded during the development process. Development was determined to be complete once the field water quality readings had stabilised over at least a five minute interval and the fines content had significantly reduced.

A summary of the final water quality parameters is provided in Table 8, with full development records provided in Appendix V.

Table 8: Summary of Airlift Development

Bore ID	Approximate Volume Removed (L)	Field Water Quality Parameters			Observations at Completion of Airlifting
		EC (µS/cm)	pH	Temperature (°C)	
BSOC_A1	21	3,005	9.02	27.2	-
BSOC_A2	720	10,667	8.12	28.9	Light brown, sandy colour, not many fines
BSOC_A3	42	4,745	8.76	26.7	Milky, sandy colour, no fines
BSOC_A4	4	2,918	8.60	26.5	Coffee coloured, not many fines
BSOC_A5	28	16,173	8.29	28.7	Sandy / grey colour, not many fines
BSOC_B1	1,800	4,430	8.18	29.8	Clean and clear
BSOC_B2	1,320	1,315	7.58	29.5	Clear water, no fines
BSOC_B3	300	3,469	8.44	29.4	Light grey colour, not many fines
BSOC_B4	172	1,334	8.77	30.0	Grey colour, not many fines
BSOC_B5	1,300	5,685	8.22	30.0	Light grey colour, no fines
BSOC_B6	321	6,117	9.05	29.6	Grey, brown colour, not many fines

3.2.4 Groundwater and Seepage Sampling

Following completion of airlift development, groundwater samples were collected by MIM personnel from the new monitoring bores and dispatched under chain of custody protocol to ALS for analysis. A summary of the field water quality parameters and results of the sample analysis are presented in Table 9. Samples were also collected from BSOC WRD South Seepage and TD3 Seepage. BSOC WRD North Seepage was not flowing at the time of sample collection.

Isotope sampling was also carried out on the new monitoring bores, seepage locations and selected existing monitoring bores.

The samples were collected and sent to the University of Queensland for analysis for hydrogen (^{1}H and Deuterium) and Oxygen ($^{16}O/^{18}O$), and sulphur isotope ^{34}S. At the time of this report issue, sample results were still pending and will be discussed in detail in the Task 7 report.

Table 9: Summary of Phase 2 Groundwater and Seepage Sampling Results

Sample Type	Sample ID	Date Sampled	Field Parameters*			Laboratory Results									
			Temp	pH	EC	SO_4	F	Al	As	Cd	Co	Cu	Pb	Ni	Zn
	Unit			-	*µS/cm*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
Groundwater	BSOC_A1	19/1/16	32.9	8.66	3,933	576	2.3	0.9	0.003	<0.0001	<0.001	0.005	<0.001	<0.001	<0.005
	BSOC_A2	19/1/16	29.4	7.18	12,753	5,580	6.4	2.20	0.002	<0.0001	<0.001	0.005	0.002	0.002	0.006
	BSOC_A3	21/1/16	33.7	8.23	5,830	727	3.4	25.8	0.007	<0.0001	<0.001	0.049	0.002	<0.001	<0.005
	BSOC_A4	Dry	-	-	-	-	-	-	-	-	-	-	-	-	-
	BSOC_A5	19/1/16	34.8	7.39	16,048	4,870	5.1	18.5	0.014	0.0001	0.004	0.002	0.002	0.003	0.015
	BSOC_B1	20/1/15	30.7	7.28	5,372	1,760	5.3	1.51	<0.001	<0.0001	<0.001	0.001	<0.001	<0.001	0.007
	BSOC_B2	20/1/15	30.1	6.93	1,346	152	1.8	0.35	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.006
	BSOC_B3	20/1/15	30.0	7.13	3,926	182	5.3	0.39	<0.001	<0.0001	<0.001	0.005	0.004	<0.001	0.022
	BSOC_B4	21/1/16	36.7	8.33	3,699	320	4.1	0.68	0.010	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005
	BSOC_B5	20/1/16	30.6	7.13	6,364	1,410	6.1	0.35	0.011	<0.0001	<0.001	<0.001	<0.001	<0.001	0.006
	BSOC_B6	21/1/16	35.0	8.79	6,224	413	4.7	4.15	0.012	<0.0001	<0.001	0.038	0.004	0.001	0.005
Seepage	BSOC WRD South Sump	25/1/16	32.2	8.57	18,600	11,900	3.9	0.1	0.092	<0.0001	0.002	0.067	0.004	0.002	0.008
	BSOC WRD South Seepage	25/1/16	30.8	8.31	12,000	8,030	4.6	0.12	0.005	0.0011	0.002	0.051	0.019	0.002	0.036
	TD3 Seepage	25/1/16	28.3	7.76	11,900	8,720	1.4	0.03	0.002	0.0344	0.002	0.026	0.009	0.036	7.59
	TD5 Pit	29/1/16	-	8.38	15,700	7,920	5.3	0.07	0.02	0.0011	0.046	0.034	0.039	0.013	0.126

*Seepage Samples – EC / pH laboratory values
Metal as total

3.2.5 Groundwater Levels

Groundwater levels were collected from the new bores by MIM personnel before groundwater sampling took place between January 19 and 21, 2016 and are presented in Table 10.

Table 10: BSOC EE and Existing Bores - Groundwater Levels

Bore ID	Easting	Northing	Ground Elevation (Lidar) (mAHD)	Stick-up (m)	Groundwater Levels			
					19-21 January 2016		27 January 2016	
					mbGL	mAHD (Lidar)	mbGL	mAHD (Lidar)
Bore 23	340150	7709794	368.54	0.95	-	-	1.44	367.10
Bore 24	340152	7709805	368.38	0.95	-	-	1.38	367.00
Bore 27	341033	7710520	357.07	0.72	-	-	11.06	346.01
Bore 29	341032	7710642	351.98	0.73	-	-	4.71	347.27
Bore 36	338325	7705939	377.94	0.54	-	-	4.71	373.23
Bore 37	338469	7706973	380.09	0.57	-	-	8.43	371.66
Bore 38	338467	7707626	370.86	0.56	-	-	4.51	366.35
Bore 39	338605	7709065	366.95	0.57	-	-	4.85	362.10
Bore 40	338940	7709746	368.33	0.48	-	-	5.43	362.90
Bore 4A	338035	7707765	366.75	0.17	-	-	6.14	360.61
S2 / MIOP01	340279	7710441	360.20	0.44	-	-	1.63	358.57
S3	338118	7707757	367.11	0.44	-	-	6.11	361.00
S8	338684	7709024	367.94	0.80	-	-	6.2	361.74
MIOP02	338847	7710387	367.76	0.74	-	-	11.91	355.85
MIOP03	338517	7710037	365.58	0.73	-	-	12.54	353.04
BSOC_A1	338873	7709022	371.38	0.94	0.81	370.57	0.87	370.51
BSOC_A2	339122	7708981	375.02	0.70	2.00	373.02	1.35	373.67
BSOC_A3	339373	7709550	374.23	0.94	2.37	371.86	2.41	371.82
BSOC_A4	338990	7709729	368.14	0.84	Dry	Dry	1.8	366.34
BSOC_A5	340475	7710561	356.72	0.85	0.74	355.98	0.69	356.03
BSOC_B1	339153	7708920	380.38	0.75	5.82	374.56	5.87	374.51
BSOC_B2	339177	7709783	375.77	1.06	6.62	369.15	5.59	370.18
BSOC_B3	339446	7709681	379.06	0.29	4.93	374.13	4.83	374.23
BSOC_B4	339676	7709695	385.43	1.11	11.24	374.19	11.07	374.36
BSOC_B5	340255	7710381	363.83	1.07	5.69	358.14	4.99	358.84
BSOC_B6	340189	7710685	366.31	0.75	7.18	359.13	7.13	359.18

Groundwater levels were also collected across all new and existing bores within the vicinity of the WRD on January 27, 2016 by MIM personnel. These levels are also shown in the table and presented spatially on Figure 6.

It should be noted that the ground elevation presented in the table and referenced for groundwater elevations has been extracted from the MIM Lidar (2010) surface. This elevation was selected to maintain consistency across all bores[2] and for use in future tasks for this project.

[2] Elevations on existing bore logs may contain errors or are presented using an alternative height datum.

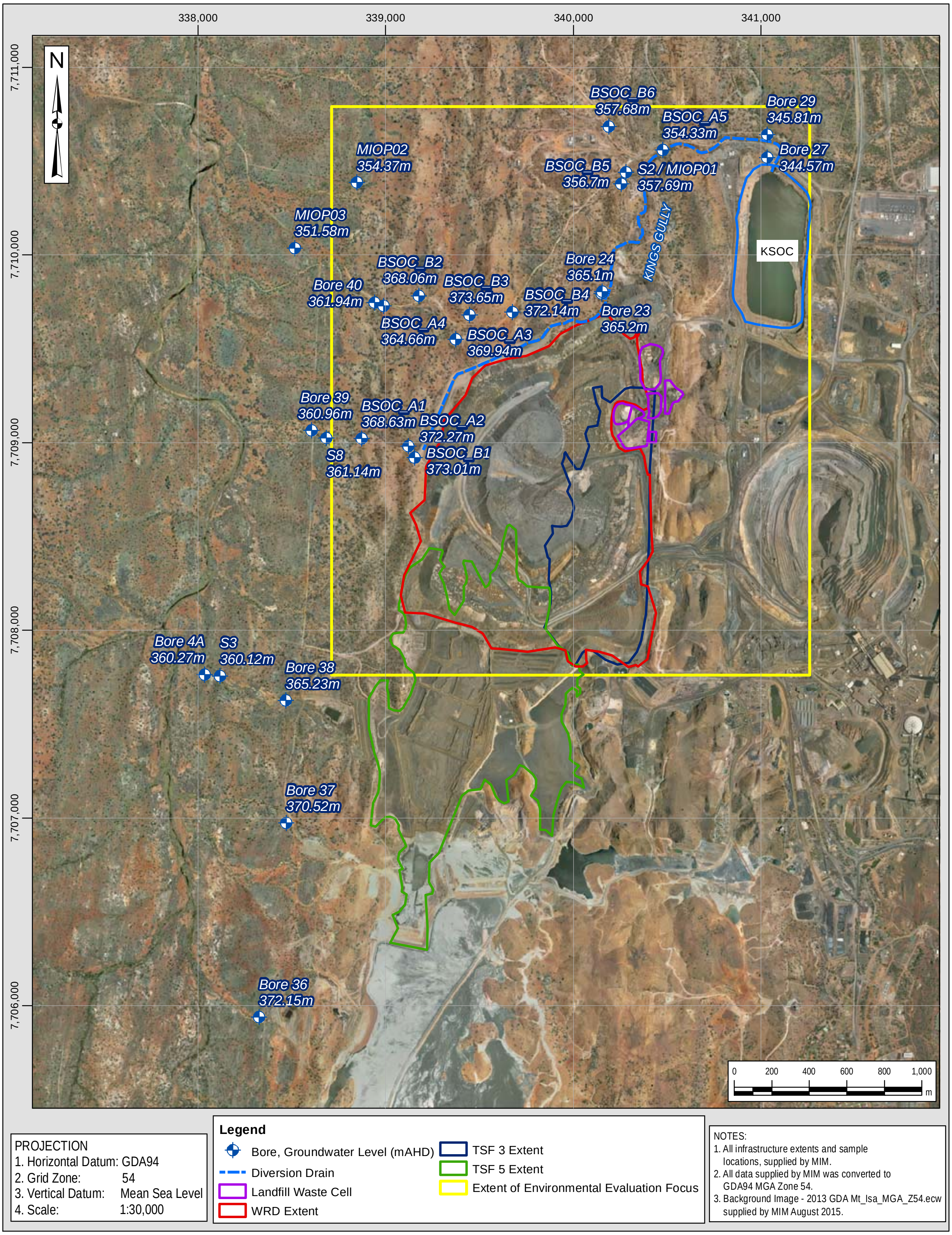

Figure 6: Groundwater Levels (January 2016)

3.3 Permeability Testing - Packer Testing

3.3.1 Overview

Borehole packers are designed to enable permeability testing in open holes and/or discrete test sections. Inflatable packers are used to seal off (isolate) the desired section of the hole prior to testing. To carry out the test, drill rods are inserted to the selected depth and packers sit beneath the drill rods. The packers are used to seal off an open section of the hole for testing and inflated using nitrogen gas. Once the packers are inflated and the selected interval isolated, hydraulic testing is undertaken by injecting water into the formation under constant pressure, with a measurement of the average stabilised flow rate (or water consumption) at the test pressure. This is repeated at a number of different pressure steps to measure the formation response at different pressures (Lugeon Tests). The resulting data are used to calculate a transmissivity of the test interval and consequently the hydraulic conductivity of the formation.

For this program a wireline straddle packer system (hired from AGE Developments Pty) was used. Drill rods of HWT size were installed in the hole, with a PQ size packer system. Water was injected into a 2 m section of the drill hole at three ascending pressure steps and two descending pressure steps.

Testing was undertaken on five of the bedrock bores, with two or three tests carried out per hole. Testing was not completed on BSOC_B6 due to problems with the packer equipment. The testing intervals were selected based on the drill cuttings and airlift yields or water inflow zones identified during drilling. A summary of the tests and results for each bores are provided in the following sections, with the full results for each hole presented in Appendix VI.

3.3.2 Data Evaluation

The following section provides some information relating to the data evaluation of packer tests:

- ***Lugeon Value Calculation and Interpretation:*** Lugeon values for each time step were calculated using the method of Houlsby (1976). Houlsby presents a method for calculating and interpreting Lugeon values based on 811 actual field tests. The method involves calculation of individual values at a range of five ascending and descending pressure steps. The magnitude of the Lugeon value defines a Lugeon pattern that can be interpreted as representing one of five flow regimes: Laminar, Turbulent, Dilation, Washout and Void Filling.
- ***Flow versus Pressure Curves*** are generated by plotting the recorded average flow for each pressure step versus pressure over time. The shape of these curves can provide information about the hydraulic system of the test interval.
- ***Hydraulic Conductivity:*** Bulk rock mass permeability has been estimated using solutions by Houslby (1976) and Thiem (1906). The Thiem method is a steady state solution which is recommended by the United States Bureau of Reclamation (USBOR) “Earth Manual” (1965). The Thiem solution requires estimation of the test radius of influence (R). The USBOR method in common use assumes that R = the length of the test interval, and uses the term ‘L’ to represent both the length of the test interval and the radius of influence. This assumption has been adopted for calculation of hydraulic conductivity using the Thiem method.

3.3.3 Testing and Results

A summary of the bore specific testing and an estimate of the average hydraulic conductivity for each testing interval are presented in Table 11. The table includes each interval tested and a description of the interval. Full results for each test are presented in Appendix VI.

Table 11: Summary of Packer Testing Intervals and Average Hydraulic Conductivity

Bore ID	Test Interval Depth (mbGL)	Interval Description	Average Hydraulic Conductivity (m/d)	
			Thiem (1906)	Houlsby (1976)
BSOC_B1	12.9 to 14.9	Water inflow zone, with yield increase observed during drilling at ~14m	0.32	0.25
	22.9 to 24.9	Fresh bedrock, with little or no fracture evidence	0.006	0.005
BSOC_B2	7.9 to 9.9	First water strike, less than 0.2 L/s. Meta-sediments, moderately weathered, strong evidence of water contact	1.58	1.23
	13.9 to 15.9	Increase in yield observed at this depth and continuous flow from airlift sustained	1.3	1.01
	20.9 to 22.9	Quartzite with potential matrix flow and an increase in yield to 1.6 L/s observed during airlifting.	0.04	0.03
BSOC_B3	19.9 to 21.9	First water strike interval	0.09	0.07
	24.4 to 26.4	Fresh bedrock with limited fracturing	0.003	0.002
BSOC_B4	18.9 to 20.9	First water strike interval	0.21	0.16
	27.2 to 29.2	Fresh bedrock with evidence of fracturing	0.001	0.001
	32.2 to 34.2	Fresh bedrock, with schist (very weak) layers. No evidence of fracturing or matrix flow	0.004	0.003
BSOC_B5	12.8 to 14.8	First water strike interval	0.12	0.08
	18.9 to 20.9	Fresh rock with no evidence of fracturing	0.004	0.003
	28.7 to 30.7	Significant water inflow zone identified during drilling at ~30m.	0.68	0.53

3.4 In-situ Permeability Testing

Hydraulic (slug) testing was completed on existing MIM monitoring bores by MIM personnel between 2 February and 25 February, 2016, to provide estimates of hydraulic conductivity. The location of the bores tested are presented in Figure 7.

A slug of known volume was either added to the monitoring bore (falling head test) or removed from the bore (rising head test), and the change in water level was measured using a pressure transducer data logger (PTDL) until the water level had recovered to at least 95% of the original level. Where high to moderate conductivity was observed, three sets of falling head / rising head tests were completed per monitoring bore to provide multiple data sets to assess for consistency in testing responses. If the recovery period was slow, one test was completed.

The raw data for each falling head test and rising head test was plotted as pressure head versus time. The raw data was then converted to deviation from static (or displacement) versus time. A normalised deviation plot is then created by dividing deviation from static by the maximum displacement.

The normalised head versus time plots were reviewed to determine if there were any issues apparent with the tests[3]. Theoretical examples of common issues to look out for in the normalised head plots include non-instantaneous introduction of the slug (which needs to be corrected), removal of the data logger during the test and a lack of coincidence in repeat tests indicating insufficient development of the well.

Hydraulic conductivity values were calculated using AQTESOLV Pro v4.5 software. Analytical solutions were selected based on underlying analytical assumptions, specific well conditions, and groundwater level responses (Butler, 1998). Estimates of hydraulic conductivity are summarised in Table 12 with interpretations obtained from the AQTESOLV Pro v4.5 software included in Appendix VII.

The majority of tests were analysed using the Bouwer and Rice (1976), KGS Model (Hyder et al., 1994) methods and Hvorslev (1951). If bores are screened across the water table these required additional compensation to account for the effective screened interval using Bouwer and Rice (1976) as described in Butler (1998).

Table 12: Estimates of Hydraulic Conductivity

Bore ID	Screened Interval (mbGL)	Assumed Geology	Hydrostratigraphic Type	Analysis Method	Average Hydraulic Conductivity (m/d)
BSOC_B6	37.0 to 55.0	Bedrock	Confined	KGS Model	0.0006
Bore 23	4.0 to 8.0	Weathered Bedrock	Unconfined	KGS Model	2.0
Bore 24	40.0 to 58.0	Bedrock	Confined	Hvorslev	0.07
Bore 38	29.0 to 37.0	Bedrock	Confined	Hvorslev	0.0006
Bore 39	18.5 to 24.5	Bedrock	Confined	KGS Model	2.4
Bore 40	19.0 to 25.0	Bedrock	Confined	KGS Model	2.0
Bore 4A	10.0 to 47.5	Bedrock	Confined	KGS Model	0.03
MIOP01/S2	2.5 to 5.5	Weathered Bedrock	Unconfined	Bouwer and Rice, corrected	0.04
MIOP02	10.0 to 15.0	Weathered Bedrock	Unconfined	Bouwer and Rice, corrected	0.1
S3	11.0 to 14.0	Weathered Bedrock	Confined	KGS Model	0.1
S7	8.0 to 13.0	Weathered Bedrock	Confined	Hvorslev	0.6
S8	11.0 to 14.0	Bedrock	Confined	KGS Model	0.003

[3] Tests were conducted for MIOP3 and BSOC_A5, however results were unsuitable for analysis

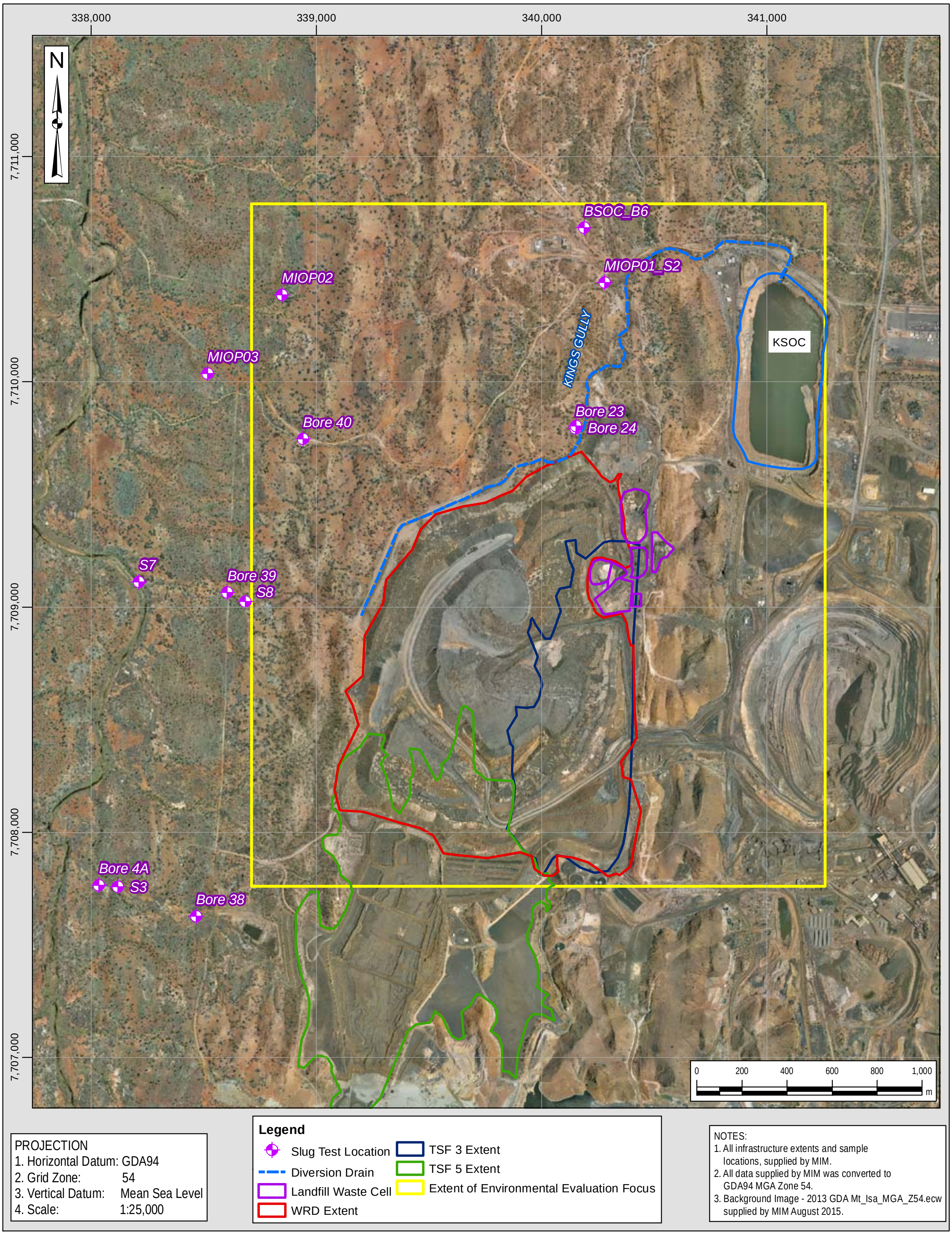

Figure 7: Location of In-situ Permeability Testing

3.5 WRD Infiltration Testing

Infiltration testing on the WRD surface was planned to be completed using a ‘soakaway’ style test to estimate the rate of infiltration. A test was attempted in the centre of the WRD (see Figure 8), however, the rate of infiltration was greater than the rate of filling from the water truck (150 L/min) and the test was abandoned.

Observational evidence was collected across the WRD surface to assess potential areas where the rate of infiltration may vary. Figure 8 presents the location of where the information was collected, with photographs presented in Appendix IX. Some observations relating to the observational evidence include:

- The size range of waste rock at the location of the trial test pit are highly variable, with rocks observed greater than 10 cm on the surface (photograph IX-2)
- A surface test was carried out on a highly trafficked area, shown in photographs IX-3, IX-4 and IX-5. Water pooled on the surface for longer than the test pit and generally the size of the rocks in this area is no greater than 2 cm and appears compacted.
- Heavy metals rejects (HMR) is also deposited on the waste rock dump surface. The rock size in this area is relatively uniform and no greater than 3 cm, with little or no compaction observed.
- Photograph IX-7 shows a highly compacted area of the WRD, located within a trafficked section. The photograph shows the size range of waste rock as being between 1 cm and 5 cm and shows evidence of precipitation. Silt sized particles were also present as a result of erosion and compaction of the rock.
- In general, the surface of the WRD had a range of waste rock sizes, with compaction limited to areas of traffic flow.
- Information from site personnel also indicated that during / after a rain event, there was no ponding of water on the WRD surface.

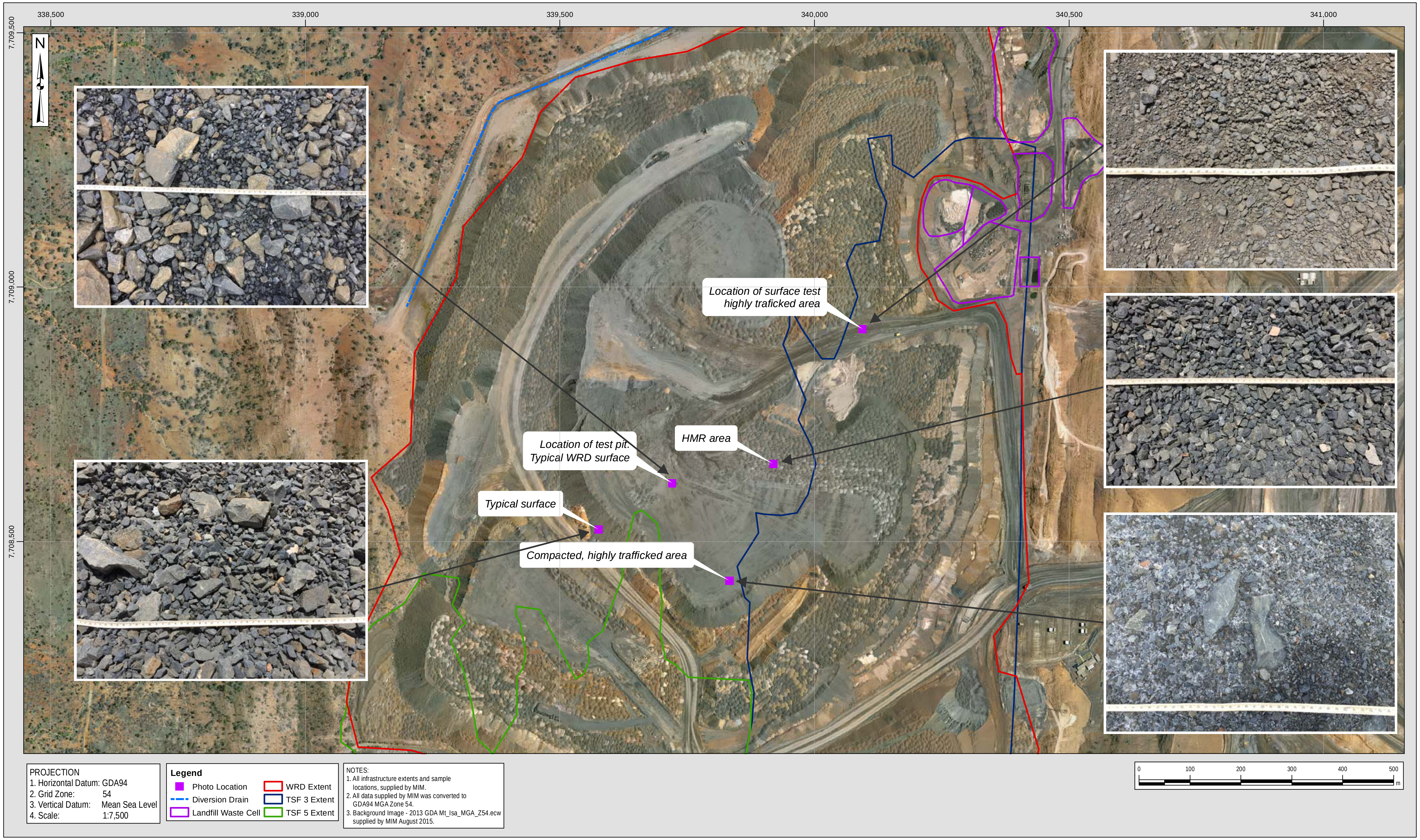

Figure 8: Location of WRD Infiltration Testing and Selected Photographs

4 CLOSING

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APPENDIX I

Phase 1 Site Investigation Photographs

APPENDIX II

Phase 1 Soil and Water Sampling Results

APPENDIX III

BSOC EE Bores - Geological Logs

APPENDIX IV

BSOC EE Bores – Drill Cutting Photographs

APPENDIX V

BSOC EE Bores – Development Records

APPENDIX VI

BSOC EE Bores – Packer Testing Records and Results

APPENDIX VII

Slug Testing Results and Analysis (Existing Bores)

APPENDIX VIII

Phase 2 Groundwater and Seepage Sampling Results

APPENDIX IX

Waste Rock Dump Photographs